Workbook Preview

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Grade 8 Science Unit

Systems in Action

D1 - Relating Science and Technology to Our Changing World
D2 - Exploring and Understanding Concepts

	Curriculum Expectations	Pages
D1.1	assess the social, economic, and environmental impacts of automating systems	93-102
D1.2	assess the impact on individuals, society, and the environment of alternative ways of meeting needs that are currently met by existing systems, taking different points of view into consideration	21-22, 102
D2.1	identify various types of systems	9-14
D2.2		-14
D2.3		23-24
D2.4		69-74, -83
D2.5	work, force, and displacement in simple systems	42-45, 49-52
D2.6	explain the relationship between input and output forces and determine the mechanical advantage of various mechanical systems, including simple machines	53-60, 63-65
D2.7	identify ways in which energy can dissipate from mechanical systems, and describe technological innovations that make these systems more efficient	67-68, 75-77, 80-81, 86-87
D2.8	explain how providing information and support to consumers helps to ensure that the systems they use run safely and efficiently	69-74, 82-83, 88-92
D2.9	describe technological innovations involving mechanical systems that have increased productivity in various industries	93-102
D2.10	identify social factors that influence the evolution of a system	97-102

Preview of 80 pages from this product that contains 185 pages total.

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Grade 8 Science Unit

Strand A - STEM Investigation and Communication Skills

	Curriculum Expectations	Pages
A1.1	use a scientific research process and associated skills to conduct investigations	112-116
A1.2	use a scientific experimentation process and associated skills to conduct investigations	46-48, 78-79, 84-85
A1.3	use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems	61-62
A1.4	follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials	46-48, 61-62, 78-79, 84-85
A1.5	communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes	46-48, 61-62, 78-79, 84-85
A2.1	write and execute code in investigations and when modelling concepts, with a focus on automating large systems in action	103-111, 113-114
A2.2	identify and describe impacts of coding and of emerging technologies, such as artificial intelligence systems, on everyday life, including skilled trades	103-104, 109-111, 113-114
A3.1	describe practical applications of science and technology concepts in various occupations, including skilled trades, and how these applications address real-world problems	103-104, 112, 115
A3.2	investigate how science and technology can be used with other subject areas to address real-world problems	103-104, 112, 115-116
A3.3	analyse contributions to science and technology from various communities	103-104, 112, 115

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SYSTEMS IN ACTION



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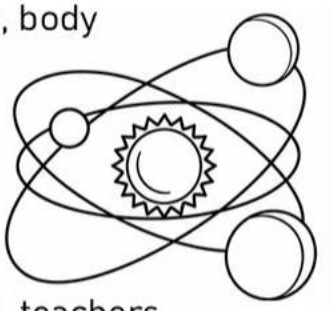
Curriculum Connection
D2.1

What is a System?

What is a System?

A **system** is a collection of components that work together for a common purpose. There are systems everywhere in our lives. We have school systems, body systems, mechanical systems, political systems, health care systems, and many more. These systems are designed to serve a purpose and we are always trying to make these systems better.



Examples of Systems

School Systems

A school system has many different components, including students, teachers, educational assistants, administrators, schools, and so much more. The components in the school system work together, which allows the overall purpose of the system to be fulfilled.

The purpose of the school system is to help each individual student develop so they can navigate life and contribute to society when they are older. The school system is changing and evolving all the time, to get better at serving that purpose. For example, the Ontario math program now includes financial literacy as its importance is now understood in preparing students for life outside of school.

Mechanical System

We also have **mechanical systems**, which are made up of physical components that are organized together to serve a purpose. Examples of mechanical systems include heating and cooling systems, vehicles, computer systems, and bicycles.

A heating and cooling system has the purpose of providing heat when it is cold, and cool air when it is hot so that we can be comfortable. The components of a heating and cooling system are often a furnace, air conditioner, thermostat, air handler, and condensing unit.

Body Systems

Our **body systems** are sets of organs and tissues that work together to serve a purpose. Our circulatory system is comprised of the heart, veins, arteries, and blood. Its purpose is to deliver oxygen and nutrients to cells throughout the body.



Other body systems include the skeletal system, muscular system, lymphatic system, respiratory system, nervous system and digestive system. These systems often work together and depend on each other in order to serve their purpose. For example, the circulatory system works with the respiratory system to deliver oxygen and remove carbon dioxide from the body.

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Curriculum Connection
D2.1

Questions

Use information from the text to support your answer.

1) What is a system? Are all systems perfect?

2) What is a technological system? What are some examples?

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Making Connections

Describe a system you know well – Ex. Minor hockey, cars, etc.

True or False

Circle whether the statement is true or false.

1) A computer is a system made of many computer parts.	True	False
2) My heart is a system with a lot of parts in it.	True	False
3) My heart is one part of my circulatory system.	True	False
4) My education is provided by the school system.	True	False
5) The justice system has police officers, lawyers, judges to keep us safe.	True	False

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Curriculum Connection
D2.3

Research – HVAC System

HVAC stands for heating, ventilation, and air conditioning. HVAC systems supply homes and businesses with the ability to control the temperature, humidity, and purity of their air. The purpose of an HVAC system is to provide comfortable temperatures and acceptable air quality.



Research Learn about the components of an HVAC system.

1) What [illegible] components of an HVAC system?

2) Write each component [illegible] left colu[illegible] hat each component's function is in the right column.

Component	Function [illegible] at It Does

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3) What is the process of the system? How does it work? Use the names of the components to describe the process.

4) What makes an HVA[illegible] What makes it inefficient?

5) Draw a diagram of an HVAC system. Label the components [illegible] the

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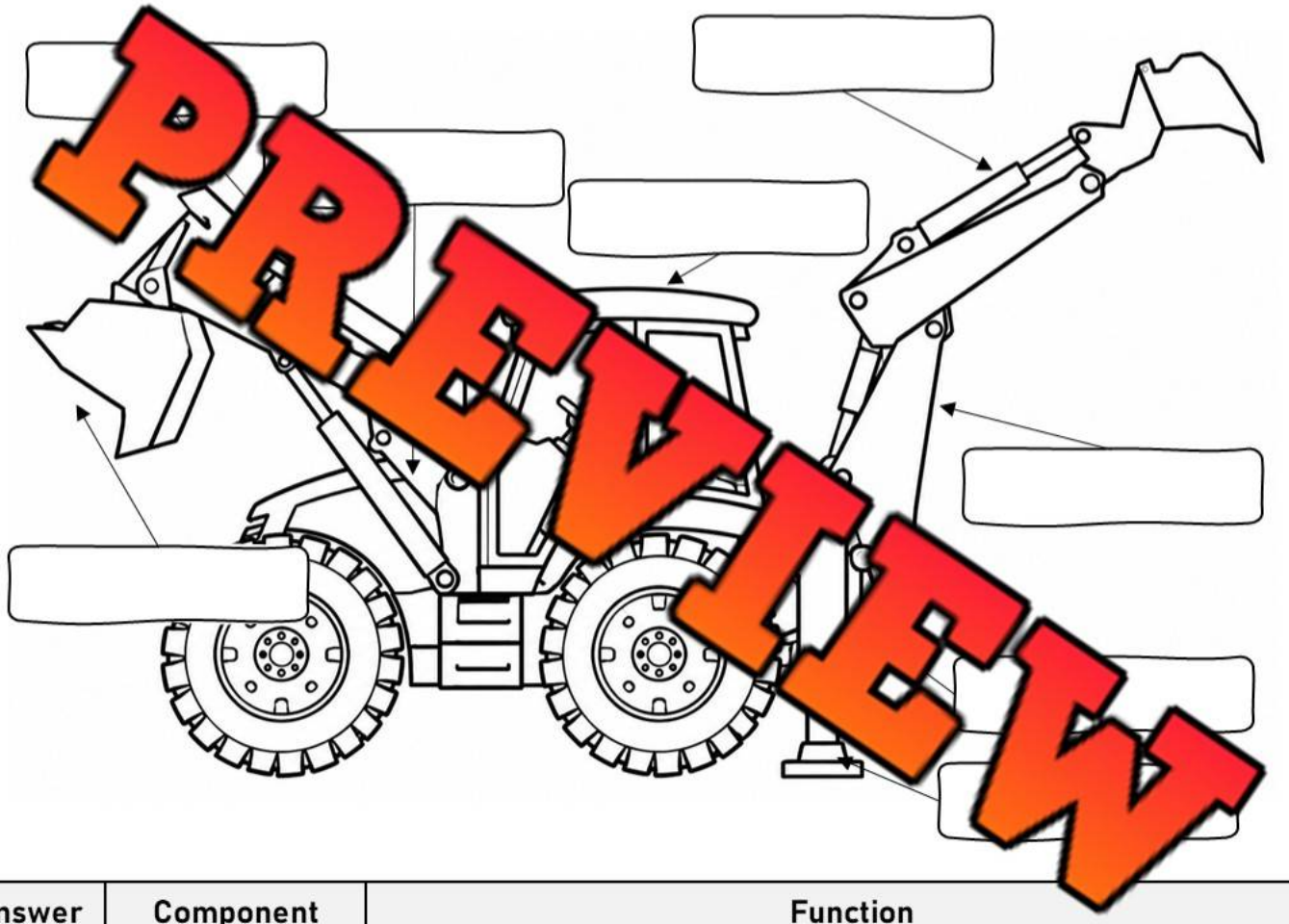
Curriculum Connection
D2.3

