Preview - Information

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Workbook Preview

Grade 8 Science Unit
Energy

Strands A - D		
	Curriculum Outcomes	**Pages**
SCI.8.A (Strand A)	Demonstrate an understanding of different First Nations, Métis, and Inuit ways of knowing, being, and doing in relationship with the land and the natural world by exploring Indigenous methods of observing and interpreting the world, applying scientific principles, and creating technologies within local traditional and contemporary cultural contexts (e.g., wholistic, reciprocal, interconnected, and sustainable ways; land-based learning; outdoor learning; intersections with Western science).	52–54, 64–69, 78–80, 92–101
SCI.8.B (Strand B)	Develop a sense of agency, identity, and belonging in science by • cultivating natural curiosity about the world • acquiring scientific skills and fostering scientific attitudes	6–8, 12–17, 24–26, 30–32, 36–38, 46, 48, [illegible] 51–63, 81–83, 110
SCI.8. (Strand		17–29, 42–45, 58–60, 84–87, 104, 113
SCI.8.D (Strand D)	**Purpose**: Science is about finding the cause or causes of phenomena in the natural world. **Method**: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time. **Application**: The knowledge produced by science is used in engineering and technologies to create products and processes. **Implication**: Applications of science often have ethical, environmental, social, economic, and political implications.	9–11, 39–41

Preview of 80 pages from this product that contains 162 pages total.

Strand E – Scientific Knowledge		
	Curriculum Outcomes	**Pages**
SCI.8.E.8	Demonstrate an understanding of the nature of solar radiation. Include the following: electromagnetic waves, visible light, solar spectrum.	6–14, 24–29, 70–77, 81–104, 108–110
SCI.8.E.9	Demonstrate an understanding of types of electromagnetic radiation with respect to relative energy, frequency, wavelength, and applications. Examples: photosynthesis, visible light, x-rays, microwaves, radio waves, infrared, ultraviolet (UV), Sun safety, mutation.	15–23, 30–69, 78–80, 88–91, 105–107, 111–113

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Name: _____

ENERGY

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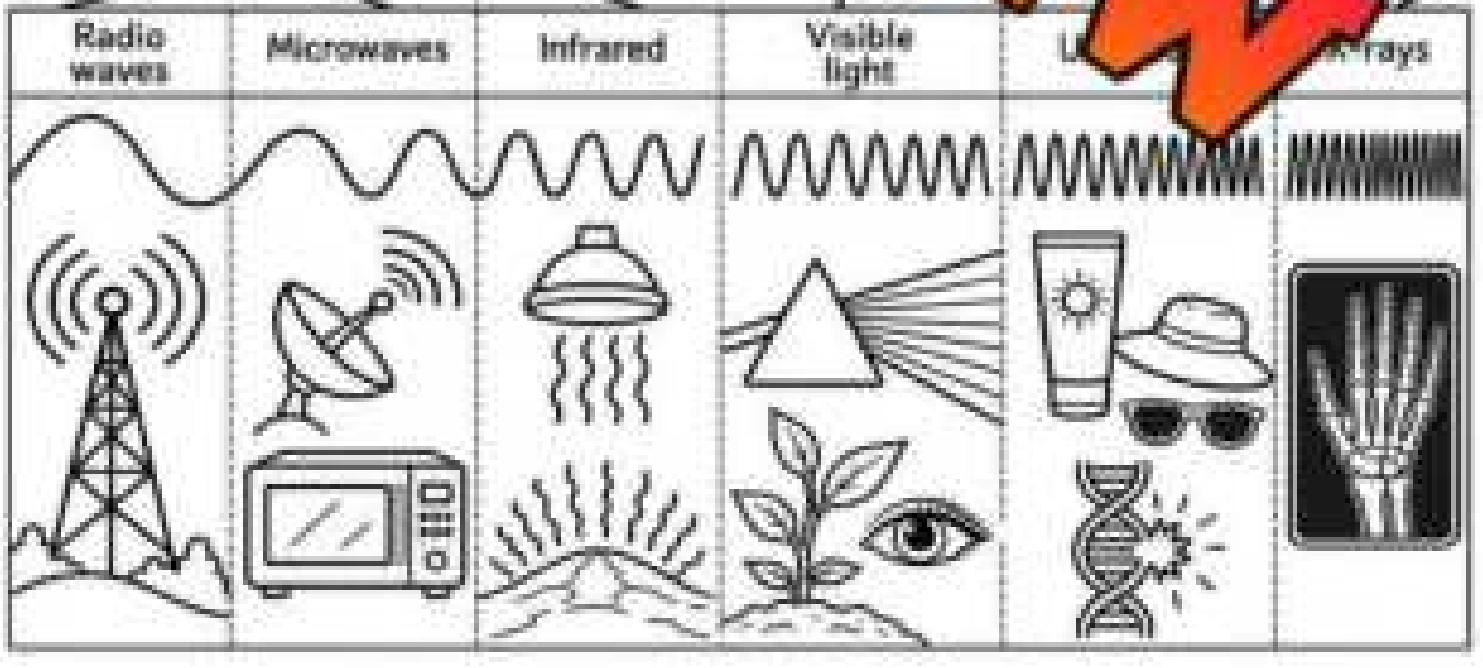

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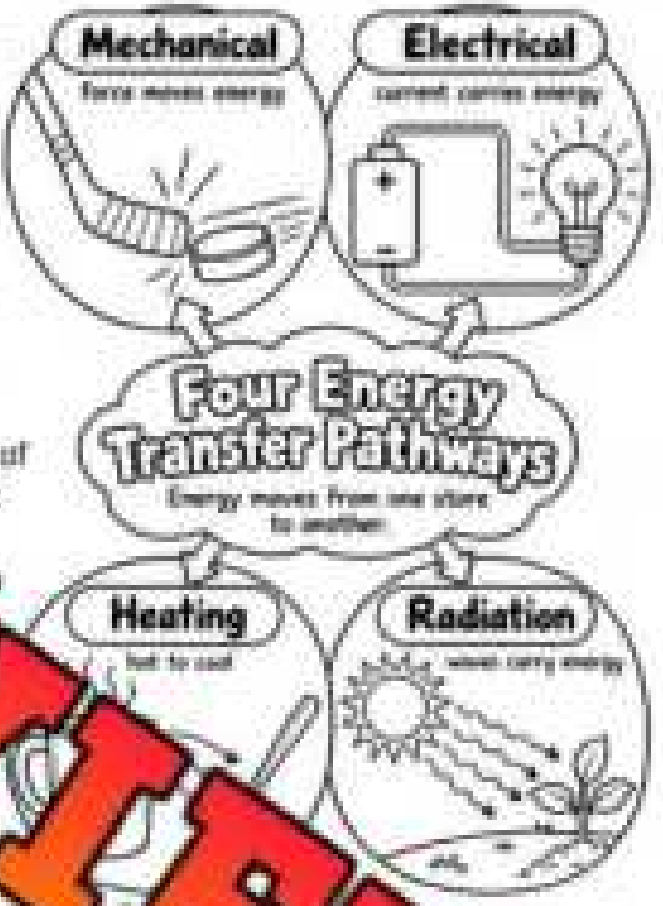
Energy Stores and Transfers

Energy in Stores

Energy is the capacity to cause change, and it is measured in **joules (J)**, a unit named after the English physicist James Prescott Joule (1818–1889). Scientists model energy as being kept in **stores**, which are the forms in which a system holds energy. The eight stores are kinetic, gravitational potential, elastic potential, chemical, thermal, nuclear, magnetic, and electrostatic.

A 1 kg ball moving at 10 m/s has a kinetic store of 50 J, calculated from its mass and speed. A stretched elastic band keeps energy in its elastic potential store until it is released. Lifting that ball up a 3 m staircase adds about 30 J to its gravitational store, while a typical granola bar holds roughly 1 MJ (1 megajoule, MJ) in its chemical store, because one food Calorie equals 4184 J.



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Four Transfer Pathways

A **transfer pathway** is a process that moves energy from one store to another, and every change uses one of four. Heating, for example, raises the thermal store of a cool object if the warmer object is hotter.

- **Mechanical** — A force moves an object, as when a hockey puck slides across the ice.
- **Electrical** — A current carries energy around a circuit, as from a battery to a bulb.
- **Heating** — Energy moves from a hotter object to a cooler one because of their temperature difference.
- **Radiation** — Energy travels as waves, such as light crossing about 150 million km from the Sun.

Energy Is Conserved

The **law of conservation of energy** states that energy cannot be created or destroyed, only transferred between stores. In the 1840s, Joule tested this law by letting falling masses turn a paddle wheel inside an insulated container of water. The water warmed by a tiny amount, and the thermal energy gained matched the gravitational energy lost by the masses. The same law applies to stars: in the Sun's core, nuclear fusion transfers energy from the nuclear store to radiation at a rate of about 4 million tonnes of matter converted every second.

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True or False

Circle whether the statement is true or false.

1) Heating is one of the eight energy stores.	T	F
2) A joule is a unit used to measure energy.	T	F
3) Radiation can transfer energy through empty space.	T	F
4) Chemical is one of the four transfer pathways.	T	F
5) Joule used falling masses to turn a paddle wheel.	T	F

Finish the Sentence

Complete each sentence below.

1) A hockey puck sliding across the ice is a kinetic store, which means...

2) Energy is conserved, so the ... goes...

3) Joule's paddle wheel experiment was important because...

Spot the Myth

One paragraph below is wrong. Circle it and explain why.

A — A hot mug of cocoa has a large thermal store, and heating is the pathway that moves that energy into the cooler air around it.

B — A battery keeps energy in its chemical store, and the electrical pathway can later transfer that energy to a bulb or a motor.

C — A hot mug of cocoa contains heat, so heating is one of the eight energy stores that scientists use to describe a system.

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Experiment - The Bouncing Ball Energy

Objective What are we learning about?

Students will investigate how energy transfers between gravitational potential energy and kinetic energy as a ball bounces.

Materials What will you need for the activity?

- ❑ Tenn[illegible] ball
- ❑ [illegible] tape
- ❑ [illegible] tape
- ❑ Recording sh[illegible]
- ❑ Pencil and
- ❑ Calculator (p[illegible]



Instructions How will you [illegible]

1. Work in groups of 2–3 students and choose a clear area in the classroom with a hard, flat floor.
2. Use masking tape to attach a metre stick vertically against a wall, with the zero mark touching the floor.
3. Hold the ball at a height of 100 cm above the floor [illegible] will bounce after being dropped.
4. Release the ball without pushing or throwing it and carefully observe the height it reaches after its first bounce.
5. Record the first rebound height in your recording sheet, then repeat [illegible] two more times from the same height to calculate an average.
6. Repeat the experiment using starting heights of 80 cm, 60 cm and 40 cm, recording three rebound heights for each starting height.
7. Calculate the percentage of the original height reached by the ball using the formula: Bounce Height Percentage = (Average Rebound Height ÷ Starting Height) × 100
8. Compare your results and discuss how gravitational potential energy changes into kinetic energy as the ball falls, and how elastic potential energy is briefly stored when the ball compresses against the floor.
9. Investigate why the ball never returns to its original height, considering sound, thermal energy and the movement or deformation of the ball and floor.
10. Create a bar graph comparing the starting height and average rebound height for each trial, then explain what your results reveal about energy conservation and energy dissipation.

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Name: _____ ID: _____

Recording Sheet | Record the details of your experiment below.

Make Your Prediction: How does the height from which a ball is dropped affect the height of its first bounce?

I predict that when the starting height increases, the rebound height will _____

because _____

_____

Measurements: Drop the ball three times from each starting height. Record the maximum height of the first bounce, then calculate the average rebound height.

Starting Height	Trial 1	Trial 2	Trial 3	Average Rebound Height
100 cm	cm	cm	cm	cm
80 cm	cm	cm	cm	cm
60 cm	cm	cm	cm	cm
40 cm	cm	cm	cm	cm

Calculate the Bounce Height Percentage

Bounce Height Percentage = (Average Rebound Height ÷ Starting Height) × 100

Starting Height	Average Rebound Height	Bounce Height Percentage
100 cm		%
80 cm		%
60 cm		%
40 cm		%

My Observations: Answer the following questions.

1) Which starting height produced the highest first bounce?

_____

_____

2) Did the ball ever return to its original height? Explain.

_____

_____

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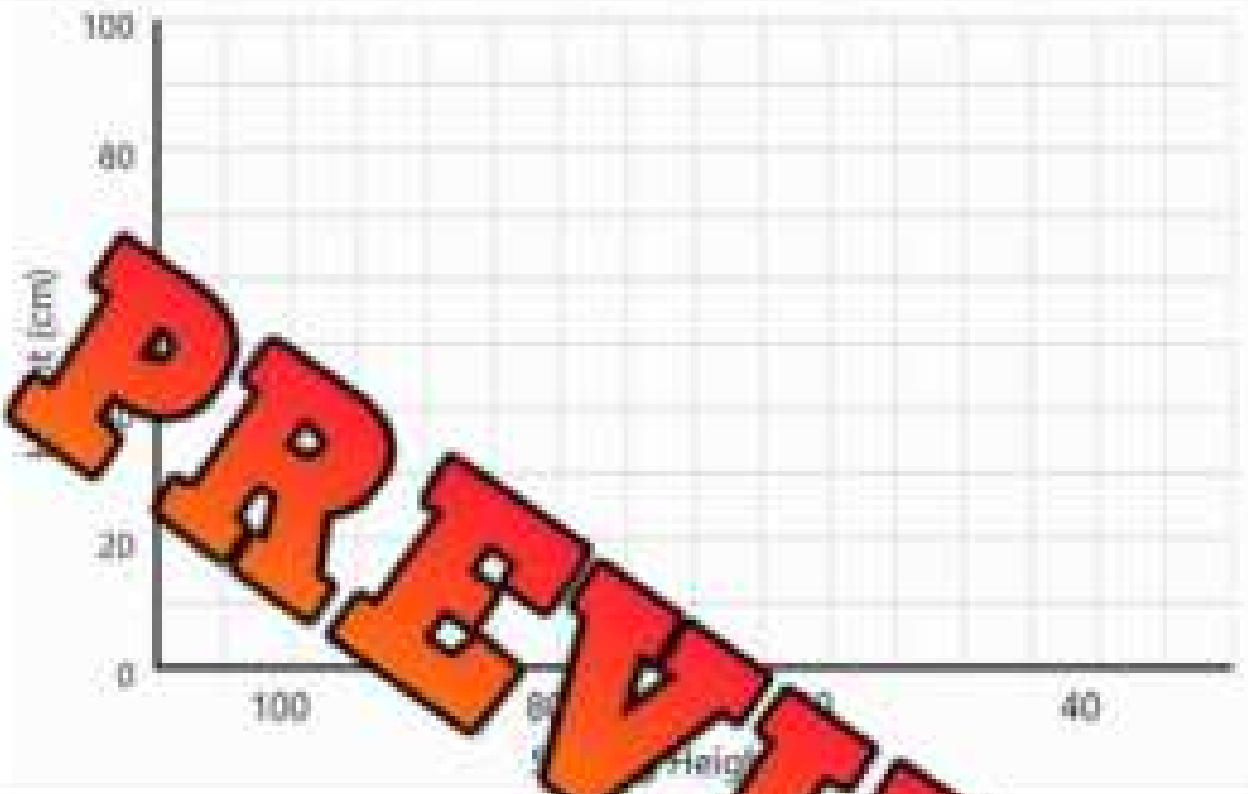
Graph Your Results: Draw a bar graph comparing the starting height and average rebound height for each of the four starting heights. Label both axes, include units and use different colours or patterns for the two sets of bars.



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1) Imagine your ball falling, striking the floor, and [illegible]. Explain how gravitational potential energy, kinetic energy, and [illegible] throughout this process.

2) You have been asked to design a ball that bounces as high as possible. What two properties of the ball would you investigate to improve its rebound height? Explain your choices.

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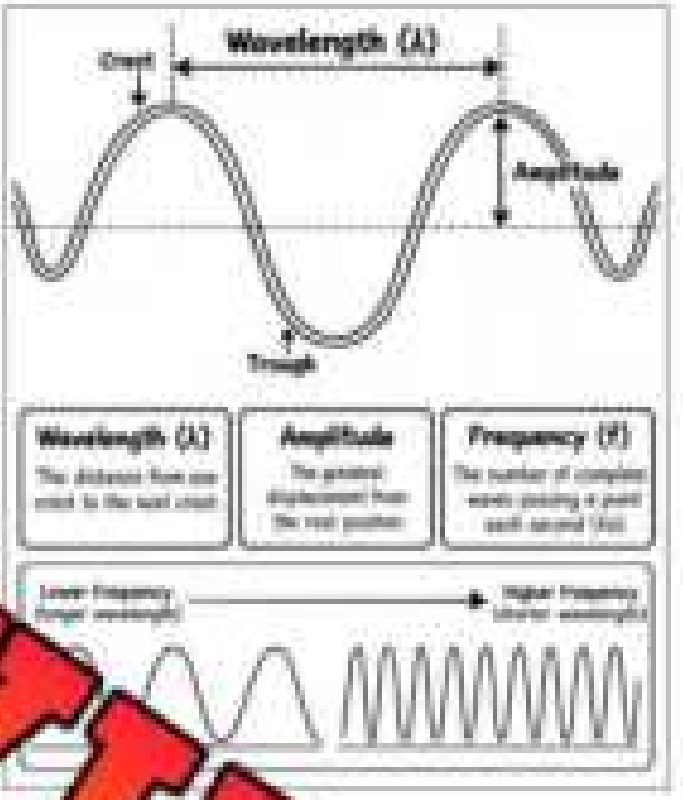
Waves: Wavelength, Frequency, and Amplitude

Describing a Wave

A **wave** is a disturbance that transfers energy from one place to another without carrying matter along with it. The **wavelength (λ)** is the distance from one crest to the next crest and is measured in metres (m). The **amplitude** is the greatest displacement of the wave from its resting position, and it shows how much energy the wave carries: a larger amplitude means a brighter beam of light or a louder sound. **Frequency (f)** is the number of complete waves passing a point each second, measured in **hertz (Hz)**, named after German physicist Heinrich Hertz, who first produced and detected radio waves in the 1880s. One hertz equals one wave per second.



The Wave Speed Equation

The speed of any wave is found with the equation $v = f \times \lambda$, where v is speed in metres per second (m/s). Sound travels through air at about 343 m/s at 20 degrees Celsius (20°C). A 440 Hz tone, the tuning pitch used by orchestras, has a wavelength of $343 \div 440 = 0.78$ m. The time for one wave to pass is the period, $T = 1 \div f$, so that note has a period of about 0.0023 s. By contrast, electromagnetic waves travel through a vacuum at exactly 3.00×10^8 m/s, or about 3.00×10^8 m/s. At a fixed speed, a rise in frequency must be matched by a fall in wavelength.

Waves You Can Calculate

Each of these waves can be solved with the same equation, using 343 m/s for sound and 3.00×10^8 m/s for radio:

- **Lowest audible sound** — Humans hear down to about 20 Hz, which has a wavelength near 17 m in air.
- **Middle C** — The piano note at about 262 Hz has a wavelength near 1.3 m.
- **Highest audible sound** — Young listeners hear up to about 20 000 Hz, a wavelength of only 1.7 cm.
- **FM radio signal** — A station at 100 megahertz (MHz) broadcasts waves 3.0 m long.

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Two Choices Circle the best answer.

1) Frequency is measured in _____.	metres	hertz
2) A larger amplitude means a wave carries _____ energy.	more	less
3) If speed is fixed and f rises, wavelength _____.	lengthens	shortens
4) Wavelength is measured from crest to _____.	crest	trough
5) Light is _____ than sound in air.	faster	slower

Quest …uestions below using evidence from the text.

1) Define amp… …y … …hows about a wave.

2) A wave has f = 50 Hz and λ = 4 m. … spee… …w your work.

Think Imagine someone gently tapping a drum and then hitting it much h… …ow would the amplitude of the sound waves change? How would this effect w… you hear?

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark: _____

True (T) or false (F)?

1) Hertz measures frequency.	T / F
2) Light travels at 343 m/s.	T / F
3) Wavelength is in metres.	T / F
4) Speed equals f × λ.	T / F
5) Amplitude is wave speed.	T / F

Name: _____ Mark: _____

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5) Amplitude is wave speed.	T / F

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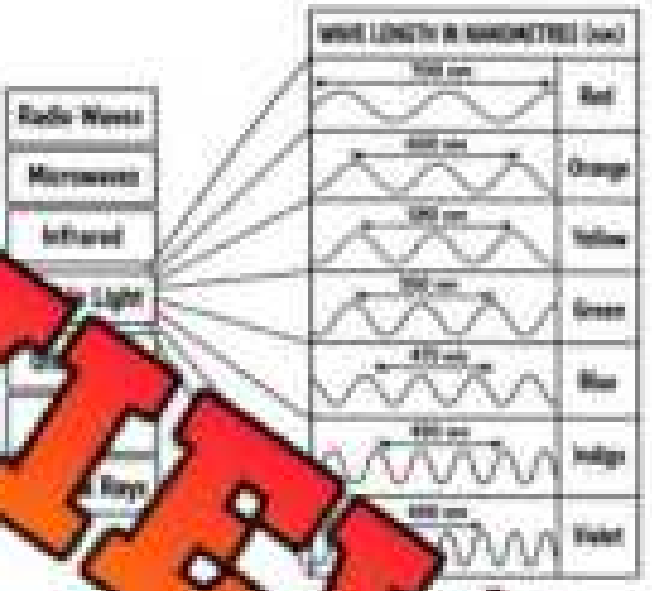
Visible Light and Colour

The Visible Spectrum

Visible light is the narrow band of electromagnetic radiation that the human eye can detect, with wavelengths from about 380 to 750 nanometres. A **nanometre (nm)** is one billionth of a metre (10^{-9} m), so even red light has a wavelength under one thousandth of a millimetre. Approximate wavelength ranges are:

- **Violet** — about 380 to 450 nm
- **Blue** — about 450 to 495 nm
- **Green** — about 495 to 570 nm
- **Yellow and orange** — about 570 to 620 nm
- **Red** — about 620 to 750 nm

PREVIEW



Newton and the Prism

In 1666 Isaac Newton passed a narrow beam of sunlight through a glass **prism**, a transparent triangular block that bends light by refraction, and saw a band of colours on the wall; the beam entered through a small hole in a window shutter. He named seven colours: red, orange, yellow, green, blue, indigo, and violet, although most people find indigo hard to tell apart from blue and would call six. The prism bends violet the most because shorter wavelengths slow down more in glass. In his book *Opticks* (1704) Newton described how a second prism recombined the colours into white light, which proved that white light is a mixture and that the prism does not add colour.

How We See Colour

The retina at the back of the eye contains about 120 million rods, which work in dim light, and about 6 million **cones**, the cells that detect colour in bright light. The human eye has three types of cone, sensitive mainly to long, medium and short wavelengths, and the brain compares their signals to produce every colour we perceive. Daytime vision is most sensitive near 555 nm, in the green region. A ripe tomato looks red because its skin reflects mostly long wavelengths and absorbs the rest. Screens on phones and televisions make every colour from tiny red, green, and blue pixels. A rainbow forms when raindrops act as prisms, and the red arc of a primary rainbow appears about 42 degrees from the point directly opposite the Sun.

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Multiple Choice Circle the best answer.

1) What is the approximate range of visible light wavelengths?			
38–75 nm	3 800–7 500 nm	380–750 nm	0.38–0.75 nm
2) What did Newton's second prism show?			
Re-formed white	Added new colours	Absorbed all light	Slowed the light
3) Which colour has wavelengths of about 495 to 570 nm?			
Gr[illegible]	Blue	Yellow	Red
4) How m[illegible]one cell does the human retina have?			
[illegible]	Three	Four	Seven
5) A ripe tomato [illegible] its skin mostly…			
absorbs red l[illegible] reflec[illegible]		emits red light	bends red light

Think A beam of sunlight [illegible] prism and lands on a white wall. Describe the bands [illegible] which colour bends most, and explain how a second prism co[illegible] light is a mixture.

Connect Your phone screen can display millions of colours using only red, green and blue light. How do you think these three colours combine to create other colours, such as yellow or white?

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Blog Post: Radio Waves and Microwaves

5 Ways Radio Waves and Microwaves Connect Us

Date: October 14, 2026 **Author**: Ms. Tamara Sinclair 4-minute read

Invisible electromagnetic waves pass through your classroom every second carrying songs, phone calls, and maps. **Radio waves** are electromagnetic waves with wavelengths longer than about 1 metre (m), while **microwaves** have shorter wavelengths, from about 1 m down to 1 millimetre (mm). Both travel at the speed of light, roughly 300 000 kilometres per second ([illegible]), and an **antenna**, a metal conductor that sends or receives waves, converts [illegible] from electrical signals.

1) **AM [illegible]**: Radio stations place sound on a carrier wave. AM (amplitude [illegible] wave's height, and Canadian AM stations broadcast between 5[illegible] 1705 [illegible] kHz). FM (frequency modulation) varies its frequency instead, in the 88 [illegible] MHz band, with station channels spaced 200 kHz apart to prevent o[illegible]
2) **Marconi's Long [illegible]**: [illegible] December 12, 1901, Guglielmo Marconi lifted an antenna with a kite [illegible] Newfoundland, and received Morse code radio waves sent from Poldhu [illegible], [illegible]. That success proved radio waves can carry messages across [illegible] th[illegible] and links to ships and aircraft.
3) **Wi-Fi and Cell Phones**: Wi-Fi most [illegible] at 2.4 gigahertz (GHz), a wavelength of 125 mm, and at 5 G[illegible] wavelen[illegible]. Frequencies near 900 MHz suit light urban coverage, but 1.8 GHz [illegible] structural walls, so towers using them must stand closer toget[illegible]
4) **Radar and Storm Tracking**: **Radar**, short for [illegible], sends a pulse of microwaves lasting about one microsecond, th[illegible] the [illegible]. Distance is the echo's travel time multiplied by the speed of light [illegible]. Today weather radars now use 10 cm S-band microwaves, which [illegible] than 5 cm C-band.
5) **Satellite Navigation**: Global Positioning System (GPS) satellites [illegible] 200 km above Earth, and their L1 microwave signal has a frequency of 1575 [illegible] MHz. A signal sent from directly overhead needs about 0.067 seconds to arrive, and a receiver compares delays from several of the 30 or more working satellites to find its position.

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Comments	
	**Nina – October 14, 2026** I never knew my Wi-Fi was a microwave! Is it as strong as an oven? Like Reply 1d ago
	**Owen – October 15, 2026** Nina, ovens use 600 to 1200 W, far more than a router ever sends. Like Reply 20m ago

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Questions

Answer the questions below.

1) Give one fact about AM radio and one about Wi-Fi from the post.

2) How are radio waves and microwaves alike, and how do they differ?

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True or False

Is the statement true (T) or false (F)?

1) FM stations broadcast between 5[illegible] 1705 kHz.	T	F
2) Radar finds distance by timing an echo.	T	F
3) Wi-Fi at 5 GHz has a wavelength of 60 mm.	T	F
4) Marconi's 1901 signal was received in Cornwall.	T	F
5) GPS satellites orbit about 20 200 km up.	T	F

Sorting

Sort each fact: Radio Wave or Microwave?

1) Stations are spaced 200 kHz apart.	
2) Used by Marconi in 1901	
3) Weather radar at 10 cm	
4) Wi-Fi at 2.4 GHz and 5 GHz	
5) GPS signal at 1575.42 MHz	

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Underline the correct answer.

1) Waves longer than 1 m are radio waves / microwaves.

2) Marconi's antenna was raised by a kite / tower.

3) Canada's weather radar now uses 10 m waves / 10 cm waves.

4) A GPS signal needs about 0.067 min / s.

Name: _____ | Mark

Underline the correct answer.

1) Waves longer than 1 m are radio waves / microwaves.

2) Marconi's antenna was raised by a kite / tower.

3) Canada's weather radar now uses 10 m waves / 10 cm waves.

4) A GPS signal needs about 0.067 min / s.

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Story: The Thermal Camera Search

Heat in the Dark

At 9:40 p.m. on a cold October night, a fourteen-year-old hiker named Jonas had not returned to Wasagaming, the townsite of Riding Mountain National Park, a 2,969 square kilometre (km²) reserve on the Manitoba Escarpment.

Search technician Dana Okafor arrived with a drone carrying a thermal camera. Marcus, a [illegible] volunteer, asked why two hours of headlamp searching had found nothing.

"D[illegible] light, not heat," Dana said. She explained that every object gives off **infrar**[illegible] magnetic waves with wavelengths from about 780 nanometres (nm) [illegible] William Herschel discovered it in 1800, when thermometers placed [illegible] [illegible]'s spectrum grew warmer. Infrared travelled at the speed of light [illegible] light made no difference.

A **thermal** [illegible] detected long-wave infrared, about 7 to 14 micrometres (µm), a[illegible] [illegible]ces as brighter shades. Human skin radiates chiefly near 10 µm [illegible] at [illegible] out against forest air at 3°C.

The drone rose to 60 m [illegible] [illegible]es above the spruce. The trees glowed only faintly because they were nearly as cold as the air. Then a huge bright shape appeared, and Marcus whispered that he had found Jonas.



Dana studied the screen. The shape was long, had four legs and moved in a steady line, so she identified an elk. A seated person would show a compact, upright form that stayed still.

Forty minutes later, a small, faint glow appeared beside a creek 3 kilometres (km) from the trail. His wet jacket had cooled almost to the temperature of the air, so only his face and hands shone brightly.

Dana lowered the drone and the shape sharpened into a person hugging his knees. She radioed the ground team, who reached Jonas in twenty-five minutes. He was cold but unharmed, and a paramedic wrapped him in a dry blanket.

Marcus kept watching the screen. All night, warm bodies had been broadcasting their own infrared signals, and the camera had finally made them visible.

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Ordering Number these events 1 to 8 in the order they happened in the story.

	Marcus mistook a bright elk for the missing hiker.
	Dana explained that warm objects give off infrared radiation.
	The ground team reached Jonas after a radio call.
	Headlamp searching failed for two hours.
	The drone rose to 60 m above the spruce forest.
	D ed a faint glow beside a creek.
	urned to Wesagaming by 9:40 p.m.
	a tow one to sharpen the image.

Question d th ucceed where headlamps failed?

Think Thermal cameras are also used by firefighters, ry inspectors. Choose one of these professions and expla infrared radiation could help someone solve a problem or danger.

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Experiment - The Invisible Energy Detectives

Objective — What are we learning about?

Students will investigate how different surface colours affect the absorption of solar radiation by comparing temperature changes in black-covered and white-covered cups.

Materials — What will you need for the activity?

- ☐ Two
- ☐ B paper
- ☐ Equ amoun
- ☐ Tape
- ☐ Stopwatch
- ☐ Recording shee
- ☐ Sunny outdoor area



Instructions — How will you complete

1) Work in groups of 2–3 students and gather mate ed for the experiment.
2) Wrap one cup completely in black paper and the cure p curing both coverings with tape.
3) Pour the same amount of room-temperature water into h c thermometer inside each one.
4) Record the starting temperature of the water in both cups and pred ch cup will warm up faster.
5) Place the two cups side by side in direct sunlight, ensuring that both receive the same amount of sunlight without shading each other.
6) Start your timer and measure the water temperature in each cup every 5 minutes for a total of 20 minutes.
7) Record all temperature readings in your recording sheet and observe whether one cup warms more quickly than the other.
8) Calculate the total temperature increase for each cup by subtracting its starting temperature from its final temperature.
9) Compare your results with your prediction and discuss how the black and white surfaces absorb and reflect different amounts of incoming solar radiation.

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Recording Sheet | Record the details of your experiment below.

Make Your Prediction: How does the colour of a cup's outer surface affect the temperature of the water inside when exposed to sunlight?

I predict that the _____ cup will warm up faster because _____

_____

_____

Record the ... of the water in both cups every 5 minutes for 20 minutes.

...	...lack Cup Temperature (°C)	White Cup Temperature (°C)
0 ...		
5 minutes		
10 minutes		
15 minutes		
20 minutes		

Calculate the Temperature Change:		...ature – Final Temperature = ...ature	
Black Cup		**...hite**	
Final Temperature	°C	Final Temp...e	°C
Starting Temperature	°C	Starting Temperatu...	°C
Temperature Change	°C	Temperature Change	°C

My Observations: Answer the following questions.

1) Which cup warmed up faster during the first 10 minutes?

_____

_____

2) Did your results support your original hypothesis?

_____

_____

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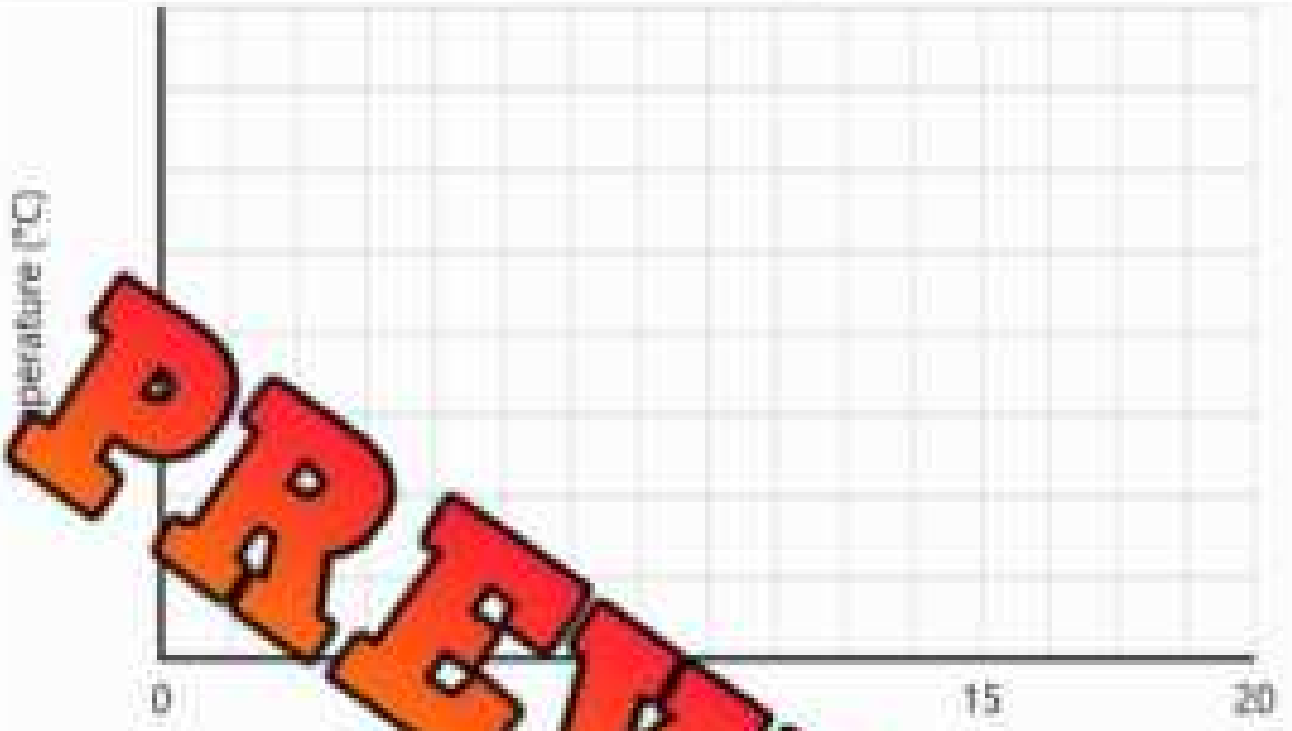
Graph Your Results: Draw a line graph showing the temperature changes in both cups over 20 minutes. Use different colours or line patterns to represent each cup and include a key.



1) Why might a black-covered cup become warm[illegible] a w[illegible]ed cup when both receive the same amount of sunlight? Explain y[illegible] absorption and reflection.

2) Explain how energy from the Sun travels to Earth and increases the thermal energy of the water inside the cups. Identify the energy transfer from the Sun and how energy passes from the cup into the water.

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Activity – Thermal Camera Search Tableau

Objective What are we learning about?

We're going on a night search! Students will freeze scenes from a thermal imaging rescue to show how infrared radiation helps people find warm bodies in the dark.

Materials What you will need for the activity

- ❑ Scenario cards
- ❑ Simple p[illegible] flashlights
- ❑ A camera to ca[illegible]



Instructions How you will [illegible]

1. Divide the class into small groups. Assign each group [illegible] scenes from the provided list.
2. Explain that a tableau is a frozen scene. Students [illegible] for each scene using only bodies and faces, with no words.
3. Give students time to read their scenes and plan the poses, [illegible] about where the heat and cold would be.
4. If props are available, allow time to select and prepare them.
5. Have each group present their tableau. While one group performs, the others observe quietly.
6. The performing group holds each pose for about 20 seconds so observers can take in the details.
7. After each performance, allow the class to ask questions about the choices made in the scene.

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Tableaus | Tableau scenes for the activity

#	History	Description of Scene for Tableau
1	**Search C…**	A dispatcher sits at a desk with a phone held to one ear and a finger pressed on a wall map. Two rescuers in bright jackets lean over the map, serious faces turned toward the marked forest.
2	**Gearin… Up**	…s pull on boots and headlamps beside a truck at …dge… park. One holds a handheld thermal …er… the screen. Others stand with arms … bag… old.
3	**Cold Forest**	The team walks … line t… …re trees, heads turning in every direc… …e … …ints at the ground, another points a… …ery… …breath makes small clouds.
4	**First Hot Spot**	A rescuer stops suddenly and raises a fist. …hers freeze and gather around the camera screen, eyes wide, pointing at one bright shape glowing against a dark background.
5	**False Alarm**	The group tiptoes forward, then stops. A rescuer shrugs and lowers the camera while others look disappointed. One person mimics a deer with hands raised like antlers.

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Tableaus | Tableau scenes for the activity

#	History	Description of Scene for Tableau
6	**Glass Border**	A rescuer holds the camera toward a window of a hunting cabin, tilting the head in puzzlement. Another taps the glass while a third shakes their head, hands out, palms up.
7	**Cool Down**	A rescuer kneels with the camera aimed at an old sleeping bag. Another reaches a hand over the [illegible] shows surprise as they feel faint [illegible]
8	**Found at Last**	A cold hiker [illegible] with a tree, arms wrapped around knees. Rescuers rush [illegible] them with arms outstretched. The hiker [illegible] in greeting, face full of relief.
9	**Warm Blankets**	Rescuers wrap a foil blanket around [illegible] shoulders and hold a warm drink. One kneels to check the hiker's hands while another speaks into a radio, smiling.
10	**Review Screen**	The whole team crowds around the camera screen, tracing the path of the search with fingers. Some smile and shake hands. One person points at the bright image of the hiker.

PREVIEW

Name: _____ 45

Reflection Answer the questions below.

1) Which scene best showed how a thermal camera works? Explain why

2) Wha[illegible]how with your body to make the infrared idea clear to the aud[illegible]

3) Which materials, such as glass or foil, chang[illegible]the [illegible]uld detect?

4) How could thermal imaging be useful in other jobs or situations?

PREVIEW

Name: _____ 46

Case: Two Long Waves, Two Jobs

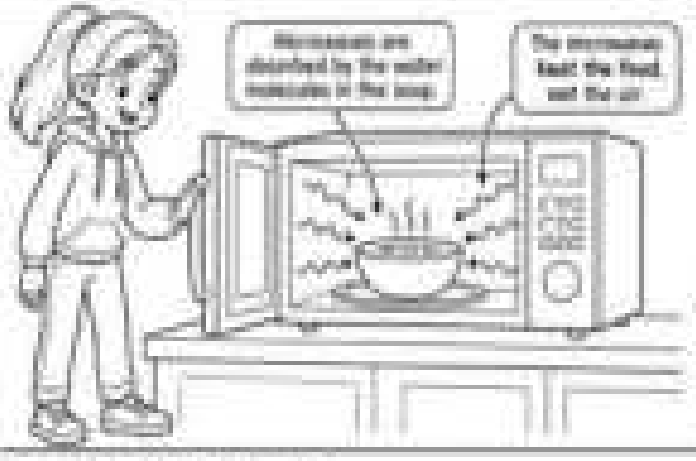
Same Family, Different Jobs

Case 1: The Microwave Oven

In a Winnipeg kitchen, a student reheats soup. The oven's **magnetron**, a vacuum tube that generates microwaves, is based on the cavity mag[illegible]on Randall and Boot built in 1940 at the [illegible]ity of Birmingham. It produces [illegible] gigahertz (GHz), which [illegible] 12.2 centi[illegible]. [illegible]cules in the soup ab[illegible] this [illegible] gains thermal energ[illegible] ty[illegible] use 800 to 1200 wa[illegible] me[illegible] the door has holes [illegible] cm, so microwaves stay [illegible] light escapes, letting the st[illegible] bowl turn. The first commercial [illegible], the 1947 Radarange, weighed 340 kilograms (kg) and consumed about 3 kilowatts (k[illegible]

Case 2: The Radio Station

In a car on Highway 59, a listener tunes to an FM station at 100 megahertz (MHz), inside the 88 to 108 MHz band used across the Americas. The station's transmitter drives electric current through a tall antenna, which launches radio waves with a wavelength of about 3 metres (m), found by dividing the speed of light, 3.0×10^8 metres per second, by the frequency. The waves spread outward in every direction and pass through car roofs and house walls. Each receiving antenna absorbs only a minute fraction [illegible] broadcast power. A transmitter 50 [illegible]es (km) away is reached in about 167 [illegible]conds (µs), since radio waves [illegible] speed of light.





What This Teaches Us

Both cases use electromagnetic waves, but frequency sets the wavelength and the job. At 2.45 GHz, the oven's waves have about 24.5 times the frequency of the 100 MHz broadcast and a wavelength about 24.5 times shorter. A **photon**, a packet of electromagnetic energy, carries energy equal to Planck's constant multiplied by frequency, so each microwave photon holds 24.5 times the energy of an FM photon. The mesh would block the longer 3 m waves too, since only holes comparable to a wavelength or larger let waves through. Neither photon is strong enough to break chemical bonds; the oven heats food because its box concentrates vast numbers of photons per second on the water inside.

PREVIEW

Name: _____ 47

Two Choices Circle the best answer.

1) A magnetron generates _____.	microwaves	X-rays
2) A 100 MHz FM wave is about _____ long.	3 m	12.2 cm
3) Randall and Boot built a magnetron in _____.	1840	1940
4) Which has more energy per photon?	FM radio	microwave
5) Home [illegible] power is typically _____.	6–12 kW	600–1200 W

Questions [illegible] questions below using evidence from the text.

1) Compare t[illegible] oven's waves with the FM station's.

2) Why can a radio reach many cars [illegible] oven [illegible] side?

PREVIEW

Finish the Sentence Complete each sentence below.

1) A radio antenna sends waves outward in every direction because...

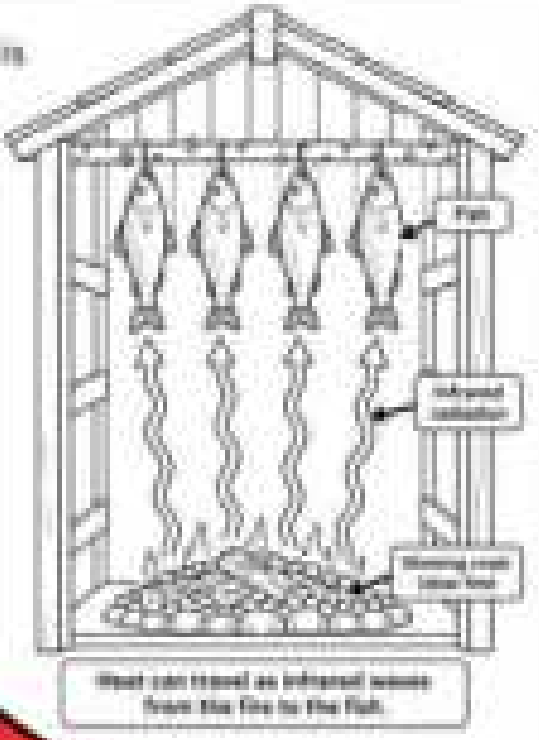
2) Microwave photons carry more energy than FM photons, which means...

Name: _____ 52

Smoking Fish at Pimachiowin Aki

Fish Smoking in Anishinaabe Territory

Lake Winnipeg, covering 24,514 square kilometres (km²), is the 12th largest lake on Earth, and walleye and whitefish make up over 90 percent of its commercial catch. East of the lake lies Pimachiowin Aki, a UNESCO World Heritage Site of 2,904,000 hectares inscribed in 2018 and shared by four Anishinaabe First Nations: Bloodvein River, Little Grand Rapids, Pauingassi, and Poplar River. Fishers in [illegible] and Bloodvein River still **smoke** white[illegible] exposing fish to the smoke of a slow [illegible] often built a smokehouse from fresh green [illegible] and old aspen, and finished a batch in [illegible] judging doneness by flesh colour. [illegible] reported that dead poplar works [illegible] and sap makes a black fire.



How Heat Reaches the Fish

A smoking fire transfers thermal energy [illegible] **infrared radiation**, electromagnetic wave[illegible] with wa[illegible] about 780 nanometres (nm) to 1 millimetre (mm), crosses from glowi[illegible] to th[illegible] out needing air. **Convection** is heat carried by moving currents [illegible] air, and **conduction** is heat passing from particle to particle, through the [illegible] sticks that pierce each fish. Sunlight supplies the same kind of ene[illegible] of the Sun's energy reaching Earth is infrared.

Why Smoked Fish Keeps

Smoking works partly by drying, which lowers **water activity**, a scale from [illegible] measuring how much water in food is available to microbes. Microbes stop multiplying below 0.60, most moulds are inhibited at 0.80, and Staphylococcus aureus stops at 0.86. The Bloodvein River fisher smokes six to eight whitefish at a time for flavour and avoids drying them out, so timing controls how much water leaves. Smoke contributes further protection:

- **Phenols** — smoke compounds that slow bacterial growth and rancid fat
- **Acidity** — smoke has a pH near 2.5, which adds to its antimicrobial effect
- **Cold smoking** — 20 to 30°C, leaving the fish raw
- **Hot smoking** — 52 to 80°C, cooking the fish fully

PREVIEW

Name: _____ 53

True or False

Circle whether the statement is true or false.

1) Pimachiowin Aki is a UNESCO World Heritage Site.	True	False
2) Wood with sap makes a clean fire for smoking.	True	False
3) Infrared radiation can travel without any air.	True	False
4) Smoke's low pH helps slow microbial growth.	True	False
5) Cold smoking at 20 to 30°C cooks fish fully.	True	False

Questions

Answer the questions below using evidence from the text.

1) Why is dea[illegible] for smoking fish?

2) Why does smoke alone not preser[illegible] helps?

Visualizing

Draw a smokehouse and label three he[illegible]

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Explain how infrared radiation heats a fish above a fire.

Name: _____ Mark

Explain how infrared radiation heats a fish above a fire.

Name: _____ Mark

Explain how infrared radiation heats a fish above a fire.

Name: _____ Mark

Explain how infrared radiation heats a fish above a fire.

PREVIEW

Name: _____ 58

Word Search – Ultraviolet Light

Objective What are we learning about?

Students will learn to identify and understand key scientific vocabulary related to ultraviolet (UV) radiation, the ozone layer, the UV index, and Sun safety.

Materials What will you need for the activity?

- ❑ [illegible] plates (grid paper)
- ❑ List [illegible] provided)
- ❑ Pencils and [illegible]
- ❑ Coloured pencils



Instructions How you will [illegible]

1) Review the key vocabulary related to [illegible] including the types of UV rays, the ozone layer, the UV index, and Su[illegible]
2) Collect a blank word search grid and the list [illegible] provided by your teacher.
3) Carefully arrange the vocabulary words within your g[illegible] vertically or diagonally. Make sure each word is spelled correc[illegible]
4) Fill the remaining empty squares with random letters to complete y[illegible]. Try to make your word search challenging but possible to solve.
5) Exchange your completed word search with a partner. Make sure your partner has the list of words they need to find.
6) Search carefully through your partner's puzzle and circle or highlight each vocabulary word you discover.
7) Once all the words have been found, discuss their meanings with your partner and explain how they connect to ultraviolet radiation, the atmosphere or Sun safety.
8) Choose one vocabulary word that you think is particularly important and write a short explanation of its meaning and importance.
9) Review your completed puzzles together, check that all words have been found correctly and discuss any new information you learned during the activity.

PREVIEW

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Name: _____ 59

Words	List of words:

ozone	sunburn	tanning	vitamin
shade	glare	melanin	skin
bo	calcium	layer	shield
c	germs	bacteria	virus
lamp	light	fluorescent	glow
bleach		cloud	noon
summer		ator	latitude
snow	sand		ice
index	scale		igh
harm	hat	sunglasses	
beach	glacier	mountain	nsor
sky	chemical	damage	eyes
iris	pupil	cataract	sunrise
sunset	daylight	forecast	dose
exposure	invisible	sterile	filter

PREVIEW

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Name: _____ 60

Word Search | Create your own word search below.

Word Bank				

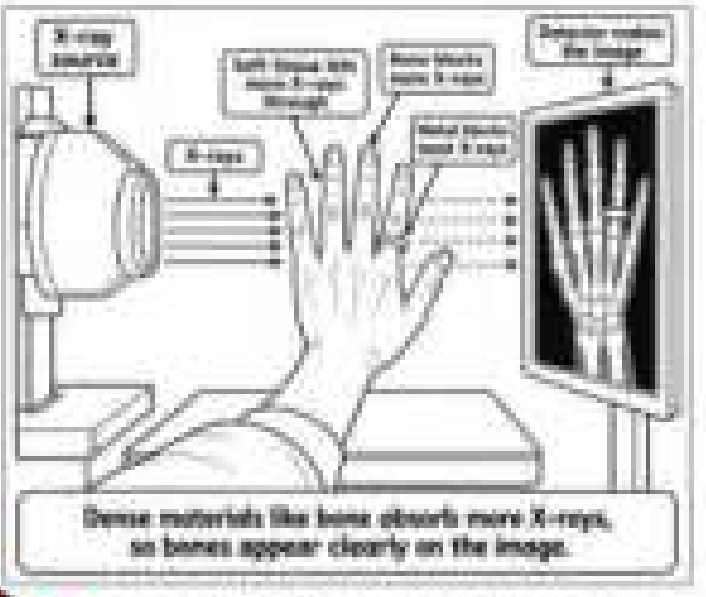


Name: _____ 61

X-Rays and Gamma Rays

Röntgen's Mysterious Rays

On 8 November 1895, the German physicist Wilhelm Conrad Röntgen was working in Würzburg when a screen coated with fluorescent chemicals glowed across his laboratory, even though his cathode-ray tube was wrapped in black card. He named the invisible rays **X-rays** because its nature was unkn[illegible] within weeks he photo[illegible]d wedding ring of his [illegible]. In 1901 he received [illegible] first [illegible] in Physics. X-rays are ele[illegible] wavelengths of [illegible] to [illegible] produced when fast [illegible] slam into a metal target [illegible]; Europe and North America were using the images to locate bullets [illegible]



Dense materials like bone absorb more X-rays, so bones appear clearly on the image.

Gamma Rays and Ionizing Radiation

Gamma rays have wavelengths shorter [illegible] about [illegible] come from atomic nuclei, as in radioactive decay, or exploding stars. Paul Villa[illegible] det[illegible]n in 1900 from radium, and Ernest Rutherford named them in [illegible]. Gamma rays are **ionizing radiation**, meaning each photon carries [illegible] trons off atoms, which can damage DNA. An X-ray photon used [illegible] es tens of thousands of times the energy of a visible photon, and gam[illegible] even more.

Uses and Shielding

Dense calcium in bone absorbs X-rays strongly while soft tissue lets most [illegible], so a detector records bones as a shadow. Lead and thick concrete absorb these photons, which is why radiographers work behind barriers and patients wear lead aprons. Radiation dose is measured in sieverts (Sv), and radiographers keep doses as low as reasonably achievable.

- **Medicine** — Harold Johns and colleagues at the University of Saskatchewan pioneered cobalt-60 cancer treatment, treating their first patient in Saskatoon in 1951.
- **Imaging** — Computed tomography (CT) scanners rotate an X-ray source around the patient to build cross-sectional images.
- **Industry** — X-ray scanners inspect welds in pipelines and screen baggage at airports.
- **Astronomy** — Earth's atmosphere absorbs these rays, so the Chandra X-ray Observatory has orbited above it since 1999.

PREVIEW

Name: _____ 62

True or False Is the statement true or false?

1) Gamma rays have longer wavelengths than X-rays.	True	False
2) Röntgen announced X-rays after a 1895 experiment.	True	False
3) Soft tissue absorbs X-rays more than bone does.	True	False
4) Ionizing radiation can knock electrons off atoms.	True	False
5) Space telescopes detect X-rays above the atmosphere.	True	False

Questions Answer the questions below using evidence from the text.

1) Why [illegible] rays during X-ray imaging?

2) Compare the sources of X-[illegible] an[illegible]

Drawing Draw and label six uses or sources of X-rays [illegible] text.

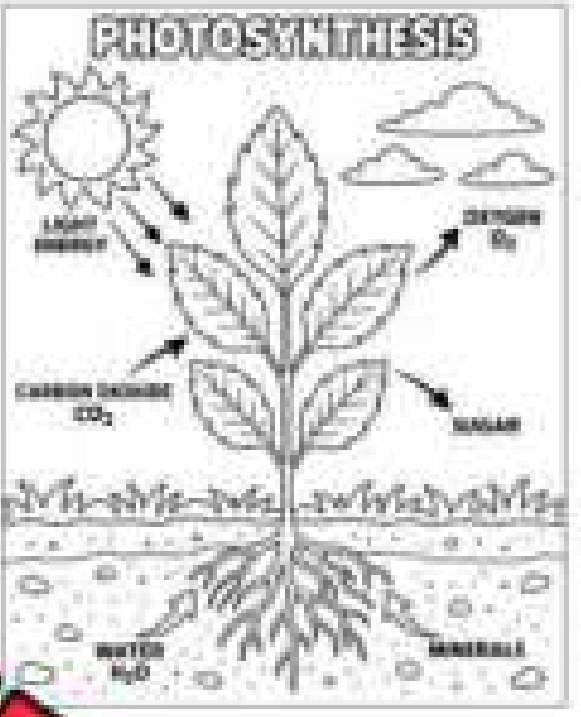
PREVIEW

Name: _____ 64

Plants, Sunlight, and Plant Knowledge

Sunlight Becomes Sugar

Photosynthesis is the process in which plant cells use light energy to convert carbon dioxide and water into glucose and oxygen, as summarized by $6CO_2 + 6H_2O + \text{light energy} \rightarrow C_6H_{12}O_6 + 6O_2$. In the process, light energy becomes chemical energy stored in the bonds of glucose. It takes place in chloroplasts, cell organelles packed with chlorophyll, a green pigment that is a molecule that absorbs some wavelengths of light. Carbon dioxide enters a leaf through stomata, pores mostly on its underside, and oxygen released right away is stored as starch. Plants use roughly 380 to 750 nm.



Why Leaves Look Green

Chlorophyll absorbs light most strongly at 430 nm (blue-violet) and 660 nm (red), but **reflects**, or bounces back, green wavelengths around 570 nm. That reflected light reaches our eyes, so leaves look green. In autumn, trees stop making chlorophyll and the existing molecules break down, which reveals the yellow and orange carotenoid pigments that were hidden underneath. These carotenoids absorb blue light and pass its energy to chlorophyll.

Plant Knowledge in the Boreal Forest

Pimachiowin Aki, meaning "the land that gives life" in Ojibwe, covers 29,000 square miles of boreal forest across Manitoba and Ontario, including Atikaki Provincial Park and Woodland Caribou Provincial Park. UNESCO listed it as a World Heritage Site in 2018 to protect the Anishinaabe cultural landscape that four Manitoba First Nations, Bloodvein, Little Grand Rapids, Pauingassi, and Poplar River, continue to care for. Across the boreal forest, Anishinaabe, Cree and other Indigenous peoples brew Labrador tea (Rhododendron groenlandicum), a plant whose features reflect its sunlit habitat.

- **Habitat** — The larger species grows in black and white spruce forests, while a dwarf species hugs the ground on subarctic tundra.
- **Leaves** — evergreen, dark green and leathery, with woolly undersides and slightly rolled edges, and the shrub belongs to the heath family.
- **Use** — Leaves are steeped in hot water as a drink, and people with training prepare it carefully, since improper preparation can cause illness.

PREVIEW

Name: _____ 65

Define What do the terms below mean?

Pigment	
Reflect	
Sto	

True or False Is ... ise?

1) Chlorophyll absorbs most g...	True	False
2) Chlorophyll absorbs red and blu...	True	False
3) Photosynthesis happens in chloroplasts.	True	False
4) Pimachiowin Aki lies entirely in Manitoba.	...	False
5) Aspen leaves turn yellow as chlorophyll breaks d...	...	False

Question Imagine placing two identical plants in different loca... sunlight and the other in a dark room. How would their gr... after two weeks?

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Sort: used up or made?

Glu	Water
Carb	Sunlight
	Oxygen

Taken in	Produced

Name: _____ | Mark

Sort: used up or made?

Glucose	Water
Carbon dioxide	Sunlight
Starch	Oxygen

Taken in	Produced

Name: _____ | Mark

Sort: used up or made?

Glucose	Water
Carbon dioxide	Sunlight
Starch	Oxygen

Taken in	Produced

Name: | Mark

Sort: used up or made?

Glucose	Water
Carbon dioxide	Sunlight
Starch	Oxygen

Taken in	Produced

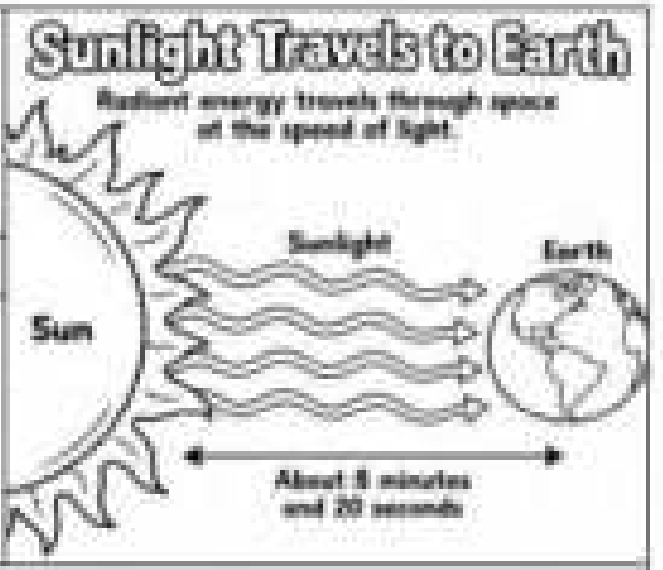
PREVIEW

Name: _____ /10

FAQ: The Sun's Energy

Prairie Sky Outreach Centre — Your Questions About the Sun!

Welcome! We are the Prairie Sky Outreach Centre, and these are the Sun questions visitors ask us most.



How much energy does the Sun give off?

The Sun ra… about 3.8×10^{26} watts (W), where on… one joule of energy per second. Only a… The **solar constant**, the r… square metre facing the Sun ab… space, averages about 1361 W…

How long does su… ke t…

Radiant energy is energy … tic waves, and it crosses space at the speed of light, about 300 … m/s). Because Earth is roughly 150 million kilometres from the Su… inutes and 20 seconds to reach us on average.

What kinds of light make up sunlight?

The Sun's **spectrum**, its range of wavelengths, i… 49% of its radiant energy is infrared, about 43% is visible light, and … le light is the part we can see, and the Sun's output peaks near 500 …

Why does the Sun look yellow?

Seen from space, the Sun is white because it emits every visible co… scatter short blue wavelengths far more than long red ones, so blue … across the sky, and the direct light that reaches your eyes looks yellow. At sunset … shifts toward orange.

What powers the Sun's glow?

Nuclear **fusion** in the core, at about 15 million °C, joins hydrogen nuclei into helium. Each second roughly four million tonnes of the Sun's mass changes into energy, following Einstein's equation $E = mc^2$. That energy slowly travels outward and escapes the surface, which is about 5500 °C.

Will the Sun ever run out of energy?

Yes, but not soon. The Sun is about 4.6 billion years old and has enough hydrogen fuel for roughly five billion more years. After that it will swell into a red giant, a large cool star, but its slow brightening will heat Earth long before then.

PREVIEW

Name: _____ 71

Questions Answer each question in a full sentence.

1) List the three kinds of light in sunlight and their shares.

2) Use the numbers to explain why Earth gets so little of the Sun's output.

PREVIEW

Two Choices Circle the correct answer.

1) The Sun makes its energy by ___.	fusion	burning
2) Air molecules scatter ___ light more.	red	blue
3) Sunlight takes about ___ to reach Earth.	8 min	8 h
4) The smallest share of sunlight is ___.		IR
5) The solar constant is measured in ___.		m/s

Connect The Sun produces enormous amounts of energy through fusion. How is this process different from burning wood or fuel on Earth? Explain why nuclear fusion is important for life on our planet.

Name: _____ 72

Show and Tell: A Device Powered by the Sun

Objective — What are we learning about?