Components of a Backhoe

Diagram Label the diagram of the backhoe using the components from the word bank.

Stabilizer	Swing Tower	Boom	Engine
Linkage	Bucket Loader	Hydraulics	Cab Enclosure



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Answer	Component	Function
	Stabilizer	a) Creates power for the backhoe
	Swing Tower	b) Long arm that is used to move and lift the bucket
	Boom	c) Allows the front bucket to move up and down
	Engine	d) Gives the backhoe more support preventing it from flipping
	Linkage	e) Provides even more power to the front and back buckets
	Bucket Loader	f) Allows the backhoe to turn
	Hydraulics	g) Protects the driver from weather or falling debris
	Cab Enclosure	h) Used to scoop up materials and hold them to be dumped

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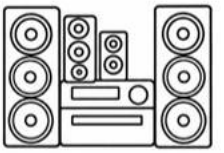
Activities - Systems



Word Search

Find the words from the word bank.

System	Purpose	Input	Output	Needs
Components	Function	Processes	Industry	Manufacturing
Politi	Environment	Social	Economy	Productivity

W I K S P R O D U C T I V I T Y R P
I U I A P H Z N G Y B U P L W U O O
Z Y O Y S Y T T C A Z U A H C E L
A Q I T F T X M B H R I S S Z I
K P T T P K I T R Y P C A D Y T
T O C T X H M L B C V O O Z E M I
E X N U O U T P U B N S S F E O C
E S U P R O C E S S E A E Y E N N S
J D F N M A N U F A C T U R I N G R O H
E N V I R O N M E N T O C F C H
K P W U V L P X C O M P O N E N G

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Word Scramble

Unscramble the words from the word bank.

AISCLO		UTNPI	
PTUUOT		URNDYSIT	
NCAMUUAFRNGTI		ETPNSMONOC	
OCTIFNNU		SETYMS	
PSOPEUR		TNINNMEOREV	

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Curriculum Connection
D2.4

Types of Energy

Types of Energy
There are many forms of energy in the world. Here are some examples of the main forms of energy we see.



Chemical Energy
Chemical energy is stored in matter. **Matter** is everything around us that has m[illegible]nd takes up space. Therefore chemical energy is stored in things l[illegible] batteries, and gasoline. Chemical energy can produce thermal [illegible]. Wood contains chemical energy that is stored in the wood. Wher[illegible]s b[illegible] the chemical energy that was stored in the wood turns into therm[illegible]ergy a[illegible]

Electrical Ene[illegible]
Electrical energy [illegible]es e[illegible]chines to work. When we plug in our favourite electronic, t[illegible] pl[illegible]rovides electrical energy. Electrical energy comes from othe[illegible]of e[illegible] the burning of fuels or the energy from natural resources like fl[illegible] dam[illegible]er. Thermal energy is often released when electrical energy is us[illegible] abo[illegible] a TV gets hot or how a cell phone will heat up after being used fo[illegible]ong tim[illegible]

Thermal Energy
Thermal energy is energy that is moved betwee[illegible] o[illegible]n hotter than the other. Thermal energy actually creates wind as t[illegible]ment [illegible] from warmer areas to cooler areas causes wind. This energy [illegible]ha[illegible]ind turbines. The sun's thermal energy produces these winds.



Mechanical Energy
Mechanical energy is the energy that is possess[illegible] by an object due to its motion or position. Wind turbines are a form of mechanical energy because they move or will move when the wind acts on it. A drawn bow and arrow has mechanical energy in the form of elastic potential energy.

Nuclear Energy
Nuclear energy comes from splitting atoms in a reactor. **Atoms** are the smallest unit of matter. All solids, liquids, and gases are composed of atoms.

There is potential energy inside of atoms that can be used to heat water into steam, which can turn a turbine. This allows electricity to be made. Nuclear fission is the process of splitting atoms resulting in the release of energy.

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Curriculum Connection
D2.4

Questions

Use information from the text to support your answer.

1) What is chemical energy? When have you used chemical energy?

2) What is [illegible] energy?

PREVIEW

Questioning

Write 3 questions you [illegible] reading.

1)	
2)	
3)	

Type of Energy

What are the types of energy below?

1. Energy that is stored in atoms	Electrical	Nuclear
2. When energy moves from one object to another	Heat	Chemical
3. Using a portable battery in my phone	Chemical	Mechanical
4. Solar energy from a solar panel on someone's roof	Mechanical	Electrical
5. Plugging in my T.V. to a wall outlet	Mechanical	Electrical

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Curriculum Connection
D2.4

Non-Contact Forces

What Are Forces?

Forces are a push or a pull that causes the movement of an object. Forces can be non-contact or contact forces. A **non-contact** force acts on an object without touching it. Examples of non-contact forces are gravitational force, electrostatic force, and magnetic force.

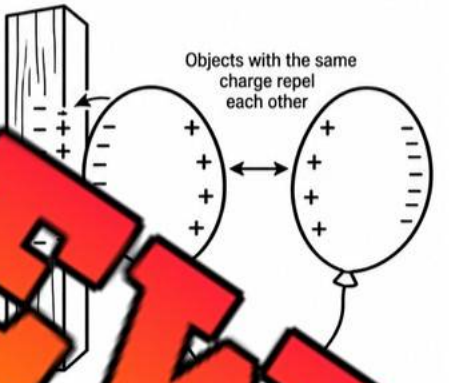
Gravitational Force

Gravity is a non-contact force that attracts matter towards the centre of the earth. Without gravity holding us, we would fall right off the Earth's surface and float away! Gravity is the reason why when you throw a ball into the air, it comes back down. When you throw a ball, you are applying a pushing force by pushing it into the air. Gravity's force is pulling harder than yours, which means the ball will come back down instead of going higher.

Our weight is the force on gravity. Weight is the measurement of the force of gravity pulling us down. This means our weight is how hard gravity is pulling us towards the Earth's surface. On other planets, we weigh a different amount because their gravitational pull is stronger or weaker.

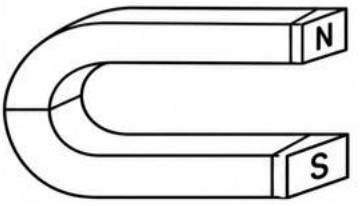
Electrostatic Force

Electrostatic forces are the attractive or repulsive forces between two electrically charged objects. When electrical charges move from one object to another, they produce static electricity.



Picture this, you rub your hair against a balloon. The negative charges in your hair move to the balloon causing more negative charges in the balloon. The extra negative charges on the balloon create what is called a buildup of negative charges. You can't see the extra negative charges but try bringing that balloon near a wall. The negative charges in the balloon will become attracted to the positive charges in the wall and they will stick together.

Magnetism



You've seen magnets and how helpful they can be. We use them for many purposes, including sticking things on our fridge. They work because of magnetism. **Magnetism** is an invisible force or field that either pushes or pulls certain objects.

A magnet is an object that is affected by the magnetic field. Magnets have a north and a south pole. You can attach two magnets by putting opposite poles together, but if you try to put the same poles together, they will repel each other.

Magnetism is a force because it pulls and pushes objects if they are made of a magnetic material. Magnetic materials are metals made from iron, nickel, cobalt and many more.

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Curriculum Connection
D2.4

Questions
Use information from the text to support your answer.

1) What is a non-contact force? What are some examples?

2) What is [illegible]atic force? How is a balloon sticking to a wall an example?

PREVIEW

Making Connections
When have you [illegible]ch of the non-contact forces?

Gravity	
Electrostatic	
Magnetism	

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

1) Gravity works because particles in matter either attract or repel.	True	False
2) A balloon will stick to a wall because they have the same charge.	True	False
3) Magnetism is a force that can either attract or repel two magnetic materials.	True	False
4) A compass works because of magnetism.	True	False
5) When a wool sweater sticks to your skin, it is because of gravity.	True	False

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D2.4

Research – How a Compass Works

The compass was invented a long time ago, to help sailors navigate their travels on oceans. Learn more about how a compass works by researching it below.



Research Answer the questions below.

1) What y[illegible]e compass invented?

2) Was GPS use[illegible]tim[illegible]eriod? Why was the compass so important?

3) Which non-contact force is used for this technology[illegible]

4) How does a compass work?

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Curriculum Connection
D2.4

5) Draw a diagram of a compass. Show where the north and south magnetic poles are located on the Earth in relation to the compass.

PREVIEW

6) Is the Earth's magnetic north pole at its geographic no Ex

7) Have you ever used a compass? If so, explain. If not, when would one be useful?

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D2.4

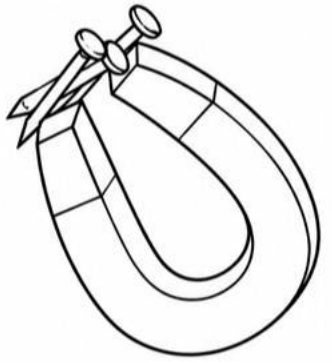
Examples of Non-Contact Forces

Examine Describe the non-contact forces at work in the pictures below.

1)



2)



3)



4)



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D2.4

Contact Forces

What are Contact Forces?

A **contact force** is any force that needs contact between objects. For example, kicking a soccer ball is a contact force because the force moving the soccer ball needed contact between the force and the soccer ball. The leg kicking the ball created the contact force, which performed work by moving the soccer ball.

Types of Contact Forces

- Friction Force

The force exerted by the surfaces of objects that move across each other. Friction usually opposes the motion of an object sliding across another object. Friction is important, as it allows objects to move around without slipping. Some materials have surfaces that create a lot of friction, like rubber, which is why shoes have rubber soles on the bottom.

- Tension Force

The force that is transmitted through a string, rope, or wire when it is pulled by forces acting on opposite sides. The force is directed over the length of the wire and it pulls equally on the objects at both ends. Suspension bridges use wires to create tension forces that spread the forces acting on the bridge equally throughout the bridge, allowing it to support larger forces.



- Normal Force

A normal force is the everyday force that is felt when a surface pushes backward against an object that is placed on that surface. For example, a water bottle resting on a table is being supported by the stable table, which is exerting an upward force on the bottle in order to support its downward gravitational force.

- Air Resistance Force – Drag Force

Air resistance is the force that is caused by air acting in the opposite direction to an object moving through it. For example, a large truck will experience more air resistance forces than a sports car with a streamlined shape.

- Applied Force

An applied force is the force that is the result of the interaction between two or more objects. Examples include a person lifting a box or rotating a doorknob. Applied forces are the forces we use everyday to move objects.



- Spring Force

A spring force is the force exerted by a compressed or stretched spring upon any object that is attached to it. The compressed spring has potential energy in it that exerts a force on anything struck by its movement. Examples include a pogo stick, trampoline, or keys on a keyboard.

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Curriculum Connection
D2.4

Definitions

What do each of the contact forces mean?

Applied	
Tension	
Air Resistan	
Norm	
Frictional	

PREVIEW

Making Connections

W ct for you use often? Give at least 2 examples.

Matching

Match the example with the force at work.

Answer	Force	Example
	Applied	a) They subtract time from Ben's 100m race because of this force.
	Tension	b) A boat is secured to a dock with ropes.
	Air Resistance	c) There is less of this force when walking on ice.
	Normal	d) Angela pulls her suitcase to her hotel.
	Frictional	e) The computer rests on the desk.

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D2.4

Examples of Contact Forces

Examine Describe the contact forces at work in the pictures below.

1)



2)



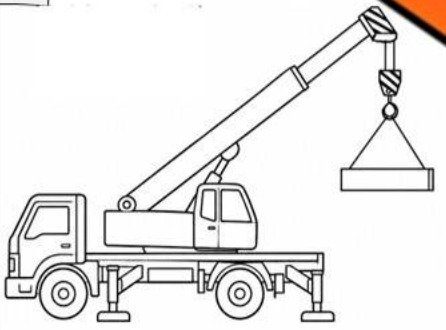
3)



4)



5)





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Curriculum Connection
D2.4

Physics – Describing Using Scientific Terms

Examine	What examples of the terms below do you see in the picture?



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Energy (Kinetic/Potential, Mechan[illegible], T[illegible] Elec[illegible]

_____

_____

_____

Work – What work is being done in the picture?

_____

_____

_____

Forces – What Contact and Non-Contact forces at acting on the objects in the picture?

_____

_____

_____

_____

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Curriculum Connection
D2.5

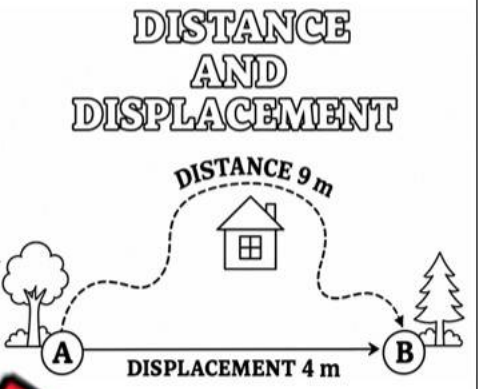
Describing Displacement

Displacement vs Distance

The terms displacement and distance are commonly confused terms in physics. Distance is what is known as a scalar quantity, while displacement is a vector quantity.

Scalar means the quantity can be fully described by a magnitude (numerical value) alone. For example, If you ran 5 km, the scalar value of the magnitude of your run would be 5 km. This is the distance you travelled, and it does not depend on any other vari

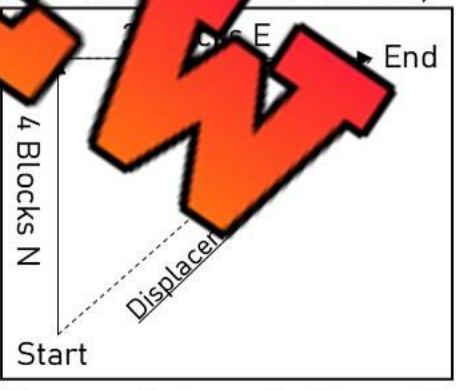
Vect s the quantity is fully described by both magnitude and direction. Both of t are needed to determine the vector quan vector quantity that tells us how fa of pla t is or the overall change in its position.



The 5 km vent o described using distance and displa nt. T 5 km, but the displacement is likely when you likely did not run in a straight li an 5 ircle, your displacement is 0 km, becaus wa your position. If you ran 5 km to your f use, distance from where you started to yo end's h is the displacement.