Students will share a device or object that uses the Sun's energy, describing how it looks, feels, and works. This builds descriptive language and helps us explain energy transfers from radiant energy to other forms.



Materials — [illegible] for our activity?

- ❑ A solar-powered [illegible] described)
- ❑ Planning page (provi[illegible]
- ❑ Crayons or pencils for drawing

Instructions — How will we complete our [illegible]

1) Explain that the Sun sends out radiant energy [illegible] transform it into electrical or thermal energy.
2) Ask each student to think of one object that uses or respo[illegible]
3) Give students time to think about what it looks like, feels like and how it works.
4) Hand out the Planning Page and help students fill it in.
5) Invite students to bring their item from home or draw a picture of it instead.
6) Have each student take a turn showing or describing their item to the class.
7) Encourage classmates to listen quietly and respectfully while others share.
8) Allow one kind comment or question after each turn.
9) Keep a tally on the board of the different energy transfers shown.
10) Talk together about how many ways the class found to use the Sun's energy.

PREVIEW

Name: _____ 74

Criteria Use the criteria below to complete the activity.

Criteria	Description
Description	Uses clear, detailed words to describe what the item looks and feels like.
Science	Explains which energy forms are transformed, using terms such as radiant and electrical.
Import	Explains why the item matters and how it uses the Sun's energy.
D	early, faces the audience and answers one question.

PREVIEW

Example Presentati example presentation below.

My [illegible]-P[illegible] Light

I brought a solar garden l[illegible]m ou[illegible]s a small flat panel on top, a plastic post, and a tiny bulb underneat[illegible]

The panel looks dark blue and shiny [illegible] warm after sitting in the sun. During the day it changes sunlight[illegible] and stores it in a small rechargeable battery.

At dusk, a sensor switches the bulb on. The battery's chemical energy becomes electrical energy, then light and a little heat. The light is dim because the panel collects only a small amount of energy.

This matters because it runs with no wires and no fuel, using the Sun's energy that arrives every day.



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Name: _____ /5

Planning Page | Answer the questions below

1) What does your item look like? Describe its shape, size and colour.	

2) How does it feel? Is it smooth, warm, heavy, or light?

3) What [illegible] it make, if any, when it is working?

4) Does it have a [illegible] works?

5) Where does the item get its energy from, and [illegible]

6) Which energy transformations happen inside it?

7) Why is this item useful, and what would we use if the Sun's energy were not available?

PREVIEW

Name: _____ 9A

Draw	Draw your item in the box. Label the parts where light goes in and where energy comes out.



Name: _____ 77

Rubric How did you do on the activity?

Criteria	1 Point	2 Points	3 Points	4 Points
Description	Vague words; little about look or feel	Some details of look or feel; general words	Clear details of shape, texture and how it works	Precise sensory details; vivid, specific words
Scienc	Energy forms missing or rect	Names one energy form; transfer unclear	Explains radiant to electrical or thermal change	Traces full energy chain; labelled diagram
Importance		Gives a general on the item seful	Explains how it uses the Sun's energy	Explains benefits and compares to fuel
Delivery	Hard to h little eye conta	Oft	Clear voice; faces lass; answers estions	Confident; answers with science terms

PREVIEW

Teacher Comments

Mark

Student Comments – What Could You Do Better?

Name: _____ /8

Case Study: Inuit Snow Goggles

Goggles Carved From the Land

Snow goggles are eye shields, carved by Inuit from wood, bone, antler, or ivory, with narrow slits to see through. The word Inuit means "people" in Inuktitut, and the Inuit homeland in Canada, Inuit Nunangat, spans four regions. Hunters who crossed open snow or waited for seals wore them. The Manitoba Museum holds a pair thought to be from Caribou Inuit in Nunavut, the territory that borders Manitoba north and west of Hudson Bay.

Carvers [illegible] goggles today, including Ross Kayotak of Igloolik, who shaped one set from [illegible] one because he had no caribou antler. The Canadian Museum of Hist[illegible] pairs, and one early example, found in an early Inuit house on Bath[illegible] between 1000 and 1600 CE.

Why Snow Glare Hurts the Eyes

Sunlight contains ul[illegible] electromagnetic waves with wavelengths shorter than visible light ([illegible] nanometers), and more energy per photon. Fresh snow reflects about 80% of [illegible] UV, [illegible] with about 15% for dry sand, so a hunter on snow receives UV from [illegible] above. Too much UV damages the cornea, the clear front layer of the eye, [illegible] a painful sunburn of the cornea and conjunctiva that is commonly called snow [illegible]. Healing usually takes 24 to 72 hours once the exposure ends, and bright [illegible] pain [illegible].

How the Design Protects

Museum records explain that the slits reduce the field of vision and the amount of UV reaching the eyes. Three design features work together:

- **Narrow slit** — admits only a thin band of light, which cuts the glare reflected from the snow surface.
- **Curved frame** — follows the face, with a groove for the nose, so light cannot leak in around the edges.
- **Opaque material** — absorbs or blocks light that strikes it, instead of passing rays through as clear glass would.



Modern sunglasses apply the same principle with lenses that absorb UV, and a UV400 label means wavelengths up to 400 nm are blocked.

PREVIEW

Name: _____ 79

Finish the Sentence

Complete each sentence below.

1) Snow goggles have narrow slits because...

2) Eyes on fresh snow face more UV than on bare ground, which means...

Questions

Answer the questions below.

1) What is photoker[illegible]?

2) Explain how slit, curve, and opaque mate[illegible] re[illegible]

3) Why might goggles matter more on open snow than on a fore[illegible]

PREVIEW

Odd One Out

Circle the word that does not belong in each group.

Bone	Glass	Antler	Ivory
Cornea	Glare	UV exposure	Field of view

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Read the clue and write the answer.

1) Waves just shorter than violet light that snow reflects	
2) About what percent of UV does fresh snow reflect?	
3) Unit of one billionth of a metre, used for wavelengths.	
4) Territory north and west of Hudson Bay where goggles were made	

Name: _____ | Mark

Read the clue and write the answer.

1) Waves just shorter than violet light that snow reflects	
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PREVIEW

Name: _____ 81

Case: Solar Panel vs Hydro Dam

Two Ways to Make Electricity

Case 1: A Rooftop Solar Panel

A **photovoltaic cell** is a semiconductor device, usually made of silicon, that converts radiant energy from sunlight directly into electrical energy. Photons striking the cell free electrons that are pushed around a circuit and Becquerel first obse and Bell Labo built commercially practical silico has no moving parts, sh energy to elect best commercial mo little over 24% of the li **efficiency**, the percentage of transformed into useful output. the light is reflected or becomes therm energy, so panels grow hot in full sun. Silicon makes up about 95% of module production.

Case 2: Keeyask Hydro Station

The Keeyask Generating Station on the Nelson River has a net capability of 637 megawatts (MW). Its dam raises the water level, storing gravitational potential energy in the reservoir. As water drops through the intake, that energy becomes kinetic energy of fast-flowing water, which spins a turbine, a wheel with angled blades. The turbine turns a generator, which transforms rotational kinetic energy into electrical energy by electromagnetic induction. This longer chain wastes little: hydropower converts up to 95% of energy to electricity, and about 9 ba's electricity is estone Generating elson River, has a

PREVIEW





What This Teaches Us

Both stations perform an **energy transformation**, a change of energy from one form to another, and both obey the law that total energy stays constant. The two differ in efficiency, roughly 24% for a panel against up to 95% for a dam, yet both depend on the Sun, because solar heating evaporates the water that returns as rain and refills the rivers. Energy that does not leave as electricity is dissipated as thermal energy into the surroundings. It is not destroyed, only less useful, so engineers compare chains by efficiency, reliability, and location. Dust, shading, and heat cut a panel's output, while a reservoir stores water for later use.

Name: _____ 82

True or False Is the statement true or false?

1) Water held behind a dam stores thermal energy.	True	False
2) A photovoltaic cell turns light into electricity.	True	False
3) Hydro stations are less efficient than solar panels.	True	False
4) Keeyask Generating Station is on the Nelson River.	True	False
5) Efficiency compares useful output with total input.	True	False

Questions Answer the questions below using evidence from the text.

1) Compare the energy losses of a solar panel and a hydro station.

2) Why is the energy a panel loses as heat destroyed? Use the text.

Making Connections Pick a device you use that runs on electricity. Trace its energy chain back as far as you can and say where energy is lost.

PREVIEW

Name: _____ 84

Drawing Contest – Design an Energy Chain

Objective What are we learning about?

Students will draw an energy chain for a solar panel or a hydroelectric station, labelling each transformation. This helps students show how energy changes form from source to use.

Materials What will you need for the activity?

- ❑ Drawing paper (1 per student)
- ❑ Crayons, coloured pencils
- ❑ Pencils and erasers
- ❑ Reference list of drawings (provided)



Instructions How will you complete the activity?

1) Talk together about how a solar panel and a hydroelectric station each produce electricity.
2) Look at the Reference List for ideas or think of your own energy chain.
3) On your paper, draw your chain from the energy source to the final use.
4) Include at least three steps and label each energy transformation with an arrow.
5) Add colour and details to your drawing to make it special.
6) When you are finished, be ready to explain each step and where energy is lost as heat.
7) Display all entries around the classroom.
8) Vote together on fun categories like 'Most Detailed' or 'Most Creative' so every entry is celebrated.

PREVIEW

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Name: _____ 85

Reference List of drawing ideas

#	Drawing idea
1	A solar panel on a roof with sunlight arriving
2	Sunlight hitting a field of solar panels
3	A dam holding back a reservoir
4	Water rushing down a pipe toward a turbine
5	A t[illegible]inning inside a power station
6	A [illegible]ected to power lines
7	[illegible] prairie
8	A home [illegible] a solar panel
9	A battery [illegible]
10	Arrows showing [illegible]
11	A river above and be[illegible]
12	A transformer beside a power st[illegible]
13	A calculator with a small solar ce[illegible]
14	A wind turbine next to a solar farm
15	A city skyline lit up at night

PREVIEW

Criteria Use the criteria below to complete the activity.

Criteria	Description
Energy source	Shows clearly where the energy comes from, such as the Sun or falling water.
Transformations	Includes at least three labelled energy changes in the right order.
Energy loss	Shows where some energy leaves the chain as heat.
Labels	Uses correct science words to label each step.
Neatness	Drawing is neat, colourful, and easy to follow.

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[illegible]

Name: _____ 86

Reflection Answer the questions below.

1) Which step in your chain loses the most energy as heat? Explain how you know.

2) How a[illegible] panel and a hydroelectric generator alike and different?

3) What would you [illegible] electricity reaching a home?

PREVIEW

Word Scramble Unscramble the words from the word bank.

WORD BANK			
turbine	battery	heat	panel
reservoir	generator	current	sunlight

ALNPE		URBINET	
TEAGRREON		URRENTC	
DEVRRREIS		ATTERYB	

Name: _____ #7

Rubric How did you do on the activity?

Criteria	1 Point	2 Points	3 Points	4 Points
Energy source	Source missing or not shown	Source drawn but not named	Names the source, e.g. Sun or falling water	Names source and its energy form
Transform[illegible]	Fewer than two changes; out of order	Two or three changes; some out of order	Three labelled changes in the right order	Four or more changes; each one explained
En[illegible]	[illegible]y loss [illegible]	Shows a loss but not as heat	Shows energy lost as heat at one step	Shows heat loss at several steps
Labels	[illegible] sci[illegible]	[illegible] labels; [illegible]rds	Labels each step with science terms	Precise terms, e.g. radiant, kinetic
Neatness	Messy; chain hard to follow	T[illegible] som[illegible] coloured; a[illegible] uncl[illegible] [illegible]ows		Colour shows each energy form

PREVIEW

Teacher Comments

[illegible]ark

Student Comments – What Could You Do Better?

Name: _____ 88

Story: Sunlight to Sandwich

Draw Draw pictures to illustrate the story.

On a July morning in a wheat field near Portage la Prairie, Manitoba, sunlight reached a leaf. It had travelled 150 million kilometres from the Sun in about 8.3 minutes. Mia's grandfather farmed there, and she helped him check the crop between [illegible] practices.



The wheat plant carried out **photosynthesis**, the process in which plants use light energy to change carbon dioxide and water into glucose, storing the energy as chemical energy. Wheat is a grass whose kernels hold most of its stored energy. Typical crops store only 1 to 2% of the sunlight they receive as biomass. Most of the rest is reflected or warms the field. By August, the glucose had become starch packed inside each kernel.

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In September, a combine harvester cut the wheat, burning diesel fuel, a chemical energy store, to move and thresh the crop. Its engine converted only part of the fuel's energy into motion, and exhaust and engine heat carried the rest away. At a mill, steel rollers ground the kernels into flour. A baker mixed flour, water, and yeast, and an oven transferred thermal energy into the dough until it became bread.



The next Saturday, Mia packed a sandwich made with that bread. Eating it, she began digestion, the process of breaking food into nutrients the body can absorb. Enzymes broke the starch down into glucose. The small intestine absorbed it through its lining, her blood carried it to every cell, and the brain, which relies on glucose constantly, received its share. There, **cellular respiration**, the release of energy from glucose using oxygen, freed the chemical energy that the wheat had stored months earlier. Each step also released a little thermal energy, which helps keep body temperature near 37 degrees Celsius (37°C).

Name: _____ 90

At 2 p.m., Mia crouched at the start of the 1500-metre race at her school track meet and listened for the whistle. The air smelled of cut grass, and her heart pumped faster, delivering glucose and oxygen to her leg muscles. She tightened her shoelaces.



Her leg muscles converted only about 25% of the chemical energy into kinetic energy, the energy of motion. The rest became thermal energy, so her skin flushed and sweat evaporated to carry heat away. Air resistance and friction with the track passed on more energy, and the sound of her footsteps and the cheering crowd spread out as sound energy. Her breathing deepened to supply oxygen, her body temperature climbed above 37°C, and her sweat glands released water to cool her. At the finish line, every joule was still accounted for, spread out as warmth in the air, the track, and the grass.

Name: _____ #1

Ordering

Number these events 1 to 8 in the order they happened in the story.

	Mia's muscles release energy as she runs the race.
	Sunlight reaches a wheat leaf in a Manitoba field.
	The mill grinds the harvested kernels into flour.
	Thermal energy spreads into the air and the track.
	P[illegible]thesis stores energy as starch in the kernels.
	[illegible] the dough into bread.
	[illegible] cuts the ripe wheat.
	Mia [illegible] glucose.

Question

Why did [illegible] Sun's energy reach Mia's muscles?

Visualization

Draw the energy chain from the field to the [illegible].

PREVIEW

Name: _____ 92

Story: Lights Over Churchill

Green Fire Over the Bay

On a clear February evening, Grade 8 students from Churchill rode 23 kilometres east to the Churchill Northern Studies Centre for a night of land-based learning.

Mrs. [illegible]nce, a Cree knowledge [illegible] grew up near Chur[illegible] viewing dome [illegible]e we [illegible] look around." She s[illegible] how wind hard[illegible] dr[illegible] point along its di[illegible] ski[illegible] family still uses on th[illegible]

Then she handed ou[illegible] "Cree and Dene peoples have [illegible] this region for generations, and c[illegible] observation is how knowledge is built," [illegible]. "Re[illegible], the colour, the shape and the direction."

At 10:40 p.m., a pale green arc rose in th[illegible] With [illegible] rippled into curtains. Devon wrote: green, moving, low in the [illegible]

The curtains brightened, and the students fell [illegible] several [illegible]

Aisha had read ahead. "The Sun constantly release[illegible] w[illegible] charged particles, mostly protons and electrons, moving at [illegible] 40[illegible] second," she said. "That means it crosses 150 million kilometres in [illegible] Earth's magnetic field steers the particles toward the poles, and Churchill [illegible] neath the auroral oval."

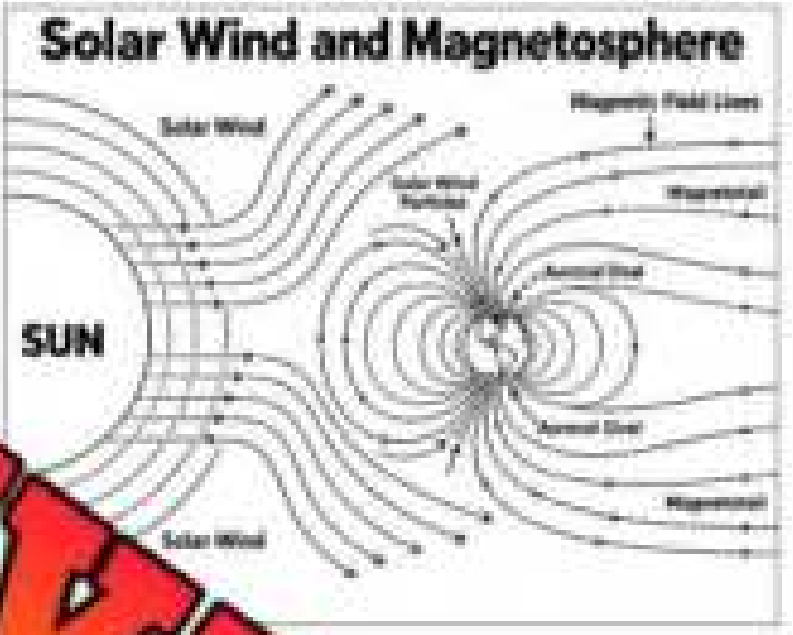
"What happens when they arrive?" Mrs. Spence asked.

Marcus answered. "About 100 kilometres up, they collide with atoms of oxygen and nitrogen. Each collision transfers kinetic energy, so the atoms become excited, and they release that energy as light. Excited oxygen glows green at 557.7 nanometres."

A faint red edge appeared above the green. Devon noted it. "Oxygen higher up emits red at 630 nanometres," Aisha added, "and nitrogen adds blue along the lower edges."

Mrs. Spence smiled. "Your notebooks and the physics describe the same sky from two directions. Observation passed along over years, and instruments that measure, make a fuller picture together."

On the ride home, the students compared their notes, amazed that Churchill can see the aurora on up to 300 nights a year. Mrs. Spence added that February and March offer the best viewing, with long, cold, clear nights.



PREVIEW

Name: _____ 93

Ordering Put these story events in the correct order by numbering them 1 to 8.

	A pale green arc rises in the north.
	Students ride 23 km east to the Studies Centre.
	A faint red edge appears above the green.
	Mrs. Spence shows how snow drifts show wind direction.
	M[illegible] describes collisions with atoms 100 km up.
	S[illegible]rs asked to record time, colour, and shape.
	[illegible] their notes on the ride home.
	[illegible] solar wind and Earth's magnetic field.

What Did You Lear[illegible] Thi[illegible]hole story, then answer below.

1) What is the solar wind, a[illegible] to reach Earth?

2) Why did Mrs. Spence say notebooks and p[illegible] ture?

Making Connections Describe a time you watched the sky or land closely a[illegible]ced a pattern. What did you record?

PREVIEW

Name: _____ 95

Role Play – Lights in the Northern Sky

Objective What are we learning about?

Students will act out short scenarios about the aurora, solar wind, and the atmosphere, then discuss the science behind them.

Materials t will we need for our activity?

- ☐ S… d)
- ☐ Props or …
- ☐ Timer or stopwa…



Instructions How will we co…

1) Divide the class into small groups of 3 to … ents.
2) Provide each group with a scenario card th… about the aurora.
3) Let each group decide who will take which role within the …
4) If available, distribute props or costumes that help students in … oles.
5) Set the timer to allocate a specific amount of time for the groups to discuss and act out their scenarios.
6) Allow each group to present their role-play to the class.
7) After all groups have presented, hold a class discussion about the different approaches and the science used.
8) Distribute reflection sheets so students can share what they learned and felt during the activity.

PREVIEW

Name: _____ 9s

Criteria Use the criteria below to complete the activity.

Criteria	Description
Science ideas	Uses correct ideas about solar wind, gases, and the atmosphere.
Teamwork	Every group member has a role and takes part.
Evidence	Gives reasons and evidence to support the decision.
Respe	sters to others and speaks respectfully.
Pres	learly and stays in role.

Scenario Card the ios below.

Scenario		Description
1	**Aurora Alert**	A group of frend ht walk spots green ribbons moving across th he . One person says it is only city light boun ff another is sure it comes from space. Eve nt explanation. How could the group use what it knows d and the atmosphere to explain it?
2	**Colour Quiz**	A class is watching a time-lapse video of the aurora with green, red, and purple parts. Someone asks why the colours differ. Others disagree about the cause. What could the group say about the gases that glow and the heights where they are found?

PREVIEW

Name: _____ 97

Scenario Cards Cut out the scenarios below.

	Scenario	Description
3	**Solar St**	A family hears a news report that a strong solar storm is heading toward Earth. One person worries the power will fail, while another says it will only make a better light show. What should the family decide to do, and reasons can it give?
4	**Knowledge Keeper**	mes a visiting knowledge holder from a munity who has watched the night sky life prepare questions about how the lights an on. How should the group ask respectful q refully?
5	**Photo Problem**	A group of friends tries hts with a phone, but the pictures come One person says the camera is broken. An camera needs more time to collect light. should the group try, and why?
6	**News Report**	A group puts together a pretend television report on a night of strong aurora activity. One person must explain what the solar wind is, and another must explain why the lights appear near the poles. How will the group share the roles and explain it clearly?

PREVIEW

Name: _____ 98

Scenario Cards Cut out the scenarios below.

	Scenario	Description
7	**Fake Post**	Someone shows a social media post claiming the aurora is only moonlight reflecting off snow. Others are not sure. The group wants to reply with evidence. What facts about particles, gases, and light could the group use to respond?
8	**Neon Sign**	[illegible] at a glowing neon sign says it works [illegible] gas lit up by energy. Others say [illegible] common. How could the group decide [illegible] really are?
9	**Trip Planning**	A family plans a [illegible] trip [illegible] the lights and must choose a night [illegible] check for clear skies and solar activity. [illegible] go on the night with the brightest [illegible] What should the family consider, and why?
10	**Radio Fade**	A group of radio hobbyists notices heavy static during a strong solar storm. Some think their equipment is broken. Others suspect the storm. What could the group check, and how might charged particles be involved?

PREVIEW

Name: _____ 99

My Role	Draw your role in the scenario. Show what you would say or do and include one science idea.



Name: _____ 100

Reflection

Create an acrostic poem using the word provided below. Your poem should relate to the word shown.

A	
C	
R	
O	
R	
A	

PREVIEW

Name: _____ 101

Rubric How did you do on the activity?

Criteria	1 Point	2 Points	3 Points	4 Points
Science ideas	Wrong or missing ideas about the aurora	Some correct ideas; few science terms	Explains solar wind and glowing gases	Links particles, gases and height correctly
Teamwo	Few members take part	Roles unclear; some members take part	Every member has a role and takes part	Shares roles evenly; supports others
Evid	N	Gives reasons but little evidence	Supports the decision with evidence	Strong evidence; answers other views
Respect	Inter… listen…	…ome…	Listens; speaks respectfully	Builds on others' ideas respectfully
Presentation	Hard to hear; breaks role	Som… Clear… party in role…	…learly …le	Confident; role shows the science

PREVIEW

Teacher Comments

…rk

Student Comments – What Could You Do Better?

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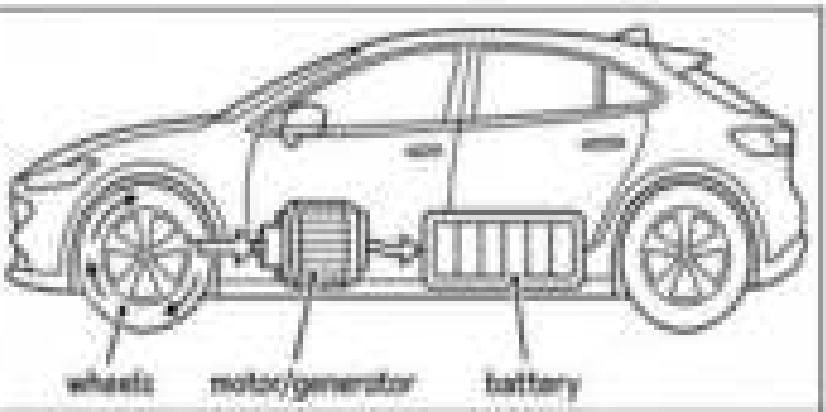
Name: _____ 102

Interview: An EV Specialist

Student: What is an electric vehicle, exactly?

Ms. Tran: An electric vehicle (EV) is driven by an electric motor that draws power from a rechargeable lithium-ion battery pack instead of burning fuel.



Student: Where does the energy come from?

Ms. Tran: From charging. Charging converts electrical energy into the battery's chemical store. In Manitoba, nearly all electricity is generated by hydro stations.

Student: How efficient is it?

Ms. Tran: Very. An EV converts about 77% of electrical energy into power at the wheels. A gasoline vehicle converts only about 12–30% of its fuel energy.

Student: Where does the rest of the energy go?

Ms. Tran: It dissipates as thermal energy: the motor, battery, and friction and air resistance heat the tires, road, and air around the vehicle.

Student: What is regenerative braking?

Ms. Tran: Braking reverses the motor so the turning wheels drive it as a generator, converting kinetic energy into electricity stored in the battery.

Student: So, no braking energy is ever wasted?

Ms. Tran: Some always becomes thermal energy, so recovery is never complete. Friction brakes still handle sudden stops.

Student: Has Winnipeg tried electric vehicles?

Ms. Tran: Yes. In 2014 Winnipeg Transit ran New Flyer electric buses on a 40 km route; about 10 minutes of charging restored a trip's energy.

Student: Thank you, Ms. Tran, for explaining EVs!

PREVIEW

Name: _____ 103

Fill in the Blanks Circle the missing word.

1)	A charged battery is a _____ energy store.	elastic	chemical
2)	Braking makes the motor act as a _____.	generator	battery
3)	Wasted EV energy ends up as _____ energy.	thermal	nuclear
4)	An EV wastes _____ energy than a gas car.	less	more
5)	Energy is conserved, so none is _____.	destroyed	transferred

Questions Answer the questions below using what you read.

1) Describe how regenerative braking recovers energy.

2) Why might EVs waste less energy in stop-and-go traffic?

Think Imagine you are the Student. What follow-up question would you ask Ms. Tran, and why?

PREVIEW

Name: _____ 105

Newspaper Article: Webb Telescope Launch

Webb Telescope Launches to Seek the Universe's Earliest Light

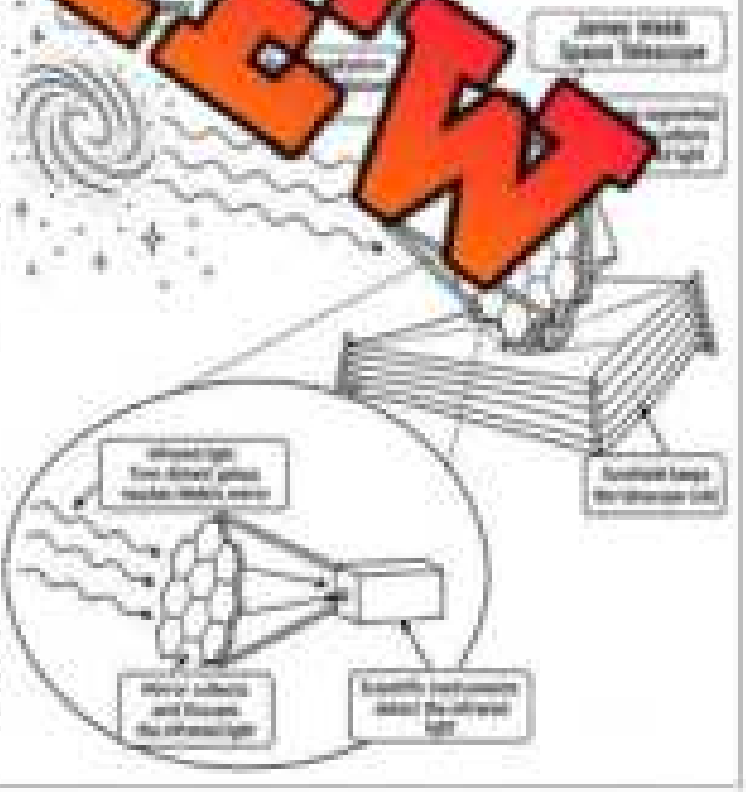
Publish Date: December 25, 2021

KOUROU, FRENCH GUIANA — The James Webb Space Telescope lifted off at 7:20 a.m. Eastern Time on December 25, 2021, aboard an Ariane 5 rocket from Europe's Spaceport, in partnership of NASA, the European Space Agency, and the Canadian Space Agency. Its primary mirror is 6.5 metres (m) across, more than the 2.4 m mirror of the Hubble Space Telescope, and it has a gold-coated, hexagonal segments, for a total area that together collect light over about 25 square metres (m²).

Webb observes mainly **infrared radiation**, electromagnetic waves with wavelengths slightly longer than red light, which we feel as heat. Infrared lets astronomers study the first galaxies, because the expansion of the universe has stretched their light into longer wavelengths, and it passes through dust clouds that block visible light. Because every warm object emits infrared, Webb must stay extremely cold. A five-layer sunshield the size of a tennis court, 21.2 m by 14.6 m, keeps its instruments near negative 233 degrees Celsius (−233°C). It will orbit Lagrange point 2 (L2), about 1.5 million kilometres (km) from Earth.

Canada built two key parts. The Fine Guidance Sensor keeps the telescope pointed with a precision of one-millionth of a degree, and the Near-Infrared Imager and Slitless Spectrograph (NIRISS) will study distant galaxies and the atmospheres of exoplanets, planets orbiting other stars. The Canadian Space Agency invested about $177.8 million in these instruments between 1998 and March 2021, and Dr. René Doyon of the Université de Montréal is NIRISS's principal investigator.

"Webb is the largest space science project in the 60-year history of Canada's space program," said François-Philippe Champagne, then Minister of Innovation, Science, and Industry. In Winnipeg, amateur astronomer Mireille Bouchard watched the launch online at home before work. "Every infrared picture will show us light that has been traveling for billions of years," she said. Over the next six months, controllers will unfold the sunshield, align the mirror segments, and calibrate the instruments before science operations begin.



PREVIEW

Name: _____ Date: _____

True or False Is the statement true or false?

1) Webb was launched from French Guiana.	True	False
2) Webb's sunshield keeps its instruments very cold.	True	False
3) Webb mainly detects visible light.	True	False
4) Webb was launched on December 25, 2021.	True	False
5) Webb's mirror is smaller than Hubble's mirror.	True	False

Questions Answer the questions below using what you read.

1) Why must Webb's detectors be kept so cold?

2) Describe Canada's role in the Webb telescope and why it matters.

Opinion Write a comment for the newspaper: Was building Webb worth it? Use two facts from the article.

Username: _____ Date: _____

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Read each clue and write the answer.

1) Webb's 25 m² light collector has 18 gold hexagons. What is it?	
2) Webb orbits this point, 1.5 million km away. What is it called?	
3) This Canadian sensor aims Webb to a millionth of a degree. Name?	
4) NIRISS studies the atmospheres of these planets. Name them.	

Name: _____ | Mark

Read each clue and write the answer.

1) Webb's 25 m² light collector has 18 gold hexagons. What is it?	
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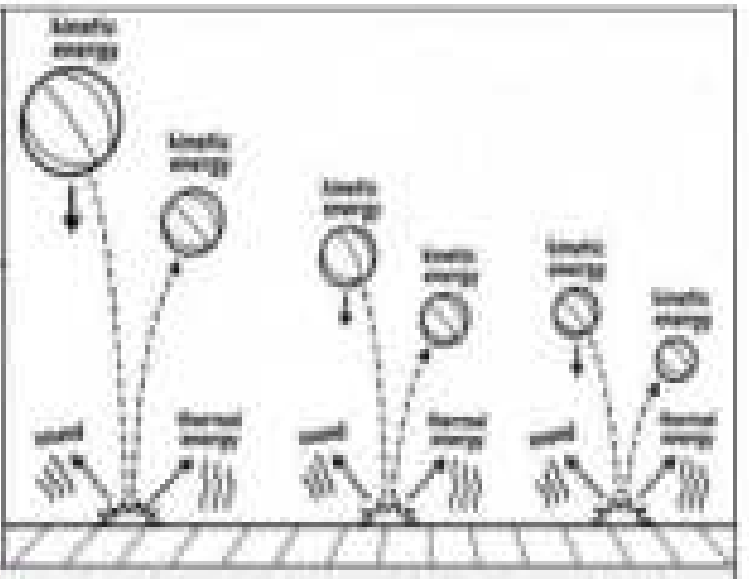
PREVIEW

Name: _____ 108

Podcast Script: Can Energy Ever Disappear?

Host (Sam): Welcome to Science Signal, the podcast for curious Grade 8 minds! Today we ask whether energy can ever disappear. Joining us is physicist Dr. Reyes, who will bust a few myths.



Dr. Reyes: [illegible], Sam! Myth one says energy ge[illegible]. In fact, the law of conserv[illegible] states that energy cann[illegible]ved, only tran[illegible] the total in a closed s[illegible]

Host (Sam): So [illegible] energy go?

Dr. Reyes: Each bounce [illegible] kinetic energy becomes sound, moves the air, and slightly warms the [illegible] stops, yet every joule has spread into its surroundings.

Host (Sam): Is that what people call [illegible]?

Dr. Reyes: Yes. Wasted energy is energy that [illegible] spread out as thermal energy where it cannot easily be used. [illegible] about 90% of its energy as heat and only 10% as light.

Host (Sam): How do engineers measure that waste?

Dr. Reyes: With efficiency, the useful energy output divided by the [illegible], multiplied by 100%. A bulb that turns 100 joules into 10 joules of light is [illegible]cient; the other 90 joules dissipate.

Host (Sam): Then what about perpetual motion machines?

Dr. Reyes: A perpetual motion machine would run forever without an energy input. In 1775 the Paris Academy of Sciences stopped examining such designs. Energy is conserved and friction dissipates some, so no machine runs forever.

Host (Sam): Who first measured this carefully?

Dr. Reyes: James Prescott Joule did. He used falling weights to turn a paddle wheel in water and measured the heating, and the joule, the SI unit of energy, honours him. Energy never vanishes; it changes form and spreads out.

PREVIEW

Name: _____ 109

Fill in the Blanks Circle the missing word.

1)	Energy cannot be created or _____.	measured	destroyed
2)	Spread-out, unusable energy is _____.	conserved	dissipated
3)	A 10% efficient bulb wastes 90% as _____.	heat	light
4)	The unit of energy honours James _____.	Joule	Watt
5)	The [illegible] targeted _____ motion.	perpetual	constant

Questi [illegible] questions below using what you read.

1) Why can no [illegible] without an energy input?

2) How does a bulb's efficiency show that ener[illegible]ons?

Think Imagine you are Sam, the host, interviewing Dr. Reyes again. [illegible] question would you ask next, and why?

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Circle where a bouncing ball's energy goes.

Moving air	Bigger bounces
Warmer floor	Destroyed
Free energy	Warmer ball
Energy created	Sound waves

Name: _____ Mark

Circle where a bouncing ball's energy goes.

Moving air	Bigger bounces
Warmer floor	Destroyed
Free energy	Warmer ball
Energy created	Sound waves

Name: _____ Mark

Circle where a bouncing ball's energy goes.

Moving air	Bigger bounces
Warmer floor	Destroyed
Free energy	Warmer ball
Energy created	Sound waves

Name: _____ Mark

Circle where a bouncing ball's energy goes.

Moving air	Bigger bounces
Warmer floor	Destroyed
Free energy	Warmer ball
Energy created	Sound waves

PREVIEW

Name: _____ L11

Letter: From a Dermatologist

Dear Grade 8 Scientists,

I am a dermatologist, a physician who diagnoses and treats diseases of the skin, and I am writing to explain what ultraviolet (UV) radiation does inside your skin cells, because the damage begins long before a sunburn appears.

Every skin cell stores its instructions in **DNA** (deoxyribonucleic acid), a long molecule built from chemical units called bases. When DNA absorbs UV-B radiation, two neighbouring thymine bases can bond to each other and bend the molecule. Cells have repair enzymes that fix most of this damage, but a repair that fails is copied the next time the cell divides. A **mutation** is a permanent change in the order of the bases in DNA.

Most mutations are harmless, yet some strike genes that tell a cell when to stop dividing. Such cells can grow without control and form a tumour, which is how skin cancer begins. **Melanoma**, the most dangerous type, starts in melanocytes, the cells that make the brown pigment melanin. In 2024 an estimated 8,000 Canadians were diagnosed with it, and in young adults aged 15 to 29 it is the fourth most common newly diagnosed cancer.

A tan is not healthy colour; it is the skin's response to injury. In 2009 the International Agency for Research on Cancer classified ultraviolet-emitting tanning beds as "carcinogenic to humans," and starting before the age of 30 raises the risk of melanoma by about 75 percent.

Protection works. Health Canada recommends a broad-spectrum sunscreen with a **sun protection factor (SPF)** of 30 or higher, because it takes 30 times longer needed to cause sunburn with sunscreen on and off. Apply about 30 millilitres (mL), roughly a shot glass, to the whole body, then reapply 20 minutes after going outside and at least every 2 hours. Add a wide-brimmed hat, shade at midday, and UV-blocking sunglasses.



Finally, check your moles monthly using the ABCDE rule: asymmetry, uneven border, varied colour, diameter larger than 6 millimetres (mm), and evolving shape or size. Show any change to a doctor promptly, because melanoma found before it spreads is far easier to treat.

Sincerely,

Dr. Priya Nair, Dermatologist

PREVIEW

Name: _____ L12

Questions

Answer the questions below.

1) How does UV radiation lead to a mutation in a skin cell?

2) Why is a mole that changes over time worth showing a doctor?

PREVIEW

This or That

1	Broad-spectrum SP		nning oil, no SPF
2	Shade at midday		ing at midday
3	Fashion lenses, no UV rating		UV unglasses
4	Bare head all day	or	brim
5	Check moles monthly	or	
6	Skip the tanning bed	or	Book

Draw

Box 1: draw a skin cell with UV rays hitting its DNA.
Box 2: draw yourself with sun protection.

1	
2	

Name: _____ 114

Mark: /

Unit Test

Energy

Part 1 Answer the questions below.

1) Energy is measured in...

A) watts
B) hertz
C) joules
D) [illegible]

2) Wasted energy mostly becomes...

A) thermal energy
B) nuclear energy
C) chemical energy
D) elastic energy

3) H[illegible]

A) less p[illegible]
B) more p[illegible]ergy
C) longer wave[illegible]
D) slower speed

4) Longest visible wavelength?

A) Violet
B) Green
C) Blue
D) Red

5) Microwave ovens use a...

A) antenna
B) prism
C) magnetron
D) photocell

6) The[illegible]cameras detect...

A) [illegible]ight
B) infr[illegible]
C) [illegible]
D) rad[illegible]s

7) Which UV band reaches us most?

A) UV-B
B) UV-C
C) UV-A
D) Gamma

8) Leaves look gre[illegible]

A) absorb green lig[illegible]
B) emit green light
C) make green sugar
D) reflect green light

9) X-rays were discovered by...

A) Wilhelm Röntgen
B) William Herschel
C) Johann Ritter
D) Heinrich Hertz

10) UV damage can cause a...

A) stronger bone
B) mutation in DNA
C) new organelle
D) blood clot

PREVIEW

Part 2 Draw a horizontal electromagnetic spectrum that includes all seven major types of electromagnetic radiation. Arrange them from longest wavelength to shortest wavelength.

Mark
/

Part 3 Draw an electric vehicle with ... using its battery, electric motor, and wheels. Use arrows to ... what ... energy when the vehicle accelerates. Explain how the ... motor during braking.

Mark
/

PREVIEW

Part 4 Answer the long answer question below.

Mark /

1) Imagine that you are an aurora researcher working in Churchill, Manitoba. Explain how charged particles from the Sun interact with Earth's magnetic field and atmosphere to produce the northern lights. Include how collisions with atmospheric gases produce different colours of light.

PREVIEW

Part 5 Answer each of the questions below.

Mark /

1) A flashlight becomes warm after being switched on for a few minutes. Explain why this does not violate the law of conservation of energy.

2) What is the main difference between how a photovoltaic solar panel generates electricity and how a hydroelectric station generates electricity?

Workbook Preview

Grade 8 Science Unit
Fields

Strands A – D		
	Curriculum Outcomes	**Pages**
SCI.8.A (Strand A)	Demonstrate an understanding of different First Nations, Métis, and Inuit ways of knowing, being, and doing in relationship with the land and the natural world by exploring Indigenous methods of observing and interpreting the world, applying scientific principles, and creating technologies within local traditional and contemporary cultural contexts (e.g., wholistic, reciprocal, interconnected, and sustainable ways; land-based learning; outdoor learning; intersections with Western science).	52–54, 64–68, 77–78, 91–100
SCI.8. (Strand	Develop a sense of agency, identity, and belonging in science by • cultivating natural curiosity about the world • [illegible]	7–14, 21–23, [illegible] 36–38, 55–63, 79–90, –108
SCI.8. (Strand	[illegible] • Careers, Hobbies, and Activities	27–29, 39–42, 72–76, –103, –112
SCI.8.D (Strand D)	**Purpose**: Science is about finding the cause or causes of phenomena in the natural world. **Method**: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time. **Application**: The knowledge produced by science is used in engineering and technologies to create products and processes. **Implication**: Applications of science often have ethical, environmental, social, economic, and political implications.	24–26, 46–48

Preview of 80 pages from this product that contains 163 pages total.

Strand E – Scientific Knowledge		
	Curriculum Outcomes	**Pages**
SCI.8.E.T	Demonstrate the understanding that energy from the Sun travels through empty space to Earth, where it is absorbed or reflected by the atmosphere, hydrosphere, and lithosphere. Include the following: radiation, electromagnetic waves, solar spectrum, albedo.	7–112

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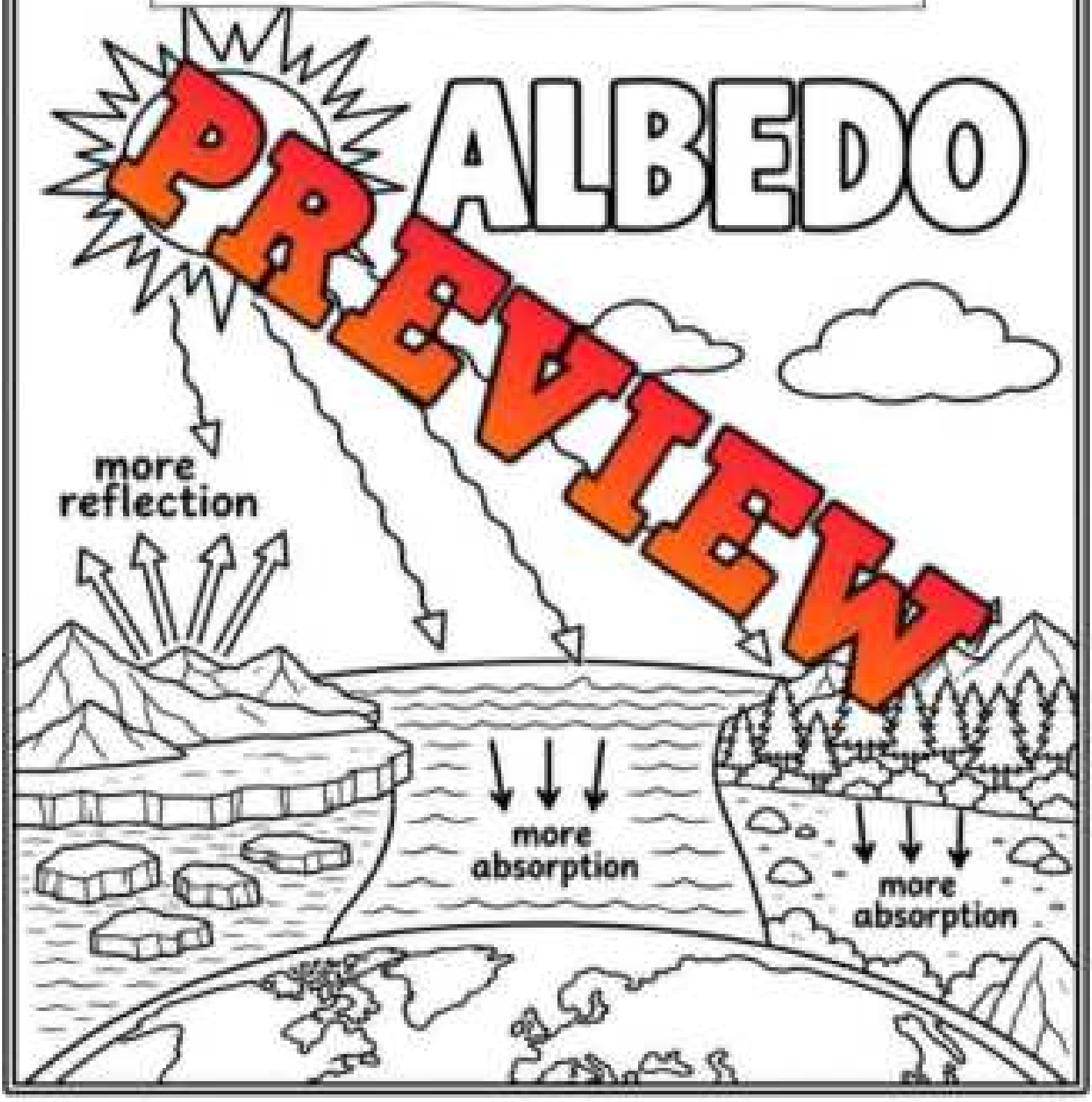
Name: _____

FIELDS

ALBEDO

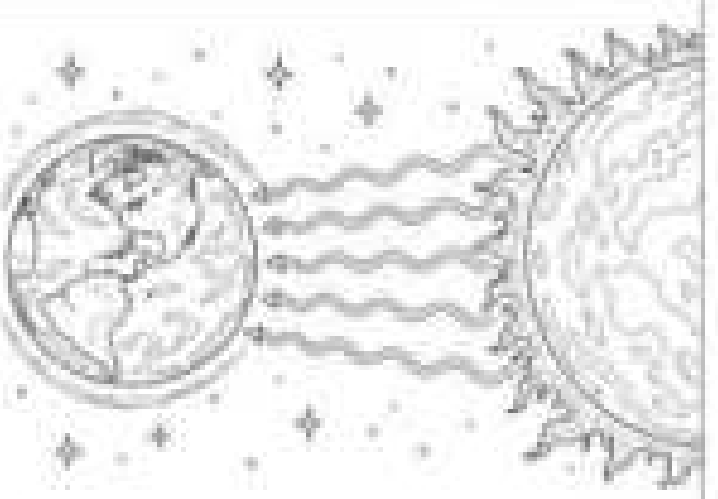


Name: _____

The Sun: Earth's Energy Source

A Star at the Centre

The Sun is a **star**, a massive sphere of hot gas that makes its own light and heat. It is about 1.4 million kilometres (km) across, more than 100 times the width of Earth, and it holds 99.8 percent of the mass of the entire solar system; measuring that mass would take more than 330 [illegible]s. Earth orbits at an average [illegible] 150 million km, close enough [illegible] sunlight but far enough [illegible]ed. The Sun formed [illegible] 4.6 [illegible] from a collapsing cloud [illegible] is made mostly of hydrogen [illegible]elium.



Fusion in the Core

The Sun's energy comes from [illegible] in which the nuclei of light atoms join to form a heavier nucleus [illegible] core, a region about 138 000 km thick, where the temperature reaches [illegible] million degrees Celsius (15 000 000°C), where the density is about 150 grams [illegible] than 13 times that of lead, four hydrogen nuclei fuse into one helium [illegible]. Each [illegible] about 4 million tonnes of the Sun's mass is converted into ener[illegible] energy [illegible]ly 170 000 years to reach the top of the convection zone, a lay[illegible] surface, before it escapes into space.

Energy Sent into Space

The Sun radiates energy at a rate of about 3.8 × 10²⁶ watts (W). Bec[illegible] it radiates out in every direction. Earth intercepts only about one part in two billion [illegible] output. Even that small share powers weather, water cycles, and life.

- **Solar energy** — radiant energy released by the Sun, carried to Earth as light, infrared and ultraviolet waves
- **Convection zone** — the layer where hot gas rises and cooler gas sinks, carrying energy toward the surface
- **Photosphere** — the visible surface layer, about 5 500°C, which radiates the light we see
- **Solar wind** — a stream of charged particles flowing outward from the Sun, which helps cause the northern lights over Churchill

PREVIEW

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Name: _____ 7

True or False

Circle whether the statement is true or false.

1) Fusion in the Sun's core turns helium into hydrogen.	True	False
2) The Sun is a star made mostly of hydrogen and helium.	True	False
3) The Sun holds about 99.8% of the solar system's mass.	True	False
4) The Sun's visible surface is hotter than its core.	True	False
5) Earth o about 150 million km from the Sun.	True	False

Questi

questions below using evidence from the text.

1) Describe h the Sun's core produces energy.

2) Why is the Sun's core, not its surf energy?

Visualizing

Draw the Sun from core to surface. Lab

PREVIEW

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Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Which one is the lie?

	Energy escapes the Sun's core within a few seconds.
	The Sun is more than 100 times wider than Earth.
	Solar wind is a stream of charged particles.

Name: _____ | Mark

Which one is the lie?

	Energy escapes the Sun's core within a few seconds.
	The Sun is more than 100 times wider than Earth.
	Solar wind is a stream of charged particles.

Name: _____ | Mark

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Name: _____ | Mark

Which one is the lie?

	Energy escapes the Sun's core within a few seconds.
	The Sun is more than 100 times wider than Earth.
	Solar wind is a stream of charged particles.

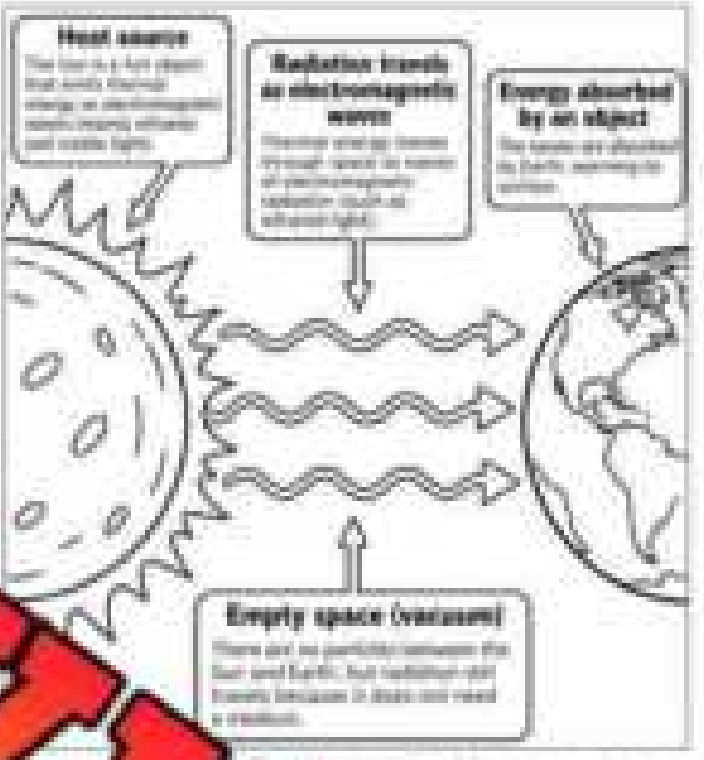
PREVIEW

Name: _____ 9

Radiation Crosses Empty Space

Three Ways Heat Moves

Thermal energy always moves from warmer matter to cooler matter, and it does so in three ways. **Conduction** is the transfer of thermal energy by direct contact between particles, which is why a metal spoon left in hot soup [illegible] burns your fingers; metals such as co[illegible]nduct especially well because [illegible] carry energy thro[illegible]



Convec[illegible] the [illegible]heat energy by the flow of [illegible] warmer rising through [illegible] cool[illegible] replacing warm air [illegible] also drives thermals, [illegible] air rising over sunny prair[illegible] hawks use to climb without [illegible]

Radiation is the transfer of energy by electromagnetic waves, which need no [illegible]es at [illegible]th you feel on your face beside a campfire is mostly radiation, because [illegible]es [illegible]stead of sideways.

Why Space Needs No Medium

A **medium** is the matter through which energy or wa[illegible]d [illegible]duction and convection depend on one. Earth's atmosphere thins gra[illegible] Kármán line, 100 km above sea level, is the usual boundary [illegible] near-**vacuum**, a region containing very little matter. One cubic centi[illegible] level holds about 25 billion billion molecules, but space between the pla[illegible] only a few particles in the same volume. Sound is also stopped by a vacuum, so [illegible]nauts outside the International Space Station, which orbits about 400 km up, hear nothing. Radiation, including visible light and infrared, crosses the gap because it needs no medium.

Radiation at Work

- **Infrared radiation** — invisible waves emitted by every warm object, which skin senses as heat.
- **Vacuum flask** — invented by Scottish scientist James Dewar in 1892; a vacuum between its walls blocks conduction and convection, while silvered walls reflect radiation.
- **Thermal imaging camera** — a detector of infrared radiation that lets firefighters locate warm objects through smoke.

PREVIEW

Name: _____ 10

True or False Circle whether the statement is true or false.

1) Radiation needs a medium to carry energy.	True	False
2) Space near Earth is packed with air molecules.	True	False
3) Conduction needs particles in contact.	True	False
4) Convection moves energy by flowing fluids.	True	False
5) Sound can travel through a vacuum.	True	False

Questions Answer the questions below using evidence from the text.

1) Compare how conduction and radiation move energy.

2) Why does a vacuum flask keep drinks hot? Use the idea of heat paths.

Fill in the Blank Choose the correct word from the box to complete each sentence.

conduction	medium	vacuum	convection	radiation

1) A metal spoon in hot soup warms by _____.

2) A sea breeze is an example of heat moving by _____.

3) Matter through which energy travels is called a _____.

4) A region with almost no matter is called a _____.

5) Energy carried by electromagnetic waves is called _____.

PREVIEW

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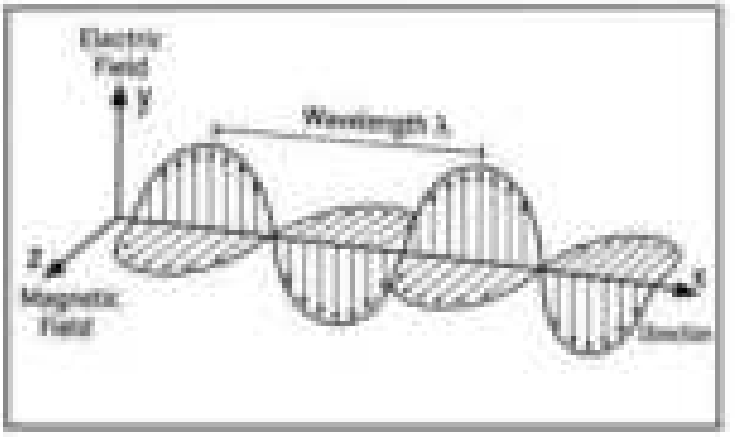
Name: _____ 12

Electromagnetic Waves

What Is an Electromagnetic Wave?

An **electromagnetic wave** is a wave of energy made of electric and magnetic fields that oscillate at right angles to each other and to the direction the wave travels. Because each changing field produces the other, the wave sustains itself and can cross empty space (a vacuum) as well as any medium. Scottish physicist James Clerk Maxwell predicted these waves in the 1860s, and German physicist Heinrich Hertz produced radio waves in his laboratory in the late 1880s, confirming the theory. Maxwell had also calculated that these waves would travel at the measured speed of light, which led him to conclude that light itself is an electromagnetic wave. The unit of frequency is named for Hertz. Nothing with mass can reach the speed of light, and every electromagnetic wave measures it in a vacuum.



PREVIEW

Measuring a Wave

Every wave has measurable parts. **Wavelength** is the distance from one crest to the next, measured in metres. **Amplitude** is the height of a crest above the resting position; a larger amplitude means a brighter light. **Frequency** is the number of complete waves passing a point each second, measured in hertz (Hz). In a vacuum all electromagnetic waves travel at the same speed, 299 792 kilometres per second. For light, a shorter wavelength means higher frequency. At that speed light crosses the 384 400 km Moon distance in about 1.3 seconds and the 150 million km from the Sun in 8 minutes. Visible light has wavelengths from about 400 to 700 nanometres (nm), roughly 430 to 750 trillion hertz.

Waves Beyond Light

- **Radio waves** — the longest wavelengths; FM stations broadcast at 88 to 108 megahertz (MHz), wavelengths of about 3 m, while AM stations use 530 to 1700 kilohertz (kHz) and waves hundreds of metres long.
- **Microwaves** — Ovens use 2.45 gigahertz (GHz) waves that make water molecules in food vibrate, and Wi-Fi routers use similar waves at 2.4 GHz.
- **X-rays** — Discovered by Wilhelm Röntgen in 1895; they pass through soft tissue but not bone.
- **Gamma rays** — the shortest wavelengths and highest frequencies, released by nuclear reactions.

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Define What do the terms below mean?

Frequency	
Hertz	
Ga... ra...	

True or False Is ... false?

1) Shorter wavelength means ...	True	False
2) Sunlight reaches Earth in about 8 ... es 20 ...	True	False
3) All electromagnetic waves need a mediu... ...vel	True	False
4) Hertz measures the number of waves per sec...		False
5) Gamma rays have the longest wavelengths.		False

Question How can an electromagnetic wave cross empty space? U... two fields in your answer.

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Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Name three kinds of electromagnetic wave.

- _____
- _____
- _____

Name: _____ Mark

Name three kinds of electromagnetic wave.

- _____
- _____
- _____

Name: _____ Mark

Name three kinds of electromagnetic wave.

- _____
- _____
- _____

Name: _____ Mark

Name three kinds of electromagnetic wave.

- _____
- _____
- _____

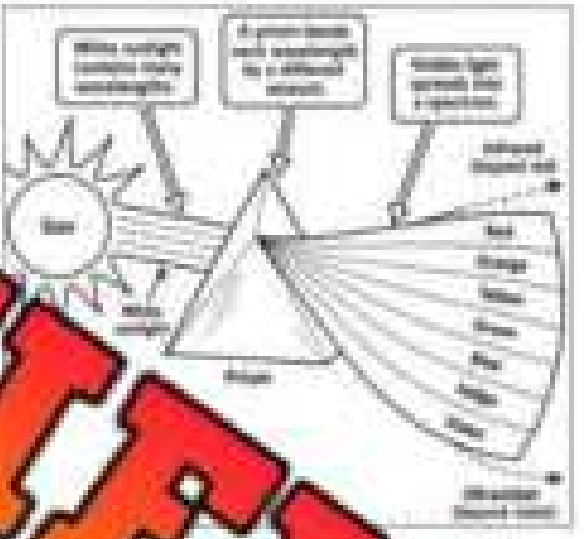
PREVIEW

Name: _____ 21

The Solar Spectrum

Splitting Sunlight
Sunlight looks white to the eye but is a mixture of all the colours of the rainbow. A **prism** is a transparent block that refracts light, bending each wavelength by a different amount, so white light spreads into a band of colours called the **solar spectrum**. Isaac Newton demonstrated this in 1666, later introducing the word spectrum, and showed that a second prism recombines the colours into white. The order is red, orange, yellow, green, blue, indigo and violet, with red bending least and violet most; red light is near 700 nm and violet near 400 nm. Raindrops act as tiny prisms, which is how a rainbow forms about 42 degrees from the point opposite the Sun, with red on its outer edge.

Light Beyond What We See
The spectrum continues beyond both ends of the visible band. Infrared radiation has wavelengths from about 700 nanometres (nm) to 1 millimetre, and radio waves have wavelengths longer than 1 millimetre. Infrared is felt as heat; television remote controls and the Wii controller send it, with it, and pit vipers such as the rattlesnake use heat-sensing organs that detect it from warm prey. In 1800 the British astronomer William Herschel placed thermometers in a prism's colours and found the highest temperature just beyond the red end.



Ultraviolet radiation has wavelengths shorter than about 400 nm. In 1801 German physicist Johann Ritter found that light beyond violet darkened silver chloride, a light-sensitive chemical. Ultraviolet is also the main cause of sunburn.

Where the Energy Lies
Measurements from NASA's SORCE satellite, launched in 2003 to orbit 640 km above the atmosphere, show how unevenly the Sun spreads its energy across the spectrum.

- **Infrared** — carries a larger share of the energy than visible light does.
- **Visible light** — accounts for roughly two-fifths of the Sun's total energy.
- **Ultraviolet** — carries the smallest share of the three, yet each wave has enough energy to damage skin cells.
- **200 to 2000 nm** — this one stretch of wavelengths holds more than 90 per cent of the Sun's total energy output.

PREVIEW

Name: _____ 22

True or False Is the statement true or false?

1) Violet light bends the least in a prism.	True	False
2) Infrared waves are shorter than 400 nm.	True	False
3) A prism bends each colour by a different amount.	True	False
4) Herschel found heat just beyond the red end.	True	False
5) Ultraviolet carries most of the Sun's energy.	True	False
6) Visible [illegible]ns about 400 to 700 nm.	True	False

Sor [illegible]tem into the correct column

Red lig[illegible]t		Green light	Infrared
Indigo light		Violet light	Microwaves

Visible to the ey[illegible]	Invisible to the eye

Making Connections Describe a time you saw a rainbow or colours split by glass. How does a prism explain it?