Examples of Displacement and Distance

- A track and field athlete runs 10 laps on a 400 m t ir tota nce is 4 km, but their total displacement is 0 metres.
- Sydney runs four blocks north and three blocks east. The distance she ran is seven blocks total. This is a scalar quantity calculated by adding the values together. The total displacement is five blocks, which was calculated using the Pythagorean theorem, $4^2 + 3^2 = 25^2$ or 5 as 5 is the square root of 25^2.



- Emma drives 10 km north to a friends house to pick her up. They drive back to Emma's house and then drive 5km south to go to the mall. Emma's car has traveled a total distance of 25 km. Emma's car's total displacement is -5 km.

  The starting coordinates are Emma's house, at 0,0 on a coordinate plane. The reason she is -5 km away is because the frame of reference that was chosen to situate Emma's friends house at +10 km away. In other words, we could switch this to her friend's house being -10 km away, in which case her car's total displacement would be +5 km.

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Curriculum Connection
D2.5

Scalar or Vector?

Are the quantities scalar or vector?

1) Roger biked 12 kilometres.	Scalar	Vector
2) Sam drove 75 kilometres north and 25 kilometres west.	Scalar	Vector
3) Courtney ran 800 m in 4 minutes.	Scalar	Vector
4) Cheryl boated 25 km north and then 25 km south.	Scalar	Vector
5) Stephan[illegible]rove 50 km south to work.	Scalar	Vector

Questio[illegible]

[illegible]ation from the text to support your answer.

1) What is the [illegible]we[illegible]alar and vector quantities?

2) When you tell someone how far you [illegible] are u[illegible]alking about distance or displacement? Explain.

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Calculate

Determine the total displacement and distance in the examples below.

Example	Distance	Displacement
1) 100 m north, 50 m south		
2) 500 km east, 300 km west		
3) 300 m north, 200 m south, 150 m north		
4) 1000 m west, 2 km east, 1500 m west		
5) 250 km north, 500 km south		

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D2.5

Calculating Displacement



Calculate Draw a diagram and calculate the displacement and distance.

1) 5 km north, 10 km south, 8 km north	
Distance	
Displacement	

2) 800 m west, 1200 m east, 300 m west	
Distance	
Displacement	

3) 125 m east, 480 m west, [illegible] east	
Distance	
Displacement	

4) 29 km south, 9 km south, 132 km north	
Distance	
Displacement	

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Question Calculate the distance and displacement.

Nicole drove 14 km west from her house to pick up her dinner. She then drove back home. Then she realized she forgot to get a drink, so she drove 7 km east to pick one up. When she got home, her friend asked to come over, so she drove another 18km west to get her before going back home. What distance did she drive when she got back home? What was her total displacement?

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Curriculum Connection
A1.2, A1.4, A1.5

Experiment – Displacement vs Distance

Research Question

What are we learning about?

What is the difference between displacement and distance? Today, you will complete two activities to reinforce the difference.

Materials

What will you need for the experiment?

- ❑ A
- ❑ A
- ❑ Tape





Activity 1

Complete the table and fill in the blanks.

1) Put a piece of tape on the ground where you start to walk outside.
2) Walk 10 steps forwards and stop. Use a metre stick and have your partner measure approximately how many metres you walked. Yes, you should round this number to the nearest metre.
3) Now turn 180 degrees from where you ended and walk 5 steps and have your partner measure the distance you just walked (the 5 steps)
4) Now turn 180 degrees again and walk 20 steps and stop. Have your partner measure the distance you just walked.
5) Have your partner measure the distance from where you ended to where you started. This is your **measured displacement.**
6) Add up all of the measurements to find the actual distance you traveled.

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Curriculum Connection
A1.2, A1.4, A1.5

Activity 1 Complete the steps and fill in the blanks.

7) Add all the forward measurements and subtract all backwards measurements to find the **calculated displacement**.

8) Why might the calculated displacement be different than your measured displacement?

Activity 2 Complete the steps and fill in the blanks.

1) Find your original piece of tape and stand on it.

2) Walk 10 steps north and measure the distance you walked.

3) Turn 90 degrees left (due west) and walk 15 steps and measure how far you walked.

4) Now turn 90 degrees left (due south) and take 10 steps and measure how far you walked.

5) Turn 90 degrees left again (due east) and talk 20 steps and measure how far you just walked.

6) Have your partner measure the distance from where you ended to where you started. This is your **measured displacement.**

7) Add up all of the measurements to find the actual distance you traveled.

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Curriculum Connection
A1.2, A1.4, A1.5

Activity 2 Complete the steps and fill in the blanks.

8) Now figure out your calculated displacement and write it below. Use the graph below to sketch your path, using a point on the graph to represent the end point of each segment of the path. Use the graph to determine total displacement. (Be sure to include both magnitude and direction – N, S, E, or W, relative to the origin.)

*** 1 square on the graph is equal to 1 metre



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Calculated displacement	

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Curriculum Connection
D2.5

Calculating Work – Forces x Distance

We have learned that Newtons are the standard unit to measure forces. Work is the use of force to move an object. Therefore, for work to be done, it requires force and movement. We can calculate work by multiplying the force used in N by the distance in metres.

Work has its own unit of measurement called the joule (J). One J equals the amount of work that is done when 1 N of force moves an object over a distance of 1 m.



Example: J[illegible]hes his lawn mower 100 metres. He uses 100 N of force to push the mow[illegible]he pushes with the same force the entire 100 m, we can deter[illegible]g this equation:

Work = 100 N x 100 m = 10 000 J

PREVIEW

Calculate H[illegible] work[illegible] the questions below?

	Force Applied	D[illegible]	Work Done
1)	100 N		
2)	200 N	[illegible]m	
3)	500 N	1000 m	
4)	250 N	2 km	
5)	700 N	4.5 km	

Word Problems How much work is done in the questions below?

1)	Chris applies 300 N of force to push his stalled car 50 m. How much work did he do?
2)	Scott uses a force of 20 N to pick up a bag of groceries. He walks it 20 metres. How much work did he do?
3)	A horse pulls a wagon 5 km using 300 N of force. How much work does the horse do?

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Calculating Work – Force x Distance

When we know two of the three parts of the equation for work, we can determine any of the missing variables.

For example, Jaylene did 2000 J of work pulling a suitcase 200 metres. Therefore our equation looks like this:

Work = force x distance
2000 = force x 200
Therefore, force = 10 N



PREVIEW

Calc ...le below finding the missing values.

	Force	Distance	Work Done
1)	350 N		7 000 J
2)			22 500 J
3)	825 N		660 000 J
4)		km	525 000 J
5)	1550 N		750 J

Word Problems How much work is done in the questi... lo...

1)	A baseball player does 2480 J of work when hitting a baseball. The ...ed 80 m away from home plate. How much force did they use to hit the ball?
2)	A backhoe uses 225 000 J of force to move a pile of dirt. The backhoe used 3000 N of force to lift the load. How far did it take the load?
3)	Evan picked up two weights and went for a walk. He used 450 N of force to pick up the weights. He completed 27 000 J of work. How far did he walk with the weights?

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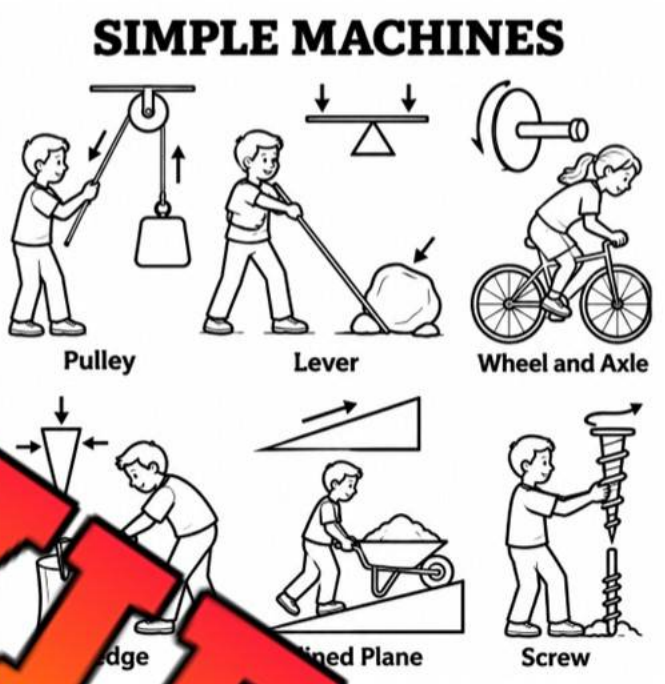
Curriculum Connection
D2.6

Simple Machines – Mechanical Force

Simple Machines

Simple machines are the basic mechanical devices that allow us to apply more force. A simple machine provides us with a mechanical advantage when doing work. This allows us to use less force when completing everyday tasks.

There are 6 types of simple machines: levers, wheels and axles, pulleys, wedges, screws, and inclined planes. To apply an even greater mechanical advantage of force, we can combine simple machines to make compound machines. Examples of compound machines are: can openers, and staplers.

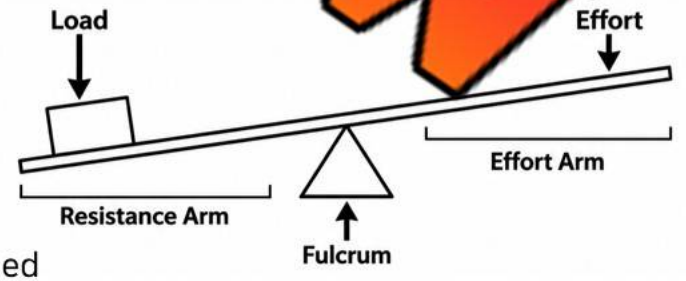


Mechanical Advantage

The mechanical advantage that a machine gives us can be calculated using the following formula:

$$\text{MA} = \frac{force\ needed\ without\ a\ simple\ machine}{force\ needed\ with\ a\ simple\ machine}$$

Using this formula will tell us how much of a mechanical advantage is received by using a simple machine. For example, if we were lifting a rock that might require 300 N of force without the help of simple machines. With a simple machine like a well-designed lever, we could lift the same rock with half the amount of force. In the example above, our MA would be:



$$\text{MA} = \frac{300}{150} = 2$$

The mechanical advantage made the work two-times easier. The load did not change, but our force was **magnified**. When we inputted 150 N of force into the lever, the output force was 300 N, making our MA 2.

Mechanical Advantage of Simple Machines

The mechanical advantage of simple machines is not always two. A poorly designed lever could actually have a negative mechanical advantage if the effort arm was shorter than the resistance arm. The mechanical advantage of each simple machine needs to be calculated based on the design and components of the machine.

PREVIEW

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Curriculum Connection
D2.6

Calculate Calculate the mechanical advantage below.

	Force Without Simple Machine	Force With Simple Machine	Mechanical Advantage
1)	500 N	100 N	
2)	1000 N	125 N	
3)	840 N	210 N	
4)	675 N		5
5)		275 N	4

Calculate e m nical advantage below.

	Simple Machine	ut	Output	Mechanical Advantage
1)	Pulley	N	00 N	
2)	Lever	525 N	3	
3)	Inclined Plane	180 N	N	
4)	Screw	760 N	20 N	
5)	Wedge		2 990	6.5
6)	Wheel and Axle	875 N		

PREVIEW

Question Why do we need simple machines? When did you use one today?

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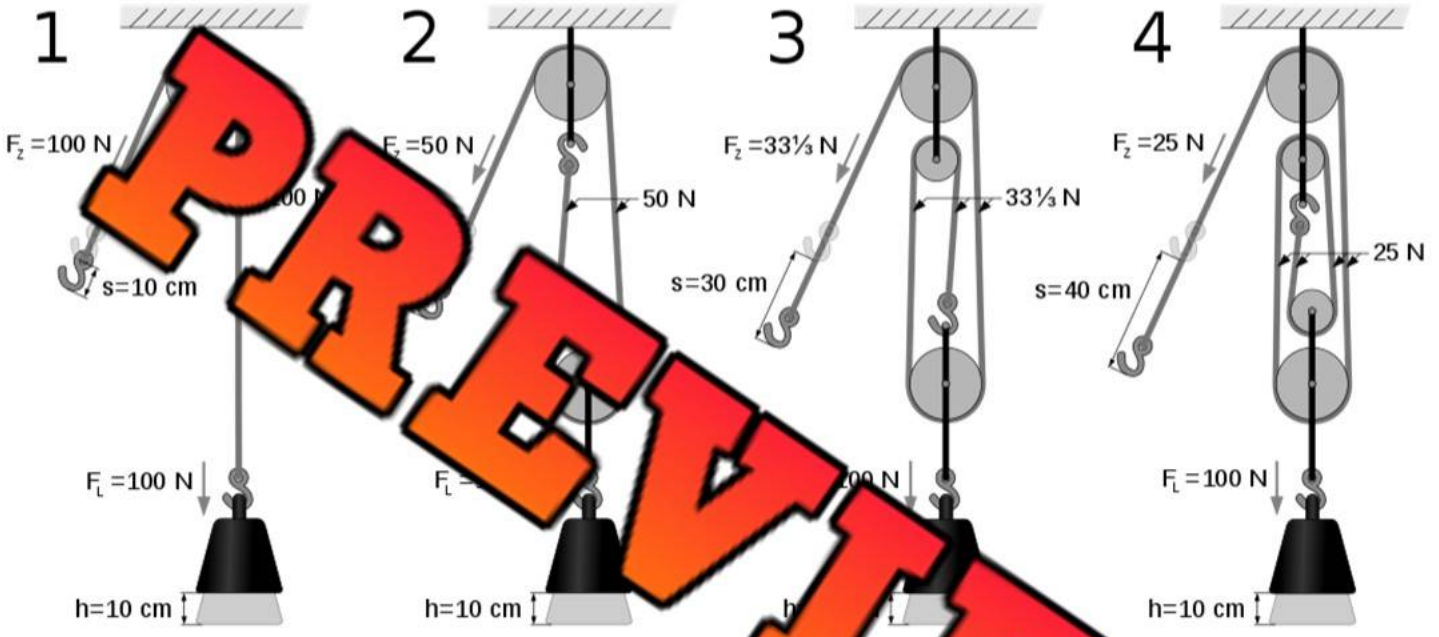
Pulley System – Force/Distance Ratios

Force and Distance Ratio
Using a pulley system allows for a mechanical advantage to make a load easier to move. When we add a pulley, it changes the amount of force you need to apply into the pulley, however, it also changes the distance you need to pull. In the diagram below, the differences between using 1 pulley compared to 2, 3, and 4 are outlined.



PREVIEW

Questions Fill in the table below and answer the questions.

Number of Pulleys	Load	Force Required (N)	Distance (cm)
1	100 N		
2	100 N		
3	100 N		
4	100 N		

1) What do you notice happens to the relationship between force required and distance to pull when you add a pulley?

2) When would you use extra pulleys? When would just one pulley be enough?

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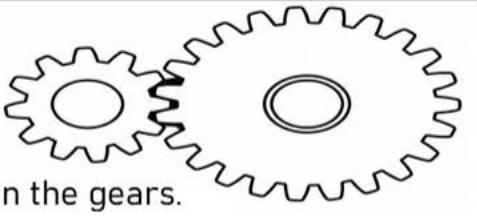
Gear Ratios – Velocity and Torque

Gears – Increasing Torque (Force) and Velocity



Gears are used to increase the torque that is applied from the driver gear onto the driven gear. Determining the gear ratio in a gear pair helps us determine the mechanical advantage. The gear ratio formula uses the number of teeth on the gears.

$$MA = \frac{Driven}{Dri}$$

If we appl force into the larger gear, the gear ratio becomes 14/28. We can multiply ply into the gear pair by the gear ratio to determine the output force x (14/28) = 5 N. We are needing to use more force to turn the larger than w ving from the smaller gear, but the smaller gear is turning more, which m t u more velocity, not torque.