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Circle the correct answer.

1) Who found UV?	Herschel / Ritter
2) Sun's top share?	Visible / Infrared
3) UV-B causes?	Sunburn / Heat
4) Newton's prism?	1800 / 1666

Name: _____ | Mark

Circle the correct answer.

1) Who found UV?	Herschel / Ritter
2) Sun's top share?	Visible / Infrared
3) UV-B causes?	Sunburn / Heat
4) Newton's prism?	1800 / 1666

Name: _____ | Mark

Circle the correct answer.

1) Who found UV?	Herschel / Ritter
2) Sun's top share?	Visible / Infrared
3) UV-B causes?	Sunburn / Heat
4) Newton's prism?	1800 / 1666

Name: _____ | Mark

Circle the correct answer.

1) Who found UV?	Herschel / Ritter
2) Sun's top share?	Visible / Infrared
3) UV-B causes?	Sunburn / Heat
4) Newton's prism?	1800 / 1666

PREVIEW

Name: _____ 24

Rainbow Makers: Splitting Sunlight

Objective — What are we learning about?

Students will investigate how white light separates into different colours when it passes through a prism. They will learn how refraction causes different wavelengths of light to bend by different amounts, identify the colours of the visible spectrum, and explore how wavelength relates to frequency.

Materials — What will you need for the activity?

- ☐ [illegible]
- ☐ [illegible]
- ☐ White paper
- ☐ Coloured [illegible]
- ☐ Pencil and ru[illegible]
- ☐ Darkened room (or [illegible])



Instructions — How will you [illegible]

1) Place a sheet of white paper on a flat surface [illegible] prism where it can receive direct sunlight or light from a flash[illegible]
2) Shine the light through the prism and slowly [illegible] of different colours appears on the white paper. A narrow be[illegible] light [illegible] ect sunlight will usually produce the clearest spectrum.
3) Observe the colours carefully and identify as many as possible [illegible] order from red to violet.
4) Trace the outline of the coloured spectrum onto your paper and use coloured pencils to recreate the colours in their correct order.
5) Slowly rotate the prism and observe how the position and appearance of the spectrum change as the light enters at different angles.
6) Compare the red and violet ends of the spectrum, identifying which has the longer wavelength and explaining how refraction separates these colours.
7) Discuss how the visible spectrum is only a small part of the electromagnetic spectrum, with infrared radiation beyond red and ultraviolet radiation beyond violet.
8) Complete your observations and discuss why ultraviolet radiation can damage skin and how sunscreen, protective clothing, and shade help reduce UV exposure.

PREVIEW

Name: _____ 25

Recording Sheet | Record the details of your experiment below.

My Prediction: Predict what will happen.

I predict that when white light passes through a prism, it will _____

_____

I think this will happen because _____

_____

My Observations: Record the colours you observe from one end of the spectrum to the other. Describe clearly each colour appears.

	Colour Observed	Brightness (Bright, Medium, Faint)
1		
2		
3		
4		
5		
6		
7		

Slowly rotate the prism and record what happens to the

Prism Position	What Happened to the S
Starting position	
Slightly rotated	
Rotated further	

Record Your Discovery: Complete the sentences using your observations.

1. White light is made up of _____.

2. The bending of light as it passes between materials is called _____.

3. The colour with the longest visible wavelength is _____.

4. The colour with the shortest visible wavelength is _____.

PREVIEW

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Name: _____ 26

Reflection Sheet | Answer the following questions.

1) White sunlight appears colourless or white, yet a prism produces a spectrum of colours. Explain why this happens and what it reveals about the nature of sunlight.

2) Red light has a wavelength of approximately 700 nm, while violet light has a wavelength of approximately [illegible]. Which has the higher frequency, and why? Explain how their wavelengths affect [illegible] prism.

3) Imagine a special camera that detects infrared and ultraviolet radiation. How could this camera reveal that our eyes cannot see? Describe one practical application for each type of radiation.

PREVIEW

Name: _____ /30

Blog Post: Light Meets Matter

5 Ways Light Meets Matter

Date: October 6, 2026 **Author**: Ms. Dana Whitecloud 5-minute read

Sunlight is radiant energy, and whenever it strikes a material, that energy follows one or more of five paths. The path depends on the substance, the smoothness of its surface, and the angle of the rays. These outcomes explain why a driveway scorches bare feet, why a lake mirrors the trees, and why a sunbeam can be seen from the side.

1) **Absorption Turns Light Into Heat: Absorption** is the process in which a material takes in light energy and converts it to thermal energy. The added energy makes the particles move faster, so its temperature rises. A dark driveway absorbs most visible light on a hot afternoon, while pale concrete beside it stays cooler.
2) **Reflection Makes Light Bounce: Reflection** is the bouncing of light off a surface, with the angle of incidence equal to the angle of reflection. A calm lake is smooth, so it produces a mirror image; rough surface sends rays in many directions. Even the Moon reflects only a small part of the sunlight that strikes it.
3) **Transmission Lets Light Through: Transmission** is the passing of light through a material. Transparent materials such as clear glass and clear water, transmit most light; translucent materials, such as frosted glass, pass some; opaque materials, such as wood or metal, transmit none. A sunbeam shows as a bright patch on a classroom floor because the transmitted light is absorbed by the floor.
4) **Refraction Bends Light's Path: Refraction** is the change in direction that occurs when light passes from one medium into another, caused by a change in its speed. Light travels about 300 000 kilometres per second (km/s) in a vacuum, 225 000 km/s in water, and about 200 000 km/s in glass. Water's refractive index of 1.33 makes a straw look bent at the surface.
5) **Scattering Sends Light Everywhere: Scattering** is the redirection of light in many directions by particles such as air molecules, dust, smoke, and water droplets. Because the particles send light toward your eyes from the side, a beam of sunlight becomes visible as it slants through mist, wildfire smoke, or gaps in clouds. These beams are called crepuscular rays.

PREVIEW

Comments



Nina – October 6, 2026
I never knew a straw looks broken because light slows down in water!
Like Reply 1d ago



Owen – October 7, 2026
Same, Nina. I'm going to test it with a glass of water and a ruler.
Like Reply 20m ago

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Name: _____ 31

Two Choices

Circle the best answer.

1) A dark driveway heating up shows _____.	absorption	reflection
2) A calm lake mirrors the trees by _____.	refraction	reflection
3) Light moves slower in _____ than in water.	a vacuum	glass
4) A straw looks broken because of _____.	refraction	scattering
5) Wood _____ most of the sunlight.	none	most

Questions

Answer the questions below using evidence from the text.

1) Compare how fast light travels in a vacuum, water, and glass.

2) Why can a sunbeam be seen from the side in the sky? Use evidence from the text.

Finish the Sentence

Complete each sentence below.

1) A rough surface reflects light in many directions, which means...

2) Window glass is transparent, but a wooden door is opaque because...

PREVIEW

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Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark ☐

Match each term to its meaning.

Absorption ☐ ☐ light passing through a material

Refraction ☐ ☐ light bending as its speed changes

Transmission ☐ ☐ light energy turned into heat

Name: _____ Mark ☐

Match each term to its meaning.

Absorption ☐ ☐ light passing through a material

Refraction ☐ ☐ light bending as its speed changes

Transmission ☐ ☐ light energy turned into heat

Name: _____ Mark ☐

Match each term to its meaning.

Absorption ☐ ☐ light passing through a material

Refraction ☐ ☐ light bending as its speed changes

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Name: _____ Mark ☐

Match each term to its meaning.

Absorption ☐ ☐ light passing through a material

Refraction ☐ ☐ light bending as its speed changes

Transmission ☐ ☐ light energy turned into heat

PREVIEW

Name: _____ 36

Story: The Hot Black Seat

The Seat That Burned

Amira sat down on the black vinyl bench beside the soccer field in Kildonan Park and leapt straight back up. The backs of her legs stung. It was a June afternoon in Winnipeg, the air temperature was 27°C, and the white bench next to it felt only pleasantly warm.

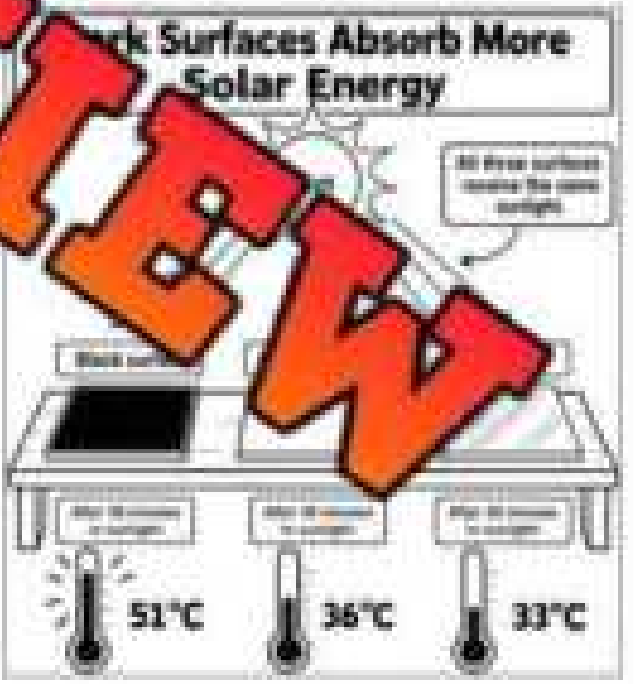
"Why could two benches in the same sunlight feel so different?" she asked Coach Singh.

"Good question," he said. "Don't just guess. Test it."

That evening she wrote her question in her notebook: does a darker surface absorb more solar energy than a lighter one? She cut three cardboard squares, each 10 cm on a side, and covered them with black paper, white paper, and aluminum foil. The size, thickness and the position the same would make the test fair. She predicted the black square would heat fastest, and a thermometer in the air would give her a comparison for the air.

At solar noon the next day the sun was about 63° above the horizon, which is Winnipeg's latitude of 49.9° north. Amira placed a digital thermometer probe under each square and laid all three flat on the bench in full sunlight.

She recorded every temperature at ten-minute intervals for half an hour. The black square climbed fastest. After 30 minutes it read 51°C, while the white square read 36°C and the foil square read 33°C.



Amira graphed her data and wrote her conclusion. The black paper had absorbed most of the visible light that hit it and changed that energy into heat. The white paper and the foil had reflected most of it back into the air, so they warmed far less. Surface colour, not air temperature, explained the difference.

Back at the field, she showed the graph to Coach Singh. The 15°C gap between the black and white squares surprised him.

"Then the fix is simple," he said. "We'll ask the club to buy white seat covers."

Amira smiled and wrote one more line in her notebook: next, test a cloudy day, when less sunlight would reach the squares.

PREVIEW

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Name: _____ 37

Ordering Put these story events in the correct order by numbering them 1 to 8.

	Amira recorded temperatures every ten minutes for half an hour.
	Amira jumped up because the black bench burned her legs.
	Coach Singh suggested buying white seat covers for the benches.
	Amira cut three squares and covered them in black, white, and foil.
	A[illegible] taped a thermometer probe under each square at solar noon.
	A[illegible]ed Coach Singh why the two benches felt so different.
	[illegible] data and wrote a conclusion about absorption.
	[illegible] test for a cloudy day.

What Did You Learn [illegible] story, then answer below.

1) Name three things Amira [illegible] her test fair.

2) Predict her squares' temperatures on a [illegible]

Making Connections Think of a dark and a light surface you have touched on [illegible] hot day, such as a jacket, car seat, or sidewalk. Which was hotter, and how does the story explain it?

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Case: Albedo — Ice vs Open Water

Two Surfaces, One Sun

Case 1: Snow-Covered Ice in March

Albedo is the fraction of incoming sunlight that a surface reflects, from 0 (absorbs everything) to 1 (reflects everything); it has no units because it is a ratio. In March, Arctic sea ice is near its yearly maximum, which [illegible] about 14.3 million km²) in 2025. A floe in the [illegible] of Alaska and the Yukon [illegible] by fresh snow with an albedo [illegible]. Wind has swept the snow away [illegible] frozen ocean water, has [illegible] 0.5 to 0.7. A surface with an albedo [illegible] absorbs only 15 per cent of the sunlight reaching it, so the floe gains little energy and stays cold.

Case 2: Open Water in September

By September, the yearly minimum, strips of open ocean separate the floes, and cracks of open water called **leads** appear even within solid pack ice. Open ocean has an albedo of only 0.06, so it absorbs about 94 per cent of the sunlight reaching it, roughly six times as much as snow-covered ice, and its water warms. Satellites have tracked **sea ice extent**, the ocean area with at least 15 per cent ice cover, since 1979. In September 2012, the extent shrank to about 3.4 million km², roughly half the 1979–2000 September average of 6.7 million km², the [illegible] record, reached in mid-[illegible]



What This Teaches Us

The **ice-albedo feedback** is a positive feedback, a process in which a change triggers effects that amplify that same change. Warmer air melts ice, the exposed dark water absorbs more sunlight, and the extra heat melts still more ice. This loop is one reason the Arctic warmed about 3.8 times faster than the globe from 1979 to 2021, according to a study led by Mika Rantanen of the Finnish Meteorological Institute. Other processes also contribute, but the albedo of a surface decides how much of the Sun's energy stays in the ocean. Faster warming of the polar north than of the planet overall is called Arctic amplification.

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Multiple Choice Circle the best answer.

1) What does a surface's albedo measure?			
Heat stored	Ice thickness	Light reflected	Light speed
2) Which surface in the cases has the highest albedo?			
Bare sea ice	Open ocean	Meltwater pond	Fresh snow
3) Why is the ice-albedo feedback called positive?			
Cancels	Is good news	Happens in July	Amplifies change
4) When [illegible] oses ocean, absorbed sunlight...			
[illegible]	ecreases	Stays equal	Drops to zero
5) The 2012 ice [illegible] action of the 1979–2000 average?			
One tenth	[illegible]	Double	Three quarters

Scenario A research sh[illegible]s [illegible] covered in fresh snow. Rain then melts the snow a[illegible]s [illegible]t happens to the floe's albedo and absorbed energy, and

Think Imagine that Arctic sea ice continues to shrink each summer. How might this change affect polar bears, seals, and other animals that depend on sea ice for survival?

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Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Circle what follows when sea ice melts.

Albedo rises	Ice grows back
Ocean warms	Less absorbed
Albedo falls	Ice melts more
Ocean cools	More absorbed

Name: _____ Mark

Circle what follows when sea ice melts.

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Name: _____ Mark

Circle what follows when sea ice melts.

Albedo rises	Ice grows back
Ocean warms	Less absorbed
Albedo falls	Ice melts more
Ocean cools	More absorbed

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Experiment - Melting Ice: The Albedo Feedback

Objective — What are we learning about?

Students will investigate how dark and light-coloured surfaces absorb and reflect solar radiation by comparing the melting rates of ice cubes placed on black and white backgrounds.

Materials — What will you need for the activity?

- ☐ Two [illegible] containers
- ☐ [illegible] paper
- ☐ [illegible] per container)
- ☐ Sunlight or [illegible]
- ☐ Stopwatch
- ☐ Paper towels
- ☐ Recording sheet [illegible]



Instructions — How will you [illegible]

1) Line the bottom of one shallow container with [illegible] the other with white paper, making sure both containers are identical in size.
2) Place the containers side by side in a sunny [illegible] lamp so they receive approximately equal amounts of light.
3) Predict which container will cause the ice to melt faster and record your prediction with a scientific explanation.
4) Place an equal number of similar-sized ice cubes in each container and start the stopwatch immediately.
5) Observe both containers every five minutes for 20–25 minutes, recording changes in the size of the ice cubes and the amount of melted water.
6) Compare the melting rates and discuss how black and white surfaces differ in their ability to absorb and reflect incoming radiation.
7) Connect your results to Hudson Bay by explaining how bright sea ice reflects sunlight while dark open water absorbs more solar energy, contributing to the ice-albedo feedback cycle.
8) Discuss how increasing water temperatures and longer ice-free seasons could affect polar bears, seals, and other organisms that depend on sea ice.

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Recording Sheet | Record the details of your experiment below

My Prediction and Hypothesis: How does the colour of a surface affect the rate at which ice melts when exposed to sunlight?

I predict the ice in the _____ container will melt faster because_____

My Observations: Observe the ice cubes every five minutes. Record their approximate size, the amount of melted water, and any changes you notice.

Time	Dark Surface Observations	White Surface Observations
0 minutes		
5 minutes		
10 minutes		
15 minutes		
20 minutes		
25 minutes		

Compare Your Results: Answer the following questions.

1) Which container showed ice melting faster?

2) What evidence from your observation table supports your answer?

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Reflection | Answer the following questions.

1) Complete the statements using your observations.

The ice in the _____ container melted faster.

The _____ surface appeared to absorb more radiant energy.

The _____ surface had the higher albedo.

2) Why do you think the ice cubes melted at different rates even though they were exposed to the [illegible]?

3) Imagine a large section of Hudson Bay's sea ice [illegible] exposing dark ocean water. Explain how this changes the amount of solar energy [illegible] and why the change might cause further warming.

3) How might longer ice-free seasons in Hudson Bay affect polar bears and seals? Describe one effect on their habitat and one effect on their ability to find food.

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Reading Sun, Snow, and Slope

Seasons Named by the Land

The Asiniskaw Ithiniwak, or Rocky Cree, live in north-central Manitoba, where their homeland includes Southern Indian Lake and the Misinipī (Churchill River). They recognize six seasons rather than four (sikwan, mithoskāmin, nīpin, tāk[illegible]iskaw, and pipon), each ide[illegible] people observe in ic[illegible]ts. Rocky Cree [illegible] shares this kno[illegible]dge i[illegible] picture book[illegible] Paul and Rhian [illegible] & Main Press to sup[illegible]claiming Indigenous languages, histories and knowledge.



Why Snow Leaves in Order

Snowmelt is the change of snow into li[illegible] on absorbs enough energy to reach 0°C. At Winnipeg's latitude of 49.9° nor[illegible] noon [illegible] only about 17° above the horizon at the December solstice, about 40° at the [illegible] and about 63° at the June solstice. A **south-facing slope** tilts toward [illegible] like it more directly and deliver more energy per square met[illegible] **Insolation**, the taking in of light energy by a material, is greatest on [illegible], so [illegible] retreats first around tree trunks, boulders, and bare soil; around trunks [illegible] there ground then absorbs even more energy.

Break-up and Open Water

Sunlight's work shows in the Rocky Cree calendar:

- **Sikwan** — the break-up season, meaning "rattling in" or "rattling feathers"; the ice begins to candle, the snow settles, streams run again, and geese arrive.
- **Candle ice** — lake ice that splits into upright crystals as spring sunlight passes through it, which keeps melting it from below until wind breaks it apart and the lake can look open within hours.
- **Mithoskāmin** — spring, meaning "good moving water"; the snow is gone, new growth is visible, and open waterways allow canoe travel, and people gather eggs and build canoes.
- **Moons** — the eagle moon and goose moon belong to sikwan, while the frog moon and egg-laying moon belong to mithoskāmin.

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True or False Is the statement true or false?

1) The Rocky Cree calendar names six seasons.	True	False
2) Sikwan, break-up, comes after mithoskâmin.	True	False
3) Manitoba's south-facing slopes get more direct sun.	True	False
4) Dark objects absorb more sunlight than white snow.	True	False
5) Snow melts first around surfaces that reflect most.	True	False

Questions ...r the questions below using evidence from the text.

1) Na... ...rk sikwan for the Rocky Cree.

2) Why does snow vanish earl... ...than elsewhere?

Making Connections Think about spring where you live. Which signs o... ...ice, water, birds, or plants, show the season is changing, an... does the Sun cause them?

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Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Read each clue. Write the answer.

1) Direction a slope faces to get the most Manitoba sun	
2) Ice that splits into upright crystals in spring	
3) Taking in light energy, mostly by dark surfaces	
4) Rocky Cree word for spring, "good moving water"	

Name: _____ Mark

Read each clue. Write the answer.

1) Direction a slope faces to get the most Manitoba sun	
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3) Taking in light energy, mostly by dark surfaces	
4) Rocky Cree word for spring, "good moving water"	

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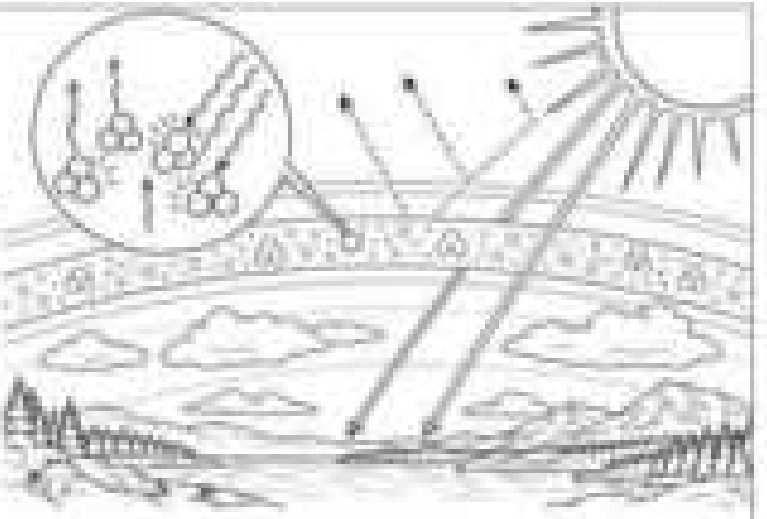
Name: _____ 55

How the Atmosphere Filters Sunlight



Sunlight Meets the Atmosphere

At the top of the atmosphere, sunlight delivers about 1,361 watts per square metre (W/m²) to a surface facing the Sun. Before it reaches the ground, it must cross the **atmosphere**, the envelope of gases that gravity holds around Earth. According to NASA's [illegible] observatory, about 29 per cent of the [illegible] arriving at Earth is reflected [illegible] space, and a further [illegible] by the atmosphere itself. [illegible] per cent is absorbed by [illegible] surface. The atmosphere [illegible] a selective filter: it removes some wavelengths, scatters [illegible] visible light pass through, so it is described as transparent to visible radiation.

The Ozone Shield

The **ozone layer** is the part of the stratosphere [illegible] to 35 km above sea level, where the gas ozone (O3) is most concentrated, [illegible] 20 km and 25 km. Each ozone molecule contains three oxygen atoms, and it absorbs [illegible] (UV) radiation, converting that energy into heat. The layer absorbs nearly [illegible] 90 per cent of UV-B but very little UV-A. Because high-energy UV [illegible] skin cells, this absorption protects organisms living at the surface. [illegible] banned the layer until the Montreal Protocol of 1987 phased them out. [illegible] projects recovery over most of the world by about 2040.

Gases, Clouds and Particles

Other parts of the atmosphere filter sunlight in different ways, and each one acts on a different part of the spectrum.

- **Water vapour** — absorbs infrared radiation, mainly in the lower atmosphere where it is most abundant.
- **Carbon dioxide (CO2)** — absorbs several narrow bands of infrared radiation.
- **Cloud albedo** — the fraction of sunlight that clouds reflect; thin clouds reflect little, while thick storm clouds can reflect as much as 80 per cent.
- **Aerosols** — tiny solid or liquid particles, such as volcanic ash and sea salt, that scatter sunlight in all directions.

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Two Choices

Circle the best answer.

1) Ozone mostly absorbs which radiation?	infrared	UV rays
2) Most reflected sunlight is bounced by _____.	oceans	clouds
3) Water vapour absorbs mainly _____ radiation.	UV rays	infrared
4) Surface absorbs about _____ of sunlight.	23%	48%
5) Thick clouds reflect _____ than thin clouds.	more	less

Questions

...the questions below using evidence from the text.

1) Na... ...o ways ...sphere changes incoming sunlight.

2) How would losing the ozone layer ...ving ...t the surface?

PREVIEW

Word Scramble

Unscramble the words from the word bank.

Word Bank				
reflect	albedo	ozone	clouds	infrared
ultraviolet	atmosphere	stratosphere	absorb	aerosol

ZEDON		ORBABS	
EFLECTR		UDSCLD	
RFNIDERA		EIRULVTTOAL	

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Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Check all the true statements.

- [ ] Air absorbs about 23%.
- [ ] Ozone sits at ground level.
- [ ] Ozone has 3 oxygen atoms.
- [ ] Aerosols can scatter light.
- [ ] 29% of sunlight is absorbed.
- [ ] Ozone layer is 15–35 km up.
- [ ] Ozone blocks all UV-A.
- [ ] Only ozone filters sunlight.

Name: _____ | Mark

Check all the true statements.

- [ ] Air absorbs about 23%.
- [ ] Ozone sits at ground level.
- [ ] Ozone has 3 oxygen atoms.
- [ ] Aerosols can scatter light.
- [ ] 29% of sunlight is absorbed.
- [ ] Ozone layer is 15–35 km up.
- [ ] Ozone blocks all UV-A.
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PREVIEW

Name: _____ | Mark

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- [ ] Ozone sits at ground level.
- [ ] Ozone has 3 oxygen atoms.
- [ ] Aerosols can scatter light.
- [ ] 29% of sunlight is absorbed.
- [ ] Ozone layer is 15–35 km up.
- [ ] Ozone blocks all UV-A.
- [ ] Only ozone filters sunlight.

Name: _____ | Mark

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- [ ] Air absorbs about 23%.
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- [ ] Ozone has 3 oxygen atoms.
- [ ] Aerosols can scatter light.
- [ ] 29% of sunlight is absorbed.
- [ ] Ozone layer is 15–35 km up.
- [ ] Ozone blocks all UV-A.
- [ ] Only ozone filters sunlight.

Name: _____ 58

Word Search – Sunlight, Sky, and Energy

Objective What are we learning about?

Students will learn and reinforce key scientific vocabulary related to sunlight, solar radiation, and energy by creating and solving word searches.

Materials What will you need for the activity?

- ❑ [illegible] paper (provided)
- ❑ List [illegible]
- ❑ Pencils and [illegible]
- ❑ Coloured pencils



Instructions How you will complete the activity

1) Review the provided list of science words and discuss their meanings to strengthen your understanding of sunlight, radiation, and energy.
2) Collect a blank word search grid and the vocabulary list provided by your teacher and plan where to position your words.
3) Carefully arrange the science words in your grid horizontally, vertically, and diagonally, making sure each word is spelled correctly.
4) Fill all the remaining empty squares with random letters to hide your science words and make the puzzle more challenging.
5) Exchange your completed word search with a partner, making sure they receive the list of words they need to find.
6) Search your partner's puzzle carefully, circling or highlighting each science word you discover until you have found them all.
7) Select three words from the puzzle and write a meaningful scientific sentence for each, showing how the terms relate to sunlight or energy.

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Words	List of words:

albedo	aerosol	carbon	dioxide
vapour	oxygen	nitrogen	argon
cir	haze	smog	altitude
	weather	shield	ocean
glacier		fusion	hydrogen
helium		corona	flare
sunspot			planet
galaxy	vacuum		conduction
convection	thermal		
joule	watt	kilowatt	
battery	inverter	grid	
azimuth	latitude	equator	polar
season	dusk	dawn	sunrise
sunset	twilight	mirage	filter
layer	gases	orbit	stratus

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Name: _____ 60

Word Search | Create your own word search below

Word Bank				

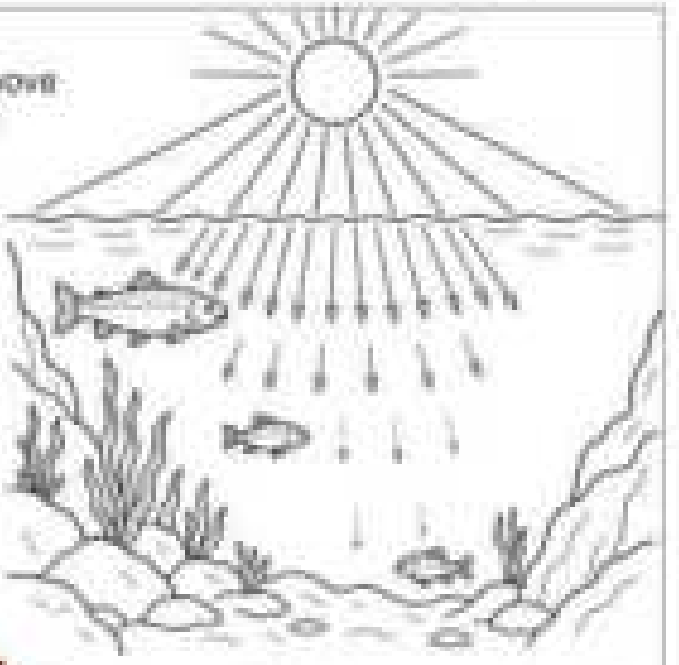


Name: _____ 61

Oceans and Lakes Absorb Sunlight

Sunlight at the Water's Surface

The **hydrosphere** is all the water on, under, and above Earth's surface, and the oceans alone cover about 71 per cent of the planet. When sunlight strikes open water, most of it enters rather than bouncing away: open ocean has an albedo of only about [illegible], meaning roughly 6 per cent of the light is reflected. Reflection depends strongly on the height of the Sun above the horizon. When the Sun is high, light enters almost straight down, but when it is low, near the horizon or the poles, more light skims across the surface and the reflectivity of water rises sharply.



Colours Disappear With Depth

Water absorbs each wavelength of light at a different rate, so sunlight changes colour as it travels downward and its energy is removed in the water. Infrared radiation is absorbed even faster than red light, so it is absorbed in the top 10 m; orange light by about 40 m and yellow before 100 m. The blue and green light penetrate deepest, which is why the open ocean looks blue.

The **euphotic zone** is the sunlit layer from the surface down to [illegible] m, where there is enough light for photosynthesis. Light fades through the twilight zone to about 1,000 m, and the aphotic zone below that is dark. Because the average depth of the ocean is about 3,700 m, most of its volume never receives any sunlight.

Lake Winnipeg as a Case

Freshwater lakes follow the same physics as the ocean, and Manitoba's largest lake shows how.

- **Size** — covers 24,514 km², making it the 12th-largest lake on Earth
- **Depth** — reaches only 36 m at its deepest point, much shallower than the ocean's 200 m sunlit layer
- **Algae** — blooms of cyanobacteria, fed by excess phosphorus, absorb and scatter light near the surface, so less reaches the deeper water
- **Ice** — the lake freezes in winter, and snow-covered ice can reflect as much as 90 per cent of sunlight, compared with 6 per cent for open water

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Finish the Sentence

Complete each sentence below.

1) Water reflects more sunlight when the Sun is low because...

2) Photosynthesis is limited below about 200 m because...

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Questions

...ns below.

1) What is the albe... ...t does it mean?

2) Why does the open ocean look blue? Use ... ...h.

3) Why might a cyanobacteria bloom leave deep lake water da...

Odd One Out

Circle the word that does not belong in each group.

red	blue	orange	yellow
euphotic	stratosphere	dysphotic	aphotic

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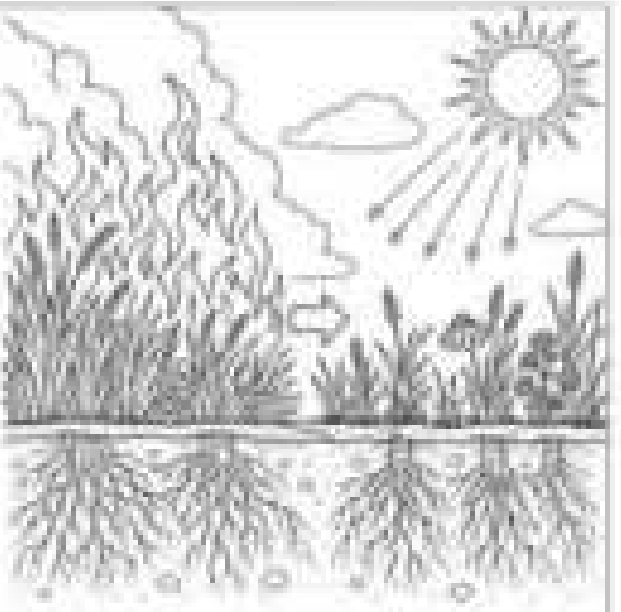
Name: _____ 64

Fire on the Tallgrass Prairie

Fire and the Prairie Landscape

Before European settlement, tallgrass prairie covered about 6,000 km² of Manitoba, but settlers ploughed most of it for farmland from the 19th century because its soil is so fertile, and today less than 1 per cent survives. The Tall Grass Prairie Preserve, [illegible] 80 km southeast of Winnipeg, protects [illegible] 2,000 hectares of what remains.



First [illegible] Red River region shap[illegible] with **prescribed burning**, fire that [illegible] a [illegible]sen time and place, to man[illegible]. U[illegible] of Manitoba resea[illegible] that [illegible]red old scrub so fresh shoo[illegible] bison to the new growth [illegible] away from places where [illegible] mer and kept aspen from invading the prairie.

Black Ground, Warm Soil

The **lithosphere**, Earth's rigid outer shell of cru[illegible]per[illegible]le, meets the Sun at the soil. After a fire, the ground is covered in bl[illegible] an[illegible]h absorb far more sunlight than green grass, which has an albe[illegible] absorbed energy raises the **soil temperature**, so burned patches [illegible] and plants there begin growing sooner.

Burning also returns nutrients to the soil and clears dry plant litter [illegible] Soak in. At one Nature Conservancy of Canada site in southern Manitoba, gras[illegible] growing and marsh marigolds were flowering within two weeks of a burn.

Fire Stewardship Today

- **Manitoba** — Nature Conservancy of Canada crews burned tallgrass prairie in spring 2024, and burns return to a site every few years to remove willows and other woody shrubs that would turn grassland into aspen and bur oak woods.
- **Roots** — 75 to 80 per cent of a prairie plant's biomass is underground, so grasses regrow from protected roots after a fire.
- **Alberta** — One Métis/Cree family in Treaty 6 territory generally burns its land in fall with low-intensity fires that encourage berries and reduce dead grass.

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True or False

Circle whether the statement is true or false.

1) Charred ground reflects more sunlight than grass.	T	F
2) Under 1% of Manitoba's tallgrass prairie remains.	T	F
3) Prescribed burning is set at a chosen time and place.	T	F
4) Most prairie plant biomass grows above ground.	T	F
5) Burned [illegible] can warm earlier in the spring.	T	F

Finish [illegible]

Complete each sentence below.

1) Charred g[illegible] spring because...

2) Prairie grasses survive [illegible]

3) Regular burning keeps the prairie open [illegible]

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Spot the Myth

One paragraph below is wrong. Circle it [illegible]

A — Burning clears dry litter and returns nutrients, so rain can soak in and fresh shoots can grow the next season.

B — Fire only harms the prairie; a burned patch stays cold and bare and cannot grow new plants for years afterward.

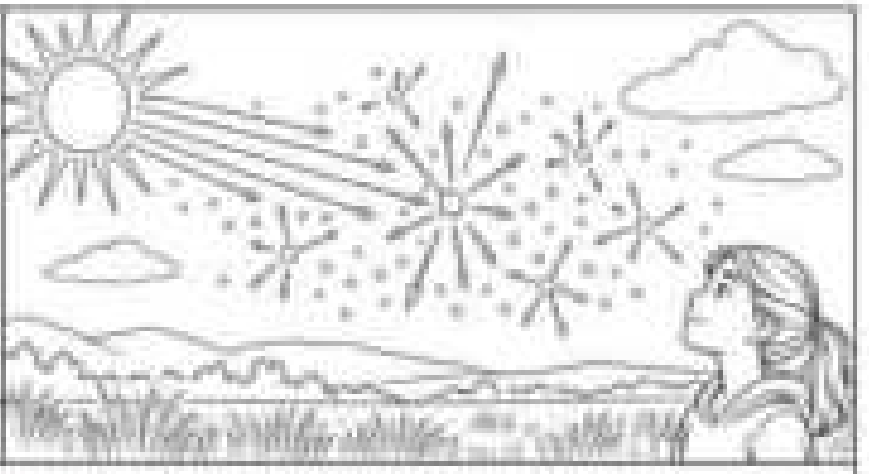
C — Blackened ground absorbs more sunlight than green grass, so burned patches warm earlier in the spring.

Name: _____ 69

FAQ: Sunlight and the Sky

Prairie Skywatchers Club — Your Questions About Sunlight and the Sky!

Welcome to the Prairie Skywatchers Club! Every clear evening our members photograph sunsets over the field[illegible] and these are the six questio[illegible] members ask us most a[illegible]ht and the sky.



Why [illegible]?

Air mo[illegible]s, fa[illegible]n light's wavelength, cause **Rayleigh scattering**, which redirects light [illegible]. [illegible]e the effect varies with 1 divided by wavelength to the fourth pow[illegible]t (ab[illegible]) scatters nearly six times more than red light (about 700 nm).

Why is the sky not viole[illegible]

Violet light, near 400 nm, scat[illegible]n [illegible]ut the Sun emits less of it, the upper atmosphere absorbs some, and [illegible]s a[illegible]nsitive to it. The blend of scattered colours that reaches us then [illegible]oks b[illegible]an eye.

Why do sunsets look red and orange?

At sunset, sunlight crosses a much longer path th[illegible]s at noon. Along that path most blue and green light is scattered [illegible]direc[illegible]so the longer orange and red wavelengths are what remain to r[illegible]e

Why are clouds white?

Cloud droplets, about 10 to 20 micrometres (µm) across, are larger [illegible]n wavelengths of visible light. They scatter every colour about equally, a process called [illegible]attering, and the mixture of all colours together appears white. Fog, cloud at ground level, looks white for the same reason.

Why do storm clouds look dark grey?

A thick storm cloud, such as a cumulonimbus that can rise more than 10 km, scatters and absorbs so much sunlight in its upper layers that little reaches the base. Seen from below, that dim, shadowed cloud looks dark grey instead of white.

Why is the Moon's sky black?

The Moon has almost no atmosphere, so no gas molecules scatter sunlight sideways. Apollo astronauts standing in full daylight still saw a black sky with a bright Sun, because only light travelling directly from the Sun reached their eyes.

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Name: _____ /0

Questions Answer the questions below.

1) Explain why a sunset looks red. Use the path length of light.

2) Why ca[illegible]ud be white on top but grey underneath?

PREVIEW

This or That Circle [illegible] that

1	Red scatters more than blue	or	[illegible]ers more than red
2	Sunsets: a longer air path	or	S[illegible]: [illegible]er air path
3	Clouds scatter all colours	or	[illegible]ds [illegible]lue
4	The Moon's sky is black	or	The [illegible] is b[illegible]
5	Blue scatters more than violet	or	Violet sc[illegible]he[illegible]
6	Thick clouds look dark below	or	Thick clouds loo[illegible]

Draw Draw the Sun, the atmosphere, and an observer at sunset. Label the long light path and the colours that remain.

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Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Is the statement true or false?

1) Blue is about 450 nm.	T / F
2) Droplets are 10–20 µm wide.	T / F
3) Eyes see violet best.	T / F
4) Violet is near 400 nm.	T / F
5) Droplets are 1 nm wide.	T / F

Name: _____ Mark

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Name: _____ Mark

Is the statement true or false?

1) Blue is about 450 nm.	T / F
2) Droplets are 10–20 µm wide.	T / F
3) Eyes see violet best.	T / F
4) Violet is near 400 nm.	T / F
5) Droplets are 1 nm wide.	T / F

PREVIEW

Name: _____ 72

Show and Tell: My Sky and Sunlight Demonstration

Objective What are we learning about?

Students will present an object or demonstration that shows how sunlight behaves in the sky, such as scatterin[illegible] builds scientific vocabulary and clear explanat[illegible]



Materials [illegible] need for our activity?

- ❑ A clear contain[illegible] flashlight
- ❑ Planning page (prov[illegible]
- ❑ Crayons or pencils for dra[illegible]

Instructions How will we complete our a[illegible]

1) Explain that scattering of sunlight explains wh[illegible] bl[illegible] sunsets are red.
2) Ask each student to choose an object or demonstration th[illegible] ght being scattered, reflected, absorbed, or bent.
3) Give students time to think about how their object looks, feels, and sounds, and what it shows about light.
4) Hand out the Planning Page and help students fill it in.
5) Invite students to bring the object from home or draw a picture of it instead.
6) Have each student take a turn showing and explaining the object to the class.
7) Encourage classmates to listen quietly and respectfully while others share.
8) Allow one kind comment or question after each turn.

PREVIEW

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Name: _____ 73

Criteria Use the criteria below to complete the activity.

Criteria	Description
Clear Voice	I speak clearly, face the class, and stay on topic about my object.
Science Words	I use words such as scatter, wavelength, reflect, and absorb correctly.
Evid	I show or describe what happens to the light, not just what the ect is.
Exp on	why it happens and link it to the sky or sunlight.

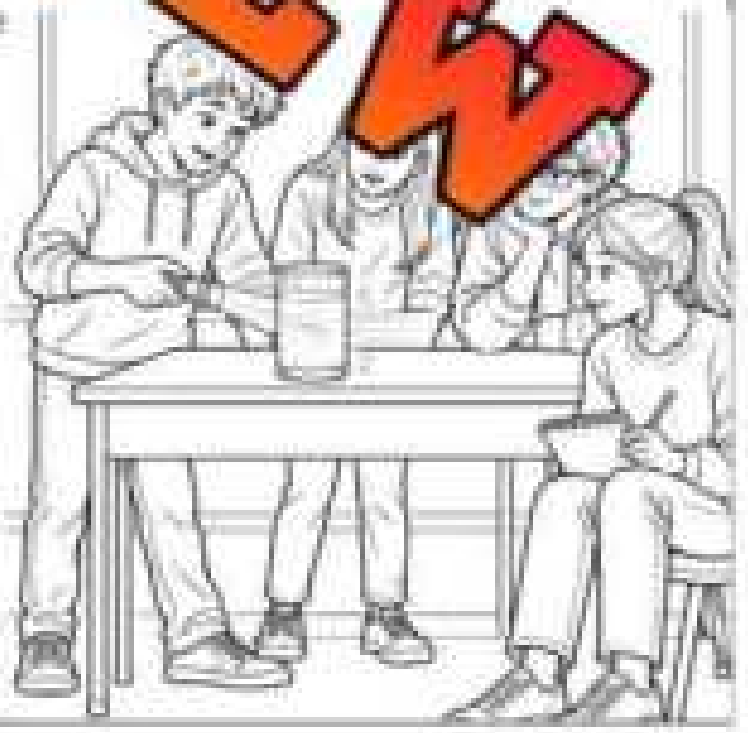
PREVIEW

Example Presentatio example presentation below.

I brought a clear glass of with th of milk stirred in, and a small flashlight.

When I shine the flashlight through beam looks slightly blue. When I look straight into the beam from the far end, it looks orange. The tiny milk particles scatter short blue wavelengths more than long red ones.

This is the same process that makes the daytime sky blue and the Sun look red near the horizon at sunset. The model helps me explain scattering.



Name: _____ 74

Planning Page | Answer the questions below

1) Name your object. What sunlight or sky idea does it show?	

2) Look: what colours do you see, and how does light pass through or bounce off it?

3) Touch: how does the surface and temperature feel in sunlight?

4) Listen: what sounds it ... ed or moved?

5) Compare: how would it look at noon compare... ...ns?

6) Which science words explain what you see?

7) Why does your object matter for understanding the sky?

PREVIEW

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Draw and Write Draw your object. Add arrows to show where light is scattered, absorbed or reflected.



Name: _____ /6

Rubric | How did you do on the activity?

Criteria	1 Point	2 Points	3 Points	4 Points
Clear Voice	Hard to hear; often off topic	Heard at times; drifts off topic	Clear voice; faces class; on topic	Confident, well paced; holds attention
Scien… Wo…	…or no terms, …congly	Some terms; meaning not always right	Uses scatter, reflect, absorb correctly	Uses all terms precisely, incl. wavelength
Evidence	…me …o light	…que about …e light	Shows or describes what light does	Shows light clearly; notes colour change
Explanation	No reason given for what happens	Gi… no …	…plains why …e sky or …	Explains with wavelengths; links to sky

PREVIEW

Teacher Comments

…rk

Student Comments – What Could You Do Better?

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Name: _____ 77

Case Study: Snow, Ice, and Hudson Bay

Reading the Ice of Hudson Bay

Hudson Bay's western coast has long been home to Dene and Cree peoples, and Inuit communities such as Arviat, Nunavut, sit farther north on the same shore. Wapusk National Park, established in 1996, protects 11,475 square kilometres (km²) of this coast east and south of Churchill, Manitoba. Each winter the bay freezes, and the frozen surface works like a mirror. **Albedo** is the fraction of incoming sunlight that a surface reflects instead of absorbing. Fresh snow has an albedo of 0.8 to 0.9, and sea ice reflects 0.5 to 0.7 of the sunlight striking it.



Why the Ice-Free Season Matters

When sea ice melts, it exposes dark water with an albedo of only 0.06. Replacing bright ice with dark water means the bay absorbs about 94 percent of the sunlight that reaches it. The warmed water then delays freeze-up in autumn, which exposes even more dark water to the Sun. This self-reinforcing cycle is called the **ice-albedo feedback**.

Satellite records begin in 1979 and show that the **ice-free season**, the period when the bay lacks continuous sea ice, averaged 124 days in the 1980s but lasted 172 days in 2025. A team of biologists found that breakup arrived about three weeks earlier in 2004 than in 1984, while the western Hudson Bay polar bear population fell from about 1,194 (1987) to about 935 (2004). Polar bears hunt seals from the ice, so bears stranded on shore have almost nothing to eat.

Watching the Bay Today

Several kinds of evidence track the changing ice.

- **Satellite imagery** — records the dates when ice breaks up and re-forms each year
- **Inuit Qaujimajatuqangit** — Inuit knowledge, which Arviat Elders say shows that coastal ice once lasted much longer each year
- **Sled-towed sensors** — used by Jimmy Muckpah of the Aqqumavvik Society in Arviat, alongside satellite images, to monitor sea ice
- **Weather records** — explain exceptions, such as 2024, when strong easterly winds packed ice against the shore and it lasted until nearly September near Arviat

Because single seasons vary, scientists compare these sources across many years before declaring a trend.

PREVIEW

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Questions Answer each question in a full sentence.

1) Why does open water absorb more sunlight than sea ice does?

2) How can a longer ice-free season speed up further melting?

PREVIEW

Two Choices Circle the correct answer.

1) Sea ice reflects _____ sunlight.	more	less
2) Open water has an albedo near _____.	0.8	0.06
3) Ice-free seasons have been getting _____.	shorter	longer
4) Melting ice _____ the bay's heat uptake.	raises	lowers
5) Arviat is a coastal community in _____.	Alberta	Nunavut

Think Imagine Hudson Bay loses more sea ice each summer. How could this lead to even more ice melting in future years? Explain the ice-albedo feedback in your own words.

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Case: Pavement vs Parkland

Two Winnipeg Surfaces

Case 1: Downtown Pavement
Asphalt parking lots and dark shingled roofs cover much of downtown Winnipeg. Freshly laid asphalt has an albedo of only 0.04, [illegible] asphalt reaches 0.12, so it abso[illegible]96 percent of the sunlight [illegible], surface temp[illegible] urban air temp[illegible], but [illegible] two are similar. [illegible] range from 0.10 to 0[illegible] becomes therma[illegible] that after sunset, and on [illegible] conventional roofing can [illegible] 37°C hotter than the surroun[illegible] heat from vehicles and air conditioners, and the result is an **urban heat island**, a built-up area that is warmer than the rural land around it.

Case 2: Assiniboine Park
Assiniboine Park spreads across 450 hectares (ha) along the Assiniboine River. Green grass has an albedo of about 0.25, while deciduous trees, such as the old-growth aspen and oak of the 285 ha Assiniboine Forest in Charleswood, reflect 0.15 to 0.18. That is close to worn asphalt, so albedo alone cannot explain why parkland feels cooler. Trees provide shade, and they release water vapour through their leaves in a process called **transpiration**, which uses heat energy to [illegible]porate water. Moist soil under the lawns [illegible]ther cooling by evaporation, [illegible] urban surfaces provide almost [illegible]none, [illegible]round therefore stays coo[illegible]n s[illegible]vement even though [illegible]s al[illegible]t little light.

PREVIEW





What This Teaches Us
Planners can lower urban heat by changing surfaces as well as by planting. White coatings on low-slope roofs can reach an aged albedo near 0.6, three times higher than the 0.20 ceiling for most existing roofs. Light-coloured concrete starts at an albedo of 0.35 to 0.40 but fades to 0.25 to 0.30 with age, so reflective pavements lose some benefit over time. Closely spaced buildings, called urban canyons, trap heat and block wind, so city layout matters too. Calm, clear weather intensifies a heat island; whereas strong wind and cloud weaken it. Surface heat islands peak in daytime sun, but air-temperature heat islands vary much less across the day.

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Name: _____ 60

Questions

Answer the questions below.

1) Why can a dark roof stay warm after the Sun sets?

2) Why do [illegible]k feel cooler although trees reflect little light?

PREVIEW

True or False

Is the [illegible] (F)?

1) Green grass has a lower albedo t[illegible]	T	F
2) Fresh asphalt reflects about 4% of sunlig[illegible]	T	F
3) Strong wind makes a heat island more intense.	T	F
4) Transpiration uses heat to evaporate water.		F
5) White roof coatings can reach an albedo near 0.6.		F

Sorting

Write H (heats the city) or C (cools it) for each.

1) Replacing a dark roof with a white coating	
2) Paving a lawn to make a larger parking lot	
3) Planting aspen and oak along a boulevard	
4) Building tall walls that trap heat and block wind	
5) Leaving moist grass and soil in a park	

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Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark |

Choose the best answer.

1) What is an urban heat island? a) City warmer than rural land b) Cool park inside a city c) Island heated by the Sun d) Roof with white coating	2) Which has the lowest albedo? a) Green grass b) Deciduous trees c) White roof coating d) Fresh asphalt
3) Transpiration releases what? a) Carbon dioxide b) Water vapour c) Glucose d) Chlorophyll	4) What is an urban canyon? a) Deep river valley b) Wide tree-lined road c) Close buildings trapping heat d) Cooling roof coating

Name: _____ | Mark |

Choose the best answer.

1) What is an urban heat island? a) City warmer than rural land b) Cool park inside a city c) Island heated by the Sun d) Roof with white coating	2) Which has the lowest albedo? a) Green grass b) Deciduous trees c) White roof coating d) Fresh asphalt
3) Transpiration releases what? a) Carbon dioxide b) Water vapour c) Glucose d) Chlorophyll	4) What is an urban canyon? a) Deep river valley b) Wide tree-lined road c) Close buildings trapping heat d) Cooling roof coating

PREVIEW

Name: _____ 82

Drawing Contest – Pavement vs Parkland

Objective What are we learning about?

Students will draw a scene that compares a hot paved surface with a cooler parkland, showing how surface t[illegible]flects the heat that cities hold.



Mater[illegible] [illegible]ou need for the activity?

- ❑ Drawing [illegible]
- ❑ Crayons, mar[illegible]
- ❑ Pencils and erasers
- ❑ Reference list of drawing [illegible]

Instructions How will you complete the ac[illegible]

1) Talk together about why pavement feels hotte[illegible] on a sunny day.
2) Look at the Reference List for ideas or think of your own c[illegible]
3) On your paper, draw one scene that shows both a paved a[illegible]land area.
4) Show at least two ways light and heat behave, such as reflection, absorption, or shade.
5) Add colour and detail to make the temperature difference clear.
6) When you finish, be ready to explain what you included and why.
7) Display all entries around the classroom.
8) Vote on fun categories such as 'Clearest Science' or 'Most Creative' so every entry is celebrated.

PREVIEW

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Name: _____ 83

Reference List of drawing ideas

#	Drawing Idea
1	A Winnipeg parking lot shimmering in summer heat
2	A tree-lined street with dappled shade
3	A school field beside a dark asphalt basketball court
4	A white roof beside a dark roof on a sunny day
5	A pond with ducks on a hot afternoon
6	A [illegible] heat rising from the streets
7	[illegible] on pavement, one on grass
8	A [illegible] brick buildings
9	Sunlight [illegible]
10	Sun rays hitting [illegible]
11	A bike path winding [illegible]
12	A tree planted beside a sunny [illegible]
13	A green roof covered in plants
14	Children cooling off in the shade of an [illegible]
15	A sunset over Assiniboine Park meadows

PREVIEW

Criteria Use the criteria below to complete the activity

Criteria	Description
Both Surfaces	The drawing shows pavement and parkland clearly in the same scene.
Science Ideas	It shows at least two ways light and heat behave on surfaces.
Detail	Colours and details show which surface is hotter and which is cooler.
Neatness	The drawing is tidy and fills the page.
Explanation	I can explain my drawing using science words.

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Name: _____ 84

Reflection Answer the questions below.

1) Which surface in your drawing absorbed more sunlight, and how can you tell?

2) Name [illegible] a city could lower its temperature on hot days.

3) What is one thing in [illegible] could measure with a thermometer?

PREVIEW

Word Scramble Unscramble the words from the word bank.

WORD BANK			
parkland	absorb	shade	pavement
reflect	asphalt	albedo	canopy

EVAPTNEM		KRAPDNAL	
EDDALB		OPYCAN	
EFLECTR		HEASD	

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Rubric How did you do on the activity?

Criteria	1 Point	2 Points	3 Points	4 Points
Both Surfaces	Shows only one surface	Both shown; hard to tell apart	Pavement and parkland clear in one scene	Both clear, labelled and easy to compare
Science Id	No light or heat [illegible] shown	One idea shown, e.g. shade	Two ideas, e.g. reflection and absorption	Three or more ideas, shown with arrows
Deta	[illegible] no [illegible]	Some colour; heat difference unclear	Colours show which surface is hotter	Heat waves, shade or thermometers added
Neatness	Messy [illegible] the page [illegible]	[illegible]	Tidy, fills most of the page	Careful, tidy work; fills the whole page
Explanation	Cannot explain what was drawn	Expl[illegible] with fe[illegible] science wo[illegible]	[illegible] using [illegible]	Explains why each surface holds heat

PREVIEW

Teacher Comments

_____

_____

_____

_____

Mark

Student Comments – What Could You Do Better?

_____

_____

_____

_____

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Name: _____ 66

Story: Eight Minutes to Manitoba

Draw Draw pictures to illustrate the story.

Deep inside the Sun, where the temperature tops 15 million degrees Celsius (15 million °C), a **photon**, a packet of light energy, begins its journey. For roughly 170,000 years its energy is passed from particle to particle through the dense interior, climbing toward the top of the convection zone.

PREVIEW

At last, the energy escapes the Sun's surface as a red photon with a wavelength of about 650 nanometres (nm). It races away at the speed of light, 299,792 kilometres per second (km/s), into space, a vacuum with almost no particles to absorb or scatter it, so nothing slows it. The trip across 150 million kilometres (km) takes about 8 minutes and 20 seconds.

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Then Earth's atmosphere rises ahead, above southern Manitoba. About 29 percent of incoming sunlight is reflected back to space, mostly by clouds, but today the sky over the Red River Valley is clear. The ozone layer absorbs most ultraviolet rays yet very little red light, so the photon slips through, hardly scattered. Roughly 48 percent of incoming energy is absorbed by the surface.

PREVIEW

Below lies a canola field near Carberry, Manitoba, glowing yellow in a July afternoon. The photon strikes a leaf on the nearest plant. Leaves contain **chlorophyll**, a green pigment that absorbs mostly red and blue light and reflects green, which sits near the middle of the visible range of 380 to 700 nm. The red photon is absorbed. Its journey ends, and the leaf warms very slightly as some of its energy becomes thermal energy.

Name: _____ 88

Inside a leaf cell, chloroplasts, the structures that contain chlorophyll, use the absorbed energy to drive **photosynthesis**, the process by which plants convert carbon dioxide and water into glucose and oxygen. The glucose feeds growth, and the oxygen escapes through tiny leaf pores called stomata.



Not every photon ends this way. Some strike the top of a cloud and bounce straight back toward space. Others strike a gravel road and warm the ground, or reach a slough, where water with an albedo of about 0.06 absorbs almost all of them. In winter, fresh snow will reflect 80 to 90 percent of the light. The canola seeds will store this energy as oil, energy that began its climb out of the Sun's core more than 170,000 years earlier and crossed space in eight minutes.

Name: _____ 89

Ordering Number these events 1 to 8 in the order they happened.

	The photon is absorbed by chlorophyll in a leaf.
	The photon slips past the ozone layer.
	The photon races across space for about 8 minutes.
	Its energy climbs through the convection zone.
	Th…ergy escapes the Sun's surface.
	T… is born in the 15 million °C core.
	…kes glucose and oxygen.
	…a leaf near Carberry.

Question Expl… …bsorbed by the leaf and not reflected.

Visualization Draw the photon's whole journey and lat…

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Circle the places the photon visited.

Hudson Bay ice	Outer space
Moon's surface	Lake bottom
Ozone layer	Cloud layer
Sun's core	Canola leaf

Name: _____ Mark

Circle the places the photon visited.

Hudson Bay ice	Outer space
Moon's surface	Lake bottom
Ozone layer	Cloud layer
Sun's core	Canola leaf

Name: _____ Mark

Circle the places the photon visited.

Hudson Bay ice	Outer space
Moon's surface	Lake bottom
Ozone layer	Cloud layer
Sun's core	Canola leaf

Name: _____ Mark

Circle the places the photon visited.

Hudson Bay ice	Outer space
Moon's surface	Lake bottom
Ozone layer	Cloud layer
Sun's core	Canola leaf

Name: _____ Mark

Circle the places the photon visited.

Hudson Bay ice	Outer space
Moon's surface	Lake bottom
Ozone layer	Cloud layer
Sun's core	Canola leaf

PREVIEW

Name: _____ 91

Story: The Colour of the Lake

Blue Water, Missing Red

On a calm June morning, Amira and her Grade 8 classmates stood on the dock at Wasagaming, looking out over Clear Lake in Riding Mountain National Park. The lake covers 29 square kilometres (km²) and is 35 metres (m) deep at its deepest point.

Rose, a knowledge holder from Keeseekoowenin Ojibway First Nation, welcomed the class. The park lies in Treaty 2 territory, and Anishinaabe people maintain connections to its land and waters. "Today we learn by observing," Rose said. "Then you can ask questions."

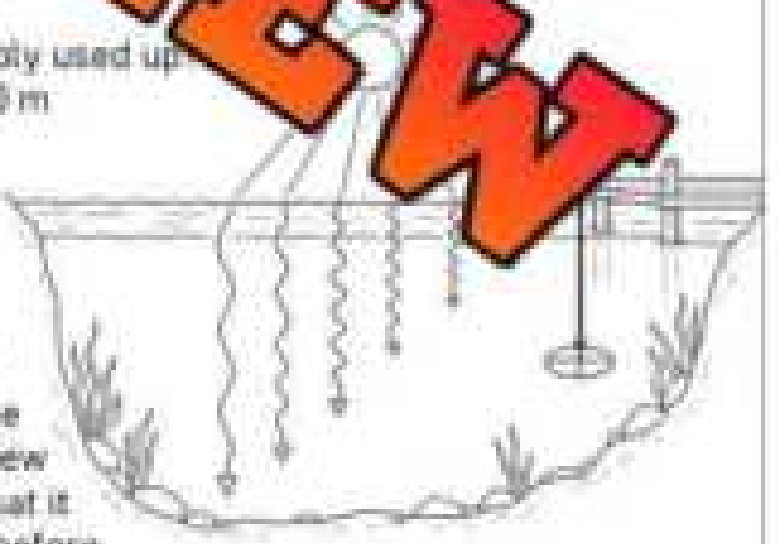
Amira looked up. The light arriving from the sky was white, yet the lake looked blue-green. She did not know why that could be.

Rose had a Secchi disk, a black-and-white disk lowered on a rope to measure how deep light travels in water. Angelo Secchi invented the device in 1865, and the fresh disk was 30 centimetres (cm) across. The class took turns lowering it until it faded from sight.

"Light passing through water is absorbed or transmitted," Rose explained. **Absorption** is the transfer of light energy into a material, while **transmission** is light passing through. Water molecules absorb red and orange wavelengths strongly, and blue wavelengths pass through best. The water's colour also depends on what floats in it, because algae and tiny particles can absorb and scatter extra light.

Jaden frowned. "So, the red is simply used up?"

"Yes," Rose answered. "By about 10 m below the surface, most of the red light has already gone. Blue is transmitted deepest. In the clearest water, at about 150 m, human eyes can see only blue. Even at Clear Lake's deepest point, red would be long gone."



Amira held a red mitten on the rope and lowered it beside the disk. Within a few metres it dulled, because the red light that it normally reflected was being absorbed before it arrived.

Back on the dock, Amira sketched the lake in layers. She coloured the top bright green-blue, then deeper blue, then nearly black. Beside it she wrote: "Deeper means darker and bluer, because water absorbs red light first."

PREVIEW

Name: _____ 92

Ordering Put these story events in the correct order by numbering them 1 to 8.

	Amira lowered a red mitten beside the disk.
	Rose handed Amira a Secchi disk.
	Amira wrote that water absorbs red light first.
	Amira asked why the lake looked blue-green.
	Rose explained absorption and transmission.
	The [illegible] lowered the disk until it faded.
	[illegible] the class to Clear Lake.
	[illegible] lake in layers of colour.

What Did You L[illegible] [illegible] whole story, then answer below.

1) Why does blue light [illegible] water?

2) How did the mitten test support what Rose [illegible]

Making Connections Describe a time you noticed colours change in water, such as in a pool or lake. What might explain it?

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Check (✓) only the true statements.

	Red light is mostly gone by about 10 m.
	The lake's colour comes from its white sky.
	Transmission means light is absorbed.
	Clear Lake is in Riding Mountain Park.
	A Secchi disk measures how deep light travels.
	Blue light is absorbed first by water.

Name: _____ | Mark

Check (✓) only the true statements.

	Red light is mostly gone by about 10 m.
	The lake's colour comes from its white sky.
	Transmission means light is absorbed.
	Clear Lake is in Riding Mountain Park.
	A Secchi disk measures how deep light travels.
	Blue light is absorbed first by water.

Name: _____ | Mark

Check (✓) only the true statements.

	Red light is mostly gone by about 10 m.
	The lake's colour comes from its white sky.
	Transmission means light is absorbed.
	Clear Lake is in Riding Mountain Park.
	A Secchi disk measures how deep light travels.
	Blue light is absorbed first by water.

Name: _____ | Mark

Check (✓) only the true statements.

	Red light is mostly gone by about 10 m.
	The lake's colour comes from its white sky.
	Transmission means light is absorbed.
	Clear Lake is in Riding Mountain Park.
	A Secchi disk measures how deep light travels.
	Blue light is absorbed first by water.

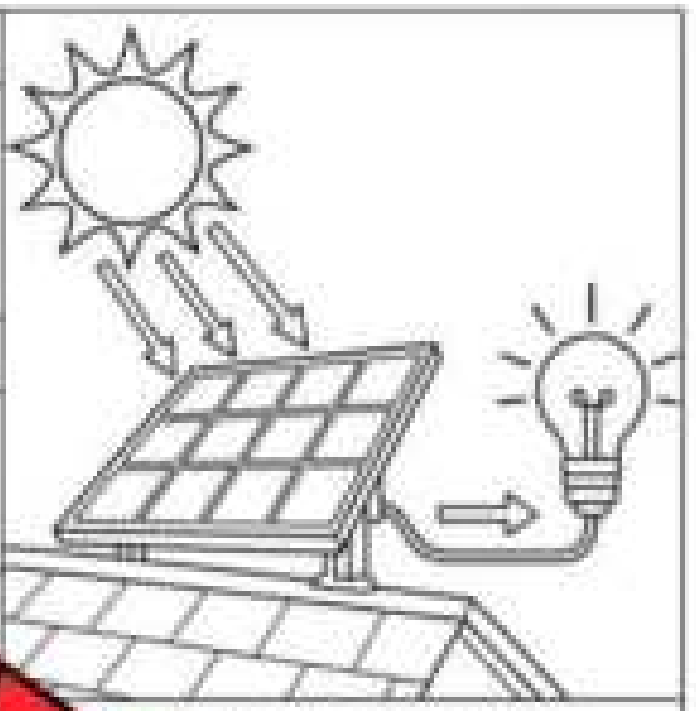
PREVIEW

Name: _____ 101

Interview: A Solar Energy Technician

Student: What does a solar technician do?

Ms. Sandhu: I install and repair **photovoltaic** (PV) panels, devices whose silicon cells convert sunlight directly into electricity.



Student: [illegible] sun does Manitoba get?

Ms. [illegible] averages about [illegible] hours of sun a year, which ranks it among [illegible] cities.

Student: How ma[illegible] make?

Ms. Sandhu: About 1,200 to [illegible] a year per kilowatt of panels in Winnipeg; one kWh is 1 kW [illegible] 1 h[illegible].

Student: Do panels need to face a certain di[illegible]

Ms. Sandhu: South, with a **tilt angle**, the slope [illegible] to Winnipeg's latitude of 49.9°N to catch the most yearly sunlight.

Student: Why would a steeper tilt help in a Manitoba win[illegible]

Ms. Sandhu: Our winter Sun sits low, so steeper panels face it more [illegible] and snow slides off them faster than off flat ones.

Student: Does snow ever help a solar panel?

Ms. Sandhu: Yes. Clean snow reflects most visible light, so it can bounce extra sunlight onto panels, especially bifacial ones lit from both sides.

Student: How long do panels keep working?

Ms. Sandhu: Systems are modelled for 25 years or more, losing about 0.6% of output yearly; heat and wiring losses leave about 75% of rated power.

Student: Thanks for explaining your work to us!

PREVIEW

Name: _____ 102

Fill in the Blanks Circle the missing word.

1)	PV panels convert sunlight to _____	heat	current
2)	Best tilt is near Winnipeg's _____	latitude	longitude
3)	Winter Sun sits _____ in the sky.	low	high
4)	A kilowatt-hour is a unit of _____	energy	power
5)	Clear snow from _____ light onto panels.	reflect	absorb

Questions Answer the questions below using what you read.

1) Name two ways to keep panels in a Manitoba winter.

2) Why might a bifacial panel make more power than a standard one?

Think What question would the Student ask Ms. Sandhu next? Write it and her likely answer.

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Read the clue. Write the answer.

1) The slope of a panel measured from flat ground, in degrees	
2) The material inside most PV cells (symbol Si)	
3) A panel that collects light on its front and back sides	
4) The compass direction Manitoba panels should face	

Name: _____ | Mark

Read the clue. Write the answer.

1) The slope of a panel measured from flat ground, in degrees	
2) The material inside most PV cells (symbol Si)	
3) A panel that collects light on its front and back sides	
4) The compass direction Manitoba panels should face	

Name: _____ | Mark

Read the clue. Write the answer.

1) The slope of a panel measured from flat ground, in degrees	
2) The material inside most PV cells (symbol Si)	
3) A panel that collects light on its front and back sides	
4) The compass direction Manitoba panels should face	

Name: _____ | Mark

Read the clue. Write the answer.

1) The slope of a panel measured from flat ground, in degrees	
2) The material inside most PV cells (symbol Si)	
3) A panel that collects light on its front and back sides	
4) The compass direction Manitoba panels should face	

PREVIEW

Name: _____ 104

Newspaper: Solar Eclipse

Moon Blocks the Sun Across North America

Publish Date: April 9, 2024

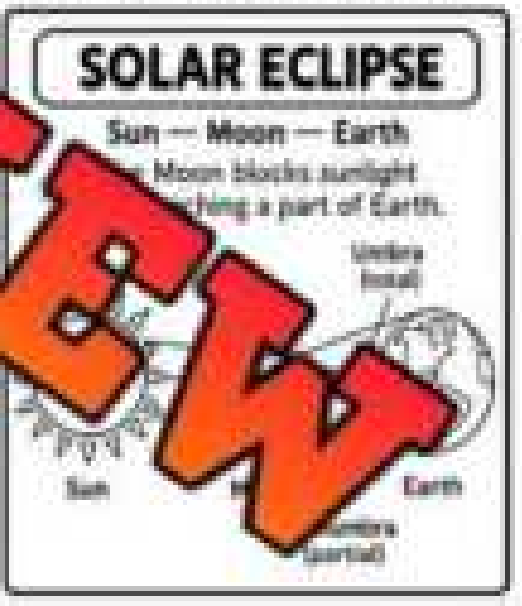
On Monday, April 8, 2024, a **solar eclipse**, an event in which the Moon passes between Earth and the Sun and blocks some or all of its light, swept across North America. Totality, when the Sun's bright face was hidden, lasted longest near Nazas, Mexico: 4 minutes 28 seconds. The path of totality was up to about 197 kilometres wide and crossed six provinces, from Ontario east to Newfoundland. It was the first total eclipse seen in southern Canada since February 26, 1979.

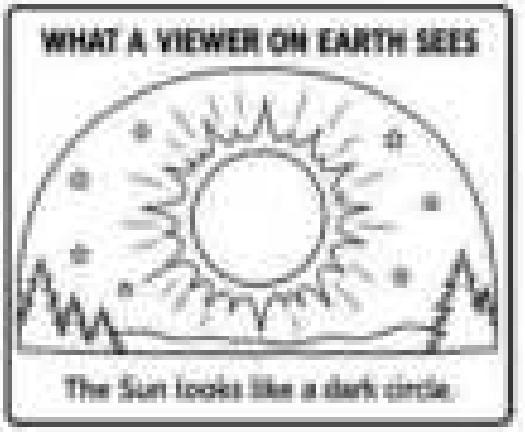
Manitoba lay outside the path, so observers saw a **partial eclipse**, in which the Moon covers only part of the Sun. In Winnipeg the Moon first touched the Sun at 12:54 p.m. CDT, reached maximum at 2:01 p.m. and left at 3:08 p.m., covering about 54 per cent of the Sun's disk. Brandon peaked near 49 per cent and Thompson near 38 per cent, because the Moon's shadow fell farther south and east. The Manitoba Museum Planetarium, the Royal Astronomical Society of Canada's Winnipeg Centre, and the Assiniboine Park Conservancy planned a free viewing party with solar telescopes at The Leaf.

Eclipses occur because the Moon casts a two-part shadow: the **umbra**, the darker inner shadow where sunlight is fully blocked, and the fainter **penumbra**, where it is only partly blocked. The Sun is about 400 times wider than the Moon but also about 400 times farther away, so the two look almost the same size, and the Moon was also close to Earth, appearing about 5.5 per cent larger than average. During an eclipse, less **solar radiation**, energy that travels from the Sun as electromagnetic waves, reaches the ground, so solar panels make less electricity.

"It looked like someone had taken a bite out of the Sun," said Amara Nguyen, a Grade 8 student who watched through certified filters.

The museum warned that sunglasses and homemade filters are not safe; only [illegible] filters block enough light to look at the Sun directly. Researchers also study eclipses because totality reveals the Sun's faint outer sphere.





PREVIEW

Name: _____ 105

True or False Is the statement true or false?

1) Totality lasted up to 4 min 28 s in Mexico.	True	False
2) Only certified solar filters make viewing safe.	True	False
3) Winnipeg was inside the path of totality.	True	False
4) Southern Canada's last total eclipse before 2024 was 1979.	True	False
5) The penumbra is the darkest part of the shadow.	True	False

Questions Answer the questions below using what you read.

1) Why did the ... the Sun covered than Winnipeg?

2) How can an eclipse reduce the electricity so... ...e?

PREVIEW

Opinion Write a comment: should schools hold eclipse viewing events? Give a reason.

Username: _____ Date: _____

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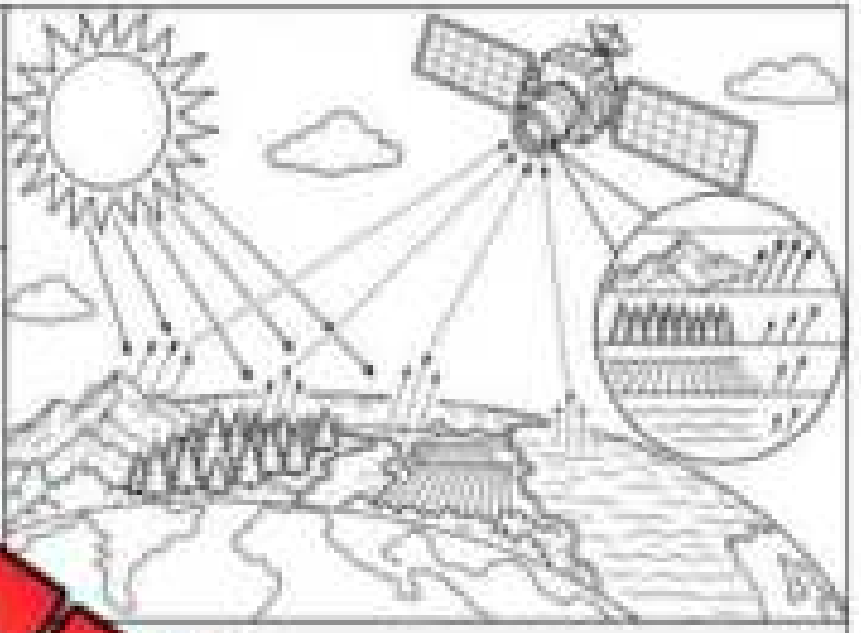
Name: _____ 107

Podcast: Satellites Measure Reflected Light

Host (Mia): Welcome to Science Signals! I'm Mia. Today we ask how satellites measure sunlight bouncing off Earth, and our guest is remote sensing scientist Dr. Amina Okoro.



Dr. Okoro: Thanks, Mia. **Remote sensing** means gathering information about Earth from a distance, usually with instruments on a **satellite**, an object that orbits a planet. Landsat 9, launched on September 27, 2021, circles about 700 kilometres above us.

Host (Mia): How can a satellite measure light?

Dr. Okoro: Its sensors count how much light each patch of ground sends back in separate wavelengths. Landsat's Operational Land Imager records visible and infrared light, and each pixel covers a 30 metre square.

Host (Mia): What do scientists do with that?

Dr. Okoro: They compare the reflected light with the amount that fell on the ground, which gives the **albedo**, the fraction of incoming light a surface reflects. Dark forest reflects little, while clean snow returns most of it.

Host (Mia): How big an area does one pass cover?

Dr. Okoro: Each pass records a strip, or swath, 185 km wide. A single camera revisits the same place every 16 days, but two working together see it every eight, which lets scientists build an **albedo map** that shows change.

Host (Mia): Is that the first satellite like this?

Dr. Okoro: Not at all. Landsat 1 launched on July 23, 1972. Terra, launched on December 18, 1999, carries CERES, an instrument that measures reflected sunlight and heat leaving Earth.

Host (Mia): Why does this matter for climate?

Dr. Okoro: Albedo maps show where bright snow and ice are shrinking, because darker ground absorbs more of the Sun's energy. Comparing images year after year lets scientists detect those changes early and test their climate predictions.

PREVIEW

Name: _____ 108

Fill in the Blanks Circle the missing word.

1)	Landsat 9 orbits _____ km above Earth.	185	705
2)	Albedo is the fraction of light a surface _____.	absorbs	reflects
3)	Remote sensing collects data from a _____.	distance	contact
4)	Landsat 1 launched in _____.	1972	1999
5)	One [illegible]swath is _____ km wide.	185	705

Questi Answer questions below using what you read.

1) Describe how [illegible] scientists find albedo.

2) Why is a record that began in 1972 useful [illegible]dying [illegible]ce?

Think Write one more question Mia could ask Dr. Okoro about satellites, and her answer.

PREVIEW

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Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

True (T) or false (F)?

1) Albedo maps never change.	T / F
2) Terra carries CERES.	T / F
3) Terra is a ground station.	T / F
4) Landsat pixels are 30 m.	T / F
5) Landsat sees infrared too.	T / F

Name: _____ Mark

True (T) or false (F)?

1) Albedo maps never change.	T / F
2) Terra carries CERES.	T / F
3) Terra is a ground station.	T / F
4) Landsat pixels are 30 m.	T / F
5) Landsat sees infrared too.	T / F

Name: _____ Mark

True (T) or false (F)?

1) Albedo maps never change.	T / F
2) Terra carries CERES.	T / F
3) Terra is a ground station.	T / F
4) Landsat pixels are 30 m.	T / F
5) Landsat sees infrared too.	T / F

PREVIEW

Name: _____ 110

Letter: From a Photographer

Dear Grade 8 Scientists,

I have photographed the Manitoba prairies for fifteen years, and I still describe my job as applied physics. A camera records **reflection**, the bouncing of light off a surface, so every picture begins with sunlight striking something and entering my lens.

My favourite time to shoot is **golden hour**, the period shortly after sunrise or before sunset when the Sun sits low and the light turns soft and reddish. Low sunlight crosses more atmosphere, which scatters blue light away and stretches shadows. At Winnipeg's latitude, 49°N, the noon Sun climbs only about 17° above the horizon at the winter solstice and about 63° at the summer solstice, so winter's warm, low light lingers for hours.

Surfaces differ in what they reflect, and a camera records. Smooth water and glass obey the **law of reflection**: they leave at the same angle at which it arrived, producing mirror-like glare. Rough [illegible] direction, and dark soil absorbs most of it. When a lake glares, I [illegible] or add a polarizing filter, which blocks much of the reflected

Winter tests every photographer. Snow reflects most visible sunlight. A camera's light meter assumes the average scene reflects only about 18 per cent of the light, so it tries to darken a bright snowfield and the photograph comes out dull and grey. I correct this by increasing the **exposure**, the amount of light that reaches the camera's sensor, which I control with aperture, shutter speed and ISO. On a clear day my starting point is the sunny 16 rule: an aperture of f/16 and a shutter speed of one over the ISO number, which is 1/100 of a second at ISO 100.



Try an experiment before you pick up a camera. Photograph one object at noon and again near sunset, then compare its shadow and light. Next, compare a white wall and a black jacket in the same sunlight. Light does not simply fall on a scene; it is reflected, absorbed and scattered by everything it meets.

Yours in light,

Marcus Delorme, Photographer

PREVIEW

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Name: _____ 111

True or False

Is the statement true or false?

1) Golden hour happens when the Sun is low.	True	False
2) Clean snow reflects most visible sunlight.	True	False
3) A rough surface reflects light like a mirror.	True	False
4) A polarizing filter reduces glare from water.	True	False
5) Winter noon Sun is higher than summer noon Sun.	True	False

Questions

...er the questions below using evidence from the text.

1) Wh... low ... the light look redder at golden hour?

2) Why can bright snow ma... he... ...il grey photo?

Drawing

Draw and label six surfaces: three that refl... ...y ... ...t absorb.

PREVIEW

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Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Find the lie. Two statements are true.

	A camera meter assumes a scene reflects about 18%.
	Golden hour is when the Sun is highest at noon.
	Low Sun light crosses more air than noon light.

Name: _____ | Mark

Find the lie. Two statements are true.

	A camera meter assumes a scene reflects about 18%.
	Golden hour is when the Sun is highest at noon.
	Low Sun light crosses more air than noon light.

Name: _____ | Mark

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Name: _____ | Mark

Find the lie. Two statements are true.

	A camera meter assumes a scene reflects about 18%.
	Golden hour is when the Sun is highest at noon.
	Low Sun light crosses more air than noon light.

PREVIEW

Name: _____ 113

Mark /

Unit Test
Fields

Part 1 Circle the correct answer for each question

1) How does the Sun make energy?
- A) Nuclear fission
- B) Burning coal
- C) N… …sion
- D) …on

2) Radiation can travel through…
- A) a vacuum
- B) only solids
- C) only liquids
- D) only air

3) Sh… …wave…
- A) Radio
- B) Gamma …
- C) Microwaves
- D) Visible light

4) A prism splits sunlight into…
- A) one colour
- B) heat only
- C) sound waves
- D) …the solar spectrum

5) Albedo measures…
- A) absorbed sound
- B) emitted heat
- C) reflected sunlight
- D) wave height

6) Lo… …bedo surface?
- A) …
- B) Op…
- C) …
- D) Cl…

7) Ozone absorbs mostly…
- A) infrared
- B) radio waves
- C) ultraviolet
- D) visible light

8) Why is the sky b…
- A) Ocean reflection
- B) Ozone absorption
- C) Cloud albedo
- D) Rayleigh scattering

9) Solar panels convert light to…
- A) electricity
- B) sound
- C) natural gas
- D) ice

10) Satellites map albedo using…
- A) sonar
- B) remote sensing
- C) carbon dating
- D) seismic mapping

PREVIEW

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Part 2 Define each of the terms below

Mark /

Term	Definition (what does it mean)
Radiation	
Electromagnetic Wa	
Sa Eclipse	

Part 3 ...tions below

Mark /

1) Why can sunlight travel thro... while conduction and convection cannot?

2) What happens to the frequency of an electromagnetic wave whe... becomes shorter?

3) Explain how a prism separates white sunlight into different colours.

PREVIEW

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Part 4	Answer the long answer question below.	Mark	/

During a summer afternoon, a downtown parking lot is much hotter than a nearby park. Explain how albedo, absorption, shade, and transpiration contribute to this temperature difference. Suggest two changes city planners could make to reduce urban heating.

PREVIEW

Part 5	Draw the Sun, Moon, and Earth in the correct positions during a solar eclipse. Illustrate the Moon's umbra and penumbra. Show where observers would experience total and partial eclipse.	Mark

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Workbook Preview

Grade 8 Science Unit
Life Science

Strands A – D		
	Curriculum Outcomes	**Pages**
SCI.8.A (Strand A)	Demonstrate an understanding of different First Nations, Métis, and Inuit ways of knowing, being, and doing in relationship with the land and the natural world by exploring Indigenous methods of observing and interpreting the world, applying scientific principles, and creating technologies within local traditional and contemporary cultural contexts (e.g., wholistic, reciprocal, interconnected, and sustainable ways; landbased learning; outdoor learning; intersections with Western science).	50–52, 65–67, 82–84, 97–106
SCI.8. (Strand	Preview of 80 pages from this product that contains 168 pages total.	2–24, 34–36, 53–55, 74–76, 97, 115
SCI.8.C (Strand C)	• Science, Technology, Society, and Environment (STSE) Contexts • Scientific Measurement • Action and Practice • Scientific Instruments • Careers, Hobbies, and Activities	16–21, 25–27, 31–33, 37–40, 47–49, 59–61, 71–73, 77–81, 88–91, 107–109, 116–118
SCI.8.D (Strand D)	**Purpose**: Science is about finding the cause or causes of phenomena in the natural world. **Method**: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time. **Application**: The knowledge produced by science is used in engineering and technologies to create products and processes. **Implication**: Applications of science often have ethical, environmental, social, economic, and political implications.	44–46, 55–58, 68–70

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Grade 8 Science Unit
Life Science

Strand E – Scientific Knowledge		
	Curriculum Outcomes	**Pages**
SCI.8.E.18	Demonstrate an understanding of cell theory. Include the following: all living things are composed of one or more cells; cells are the basic unit of structure and function of any organism; all cells come from pre-existing cells; the activity of an organism depends on the total activity of all its cells.	7-9, 34-40, 110-112
SCI.8.E.19	Demonstrate the understanding that various types of cells have particular conditions that are ideal for their growth.	41-52, 116-118
SCI.8.E.20	Demonstrate the understanding that cells have specialized structures for particular functions. Include the following: organelle, cytoplasm, cell membrane, cell wall, nucleus, mitochondria, chloroplast, vacuole.	10-21, 97-106
SCI.8.E.21	Demonstrate an understanding of the structural and functional relationships among cells, tissues, organs, and organ systems. Include the following: stem cells, specialized cells.	22-33, 82-84
SCI.8.E.22	Demonstrate the understanding that in living things, cells contribute to homeostasis to maintain conditions required for life. Examples: cellular respiration, pH balance, osmosis, diffusion, selective permeability	53-61, 85-96, 113-115
SCI.8.E.23	Demonstrate an understanding of the structure and function of the human circulatory system in maintaining homeostasis. Examples: heart, blood, blood components, blood vessels, oxygen, waste, water, temperature regulation	62-81, 92-96, 107-109

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Name: _____

LIFE SCIENCE



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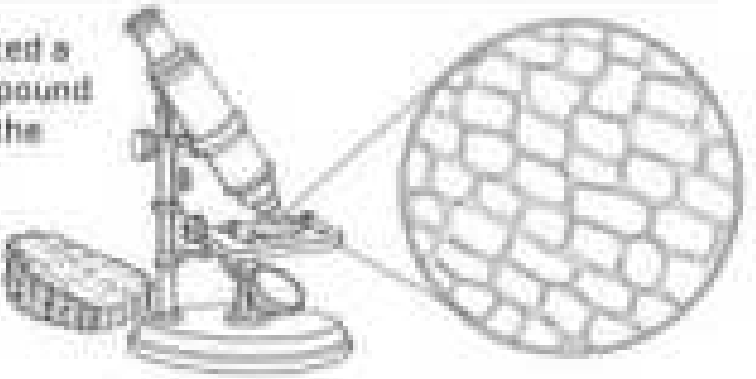
Name: _____ 7

Cell Theory

Discovering the Cell

In 1665, English scientist Robert Hooke sliced a thin piece of cork, viewed it through a compound microscope and published his drawings in the book Micrographia. He saw rows of small box-shaped compartments that reminded him of the [illegible], called cellulae in Latin, where monks lived, so he named them **cells**, the [illegible] of structure and function. Hooke was really observing [illegible] dead plant tissue, yet his word stuck, and better microscopes soon revealed cells everywhere.



Three Scientists, One Theory

German botanist M[illegible] Schleiden published in 1838 that plants are built from cells, and German zoologist [illegible] Schwann reached the same conclusion about animals in 1839.

In 1855, physician Rudolf Virchow popularized the Latin phrase omnis cellula e cellula, meaning every cell comes from a cell. [illegible] disproved belief in spontaneous generation, the idea that living things could appear from non-living matter. Together, their well-tested ideas became the **cell theory**, a scientific explanation supported by evidence from many observers.

The Four Statements

Modern cell theory has four statements, and each applies to every [illegible] known living thing, from bacteria to blue whales.

- **All organisms are composed of one or more cells** — a bacterium is a single cell, usually 0.1 to 5 micrometres (µm) across, while a human body contains an estimated 30 to 40 trillion.
- **The cell is the basic unit of structure and function** — a human egg cell, about 0.1 millimetres (mm) wide, is just visible to the unaided eye, while a red blood cell is only about 8 µm wide, yet each completes its own work.
- **All cells come from pre-existing cells** — a cell divides to form two new cells, which is how one fertilized egg becomes a body and how a scraped knee heals.
- **An organism's activity depends on the total activity of its cells** — each heartbeat is the combined contraction of billions of cardiac muscle cells, so damage to many of them weakens the whole heart.

PREVIEW

Name: _____ 8

Define What do the terms below mean?

Cell	
Organism	
Theory	

True or False Is the statement true?

1) Schwann concluded that plants are made of cells.	True	False
2) The word cell comes from a Latin word for small room.	True	False
3) New cells arise only from cells that already exist.	True	False
4) A human egg cell is about 8 µm wide.	True	False
5) A single bacterium is a whole organism.	True	False

Question Explain how a scraped knee healing supports cell theory.

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Why did Virchow's idea challenge spontaneous generation?

Name: _____ Mark

Why did Virchow's idea challenge spontaneous generation?

Name: _____ Mark

Why did Virchow's idea challenge spontaneous generation?

Name: _____ Mark

Why did Virchow's idea challenge spontaneous generation?

PREVIEW

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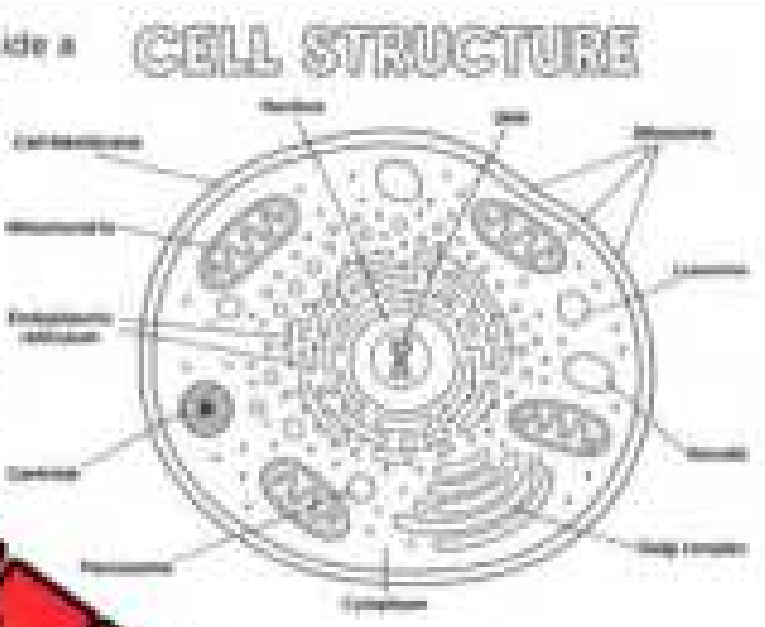
Name: _____ 10

Inside the Cell: Organelles

Tiny Organs Inside Cells

An **organelle** is a specialized structure inside a cell that carries out a particular function, much as an organ does in a body. The largest organelle in an animal cell is the **nucleus**, which holds the cell's DNA and directs its activities. In human cells it measures about 6 micrometers across, takes up roughly 10 percent of the cell's volume and contains most of the cell's genes. A double membrane called the nuclear envelope surrounds it, perforated by thousands of pores that control what enters and leaves. Mature red blood cells lose their nucleus entirely, which is why they can't divide.



Energy and Boundaries

Mitochondria (singular: mitochondrion) are the organelles that release energy from glucose and store it in a molecule called ATP, the cell's usable energy. Cells with high energy demands contain the most, and a liver cell can hold over a thousand. Each has a folded inner membrane that increases the surface area for making ATP, and its own small loop of DNA suggests mitochondria descend from ancient free-living bacteria. The **cell membrane** is the thin, flexible boundary around every cell, built from a double layer of phospholipid molecules. It is selectively permeable, which means it lets some substances cross while blocking others, and it is studded with protein channels and pumps that move ions and nutrients in and waste out.

Inside the Cytoplasm

The **cytoplasm** is the jelly-like fluid between the nucleus and the cell membrane. It is mostly water, and many of the cell's chemical reactions take place there while its slow streaming carries materials around. A dense region inside the nucleus, the nucleolus, assembles the ribosomes described below. Other organelles float in the cytoplasm too.

- **Ribosomes** — tiny structures that assemble amino acids into proteins, found free in the cytoplasm or attached to membranes
- **Endoplasmic reticulum** — a folded network of membranes that moves proteins and builds lipids, with a rough form studded with ribosomes and a smooth form without them
- **Golgi apparatus** — stacked membranes that package proteins into vesicles for delivery
- **Lysosomes** — sacs of digestive enzymes that break down worn-out parts

PREVIEW

Name: _____ L1

True or False Circle whether the statement is true or false.

1) Mitochondria package proteins for delivery.	True	False
2) Human red blood cells keep a large nucleus.	True	False
3) The nucleus holds the cell's DNA.	True	False
4) Cytoplasm is mostly water.	True	False
5) The cell membrane lets only some substances pass.	True	False

Questions Answer the questions below using evidence from the text.

1) Why would a liver cell need more mitochondria than a skin cell?

2) How do the cell membrane and nucleus both act as gates?

Diagram Draw an animal cell and label five organelles.

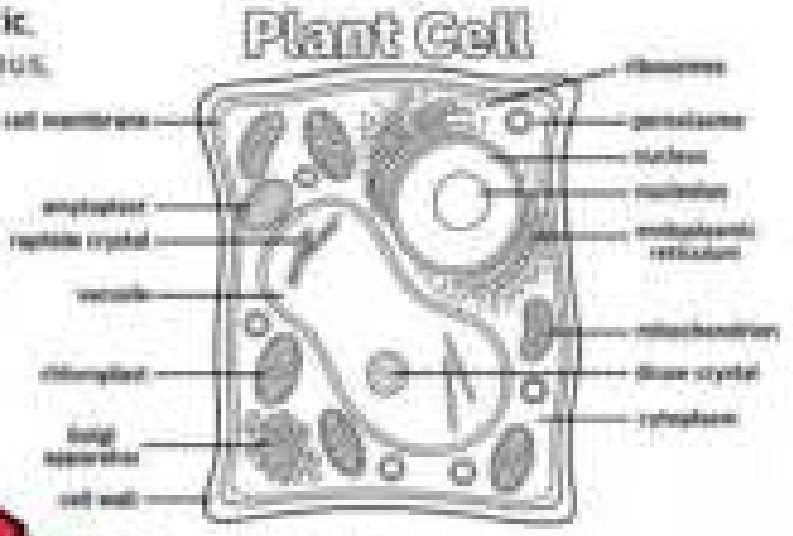
PREVIEW

Name: _____ L3

Plant and Animal Cells

Shared and Different Structures

Plant and animal cells are both **eukaryotic**, meaning their DNA is enclosed in a nucleus, and both contain mitochondria, cytoplasm and a cell membrane. Plant cells use their mitochondria to release energy just [illegible] animal cells do. Their shapes [illegible] differ, however: animal cells are [illegible] rounded or irregular and [illegible] across, whe[illegible] boxy and range [illegible] about [illegible]. They also store [illegible] keep surplus g[illegible] starch; animal cells store [illegible] and muscle cells.



PREVIEW

Plant-Only Structures

Three structures set plant cells [illegible] fr[illegible]

- **Cell wall** — a rigid layer of cellulose [illegible] outside the membrane that supports and protects the cell; animal cells have non[illegible]ngi[illegible] walls from chitin instead
- **Chloroplasts** — organelles holding the green [illegible] that captures light energy for **photosynthesis**, the process that [illegible] glucose [illegible] carbon dioxide and water; leaf cells of the water plant Elodea show [illegible] under a microscope
- **Large central vacuole** — a membrane-bound sac that stores w[illegible] dissolved salts and typically fills more than 30 percent of a mature p[illegible] sometimes up to 80 percent; animal vacuoles are smaller and more numerous

Why Plants Stand Tall

Plants have no skeleton, so their rigidity comes from the cell wall working with the vacuole. When water fills the vacuole, it presses the cell membrane firmly against the wall, creating **turgor pressure**, the internal force that makes plant cells firm. The wall resists this outward push, which prevents the cell from bursting; animal cells, lacking a wall, cannot tolerate such pressure. If a plant loses water, turgor pressure drops and its leaves and stems wilt.

Trees gain extra strength because their thickened walls are reinforced with lignin, a compound that remains after the cells die, forming wood. Animal cells depend instead on an internal framework called the cytoskeleton and, in vertebrates, on bones and muscles.

Name: _____ 14

True or False Is the statement true or false?

1) Plant cells have mitochondria.	True	False
2) Chlorophyll captures light energy.	True	False
3) Animal cells are surrounded by a cellulose wall.	True	False
4) Water in the vacuole presses against the wall.	True	False
5) Animal cells have one huge central vacuole.	True	False
6) Chloro[illegible]e found in animal cells.	True	False

Sorti[illegible] [illegible]nto the correct column.

Cell wall	Chl[illegible]	Large vacuole	Chlorophyll
Nucleus	[illegible]	Cell membrane	Cytoplasm

Found only in plant ce[illegible]	both plant and animal cells

PREVIEW

Making Connections A lettuce leaf left on the counter goes limp. Use what you read about vacuoles and cell walls to explain what happened inside its cells.

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Read the clue and write the answer.

1) I am the pigment that makes leaves green.	
2) I am the strong cellulose layer outside a plant cell membrane.	
3) I am the force that keeps plant cells firm.	
4) I am the sugar-making organelle in leaf cells.	

Name: _____ | Mark

Read the clue and write the answer.

1) I am the pigment that makes leaves green.	
2) I am the strong cellulose layer outside a plant cell membrane.	
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3) I am the force that keeps plant cells firm.	
4) I am the sugar-making organelle in leaf cells.	

PREVIEW

Name: _____ 16

Memory Game – Plant and Animal Cells

Objective What are we learning about?

Students will learn to identify and describe the structures and functions of plant and animal cells by matching scientific terms with their definitions, strengthening their understanding of cell organelles and their roles in living organisms.

Materials ...u need for the activity?

- ❑ Memory G...
- ❑ Scissors
- ❑ A flat table



Instructions How will you co... th...

1) Carefully cut out all 40 memory game cards ...g su... ...ientific terms and their definitions remain on separate cards.
2) Shuffle the cards and arrange them face down ... on a ... e. Keep the term cards in one group and the definition cards in an...
3) Take turns flipping over one term card and one definition card ... carefully to determine whether they form a correct match.
4) If the definition correctly matches the scientific term, keep both cards as a pair and take another turn.
5) If the cards do not match, return them to their original positions face down. Try to remember their locations for your next turn.
6) Continue playing until all 20 pairs have been correctly matched. The player who collects the most matching pairs wins the game.
7) After completing the game, answer the quiz questions and choose two scientific terms to explain in your own words, including their functions in plant or animal cells.

PREVIEW

Name: _____ L7

Cards | Memory Game Cards

Cell wall	Rigid outer layer that gives a plant its fixed shape and support
Ch[illegible]t	Double-membraned organelle found only in plants and algae; sugar is built here
Chlorophyll	[illegible]nt that absorbs [illegible] light and [illegible]een
Cellulose	Tough, indig[illegible]ore made of long [illegible]cose chains in plant structures
Central vacuole	Large sac that takes up much of a mature plant cell; stores water, sugars and wastes.

PREVIEW

Name: _____ 18

Cards | Memory Game Cards

Turgor pressure	Force of water pushing outward in plant cells that keeps leaves and stems firm
	Animal-cell organelle holding digestive enzymes that break down worn-out parts
Centriole	of a pair of tiny rs in animal organize res
Glycogen	Branched e animals stor the liver and muscles for quick energy
Starch	Sugar chains plants store in potato tubers and grain seeds

PREVIEW

Name: _____ 19

Cards | Memory Game Cards

Ribosome	Tiny structure that reads instructions to join amino acids into proteins
Golgi apparatus	Stack of flattened sacs that sorts, packages and ships proteins
Nucleolus	…se spot inside the …centre where …ot…ing parts …
Cytoskeleton	Network of …s that holds orga…es in place and lets a cell change shape
Plastid	Any of several double-membraned plant organelles that store starch or hold pigments

PREVIEW

Name: _____ 20

Cards | Memory Game Cards

Stomata	Tiny pores in leaf surfaces that let carbon dioxide in and water vapour out
G[illegible]	Bean-shaped partner that swells or shrinks to open or close a leaf pore
Cuticle	[illegible] coating on a leaf [illegible]at reduces [illegible]s
Eukaryote	Organism [illegible] have a membra[illegible]bound nucleus and other organelles
Vesicle	Small membrane bubble that carries materials between organelles

PREVIEW

Name: _____ 21

Quiz Check-In

This quiz will assess students' understanding of the concepts covered in the Memory Game activity. Cut along the lines and give each section to a student.

Name: _____ Mark: ____

Write about 2 words from the game and explain what they mean.

Name: _____ Mark: ____

Write about 2 words from the game and explain what they mean.

Name: _____ Mark: ____

Write about 2 words from the game and explain what they mean.

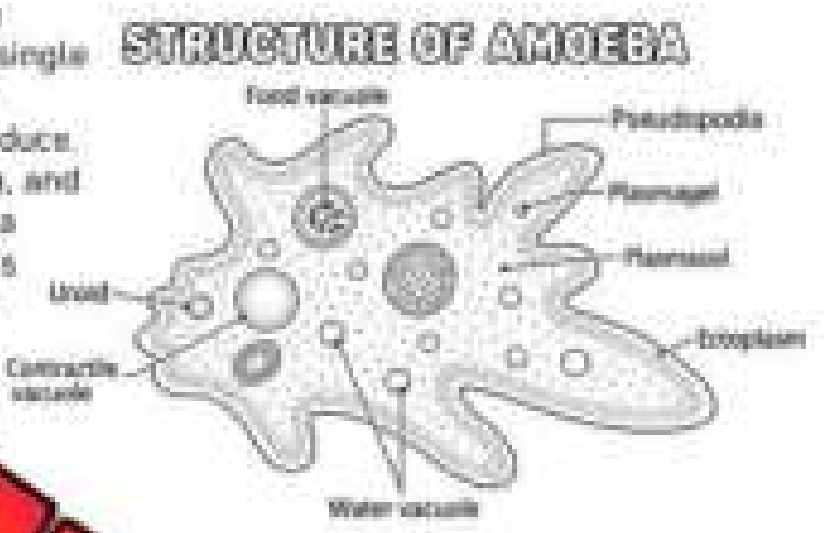
PREVIEW

Name: _____ 22

One Cell or Many?

Life in a Single Cell

A **unicellular** organism is a living thing whose whole body is one cell, so that single cell must obtain food, remove wastes, respond to its surroundings and reproduce. Unicellular organisms include bacteria, and many are too small to see without a microscope. Their simple design allows them to live anywhere there is water, from the inside of your gut to ... as Euglena, contain ... make their own ... as like Amoeba, ... it.



PREVIEW

Four Examples Compared

Each of these organisms sho... the same challenge.

- **Amoeba proteus** — a pond protist ... by sticking out pseudopodia, or false feet, and engulfs food particles wi...
- **Paramecium** — a protist 0.06 to 0.3 mm lon... swims ... rows of cilia, which also sweep bacteria into its oral groo... organism
- **Yeast (Saccharomyces cerevisiae)** — a fungus 5 t... reproduces by budding, in which a small daughter cell grows out of ... carbon dioxide gas that makes bread dough rise
- **Volvox** — a hollow, ball-shaped colony of up to 50 000 cells, ea... carrying two flagella, or whip-like tails, with only a few cells reserve... reproduction

Life in Many Cells

A **multicellular** organism is a living thing made of many cells that cooperate. Plants, animals and many fungi are multicellular: a mushroom, for example, is built from threads of connected cells. A human body contains an estimated 30 to 40 trillion cells, and their activities are shared out instead of repeated. Specialized cells such as neurons, muscle cells and red blood cells each perform one function extremely well, which allows large, complex bodies to exist. Because no single cell must do everything, one damaged cell rarely threatens the organism's life, whereas a unicellular organism dies if its only cell fails. Specialization has a cost, though: the cells depend on one another and cannot survive for long separately.

Name: _____ 23

Multiple Choice Circle the best answer.

1) Which gas makes bread dough rise?			
Oxygen	Nitrogen	Carbon dioxide	Hydrogen
2) Roughly how many cells can one Volvox colony contain?			
Up to 50 000	Up to 50	Up to 500	Up to 5 million
3) How does an amoeba surround its food?			
Pseud	Cilia	Flagella	Budding
4) Why c	rvive one damaged cell?		
It r	r cells share the work	Humans have one cell	All cells are identical
5) Which struc	nectium takes in food?		
Cell wall	Fo	Chloroplast	Nucleolus

PREVIEW

Scenario A drop of pond w shows a speck with hairlike projections swimmin multicellular, and what evidence from the text would

Think If you were a unicellular organism, what challenges would you face when finding food, moving around, and staying alive? Explain how your life would be different.

Name: _____ 28

Blog Post: Levels of Organization

5 Levels of Organization in Living Things

Date: October 6, 2026 **Author**: Ms. Tamara Fontaine 4-minute read

Every organism is built in layers. Biologists call these **levels of organization**: a hierarchy in which each level is assembled from the one below it. Here are five, from smallest to largest.

1) **Cells: The Basic Units:** A **cell** is the basic unit of structure and function in an organism. Cell s[hape] its function. A **motor neuron**, a nerve cell that signals muscles, can reach 1 m [from] the spine to the foot, yet its fibre is only a few micrometres wide. S[ome] develop from **stem cells**, unspecialized cells able to divide and

2) **Tissues: Cells** **tissue** is a group of similar cells that work together to perform [a] [hum]ans have four basic types: epithelial tissue covers surfaces and lines [cavities]; connective tissue includes blood, bone and tendon; nervous tissue carries signals; [and] muscle tissue contracts. Muscle tissue itself comes in three kinds: skeletal, cardiac and

3) **Organs: Tissues Combined:** [An] **organ** is made of several tissues that together perform a specific [func]tion. Skin is a good example. Its outer layer, the epidermis, is epithelial tissue in which keratin[ocytes] make up about 95% of the cells. The dermis beneath it is connective tissue containing nerves, hair roots and blood vessels.

4) **Organ Systems: Organs Cooperating:** An **organ system** is a group of organs that cooperate to carry out a major body function. Humans have 11 organ systems, among them the digestive, circulatory, respiratory and [nervous]. The digestive tract measures about 9 m at autopsy, and the small intestine alone is about 7 m long. A few organs, such as the nose, serve two systems.

5) **Organism: The Whole Individual:** An **organism** is a complete living [thing]. All organ systems depend on one another. Plants have only two: the root system and the shoot system. In General Sherman, a giant sequoia in Sequoia National Park, California, these two systems support a body 83.8 m tall. As in every organism, its activity depends on the total activity of all its cells.

PREVIEW

Comments



Nina – October 6, 2026

I never knew skin counts as an organ made of different tissues!

Like Reply 1d ago



Owen – October 7, 2026

Nina, same. Eleven organ systems is a lot to keep working together.

Like Reply 20m ago

© Super Simple Reads

Name: _____ 29

True or False Circle whether the statement is true or false.

1) Muscle tissue comes in only two kinds.	True	False
2) Animals have four basic types of tissue.	True	False
3) The human body has 11 organ systems.	True	False
4) Plants have no organ systems.	True	False
5) Organs are made of several tissues.	True	False

Questions Answer the questions below using evidence from the text.

1) How does one organ system depend on the one below it?

2) Why could harm to one organ system affect the whole organism?

Fill in the Blank Choose the correct word from the box to complete each sentence.

systems	stem	tissue	organism	organ

1) Similar cells that work together form a _____

2) The skin is an _____ because it combines several tissues.

3) The human body has 11 organ _____.

4) General Sherman is a giant sequoia, a whole _____.

5) A _____ cell can divide and become a specialized cell.

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Match each term to its description.

Epidermis ☐	☐ Includes blood, bone and tendon
Motor neuron ☐	☐ Nerve cell up to 1 m long
Connective ☐	☐ Outer layer of the skin

Name: _____ Mark

Match each term to its description.

Epidermis ☐	☐ Includes blood, bone and tendon
Motor neuron ☐	☐ Nerve cell up to 1 m long
Connective ☐	☐ Outer layer of the skin

Name: _____ Mark

Match each term to its description.

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Name: _____ Mark

Match each term to its description.

Epidermis ☐	☐ Includes blood, bone and tendon
Motor neuron ☐	☐ Nerve cell up to 1 m long
Connective ☐	☐ Outer layer of the skin

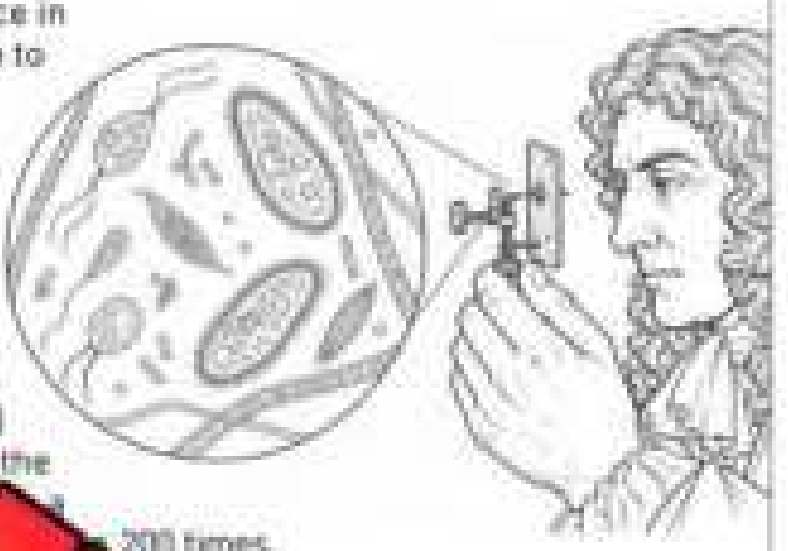
PREVIEW

Name: _____ 34

Story: Leeuwenhoek's Tiny Animals

The Apprentice and the Lens

In the autumn of 1676, Femke, an apprentice in a Delft cloth shop, carried a parcel of linen to Antony van Leeuwenhoek, a draper who also made his own magnifying lenses. He used them to count the threads in cloth, but that day he had something stranger to show him.



She was smaller than her hand. The glass [illegible] of his lenses measuring only [illegible] across, set between [illegible] the specimen waited on a pin. A screw. A single lens like [illegible] 200 times.

Two years earlier, in 167[illegible], Antony had gathered water from a lake near Delft. Through the lens, he had seen green threads and swimming among them, creatures far too small for the unaided eye. He called them **animalcules**, meaning "little animals."

Femke looked. A cloudy drop became a [illegible] world. Some spun and others glided past. She was seeing **microorganisms**, living [illegible] seen without a microscope. Today scientists know that many of them [illegible] cells.

Antony knew of a London scientist, Robert Hooke. In [illegible] Hooke had published a book called Micrographia, in which he sliced thin cork and saw rows of tiny [illegible] compartments. He named them **cells**, because they resembled small [illegible]. He saw only the walls of dead cork cells, and his compound microscope magnified [illegible] 40 to 50 times.

That month, on 9 October 1676, Antony wrote to the Royal Society in London about his animalcules. Many members doubted the letter; because nobody else had seen such creatures. In 1677, the Society's investigators confirmed his observations, and his reputation was secured. He kept looking. In 1683, he described even smaller organisms in plaque scraped from his own teeth. Later scientists named them **bacteria**, single-celled organisms without a nucleus.

Femke wrote in her notebook that cork contained cells and pond water contained living ones. Hooke had found the building blocks, and Antony had found them alive. Together, their observations revealed a hidden level of structure in living things.

PREVIEW

Name: _____ 35

Ordering Number these events 1 to 8 in the order they happened in the story.

	Femke saw crowded oval bodies spinning in a drop.
	Antony wrote to the Royal Society on 9 October 1676.
	Femke delivered a parcel of linen in Delft.
	Many Society members doubted the letter.
	The Society's investigators confirmed his observations.
	[illegible] explained his 1674 lake water observations.
	[illegible]ed organisms from tooth plaque.
	[illegible] cells and pond cells fit together.

Question [illegible] Why does Antony's work both matter?

Visualization Picture the drop of lake water. Draw what Fe[illegible]

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Circle what was seen by 1700.

Animalcules	Mitochondria
DNA	Pond microbes
Ribosomes	Cork cells
Bacteria	Viruses

Name: _____ Mark

Circle what was seen by 1700.

Animalcules	Mitochondria
DNA	Pond microbes
Ribosomes	Cork cells
Bacteria	Viruses

Name: _____ Mark

Circle what was seen by 1700.

Animalcules	Mitochondria
DNA	Pond microbes
Ribosomes	Cork cells
Bacteria	Viruses

Name: _____ Mark

Circle what was seen by 1700.

Animalcules	Mitochondria
DNA	Pond microbes
Ribosomes	Cork cells
Bacteria	Viruses

Name: _____ Mark

Circle what was seen by 1700.

Animalcules	Mitochondria
DNA	Pond microbes
Ribosomes	Cork cells
Bacteria	Viruses

PREVIEW

Name: _____ 37

Tableau – Leeuwenhoek's Tiny Animals

Objective What are we learning about?

Students will learn how Antony van Leeuwenhoek's observations of microscopic organisms contributed to the development of cell theory and changed scientific understanding of living things by recreating important historical moments through collaborative frozen scenes.

PREVIEW

Materials What will you need for the activity?

- ❑ Tableau scene cards
- ❑ Open floor space
- ❑ Props such as hats or simple costumes
- ❑ Timer



Instructions How will you complete the activity?

1) Form groups of four or five students and choose one scene card related to the discovery of microscopic life.
2) Read your chosen scene carefully and discuss what the event represents. Assign each group member a role as a person, object, or part of the scene.
3) Work together to create a frozen picture of the event. Decide where each person should stand and use appropriate body positions, gestures, and facial expressions to communicate the scene.
4) Practise holding your positions completely still and remaining silent for at least ten seconds. Make any adjustments needed to ensure the scene is clear and recognizable.
5) Present your tableau to the class without speaking or moving. Allow the audience to observe your frozen scene and guess which historical moment you are representing.
6) After each performance, audience members should describe what they think the characters are feeling or thinking and explain which visual clues helped them reach their conclusions.
7) Exchange scene cards with another group and prepare a different tableau. After completing the performances, answer the reflection questions to explain how scientific observations contributed to our understanding of cells and microorganisms.

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Name: _____ 38

Tableaus | Tableau scenes for the activity

#	History	Description of Scene for Tableau
1	**Delft Cloth Shop**	A cloth merchant in a Dutch shop holds a thread up to a tiny glass lens, squinting to count the fibres. Customers wait at the counter while he leans close, one eye shut.
2	**Grindi… Lens**	…ens maker bends over a workbench, slowly …bead of glass no bigger than a seed. Tools …oulders are tight and every face …ation.
3	**Hooke's Cork Drawing**	A scientist … a candle sketching a thin slice of cork … microscope. His page shows rows … an in with wide eyes.
4	**Pond Water Drop**	At the edge of a lake, a figure dips … tube into the water and carefully lifts one drop, holding it to the light with hopeful eyes.
5	**First Animalcules**	At a tiny brass microscope, the merchant freezes in astonishment as minute creatures swirl through a drop of water. A family member peers over his shoulder, mouth open.

PREVIEW

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Name: _____ 39

Tableaus | Tableau scenes for the activity

#	History	Description of Scene for Tableau
6	**Letter to London**	A man writes late into the night with a quill; drawings spread around him. He is describing the tiny creatures for the Royal Society, face lit by a single candle.
7	**Doubting Scholars**	A group of scholars sits around a table staring at the [illegible] crossed and eyebrows raised. One shakes [illegible] while another leans in, curious.
8	**Witnesses Look**	Several [illegible] take turns at the microscope, each with a different expression: shock, delight, quiet wonder [illegible] confirm the creatures are real.
9	**Teeth Scrapings**	A man holds a small mirror and scrapes material from his teeth. He peers into the lens, surprised to find creatures even smaller than those in the pond water.
10	**A New World**	Everyone stands in a wide arc facing one microscope. Each person points, reaches out or shields their eyes as though a hidden world has just opened in front of them.

PREVIEW

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Name: _____ 40

Reflection Answer the questions below.

1) Which scene showed the biggest change in what people knew about life?

2) W[illegible] other observers to confirm what Leeuwenhoek saw?

3) How did the microscope link Hooke's cork [illegible] ani[illegible] water?

4) What would you have done to prove the creatures were real?

PREVIEW

Name: _____ 41

Case: Bacteria and Yeast Need the Right Conditions

Two Kitchens, Two Kinds of Cells

Case 1: Soup on the Counter
A pot of chicken soup sits on a counter for four hours after dinner. **Bacteria** are single-celled organisms without a nucleus, and many that cause food poisoning grow fastest near the **optimum temperature**, the temperature at which a type of cell grows best. For [illegible] this is about 37 degrees Celsius, close to body temperature. Under [illegible] conditions, Escherichia coli can [illegible] as 20 minutes. The steady supply of substances cells need for energy and growth. Canadian food [illegible] calls 4°C to 60°C the danger [illegible] warms that food left there for [illegible] two hours may be unsafe. A refrigerator at 4°C or colder slows the same bacteria.

Case 2: Dough in the Fridge
A baker prepares two bowls of bread dough. **Yeast** is a single-celled fungus that feeds on sugars in dough and releases ethanol and carbon dioxide gas, which makes the dough rise. Bowl A rests in a kitchen near 30°C, inside the ideal range for yeast of roughly 27°C to 32°C, so its cells feed and reproduce quickly. Bowl B goes into a refrigerator at 4°C, where the yeast stays alive but works extremely slowly, so the dough rises overnight. Salt and sugar can also inhibit yeast, with salt having the stronger effect. A third baker mixes [illegible] water at 70°C; yeast dies at [illegible] to 60°C, so that dough never [illegible]

PREVIEW



What This Teaches Us
Both cases show that each type of cell has a range of conditions in which it thrives. **pH**, a scale from 0 to 14 that measures how acidic or basic a solution is, adds a third condition. Illness-causing bacteria are mostly **neutrophiles**, microbes that grow best between about pH 6.5 and 7.5, while spores of Clostridium botulinum cannot grow in foods with a pH of 4.6 or lower. This explains why vinegar-based pickles resist that bacterium. Cold slows cells, yet heat above 60°C kills most of them. Because every organism has its own limits, a food-safety rule or a bread recipe is really a set of instructions for controlling temperature, nutrients and pH.

Name: _____ 42

Questions

Answer the questions below.

1) Explain why leftovers belong in the fridge, not on the counter.

2) Why do cold fridge slow yeast and bacteria without killing them?

PREVIEW

True or False

Is the s... (T) or false (F)?

1) Yeast grows best at about 4°C.	T	F
2) E. coli can divide in as little as 20 minutes.	T	F
3) Water at 70°C would kill yeast cells.	T	F
4) Food is safe for days in the 4°C–60°C danger zone.		F
5) Many disease bacteria prefer a neutral pH.		F

Sorting

Sort each action: Slows Growth or Speeds Growth?

1) Leave cooked rice on the counter for three hours.	
2) Put leftover soup in a 4°C refrigerator.	
3) Set bread dough in a 30°C kitchen to rise.	
4) Store bread dough in the fridge overnight.	
5) Pickle cucumbers in vinegar to lower the pH.	

Name: _____ 44

Experiment: Yeast Balloon Challenge

Objective — What are we learning about?

Students will learn how temperature affects the activity of living yeast cells by investigating carbon dioxide production at different temperatures and understanding why cells require suitable environmental conditions to function efficiently.

Materials — What will we need for our activity?

- ❑ 3 [illegible] (same size)
- ❑ 3 [illegible]
- ❑ Dry yeast
- ❑ Sugar
- ❑ Cold water, room temperature and warm water (approximately)
- ❑ Measuring spoons
- ❑ Measuring cup
- ❑ Thermometer
- ❑ String and ruler



PREVIEW

Instructions — How will we complete our activity?

1) Label three empty plastic bottles Cold, Room Temperature, and Warm so you can identify each experimental condition.
2) Pour 100 mL of water into each bottle, using cold water in the first, room temperature water in the second, and warm water in the third. Measure and record the temperature of each sample.
3) Add one teaspoon of sugar and one teaspoon of dry yeast to each bottle. Gently swirl the bottles to mix the ingredients without spilling.
4) Carefully stretch a balloon over the opening of each bottle, ensuring it fits securely and no air can escape around the edges.
5) Place the three bottles beside one another and observe them for approximately 20–30 minutes. Watch for bubbles forming in the liquid and changes in balloon size.
6) Every five minutes, use a piece of string to measure the circumference of each balloon at its widest point, then measure the string with a ruler. Record your results in a table.
7) Compare the measurements to determine which temperature produced the greatest balloon inflation. Discuss how temperature affected yeast activity and why living cells function best within certain temperature ranges.

Name: _____ 45

Recording Sheet | Record the details of your experiment below:

Make Your Prediction: Which water temperature do you think will cause the greatest balloon inflation? Explain why.

Record the ... Conditions		
Bottle	Water temperature (°C)	Initial balloon circumference (cm)
Room temper...		
Warm		

My Observations: measur... ...ch balloon every five minutes. Record your results in centimetres (... ...e 0 cm.

Time	Cold (cm)	Room ... (cm)	Warm (cm)
0 min			
5 min			
10 min			
15 min			
20 min			
25 min			
30 min			

1) Which bottle showed the first signs of bubbling?

2) Which balloon increased in size the fastest?

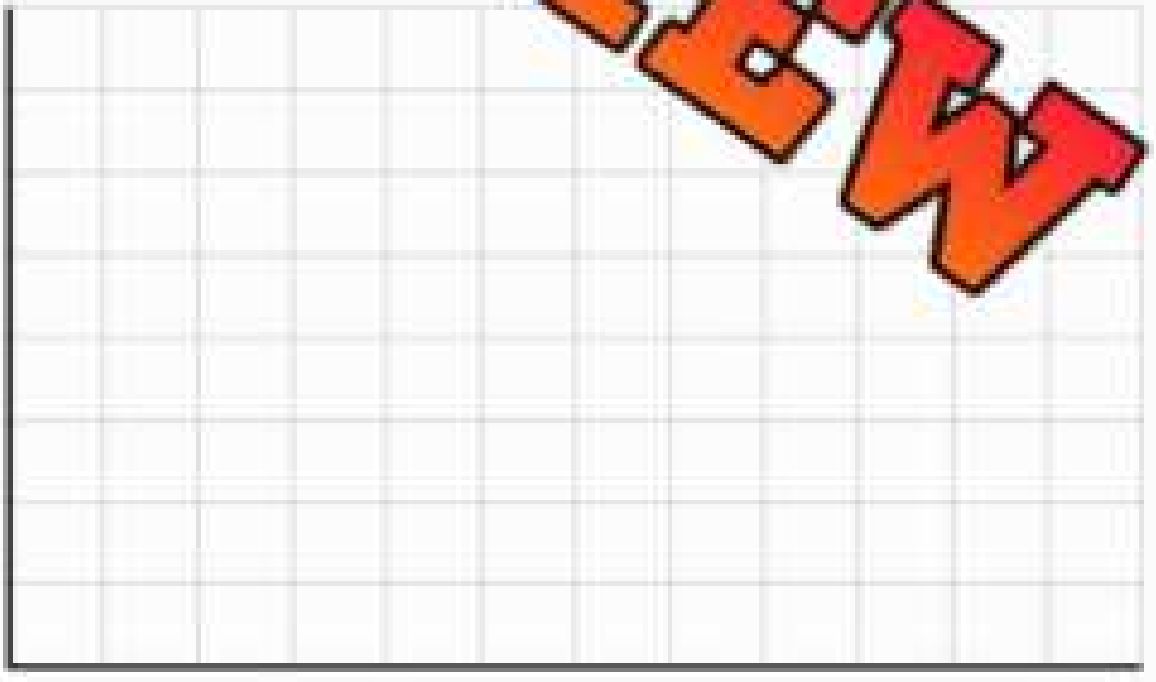
PREVIEW

3) Describe one unexpected observation during your experiment.