On the o we a N of force into the smaller gear, the resulting force from the larger ge ld be 20 N, providing two times more torque, but half as much velocity.

PREVIEW

Questions Use information the your answer.



1) What is the g ratio in ictu the left if the smaller gear is the driver gear?

_____

2) If you apply 100 N of force i aller how much force would the larger gear have e d?

_____

3) Which is being increased, the velocity or torque? Explain.

_____

_____

4) If you apply 100 N of force into the larger gear, how much torque would be created from the smaller gear?

_____

_____

5. Which is being increased, the torque or the velocity? Explain.

_____

_____

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D2.6

Calculating Mechanical Advantage - Gears

Calculate Calculate the MA and output force in the examples below.

	Input Force	Driven Gear Teeth - Output	Driver Gear Teeth - Input	Gear Ratio	Output Force	Increased Speed or Torque
1)	100 N	15	5	15/5	300	Torque
2)	800	10	40	10/40	200	Speed
3)			16			
4)	550 N		36			
5)	875 N					
6)	1200 N	28	4			
7)	1500 N	24				
8)	2200 N	16	48			
9)	1750 N	32	8			
10)	1375 N	40	4			

PREVIEW

Word Problem Answer the questions below.



Julia is biking up a hill, so she changes her gears. She is pedaling a gear with 48 teeth on it that drives the driven gear that has 12 teeth.	
1) What is the gear ratio?	
2) Why did she choose this gear ratio to go up the hill?	
3) When she gets to a flat ground, what would be a good gear ratio if she had 32 teeth on her pedal gear?	

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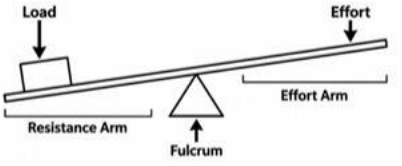
D2.6

Calculating Mechanical Advantage - Lever

Calculating Mechanical Advantage Using a Lever
To calculate the MA of a lever, you will need to know the lengths of the effort arm and the load arm. The formula is:



$$\frac{Effort\ Arm\ (length)}{Resistance\ Arm\ (length)}$$

This will give you the MA, which you can then use to determine how much force will be outputted [illegible] on how much force you inputted.

PREVIEW

Calcu[illegible] the MA and output force in the examples below.

	Effort A[illegible]	Loa[illegible] Length	MA	Input Force	Output Force
1)	50 c[illegible]	[illegible]		300 N	
2)	4 m	[illegible] m		600 N	
3)	2 m	[illegible]m		225 N	
4)	3 m	3 m		900 N	
5)	1.5 m	3 m		[illegible] N	
6)	3.6 m	45 cm			5 800 N
7)	5.25 m	75 cm			4 760 N
8)	8.95 m		5	[illegible] N	
9)		33 cm	7	410 N	
10)		1.2 m	3		894 N

Word Problem Answer the questions below.

Steven uses a lever to pry a rock off the ground. He puts the fulcrum closer to the load to make it easier. The effort arm is 2.2m and the load arm is 40cm.	
a) What is the mechanical advantage?	
b) If Steven uses 400 N of input force, how much output force will he create?	
c) If the work requires 2500 N of force, will he be able to move it? What could he change?	

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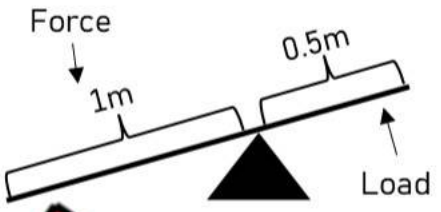
D2.6

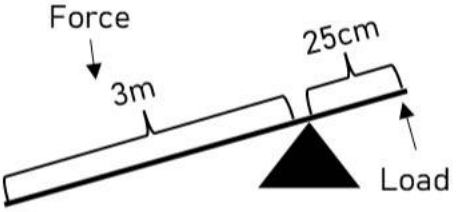
Calculate Calculate the MA and output force in the examples below.

1)



[illegible]	750 N
[illegible]	

2)



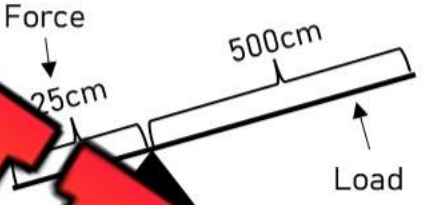
MA	
Input Force	915 N
Output Force	

3)



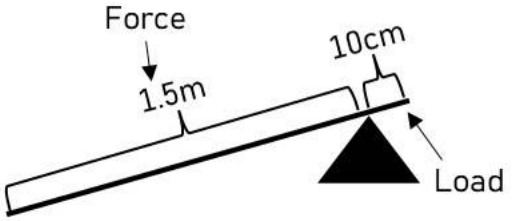
MA	
Input Force	348 N
Output Force	

4)



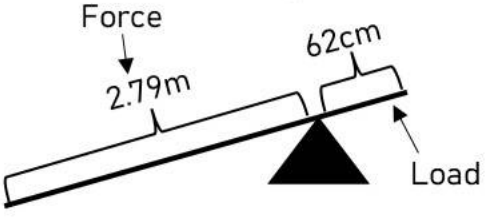
[illegible]	
Output Force	

5)



MA	
Input Force	475 N
Output Force	

6)



MA	
Input Force	
Output Force	3222 N

PREVIEW

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Curriculum Connection
A1.3, A1.4, A1.5

Experiment – Testing Different Levers

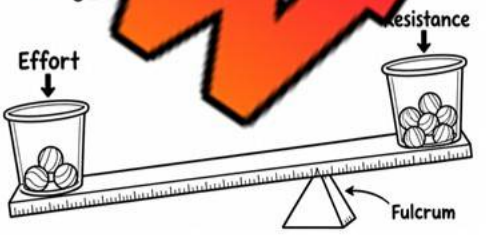
Research Question How does moving the fulcrum affect the force needed to lift a load?

Materials What will you need for the experiment?

- ✓ Ruler
- ✓ Two cups
- ✓ Tape
- ✓ Weights – objects that all[illegible] marbles, paper clips, etc.)
- ✓ Fulcrum – metal binder clip, pencils [illegible]

Procedure How will you complete the experiment?

1) Tape the cups to the ends of the ruler.
2) Decide which side will be the load. Put a reasonable amount of weight into the cup that will be the load.
3) Put the fulcrum in the centre of the ruler. Add weights into the cup on the effort side of the lever until the lever is balanced. Record the weight you added (number of marbles).



4) Empty the effort cup but leave the same weight in the resistance cup. Put the fulcrum closer to the effort side of the ruler. Complete the same steps as above and record how much effort was needed to balance the lever.
5) Lastly, empty the effort cup again and repeat the same steps as above, but move the fulcrum closer to the resistance cup. Record your results.
6) Answer the questions on the backside of the page.

PREVIEW

Curriculum Connection
A1.3, A1.4, A1.5

Observations

What did you notice as you completed the experiment?

Fulcrum Position	Fulcrum Position on Ruler – cm or mm	Weight in Load Cup	Weight in Effort Cup
In the Middle			
Close to Effort Cup			
Close to F e			

Results

An ues ns below.

1) What position allo the force to move the load? Explain why this was the case.

2) Was there a relationship between the number of mm and the nt of weight needed to move the load? Explain.

3) What distance from the load on the ruler gave a mechanical advantage of 2 (you needed half as much weight to lift the load). What distance provided an MA of 3 and 4?