4) Was your original prediction supported by the evidence? Explain.

5) W[illegible] the greatest balloon inflation? Use two measurements from your [illegible] rt your answer.

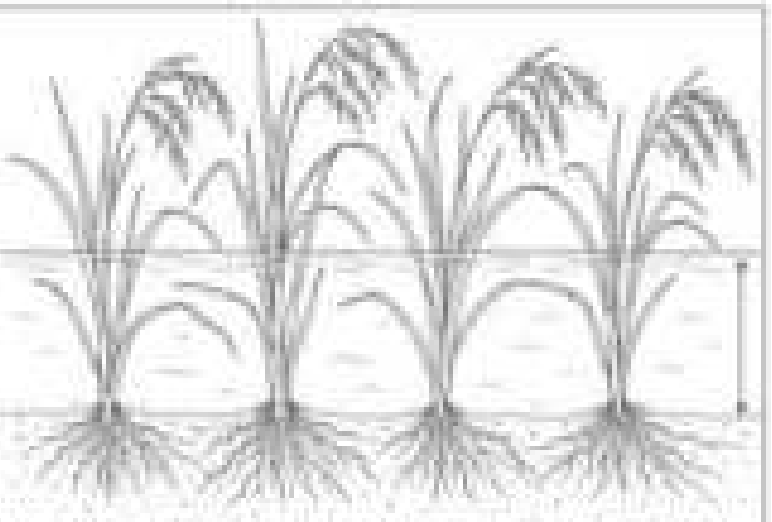
Graph Your Results: Use your measure[illegible] graph showing how the balloon circumference changed over ti[illegible] ures. Include a title, labelled axes, units, and a key.



PREVIEW

Name: _____ /10

Manoomin: Wild Rice and Its Waters



Manoomin and Its Home

Manoomin, the Anishinaabemowin word for northern wild rice (*Zizania palustris*), means "the good berry." It is an annual grass, a plant that completes its life cycle in a single growing season, so every crop begins with seed. In Manitoba it grows in shallow, c… in many Whiteshell lakes an… along the east shor… far north as Nort… h into Manitob… om M… gus peoples have … for more than a thousand years, and it supplied up to a quarter … of … groups. It remains important today.

What Manoomin Needs

A **habitat** is the place that … th conditions. Healthy manoomin beds depend on several of them:

- **Depth** — shallow water, roughly 30 … deep
- **Sediment** — soft, silty mud rich in organic …
- **Clean water** — low sulphate, preferably under … mg/L), which can be converted into toxic sulfide
- **Slow flow** — lakes and slow-moving streams, not ra…
- **Steady levels** — sudden rises uproot plants; sudden drops …

Germination and Harvest

Seeds drop to the muddy bottom, overwinter there, and begin **germination** — the sprouting of a seed into a new plant — in spring as the water warms. Each seedling passes through a floating-leaf stage before the stalk rises above the surface. In September, harvesters in canoes knock ripe grain into the boat with wooden sticks, and some always falls back into the water to seed the next stand.

Pimachiowin Aki, a World Heritage Site shared by the Bloodvein River, Little Grand Rapids, Pauingassi and Poplar River First Nations, explains that heads take about 10 days to fill, so rain or wind can knock ripe kernels into the lake. After harvest, kernels are dried over a fire in a metal pail, then husks are separated by treading the rice on canvas in a shallow pit and tossing it, so the wind carries the husks away. Dams, shoreline development, motorboats and pollution have harmed beds elsewhere.

PREVIEW

Name: _____ 51

True or False Is the statement true or false?

1) Manoomin grows best in water 30 to 90 cm deep.	True	False
2) Manoomin is a perennial that regrows from roots.	True	False
3) Seeds overwinter on the muddy bottom before sprouting.	True	False
4) Sudden water-level changes can uproot manoomin.	True	False
5) Manoomin grows best in fast, rushing rapids.	True	False

Questions ...the questions below using evidence from the text.

1) Des... thre... that manoomin needs in its habitat.

2) How does harvesting fro... for next year?

Drawing Draw and label six boxes showing manoomi...

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Underline the correct answer.

1) Manoomin means the good berry / leaf

2) Heads take about 10 weeks / days

3) Harvest happens in September / April

4) Sulphate becomes toxic as starch / sulfide

Name: _____ | Mark

Underline the correct answer.

1) Manoomin means the good berry / leaf

2) Heads take about 10 weeks / days

3) Harvest happens in September / April

4) Sulphate becomes toxic as starch / sulfide

PREVIEW

Name: _____ | Mark

Underline the correct answer.

1) Manoomin means the good berry / leaf

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Name: _____ | Mark

Underline the correct answer.

1) Manoomin means the good berry / leaf

2) Heads take about 10 weeks / days

3) Harvest happens in September / April

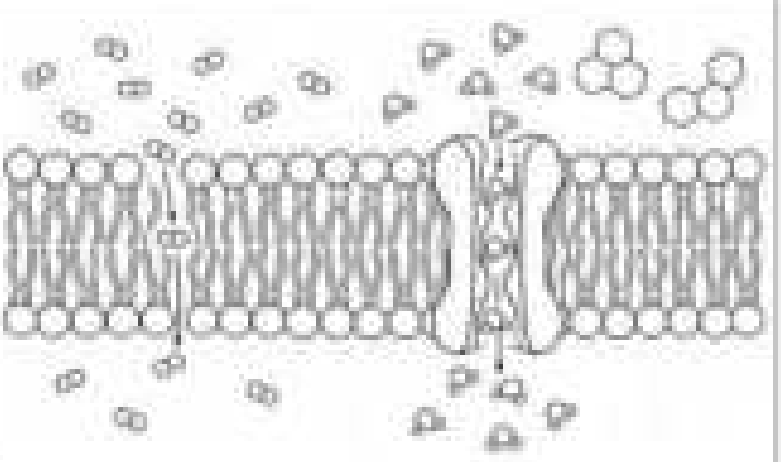
4) Sulphate becomes toxic as starch / sulfide

Name: _____ 53

Diffusion, Osmosis and the Cell Membrane

Selective Permeability

The **cell membrane** is a boundary less than 10 nanometres (nm) thick that surrounds every cell. It is built from a double layer of fat-like molecules called phospholipids, with proteins embedded in it. The membrane has **selective permeability**, which means it lets some substances pass while blocking others. Small molecules such as oxygen can slip between phospholipids, but ions and large molecules cannot pass without help. Carbon dioxide enters and leaves.



PREVIEW

Diffusion and Osmosis

Diffusion is the movement of particles from an area of higher concentration to an area of lower concentration until the concentration is even. A difference in concentration is called a gradient, and particles move down it. Energy comes from the cell, which makes diffusion and osmosis types of **passive transport**. In the lungs, oxygen diffuses from air in the alveoli into the blood, while carbon dioxide diffuses the other way. The Scottish chemist Thomas Graham made the first systematic experiments on diffusion of gases in the early 1830s, and in 1855 the German physiologist Adolf Fick described it as a mathematical law.

Osmosis is the diffusion of water across a selectively permeable membrane from the side with more dissolved particles. In 1748 the French scientist Jean Antoine Nollet sealed alcohol inside a pig bladder and placed it in water, and the bladder swelled as water passed through the membrane. A raisin soaked in water swells for the same reason, because more water enters it faster than it leaves. Seawater holds about 35 g of dissolved salts per litre, so it draws water out of a freshwater cell.

Ways Across the Membrane

- **Simple diffusion** — oxygen enters, and carbon dioxide leaves, directly through the phospholipids
- **Facilitated diffusion** — glucose and ions move down their gradients through transport proteins, still without energy
- **Aquaporins** — protein channels that speed water across the membrane; Peter Agre reported the first in 1992 and shared the 2003 Nobel Prize in Chemistry
- **Active transport** — protein pumps use energy to move particles against their gradient, from low to high concentration

Name: _____ 54

Two Choices Circle the best answer.

1) Oxygen crosses the membrane by _____.	osmosis	diffusion
2) Osmosis is the movement of _____.	glucose	water
3) Diffusion moves particles _____ a gradient.	up	down
4) The cell membrane is selectively _____.	solid	permeable
5) Peter A[illegible]found channels for _____.	water	glucose

Questi[illegible] questions below using evidence from the text.

1) Explain wh[illegible]er[illegible]ity means for a cell.

2) Compare diffusion and osmosis. How are th[illegible]e[illegible]erent?

PREVIEW

Finish the Sentence Complete each sentences below.

1) Glucose needs a transport protein to enter a cell because...

2) Oxygen moves into a muscle cell without energy because...

Name: _____ 5b

Experiment: The Shrinking Potato

Objective

What are we learning about?

Students will learn how osmosis affects the movement of water across selectively permeable cell membranes by investigating changes in potato mass and firmness when exposed to different salt concentrations.

Materials

What will you need for the activity?

- ☐ 3
- ☐ 3 c
- ☐ Water
- ☐ Table salt
- ☐ Measuring cup
- ☐ Measuring spoons
- ☐ Digital kitchen scale
- ☐ Ruler
- ☐ towels
- ☐ marker
- ☐ eet



Instructions

How will you

1) Label three clear cups Plain Water, Mild Sa , and alt Water to identify the different conditions being tested.
2) Pour 150 mL of water into each cup. Leave the e teaspoon of salt in the second cup, and dissolve three teaspo in
3) Cut three potato strips of equal length and thickness, ap d 1 cm wide. Gently dry each strip with a paper towel and record g a digital scale.
4) Place one potato strip into each cup, ensuring the strips are comple submerged. Leave them undisturbed for approximately 45–60 minutes so water can move across their cell membranes.
5) Carefully remove the potato strips and gently blot away excess surface water. Measure and record their final masses, then compare their firmness by gently bending each strip without breaking it.
6) Calculate the percentage change in mass for each potato strip. Record your results in a table and identify which strips gained or lost water.
7) Compare the results from all three cups and discuss how salt concentration affected water movement. Explain how osmosis influences the central vacuole, turgor pressure, and the ability of plant cells to maintain their shape.

PREVIEW

Name: _____ 97

Recording Sheet | Record the details of your experiment below.

Make Your Prediction: Which solution do you think will cause the potato strip to lose the most mass? Explain your prediction using what you know about osmosis.

My Observ ecord the amount of salt, water, and initial potato mass for each cup.

S	Amount of Salt	Water (mL)	Initial Mass (g)
P ater	0 tsp	150	
Mild salt w		150	
Strong salt water		150	

My Results: After 45–50 minutes, ref each potato strip before measuring its final mass.

Solution	Final Mass (g)	Chang ss (	mness After Soaking
Plain water			
Mild salt water			
Strong salt water			

Use the formula to calculate how much mass each potato strip gained or lost.

$$\text{Percentage Change} = \frac{\text{Final Mass} - \text{Initial Mass}}{\text{Initial Mass}} \times 100$$

Solution	Percentage Change (%)	Gained or Lost Mass?
Plain water		
Mild salt water		
Strong salt water		

PREVIEW

Name: _____ 98

My Observations: Complete the table using short descriptions of how the potato strip felt during each stage.

1) Which potato strip felt the firmest after soaking?

2) Which potato strip felt the softest or most flexible?

3) Did [illegible] you? Describe what you noticed.

My Conclusion: Was y[illegible] your results? Explain how different salt concentrations affected w[illegible]o cells. Include at least two measurements from your re[illegible]

PREVIEW

Reflection Answer the following questions.

1) Which potato strip lost the most mass? Explain how the diff[illegible] concentration inside and outside the cells caused water to move.

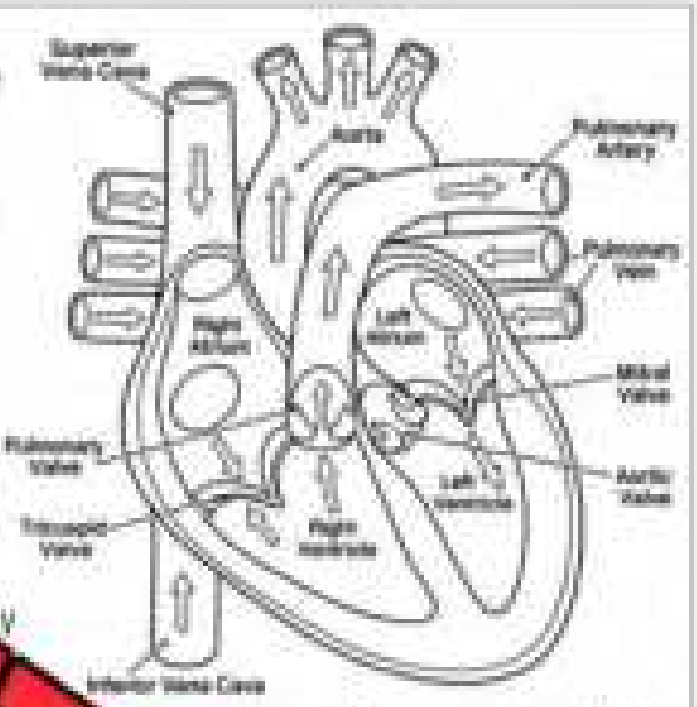
2) Why might a potato strip become firmer in plain water but softer in strong salt water? Explain your answer using the terms central vacuole and turgor pressure.

Name: _____ 62

The Heart and Blood Vessels

The Four-Chamber Pump

The **heart** is a muscular organ, roughly the size of a fist, that pumps blood through the body and has a mass of 250 to 350 grams (g) in an adult. Its interior is divided into four **chambers**, the hollow compartments that fill with blood and then contract. The two upper chambers, the left and right **atria**, receive blood arriving from the body or lungs. The two lower chambers, the **ventricles**, push blood out of the heart.



The left ventricle is thicker because it must drive blood through the entire body, while the right ventricle only needs to push blood to the nearby lungs. Four valves keep blood flowing in one direction, and the familiar "lub-dub" sound heard through a stethoscope is made by these valves snapping shut. At rest, an adult heart beats about 5 litres of blood every minute.

One Heart, Two Circuits

In 1628 the English physician William Harvey proposed that blood moving in a closed circuit, not being used up by the body. Today we describe two loops. In the **pulmonary circuit**, the right ventricle sends oxygen-poor blood to the lungs, and oxygen-rich blood returns to the left atrium.

In the **systemic circuit**, the left ventricle pumps oxygen-rich blood into the body's largest artery, and onward to the remaining organs. Because blood passes through the heart twice on every full trip, the arrangement is called a double circulation.

Three Kinds of Blood Vessel

Blood vessels are the tubes that carry blood through a closed network, and each type is built for its job.

- **Artery** — a thick, elastic-walled vessel that carries blood away from the heart; the pulmonary artery is the exception, since it carries oxygen-poor blood
- **Vein** — a thinner-walled vessel that carries blood back toward the heart, with valves that keep blood moving one way
- **Capillary** — a microscopic vessel only 5 to 10 micrometres (µm) wide, whose wall is a single cell thick, so oxygen and nutrients can pass into tissues

PREVIEW

Name: _____ 63

Finish the Sentence

Complete each sentence below.

1) The left ventricle has a thicker wall than the right because...

2) Capillary walls are one cell thick, which means...

Question

...ions below.

1) Name the four ... that each pair does.

2) Why does blood pass through the heart t... one...

3) Compare an artery with a vein in structure and direction of ...

PREVIEW

Odd One Out

Circle the word that does not belong in each group.

Left atrium	Valve	Right atrium	Left ventricle
Artery	Vein	Aorta	Ventricle

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Check all that are true.

	Valves let blood flow back
	Veins have valves
	Blood passes through the heart twice
	Veins carry blood away
	Atria push blood to body
	Right side feeds the lungs
	Aorta is the largest artery
	Capillary walls are thick

Name: _____ Mark

Check all that are true.

	Valves let blood flow back
	Veins have valves
	Blood passes through the heart twice
	Veins carry blood away
	Atria push blood to body
	Right side feeds the lungs
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Name: _____ Mark

Check all that are true.

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	Blood passes through the heart twice
	Veins carry blood away
	Atria push blood to body
	Right side feeds the lungs
	Aorta is the largest artery
	Capillary walls are thick

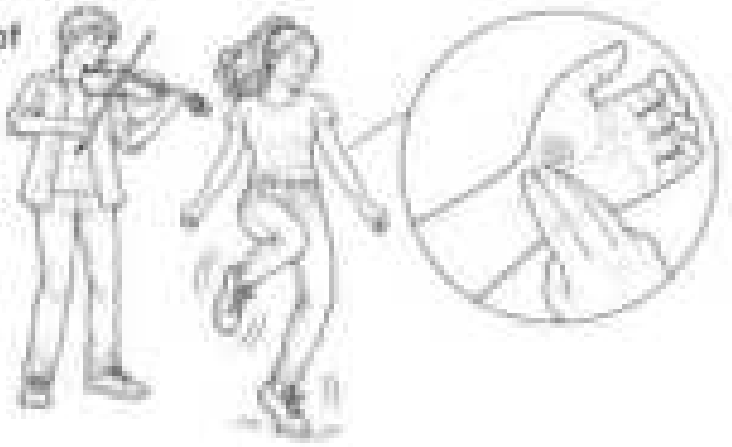
PREVIEW

Name: _____ 65

Métis Jigging and the Heartbeat

The Red River Jig

The **Red River Jig** is the best-known dance of the Métis, an Indigenous nation whose homeland includes Manitoba's Red River Valley. The Manitoba Métis Federation says Métis jigging began in the Red River area in the mid-1[illegible] and the first recorded reference [illegible]ne is from 1860, when a fiddler p[illegible] Métis wedding dance. The d[illegible]ions footwork with [illegible] and [illegible]adian step-dancing.



Today jiggers c[illegible] Métis and Manitoba groups such as United Thunder, formed in 2017, per[illegible] their upper body straight while their feet work quickly, so the leg[illegible] dancers share a basic jig step but add personal "fancy" steps, and [illegible]eir home community. Fiddlers play the tune, and a driving "horse [illegible]" rh[illegible]ddle music apart from other styles.

PREVIEW

Heart Rate During a Jig

Heart rate is the number of times the heart bea[illegible] m[illegible]g muscles use oxygen faster, so the nervous system raises the he[illegible] the [illegible] supplying those muscles widen. The extra blood delivers the oxy[illegible] co[illegible]ells need for cellular respiration and carries away carbon dioxide.

Heart rate can climb from about 60 beats per minute at rest to abo[illegible] exercise. Stroke volume, the volume of blood pushed out by each beat, r[illegible], from about 70 millilitres (mL) to 120 mL. Cardiac output is heart rate multiplied by stroke volume, so it can grow from roughly 4 L per minute to more than 20 L per minute.

Measuring Your Response

- **Pulse** — the rhythmic stretch of an artery wall with each heartbeat, felt at the wrist or the neck
- **Before** — a resting count taken after sitting quietly, giving a baseline
- **During** — a count taken right after a minute of jigging, which should be much higher
- **Recovery** — the drop in heart rate after stopping, since a larger drop within a minute generally shows a fitter heart

Name: _____ 66

True or False Is the statement true or false?

1) Heart rate stays the same during exercise.	True	False
2) The Red River Jig was first recorded in 1860.	True	False
3) Métis jigging began in the Red River area.	True	False
4) The jig uses only European dance steps.	True	False
5) Output [illegible]eart rate times stroke volume.	True	False

Questi[illegible] [illegible]tions below using evidence from the text.

1) Describe ho[illegible] ch[illegible]tput when a jig begins.

2) Why would a faster recovery heart rate sug[illegible]tter

PREVIEW

Think Think of a time you danced, played a sport or ran hard. Describe how your heartbeat and breathing changed, and explain why your muscles needed this change.

Name: _____ 68

Experiment: Heart Rate Investigation

Objective What are we learning about?

Students will learn how physical activity affects heart rate by measuring their pulse before and after exercise and investigating how the circulatory system responds to increased oxygen demands and helps maintain homeostasis.

Materials What will you need for the activity?

- ☐ Stopwatch
- ☐ Pencil
- ☐ Recording sheet
- ☐ Graph paper
- ☐ Ruler
- ☐ Open classroom space



Instructions How will you complete the investigation?

1) Sit quietly for three minutes to allow your heart rate to stabilise. Find your pulse on your wrist using your index and middle fingers.
2) Count the number of heartbeats you feel in 60 seconds. Record this number as your resting heart rate in beats per minute (bpm).
3) Stand up and march in place or perform another gentle physical activity for 60 seconds. Keep moving at a steady and comfortable pace.
4) Immediately after stopping, measure your pulse for 60 seconds and record your heart rate. This will show how your body responds to physical activity.
5) Continue resting and measure your pulse again at two, three, and four minutes after exercise. Record each measurement in your results table.
6) Use your recorded measurements to create a line graph showing how your heart rate changes over time. Label both axes and include a suitable title.
7) Compare your resting, post-exercise, and recovery heart rates. Discuss why your heart beats faster during exercise and how returning towards its resting rate demonstrates homeostasis.

PREVIEW

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Name: _____ 69

Recording Sheet Record the details of your experiment below.

Make Your Prediction: What do you think will happen to your heart rate immediately after exercising for 30 seconds? Why?

_____

_____

_____

How many minutes do you predict it will take for your heart rate to return close to its resting level?	_____ minutes

My D... ...ur pulse for 60 seconds at each stage of the investigation. Record the number ...er minute (bpm).

Stage of ...ion	Heart Rate (bpm)
Resting (before ...	
Immediately after exercise	
2 minutes after exercise	
3 minutes after exercise	
4 minutes after exercise	

Calculate how much your heart rate increased immediately after ex...

Heart rate after exercise:	_____
Resting heart rate:	_____ bpm
Increase in heart rate:	_____ bpm

Calculate the difference between your resting heart rate and your heart rate after four minutes of recovery.

Difference: _____ bpm

Did your heart rate return to its resting level during the investigation?

☐ Yes	☐ No	☐ Almost

PREVIEW

Name: _____ 70

My Observations: Complete the table using short descriptions of how your body felt during each stage.

Stage	Breathing	How My Body Felt
Before exercise		
Immediately after exercise		
During recovery		

My Conc your experiment reveal about the relationship between physical activ at least two measurements from your investigation to support your tion.

PREVIEW

Reflection Answer the following qu

1) Look at your recorded results. At which st the highest, and why do you think this happened?

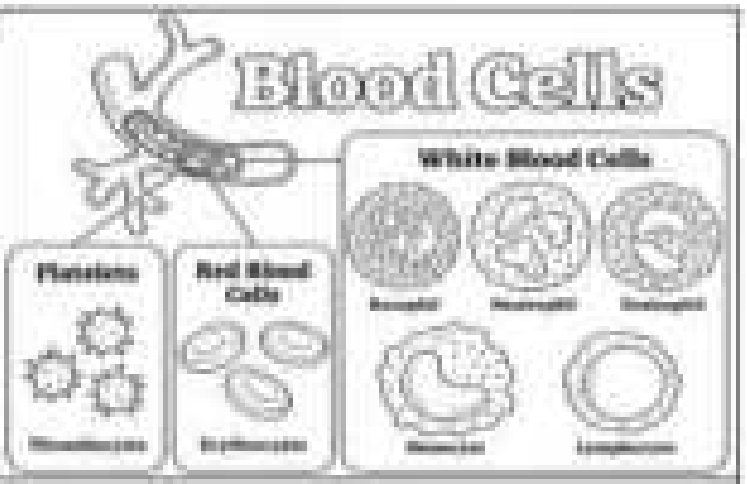
2) When you exercise, your muscles require more energy. Explain why your heart must beat faster to meet your muscles' needs.

Name: _____ 74

FAQ: What Is in Your Blood?

What is blood made of?

Blood is a connective tissue made of **plasma**, the pale yellow liquid that makes up about 55 percent of its volume, and blood cells that make up the rest. Plasma is mostly w[illegible] and carries dissolved salts, nutrients, [illegible]s and proteins to every organ.



What [illegible]

Red blood cell[illegible] lungs to the tissues using haemoglobin, an iron-containing pro[illegible]s bl[illegible]d colour. Each cell is shaped like a disc with a dip in the middle. A ma[illegible]d b[illegible] nucleus, and a cubic millimetre (mm³) of blood holds about 4 to[illegible]

How do white blood cells pro[illegible]

White blood cells defend the body agai[illegible]gens [illegible] disease-causing organisms. Some engulf germs, while [illegible] make [illegible]h has a nucleus, and they can squeeze out through capillary walls int[illegible]d t[illegible]. A cubic millimetre of blood holds only 4,000 to 11,000 of them.

What are platelets for?

Platelets are cell fragments, about 2 to 3 micrometres (µm) [illegible]s, [illegible]r at a cut and help form a clot that seals the wound. They break off gian[illegible]s called megakaryocytes. Each one yields roughly 1,000 to 3,000 plate[illegible]. [illegible]culate for about 8 to 9 days.

How are blood cells replaced?

Bone marrow, the soft tissue inside larger bones such as the sternum, ribs and pelvis, produces blood cells. Red blood cells last about 120 days before the spleen and liver break them down, so the marrow must constantly make replacements.

How much blood do you take?

A standard whole blood donation is approximately 450 millilitres (mL), roughly 9 percent of the 5 litres (L) an average adult carries. Donors must be at least 17 years old, and a finger prick checks their haemoglobin level before each donation. The donation itself takes about 10 minutes.

PREVIEW

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Name: _____ /5

True or False Circle whether the statement is true or false.

1) Platelets live longer than red blood cells.	T	F
2) Plasma makes up about 55 percent of blood volume.	T	F
3) Donors must be at least 12 years old.	T	F
4) Platelets are fragments of bone marrow cells.	T	F
5) A stand[illegible]donation is about 450 mL of blood.	T	F

Finish t[illegible] [illegible]mplete each sentence below.

1) Platelets a[illegible]ft[illegible]cut because...

2) Red blood cells must [illegible]d r[illegible]ause...

3) Plasma is useful to the body because it...

PREVIEW

Spot the Myth One paragraph below is wrong. Circle it.

A — Blood is mostly red cells with a little liquid, and the pale plasma makes up only about 5 percent of its total volume.

B — Plasma, the pale yellow liquid, makes up a little over half of blood, and the blood cells float in it to make up the rest.

C — Blood cells are made in bone marrow, and a donation of about 450 mL is roughly nine percent of an adult's total blood.

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Sort each clue: red or white cell?

Carries oxygen	Leaves vessels
Has a nucleus	Fights germs
No nucleus	Haemoglobin

Red blood cell	White blood cell

Name: _____ Mark

Sort each clue: red or white cell?

Carries oxygen	Leaves vessels
Has a nucleus	Fights germs
No nucleus	Haemoglobin

Red blood cell	White blood cell

Name: _____ Mark

Sort each clue: red or white cell?

Carries oxygen	Leaves vessels
Has a nucleus	Fights germs
No nucleus	Haemoglobin

Red blood cell	White blood cell

Name: _____ Mark

Sort each clue: red or white cell?

Carries oxygen	Leaves vessels
Has a nucleus	Fights germs
No nucleus	Haemoglobin

Red blood cell	White blood cell

PREVIEW

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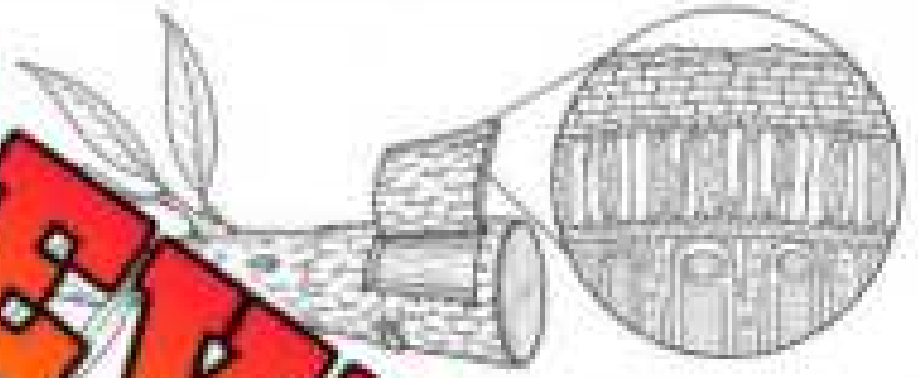
Name: _____ 82

Case Study: From Willow Bark to Aspirin

Plants, People and Knowledge

Ethnobotany is the scientific study of how people use plants, and its records show knowledge built through generations of careful observation. Cree and Ojibwe (Anishinaabe) knowledge recorded in ethnobotanical databases includes willow. The Cree use the bark of shining willow (Salix lucida) for mouth sores and chest colds, while the Ojibwe apply a bark poultice to sores and cuts. Cree knowledge also describes a tea from willow inner bark for stomach problems. This case study explains the science behind such knowledge. It is not medical advice; ask a doctor or pharmacist before using any plant or medicine.



Inside the bark

Bark is the outer part of a woody stem or root. It has several layers, and each layer is made of a different **tissue**. A tissue is a group of similar cells that work together to perform one function. The outermost layer, the cork, is made of dead cork cells that form a waterproof, protective shield, while the inner **phloem** carries sugars made in the leaves to the roots. Willows also store **salicin**, a compound that deters insects feeding on the tree. When a person swallows salicin, the body converts it into salicylic acid, which lowers pain and fever. Chemists later followed the same chemistry in the laboratory.

- **Edward Stone, 1763** — an English clergyman who dried powdered willow bark, gave it to about 50 people with fevers, and reported his findings to the Royal Society in London.
- **Felix Hoffmann, 1897** — a chemist at Bayer in Germany who modified salicylic acid into acetylsalicylic acid, which irritates the stomach less; Bayer registered the name Aspirin on 6 March 1899.
- **Reye's syndrome** — Health Canada warns never to give medicine containing ASA to a child with flu or chickenpox, because of this rare illness of the brain and liver.

Why Purified Compounds Matter

Salicin content differs between willow species and seasons, so a cup of bark tea delivers an unpredictable dose. Chemists solve this problem by purifying a compound and measuring it exactly in milligrams. Canada's research ethics policy, the Tri-Council Policy Statement (TCPS 2), also requires researchers to engage First Nations, Inuit and Métis communities when a study involves their knowledge.

PREVIEW

Name: _____ 83

Two Choices Circle the best answer.

1) Willow stores a compound called _____.	salicin	insulin
2) Edward Stone reported on willow bark in _____.	1897	1763
3) Felix Hoffmann worked for the firm _____.	Pfizer	Bayer
4) The tissue that carries sugars is the _____.	phloem	cork
5) The Ojib[illegible] bark as a _____ on cuts.	vaccine	poultice

Question [illegible] questions below using evidence from the text.

1) Define ethn[illegible] willow use recorded by the Cree.

2) Why do chemists purify salicin rather [illegible] bark?

Think Imagine you discover that a plant has traditionally been used [illegible] What questions would you investigate before deciding whether a [illegible] could be developed from it? Explain your reasoning.

PREVIEW

Name: _____ 85

Case: Osmosis in Action

Salt, Water and Cells

Case 1: Salt on Roots and Slugs
Every winter, de-icing salt (sodium chloride) from Manitoba roads washes onto the soil beside boulevard trees. The dissolved salt makes the soil water more concentrated in solutes than the water inside root cells. **Osmosis** is the movement of water across a selectively permeable membrane from lower to higher solute concentration. Water therefore leaves roots, then tree wilts, and leaf edges brown even when the soil is wet. A garden slug loses this moisture faster. Its thin, moist body has no waterproof covering, so salt on its skin draws water out of its body, causing **dehydration**. The slug loses more body water than is replaced, and salt can kill the plant's problem physiological drought because its roots cannot absorb water that is actually present.

Case 2: Saline in a Hospital
In a Manitoba hospital, a patient who cannot drink may receive fluid through an **intravenous (IV)** line, a thin tube placed in a vein. A common bag holds normal saline, which is 0.9 per cent sodium chloride, or 9 grams of salt per litre of water. This solution is **isotonic**, meaning its solute concentration equals that inside red blood cells. As a result, water enters and leaves the cells at equal rates and they keep their shape. Doctors use it to replace water lost through vomiting, fever or heavy sweating. Pure water would be dangerous because it is hypotonic: water would rush into red blood cells until they swell and burst.

PREVIEW



What This Teaches Us
Both cases show that water moves according to relative concentration. A **hypertonic** solution has more solute than the cell, so the cell shrinks. A **hypotonic** solution has less solute, so the cell swells. In an isotonic solution there is no net movement. Sea water is about 3.5 per cent salt, nearly four times as concentrated as normal saline, so drinking it draws water out of body cells and worsens dehydration. Healthy kidneys support homeostasis by adjusting how much water leaves the body in urine, which keeps body fluids close to isotonic. Freshwater fish face the opposite problem, because water constantly enters their cells from the surrounding hypotonic water.

Name: _____ 86

Questions Answer each question in a full sentence.

1) Why would pure water given by IV harm red blood cells?

2) Why can wet soil still make a roadside tree wilt? Use osmosis.

PREVIEW

Two Choices Circle the co[illegible]wer.

1) Normal saline is _____ salt.	0.9%	9%
2) Cells in a hypotonic solution _____.	swell	shrink
3) Salted roots lose water, so plants _____.	grow	wilt
4) Sea water is _____ than normal s[illegible]	[illegible]er	fresher
5) A slug on salt loses _____.	[illegible]	salt

Connect Imagine a patient needs fluids after becoming sever[illegible] Why would a hospital use a carefully prepared saline solution [illegible] of injecting pure water directly into the bloodstream?

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Sort: does the cell shrink or swell?

Hypertonic	Distilled
Pure water	Hypotonic
Road salt	Sea water

Cell shrinks	Cell swells

Name: _____ | Mark

Sort: does the cell shrink or swell?

Hypertonic	Distilled
Pure water	Hypotonic
Road salt	Sea water

Cell shrinks	Cell swells

Name: _____ | Mark

Sort: does the cell shrink or swell?

Hypertonic	Distilled
Pure water	Hypotonic
Road salt	Sea water

Cell shrinks	Cell swells

Name: _____ | Mark

Sort: does the cell shrink or swell?

Hypertonic	Distilled
Pure water	Hypotonic
Road salt	Sea water

Cell shrinks	Cell swells

PREVIEW

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Name: _____ 88

Drawing – Osmosis in Action

Objective — What are we learning about?

Students will learn how osmosis moves water across selectively permeable cell membranes and how different solute concentrations affect cells by creating and labeling scientific drawings that demonstrate the movement of water.

Materials — What will you need for the activity?

- ❑ Drawing paper
- ❑ Pencils and pencil sharpener
- ❑ Ruler
- ❑ Word bank page



Instructions — How will you complete the activity?

1) Choose one example of osmosis from the [illegible] you would like to illustrate.
2) Plan your drawing by identifying what happens before and after osmosis, including how the cells change and where water moves.
3) Use a pencil to create a clear scientific sketch. Organize your [illegible] leave enough space for labels.
4) Add arrows to show the direction of water movement across the cell membrane. Make sure your arrows accurately represent osmosis.
5) Label at least five important structures or features using scientific vocabulary from the word bank. Use a ruler to draw neat labelling lines.
6) Carefully colour your drawing to help distinguish the different structures and make the scientific process easier to understand.
7) Complete the word scramble and reflection questions to demonstrate your understanding of osmosis and its effects on cells.
8) Review your finished drawing using the assessment rubric. Check that your labels, arrows, and scientific explanations are accurate and complete.

PREVIEW

Name: _____ 89

Reference List of drawing ideas

#	Drawing idea
1	A raisin before and after soaking in water
2	A limp celery stalk standing crisp in water
3	A roadside plant with brown, salt-damaged leaves
4	A plant cell swollen firm in fresh water
5	A [illegible] cell shrunken in salty water
6	[illegible] beside a hospital bed
7	[illegible] cross [illegible] passage toward more solute
8	A potat[illegible] [illegible]ape in fresh water
9	A runner dri[illegible] [illegible]tion
10	A dry prune plump[illegible] [illegible]
11	Two beakers split by a m[illegible]
12	A houseplant before and after w[illegible]
13	A person with a dry mouth reaching for [illegible]
14	Three cells in isotonic, hypotonic and hyper[illegible]
15	Cucumbers shrinking in a jar of brine

PREVIEW

Criteria Use the criteria below to complete the activity

Criteria	Description
Accuracy	Water movement is shown correctly with arrows.
Labels	At least five parts are labelled with unit words.
Before and after	Both the start and the result are clear.
Neatness	Lines are clean and the page is easy to read.
Colour	Colours help show the science, not just decorate.

Name: _____ 90

Reflection Answer the questions below.

1) Which way did water move in your drawing, and how do you know?

2) How would your picture change if the solute amount doubled?

3) How is your drawing similar to an animal cell?

PREVIEW

Word Scramble Unscramble the words from the word bank.

WORD BANK			
isotonic	saline	dehydration	osmosis
solute	hypotonic	hypertonic	membrane

SMOSISO		TOSICNO	
BMEMENAR		UTESOL	
INESAL		DAYDRHNTDE	

Name: _____ 91

Rubric How did you do on the activity?

Criteria	1 Point	2 Points	3 Points	4 Points
Science accuracy	Water moves the wrong way or is not shown	Water moves, but solutions are mixed up	Water moves toward more solute, few errors	Correct water movement and cell change
Labels	0 to 1 labels; unit words missing	2 to 3 labels; some unit words wrong	4 labels using unit words correctly	5 or more unit word labels with ruled lines
Arrows	No arrows shown	Arrows shown, but direction is unclear	Arrows show water crossing the membrane	Arrows show direction before and after
Neatness and colour	Messy; colour hides science	Some neat parts; uneven drawing	Neat sketch; colour separates parts	Clean ruled lines; colour shows each part
Reflection	Not answered or off topic	Short answers that repeat the drawing	Explains water movement with some detail	Explains osmosis and predicts changes

PREVIEW

Teacher Comments

_____

_____

_____

_____

Mark

Student Comments – What Could You Do Better?

_____

_____

_____

_____

Story: The Manitoba Marathon

Draw Draw pictures to illustrate the story.

Amara stood among thousands of runners at the University of Manitoba on Father's Day morning, the 42.195-kilometre Manitoba Marathon ahead of her. At rest her heart beat about 70 times per minute and her core temperature sat at 37°C, held steady by **homeostasis**, the body's regulation of its internal conditions.



The horn sounded. Within minutes her muscle cells were performing **cellular respiration**, the process that releases energy from glucose using oxygen. It also released heat, which began to warm her blood. Her brain's hypothalamus, the control centre for body temperature, sensed the change and signalled her sweat glands, while her heart rate climbed past 150 beats per minute to deliver oxygen to her working muscles faster.

By the 10-kilometre mark sweat covered her skin. As it evaporated, it carried heat away from her body. Blood vessels near her skin widened, bringing warm blood close to the surface, so her skin flushed pink and heat could escape. Her shirt darkened with sweat. At each aid station she sipped a sports drink, because sweat removes salt as well as water, and her cells needed both to keep their water balance by osmosis.



Near the 30-kilometre mark her legs grew heavy, because her muscles were running low on glycogen, the form in which they store glucose. Her breathing quickened to more than 30 breaths per minute, and her heart returned carbon dioxide to her lungs. Carbon dioxide, a waste product of respiration, dissolves in blood and makes it slightly more acidic. Sensors in her brain and arteries detected the change, and faster breathing removed the gas, restoring her blood pH to about 7.4. Her liver released stored glucose into her blood to help, but the supply was limited.

Crowds roared as she turned toward the stadium with two kilometres left while spectators held out orange slices. Her legs ached and her shirt was soaked, but her heart, lungs, skin and kidneys were still cooperating to hold her internal balance.



Amara crossed the finish line at field level inside Princess Auto Stadium in just over four hours. Her heart rate stayed high for several minutes, then slowly fell as her muscles needed less oxygen. She kept walking, because contracting leg muscles squeeze the veins and help blood return to the heart. Sweating gradually slowed, and her temperature drifted back toward 37°C. Volunteers handed her water and a foil blanket, and she smiled, knowing that trillions of cells and several organ systems had cooperated to carry her the whole distance.

Name: _____ 95

Ordering Put these story events in the correct order by numbering them 1 to 8.

	Her hypothalamus signals the sweat glands as blood warms.
	Rising carbon dioxide triggers faster breathing.
	Amara waits at the start with a steady 37°C temperature.
	She sips a sports drink to replace water and salt.
	Sh[illegible]nishes, and her heart rate and temperature settle.
	T[illegible]ounds and her muscles speed up respiration.
	[illegible]muscles run low on stored glycogen.
	[illegible]at e[illegible]nd warm blood flows near the skin.

What Did You Lear[illegible] Thin[illegible]hole story, then answer below.

1) Describe how Amara's b[illegible]t[illegible]s near 37 °C.

2) Why must Amara's breathing speed up as [illegible]usc[illegible]r?

Making Connections Think of a time you ran, played a sport or climbed stai[illegible] changes did you notice in your breathing, heartbeat and skin, and why?

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Underline the correct answer.

1) A full marathon is 42.195 km / 21.1 km

2) Normal blood pH is near 7.4 / 6.4

3) Muscles store glucose as glycogen / glycerol

4) Heat leaves when sweat condenses / evaporates

Name: _____ | Mark

Underline the correct answer.

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2) Normal blood pH is near 7.4 / 6.4

3) Muscles store glucose as glycogen / glycerol

4) Heat leaves when sweat condenses / evaporates

PREVIEW

Name: _____ 97

Story: Pond Water Under the Microscope

A Drop from the Shore

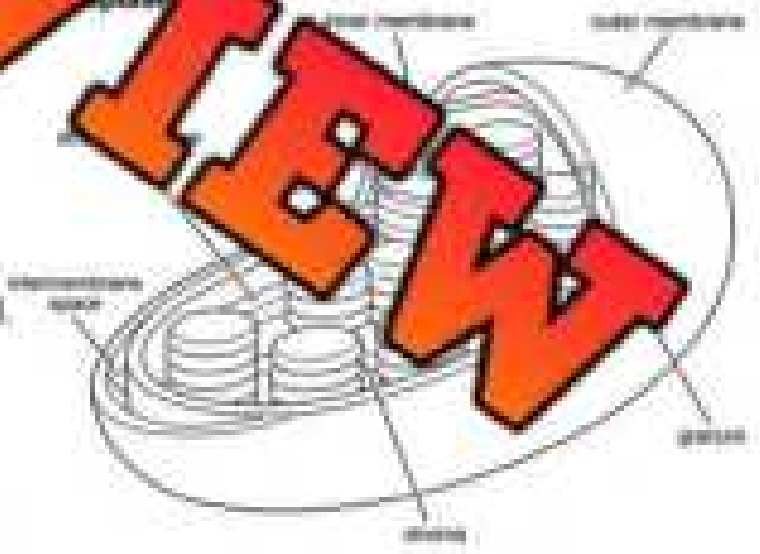
The bus rolled to a stop on the east shore of Lake Winnipeg, and the Grade 8 class stepped onto the gravel near Hollow Water First Nation. A knowledge holder from the Anishinaabe community waited beside a folding table. Priya noticed a row of clear jars and a microscope.

"This [illegible] has been watched by my community for generations," the knowledge holder said. "Notice how the water colour and clearness change with each season. Today, [illegible] clear."

[illegible] of the world's largest freshwater lakes, and its chlorophyll level [illegible] among [illegible] of the largest lakes, a sign of abundant algae. Liam filled a jar from the shallows; the water looked faintly cloudy. The knowledge holder reminded everyone to wash their hands after touching lake water.

Back at the [illegible], Priya placed a drop on a glass slide and covered it with a coverslip. The microscope's 40× objective and 10× eyepiece magnified the drop 400 times.

Liam gasped. Long green threads filled the view. Each thread was a chain of rectangular cells, and inside every cell a bright ribbon curled in a spiral. The threads felt slippery between Liam's fingers, which is why people often call them pond scum.



"That ribbon is a **chloroplast**, the organelle where photosynthesis takes place," the knowledge holder explained. "The alga is Spirogyra, named for its spiral. Chlorophyll inside absorbs red and blue light and reflects green, which is why the thread looks green."

Priya moved the slide and found golden, boat-shaped cells. These were diatoms, algae with hard cell walls made of silica. She noticed that diatoms held no green spiral, but golden-brown chloroplasts instead.

Liam spotted tiny blue-green specks. "Those are cyanobacteria," the knowledge holder said. "They are not true algae, and their cells have no chloroplasts. Too much phosphorus from fertilizer and sewage feeds large blooms."

The students sketched what they saw, then returned the water to the lake. Priya counted 14 cells in a single Spirogyra thread and realized that one drop held more living cells than her whole class had students.

PREVIEW

Name: _____ 98

Ordering Number these events 1 to 8 in the order they happened in the story.

	Liam spots blue-green cyanobacteria with no chloroplasts.
	The class arrives at the shore near Hollow Water First Nation.
	Priya finds golden diatoms with silica cell walls.
	Liam fills a jar with water from the shallows.
	Th[illegible]owledge holder explains the spiral chloroplast.
	P[illegible]nts a drop of water on a slide.
	[illegible]ch their cells and return the water.
	[illegible]ogyr[illegible]ppear at 400 times magnification.

Question [illegible] chl[illegible]e Spirogyra look green?

Diagram Draw a Spirogyra cell and its spiral. Add labels.

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Why are cyanobacteria not true algae?

Name: _____ Mark

Why are cyanobacteria not true algae?

Name: _____ Mark

Why are cyanobacteria not true algae?

Name: _____ Mark

Why are cyanobacteria not true algae?

PREVIEW

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Name: _____ 110

Newspaper: Dolly the Sheep

Scientists Reveal Dolly, a Cloned Sheep

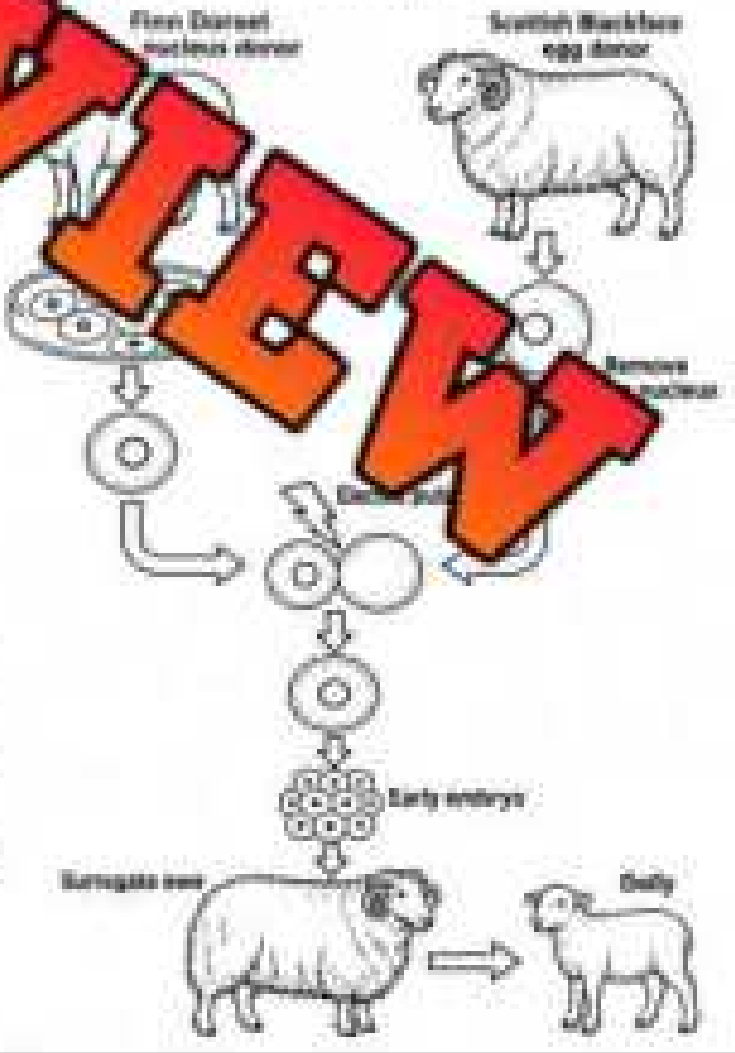
Publish Date: February 24, 1997

ROSLIN, Scotland — Scientists at the Roslin Institute near Edinburgh announced on Saturday, February 22, 1997, that they have produced a lamb named Dolly, the first mammal cloned from an adult cell. A **clone** is an organism that is genetically identical to the parent that supplied its DNA. Dolly was born July 5, and the team waited for her results to be accepted by the journal Nature before publishing them later this week.

The team used **somatic cell nuclear transfer**, a technique that moves the **nucleus**, the organelle holding a cell's DNA, from a body cell into an egg cell whose own nucleus has been removed. The nucleus came from a mammary gland cell of a six-year-old Finn Dorset ewe, and the egg came from a Scottish Blackface ewe. An electric pulse fused the two, and the new cell began dividing into an embryo, which grew inside a Blackface surrogate mother. Because her DNA came from the donor, Dolly has the white face of a Finn Dorset, not the black face of her surrogate.

Cell theory states that all cells come from **pre-existing cells**, and Dolly fits that rule: every cell in her body descends by cell division from one fused cell. The result also shows that the nucleus of a specialized adult cell still holds a complete set of genetic instructions. One Winnipeg cell biologist said that Dolly shows the egg's cytoplasm can switch an adult nucleus back to its earliest state. She cautioned that one success does not make cloning easy or safe.

Dolly is healthy and is kept at the Roslin Institute, where veterinarians will monitor whether she grows, ages and breeds like other sheep. Researchers hope that similar methods could produce animals that make medicines in their milk. Governments in several countries are already reviewing whether cloning of humans should be banned, since the technique could, in theory, be applied to any mammal.



PREVIEW

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Name: _____ L11

True or False Is the statement true or false?

1) Dolly's DNA came from a mammary gland cell.	True	False
2) Dolly was born on July 5, 1996.	True	False
3) The donor nucleus came from a Blackface ewe.	True	False
4) The egg's own nucleus was removed before fusion.	True	False
5) Cloning contradicts the third idea of cell theory.	True	False

Questions Answer the questions below using what you read.

1) Describe the steps used to produce Dolly from donor cell to lamb.

2) How does Dolly's origin support the idea that all cells come from cells?

Opinion Write a comment for the newspaper website: should scientists clone animals? Give one reason.

Username: _____ Date: _____

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Two are true. Circle the lie.

	Dolly resembles her white-faced Finn Dorset donor.
	An adult nucleus lacks the DNA to build a body.
	Dolly's cells all descend from one fused cell.

Name: _____ Mark

Two are true. Circle the lie.

	Dolly resembles her white-faced Finn Dorset donor.
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Name: _____ Mark

Two are true. Circle the lie.

	Dolly resembles her white-faced Finn Dorset donor.
	An adult nucleus lacks the DNA to build a body.
	Dolly's cells all descend from one fused cell.

PREVIEW

Name: _____ 116

Letter: From a Greenhouse Grower

Dear Grade 8 Scientists,

Last month a student on a school tour asked how I grow tomato seedlings through a Manitoba January, so I am writing to explain my work as a greenhouse grower. A **greenhouse** is a building with transparent walls and roof that traps heat and admits sunlight, which lets me give plant cells their **optimum conditions**, the settings at which they grow and divide fastest. Plants grow when cells divide and then enlarge, so everything I do helps those cells work well.

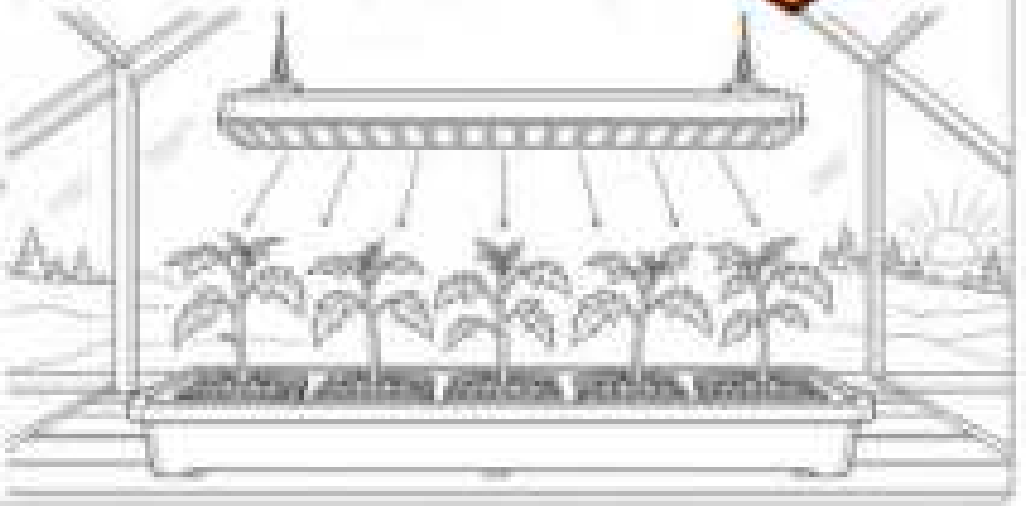
Temperature comes first, because chemical reactions inside cells speed up in warmth and slow in cold. Seeds in my trays sprout in air near 25°C, and Alberta Agriculture guidelines note that tomato plants held below 15°C develop and flower late. Once seedlings have true leaves, I lower the air to about 20°C.

Light is the second condition. At the winter solstice, December 21, Winnipeg receives only about [illegible] of daylight, far less than seedlings need, so I run LED lamps for 16 hours a day. Leaf cells contain **chloroplasts**, organelles that capture light energy, and chlorophyll absorbs mainly red and blue light while reflecting most green, so I tune my lamps to red and blue.

Nutrients are the third condition. **Nutrients** are [illegible] cells need to build new material, and roots absorb them from the water supply. Fertilizer labels show three numbers for **nitrogen**, which builds proteins and chlorophyll, **phosphorus**, which supports energy transfer and DNA, and **potassium**, which helps water movement. I also adjust my seedling feed to pH 5.8, because acidity affects which nutrients roots can absorb.

Many growers learn their trade through programs such as [illegible] production at Assiniboine College in Brandon, and many begin as hobbyists with a windowsill and a grow lamp. Whatever your path, change one condition at a time and record the results in a notebook, because only then can you tell which change helped the cells. I hope you try it with a few seeds this spring.

Growing with you,
Marie Gagnon,
Greenhouse Grower



PREVIEW

Name: _____ L17

Questions

Answer the questions below.

1) Name two conditions a grower controls and give one reason for each.

2) Why must a grower manage temperature, light and nutrients together?

This or That

Write the letter of the better choice.

1	Seedlings near 25 °C		Seedlings under 15 °C
2	Add lamps for 16 hours		8 hours of sun
3	Water with plain water only		Fe… nutrient solution
4	Ignore the feed's pH	or	…the… pH 5.8
5	Use red and blue LEDs	or	…ight
6	Change one condition at a time	or	Cha…ing…

Draw

Box 1: draw a seedling in a cold, dim room. Box 2: draw it in… …ions.

1	

2	

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Circle what a fertilizer label's three numbers show.

Sodium	Nitrogen
Oxygen	Carbon
Calcium	Potassium
Iron	Phosphorus

Name: _____ Mark

Circle what a fertilizer label's three numbers show.

Sodium	Nitrogen
Oxygen	Carbon
Calcium	Potassium
Iron	Phosphorus

Name: _____ Mark

Circle what a fertilizer label's three numbers show.

Sodium	Nitrogen
Oxygen	Carbon
Calcium	Potassium
Iron	Phosphorus

Name: _____ Mark

Circle what a fertilizer label's three numbers show.

Sodium	Nitrogen
Oxygen	Carbon
Calcium	Potassium
Iron	Phosphorus

Name: _____ Mark

Circle what a fertilizer label's three numbers show.

Sodium	Nitrogen
Oxygen	Carbon
Calcium	Potassium
Iron	Phosphorus

PREVIEW

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Name: _____ L19

Mark	/

Unit Test

Life Science

Part 1 Circle the correct answer for each question.

1) Who first named cells? A) Charles Darwin B) Louis Pasteur C) Robert D) Greg	**2) Which organelle yields energy?** A) Mitochondria B) Nucleus C) Vacuole D) Ribosome
3) Pl[illegible], an[illegible] lack... A) Cell memb[illegible] B) Cell wall C) Nucleus D) Cytoplasm	**4) A unicellular organism has...** A) two cells B) many cells C) no cells D) [illegible] cell
5) Similar cells together form a... A) organ system B) organism C) tissue D) organelle	**6) Arteries carry blood...** A) [illegible] B) fr[illegible] C) aw[illegible] D) only to [illegible]
7) Osmosis moves... A) sugar B) salt C) water D) oxygen	**8) Which cells carr[illegible]** A) White blood cells B) Platelets C) Plasma D) Red blood cells
9) Homeostasis means keeping... A) conditions stable B) cells identical C) energy at zero D) pH at 14	**10) Dolly the sheep was a...** A) hybrid B) clone C) mutant D) stem cell

PREVIEW

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Mark
/

Part 2 Draw a plant cell and an animal cell side by side. Label the organelles.

PREVIEW

Part 3 A student measured [illegible] a short period of physical activity. Create a line g[illegible] the increase in heart rate immediately after exercise [illegible] recovery

Mark
/

[illegible]surement	Heart Rate (bpm)
[illegible]	72
[illegible]	132
2 minutes after exercise	105
3 minutes after exercise	88
4 minutes after exercise	76

Part 4 Answer the long answer question below.

Mark /

Compare unicellular and multicellular organisms using an amoeba and a human as examples. Explain how each organism obtains nutrients, removes wastes, and performs life processes.

PREVIEW

Part 5 Answer each of the questions below.

Mark /

1) How do the cell membrane and cell wall differ in th[illegible]? E[illegible]hy plant cells need both structures.

2) What is the role of mitochondria in cellular respiration, and why do active muscle cells require a steady supply of energy?

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Workbook Preview

Grade 8 Science Unit
Earth Science

Strands A – D		
	Curriculum Outcomes	**Pages**
SCI.8.A (Strand A)	Demonstrate an understanding of different First Nations, Métis, and Inuit ways of knowing, being, and doing in relationship with the land and the natural world by exploring Indigenous methods of observing and interpreting the world, applying scientific principles, and creating technologies within local traditional and contemporary cultural contexts (e.g., wholistic, reciprocal, interconnected, and sustainable ways; landbased learning; outdoor learning; intersections with Western science).	47–49, 62–67, 76–78, 94–103
SCI.8. (Strand	Preview of 80 pages from this product that contains 165 pages total.	22–24, 34–36, 50–52, 68–70, 89–93, 112
SCI.8.C (Strand C)	• Science, Technology, Society, and Environment (STSE) Contexts • Scientific Measurement • Action and Practice • Scientific Instruments • Careers, Hobbies, and Activities	16–21, 25–27, 31–33, 37–40, 44–46, 56–58, 71–75, 85–88, 104–106, 113–115
SCI.8.D (Strand D)	**Purpose**: Science is about finding the cause or causes of phenomena in the natural world. **Method**: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time. **Application**: The knowledge produced by science is used in engineering and technologies to create products and processes. **Implication**: Applications of science often have ethical, environmental, social, economic, and political implications.	53–55, 82–84

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Grade 8 Science Unit
Earth Science

Strand E – Scientific Knowledge		
	Curriculum Outcomes	**Pages**
SCI.8.E.10	Demonstrate an understanding of the physical structure and physical properties of Earth. Include the following: crust, mantle, outer core, inner core.	7–12, 47–49, 104–106, 110–112
SCI.8.E.11	Demonstrate an understanding of the factors contributing to Earth's internal heat. Examples: residual heat during Earth's formation (accretional heat), nuclear heat, frictional heat)	13–21, 113–115
SCI.8.E.12	Demonstrate the understanding that tectonic activity due to Earth's internal heat leads to various types of geological activity. Include the following: tectonic plates, continental drift, faults, mountain ranges, earthquakes, volcanoes, geysers, hot springs.	22–46, 94–103
SCI.8.E.13	Demonstrate the understanding that solar energy heats the surface of Earth. Examples: Sun's radiation energy, transparent atmosphere, albedo, soil thermal properties	50–58
SCI.8.E.14	Demonstrate an understanding of the role of water in shaping the features of Earth's surface. Examples: erosion, deposition, precipitation, flooding, glaciers, ice age, watersheds	59–67
SCI.8.E.15	Demonstrate a basic understanding that all energy arriving at Earth from the Sun eventually radiates back into space. Include the following: energy budget.	68–75
SCI.8.E.16	Demonstrate an understanding of how the Sun's radiation provides energy to plants through the process of photosynthesis. Include the following: chlorophyll, glucose, food chain, food pyramid.	89–93
SCI.8.E.17	Demonstrate an understanding of the mechanisms of the greenhouse effect in raising temperatures on Earth. Include: greenhouse gases, infrared radiation, energy budget, energy balance, atmosphere, natural versus human accelerated greenhouse effect.	76–88, 107–109

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Name: _____

EARTH SCIENCE



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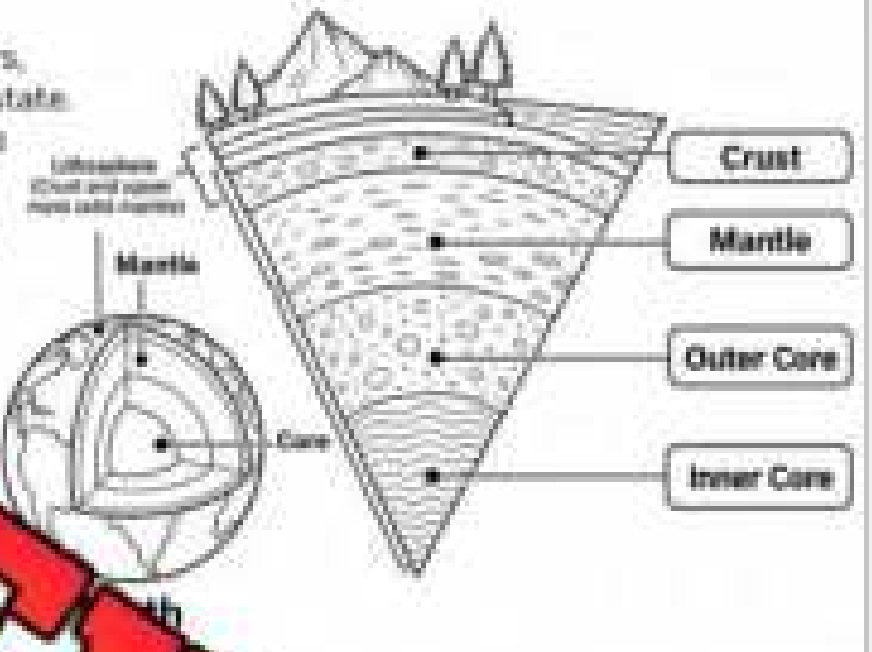
Name: _____ 7

Earth's Four Layers

The Crust and Mantle

Earth is divided into four main layers, each with its own composition and state. The outermost layer is the **crust**, the thin, rigid shell of rock on which we live. Oceanic crust is only about 5 to 10 kilometres (km) thick and is made mostly of dense basalt, while continental crust averages about 3[illegible] rich in light[illegible]ntain ranges[illegible] as th[illegible] continental c[illegible] at[illegible] 70 km. Oceanic [illegible]so m[illegible] younger. Almost n[illegible] is [illegible] than 200 million year[illegible]



PREVIEW

Beneath it lies the **mantle**, a [illegible] about 2,900 km thick that makes up roughly 84 percent of Earth's vo[illegible]e. M[illegible] yet heat and pressure let it flow extremely slowly, moving only a f[illegible]metr[illegible] each year. Seismologists divide it into the upper mantle and lower mantle a[illegible]th [illegible] 660 km. It consists mostly of peridotite, a rock rich in iron and ma[illegible]

The Core

Below the mantle is the **core**, a sphere of iron and nick[illegible] about 6,360 km. The **outer core** is a liquid layer roughly 2,200 km thick. Its [illegible] m[illegible] electric currents that produce Earth's magnetic field, which deflect[illegible] streaming from the Sun, makes compass needles point toward mag[illegible] the very centre lies the **inner core**, a solid ball of iron and nickel with a radius [illegible]bout 1,220 km, roughly 70 percent of the Moon's radius of 1,737 km.