MA of 2	
MA of 3	
MA of 4	

PREVIEW

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Curriculum Connection
D2.6

Calculating Mechanical Advantage – Inclined Plane

Calculating Mechanical Advantage Using an Inclined Plane

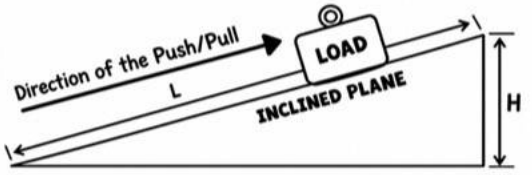
An inclined plane is used to allow us to move a load using less force. There is a trade-off though. The longer the inclined plane, the further the distance is that we need to move the load.

Picture this, your standing at the edge of a moving truck that is 1.5 m tall. You want to move a box up to the opening of [illegible] truck. You would only need to lift it 1.5 m if you lifte[illegible]ight up. But, if the box is too heavy, you could [illegible]clined plane to increase your force acting [illegible]

[illegible] ramp n[illegible]each 1.5 m tall, you could create a [illegible]echani[illegible]ge of 2 by making the ramp 3 metres long.

$$MA = \frac{length\ of\ s[illegible]}{height\ of\ slope} = \frac{3}{1[illegible]}$$





$$\text{Mechanical advantage (MA)} = \frac{\text{(L) Length of the slope}}{\text{(H) Height of the slope}}$$

Calculate Calculate the m[illegible]sing [illegible]bles below.

	Length of Slope	Height of Slope	MA
1)	60 cm	20 cm	
2)	3 m	0.5 m	
3)	4.5 m	75 cm	
4)	6 m	1.5 m	
5)	10 m	2.5 m	

	Leng[illegible] Sl[illegible]	Height of Slope	MA
6)			3
7)			5
8)			4
9)		1[illegible]	6
10)		2[illegible]m	10

Word Problem Answer the questions below.

Hilary can produce 500 N of force to lift a box. The box she needs to lift onto a ledge is 1.75m tall. She will need to be able to produce 2000 N of force to move the box. If she uses a ramp, how long should her ramp be so that she can move the box?

PREVIEW

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Curriculum Connection
D2.6

Calculate Draw a diagram of the situations below and answer the questions.

1) Jack needs to move a bag of dirt onto a cliff. The cliff is 3 metres high, so he can't reach it. He knows he can exert 300 N of force, but it will take 1 500 N of force to move the bag up 3 metres.

a) If he make the ramp 6 metres long, will he be able to move the bag onto the cliff? Explain.

b) What eal ramp length to allow him to move the dirt onto the cliff?

2) Luke built a ra ove h washer into his truck. The pressure washer is heavy, so it requires 9 N it into the truck. He can produce 600 N of force.

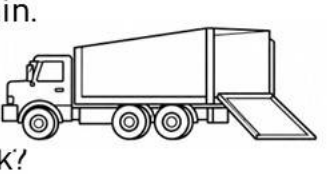
a) What mechanical advanta s h lined plane to provide him?

b) He built the ideal ramp length of 280 cm. H t is th

3) Ashley needs to move a piano onto a moving truck. She needs 2 2 N , but can only produce 400 N. She is going to use a ramp to move the piano.

a) What mechanical advantage does she need the inclined plane to provide her?

b) She pulled out the ramp on the truck. The truck is 125 cm tall, and the ramp is 500 cm long. Will she be able to move the piano onto the truck? Explain.



c) How long of ramp does she need to move the piano onto the truck?

PREVIEW

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Activities – Machines and Physics

Word Search Find the words from the word bank.

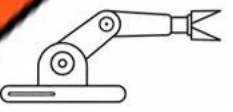


Energy	Work	Force	Physics	Magnetism
Friction	Simple	Machines	Displacement	Distance
Mechan	Advantage	Dissipating	Automation	Efficiency

A		T		V	W	I	S	N	O	K	Z	W	X	R	F	P	Q
U	F	G	U		Z	C	T	M	M	L	S	W	O	R	K	R	E
T	I	A	R	E		E	D	N	Q	V	K	K	S	O	H	L	
O	N	N	C	Z		L	A	C	E	M	E	N	T	F	P		
M	B	X	D	V	B		U	Z	C	H	I	E	B	R	M		
A	N	G	E	N	C	Y	E	F		E	N	C	Y	F	G	I	I
T	N	C	C	P	H	Y	S	I	S	M		I	N	E	S	C	S
I	R	J	R	M	A	G	N	E	T	I		T	E	N	Z	T	Q
O	K	A	O	F	D	I	S	T	A	N	C	E		U	Y	I	B
N	T	F	F	E	H	O	J	U	A	D	V	A		A	E	O	B
M	E	C	H	A	N	I	C	A	L	D	I	S	S	I	E		G

PREVIEW

Word Scramble Unscramble the words from the word bank.



LSIPEM		CIHPYSS	
FCORE		MEHIACNS	
NPLIMEATDSCE		GNEEYR	
TNMEIASGM		TSDACEIN	
NAEAADVGT		ITORCNIF	

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Curriculum Connection
D2.7

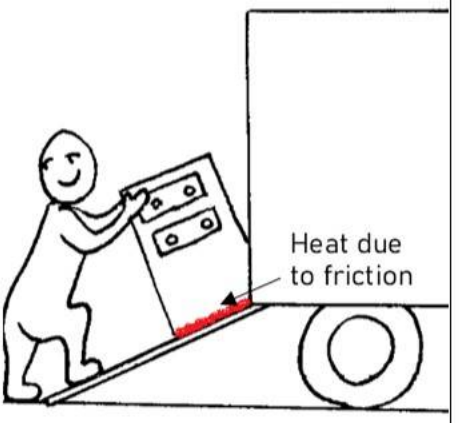
Dissipating Energy in Mechanical Systems

What is Dissipation of Energy?

The term **dissipation** is commonly used to describe ways in which energy is wasted. When we use mechanical systems, there is often energy wasted, meaning some of the energy lost was not used for the intended purpose of the machine.

Dissipation by Friction

Many simple machines have to deal with friction causing a dissipation of energy. For example, when you push a box up a ramp, the work might be easier than picking it up, depending on the frictional force resisting the movement of the box.

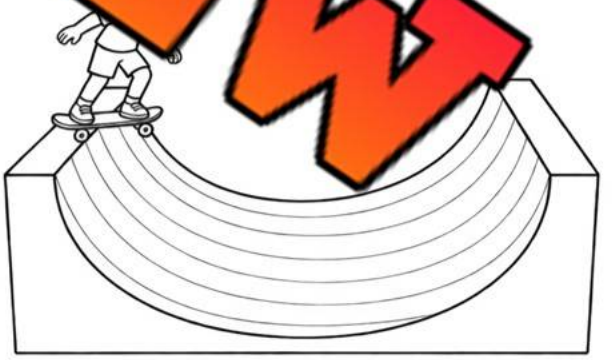


If the two surfaces – the box and the ramp are made out of materials that increase friction, the box will not slide as well. The work lost due to energy created, as the mechanical energy used to move the box will result in movement of the surfaces and thermal energy. Examples of these surfaces include sandpaper and carpet.

If materials are used to reduce friction, like oil or grease, there will be less wasted thermal energy. Ice is an example of a surface with little friction. If you were sliding a box along ice, there would not be as much dissipated thermal energy.

Example of Frictional Dissipation

If we drop a skateboard down a half-pipe ramp, its potential energy at the top of the ramp is converted to kinetic, mechanical energy as it moves down the ramp. When it gets to the other side, it doesn't go as high up the ramp as it was when it started. As it travels back to the original side of the ramp, it makes it less far and eventually it will stop in the middle.



The reason it cannot travel up and down forever is because of friction. The wheels on the skateboard are creating **rolling friction** that creates thermal energy that could not be used to move the skateboard. In addition, the skateboard moving through the wind is creating **frictional drag** which produces more thermal energy that is dissipated.

With the dissipated energy, the skateboard loses energy as it moves up and down the ramp. This results in it reaching lower levels on the ramp each time.

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D2.7

Questions
Use information from the text to support your answer.

1) What does it mean for a mechanical system to dissipate energy?