Boundaries and Proportions

Scientists identify layers by the boundaries where rock properties change abruptly, and each boundary was discovered by studying earthquake waves.

- **Mohorovičić discontinuity** — the crust-mantle boundary, identified in 1909 by Croatian seismologist Andrija Mohorovičić
- **Gutenberg discontinuity** — the mantle-core boundary, about 2,900 km below the surface
- **Crust volume** — only about 1 percent of Earth's volume, comparable to the skin of an apple
- **Earth's radius** — about 6,371 km from the surface to the centre

Name: _____ 8

Two Choices

Circle the best answer.

1) The outer core is _____.	liquid	solid
2) Continental crust averages about _____ km.	350	35
3) Most of Earth's volume is the _____.	mantle	crust
4) The inner core is mostly iron and _____.	basalt	nickel
5) The thi[illegible] layer is the _____.	mantle	crust

Questi[illegible]

[illegible] questions below using evidence from the text.

1) Compare c[illegible]ntinental crust in thickness and rock type.

2) Compare the mantle and outer co[illegible]w do [illegible]cts differ?

PREVIEW

Finish the Sentence

Complete each sentence below.

1) Mantle rock can flow even though it is solid because...

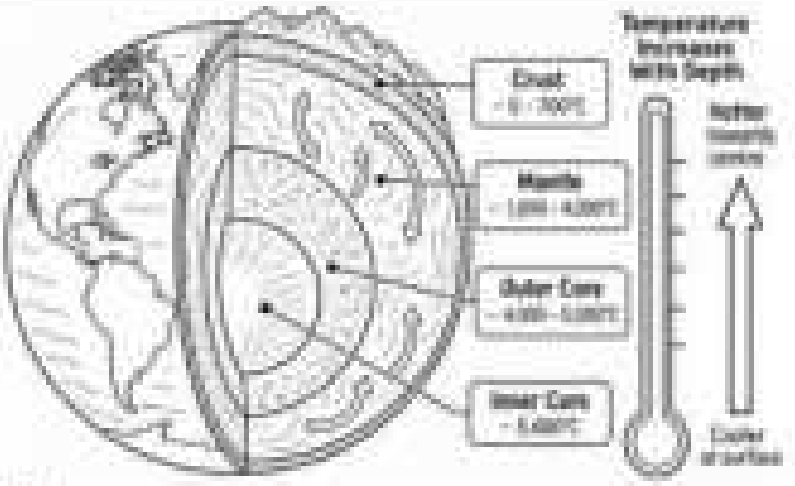
2) Earth's magnetic field is important because it...

Name: _____ 10

Temperature, Pressure, and Density Inside Earth

Temperature Rises With Depth

Temperature is a measure of the average kinetic energy of a substance's particles, and inside Earth it increases steadily with depth. The upper mantle already reaches roughly 1,000 degrees Celsius (°C), and the base of the mantle is [illegible],000°C. The inner core is hotter still, at about 5,400°C, similar to the surface of the Sun, which is [illegible]. You cannot place a thermometer there, so scientists estimate these values [illegible] on minerals and [illegible] seismic waves travel.



PREVIEW

Pressure Squeezes Matter

Pressure is the force acting [illegible] inside Earth it comes from the weight of all the rock above. It [illegible] gigapascals (GPa); the air pressure at sea level is only about 0.0001 GPa. Pressure [illegible] GPa at the base of the mantle and about 360 GPa at Earth's centre, more than [illegible] the pressure of the air around you.

Pressure also changes melting points: pure iron melts [illegible] at the surface, but squeezing its atoms together raises the melting point far [illegible] the outer core is hot, yet its temperature stays below the pressure-raised melting [illegible] of the inner core remains solid, while the outer core, under less pressure, stays liquid.

Density Sorts the Layers

Density is the mass of a substance in a given volume, usually written in grams per cubic centimetre (g/cm³). Water has a density of 1 g/cm³, and Earth's average of 5.51 g/cm³ makes it the densest planet in the solar system. Henry Cavendish's 1798 experiment with lead balls first measured a value close to this, 5.45 g/cm³. Because dense materials sink, the heavy iron-nickel alloy settled in the core early in Earth's history while lighter rock rose.

- **Crust** — about 2.7 to 3.0 g/cm³, light enough to float on the mantle
- **Mantle** — about 3.4 to 5.6 g/cm³, rising with depth as pressure compresses rock
- **Outer core** — about 10 to 12 g/cm³ of liquid iron-nickel
- **Inner core** — about 13 g/cm³, denser than lead, which is 11.3 g/cm³

Name: _____ L1

Curriculum Connections
SCI 6.3E, SCI 6.4E, 6.5E

True or False

Is the statement true or false?

1) The inner core is liquid because it is so hot.	True	False
2) The crust is denser than the inner core.	True	False
3) Temperature increases steadily with depth.	True	False
4) Pressure comes from the weight of rock above.	True	False
5) The inner core is about as hot as the Sun's surface.	True	False

Questions

Answer the questions below using evidence from the text.

1) How do temperature, pressure, and density change toward the centre?

2) Why is the inner core solid even though it is extremely hot?

Draw

Draw four rock particles at different depths inside Earth, becoming more tightly packed as depth increases. Arrows represent the increasing weight and pressure of the rock above.

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Underline the correct answer.

1) Earth's average density is 1.00 g/cm³ / 5.51 g/cm³

2) Pressure at Earth's centre is about 36 GPa / 360 GPa

3) Heavy iron-nickel sank to the crust / core

4) Iron's melting point is raised by pressure / density

Name: _____ | Mark

Underline the correct answer.

1) Earth's average density is 1.00 g/cm³ / 5.51 g/cm³

2) Pressure at Earth's centre is about 36 GPa / 360 GPa

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4) Iron's melting point is raised by pressure / density

PREVIEW

Name: _____ 16

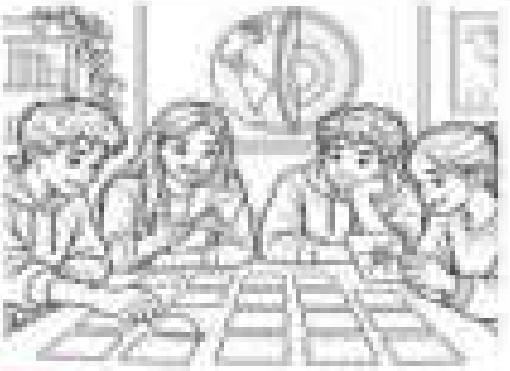
Memory Game – Earth's Heat Words

Objective What are we learning about?

Students match key words about Earth's internal heat with their meanings in a memory card game. This builds the vocabulary needed to explain where the heat comes from and how it mo

Materials need for the activity?

- ❑ One set of [illegible] provided)
- ❑ A table or cl[illegible] space



Instructions How will you [illegible]

1. Divide the class into groups of [illegible] set of Earth's heat word cards. (provided)
2. Have each group lay all the cards face do[illegible] the floor.
3. Students take turns flipping over two cards at a t[illegible] ing term and its definition.
4. If a student finds a match, they remove those cards from the g[illegible] keep them.
5. If the cards do not match, they are turned back over, and the next student takes a turn.
6. The game continues until all the cards have been matched.
7. After the game, review the terms and definitions with the class.
8. Discuss why each heat source or process matters for what happens inside Earth.

PREVIEW

Name: _____ L7

Cards | Memory Game Cards

Accretion	Clumping of dust and rock fragments into a growing planet
Pl[illegible]	Small rocky body that merged with others to build the planets
Isotope	Fo[illegible] of an element with sa[illegible] protons but a fe[illegible] count
Half-life	Time neede[illegible] of unstable atoms to change into other atoms
Uranium-238	Dense metal with a 4.5-billion-year half-life whose decay warms rock

PREVIEW

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Name: _____ 18

Cards | Memory Game Cards

Thorium-232	Element with a 14-billion-year half-life that supplies slow warmth
Pot[illegible]	Unstable form of an element found in feldspar and mica that warms the crust
Differentiation	[illegible] of dense iron to the [illegible] lighter rock [illegible] layers
Gravitational compression	Squeezing by [illegible]'s own weight that raises its inside temperature
Frictional heat	Thermal energy made as dense metal grinds past surrounding rock

PREVIEW

Name: _____ 19

Cards | Memory Game Cards

Heat flow	Thermal energy escaping through each square metre of Earth's surface
Geothermal gradient	Rise in temperature with depth, roughly 25°C to 30°C per kilometre
Primordial heat	Energy left over from Earth's formation about 4.5 billion years ago
Latent heat	Energy released when liquid iron freezes onto the solid inner core
Conduction	Transfer of thermal energy by direct contact between particles in solid rock

PREVIEW

Name: _____ 20

Cards | Memory Game Cards

Convection current	Looping flow of hot rock rising and cooler rock sinking in the mantle
	Place above a rising column of mantle rock, such as Hawaii
Kinetic energy	Energy of motion released when large bodies slammed into the planet
Proto-Earth	Early, partly molten planet before it reached its present size
Magma ocean	Global layer of molten rock that once covered the young planet's surface

PREVIEW

Name: _____ 21

Quiz Check-In

This quiz will assess students' understanding of the concepts covered in the Memory Game activity. Cut along the lines and give each section to a student.

Name: _____ Mark: ____

Write about 2 words from the game and explain what they mean.

Name: _____ Mark: ____

Write about 2 words from the game and explain what they mean.

Name: _____ Mark: ____

Write about 2 words from the game and explain what they mean.

PREVIEW

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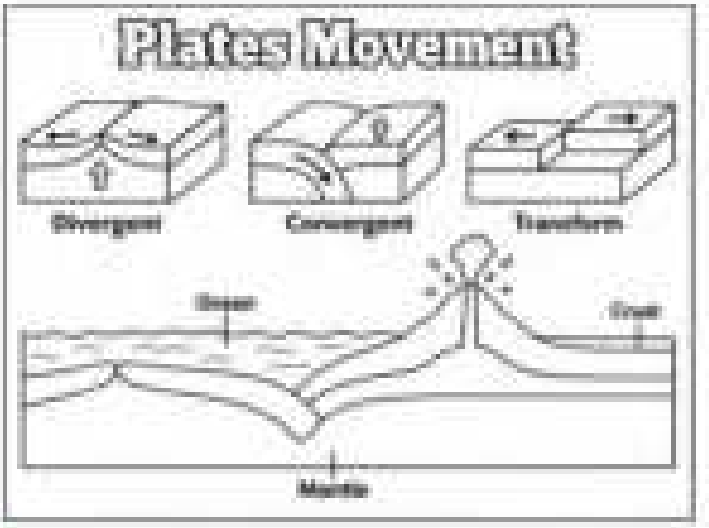
Tectonic Plates and Their Boundaries

Plates in Motion

Earth's rigid outer shell is broken into large slabs called **tectonic plates**, which ride on the softer mantle beneath. Seven major plates, including the Pacific, North American and Eurasian plates, cover most of the surface, together with many smaller ones, and each is roughly 100 km thick. Heat from Earth's interior drives slow currents in the mantle that move the plates at roughly 2 to 15 cm per year. A boundary is a line along which two plates meet, and most earthquakes and volcanoes occur along these lines.



PREVIEW

Three Kinds of Boundaries

Plates interact in three ways, each producing distinct landforms.

- **Convergent** — Plates move together. The collision between India and Eurasia, which began about 50 million years ago, crumpled the crust to form the Himalayas, while the Mariana Trench, about 11 km deep, marks where one plate sinks beneath another.
- **Divergent** — Plates pull apart. Magma rises through the gap and hardens into new crust along the Mid-Atlantic Ridge, an undersea chain 65,000 km long that widens about 2.5 cm a year and splits Iceland in two, and the East African Rift valley slowly opening where the Nubian and Somali plates separate.
- **Transform** — Plates slide sideways past each other. The Pacific and North American plates move along California at roughly 5 cm per year.

Faults and Mountain Ranges

A **fault** is a fracture in Earth's crust along which blocks of rock have moved. Faults range from centimetres to more than 1,000 km in length; California's San Andreas Fault is roughly 1,200 km long. Stress builds as plates stick, and when the rock suddenly slips, the ground shakes. A **mountain range** is a long chain of mountains created where colliding plates push rock upward and fold it. Mount Everest, at 8,849 m, is the highest peak above sea level and is still rising by a few millimetres each year. Manitoba lies in the stable interior of the North American Plate, far from any boundary, so strong earthquakes are rare here.

Name: _____ 23

True or False Is the statement true or false?

1) The Himalayas formed where plates pulled apart.	True	False
2) The San Andreas Fault is a convergent boundary.	True	False
3) Seven major plates cover most of Earth.	True	False
4) Plates move about 2 to 10 cm each year.	True	False
5) Manitoba sits right on a plate boundary.	True	False
6) The Mi[illegible]c Ridge is a divergent boundary.	True	False

Sor[illegible] So[illegible]m into the correct column.

Himalayas	M[illegible]rch	India–Eurasia	Crust crumples
Atlantic Ridge	[illegible]	Rift valley	Plates part

Convergent boundary	[illegible]vergent boundary

Making Connections Think of a place you have visited with mountains, hills, or flat land. How might moving plates, or the lack of them, explain what it looks like?

PREVIEW

Name: _____ 28

Blog Post: 5 Tips for Earthquake Safety

5 Tips for Earthquake Safety

Date: October 14, 2026 **Author**: Ms. Priya Sandhu 4-minute read

An **earthquake** is a sudden shaking of the ground caused by energy released as rock slips along a fault in Earth's crust. Manitoba lies far from active plate boundaries and seldom feels strong shaking, but families who travel to coastal British Columbia, Japan, or California should know how to react.

1) **Drop, [illegible] and Hold On**: Drop to your hands and knees, cover your head and neck beneath a sturdy table, and hold on until the shaking stops. This beats standing in a doorway, [illegible] from photographs of collapsed adobe houses, because falling or flying lamps, televisions, and glass injure far more people than collapsing walls.
2) **Know Where to Shelter**: The **epicentre** is the point on Earth's surface directly above the [illegible] point where fault slipping begins. **Seismic waves**, vibrations that [illegible] through rock, weaken with distance from the epicentre, yet glass [illegible]. Do not run outside, because bricks and glass may be falling.
3) **Read the Magnitude: Ma[illegible]** a [illegible] expresses the energy an earthquake releases. Each whole-number step [illegible] more energy, so the magnitude 7.8 Haida Gwaii earthquake [illegible] October 28, 2012, released roughly 32 times the energy of a magnitude 6.8 event. The strongest earthquake ever measured, near Valdivia, Chile, in 1960, reached about magnitude 9.5.
4) **Expect Aftershocks: Aftershocks** are smaller [illegible] the main shock as the crust adjusts. The largest aftershock is typically [illegible] magnitude units weaker than the main shock, and sequences can last for years. Any [illegible] damaged by the first event can still collapse. Stay out of damaged buildings until [illegible] have inspected them.
5) **Build a 72-Hour Kit**: Pack an emergency kit covering at least 72 hours [illegible] litres of water per person per day, non-perishable food, a flashlight, a battery- or hand-crank radio, and medications. Secure bookcases to walls and store heavy objects on low shelves, since most injuries come from falling items. Practise your plan with your family.

PREVIEW

Comments



Nina – October 14, 2026

I never knew doorways were a myth. Our school drill uses desks!

Like Reply 1d ago



Owen – October 15, 2026

Same, Nina. A 32-times jump in energy for each magnitude step is wild.

Like Reply 20m ago

Name: _____ 29

Questions

Answer the questions below.

1) Why is Drop, Cover, and Hold On safer than standing in a doorway?

2) How does distance from the epicentre change what a person feels?

PREVIEW

This or That

1	Drop, cover and ho	or	Stand in a doorway
2	Run outdoors while it sha	or	ide until it stops
3	Cover only your face	or	Co ad and neck
4	Stack heavy items up high	or	hea n low shelves
5	Pack 72 hours of supplies	or	
6	Crouch beside an interior wall	or	Stand

Draw

Draw a room with two earthquake hazards. Label e where you would drop and cover.

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Explain why aftershocks can still be dangerous.

Name: _____ Mark

Explain why aftershocks can still be dangerous.

Name: _____ Mark

Explain why aftershocks can still be dangerous.

Name: _____ Mark

Explain why aftershocks can still be dangerous.

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Name: _____ 34

Story: Wegener's Puzzle

The Puzzle of the Coastlines

Alfred Wegener, a German meteorologist born in Berlin in 1880, often studied maps of the world. He noticed that the east coast of South America seemed to fit against the west coast of Africa, like two torn pieces of paper.



[illegible] day called the fit a coinc[illegible]d that, so he began collecting [illegible]s gathered through observ[illegible] idea, from geologists [illegible] hunt[illegible] sides of the Atlantic.

The fossils amaze[illegible] saur[illegible] freshwater reptile, left fossil[illegible] a[illegible] South Africa, yet it could not have swum across a salty ocean. Glossopteris, a se[illegible] grew in South America, Africa, India, Aus[illegible]a, and [illegible]. Its seeds were far too heavy to blow across open sea.

Wegener also compared rock types and ge[illegible] the continents were pushed together on a map, rock formations on [illegible]ross [illegible] as neatly as the words on a torn page.

On January 6, 1912, he presented his idea in Frankfurt: [illegible] hypothesis that continents move slowly across Earth's surface. His [illegible] Origin of Continents and Oceans, described one ancient landmass. The name Pa[illegible] from Greek words meaning "all Earth," appeared in a later edition.

Many geologists rejected the idea. Wegener could not explain what force pushed continents through solid ocean floor, and the causes he suggested, such as Earth's rotation, were far too weak. Some critics also saw him as an outsider, since he was trained in meteorology rather than geology.

In November 1930, at age 50, Wegener died in his tent on the Greenland ice sheet during an expedition. He never learned that his idea would be proven right.

The proof arrived after his death. In the 1950s, measurements of ancient magnetism in rock supported drift. In the early 1960s, mapping of the ocean floor revealed sea-floor spreading, and by 1967 the theory of plate tectonics was widely accepted. Today scientists measure the Atlantic Ocean widening by about 2.5 cm each year.

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Ordering Put these story events in the correct order by numbering them 1 to 8.

	Wegener presented continental drift in Frankfurt.
	Geologists rejected the idea.
	Wegener noticed that two coastlines seemed to fit.
	Wegener died on the Greenland ice sheet.
	Hi[illegible]15 book described one ancient landmass.
	H[illegible]d fossil and rock evidence.
	[illegible]ing revealed sea-floor spreading.
	[illegible]t sci[illegible]pted plate tectonics.

What Did You Lea[illegible] Thin[illegible]hole story, then answer below.

1) How did fossils like Gl[illegible]su[illegible]er's idea?

2) Why did geologists reject drift even though hi[illegible]a[illegible]

Making Connections Think of a time people doubted your idea. How did you respond, and what evidence could you gather to support it?

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Tableau – The Story of Continental Drift

Objective What are we learning about?

Students freeze key moments in the story of continental drift and plate tectonics, using only bodies and faces. This helps us see how evidence built up over time.

Materials ...at you will need for the activity

- ❑ ...
- ❑ Simple p... ...per fossils
- ❑ A camera for p... ...u



Instructions How you will ... ...ete

1) Divide the class into small groups, assig... ...ch ... different set of scenes from the cards. Explain that they ... ...d to 5 separate frozen scenes.
2) Students arrange themselves for each scene and ... to ... ... teacher claps.
3) Give groups time to read their scenes and plan how each perso... ...ll show an idea.
4) If props are available, allow time to select and prepare them.
5) Have each group present while the others observe quietly.
6) Groups hold each pose for about 20 seconds so observers can take in the details.
7) After each performance, the class asks questions about the evidence and choices shown.

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Name: _____ 38

Tableaus | Tableau scenes for the activity

#	History	Description of Scene for Tableau
1	**Coastline Pu[illegible]**	A researcher stands over a world map, tracing a finger along the coasts of South America and Africa. Others lean in close, eyebrows raised, pointing at the shapes that seem to fit together like torn paper.
2	**Matchi[illegible] Fossils**	[illegible]ups kneel on opposite sides of the room, each [illegible]ing [illegible]ail of the same freshwater reptile. They [illegible] toward each other, faces full of wonde[illegible]
3	**Scratched Rock**	Students crouc[illegible] hand[illegible] tracing long grooves in a rock surf[illegible]th[illegible]tips. Their faces show puzzlement at i[illegible]hes [illegible] in warm southern lands.
4	**Matching Mountains**	Two long lines of students stand far apart, [illegible]es stretched tall as mountain ridges. A few members point across the gap, as if the two ranges once joined into one.
5	**Lecture Hall**	A speaker points to a map at the front while listeners cross their arms, shake their heads, and lean back. A few look curious but hold their hands tight in their laps.

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Tableaus | Tableau scenes for the activity

#	History	Description of Scene for Tableau
6	**One Giant Land**	The whole group presses together into one solid mass, arms linked and faces turned upward. Everyone stands very still to show a single supercontinent.
7	**Slow Splitting**	linked mass begins to pull apart in slow motion. ers drift away, arms stretching and ces turned toward their new
8	**No Engine Yet**	A researche hands, palms up, unable to explain wha ts. Surrounding listeners shrug, fro ther in doubt.
9	**Seafloor Survey**	A crew leans over instruments wea headphones. Behind them, students lie i s with alternating arm positions to show stripes on the ocean floor.
10	**Idea Accepted**	The group gathers around a map in the 1960s, nodding, shaking hands, and pointing to plate edges. One person lifts a fist in triumph while others smile and applaud silently.

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Reflection | Answer the questions below.

1) Which scene showed the strongest evidence for moving continents? Explain why.

2) Wh[illegible]ts reject the idea at first?

3) What new evidence in the 1960s helped e[illegible]w g[illegible]

4) How did your group use faces and bodies to show an idea without words?

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Case: A Volcano and a Geyser

Heat From Below

Case 1: Mount St. Helens, 1980

At 8:32 a.m. on May 18, 1980, a magnitude 5.1 earthquake shook Mount St. Helens in Washington State, triggering the largest landslide [illegible] recorded history. A **volcano** is an opening [illegible] through which magma, ash, [illegible] the eruption, rising [illegible] bulge out of the north [illegible] The [illegible] and pressure on the **magma** [illegible] beneath the surface, and [illegible] ved [illegible] ded sideways. The blast [illegible] about 596 square kilome[illegible] an as column rose more than 19 [illegible] pe died. Hot material melted much [illegible] e mountain's snow and glaciers, and defe[illegible] ash fell across about 57,000 km² in 11 [illegible] states. The summit dropped from 2,950 metres (m) to 2,549 m.

Case 2: Old Faithful, Yellowstone

Old Faithful, in Yellowstone National Park, erupts about every 90 minutes, shooting 14,000 to 32,000 litres of boiling water 30 to 55 m into the air. A **geyser** is a hot spring that erupts jets of water and steam at intervals. Rain and snowmelt seep underground, where rock heated by magma as shallow as 5 to 13 km below the surface warms it. Yellowstone sits above a hotspot, a place where magma rises from deep inside Earth to [illegible] at the crust. Each eruption lasts 1.5 [illegible] minutes, and the wait varies from [illegible] minutes. Narrow [illegible] the plumbing trap the [illegible] ure builds, and the [illegible] ter

PREVIEW



What This Teaches Us

Both events are surface effects of Earth's internal heat, which melts rock into magma. Mount St. Helens lies above a subduction zone, where the Juan de Fuca Plate sinks beneath North America, and its magma erupted violently through the crust once the mountain collapsed. At Old Faithful, the magma stays deep and only heats groundwater, so eruptions repeat in a steady pattern. Scientists can monitor both places with instruments that record ground shaking and temperature, which helps them judge hazards. Internal heat can therefore build a single catastrophic event or a long, repeating one.

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True or False — Circle whether the statement is true or false.

1) Old Faithful shoots magma into the air.	T	F
2) A magnitude 5.1 quake started the 1980 collapse.	T	F
3) Old Faithful erupts about every 90 minutes.	T	F
4) Mount St. Helens erupted in the year 1880.	T	F
5) Geyser [illegible] is warmed by hot rock below.	T	F

Finish — Complete each sentence below.

1) Geysers [illegible] because...

2) The landslide at Mount [illegible] because...

3) The two cases share a cause, which means...

Spot the Myth — One paragraph below is wrong. Circle it and [illegible]

A — Geyser water is heated by hot rock that magma deeper down has warmed.

B — Mount St. Helens blew apart after a landslide freed its trapped magma.

C — Old Faithful erupts because a hidden volcano spews lava every hour.

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Check every true statement.

- [ ] Ash fell in many states.
- [ ] St. Helens is in Canada.
- [ ] Magma can lie below geysers.
- [ ] Ash stayed in the crater.
- [ ] Steam builds in geysers.
- [ ] Geysers erupt only once.
- [ ] The summit lost 400 m.
- [ ] Old Faithful is a volcano.

Name: _____ Mark

Check every true statement.

- [ ] Ash fell in many states.
- [ ] St. Helens is in Canada.
- [ ] Magma can lie below geysers.
- [ ] Ash stayed in the crater.
- [ ] Steam builds in geysers.
- [ ] Geysers erupt only once.
- [ ] The summit lost 400 m.
- [ ] Old Faithful is a volcano.

Name: _____ Mark

Check every true statement.

- [ ] Ash fell in many states.
- [ ] St. Helens is in Canada.
- [ ] Magma can lie below geysers.
- [ ] Ash stayed in the crater.
- [ ] Steam builds in geysers.
- [ ] Geysers erupt only once.
- [ ] The summit lost 400 m.
- [ ] Old Faithful is a volcano.

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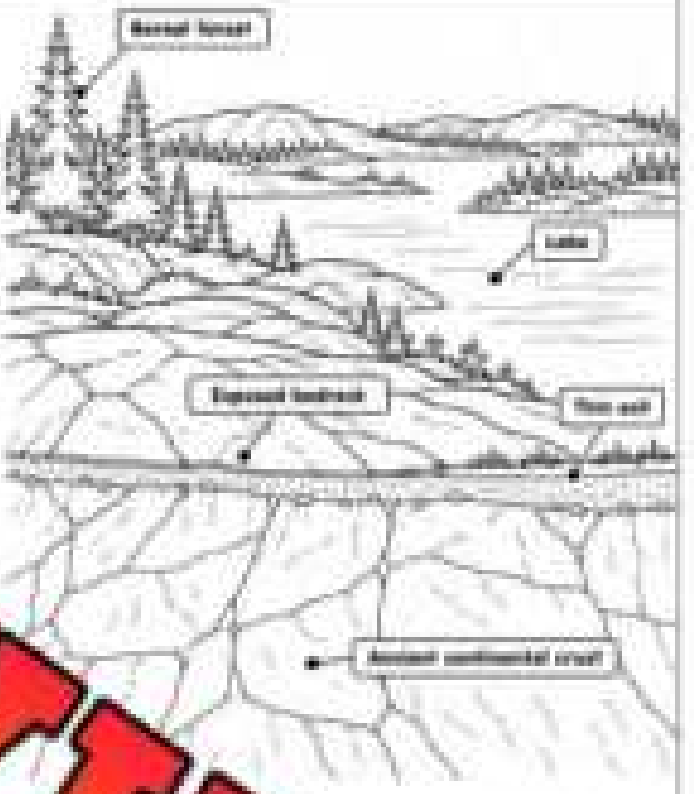
Pimachiowin Aki: The Ancient Shield

The Bedrock of the Shield

The Canadian Shield is a vast region where ancient **bedrock**, the solid rock beneath soil and loose sediment, lies exposed at Earth's surface. This bedrock is part of the continental **crust**, Earth's thin, rocky outer layer. In eastern Manitoba it belongs to the Superior Craton, the largest Archean craton, a block of ancient crust covering [illegible] km² and shaped by events [illegible] billion years ago. Its rocks [illegible] and gneiss, and some [illegible] are older than 3.5 billion [illegible] the surface clean, [illegible] soil, [illegible] and thousands of [illegible]



A Mixed World Heritage Site

In July 2018, UNESCO inscribed [illegible] Aki, Anishinaabemowin for "the land [illegible] life," on the World Heritage List. It is Canada's first mixed site, recognised for both natural and [illegible] value. The site covers 29,040 square kilometres (km²) of boreal forest straddling the Manitoba–Ontario border, with more than 3,200 lakes, and it also takes in two adjacent provincial parks, Nopiming in Manitoba and Woodland Caribou in Ontario. It shelters [illegible] and about 400 vertebrate species, including woodland caribou and [illegible] Anishinaabe First Nations on the Manitoba side are part of it: Bloodvein River, Little Grand Rapids, Pauingassi, and Poplar River. The designation followed a 16-year campaign begun in 2002 as an Anishinaabe-led initiative.

Keeping the Land Today

The Anishinaabe cultural tradition of **Ji-ganawendamang Gidakiiminaan**, "Keeping the Land," has guided care of this territory for more than 7,000 years and still does today.

- **Resource rotation** — Hunting, fishing, and harvesting sites are shifted so plants and animals can recover.
- **Controlled burning** — Shoreline vegetation is burned to help wild carrots, grasses, and reeds grow, improving habitat for muskrats and waterfowl.
- **A long record** — About 285 archaeological sites, including pictographs, and a spear point 9,000 to 7,000 years old at Rowdy Lake, Ontario.
- **Shared leadership** — The Pimachiowin Aki Corporation was formed in 2006 to carry the First Nations' nomination forward.

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Multiple Choice Circle the best answer.

1) In which year did UNESCO inscribe Pimachiowin Aki?			
2002	2006	2018	2016
2) What is the site's area?			
2,904 km²	29,040 km²	290,400 km²	9,000 km²
3) Which rocks dominate the Craton here?			
Granite	Limestone, shale	Sandstone, coal	Chalk, clay
4) Why is [illegible]l so thin?			
Ri[illegible]	[illegible] blew it away	Glaciers scraped it	Fires burned it
5) How many Ma[illegible]ations are in the site?			
Two	[illegible]	Four	Six

Think How does the Anis[illegible]ectic[illegible]ng the Land" connect to the idea of sustainability? Choose [illegible]tic[illegible]ource rotation or controlled burning, and explain how it helps [illegible]r or remain healthy.

Scenario A classmate says the Shield's thin soil means the land cannot support life. Using the text, how would you respond?

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Experiment - Solar Energy and Surface Heating

Objective — What are we learning about?

Students will learn how different surfaces absorb and reflect solar energy by investigating temperature changes in sand, soil, stones, and water.

Materials — What will you need for the activity?

- ☐ Four [illegible] shallow containers
- ☐ Sa[illegible]
- ☐ [illegible] gravel
- ☐ W[illegible]
- ☐ Four therm[illegible]
- ☐ A bright la[illegible]
- ☐ Stopwatch or [illegible]
- ☐ Recording sheet
- ☐ Pencil and graph pap[illegible]





Instructions — How you will complete [illegible] activity:

1) Place equal volumes of sand, dark soil, light [illegible] and [illegible] water into four identical containers. Make sure all materials [illegible] same temperature.
2) Arrange the containers side by side in an area rece[illegible] beneath a bright lamp. Keep each container the same distance fro[illegible]
3) Before beginning, predict which material will heat up the fastest [illegible] the coolest. Write a hypothesis explaining your prediction.
4) Place a thermometer into each material at approximately the same de[illegible] ensuring that the thermometer is measuring the material rather than the container.
5) Record the starting temperature of each material. Turn on the lamp or expose all four containers to sunlight at the same time.
6) Measure and record the temperature of each material every three minutes for 15 minutes. Avoid moving the containers or changing the position of the light source.
7) Turn off the lamp or move the containers into the shade. Continue measuring the temperatures every three minutes for another nine minutes to observe how quickly each material cools.
8) Create a line graph showing how the temperatures of all four materials changed throughout the experiment. Use a different colour or line pattern for each material.
9) Compare your results with your original hypothesis. Discuss how albedo, energy absorption, and the thermal properties of different materials help explain the temperature differences.

PREVIEW

Name: _____ S4

Recording Sheet | Record the details of your experiment below.

Make Your Prediction: Which material do you think will heat up the fastest? Why?

_____

_____

_____

Observation: Record the temperature of each material every 3 minutes.

Time (min)	Sand (°C)	Dark Soil (°C)	Light-Coloured Stones (°C)	Water (°C)
0 (Start)				
3				
6				
9				
12				
15 (End of heating)				
18 (Cooling)				
21 (Cooling)				
24 (Cooling)				

PREVIEW

Compare the Results:

Material with the greatest temperature increase:	
Material with the smallest temperature increase:	

Calculate: Temperature increase = Temperature at 15 minutes − Starting temperature

Sand	_____ °C	Soil	_____ °C
Stones	_____ °C	Water	_____ °C

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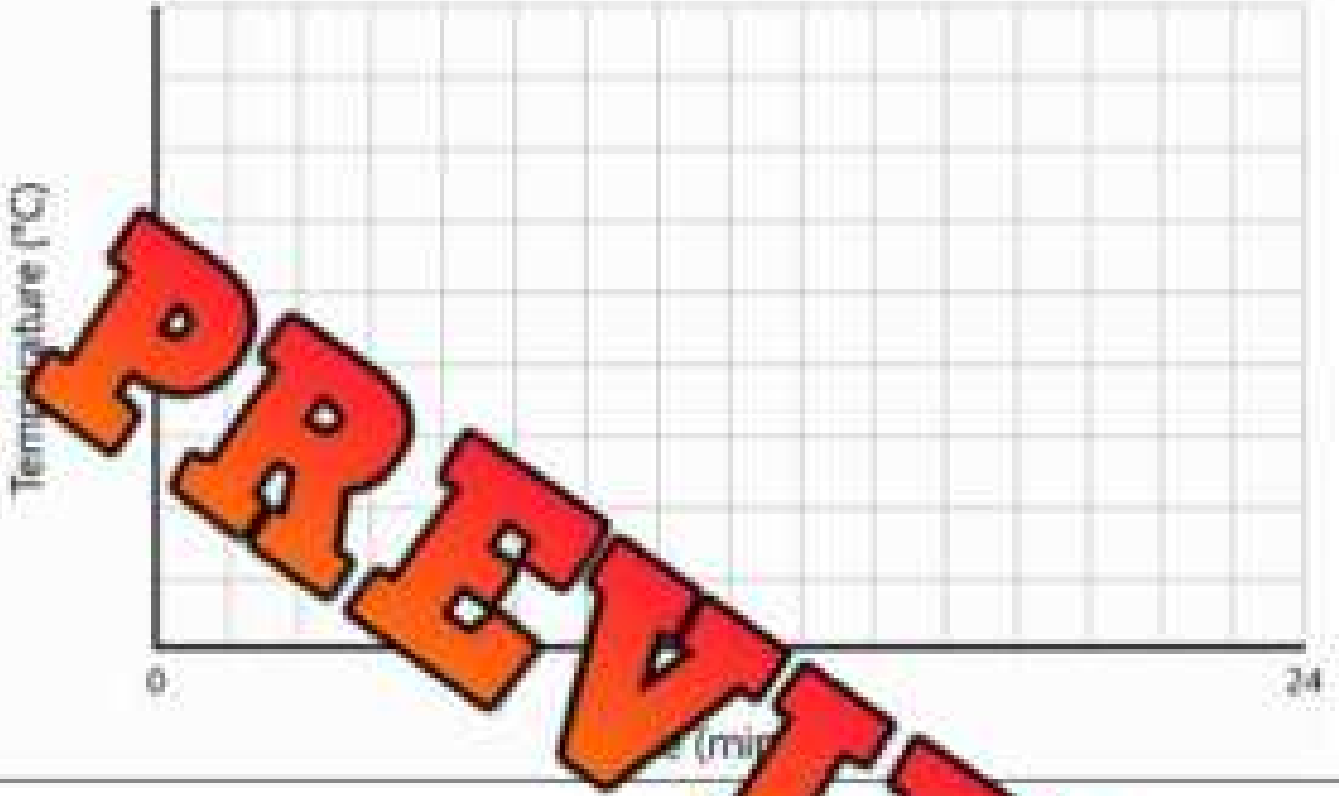
Graph Your Results: Create a line graph using your temperature measurements. Put time on the horizontal axis and temperature on the vertical axis, using four different colours or line patterns.



PREVIEW

1) Was your hypothesis supported by your results? Use your measurements as evidence.

2) Which material cooled the most during the nine-minute cooling period? Suggest a scientific explanation for your observation.

Name: _____ 59

Water Shapes the Land

Erosion and Deposition

Erosion is the process by which moving water, ice, wind, or gravity wears away rock and soil and carries the pieces to a new place, while **deposition** is the process that drops this material once the moving agent slows down. Over about 5 to 6 million years, the Colorado River has cut the Grand Canyon in Arizona to a length of about 446 kilometres (km), a width of up to 29 km and a maximum depth of about 1,857 metres (m). Where a fast river enters a lake or ocean, it slows suddenly and deposits its sediment, building a fan-shaped landform called a delta.

Glacier

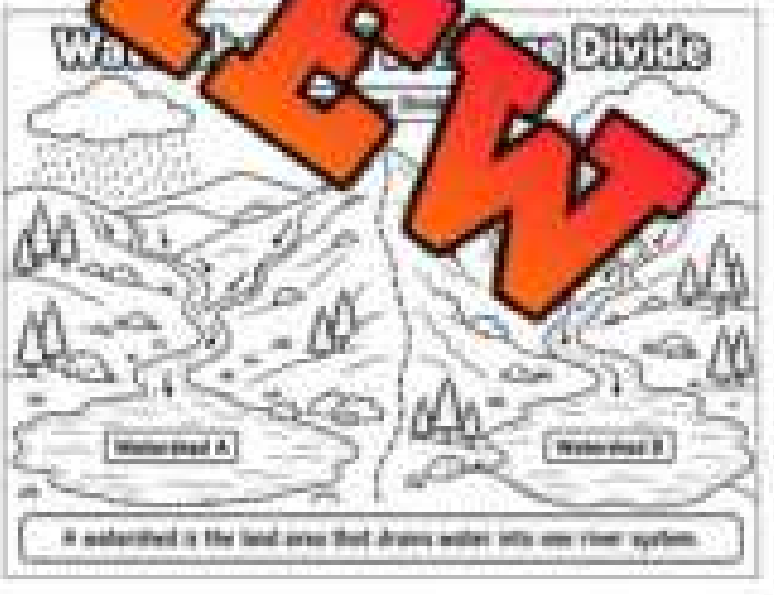
A **gl** is a slow-moving mass of ice formed from compacted snow, and during the last Ice Age the Laurentide Ice Sheet buried most of Canada beneath ice up to about 3 km thick. Its lobe reached southern Manitoba, scraping bedrock and carrying boulders called erratics that were dropped far from their source when the ice melted.

About 13,000 years ago the melting ice covered southwestern Manitoba, and meltwater collected against the ice edge. Ancient Lake Agassiz was the largest lake in North America at the time. At times the site of present-day Winnipeg lay under about 213 m of water. The lake drained by about 8,200 years ago, and Lake Manitoba, Lake Winnipegosis and Lake Winnipeg are among its remnants.

Watersheds and Lake Bed Landforms

A **watershed** is the entire area of land that drains its rain and meltwater into one river system, and a **drainage divide**, such as a ridge, separates neighbouring watersheds.

The Red River collects water from a watershed of about 287,500 square kilometres (km²) and flows roughly 885 km north to Lake Winnipeg, whose water continues through the Nelson River to Hudson Bay. Shorelines of the vanished lake still mark the Manitoba landscape.



- **Campbell Beach** — a sand and gravel ridge built by the lake's waves
- **Pembina Mountain** — a raised terrace that was the lake's ancient shore
- **Construction material** — old beaches still supply sand and gravel

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True or False Circle whether the statement is true or false.

1) A glacier forms when moving water drops sediment.	True	False
2) Erosion moves worn-away rock and soil elsewhere.	True	False
3) Lake Agassiz drained completely 1,000 years ago.	True	False
4) The Laurentide Ice Sheet was up to 3 km thick.	True	False
5) Lake Winnipeg is a remnant of Lake Agassiz.	True	False

Questions Answer the questions below using evidence from the text.

1) Explain the difference between erosion and deposition.

2) Explain how retreating ice [illegible] and southern Manitoba.

Visualizing Draw a river leaving a canyon and entering [illegible] deposition, and the delta.

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Which one is the lie? Circle it.

	Pembina Mountain is an ancient Lake Agassiz shore.
	Old Lake Agassiz beaches supply sand and gravel.
	A watershed drains water into several river systems.

Name: _____ | Mark

Which one is the lie? Circle it.

	Pembina Mountain is an ancient Lake Agassiz shore.
	Old Lake Agassiz beaches supply sand and gravel.
	A watershed drains water into several river systems.

Name: _____ | Mark

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Name: _____ | Mark

Which one is the lie? Circle it.

	Pembina Mountain is an ancient Lake Agassiz shore.
	Old Lake Agassiz beaches supply sand and gravel.
	A watershed drains water into several river systems.

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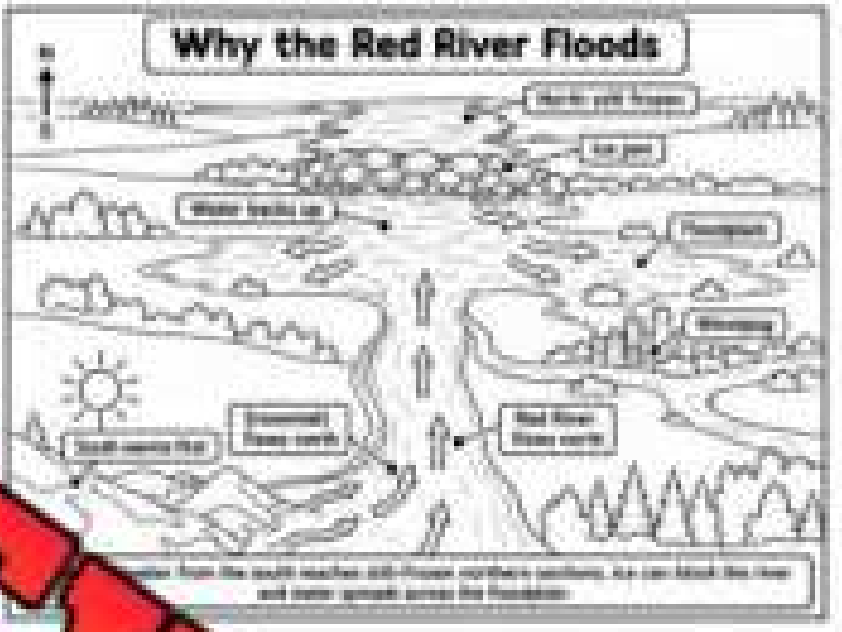
The Red River: Floods and Knowledge

Why the Red River Floods

A **flood** is the overflow of water onto land that is normally dry, and the Red River floods often because it flows north. Spring melt begins in the warmer south while the northern part is still blocked by an **ice jam**, a pile of broken river ice that [illegible]. The water then [illegible] **floodplain**, the flat [illegible] it is covered when [illegible] Winnipeg sta[illegible] at the meeting [illegible] Assiniboine Rivers.



PREVIEW

Floods and Flood Control

In response to the 1950 disaster, [illegible] River Floodway between 1962 and 1968. The **floodway** is a 47 km cha[illegible] around Winnipeg. The original project cost $63 million, and its [illegible] since 1968 exceeds $40 billion, and an expansion finished in 2010 [illegible] cubic metres per second. The 1997 flood put more than 2,560 km² [illegible] earning the nickname "Red Sea."

- **1950** — Between 70,000 and 100,000 people evacu[illegible] of Winnipeg flooded.
- **1997** — 28,000 Manitobans evacuated, and the floodway carried [illegible] second.
- **2011** — 18 First Nations communities evacuated across Manitoba.

Knowledge and Flooding Today

Flooding has affected First Nations unevenly. In 1907 the reserve of Pegus First Nation was moved about 170 km northwest from St. Peter's, near Selkirk, to the Interlake, and a land claim about that surrender was finalized in 2008. The community has flooded repeatedly since, and one consulting firm estimates that nearly 90% of Manitoba First Nations have been affected by flooding. Pegus has long expected a major flood every five or six years, and more than 300 homes were damaged in 2022. Pegus trappers noticed changed beaver dams and foxes and raccoons moving to higher ground before that flood. Leaders say observations like these should be combined with measured data. After 2011, Lake St. Martin First Nation rebuilt on higher land above the 2011 flood level, and by 2020 it had 345 new homes ready.

Name: _____ 63

Define What do the terms below mean?

Flood	
Floodway	
Ice jam	

True or False Is the [illegible] true?

1) The floodway was built before 19[illegible]	True	False
2) In 1950, up to 100,000 people were evacu[illegible]	True	False
3) Winnipeg stands on a floodplain.		False
4) Lake St. Martin rebuilt on lower land.		False
5) Peguis trappers noticed animals moving uphill.		[illegible]se

Question Explain how observations by Peguis trappers and measured data could work together to prepare for a flood.

PREVIEW

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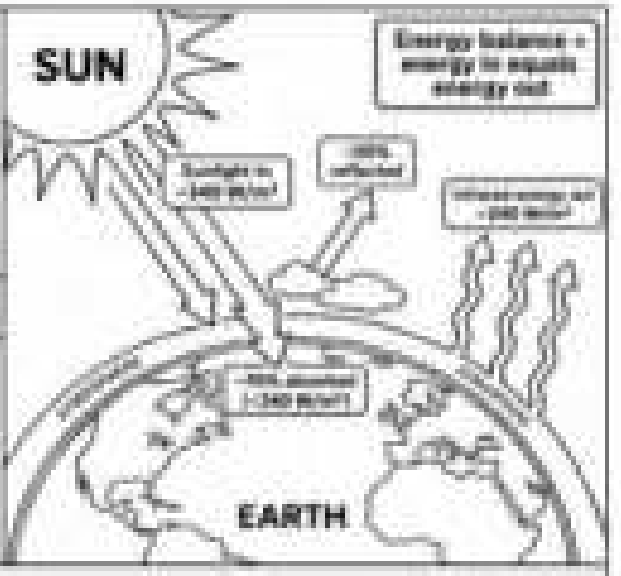
FAQ: Earth's Energy Budget

Sunrise Ridge Climate Education Society — Your Questions About Earth's Energy!

Welcome! We are the Sunrise Ridge Climate Education Society, a fictional group of climate teachers, and these are the questions Grade 8 students ask us most about energy.



What is Ea[illegible]nergy budget?

The **energy** [illegible] the balance sheet of all solar energy [illegible] climate system and all ener[illegible] over the whole planet, about [illegible] watts per [illegible] (W/m^2) of sunlight arrive[illegible] the atmosphere.

How much sunlight [illegible] Earth

About 30% of arriving [illegible] back to space by clouds, bright surfaces such as ice and snow, and [illegible] reflected light never becomes heat. The remaining 70%, roughly 24[illegible], [illegible] atmosphere, land and oceans.

What happens to the absorbed energy?

Every warm object will **radiate**, or emit energy as [illegible] and [illegible] sends its absorbed energy back to space as infrared radiation, a [illegible] heat [illegible] not see. A surface averaging about 15°C emits infrared constantly, [illegible] surfaces radiate more intensely.

What does energy balance mean?

Energy balance exists when the energy arriving equals the energy [illegible] temperature stays steady. Since Earth absorbs about 240 W/m^2, it must [illegible] close to 240 W/m^2 back to space. If outgoing energy fell short, the planet would [illegible] warm.

Does every region receive equal heating?

No. The tropics receive more energy than the polar regions because sunlight strikes them more directly. Winds and ocean currents carry heat toward the poles, which reduces the temperature difference between regions, spreads solar energy across the globe and keeps most regions habitable.

How do scientists measure the budget?

NASA flies instruments called CERES, short for Clouds and the Earth's Radiant Energy System, on satellites. The first was launched in 1997. They measure reflected sunlight and outgoing infrared, and the difference between absorbed and emitted energy shows whether Earth is gaining or losing heat.

PREVIEW

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Questions

Answer the questions below.

1) State the percentages of sunlight reflected and absorbed.

2) Why does Earth stay near 15 °C even though it absorbs energy daily?

True or False

State whether each is true (T) or false (F).

1) Reflected sunlight is [illegible] into space.	T	F
2) Earth absorbs about 70% of [illegible].	T	F
3) At balance, energy out is less than energy in.	T	F
4) Clouds reflect none of the arriving sunlight.	T	F
5) Earth gives off absorbed energy as infrared.	T	F

Sorting

Sort each statement: Reflected or Absorbed?

1) Clouds send some sunlight back to space unchanged.	
2) Land and oceans take it in and warm up.	
3) About 70% of arriving sunlight ends up here.	
4) Bright snow does this to much of the light.	
5) This energy is later given off as infrared.	

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark: |

Circle the best answer.

1) What do CERES instruments measure? a) Ocean depth b) Earth's radiation budget c) Earthquake waves d) Soil moisture	2) Average incoming sunlight? a) 34 W/m² b) 340 W/m² c) 3,400 W/m² d) 1 W/m²
3) Earth's average surface temp? a) About −18°C b) About 100°C c) About 15°C d) About 37°C	4) What carries heat to the poles? a) Earthquakes b) Winds and ocean currents c) Reflected light d) Soil moisture

Name: _____ | Mark: |

Circle the best answer.

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PREVIEW

Name: _____ 7A

Case Study: Peatlands, Permafrost, and Carbon

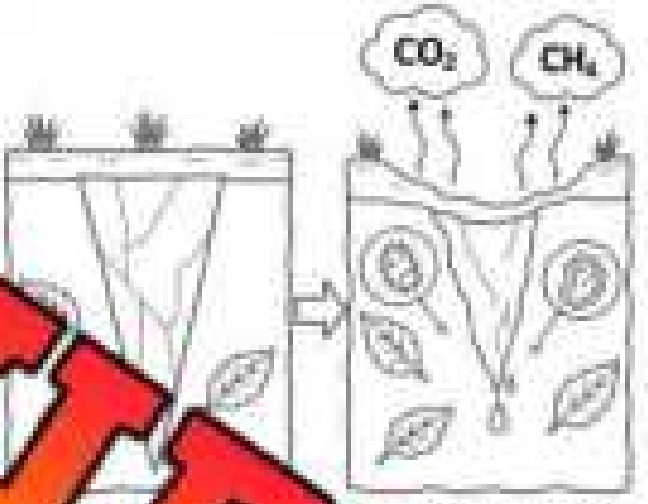
Peat: A Carbon Vault

A **peatland** is a wetland where waterlogged, oxygen-poor conditions slow decay, so dead plants pile up as **peat**, a dark soil of partly decomposed plant matter that thickens by only about 1 millimetre (mm) per year.

Peatlands cover roughly 3% of Earth's land, yet the carbon they store outweighs that held in all of the world's forests. The Hudson Bay Lowland, along the coast of Manitoba and Ontario, is the world's second-largest peatland complex. It covers more than 250,000 square kilometres (about the size of Japan) and holds about 30 billion tonnes of carbon.

Frozen Ground and Hidden Stores

Permafrost is ground that stays at 0 °C or below for at least two years in a row. Northern permafrost holds an estimated 1,400 to 1,650 billion tonnes of carbon, about twice the amount in the atmosphere. Most of it, about 1,035 billion tonnes, lies in the top 3 m of ground, where warming reaches first. When it thaws, microbes decompose the freed plant material and release carbon dioxide and methane, two **greenhouse gases**, which are gases that absorb infrared radiation and warm the atmosphere. Over 100 years, methane traps about 28 times more heat than the same mass of carbon dioxide, so even small releases matter.



Wapusk: Land, People and Knowledge

Wapusk National Park, created in 1996, covers 11,475 km² about 45 km south of Churchill. Peat covers about 27% of its land, and pregnant polar bears give birth in maternity dens in the peatlands, emerging in March. Permafrost and peat occur together in the northern Hudson Bay Lowland, so thaw there exposes stored carbon to decay.

- **Territory** — The Cree of York Factory First Nation and Fox Lake First Nation, the Sayisi Dene First Nation and Inuit all have traditional territory in the park.
- **Name** — Wapusk comes from a Cree word for white bear.
- **Plan** — The 2017 management plan aims to bring traditional ecological knowledge into park decisions.
- **Habitat** — Thawing permafrost is shrinking tundra used by caribou, so thaw affects wildlife as well as climate.

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Two Choices Circle the best answer.

1) Permafrost stays frozen at least _____ years.	two	ten
2) Peatlands store more carbon than world _____.	lakes	forests
3) Thawing permafrost releases CO_2 and _____.	oxygen	methane
4) The Lowland ranks _____ among peat areas.	second	fifth
5) Wapus[illegible]t Park was created in _____.	2017	1996

Quest [illegible]estions below using evidence from the text.

1) Explain ho[illegible]s ar[illegible]tores so much carbon.

2) How could thawing permafrost speed up [illegible]wer

Think Imagine the Canadian government asks you to recommend one action to protect northern peatlands and their stored carbon. What would you suggest?

PREVIEW

Name: _____ ??

Case: Earth and Venus

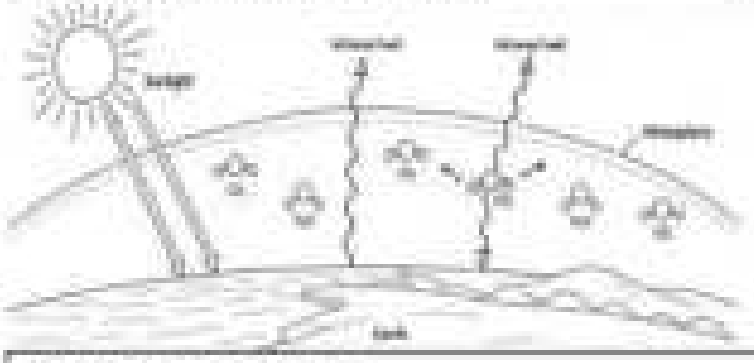
Two Worlds, Two Greenhouses

Case 1: Earth's Natural Blanket

Earth's **greenhouse effect** is the natural warming that occurs when greenhouse gases absorb **infrared radiation**, the heat energy given off by the warm surface, and send part of it back toward the ground. Without this effect, the surface temperature would be about −18 degrees Celsius (0 °F), cold enough to freeze the oceans. With it, the average is about 15°C, a natural warming of roughly 33 degrees. The gases responsible include water vapour, carbon dioxide (CO_2), methane, and nitrous oxide. Carbon dioxide makes up about 0.04% of the air, yet it matters greatly because nitrogen and oxygen, which form most of the atmosphere, do not absorb infrared radiation. Water vapour amounts respond to temperature, but carbon dioxide lingers in the atmosphere for centuries.

Case 2: Venus Heats Up

Venus shows what a far stronger greenhouse effect can do. Its atmosphere is about 96% carbon dioxide, and the pressure at its surface is more than 90 times Earth's, similar to the pressure about 900 m under the ocean. Although Venus is farther from the Sun than Mercury, its surface averages about 465°C, hot enough to melt lead, which melts at about 327°C. Many scientists think Venus once had oceans that evaporated, adding water vapour to the air. In a **runaway greenhouse effect**, a process in which warming triggers changes that cause still more warming. Thick clouds of sulfuric acid reflect much sunlight, yet Venus is the hottest planet. Soviet lander transmitted data for about two hours.





What This Teaches Us

These cases show that the greenhouse effect is natural and essential; the amount of greenhouse gas decides how warm a planet becomes. Earth's natural effect keeps it habitable, while Venus holds an enormous load of carbon dioxide. The **human-accelerated greenhouse effect** is the extra warming caused by people adding greenhouse gases, mainly by burning fossil fuels such as coal, oil, and natural gas, which releases carbon stored underground for millions of years. Volcanoes also release CO_2, but far less each year than human activities do. Earth is not on course to become Venus, but the comparison shows why changing the gas balance changes the temperature.

PREVIEW

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Questions Answer each question in a full sentence

1) Why is Earth's natural greenhouse effect essential to life?

2) Compare Venus's and Earth's atmospheres and temperatures.

PREVIEW

Two Choices [illegible] co[illegible]er.

1) Natural greenhouse [illegible] ab[illegible]	33°C	15°C
2) Venus's air is mostly _____	CO_2	oxygen
3) Venus's surface averages about _____	15°C	465°C
4) Nitrogen and oxygen _____ absor[illegible]ed	[illegible]ot	do
5) A runaway effect is warming causing more _____	w[illegible]	cooling

Think Imagine Earth suddenly lost all its greenhouse gases. H[illegible]ange our oceans, weather and ability to support life? Explain your [illegible]g

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Which statement is the lie?

	Lead would melt on the surface of Venus.
	Carbon dioxide is only about 0.04% of Earth's air.
	Venus is hotter than Mercury as it is nearer the Sun.

Name: _____ Mark

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	Carbon dioxide is only about 0.04% of Earth's air.
	Venus is hotter than Mercury as it is nearer the Sun.

PREVIEW

Name: _____ 82

Experiment - The Greenhouse Effect

Objective — What are we learning about?

Students will learn how the greenhouse effect influences Earth's temperature by investigating how covering a container changes its heating and cooling.

Materials — What will you need for the activity?

- ☐ Two identical transparent containers
- ☐ [illegible]
- ☐ [illegible]
- ☐ A [illegible] lamp or sunlight
- ☐ Stopwatch
- ☐ Recording [illegible]
- ☐ Tape or an elastic band



Instructions — How you will [illegible]

1) Place two identical transparent containers side by side on a flat surface. Label them Container A and Container B.
2) Position a thermometer inside each container, making sure the thermometers are at approximately the same height and are not touching the sides.
3) Leave Container A uncovered and tightly cover the top of Container B with transparent plastic wrap. Secure the wrap using tape or an elastic band.
4) Place both containers at an equal distance from a desk lamp or in a location receiving direct sunlight. Make sure they receive approximately the same amount of light.
5) Predict which container will become warmer during the experiment. Write a hypothesis explaining how the plastic covering might affect the temperature inside Container B.
6) Record the starting temperature of both containers. Turn on the lamp or expose both containers to sunlight at the same time.
7) Measure and record the temperature inside each container every three minutes for 15 minutes. Keep both containers in the same positions throughout the investigation.
8) Turn off the lamp or move both containers into the shade. Continue recording their temperatures every three minutes for another nine minutes to investigate how quickly they cool.
9) Create a line graph showing the temperature changes in both containers throughout the experiment. Compare their heating and cooling patterns and determine whether your results support your hypothesis.
10) Discuss how the plastic covering changes heat exchange with the surrounding air.

PREVIEW

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Recording Sheet | Record the details of your experiment below.

My Prediction: Which container do you predict will reach a higher temperature?

☐ Container A (Uncovered) | ☐ Container B (Covered with plastic wrap)

Explain your hypothesis. _____

Observati ure and record the temperature of each container every three minutes.

T	Container A – overed (°C)	Container B – Covered (°C)	Temperature Difference (°C)
0 (Starting)			
3			
6			
9			
12			
15 (End of heating)			
18 (Cooling)			
21 (Cooling)			
24 (Cooling)			

Temperature Difference = Container B Temperature − Container A

Compare Your Results: Complete the table using your measurements.

Observation	Container A	Container B
Starting temperature (°C)		
Highest temperature (°C)		
Temperature at 15 minutes (°C)		
Temperature increase during heating (°C)		
Temperature at 24 minutes (°C)		
Temperature decrease during cooling (°C)		

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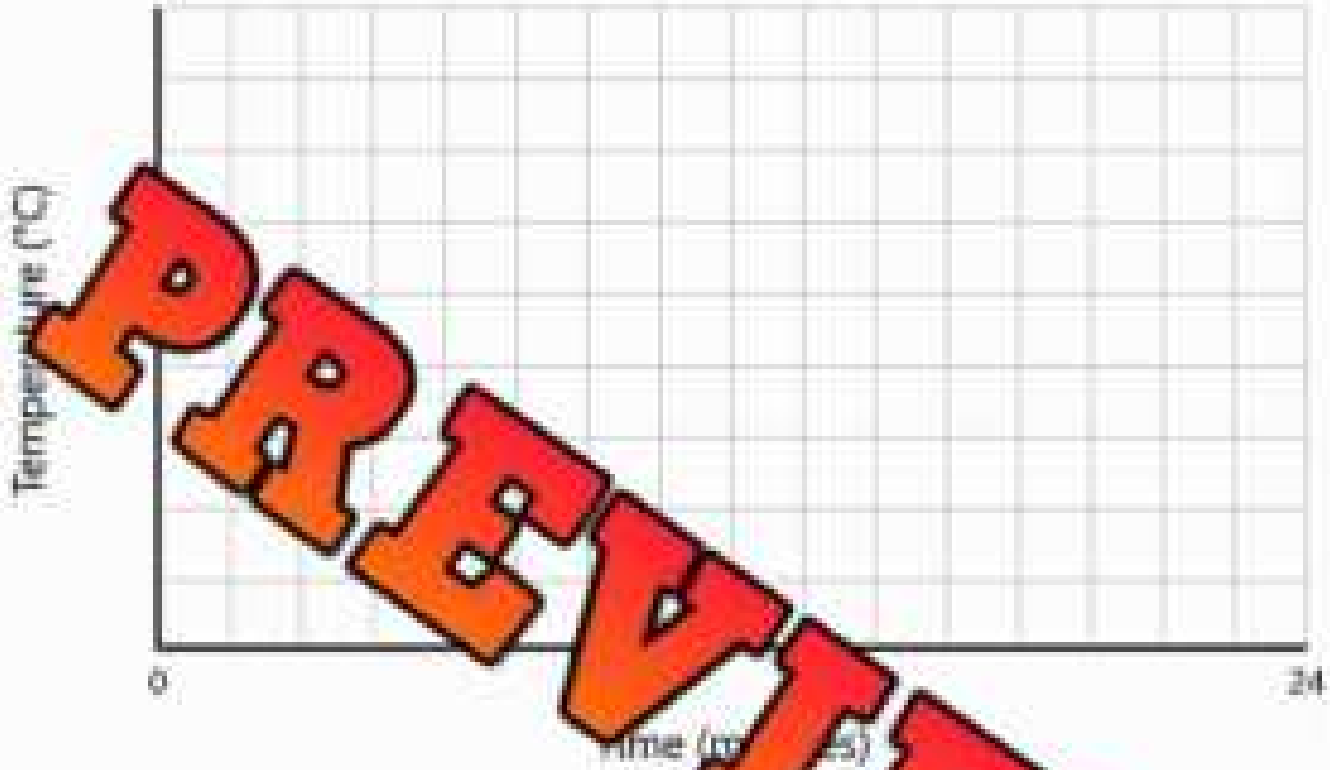
Graph Your Results: Create a line graph showing the temperature changes in both containers throughout the experiment. Horizontal axis (X): Time in minutes, Vertical axis (Y): Temperature in °C. Solid line: Container A (Uncovered). Dashed line: Container B (Covered)



PREVIEW

1) Which container reached the highest temperature?

2) Which container experienced the greatest temperature decrease during cooling?

3) Did your observations support your original hypothesis? Explain.

Name: _____ 85

Drawing Contest – Greenhouse Effect Diagram

Objective What are we learning about?

Students draw a labelled diagram of the greenhouse effect on Earth or Venus. This helps students ... how gases trap heat and how natural ... caused effects differ.



Materials ... need for the activity?

- ❑ Drawing pap... pe...
- ❑ Crayons, markers, ... pe...
- ❑ Pencils and erasers
- ❑ Reference list of drawing ideas (... ed)

Instructions How will you complete the ac...

1) Talk together about how the greenhouse effect wa... pl...
2) Look at the Reference List for ideas or think of your own ...
3) On your paper, draw your diagram. Include sunlight, a surface, and at least two labelled arrows for energy.
4) Add colour and details to make it clear and eye-catching.
5) Be ready to explain what your diagram shows and why it matters.
6) Display all entries around the classroom.
7) Vote together on fun categories like 'Most Detailed' or 'Clearest Science' rather than picking one winner, so every entry is celebrated.

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Reference List of drawing ideas

#	Drawing idea
1	Sunlight, a cloud layer, and Earth's surface with arrows
2	The natural greenhouse effect on a clear day
3	Venus wrapped in a thick, bright atmosphere
4	A cu[illegible] of a greenhouse with sunlight entering the glass
5	Inf[illegible]ys leaving Earth and bouncing back down
6	[illegible]owing different temperatures
7	A [illegible] mor[illegible]ing [illegible]°C and -18°C
8	A car pa[illegible] sun [illegible]d heat inside
9	Smokestacks [illegible] [illegible]sphere
10	A forest absorbing [illegible]
11	The runaway warming loop on Ve[illegible]
12	Layers of the atmosphere with ga[illegible]ecule
13	A prairie farm under a warming sun
14	A poster: how can people slow warming?
15	A split Earth: with and without the greenhouse effect

PREVIEW

Criteria Use the criteria below to complete the activity

Criteria	Description
Accuracy	Shows sunlight entering and infrared energy leaving correctly.
Labels	Uses at least five science words to label parts.
Arrows	Arrows show the direction energy moves.
Neatness	Drawing is clear and easy to read.
Creativity	Adds original ideas or colours that help explain.

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Reflection Answer the questions below.

1) How does a greenhouse gas change the way energy leaves Earth?

2) How is [illegible] different from Earth in your drawing?

3) What would you add to [illegible] human activity?

PREVIEW

Word Scramble Unscramble the words from the word bank.

WORD BANK			
infrared	carbon	warming	sunlight
surface	atmosphere	greenhouse	Venus

LNUSTHGI		RFNIDERA	
TSEAOHEMPR		RNUGEDEEHS	
BONCAR		URFACES	

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Rubric How did you do on the activity?

Criteria	1 Point	2 Points	3 Points	4 Points
Accuracy	Energy path missing or incorrect	Shows sunlight in; heat path unclear	Sunlight in and infrared out shown correctly	Correct path; shows gases trapping heat
Labels	Fewer than 3 labels; few science words	3–4 labels; some science words	5 labels using correct science words	More than 5 precise science labels
Arrows	[illegible]	Some arrows; direction unclear	Arrows show energy in and out correctly	Labelled arrows show trapped heat
Neatness	Messy; [illegible] to identify	[illegible]	Neat; parts easy to identify	Neat, organized layout; easy to follow
Creativity	Copies an idea with no additions	[illegible] details or col[illegible]	[illegible] details	Compares natural and human causes

PREVIEW

Teacher Comments

Mark

Student Comments – What Could You Do Better?

Name: _____ 89

Story: From Sunlight to Supper

Draw Draw pictures to illustrate the story.

On a bright July morning, Amara and her uncle Jonas walked into the Manitoba Tall Grass Prairie Preserve near Gardenton. The air smelled of warm grass and clover. Big bluestem towered over her head. "Everything here," Jonas said, "runs on sunlight." Amara raised an eyebrow. "Sunlight? Even the hawks?"

PREVIEW

Jonas knelt beside a blade of grass. "Plants capture light with **chlorophyll**, the green pigment inside the chloroplasts of their leaf cells." It absorbs red and blue light and reflects green, so leaves look green. Using that energy, the plant combines carbon dioxide from the air with water from the soil to make **glucose**, a sugar, and releases oxygen. "That sugar feeds the whole prairie," he said. Without it, no energy would enter.

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By noon, a grasshopper had landed on Amara's sleeve, chewing a blade of bluestem. "This is a link in a **food chain**," Jonas explained, "a sequence showing who eats whom." The grass is a producer because it makes its own food. The grasshopper is a primary consumer, and a western meadowlark that snaps it up is a secondary consumer. A **consumer** is an organism that gets energy by eating other organisms.

PREVIEW

That evening, Jonas sketched a **food pyramid** in his notebook, a diagram showing how much energy is available at each feeding level. "Only about 10 percent of the energy at one level reaches the next," he said. "The rest powers movement and body heat or is lost as waste." He wrote 10,000 kilojoules (kJ) for the grass, 1,000 for the grasshoppers, 100 for the meadowlarks and just 10 for the hawk. Amara realized this explained why a prairie holds far more grass than hawks. She copied the numbers carefully. "Each level needs a much larger level beneath it," she wrote.

Name: _____ 91

At dusk, a hawk circled high above the grassland against the orange sky. Amara watched it dive toward the meadowlark's song, which stopped abruptly. Amara held her breath. Its shadow slid across the bluestem. "All that power," she whispered, "began as sunlight landing on grass."



On the drive home, Amara learned why this place mattered. Tall-grass prairie once covered about 6,000 square kilometres (km²) of southern Manitoba, but less than 1 percent remains, much of it in this preserve of over 5,800 hectares (ha), which also shelters the endangered western prairie fringed orchid. Where the grass disappears, the energy path from sunlight to hawk breaks at its first link. That night she drew her own pyramid for her class, putting the Sun at the bottom, because every consumer, including her own supper, depends on a producer. She decided to return in August to measure how tall the bluestem had grown.

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Ordering Put these story events in the correct order by numbering them 1 to 8.

	She drew her own pyramid for her class.
	A hawk circled over the grassland at dusk.
	Jonas explained how chlorophyll captures light.
	Amara and Jonas walked into the prairie preserve.
	He sketched a food pyramid with energy numbers.
	Amara learned how little tall-grass prairie remains.
	A beetle landed on Amara's sleeve.
	It moves up the levels of the food chain.

What Did You Learn? Think about the whole story, then answer below.

1) Describe what chlorophyll can do in plants.

2) Predict what would happen to the hawk if the grassland

Connect Think of a meal you ate recently. Trace its energy back to the Sun.

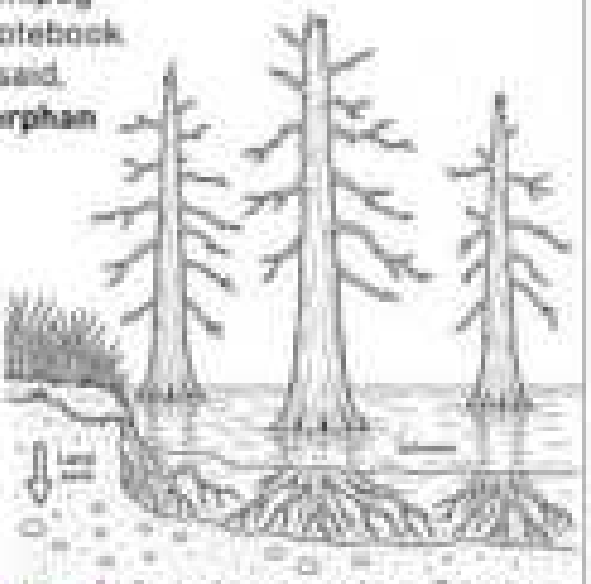
PREVIEW

Name: _____ 94

Story: The Orphan Tsunami

A Wave With No Parent

Mr. Sinclair wrote one date on the board in Daniel's Winnipeg classroom: January 26, 1700. Daniel copied it into his notebook. "Japanese officials recorded a tsunami a day later," he said. "but nobody felt an earthquake. Scientists call that an **orphan tsunami**, a wave with no known parent quake."



Ma[illegible] no active subduction zone, so the class l[illegible]ish Columbia. A **subduction zone** [illegible]re one tectonic plate slides [illegible]ath an[illegible]ncouver Island, the Juan de Fuca [illegible] North America along the Cas[illegible]ion.

Daniel learned [illegible] parent. In 1996, Kenji Sat[illegible] coll[illegible]d Japanese records, which list[illegible]ot[illegible]tres (m) at places such as Tanabe and Ōtsuchi, to calculate the qua[illegible] tim[illegible]January 26, 1700.

Along the coasts of Washington a[illegible]egon, [illegible]ed[illegible]s stood in marshes. Their outermost tree rings dated to 1699, because the[illegible]d d[illegible]denly and seawater killed the trees. Together, the evidence showed [illegible]out [illegible] (km) of the boundary had ruptured at once, in an earthquake o[illegible]

"Scientists were not the first to describe it," Mr. Sinc[illegible]d. [illegible] First Nation, one of the Nuu-chah-nulth nations on the west coast o[illegible]an[illegible]. **oral history**, knowledge carried in spoken accounts from generation to generation, about a night when the land shook and a wave struck the people of Pachena Bay.



Chief Louis Nookmis recorded one such account in 1964. It tells how people living on high ground survived. Decades later, Robert Dennis, Chief Councillor of the Huu-ay-aht First Nation and a descendant of Nookmis, helped retranslate the recording. Its details place the event between 1640 and 1740, a range that includes 1700.

Daniel wrote in his notebook that the oral history, the tree rings and the Japanese records had each described the same event in different ways. Then he underlined one sentence: the Cascadia zone is still capable of producing great earthquakes.

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Ordering Number these events 1 to 8 in the order they happened in the story.

	Daniel noted that three kinds of evidence agreed.
	Scientists found the cedars' last rings grew in 1699.
	Mr. Sinclair wrote January 26, 1700, on the board.
	Robert Dennis helped retranslate the 1964 recording.
	T[illegible] learned Manitoba has no active subduction zone.
	[illegible]bed the Huu-ay-aht account.
	[illegible]ese tsunami records.
	Evide[illegible]d 1,[illegible]be boundary ruptured.

Question Why is or[illegible] evidence?

Visualization Draw Pachena Bay during the quake. D[illegible]

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Circle the correct answer.

1) Tsunami year?	1700 / 1699
2) Rupture length?	100 km / 1,000 km
3) Japan wave size?	2–5 m / 20–50 m
4) Huu-ay-aht home?	Manitoba / BC coast

Name: _____ | Mark

Circle the correct answer.

1) Tsunami year?	1700 / 1699
2) Rupture length?	100 km / 1,000 km
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Name: _____ | Mark

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3) Japan wave size?	2–5 m / 20–50 m
4) Huu-ay-aht home?	Manitoba / BC coast

PREVIEW

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Role Play – Earthquakes and Tsunamis

Objective What are we learning about?

Students act out short scenarios about tsunami safety and ways of knowing, then discuss choices. This helps students apply what they learned about subduction and oral histo

Materials ...ll we need for our activity?

- ❑ Scenario ...d)
- ❑ Props (option...
- ❑ Timer or stopwatch



Instructions How will we complet... activit...

1) Divide the class into small groups of 3 ...de...
2) Provide each group with a scenario card that d... stu... ...lated to earthquakes and tsunamis.
3) Let groups decide who will take each role in the scenario ...s.
4) If available, distribute props that may help students show their roles.
5) Set the timer to allocate time for the groups to discuss and act out their scenarios.
6) Allow each group to present their role play to the class.
7) After all groups have presented, discuss the different approaches and outcomes observed.
8) Distribute reflection sheets for students to express what they learned.

PREVIEW

Name: _____ 98

Criteria Use the criteria below to complete the activity.

Criteria	Description
Use of science	Uses facts about earthquakes, subduction, or tsunamis.
Respect	Treats oral history and other knowledge with respect.
Teamw	Every group member has a clear part.
Clear	is so the audience can hear and follow.
Deci	decision and explains the reasons.

PREVIEW

Scenario Cards low

	Scenario	iption
1	**Warning Siren**	A coastal town hears a ... mu... fter strong shaking ends. A group ... ding whether to wait for official word or m... gh... ad. Some want to collect belongings first. What ... up do?
2	**Safe Route**	A class is planning the safest walking route from a coastal school to high ground. One person suggests the shortest road, another notices it crosses low land. How should the class choose a route?

Name: _____ 99

Scenario Cards | Cut out the scenarios below.

	Scenario	Description
3	**Two Kinds of Evid**	A group of students is comparing an oral history of a night flood with layers of sand found in marsh mud. Someone says only the sand counts as evidence. Another disagrees. …w should the group respond?
4	**Museum Display**	…committee is planning a display about a huge …quake that struck the west coast in 1700. Some mem… …t on …ific data, while others want the oral histori… tol… …own words. What should the committee de…e?
5	**Beach Visitors**	A family on a beach feels th… …sha… …more than a minute. Someone says it is only …na… …ey should stay. Another has read about nat… …g signs. What should the family do?
6	**Town Meeting**	A town council hears a request to pay for tsunami signs and sirens. Some residents say it is too expensive for something that happens rarely. Others point to the long record of past quakes. How should the council decide?

PREVIEW

Name: _____ 100

Scenario Cards | Cut out the scenarios below

	Scenario	Description
7	Boat [illegible]	A group of fishers at a harbour learns of a large earthquake offshore. Someone wants to move the boats out to deep water, while others say to tie them tight to the dock. What should the group do?
8	Science Fair	[illegible] preparing a science fair booth about [illegible] person wants to model plates with clay [illegible] others a drawing. They must explain why [illegible] quakes but the prairies do not. How will they present?
9	Guest Talk	A class is preparing to lea[illegible] kno[illegible]pe keeper about how a coastal nation rem[illegible]s. Someone asks what questions are re[illegible]sk. What advice should the class give?
10	School Drill	A school is holding a tsunami drill. During practice, some students joke and walk slowly while others take it seriously. Someone says real events never happen. How should the group respond?

PREVIEW

Name: _____ 101

My Role

Draw a scene from your role play. Show where the group is, what the danger is, and the action you chose.



Name: _____ 102

Reflection Create an acrostic poem using the word provided below. Your poem should relate to the word shown.

S	
U	
B	
D	
U	
C	
T	
I	
O	
N	

PREVIEW

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Name: _____ L03

Rubric | How did you do on the activity?

Criteria	1 Point	2 Points	3 Points	4 Points
Use of science	No facts about quakes or tsunamis	A few facts; some are incorrect	Accurate facts about subduction or tsunamis	Uses facts to explain each choice
Respect	Dismisses oral [illegible]tory or others' ideas	Listens to oral history; rarely uses it	Treats oral history as knowledge	Connects oral history with science
Team	[illegible]	Roles shared; some unclear	Every member has a clear part	Clear parts; members build on each other
Clear voice	Hard [illegible] follo[illegible]	[illegible]but [illegible]	Clear; steady voice; easy to follow	Clear and expressive; fits the role
Decision	No decision reached	De[illegible]side; reasons unclea[illegible]	[illegible]ion with [illegible]m the [illegible]	Safe choice; weighs risks with evidence

PREVIEW

Teacher Comments

[illegible]rk

Student Comments – What Could You Do Better?

Name: _____ 104

Interview: A Geologist

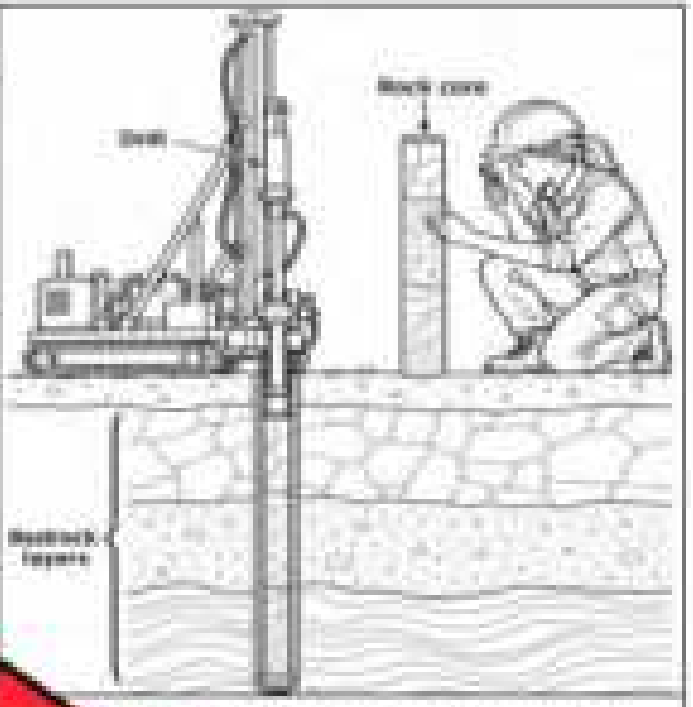
Student: What does a geologist study?

Dr. Reid: A **geologist** is a scientist who studies Earth's solid materials. I work for the Manitoba Geological Survey in Winnipeg, mapping bedrock.

Student: [illegible]edrock?

Dr. R[illegible]ock beneath the soil. [illegible]anic bedrock formed about [illegible]

Student: How do [illegible] underground?



Dr. Reid: We drill with diamond-[illegible] a **rock core**, a rock cylinder showing every layer. Manitoba store[illegible]

Student: What do you look for in the core?

Dr. Reid: Minerals: naturally formed solids wit[illegible] Granite holds quartz, feldspar, and mica, and quartz can s[illegible]

Student: Which minerals matter in Manitoba?

Dr. Reid: The Flin Flon belt, about 250 km long, holds copper and [illegible] Thompson belt is a major source of nickel.

Student: Why does the core go into a library?

Dr. Reid: Companies and researchers re-examine it at sites like Winnipeg, The Pas and Thompson. Core boxes cannot leave the building.

Student: What do you do outside of work?

Dr. Reid: I hike and rock climb on exposed Shield granite. Climbing shows me how crystals and cracks control how rock breaks.

Student: Thanks, Dr. Reid! Rocks look different now.

PREVIEW

Name: _____ 105

Fill in the Blanks Circle the missing word.

1)	A _____ is a scientist who studies rock.	chemist	geologist
2)	Solid rock under soil is called _____.	bedrock	sediment
3)	A rock _____ is a cylinder drilled from rock.	core	crust
4)	Quartz and mica are examples of _____.	minerals	fossils
5)	Near[illegible] mines yield copper and _____.	zinc	coal

Ques [illegible] questions below using what you read.

1) Name two [illegible] bedrock.

2) Why do geologists keep rock core [illegible]

Think Write one more question the Student could ask Dr. Reid abo[illegible] work and predict her answer.

PREVIEW

Name: _____ 107

Newspaper: Carbon Dioxide Hits a Record

Carbon Dioxide Hits New Record of 432 ppm

Publish Date: June 11, 2026

MAUNA L[illegible], Hawaii, June 11, 2026 — Scientists [illegible] Scripps Institution of Oceanog[illegible]ed that the monthly aver[illegible] (CO_2), a gree[illegible] gas, r[illegible]00 **parts per million** (ppm) at [illegible]bservatory in May 2026. On [illegible] molecule in ever[illegible] mol[illegible] The reading is 1.8 p[illegible] recorded in May 2025, a[illegible] independent measurement [illegible]

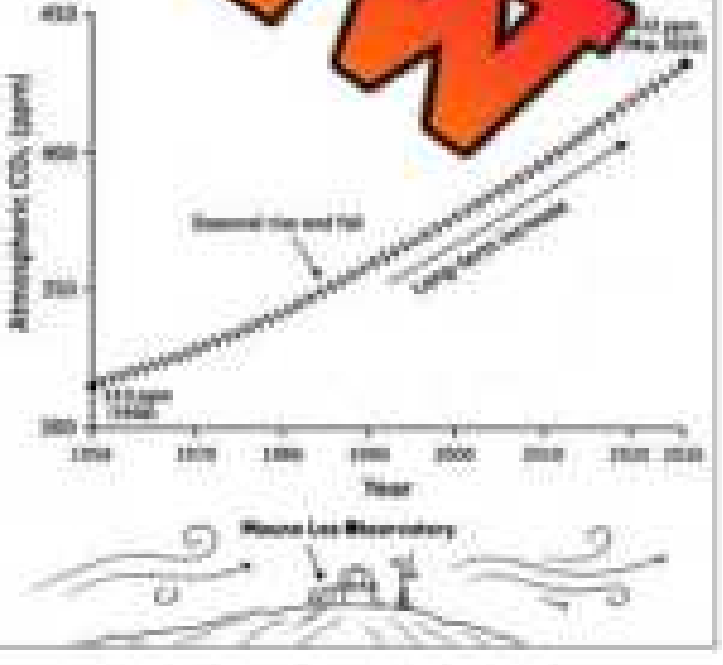
The observatory sits abo[illegible]00 metres (m) above sea level on a volca[illegible] Charles David Keeling began measuring there in 1958 and recorded 313 ppm on March 29. His graph, the Keeling Curve, showed that Northern Hemisphere CO_2 peaks each May, falls while plants absorb it during the growing season, and rises again in autumn. It also revealed a second pattern: every year's cycle sits higher than the last.

Scientists attribute this climb to burning **fossil fuels**, energy-rich materials such as coal, oil, and natural gas formed from ancient organisms over millions of years. Burning them releases the stored carbon as CO_2 within moments. Before the Industrial Revolution, atmospheric CO_2 stayed near 280 ppm, so today's level is roughly 50 per cent higher. CO_2 absorbs infrared radiation leaving Earth's surface, which is the **greenhouse effect**. The natural greenhouse effect keeps the planet habitable, but the **human-accelerated greenhouse effect**, extra warming caused by gases that human activity adds, is raising global temperatures.

Measurements were nearly lost in November 2022, when an eruption sent a lava flow over more than 1.6 kilometres (km) of the observatory's access road. Instruments moved temporarily to Maunakea, and NOAA restarted Mauna Loa measurements in 2023 using solar panels and batteries. NOAA has kept its own independent record since 1974.

Ralph Keeling, director of the Scripps CO_2 Program, said the long climb [illegible]tinues and added, "I wish we had better [illegible]." A Winnipeg teacher said much of the [illegible]d today will remain in the [illegible] centuries. "Students in Mar[illegible]ext year's record, and [illegible]ery cut in emissions [illegible]

Atm[illegible] conc[illegible]t Mauna Loa is inc[illegible] annual



PREVIEW

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Name: _____ 108

True or False Is the statement true or false?

1) Mauna Loa's May 2026 CO_2 peak was 432.00 ppm.	True	False
2) CO_2 absorbs infrared radiation leaving Earth.	True	False
3) Today's CO_2 level is about the same as in 1750.	True	False
4) Burning fossil fuels releases stored carbon as CO_2.	True	False
5) The obs[illegible]tory lies at sea level near a city.	True	False

Questio[illegible] the questions below using what you read.

1) What does [illegible] ow does it compare with 2025?

2) How do fossil fuels speed up the n[illegible]ffect?

Opinion Write a comment: what could your family or sc[illegible] emissions, and why?

Username: _____ Date: _____

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Underline the correct answer.

1) The first Mauna Loa reading in 1958 was 313 ppm / 432 ppm

2) In 2022 measurements were disrupted by a hurricane / volcanic eruption

3) Northern Hemisphere CO_2 peaks each May / November

4) NOAA's independent record began in 1998 / 1974

Name: _____ | Mark

Underline the correct answer.

1) The first Mauna Loa reading in 1958 was 313 ppm / 432 ppm

2) In 2022 measurements were disrupted by a hurricane / volcanic eruption

3) Northern Hemisphere CO_2 peaks each May / November

4) NOAA's independent record began in 1998 / 1974

Name: _____ | Mark

Underline the correct answer.

1) The first Mauna Loa reading in 1958 was 313 ppm / 432 ppm

2) In 2022 measurements were disrupted by a hurricane / volcanic eruption

3) Northern Hemisphere CO_2 peaks each May / November

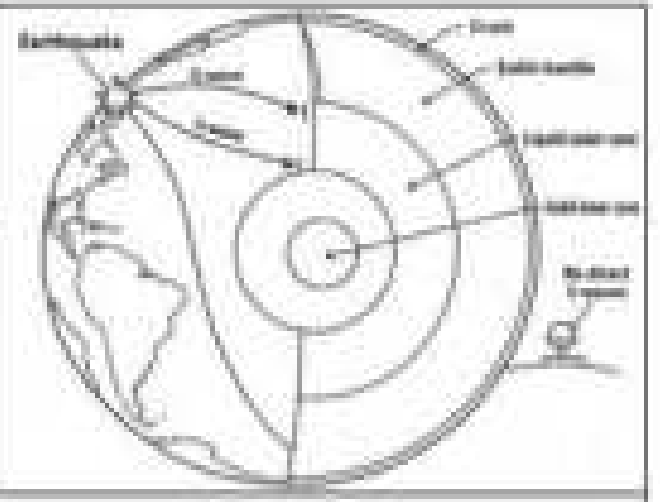
4) NOAA's independent record began in 1998 / 1974

PREVIEW

Name: _____ L10

Podcast Script: How Do We Know What Is Inside Earth?

Host (Mia): Welcome to Earth Talk! Today geophysicist Dr. Okoye explains how scientists explore places no one can ever reach, from the crust to the core.



Dr. Okoye: Thanks, Mia. The Kola Superdeep Borehole [illegible], a deep, narrow hole drilled to sample [illegible] reached 12,262 metres (m) in 1989. That is [illegible] per cent of the 6,371 kilom[illegible] Earth's centre.

Host (Mia): So [illegible] the rest?

Dr. Okoye: We use [illegible] waves that travel through Earth after an earthquake. Seismographs around [illegible] each wave arrives, and the travel times reveal the materials the [illegible] through.

Host (Mia): Are there different kinds of [illegible]?

Dr. Okoye: Yes. **P-waves**, or primary waves, are [illegible] travel through solids and liquids. **S-waves**, or secondary waves, shake [illegible] more slowly, and cannot pass through liquid.

Host (Mia): What happens when they reach the core?

Dr. Okoye: S-waves vanish on the far side of Earth, leaving a shadow [illegible] cannot cross liquid, scientists concluded that the outer core is liquid [illegible] sharply at the core too.

Host (Mia): And how did we find the solid inner core?

Dr. Okoye: In 1936, Danish seismologist Inge Lehmann studied P-waves from a 1929 earthquake in Buller, New Zealand. They arrived where a liquid core alone would bend them away, so she concluded that a solid inner core bends and reflects them.

Host (Mia): What stopped the Kola drilling?

Dr. Okoye: Heat. The rock at the bottom reached about 180 degrees Celsius (180°C), too hot for the equipment. Drilling samples only Earth's thin outer skin, while seismic waves sample the whole planet.

PREVIEW

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Name: _____ L11

Fill in the Blanks Circle the missing word.

1)	S-waves cannot travel through _____.	solid	liquid
2)	Kola is the deepest _____ ever drilled.	volcano	borehole
3)	Inge Lehmann found a solid inner _____.	core	crust
4)	The fa[illegible] waves are called _____-waves.	P	S
5)	The [illegible] stopped because of _____.	heat	water

Questio[illegible] [illegible]questions below using what you read.

1) How do P-wav[illegible] S-[illegible] what they can cross?

2) Why can waves reveal more about Earth th[illegible]ing?

Think Think of one more question Host (Mia) could ask Dr. Okoye [illegible]e mantle, then predict her answer.

PREVIEW

Name: _____ 113

Letter: From a Geothermal Technician

Dear Grade 8 Scientists,

Last week a student asked how a Manitoba home can be heated using the ground, so I am writing to explain my work as a geothermal technician. I install and repair **ground-source heat pumps**, systems that move heat between a building and the soil beneath it.

The ground is a steady heat source because soil conducts heat slowly, so seasonal change fades with depth. About 5 metres (m) down, the soil sits a little above the yearly average air temperature. In Gillam, northern Manitoba, one December it recovered −32.5°C at the surface but +5°C at 20 m. That warmth is mostly sunlight stored in the soil, topped up by a small, steady flow of Earth's internal heat from the planet's formation and from radioactive decay in rock.

Every system has three parts: the ground loop, the circulating fluid, and the indoor heat pump unit. Most properties use a **closed loop**, a circuit of plastic pipe, in horizontal trenches or vertical boreholes. Drilling boreholes can make up about half of an installation's cost. A mixture of water and antifreeze flows through the loop and picks up heat in winter, and the indoor unit's refrigerant circuit warm the air. In summer the process reverses, and the loop releases the building's heat into the ground.

Efficiency is why customers choose these systems. A gas furnace can exceed 100 per cent, but ground-source heat pumps move heat rather than make it, reaching efficiencies of 300 to 600 per cent, meaning 3 to 6 units of heat for every 1 unit of electricity. Air-source heat pumps reach about 175 to 250 per cent.

Soil type also shapes my designs, because moist soil conducts heat better than dry, loose soil, so a damp site can need less pipe. Before every job I record the soil, the water table, and the building's heating needs.



I trained as a refrigeration mechanic, since a heat pump is a refrigerator running in reverse, and I add that I love fishing on Lake Winnipeg on my days off. If you enjoy mathematics, measurement, and working outdoors, consider the trades.

Warm regards,

Kelsey Moar, Geothermal Technician

PREVIEW

Name: _____ 114

True or False Is the statement true or false?

1) Soil about 5 m down stays near the yearly average.	True	False
2) A heat pump moves heat instead of making it.	True	False
3) Heat pump loops only work in summer.	True	False
4) Boreholes are about half of installation costs.	True	False
5) Ground-source efficiency tops out at 100 per cent.	True	False

Questions ...e questions below using evidence from the text.

1) Exp... ...ow a ... works in winter and in summer.

2) Why is ground below 5 m a steadier ... sour... ...r?

PREVIEW

Making Connections Think about your home or school. Where could a ground loop be buried, and what about the soil might affect its design?

Name: _____ 11s

Mark /

Unit Test

Earth's Science

Part 1 Circle the correct answer for each question.

1) Which layer of Earth is liquid?

A) Inner core
B) Mantle
C) O[illegible]
D) [illegible]

2) Who proposed continental drift?

A) Alfred Wegener
B) Inge Lehmann
C) Charles Richter
D) Harry Hess

3) W[illegible]ndar[illegible]ates?

A) Conve[illegible]
B) Diverge[illegible]
C) Transform
D) Subduction

4) Pangaea was an ancient...

A) ocean basin
B) mountain range
C) ice sheet
D) supercontinent

5) Which gas traps heat in air?

A) Nitrogen
B) Argon
C) Carbon dioxide
D) Helium

6) Wh[illegible] the highest albedo?

A) [illegible]pe[illegible]
B) Fre[illegible]
C) [illegible]orest
D) De[illegible]d

7) Which pigment traps sunlight?

A) Glucose
B) Peat
C) Chlorophyll
D) Magma

8) Frozen ground is[illegible]

A) peat
B) bedrock
C) floodplain
D) permafrost

9) Uranium-238 warms rock through...

A) radioactive decay
B) frictional heat
C) solar heat
D) tidal heat

10) What drains into one river?

A) a fault
B) a watershed
C) a glacier
D) a geyser

PREVIEW

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Part 2	Define each of the terms below	Mark	/

Term	Definition (what does it mean)
Volcano	
Geyser	
Albedo	

PREVIEW

Part 3	Answer each of the questions below	Mark	/

1) How does radioactive decay contribute to the internal energy inside Earth?

2) Why do earthquakes frequently occur near tectonic plate boundaries?

3) How does chlorophyll help plants begin the transfer of energy through a food chain?

Part 4	Answer the long answer question below.	Mark	/

Imagine you could travel from Earth's surface to its centre. Describe the four main layers you would pass through, explaining how their composition, physical state, temperature, and pressure differ.

PREVIEW

Part 5	Draw a large cross-section of Ea[illegible]g th[illegible]ain layers. Label the crust, mantle, outer co[illegible] inner [illegible], which layers are solid and which are liquid.	Mark	

Workbook Preview

Grade 8 Science Unit
Matter

Strands A - D		
	Curriculum Outcomes	**Pages**
SCI.8.A (Strand A)	Demonstrate an understanding of different First Nations, Métis, and Inuit ways of knowing, being, and doing in relationship with the land and the natural world by exploring Indigenous methods of observing and interpreting the world, applying scientific principles, and creating technologies within local traditional and contemporary cultural contexts (e.g., wholistic, reciprocal, interconnected, and sustainable ways; land-based learning; outdoor learning; intersections with Western science)	53-55, 65-70, 79-81, 94-103
SCI.8. (Strand	Preview of 80 pages from this product that contains 168 pages total.	17-19, 32-34, 47-49, 62-64, 82-84, 107-112
SCI.8.C (Strand C)	• Science, Technology, Society, and Environment (STSE) Contexts • Scientific Measurement • Action and Practice • Scientific Instruments • Careers, Hobbies, and Activities	29-29, 29-31, 35-37, 43-46, 50-52, 59-61, 74-78, 85-88, 104-106, 113-115
SCI.8.D (Strand D)	**Purpose**: Science is about finding the cause or causes of phenomena in the natural world. **Method**: Scientific explanations, theories, and models are those that best fit the evidence available at a particular time. **Application**: The knowledge produced by science is used in engineering and technologies to create products and processes. **Implication**: Applications of science often have ethical, environmental, social, economic, and political implications.	13-16, 41-42

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Grade 8 Science Unit
Matter

Strand E – Scientific Knowledge		
	Curriculum Outcomes	**Pages**
SCI.8.E.1	Demonstrate an understanding of the nature of density as a physical property of matter. Include the following: mass, volume, density, d=m/v.	7-25, 104-106
SCI.8.E.2	Demonstrate an understanding of the effect of temperature on density using the particle theory of matter. Include the following: solids, liquids, gases.	26-37
SCI.8.E.3	Demonstrate an understanding of the nature of viscosity as a physical property of a fluid. Example: viscosity-temperature relationship	38-52, 79-81
SCI.8.E.4	Demonstrate an understanding of the relationship between temperature, volume, and pressure using the particle theory of matter. Include the following: water, steam, vapor, ice, compressibility.	57-64, 113-115
SCI.8.E.5	Demonstrate an understanding of how the nature of attractions between particles in a substance dictate how much energy is required to cause their temperatures and phases to change.	53-55, 71-78, 110-112
SCI.8.E.6	Demonstrate the understanding that water has properties caused by the nature of its particles, which make it important to climate and vital to living things. Include the following: heat capacity, boiling and melting point, liquid and solid density difference, universal solvent, transport, humidity, precipitation.	65-70, 82-103, 107-109

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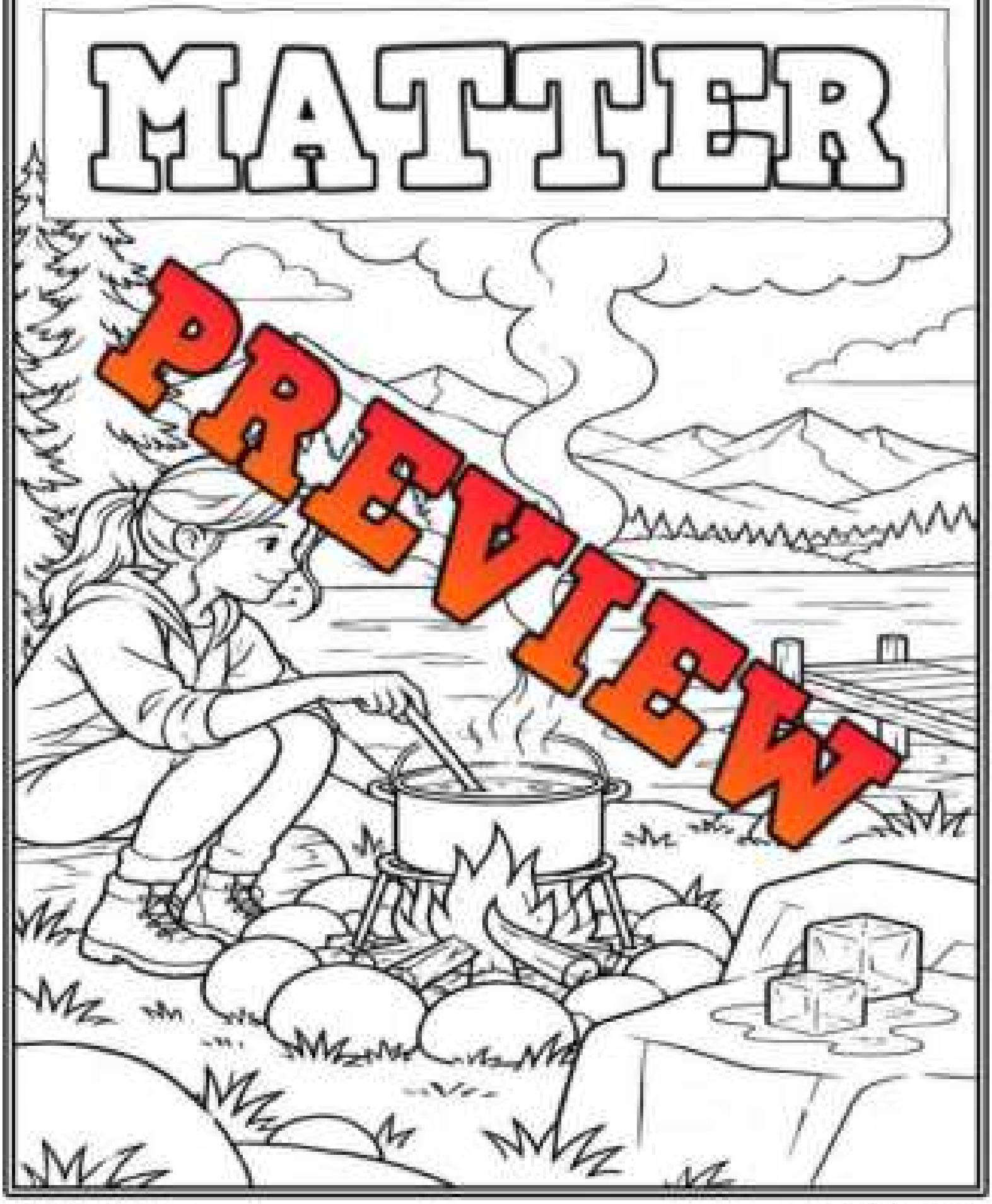
Name: _____

MATTER



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Name: _____ 7

What Is Matter?

Matter, Mass and Weight

Matter is anything that has mass and takes up space, from a hockey puck to the air inside a gymnasium. **Mass** is the amount of matter in an object, measured in grams (g) or kilograms (kg) with a balance, which compares it against known masses. Since 20 May 2019, the kilogram has been defined using Planck's constant instead of a platinum–iridium cylinder stored near Paris.

Weight is [illegible] of gravity pulling on an object's mass, so it is measured in newtons (N) with a s[illegible] changes with location. Gravity on the Moon is about one-sixth of Earth[illegible] astronaut with a mass of 80 kg keeps that mass there but weighs only [illegible]-s[illegible]

Measuring Vo[illegible]

Volume is the s[illegible] space [illegible] occupies. Liquid volume is measured [illegible] volume in cubic centimetres (cm³). [illegible] so 1000 mL make one litre (L). A gas has [illegible] pads to fill its container. The volume of a [illegible] width × height. For an irregular object such [illegible] scie[illegible] **displacement**, which means submerging the object [illegible] graduated cylinder and measuring how far the [illegible] level rises. If a stone raises the level from 50 mL to [illegible] volume is 12 cm³. The Greek scholar Archimedes [illegible] is credited with applying this idea in the third century B[illegible]



The Particle Theory

The **particle theory of matter** explains why every substance behaves as it does. Its main ideas are:

- All matter is made of extremely small particles; a single atom is only about 0.1 nanometres (nm) across.
- Particles are always moving, and they move faster as temperature rises, which explains why tiny bits from pollen jiggle in water, as Robert Brown saw in 1827.
- Empty space lies between particles, so mixing 50 mL of ethanol with 50 mL of water produces slightly less than 100 mL.
- Particles attract one another, and the attractions are strongest in solids.

PREVIEW

Name: _____ Date: _____

True or False

Circle whether the statement is true or false.

1) Mass and weight mean exactly the same thing.	True	False
2) One millilitre equals one cubic centimetre.	True	False
3) Displacement can measure a rock's volume.	True	False
4) Particles in matter are fixed and never move.	True	False
5) A box's volume is length × width × height.	True	False

Question

Answer the questions below.

1) Explain how you would find the volume of a rock using displacement.

2) Why can mixed liquids take up less space than expected?

PREVIEW

Fill in the Blank

Choose the correct word to complete each sentence.

1) Anything that takes up space and has mass is _____.

2) The amount of matter in an object is its _____.

3) The amount of space an object occupies is its _____.

4) A stone's volume can be found by the _____ of water.

5) The particle theory says matter is made of small _____.

Name: _____ 10

Density: The d = m/v Formula

What Density Measures

Density is the mass of a substance per unit of volume, which tells scientists how tightly its particles are packed. It is a physical property, so a pure sample has the same density whatever its size, and scientists use it to identify unknown substances. The formula is d = m ÷ v, where d is density, m is mass in grams (g) and v is volume in cubic centimetres (cm³), giving units of g/cm³.

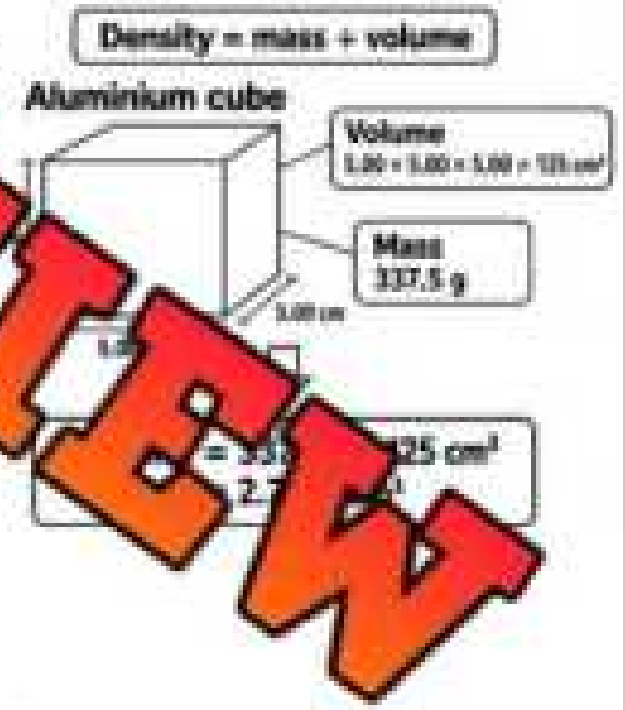
A result should not be more precise than the least precise measurement, so 2.70 keeps three digits because 1 g/cm³ equals 1000 kg/m³, engineers who work with large quantities often convert using two. Gases have very low densities: air at 20°C is only about 0.00

PREVIEW

Worked Calcu

A 250 mL glass [illegible] as a mass of about 250 g, so, its density is 25[illegible] An aluminum metal cube, [illegible] has a volume of 125 cm³ and a mass of 3[illegible] d = 337.5 ÷ 125 = 2.70 g/cm³.

Rearranging the formula gives m = d × v = m ÷ d. A 10.0 cm³ piece of lead, with density of 11.3 g/cm³, therefore, has a mass of 113 g.



A Gold bar of mass 12.4 kg (12 400 g) and density 19.3 g/cm³ has a volume of 12 400 ÷ 19.3, or about 640 cm³. For an irregular rock, a balance gives a mass of 52.0 g and displacement gives a volume of 20.0 cm³, so its density is 2.60 g/cm³.

Densities of Elements

Different elements pack their particles very differently:

- **Lithium** — 0.53 g/cm³, the least dense metal
- **Copper** — 8.96 g/cm³, the metal in electrical wire
- **Gold** — 19.3 g/cm³, which is why panning washes lighter sand away from gold flakes
- **Iron** — 7.87 g/cm³, the main metal in steel
- **Mercury** — 13.53 g/cm³, a metal that is liquid at room temperature
- **Osmium** — 22.59 g/cm³, among the densest elements known, so a 1 L block would have a mass of 22.59 kg

Name: _____ L1

Multiple Choice Circle the best answer.

1) Which formula correctly calculates density?			
d = m × v	d = v ÷ m	d = m ÷ v	d = m + v
2) A 270 g block has a volume of 100 cm³. Its density is…			
0.37 g/cm³	27.0 g/cm³	2.70 g/cm³	170 g/cm³
3) Which formula finds volume from mass and density?			
v = m	v = d × m	v = m ÷ d	v = d − m
4) Which [illegible] reading has the lowest density?			
[illegible]	Mercury	Osmium	Lithium
5) Gold [illegible] 3 g/ [illegible] mass of 2.0 cm³ of gold?			
9.65 g	[illegible]	0.10 g	38.6 g

PREVIEW

Think A nugget has a [illegible] g and [illegible] of 5.00 cm³. Calculate its density, then decide whether it [illegible] What should you do next to be sure?

Think Imagine you find a strange rock while hiking. How could you use its mass, volume, and density to help identify what type of material it might be?

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

How can two objects of equal size have different masses?

Name: _____ | Mark

How can two objects of equal size have different masses?

Name: _____ | Mark

How can two objects of equal size have different masses?

Name: _____ | Mark

How can two objects of equal size have different masses?

PREVIEW

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Name: _____ 13

Experiment – Densities of Solids

Hypothesis Rank the solids in order from highest density to lowest density

1)	2)	3)
4)	5)	6)

PREVIEW

Materials u need for the activity?

- ❑ Scale or test ance or digital scale
- ❑ Cylinder ure to measure displacement
- ❑ 6 solids to t ble rock, eraser, paper clip, ping pong ball, etc.
- ❑ Optional – if using ll need to use a sinker. A **sinker** is a heavy/dense object t ing object. You will need to determine the volume o act it from the total volume of the sinker and the floating object t just the floating object.

Instructions How will you complete the act

1) Complete the hypothesis by writing the solids t in xes at the top of the page.
2) Rank them in order of which solids you think will be e

Calculating the volume of the solids – Use the next page to record r

1) Fill the cylinder up with water to a measurable line.
2) Drop a solid into the cylinder.
3) Measure in mL how much water is displaced by calculating the difference between the starting water level by the current water level. Note: 1mL is the same as 1 cm^3 volume.
4) Write down the volume in cm^3.

Calculating the mass of the solids – Use the next page to record results.

1) Use the scale or balance to measure how much mass the solids have.

Calculate the density of the solids

1) Fill in the table on the next page using the formula: density = $\frac{\text{mass}}{\text{volume}}$

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Observations

Fill in your measurements below

Solid	Volume – cm^3	Mass – g	Density – g/cm^3

PREVIEW

Results

Answer the questions

1) Was your hypothesis correct? Did anything s[illegible]you?

2) Why do you think the water level goes up when the solid is put into the [illegible]?

3) Why would you need a sinker if you used a floating object?

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Name: _____ 15

Experiment – Densities of Liquids

Hypothesis Rank the liquids in order from highest density to lowest density.

1)	2)	3)	Optional 4)

Materials What will you need for the activity?

- ❑ 1
- ❑ 3 o liquids ve table oil, water, corn syrup, maple syrup. Do not use liquids th
- ❑ Food colour

PREVIEW

Instructions How will you

1) Complete the hypothesis by wri liqu est in the boxes at the top of the page.
2) Rank them in order of which liquids you th density to lowest density.
3) If you use water, place a few drops of food colouring the easier to tell it apart from other clear liquids.
4) Pour all the liquids together into the beaker or large jar. Let it
5) Fill in the observations of what you noticed about the settling of the liquids.

Observations What did you notice as you completed the experiment?

1) Write the actual order of the liquids after you have completed the experiment.

_____

_____

_____

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2) Draw a diagram of the liquids in the beaker. Label each layer of the liquids.

PREVIEW

Results Answer the qu... ...lo...

1) Was your hypothesis correct? Did an... ...surpr... ...en.

2) Which liquids have a higher density than water? Which have a lo... ...er?

Higher	Lower

3) Did any of the liquids dissolve in the water? How would that affect the experiment?

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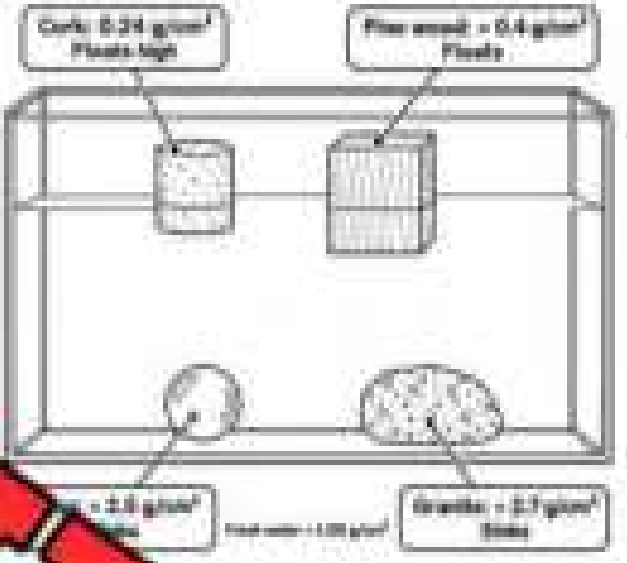
Name: _____ 17

Why Things Float and Sink

Comparing With Water

An object floats in a fluid when its density is less than the fluid's and sinks when its density is greater. This happens because of **buoyancy**, the upward force that a fluid exerts on any object placed in it. Fresh water has a density of 1.00 g/cm³, so it is the standard for comparison:



- **Cork** — 0.24 g/cm³, so it floats high on the surface
- **Pine wood** — 0.4 g/cm³, so it floats
- **Glass** — 2.5 g/cm³, so it sinks
- **Granite** — roughly 2.7 g/cm³, so a granite pebble sinks

Layers and Ships

Liquids that do not mix stack in order of density, with the densest at the bottom. In a density column, corn syrup (roughly 1.4 g/cm³) forms the bottom layer, water the middle, and vegetable oil (0.92 g/cm³) the top, with isopropyl alcohol (0.79 g/cm³) sitting above the oil. Carefully. Solid steel, at about 7.85 g/cm³, sinks, yet a steel ship floats because its hull encloses air, making the average density of the whole ship less than water. By Archimedes' principle, the water it pushes aside has the same weight as the ship.

Since the Merchant Shipping Act of 1876, British ships have carried a Plimsoll line, a load mark painted on the hull and named for Samuel Plimsoll, a British politician who campaigned for it, and separate marks exist for fresh water and salt water because salt water is denser.

Floating in Salt Water

Dissolved salt raises a liquid's density. Ocean water is about 1.03 g/cm³, while the Dead Sea, whose surface lies more than 430 m below sea level, is roughly 34% salt by mass and has a density of 1.24 g/cm³. Swimmers float with much of their bodies above the surface because their density is lower than the water's. Living things use the same principle: many bony fish, such as walleye, adjust their depth with a gas-filled swim bladder, and submarines fill ballast tanks with water to dive and blow it out with compressed air to rise.

PREVIEW

Name: _____ 18

True or False Is the statement true or false?

1) An object sinks if its density exceeds the liquid's.	True	False
2) Vegetable oil forms a layer above water.	True	False
3) Steel is less dense than water, so ships float.	True	False
4) Dead Sea water is denser than fresh water.	True	False
5) Corn syrup would float on top of vegetable oil.	True	False
6) Buoyan[illegible]ward force from a fluid.	True	False

Sortin[illegible] [illegible]to the correct column.

Cork [illegible]d	Vegetable oil	Steel ship
Corn syrup	Glass	Granite

Floats in fresh water	Sinks in fresh water

PREVIEW

Making Connections Think of a lake, pool or bathtub you know. Describe one object that floats and one that sinks and explain each using density.

Name: _____ 26

Heat, Particles and Density

Expansion and Contraction

Thermal expansion is the increase in the volume of matter as its temperature rises, and **contraction** is the decrease in volume as it cools. The particle theory explains both: added thermal energy makes particles vibrate or move faster, so they push slightly farther apart, although the particles themselves stay the same size. **Temperature** is a measure of the average kinetic energy of a substance's particles. Mass does not change while volume does, so density changes too: $d = m \div v$ falls when matter expands and rises when it contracts.

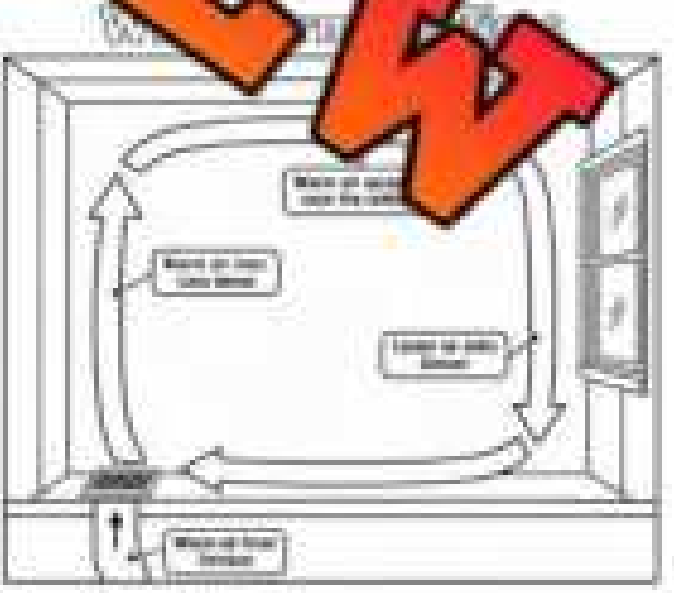
Solid

Each [illegible] differently because its particles are held differently.

- **Solids** — [illegible] particles in fixed positions where they only vibrate, so expansion is [illegible] lengthens by about 7 cm when warmed by 60°C, a change that [illegible] $\times 12 \times 10^{-6}$ per °C for steel.
- **Liquids** — particles slide [illegible] weaker attractions, so they expand more; 1 L of gasoline warmed by 10 [illegible] mL.
- **Gases** — particles are far apart with [illegible] they expand most; dry air has a density of 1.293 kg/m³ at 0°C but only [illegible] g/m³.

Gaps and Rising Air

Hot air rises because warmed air is less dense than the cooler air around it, and the cooler, denser air sinks beneath it and pushes it upward. In Manitoba homes this is why warm air from a furnace collects near ceilings. Winnipeg's winter lows near −30°C and summer highs near 30°C force engineers to leave small gaps between rail sections and to build expansion joints into bridges, so the steel can lengthen on hot days without buckling.



Aluminum expands about twice as much as steel, at 25×10^{-6} per °C. Even the 1280 m steel span of the Golden Gate Bridge changes length by about 0.84 m over a 55°C range, and overhead power lines sag more in July than in January.

PREVIEW

Name: _____ 27

Two Choices

Circle the best answer.

1) Warmed particles move _____.	faster	slower
2) When matter expands, its density _____.	increases	decreases
3) Of the three states, _____ expand the most.	solids	gases
4) Cooling a liquid causes it to _____.	expand	contract
5) Rail gaps [illegible]room for steel to _____.	shorten	lengthen

Quest[illegible]

[illegible]questions below.

1) Why does h[illegible]ove [illegible]? Use density in your answer.

2) Explain why a steel bridge needs expansion joi[illegible]

Finish the Sentence

Complete each sentence below.

1) Gases expand more than solids because...

2) A warmed liquid has a lower density, which means...

PREVIEW

Name: _____ 22

Blog Post: Temperature and Density

5 Everyday Effects of Temperature on Density

Date: October 6, 2026. **Author**: Ms. Dana Kowalchuk. 3-minute read

Density is the mass of a substance packed into each unit of volume, and heating nearly always lowers it because faster-moving particles push farther apart. Builders, pilots, plumbers and forecasters all depend on **thermal expansion**, the increase in a material's volume as its temperature rises. Here are five everyday Manitoba examples of temperature changing density.

1) **Hot-Air Balloons Climb:** A balloon rises because of **convection**, the circulation set up when dense fluid is pushed upward by cooler, denser fluid. Heating the envelope to about 99°C gives roughly 720 kg of lift. Nylon fabric is used to a... The first crewed free flight took place in Paris in 1783.

2) **Thermometers Rise:** In a household thermometer, a dyed liquid rises through a ... bec... pands when warmed. Ethanol expands by about 0.075% for ea... rou... as much as mercury, which makes small changes easy to ... uid down to about -114°C, so it keeps working through a Pr... snap...

3) **Concrete Slabs Need Gaps:** ... about 0.012 mm per metre for each 1°C, so a 5 m sidewalk slab w... roughly 3 mm. Crews leave an **expansion joint**, a narrow gap or ... strip ... material room to grow, between slabs. Without them, slabs would pr... ... and crack.

4) **Cold Air Masses Sink:** An **air mass** is a hug... of air ... uniform temperature and humidity. Arctic air at -25 ... ...2 kg/m³, roughly 24% greater than the 1.15 kg/m³ of air at ... ...ense ... and spreads along the ground, forming high-pressure ... ...erly cold skies.

5) **Hot Water Stays on Top:** In a household water tank, water at 60 ... 0.983 g/cm³, while water at 20°C measures 0.998 g/cm³. This ... about 1.5% makes hot water float above cold, forming temperature layers. Cold ... water enters low in the tank, so the top outlet delivers the hottest water.

PREVIEW

Comments



Nina – October 6, 2026
My grandfather's alcohol thermometer reads -35°C on January mornings, and the red line never freezes!
Like Reply 1d ago



Owen – October 7, 2026
Nina, that makes sense now. Ethanol must stay liquid far below any Winnipeg temperature.
Like Reply 20m ago

Name: _____ 33

True or False Is the statement true or false?

1) Water at 60°C is denser than water at 20°C.	True	False
2) A balloon's heated air is less dense than the air outside.	True	False
3) The liquid in a thermometer expands as it is warmed.	True	False
4) Pilots can heat nylon balloons well past 150°C.	True	False
5) Expansi[illegible]ints give concrete slabs room to grow.	True	False

Questio[illegible] [illegible]questions.

1) Describe ho[illegible]s that temperature has risen.

2) Pick two examples from the blog po[illegible]ell w[illegible]about particles.

Drawing Draw and label three places where heat changes density.

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

Circle the correct answer.

1) Heated room air	sinks / rises
2) Steel in July	shrinks / expands
3) Cooled mercury	shrinks / grows
4) Dense cold air	rises / sinks

Name: _____ Mark

Circle the correct answer.

1) Heated room air	sinks / rises
2) Steel in July	shrinks / expands
3) Cooled mercury	shrinks / grows
4) Dense cold air	rises / sinks

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2) Steel in July	shrinks / expands
3) Cooled mercury	shrinks / grows
4) Dense cold air	rises / sinks

PREVIEW

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Name: _____ 38

Story: The Great Pour-Off

The Great Pour-Off

On a grey Monday morning in Winnipeg, Mr. Bhatt's Grade 8 class found four clear cups waiting on the lab bench beside a tray propped at an angle of 20 degrees (20°). Each cup held 50 mL of a different liquid: water, vegetable oil, dish soap and honey.

"Today you will race them," Mr. Bhatt announced. "Predict the order in which they reach the bottom of this 50 cm ramp." He wrote **viscosity** on the whiteboard and defined it as a liquid's resistance to flow.

Jayden raised his hand almost immediately. "Oil is lighter than water," he said, "so oil will win, and honey, which looks heaviest." Priya disagreed and ranked the soap second. They recorded their predictions beside a stopwatch.

At the signal, Mr. Bhatt tipped all four cups at once. Water streaked down in about three seconds. The vegetable oil followed nearly half a minute. The soap crept along for several minutes. Honey refused to budge: the honey had barely left the top edge. Jayden frowned at the results. Earlier, Mr. Bhatt had poured oil into a beaker of water, the oil had floated on top, and he had said it was less dense. If lightness meant speed, the oil should have beaten the water. "The data does not make sense," he muttered.

Mr. Bhatt smiled. "You have found the real problem," he said. "Density compares mass with volume, but viscosity measures the internal friction between a fluid's particles.

At 20°C, water has a viscosity of about 1 millipascal-second (1 mPa·s). Honey measures roughly 2,000 to 10,000 mPa·s, thousands of times higher."



He described the pitch drop experiment at the University of Queensland in Australia, which began in 1927. Pitch looks solid, yet it is about 230 billion times as viscous as water, and only nine drops had fallen by April 2014.

Jayden walked to the whiteboard and erased his prediction rule. In its place he wrote, "Light does not mean fast. Viscosity decides." Beneath it, Priya added a new question: what would warming the honey do?

PREVIEW

Name: _____ 39

Ordering Number these events 1 to 8 in the order they happened in the story.

	Jayden crossed out his rule that light liquids flow fastest.
	The class watched water finish the race in seconds.
	Mr. Bhatt set four liquids at the top of a tilted ramp.
	Mr. Bhatt described the Queensland pitch drop experiment.
	T[illegible]y had barely moved after ten minutes.
	[illegible] predictions for the finishing order.
	[illegible]et flowed more slowly than water.
	Mr. B[illegible]ha[illegible]sity is not the same as density.

Question Explain [illegible] about liquids.

Visualization Draw the ramp race and describe what you pictured.

PREVIEW

Name: _____ 41

Experiment – Comparing Viscosities

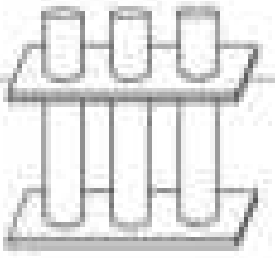
Hypothesis Rank the fluids in order from highest viscosity to lowest viscosity.

Water	Honey	Molasses	Milk	Oil	Dish Soap

1)	2)	3)
4)	5)	6)

PREVIEW

Materials W[illegible] activity?



- ❑ Stopwatch
- ❑ Graduated cylinder (the [illegible]
- ❑ Marble – about half the size of th[illegible]meter [illegible]r
- ❑ Enough fluid to fill the cylinder for each [illegible], honey, molasses, milk, oil, dish soap. You can substi[illegible], [illegible]ut the fluids from the hypothesis and write in the fluids you [illegible]

Instructions How will you complete the activity?

1) Fill the cylinder with the first fluid you will measure.
2) Have a stopwatch ready, especially with the fluids that have a low viscosity.
3) Drop the marble into the cylinder and start the stopwatch.
4) Write down how long it took for the marble to fall to the bottom.
5) Repeat with another fluid until you have measurements for each fluid. You could share fluids to minimize waste.
6) Answer the questions on the back of this page.

Observations What did you notice as you completed the experiment.

Fluid	Time To Fall

PREVIEW

Results An[illegible] [illegible]ow

1) Was your hypothes[illegible] [illegible]prise you? Explain.

2) Viscosity measures a fluid's resistance to flow. How do[illegible] [illegible]t help explain the viscosity of these fluids?

3) Rank the fluids in order from which the marble fell the fastest to slowest.

1)	2)	3)
4)	5)	6)

4) How could you have decreased the viscosity of these fluids?

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Name: _____ 43

Tableau – The Great Pour-Off

Objective What are we learning about?

Students will learn to use frozen poses and facial expressions to represent scenes from a liquid race and demonstrate how viscosity affects the flow of liquids.



Materials What do we need for the activity?

- ❑ Tableau s
- ❑ Open space in th
- ❑ Stopwatch or timer
- ❑ Pencil for reflection

PREVIEW

Instructions How will you complete the acti

1. Work in groups of four or five students.
2. Choose one scene from the lists on pages 2 and 3.
3. Plan a freeze frame that shows the scene without any words.
4. Decide each person's role, and where each one stands and looks.
5. Use faces and body positions to show feelings and actions.
6. Practise holding your tableau perfectly still for ten seconds.
7. Present to the class. The audience guesses the scene and liquid.
8. Tap a frozen student on the shoulder. They say one thought aloud.
9. Complete the reflection questions on the last page.

Name: _____ 44

Tableaus | Tableau scenes for the activity

#	History	Description of Scene for Tableau
1	**Lining Up Cups**	Four students stand behind a long table, each holding a clear cup of a different liquid. Eyes are wide, shoulders lean forward, and one student raises a hand high as if signalling the start.
2	**Water [illegible]wn**	One student tips a cup so water splashes quickly down [illegible]ted tray. Two classmates lean in with mouths [illegible]oint, while a fourth stares at a stopwatch [illegible] wi[illegible]
3	**Oil Slides Slowly**	A gro[illegible]ches [illegible] tray as vegetable oil creeps along [illegible] till. [illegible]s are pinched, one student taps a [illegible]and [illegible]hand in front of an open mouth.
4	**Honey Holds Back**	A student holds a cup tipped alm[illegible], but only a thin thread of honey hangs from [illegible]m. Everyone freezes with raised eyebrows, folded arms and one palm pressed to a forehead.
5	**Dish Soap Crawl**	Students lie with chins on their hands at table level, watching dish soap ooze forward. Faces show patience and doubt, and one student rolls their eyes while another gives a thumbs up.

PREVIEW

Name: _____ 45

Tableaus | Tableau scenes for the activity

#	History	Description of Scene for Tableau
6	**Timer Check**	One student holds up a stopwatch while the others lean close to read it. A recorder bends over a clipboard, pencil raised, as another student stretches out an arm to point at the number.
7	**Warm [illegible]**	A cup of honey sits in a bowl of warm water. Students [illegible] around it at eye level with hands cupped close, [illegible]ved, and one student blowing gently on their [illegible]ers.
8	**Cheering the Winner**	Water [illegible]ched [illegible] the tray first. Arms shoot into the air, mouths [illegible] open [illegible]ers, one student bounces on tip[illegible] [illegible]k with a huge grin.
9	**Puzzled Scientists**	Two students stand with hands on [illegible]owed brows, staring at a messy table of stick[illegible]es. A third scratches their head while a fourth shrugs with both palms up.
10	**Sharing Results**	The whole class gathers around a chart on the board. One student points to the slowest liquid, others nod, a few lean on each other's shoulders, and everyone looks proud.

PREVIEW

Name: _____ 46

Reflection Answer the questions below.

1) Which scene was hardest to show without words? Why?

2) What c[illegible] tableau show about thick and thin liquids? Explain.

3) How could you show a fluid with low [illegible] using body movements?

4) What would you change to make your freeze frame clearer?

PREVIEW

Name: _____ 47

Case: Viscosity and Temperature

Warmth Changes How Fluids Flow

Case 1: A −35°C Morning in Winnipeg

At 7:15 on a January morning in Winnipeg, the thermometer reads −35°C. The engine oil in a parked car has thickened until it flows like syrup, because its particles have lost energy and slide past one another. A cold start would force the pump to push thick fluid through narrow passages, leaving metal parts poorly lubricated. Block heaters prevent this wear. They create electric element that warms the coolant and the oil around it. Drivers advise plugging in below −20°C three hours before driving. Many drivers also choose multigrade oil such as 5W-30, in which the number before the W (for winter) rates how well the oil flows when cold.



Case 2: Lava on Kīlauea

On Kīlauea in Hawaii, basalt lava erupts at temperatures above 1,000°C and flows readily. According to the United States Geological Survey (USGS), the leading edges of fluid basalt flows can reach 10 km/h down steep slopes, yet they usually creep along at less than 1 km/h on gentle ground. As lava loses heat to the air, its viscosity rises, so the flow slows, thickens and finally freezes into rock. Composition matters as well: dacite and rhyolite lavas are so viscous that they typically advance less than a few metres per hour. Honey shows the same pattern in a kitchen, pouring beautifully slowly from a cold cupboard and running freely after a warm-water bath.



What This Teaches Us

In both cases, **viscosity**, a fluid's resistance to flow, changed with temperature. Liquid viscosity falls as temperature rises because heated particles move faster and break free of the attractions holding neighbours together. Water shows the trend clearly: its viscosity is 1.31 mPa·s at 10°C, 1.00 mPa·s at 20°C and only 0.31 mPa·s at 90°C, so hot water flows about four times more easily than cool water. Block heaters and warm-water baths use this rule by heating a fluid until it flows well enough to work, while cooling does the reverse. Because the effect depends on particle motion, it applies to nearly all liquids and explains why one fluid can pour easily in July yet barely move in January.

PREVIEW

Name: _____ 48

Finish the Sentence

Complete each sentence below.

1) A cold engine is harder to start because its oil...

2) Warm honey pours faster than cold honey, which means...

Questions

...e o... below.

1) Why do Manitoba dri... bloc... in winter?

2) What happens to lava's flow as it loses heat? ... wh...

3) Explain how particle motion links temperature to viscosity.

Odd One Out

Circle the word that does not belong in each group.

Heating	Warming	Cooling	Thawing
Cold oil	Water at 90°C	Basalt lava	Warm honey

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Sort each tile into a column.

Fridge syrup	Cooling lava
Chilled honey	Honey in sun
Warmed-up oil	Heated water

Viscosity rises	Viscosity falls

Name: _____ | Mark

Sort each tile into a column.

Fridge syrup	Cooling lava
Chilled honey	Honey in sun
Warmed-up oil	Heated water

Viscosity rises	Viscosity falls

Name: _____ | Mark

Sort each tile into a column.

Fridge syrup	Cooling lava
Chilled honey	Honey in sun
Warmed-up oil	Heated water

Viscosity rises	Viscosity falls

Name: _____ | Mark

Sort each tile into a column.

Fridge syrup	Cooling lava
Chilled honey	Honey in sun
Warmed-up oil	Heated water

Viscosity rises	Viscosity falls

PREVIEW

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Name: _____ 53

Boiling Down Maple Sap

Sugar-Making in the Red River

Anishinaabe (Ojibwe) communities make **maple sugar**, called ziinzibaakwad in Anishinaabemowin, a food produced by boiling sap until nearly all its water is gone. Historian Susan Deborah Wade, whose research on Ojibwe women and maple sugar production covers 1670 to 1873, found that Ojibwe sugar makers moved west into the Red River region in the mid-1700s and tapped the Manitoba maple (*Acer negundo*), a tree also called box elder.

Today the [illegible] Maple Syrup Festival at McCreary, on Treaty 2 territory and the traditi[illegible]shinabe, honours that history of tapping. Sap runs in early spri[illegible] 0°C and nights fall below it.



Boiling Down

Sap leaves the [illegible]stly [illegible] maple sap averages only abo[illegible] sap is slightly less sweet, so [illegible] to 80 L of it to produce 1 L o[illegible] about 40 L for sugar maple, which [illegible] 39 L of water for every litre of syrup.

Evaporation is the change of a liquid into a gas, a[illegible] takes energy because particles must overcom[illegible] attractions holding them together. The sugar par[illegible] stay behind, so the **concentration**, the amount of diss[illegible] in a[illegible] amount of solution, steadily rises. Finished syrup is abou[illegible]y 4°C above the **boiling point** of water, the temperature at which a liquid [illegible] throughout its volume, because dissolved sugar attracts water par[illegible]

Steps in the Sugarbush

- **Tapping** — taps go first on sun-facing slopes, and Anishinaabe sugar makers at Grand Portage, Minnesota, watch for pussy willow buds as the signal.
- **Collecting** — sap is gathered daily because it ferments quickly.
- **Sorting runs** — the first sap is sweetest, while later "second sap" is thicker, like molasses.
- **Sugaring off** — syrup is traditionally worked in troughs with paddles until it becomes sugar.
- **Ending the season** — tapping stops when new leaf buds form and the sap turns off-flavour.

PREVIEW

Name: _____ 54

Define What do the terms below mean?

Boiling point	
Maple sugar	
Tappin	

True or False Is the [illegible]

1) Sugar maple sap averages about 2%	True	False
2) Finished syrup is about 2% sugar.	True	False
3) Boiling sap leaves its sugar behind.		False
4) Manitoba maple is also called box elder.		[illegible]
5) Manitoba maple sap is sweeter than sugar maple sap.		False

Question Explain how boiling sap makes syrup, using particles.

PREVIEW

Name: _____ 56

Gases: Temperature, Volume and Pressure

Gas Particles in Motion

The particle theory of matter states that all matter is made of tiny particles in constant motion. A **gas** is a state of matter with no fixed shape or volume, in which particles are far apart and travel in straight lines until they collide with something. One cubic centimetre of air holds about 2.5×10^{19} molecules. At 20°C, the average nitrogen molecule in air moves at roughly 500 metres per second (m/s).

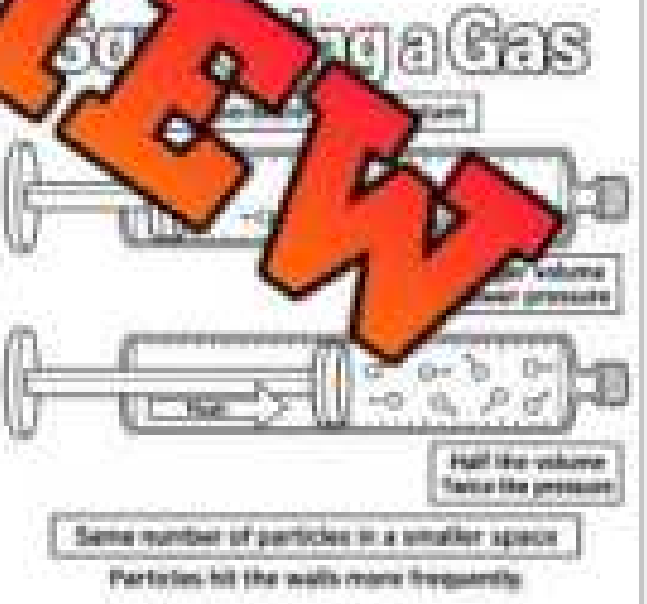
Pressure is the force that colliding particles exert on each unit of area of a surface, measured in kilopascals (kPa). Air pressure at sea level averages 101.3 kPa because the weight of the air above pushes down on every surface.

Temperature and Motion

Temperature is a measure of average **kinetic energy**, or energy of motion, of a substance's particles. When a rigid container is heated, its particles speed up, so they strike the walls harder and more often, and pressure rises. That is why aerosol cans carry warnings against heating: above 50°C the pressure can rupture the metal. Cooling has the opposite effect, and pressure falls by about 7 to 14 kPa for every 5.6°C drop in air temperature, so drivers should check their tires during cold snaps. At **absolute zero**, −273.15°C, particle motion would reach its minimum.

Squeezing a Gas

When temperature stays constant, reducing the volume of a gas raises its pressure, because the same particles hit the walls more frequently in a smaller space. Irish-born chemist Robert Boyle published this relationship in 1662: halving the volume doubles the pressure. A flexible container behaves differently, since heated gas pushes the walls outward until its pressure matches the air around it, so the volume increases instead.



- **Bicycle pump** — shrinks the air's volume, raising its pressure above the tire's so air flows in
- **Scuba cylinder** — air compressed to roughly 20,000 kPa packs a diver's supply into a few litres
- **Weather balloon** — rises into thinner air, where lower outside pressure lets the helium expand

PREVIEW

Name: _____ 97

True or False Circle whether the statement is true or false.

1) Gas particles stay still until they collide.	True	False
2) Heating a sealed rigid container raises its pressure.	True	False
3) Cooling the air in a tire lowers its pressure.	True	False
4) Squeezing a gas into less volume lowers its pressure.	True	False
5) Boyle's [illegible] linked gas pressure to gas volume.	True	False

Questions [illegible] questions below.

1) Desc[illegible] how [illegible] create gas pressure in a container.

2) Predict and explain what happ[illegible] if [illegible] squeezed to half.

Visualizing Draw gas particles in a cold tire and a warm tire [illegible].

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____

Match each term to its description.

Mark ☐

Pressure ☐ ☐ Minimum-motion limit, −273.15°C

Kinetic energy ☐ ☐ What moving particles carry

Absolute zero ☐ ☐ Collision force on walls

Name: _____

Match each term to its description.

Mark ☐

Pressure ☐ ☐ Minimum-motion limit, −273.15°C

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Mark ☐

Pressure ☐ ☐ Minimum-motion limit, −273.15°C

Kinetic energy ☐ ☐ What moving particles carry

Absolute zero ☐ ☐ Collision force on walls

PREVIEW

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Name: _____ 62

Water, Ice, Steam and Vapour

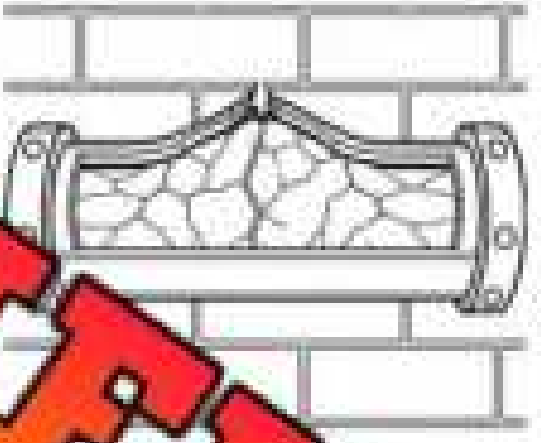
Four Forms of H_2O

Water exists as a solid, a liquid and a gas, and each state has its own particle arrangement. **Ice** is the solid state, in which molecules vibrate in fixed positions within a hexagonal framework. In liquid water, molecules slide past one another while staying in contact.

Water vapour is water in its gas state, with molecules far apart, and it is invisible. It enters the air through evaporation from lakes, soil and plants at temperatures well below 100°C. **Steam** is the visible gas produced when water boils at 100°C at sea level. The white cloud above a kettle is not steam but tiny liquid droplets formed as steam cools.

Why Ice Floats

Water is unusual because its volume increases when it freezes. As ice forms, hydrogen-bonded molecules into an open crystal. liquid water becomes about 9 per cent expansion bursts water pipes and cracks Winnipeg streets, which is how many [illegible]. Boiling causes a far bigger change: water turning to steam at atmospheric pressure expands about 1 700 times, which is why a sealed boiler needs a pressure-relief valve.



Compressibility and Hydraulics

Compressibility is a measure of how much a substance's volume decreases under pressure. Gases compress easily because their particles are far apart; liquids and solids the particles already touch. An extra 101.3 kPa shrinks liquid water's volume by only about 0.005 per cent. Engineers exploit this in **hydraulics**, technology that transmits force through a liquid.

French scientist Blaise Pascal showed that pressure applied to an enclosed fluid spreads equally in all directions. Because that pressure is equal everywhere, a piston with ten times the surface area produces ten times the force, which is how a small push can lift heavy loads.

- **Hydraulic brakes** — pedal force travels through brake fluid to every wheel.
- **Landing gear** — hydraulic lines raise and lower an aircraft's wheels.
- **Excavator arm** — pumped oil moves pistons that dig and lift soil.

PREVIEW

Name: _____ 63

True or False Circle whether the statement is true or false.

1) Water vapour forms only when water boils.	T	F
2) Steam is an invisible gas.	T	F
3) Liquids compress far more easily than gases do.	T	F
4) Hydraulic brakes send force through a liquid.	T	F
5) Freezing water expands by about 9 per cent.	T	F

Finish Complete each sentence below.

1) A water pi... because...
2) Brake fluid transmits for...
3) A kettle's white cloud is visible because...

PREVIEW

Spot the Myth One paragraph below is wrong. Circle it and explain

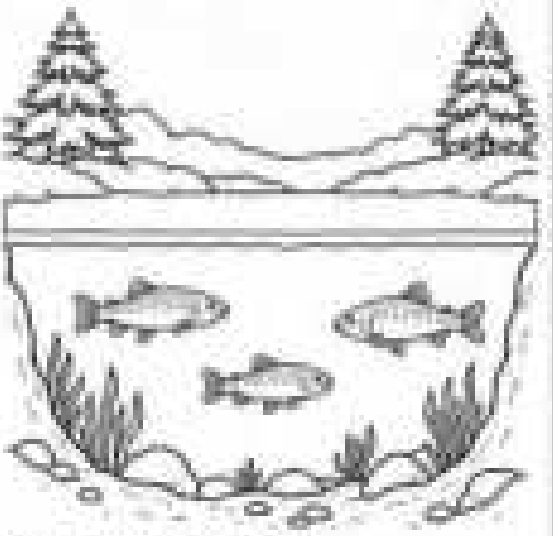
A — Steam itself is invisible; the white cloud is tiny liquid droplets that form as the hot gas cools in the air.
B — The white cloud above a boiling kettle is steam, a visible gas made of water vapour at exactly 100 °C.
C — Water vapour is found in air even on a cold day, since water evaporates from lakes and soil below 100 °C.

Name: _____ 65

Reading the Ice on Manitoba Lakes

Why Lakes Freeze From the Top

Water is densest at about 3.98°C, so as autumn air cools a lake's chilled surface water sinks until the whole lake approaches 4°C. Below that temperature, colder water becomes less dense and stays on top, where it freezes at 0°C. Ice has a density of about 0.917 g/c[illegible]er than liquid water, so it floats.



The ic[illegible] **insulator**, a material that slow[illegible] survive in the unfrozen water [illegible]ath i[illegible]ke Winnipeg, which covers 23,75[illegible] world's 10th-largest l[illegible] lake[illegible]m of shoreline freezes [illegible] ce less water must lose heat.

PREVIEW

Knowledge of Ice on the L[illegible]

The Anishinaabeg of Pimachi[illegible]ki[illegible] Heritage Site straddling the Manitoba–Ontario border, fish year-r[illegible] the l[illegible]es and rivers. They trap furbearers in winter and early spring, [illegible] hunt [illegible]u in early spring, when small groups stand on the ice. Cree hu[illegible] the [illegible]mes Bay region, outside Manitoba, report that lake ice is weak[illegible] the[illegible] has changed and that more rain falls in winter, which can form [illegible] place[illegible]nger congelation ice. Researchers working with them conc[illegible] C[illegible]ific knowledge are complementary. Scientists distinguish **con[illegible]ior**[illegible]e frozen from lake water, from **snow ice**, white ice formed when s[illegible]h holds air bubbles and is generally weaker.

Judging Ice Safely

Manitoba Public Insurance recommends at least 10 cm of good ice for walking, 12 cm for an ATV or snowmobile, 20 to 30 cm for a car and 30 to 38 cm for a truck. Thickness varies widely across one lake, and even thick ice can crack, so travellers measure the thickness often and in several places.

- **Snow cover** — insulates ice, slowing its growth, so snowy ice can be thinner
- **Moving water** — currents near river mouths and narrows keep ice thin
- **Spring thaw** — meltwater weakens ice that is still thick

Name: _____ 66

Questions

Answer the questions below

1) Explain why a deep lake freezes from the top down.

2) How can ... ice observations and scientific testing work together?

PREVIEW

True or False

Is the ... true (T) or false (F)?

1) Lake ice grows from the bottom of the ...	T	F
2) Ice floats because it is less dense than liquid ...	T	F
3) Water is densest at about 4°C.	T	F
4) Snow ice is stronger than clear congelation ice.	T	F
5) Ice insulates the water beneath it from cold air.	T	F

Sorting

Sort each action: Safe or Not Safe?

1) Walk onto 10 cm of hard, clear ice	
2) Drive a car onto 35 cm of good ice	
3) Ride a snowmobile over 8 cm of ice	
4) Park a loaded truck on 25 cm of ice	
5) Treat white snow ice like hard clear ice	

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark: _____

Circle the best answer.

1) Ice has a density of about a) 1.09 g/cm³ b) 1.00 g/cm³ c) 0.50 g/cm³ d) 0.917 g/cm³	2) Which ice forms from slush? a) Snow ice b) Congelation ice c) Glacier ice d) Hail
3) Snow cover makes lake ice a) grow faster b) grow more slowly c) turn into slush d) sink	4) Lake Winnipeg ranks as the a) largest lake in Canada b) 2nd-largest lake on Earth c) deepest lake in Manitoba d) 10th-largest freshwater lake

Name: _____ Mark: _____

Circle the best answer.

1) Ice has a density of about a) 1.09 g/cm³ b) 1.00 g/cm³ c) 0.50 g/cm³ d) 0.917 g/cm³	2) Which ice forms from slush? a) Snow ice b) Congelation ice c) Glacier ice d) Hail
3) Snow cover makes lake ice a) grow faster b) grow more slowly c) turn into slush d) sink	4) Lake Winnipeg ranks as the a) largest lake in Canada b) 2nd-largest lake on Earth c) deepest lake in Manitoba d) 10th-largest freshwater lake

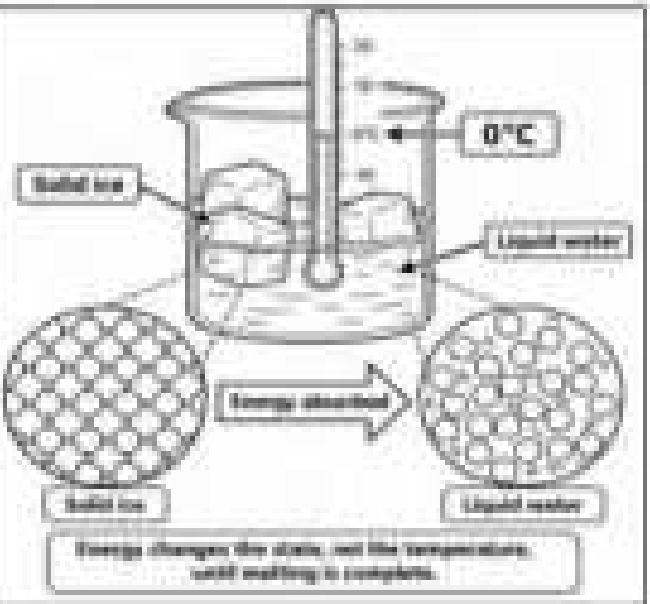
PREVIEW

Name: _____ 71

FAQ: Energy and Changing State

Frostline Ice Cream Lab — Your Questions About Energy!

Welcome to the Frostline Ice Cream Lab! Our food scientists answer the questions visitors ask most about energy and changing state.



Why does temperature stay flat while ice melts?

At the melting point, 0°C for water, added energy b[reaks] attractions holding particles in pla[ce] instead of speeding them up. Temp[erature] measures average kinetic energy, so it hol[ds] steady while solid has become liquid. The same [is] true during freezing, when energy is releas[ed].

How much energy does it take to melt ice?

Melting one gram of ice at 0°C absorbs about 334 joules (J), called the latent heat of fusion. That same energy would warm one gram of water by roughly 80°C, because water absorbs 4.18 J per gram per degree. A freezer must remove the same amount from each gram.

Why do steam burns hurt more than boiling water?

Vaporizing water absorbs about 2,260 J per gram, and steam releases all of it onto skin. Boiling water cooling from 100°C to 37°C releases about 251 J per gram, so steam delivers roughly ten times more energy than boiling water.

How does salt help freeze ice cream?

Salt dissolves in the thin film of meltwater on ice and lowers its freezing point, so the ice keeps melting and absorbing energy. A salt-and-ice brine can fall to about −21°C, cold enough to freeze the cream. Plain melting ice cannot drop below 0°C.

What is sublimation, and where is it used?

Sublimation is a change from solid directly to gas. At normal air pressure, dry ice, which is solid carbon dioxide, sublimes at −78.5°C, absorbing energy as it goes, so it chills frozen food without leaving puddles. Freezer burn is also sublimation, as ice leaves frozen food.

Why does gallium melt in a person's hand?

Gallium's particles attract one another weakly, so its melting point is only 29.8°C. Body heat, near 37°C, supplies enough energy to overcome those attractions, whereas metals with stronger attractions need far more energy to melt, so a gallium spoon melts in hot tea.

PREVIEW

Name: _____ 72

Two Choices Circle the best answer.

1) Melting ice _____ energy from its surroundings.	absorbs	releases
2) Condensing steam _____ energy onto skin.	absorbs	releases
3) While ice melts, its temperature stays _____.	flat	rising
4) Dry ice changes directly from solid to _____.	gas	liquid
5) Salt _____ the freezing point of meltwater.	lowers	raises

Questions Answer the questions below.

1) Why does melting absorb energy without getting warmer?

2) Predict why a metal with strong attractions [illegible]

PREVIEW

Word Scramble Unscramble the following words.

OALSIMBNTIU		NTRADCTSIAT	
INETICK		REIGN	
ENTLAT		ALLIUMG	

Name: _____ 74

Show and Tell – An Ice Cube Melting

Objective What are we learning about?

Students will learn to present an object that changes state and use particle theory to explain how energy transfer a[illegible] its particles during the change.



Materi[illegible] e need for our activity?

- ❑ An ice cub[illegible]
- ❑ A magnifying gl[illegible]
- ❑ Planning page
- ❑ Paper and drawing tools
- ❑ Peer compliment card

Instructions How will we complete our activity?

1) Choose an object that changes state, such as ice, candle wax o[illegible]
2) Use the criteria table to plan your presentation.
3) Answer the seven planning questions with your senses.
4) Draw your object and label the changes you observe.
5) Practise your presentation so it lasts about two minutes.
6) Present the object. Explain where the energy comes from.
7) Listen to classmates and write each one a peer compliment card.
8) Use the rubric on the last page to check your own work.

PREVIEW

Name: _____ /5

Criteria	Use the criteria below to complete the activity

Criteria	Description
Description	Describes the object using at least three senses and accurate vocabulary.
Science Ideas	Explains the change of state using energy, particles and attractions.
Evid	Uses observations or measurements, such as a temperature, as idence.
D	ly, holds the object up and stays on topic for two minutes.

PREVIEW

Example Presentation

M **dds**

Today I am showing an ice cube. I w t f minutes. At first, it was clear and hard with sharp corners. The fi r formed on the surface and the corners rounded.

It smells like nothing at all, and it feels so co As it melts it cracks and pops as trapped air escapes. The ice whole time it melted, even though the room was warmer.

Energy flows from the warm air into the ice. That energy does not raise the temperature. It loosens the attractions between particles so they leave the fixed pattern and slide past each other as liquid water.



Name: _____ 7A

Planning Page | Answer the questions below.

1) What does your object look like before warming? Describe its shape, colour, and state.	

2) Does your object have a noticeable smell? If not, record "no noticeable smell."

3) If [illegible] your object feel? How does its texture change as it warms?

4) Do you hear any sound[illegible] state?

5) What is the temperature of your object, and [illegible]?

6) Where does the energy for the change of state come from? Use particle theory to explain what this energy does.

7) How do changes of state affect everyday life? Explain one example.

PREVIEW

Name: _____ 77

Draw and Write	Draw your object before and after it changes state. Label the solid and the liquid, and show with arrows where energy flows in.



Name: _____ /8

Rubric | How did you do on the activity?

Criteria	1 Point	2 Points	3 Points	4 Points
Description	Names the object only	Uses one or two senses	Uses three senses with detail	Uses all senses with precise vocabulary
Science	Few ideas, some correct	States a change of state	Explains with energy and particles	Explains clearly and links to attractions
Evidence	[illegible]	One observation	Several observations	Observations and measurements support claims
Delivery	Hard to hear or follow	[illegible]	Clear and organized	Confident, engaging and well timed

PREVIEW

Teacher Comments

Mark

Student Comments – What Could You Do Better?

Name: _____ 79

Case Study: Pemmican

From Bison to Pemmican

Pemmican is a preserved food made from dried, pounded meat mixed with an equal mass of melted fat. The Red River Métis made it in large quantities during their organized bison hunts on the Prairies, travelling with Red River carts. After hunters butchered a bison, the lean meat was cut into thin strips, dried in the sun and smoke, and pounded into a coarse powder. The fat was **rendered**, which means it was heated gently until it melted and separated from the tissue around it. Pouring the hot fat over the powdered meat and stirring produced a thick paste that was sewn into bison-hide bags holding about 90 kilograms (kg) each.



Why Pemmican Keeps

Rendered fat [illegible] changes the behaviour of **liquid**. A liquid is a substance that flows, and **viscosity** is a measure of how easily it flows. Hot fat has particles that move [illegible] one another, so its viscosity is low and it can coat around every piece of meat. As the fat cools, particle motion slows and viscosity rises. The fat solidifies at its **melting point**, the temperature at which a substance changes between solid and liquid. The hardened fat seals out air and moisture. Drying had already removed most of the water, leaving too little for bacteria and water to grow, so a dry, sealed food resists spoilage without refrigeration.

Pemmican in History and Today

Pemmican shaped the economy and the land of the Prairies, and [illegible] it.

- **Fur trade** — Carts hauled it to Fort Garry, Norway House and Cumberland House, where it fed fur trade workers on long journeys.
- **1814** — Governor Miles Macdonell's Pemmican Proclamation banned food exports from the Red River Colony and nearly started a war with the Métis.
- **Bison loss** — Plains bison once numbered an estimated 30 to 60 million, but market hunting and a deliberate U.S. government effort to wipe them out left only 512 by 1889, ending the great hunts.
- **Today** — Métis cooks still make pemmican with bison, beef, moose or caribou, often adding saskatoon berries or cranberries.

PREVIEW

Name: _____ 80

True or False

Is the statement true or false?

1) Pemmican mixes dried meat with an equal mass of fat.	True	False
2) Rendering fat means drying it in sun and smoke.	True	False
3) No one makes pemmican today.	True	False
4) Hot melted fat has a low viscosity and pours easily.	True	False
5) Bison fell from millions to hundreds by 1889.	True	False

Questions

...the questions below.

1) Explain how dry... ...ting work together to keep pemmican from spoiling.

2) Why did the fat need to be hot when ...ured ...eat?

PREVIEW

Making Connections

Think of a food your family keeps for a long time. How is it ... from spoiling? Compare this to pemmican.

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark

List three steps in making pemmican.

- _____
- _____
- _____

Name: _____ Mark

List three steps in making pemmican.

- _____
- _____
- _____

Name: _____ Mark

List three steps in making pemmican.

- _____
- _____
- _____

Name: _____ Mark

List three steps in making pemmican.

- _____
- _____
- _____

PREVIEW

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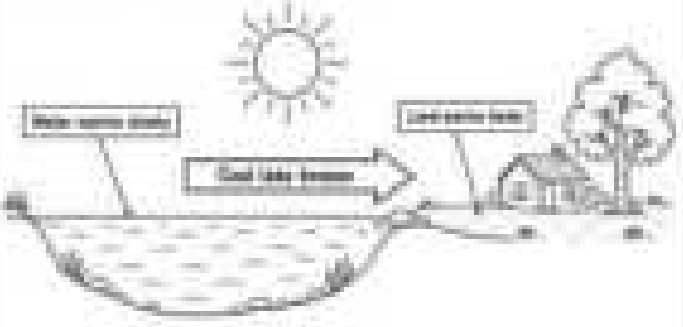
Name: _____ 82

Case: Why Lake Winnipeg Keeps Its Cool

Two Different Shores

Case 1: A Lake-Cooled Shore

On a hot July afternoon, a family at Gimli, on the western shore of Lake Winnipeg, felt a breeze blowing in off the water. The reason is the lake's **heat capacity**, the energy required to raise the temperature of 1 gram by 1 degree Celsius (°C). Water's is unusually high, 4.18 joules (J), which means Lake Winnipeg, which covers about 23,750 square kilometres (km²) and is the 10th largest freshwater lake in the world, can hold an enormous amount of heat that warms slowly. Wave action and currents mix the warmed surface water with cooler water, spreading the energy through a deep layer. Air over the lake stays cooler than the air over land, and that cooler air moves onshore as a lake breeze.



Case 2: A Swinging Inland Day

Farmland far from any big lake behaved differently on the same afternoon. Rock and dry soil have a much lower specific heat capacity: granite needs only 0.79 J to warm 1 gram by 1°C. The same sunlight therefore raises the temperature of rock more than five times as much as it raises water. By evening, the ground radiated its heat away to space just as quickly, and the clear night air dropped sharply. Air spaces in soil also slow heat moving downward, so the surface takes the full swing. Observers there saw a wide gap between the daytime high and the overnight low.



What This Teaches Us

Water's high specific heat capacity comes from the nature of its particles. Water molecules attract one another strongly, so much of the energy added goes into moving them against those attractions rather than raising the temperature. A large lake therefore acts like a thermal battery: it stores energy slowly in summer and releases it slowly in autumn, which moderates the **climate** of nearby land, meaning its typical weather over many years. The same stability protects organisms. Fish such as walleye, which cannot control their own body temperature, face gradual changes rather than sudden ones. This is also why coastal cities often have milder winters than inland cities at the same latitude.

PREVIEW

Name: _____ 83

Questions

Answer the questions below.

1) Why does a large lake cool the nearby shore in summer?

2) How would an autumn night differ at the shore and inland? Explain.

PREVIEW

This or That

1	Lake water warms quickly	or	Land warms slowly
2	Rock heats slowly in the sun	or	Rock heats fast in the sun
3	Shore towns: mild swings	or	Inland towns: wide swings
4	Water: high specific heat	or	Air: low specific heat
5	0.79 J warms 1 g of water	or	4.18 J warms 1 g of water
6	Lake keeps nights milder	or	Lake makes nights colder

Draw

Draw a lake shore town and an inland field on a hot day. Label which warms faster.

1	
2	

Name: _____ 85

Drawing – Water, Heat and Climate

Objective What are we learning about?

Students will learn to illustrate how water's high heat capacity slows temperature changes and moderat[illegible] climate of nearby land.



Mater[illegible] [illegible]ou need for the activity?

- ❑ Drawing [illegible]
- ❑ Pencils and c[illegible]d p[illegible]
- ❑ Ruler
- ❑ Eraser
- ❑ Plain paper

Instructions How will you complete the ac[illegible]

1) Read the list of drawing ideas.
2) Choose one idea you can explain with science.
3) Sketch your plan lightly in pencil first.
4) Add details that show heat moving or temperatures changing.
5) Use arrows, colour and labels to show what is warmer and cooler.
6) Use at least four words from the word bank in your labels.
7) Complete the reflection questions and the word scramble.
8) Use the criteria and rubric to check your drawing.

PREVIEW

Name: _____ 86

Reference List of drawing ideas

#	Drawing Idea
1	A sandy beach beside a lake on a hot summer afternoon
2	A cottage on the Lake Winnipeg shoreline with a cool breeze
3	Sun rays heating the sand and the water side by side
4	A th[illegible]ometer in hot sand and one in cool lake water
5	A [illegible] half to show warm water over cool water
6	[illegible]ing on a stove
7	[illegible] of w[illegible]ete[illegible]an on the same stove
8	Arrows [illegible]owing toward the land
9	A frozen lake [illegible]t
10	A desert with sand [illegible] a [illegible]
11	A cold desert night with a [illegible]
12	A map sketch of Manitoba with L[illegible]Winnipe[illegible]
13	A swimmer stepping from hot sand into [illegible]er
14	A hot water bottle warming a bed in winter
15	A mug of hot chocolate staying warm for a long time

PREVIEW

Criteria Use the criteria below to complete the activity.

Criteria	Description
Science Content	Shows how water and land heat up and cool down differently.
Labels	Labels the warmer and cooler parts with accurate words.
Detail	Includes at least five details that support the idea.
Colour	Uses warm and cool colours to show temperature differences.
Neatness	Drawing is neat, complete and easy to understand.

Name: _____ 87

Reflection

Answer the questions below.

1) Why does a lake stay cooler than the land on a hot day?

2) W[illegible]st shows heat capacity? Explain.

3) How does a large lake affect the [illegible]?

PREVIEW

Word Scramble

Unscramble the words.

APACYTIC		LESJOU	
IHLSEERNO		LIMATEC	
EDOMETAR		ORBABS	

Name: _____ 88

Rubric How did you do on the activity?

Criteria	1 Point	2 Points	3 Points	4 Points
Science Content	Idea is unclear	Shows one idea	Shows heat capacity clearly	Shows and explains effects on climate
Label	Few labels	Some labels	Most parts labelled	All labels accurate and precise
	wo	Three details	Four details	Five or more details
Colour		colour	Colour shows warm and cool	Colour used with purpose throughout
Neatness	Hard to read		ly neat	Very neat and complete

PREVIEW

Teacher Comments

ark

Student Comments – What Could You Do Better?

Name: _____ 89

Story: Journey of a Raindrop

Draw Draw pictures to illustrate the story.

Far above southern Manitoba, a raindrop was born. On a warm morning, water had evaporated from Lake Winnipeg and risen as vapour. High in the cold sky, the vapour condensed onto a speck of dust. Droplets merged until this one measured about 3 millimetres (0.1 in) across, heavy enough to fall.

PREVIEW

It dropped at roughly 8 metres per second (m/s) and splashed onto a farm field beside the Assiniboine River. Rain is **precipitation**, water that falls from clouds to the surface. As it soaked down, it dissolved carbon dioxide and became slightly acidic, like all-natural rain. Below the soil lay limestone, and the drop dissolved calcium from it, because water is the **universal solvent**, able to dissolve more substances than any other liquid.

Name: _____ 90

Days later, the long, thin root hair of a young aspen touched the water. The drop was absorbed and rose through the xylem, narrow tubes that carry water upward. Calcium travelled with it, dissolved, ready to build cell walls. Moving materials through an organism is **transport**, and water does most of it. Leaves lose much of their water as vapour through tiny pores, a process called **transpiration**, but this drop stayed inside a leaf cell.



In late summer, a white-tailed deer browsed that leaf. The drop entered the deer's digestive system and was absorbed through the wall of the small intestine into the bloodstream, the network of blood vessels. There it joined the plasma, the liquid part of blood, which makes up about 55 percent of blood volume. The plasma carried the dissolved calcium to growing bones, along with glucose and nutrients for cells. Dissolved wastes travelled in the same plasma to the kidneys, which filtered them out. Every substance moved because water dissolved it and carried it along.

By autumn, the drop had left the deer and drained into the Assiniboine River, which joins the Red River at The Forks in Winnipeg. The Red River flows north into Lake Winnipeg, and the Nelson River, the lake's only outflow, carried the drop toward Hudson Bay.



The following summer, the sun warmed the bay's surface. **Evaporation** is the change of a liquid to a gas at its surface, and it happens when the fastest-moving particles gain enough energy to escape. The drop became vapour. Warm air holds more water vapour, so the **humidity**, the amount of water vapour in the air, rose. As the moist air rose, it cooled, the vapour condensed onto dust, and a new cloud grew. Somewhere beneath it, another raindrop was about to begin the same journey, because the water cycle never stops, and the same water keeps moving between sky, land and sea.

Name: _____ 92

Ordering Put these story events in the correct order by numbering them 1 to 8.

	A root absorbed the drop into the xylem
	The Nelson River carried it toward Hudson Bay
	Vapour condensed onto dust in a cloud
	Rainwater dissolved calcium from limestone
	A deer ate the leaf and absorbed the water
	[illegible] fell as precipitation onto a field
	[illegible] heated the water into vapour
	[illegible] it into Lake Winnipeg

What Did You L[illegible] [illegible] whole story, then answer below.

1) How does water's [illegible] and animals live?

2) Why does the story end with a new cloud forming? [illegible] cycle.

Making Connections Trace a drop of tap water at home. Where might it [illegible] and where could it go next?

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Circle the correct answer.

1) Plasma is mostly:	salt / water
2) Limestone gives:	calcium / iron
3) Nelson River to:	Red River / Hudson Bay
4) Water in air:	pressure / humidity

Name: _____ | Mark

Circle the correct answer.

1) Plasma is mostly:	salt / water
2) Limestone gives:	calcium / iron
3) Nelson River to:	Red River / Hudson Bay
4) Water in air:	pressure / humidity

Name: _____ | Mark

Circle the correct answer.

1) Plasma is mostly:	salt / water
2) Limestone gives:	calcium / iron
3) Nelson River to:	Red River / Hudson Bay
4) Water in air:	pressure / humidity

PREVIEW

Name: _____ 94

Story: Salt, Sea Ice and Churchill

The Bay That Would Not Freeze

Niviaq pressed her forehead against the airplane window as Churchill, Manitoba, appeared below, where the Churchill River meets Hudson Bay. Her family was Inuit, the Indigenous people of the Arctic coast, and they had flown south from Arviat, Nunavut, to visit relatives.

Beh[illegible] aunt's house, a pond had frozen solid in November at 0 degrees Celsius (°C), but the bay beyond had stayed open for weeks longer.

"[illegible] take so long to freeze?" Niviaq asked her uncle as they walk[illegible] the sta[illegible]ary.

"Ta[illegible] the [illegible]ain," he did, wincing. "Seawater holds dissolved salt, much as [illegible]s sugar. Water is a **solvent**, a substance that dissolves others, and salt is a **solute**. Salt particles get between water particles and make it harder for them to [illegible]. We call seawater with a **salinity**, or mass of dissolved salt, of 35 parts per thousand, and it freezes at about −1.8°C."

"Hudson Bay is less salty than [illegible]," he added, "because about 700 cubic kilometres (km³) of river water flow into it every year. It still freezes below 0°C."

At the ice edge, he chipped out a block. [illegible] patches through it. "Those pockets are **brine**, water so salty it stays liquid even [illegible]es, the salt does not join the crystals. It is squeezed into pockets."

"This winter's ice might grow 30 to 150 centimetres [illegible]," he continued. "In the Arctic, ice that lasts a summer loses brine, so it grows harder and stronger. As ice cools further, part of its brine freezes and the rest grows saltier."

"Inuktut has dozens of words for the form, type, location and age of sea ice," he said. "Inuit have read ice this way for generations to travel and harvest safely, and we still do."

Niviaq nodded slowly and studied the white sheet that covered much of the 1,230,000 square kilometres (km²) of Hudson Bay, which stays largely frozen from mid-December to mid-June. It was not simply frozen water. It recorded salt, temperature and time.



Dissolved salt makes it harder for ice crystals to form.

PREVIEW

Name: _____ 95

Ordering Number these events 1 to 8 in the order they happened in the story.

	Niviaq tasted the seawater and winced
	Her uncle chipped a block from the ice edge
	Niviaq flew south to visit relatives in Churchill
	She looked across the frozen bay and understood
	H[illegible] explained that Inuktut names many ice types
	[illegible] by the bay froze later than the pond
	[illegible] how salt lowers freezing point
	He sh[illegible] in the ice

Question Why [illegible] the bay? Explain.

Visualization Draw the ice block and its brine pockets. Add la[illegible]

PREVIEW

Name: _____ 97

Role-Play – Salt, Ice and Solutions

Objective What are we learning about?

Students will learn to explain how salt dissolves in water and lowers its freezing point by acting out everyday [illegible].



Materials [illegible]eed for our activity?

- ❑ Scenario [illegible]
- ❑ Scissors
- ❑ Role-play criteria [illegible]
- ❑ Pencil

Instructions How will we complete our activity?

1) Work in groups of three or four students.
2) Cut out the scenario cards and have each group select a [illegible]
3) Draw one card and read it aloud together.
4) Decide who will play each part in your scenario.
5) Plan a short scene of about two minutes that ends with a decision.
6) Use science words such as solute, solvent, brine and freezing point.
7) Perform for the class. The audience says the science idea they saw.
8) Fill out the My Role page.
9) Write the acrostic poem and use the rubric to check your work.

PREVIEW

Name: _____ 98

Criteria Use the criteria below to complete the activity.

Criteria	Description
Science Ideas	Explains the science using accurate ideas about solutions.
Vocabulary	Uses words such as solvent, solute, brine and salinity.
Team	Every group member has a clear part in the scene.
Proble	Group reaches a decision supported by evidence.
P	clearly and stays in the role.

Scenario Cards ut th below.

Scenario		Description
1	**Icy Road**	The class is on a ... the driver explains that crews spread ... student asks why the ice melts even ... below freezing. Others are not sure ... ould the group explain it using freezing p...
2	**Ice Cream**	A family is making ice cream in a bucket packed with ice. Someone adds rock salt to the ice, and the bucket becomes colder than the ice alone. Another person thinks the salt must be adding cold. How should the group explain what is going on?

PREVIEW

Name: _____ 99

Scenario Cards Cut out the scenarios below.

	Scenario	Description
3	**Sea Ice**	A group of students compares a piece of lake ice with a piece of frozen seawater from a science kit. The seawater ice feels slushier and breaks apart more easily. Someone says both should be identical. How should the group explain the difference?
4	**Salty Swim**	[illegible] friends visits a very salty lake and notices [illegible] higher than in their home pool. [illegible] water is somehow stronger. How cou[illegible] group [illegible] what they notice?
5	**Sugar Stir**	At a camp kitchen, som[illegible] sug[illegible] hot tea and it seems to disappear. A you[illegible] ca[illegible] sugar is gone for good. Another pe[illegible] test it. How could the group show that the sug[illegible] still there?
6	**Pasta Pot**	A family is cooking pasta, and someone wonders if adding salt to the pot makes the water boil faster. Others have heard it raises the boiling point. What should the family test, and how would they do it?

PREVIEW

Name: _____ 100

Scenario Cards | Cut out the scenarios below.

	Scenario	Description
7	**Stream Water**	After a hike, a group of friends notices that the stream water is clear. Someone says nothing is dissolved in it because nothing can be seen. How could the group show that dissolved minerals are in the water?
8	**Fish Tank**	[illegible] is setting up two aquariums, one for [illegible] and one for ocean fish. Someone says [illegible] work for both. Another says the [illegible] at should the group decide, and why?
9	**Brine Pockets**	A group of scientists [illegible] small pockets of very salty liquid [illegible] sks why the brine stays liquid when ev[illegible] it is frozen. How should the group explain th[illegible]
10	**Freezer Test**	A group of friends leaves cans of pop, juice and plain water in a freezer. The plain water freezes solid first, while the sweet drinks stay slushy. Someone says the freezer is broken. What should the group say?

PREVIEW

Name: _____ 101

My Role | Draw yourself in your role. Add a speech bubble that states one science fact you used in your scene.



Name: _____ 102

Reflection Create an acrostic poem using the word provided below. Your poem should relate to the word shown.

S	
O	
L	
U	
T	
I	
O	
N	

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Name: _____ L03

Rubric How did you do on the activity?

Criteria	1 Point	2 Points	3 Points	4 Points
Science Ideas	Mostly incorrect	Some correct ideas	Accurate ideas	Accurate, detailed and well linked
Vocabu	No science words	One or two words	Several words used correctly	Many words used precisely
Team		Some shared parts	Most shared parts	Everyone contributed equally
Problem Solving			Decision with a reason	Decision backed by strong evidence
Presentation	Hard to follow	Partly cl		Clear, confident and creative

PREVIEW

Teacher Comments

Student Comments – What Could You Do Better?

Name: _____ 104

Interview: A Materials Scientist



Student: What does a materials scientist do?

Dr. Reyes: I study **materials**, the substances things are built from, and test strength, hardness and density to match each to a job.

Student: [illegible] density matter?

Dr. R[illegible] per unit volume. Alum[illegible] 2.70 [illegible] steel is 7.85 g/cm³, so an aluminum [illegible] of the mass.

Student: Why not [illegible]?

Dr. Reyes: Density is only [illegible] **strength-to-weight ratio**, the load a material carries for [illegible].

Student: Has this changed vehicles [illegible] roads?

Dr. Reyes: Yes. Ford's 2015 F-150 changed [illegible] became up to 700 pounds (about 318 kg) lighter, which saves [illegible]

Student: What is an alloy?

Dr. Reyes: An **alloy** is a metal mixed with other elements. Addi[illegible] silicon gives 6061 aluminum, with the 2.70 g/cm³ density.

Student: What about plastics and composites?

Dr. Reyes: A **composite** joins two materials. Carbon-epoxy has a density near 1.58 g/cm³, and half a Boeing 787's airframe mass is composite.

Student: How do you find a sample's density?

Dr. Reyes: I weigh it on a balance, get volume by displacement, then divide. A 54 g block displacing 20 cm³ has $d = 2.7$ g/cm³.

Student: Thank you! Now I see how design is guided by density.

PREVIEW

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Name: _____ 105

Fill in the Blanks

Circle the missing word.

1)	An _____ is a metal mixed with others.	composite	alloy
2)	Steel is _____ dense than aluminum.	more	less
3)	Density equals mass _____ volume.	divided by	times
4)	Alum[illegible]nels lower a truck's _____.	mass	strength
5)	A [illegible] an object's _____.	mass	volume

Questions

[illegible] below.

1) Why compare stre[illegible]ct density alone?

2) Why might a bike maker pick carbon-epoxy [illegible] of st[illegible]e?

PREVIEW

Think

The student interviewed Dr. Reyes about materials. What would you ask next about choosing a material for a hockey stick?

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ Mark ☐

Match each material to its density.

Steel ☐	☐ plastic-fibre blend, 1.58 g/cm³
Aluminum ☐	☐ light metal near 2.70 g/cm³
Carbon-epoxy ☐	☐ iron alloy near 7.85 g/cm³

Name: _____ Mark ☐

Match each material to its density.

Steel ☐	☐ plastic-fibre blend, 1.58 g/cm³
Aluminum ☐	☐ light metal near 2.70 g/cm³
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Name: _____ Mark ☐

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Name: _____ Mark ☐

Match each material to its density.

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Aluminum ☐	☐ light metal near 2.70 g/cm³
Carbon-epoxy ☐	☐ iron alloy near 7.85 g/cm³

PREVIEW

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Name: _____ 107

Newspaper Article: Humid Heat and Storm Warnings

Humid Heat Brings Storm Watch to Southern Manitoba

Publish Date: August 5, 2026

WINNIPEG — A warm, moist air mass settled over southern Manitoba on Wednesday, prompting Environment and Climate Change Canada to issue a severe thunderstorm watch for the Red River Valley. By mid-afternoon, at 3 p.m., the air temperature at Winnipeg James Armstrong Richardson International Airport reached 31°C, while the dew point, the temperature to which air must be cooled before water vapour condenses, climbed to 23°C.

Most people in temperate climates find a dew point above 21°C oppressive, and Wednesday's reading produced a humidex of 41, which Environment Canada ranks as "great discomfort." **Humidity** is the amount of water vapour in the air, and warm air can hold far more of it: air at 30°C can carry up to 30.4 grams of vapour per cubic metre, while air at 20°C holds only 17.2 grams. With a dew point 8°C below the air temperature, relative humidity was about 62 per cent, since each 1°C gap lowers it by roughly 5 per cent from 100. Humid air also slows the evaporation of sweat, so the body sheds heat less efficiently. The highest humidex ever recorded in Canada, 52.6, was measured in Carman, Manitoba, on July 25, 2007.

As heated air rises, it cools toward its dew point, and the vapour condenses into cloud droplets. Forecasters expect this lifting to build towering clouds that release **precipitation**, water that falls from clouds as rain or hail. Marta Olenick, who farms canola near Portage la Prairie, said, "The air felt like a wet towel by noon. I brought the cattle in from pasture and parked the tractor in the shed, because this kind of heat usually ends in a storm."

A cooler, drier air mass is forecast to arrive on Thursday, bringing clear skies after the storms pass. Overnight lows are expected to fall below 15°C. Until then, residents of the region are advised to limit strenuous outdoor activity and exercise outdoors in the early morning, stay away from windows, and monitor local media for updates by checking alerts from Environment and Climate Change Canada.

PREVIEW



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Name: _____ 108

True or False Is the statement true or false?

1) Air cooled to its dew point begins to condense.	True	False
2) A dew point above 21°C feels oppressive to most.	True	False
3) Warm air holds less water vapour than cool air.	True	False
4) Carman, Manitoba recorded Canada's top humidex.	True	False
5) Humid [illegible] sweat evaporate faster.	True	False

Questi[illegible] [illegible]estions below

1) Explain ho[illegible] air [illegible] cloud droplets and rain.

2) Why can a humidex feel hotter than [illegible]temp[illegible]?

Opinion Write a comment for the newspaper website: how [illegible]pare for a humid, stormy day?

Username: _____ Date: _____

PREVIEW

Exit Cards

Cut Out Cut out the exit cards below and have students complete them at the end of class.

Name: _____ | Mark

Two are true. Circle the lie.

	Precipitation includes rain and hail.
	A humidex of 41 is ranked as little discomfort.
	Rising air cools and its vapour condenses.

Name: _____ | Mark

Two are true. Circle the lie.

	Precipitation includes rain and hail.
	A humidex of 41 is ranked as little discomfort.
	Rising air cools and its vapour condenses.

Name: _____ | Mark

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	Precipitation includes rain and hail.
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Name: _____ | Mark

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Name: _____ | Mark

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	Precipitation includes rain and hail.
	A humidex of 41 is ranked as little discomfort.
	Rising air cools and its vapour condenses.

PREVIEW

Name: _____ 11s

Unit Test
Matter

Mark	/

Part 1 Circle the correct answer for each question.

1) What is the density formula?

A) d = v / m

B) d = m × v

C) d = m / v

D) d = v × m

2) Which has the highest density?

A) Osmium

B) Gold

C) Iron

D) Lithium

3) An ice cube floats...

A) denser than the fluid

B) less dense than the fluid

C) heavier than the fluid

D) colder than the fluid

4) Heating a gas makes particles...

A) stop moving

B) move slower

C) join together

D) move faster

5) Viscosity is resistance to...

A) heat

B) light

C) flow

D) mixing

6) Colder water will is...

A) [illegible] cool

B) [illegible] vis

C) less

D) a gas

7) Most compressible state?

A) Liquid

B) Solid

C) Gas

D) Ice

8) Water stores heat...

A) poorly

B) never

C) only as steam

D) very well

9) Ice floats because it is...

A) less dense than water

B) denser than water

C) hotter than water

D) made of salt

10) Sea water freezes...

A) at exactly 0°C

B) below 0°C

C) above 0°C

D) never

PREVIEW

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Part 2	Define each of the terms below.	Mark	/

Term	Definition (what does it mean)
Density	
Viscosity	
Volu	

Part 3	...tions below.	Mark	/

1) A metal object has a mass of 150 ... cm³. Calculate its density and include the correct unit.

2) How does the movement of gas particles change when a se... is heated?

3) Why does ice float on liquid water even though both substances are made of the same molecules?

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Part 4	Answer the long answer question below.	Mark	/

A student places two objects of equal volume into a container of water. One floats while the other sinks. Explain how density and buoyancy determine what happens to each object. Describe how the student could calculate their densities to support the observations.

PREVIEW

Part 5	Draw three containers of water. Show an object floating, one sinking first, sinking in the second, and remaining suspended in the third. Label the densities of the objects and water. Add arrows showing gravity and buoyancy.