2) How do[illegible]iction cause dissipation of energy? Give an example.

PREVIEW

Explain
How is the cav[illegible]atin



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

1) Friction often causes unintended wasted energy.	True	False
2) Some materials create more friction, which creates dissipation.	True	False
3) Dissipation is high when pushing a box along ice.	True	False
4) Dissipation is high when sliding a box along a wooden ramp.	True	False
5) Dissipation is a result of wasted and unintended thermal energy.	True	False

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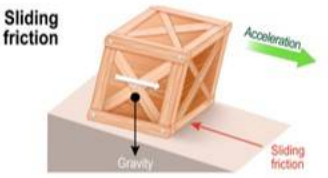
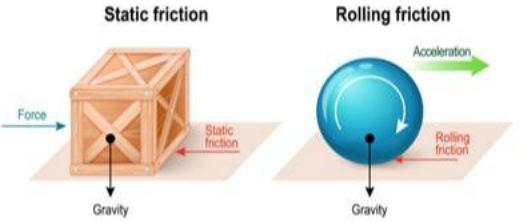
Curriculum Connection
D2.7

Technologies That Reduce Friction

Three Types of Friction
There are three types of friction – static, rolling, and sliding.



Static Friction – The frictional force that opposes any applied force by keeping it still. For example, there is static friction between your desk and the floor because the desk is stationary. If you push the desk and it moved, yo[illegible]plied force has overcome the static friction.



Sliding [illegible]tional force that resists the move[illegible]of two s[illegible]at slide against one another. [illegible]hen yo[illegible]desk and it begins to move, it will still require a lot of applied force [illegible]se[illegible] is s[illegible]friction.

Rolling Friction – [illegible]tiona[illegible]e[illegible]esist the motion when an on object rolls over it. This happens when y[illegible]et, [illegible]cylinder over a surface.

Technologies Reducing Fricti[illegible]
To reduce the frictional force tha[illegible]ffect[illegible]is needed to do work, numerous technologies have been developed.

1) **Furniture Sliders** – When moving furniture ar[illegible]a roo[illegible]static friction often makes it difficult to move the objects. Furn[illegible]liders[illegible]er each part of the furniture that is in contact with the ground's s[illegible]ce[illegible]rubber on one side to create a lot of friction between the slider a[illegible]furniture[illegible]doesn't move. On the other side, the sliders are made of felt, which [illegible]ery[illegible]th reduces the friction. This reduction in sliding friction allo[illegible]us t[illegible]ith less force.

2) **Lubricants** – A lubricant reduces friction between two surfaces by ac[illegible]a slippery substance so they can slide past each other. Under the hood of a vehicle, lubricants allow engines and gearboxes to run smoothly. If you've ever touched a machine's engine, you've likely felt the grease get on your hands. Engines have a lot of moving parts, which means they need to be lubricated so they can run efficiently, so they do not create dissipated heat energy.

3) **Wheels** – Using wheels to move an object reduces frictional forces. A wheel reduces friction by allowing the contacting surfaces to roll rather than to slide over each other. Ball bearings are a technology used to reduce rolling friction even more. They use balls to separate two bearing rings that roll instead of slide. Ball bearings can hold a large load, so they are used in vehicles, bicycles, and skateboards.



PREVIEW

Name: _____ 76

Curriculum Connection
D2.7

Definitions

What do the forms of friction mean?

Static Friction	
Sliding Friction	
Rolling Friction	

Questions

information from the text to support your answer.

1) How liding e friction and make work easier? Explain.

2) Why are lubricants important a veh

3) What are ball bearings? Why are they useful?

PREVIEW

True or False

Circle whether the statement is true or false.

1) Sliding friction is weaker than rolling friction.	True	False
2) Lubricants are added to systems to reduce sliding friction.	True	False
3) Lubricants, wheels and slippery surfaces reduce dissipation.	True	False
4) Lubricants can be added to slippery surfaces to reduce friction further.	True	False

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Curriculum Connection
D2.7

Exit Cards

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

Name: _____

Fill in the blanks using the word bank.

Ball Bearings	Rolling Friction	Mark	
Furniture Sliders	Static Friction	Lubricants	

1) _____ prevents an object from moving until enough force is applied.
2) _____ reduce friction by allowing surfaces to slide smoothly.
3) _____ help move heavy objects across floors with less effort.
4) _____ use small metal balls to reduce friction between moving parts.
5) _____ occurs when a wheel or ball moves across a surface.

Name: _____

Fill in the blanks using the word bank.

Ball Bearings	Rolling Friction	Mark	
Furniture Sliders	Static Friction	Lubricants	

1) _____ prevents an object from moving until enough force is applied.
2) _____ reduce friction by allowing surfaces to slide smoothly.
3) _____ help move heavy objects across floors with less effort.
4) _____ use small metal balls to reduce friction between moving parts.
5) _____ occurs when a wheel or ball moves across a surface.

PREVIEW

Name: _____ 78

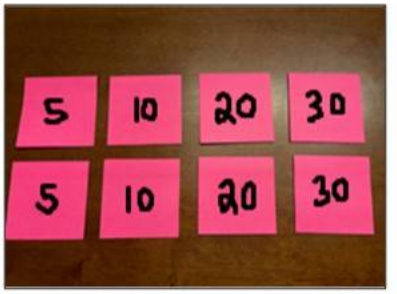
Curriculum Connection
A1.2, A1.4, A1.5

Experiment – Sticky Note Friction

Research Question What is the maximum number of sticky notes weaved together that you could pull apart? Explain your hypothesis below.

Materia What will you need for the experiment?

- ❑ 2 pads of stic
- ❑ Pen or penc
- ❑ Recording sheet



Procedure How will you mple nt?

1) Split the sticky notes up so you have two pile , 10, 2 0 notes
2) Start with interweaving the two piles of 5 n o th ing the pages of each stack one at a time.



3) Pull the stacks to see if you can separate them. Try holding them as shown in the picture, or horizontally like in the picture above. Write down your results.



4) Perform the same instructions as above, but with the stacks of 10 notes.
5) Next do the stack of 20, and then the stack of 30 notes.
6) Answer the questions on the back of this page.

PREVIEW

Curriculum Connection
A1.2, A1.4, A1.5

Observations

Could you pull apart the notes?

Number of Notes in Stack	Could Pull Apart? Yes or No?
5	
10	
20	
30	

Results

Answer the questions below.

1) What forces are acting on the notes making them difficult to pull apart? Explain.

2) If you have time, find the number of notes that you could no longer pull apart?

3) Did you have the same results as the groups around you? What could have impacted the difference in results?

4) If you pulled the notes apart while they were horizontal, was it easier? Was it easier to pull them apart while they were vertical? Explain.

5) How was normal force part of this experiment? Explain what normal force is and how it acted on the notes.

PREVIEW

Name: _____ 80

Curriculum Connection
D2.7

Research – Lubricants Used In Vehicles

Learn more about how lubricants are used in vehicles to reduce friction and dissipation by answering the questions below.

Research Answer the questions below.



1) What ar[illegible]h of the types of oil below and how are they used in a vehicle?

Engi[illegible] And Gear Oil	
Grease	
Penetrating Lubricant	
Dry Lubricant	

PREVIEW

2) How often should you get the oil changed in your car? Why do you need to change your oil?

3) What would happen if your vehicle had no oil?

4) How does usi ants m burn less fuel?

5) What is oil viscosity?

6) What is the best oil viscosity for warm climates? Explain why.

7) What is the best oil viscosity for cold climates? Explain why.

PREVIEW

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Name: _____ 82

Curriculum Connection
D2.4, D2.8

Calculating Efficiency

Calculating Efficiency of Machines

Machines are built to serve a purpose. When all the energy used to power the machine is used for the intended purpose, the machine is operating at 100% efficiency. But, if a machine dissipates energy, the machine won't be as efficient. To calculate the efficiency of a machine, we use the following formula:



$$\text{efficiency} = \frac{useful\ energy\ out}{total\ energy\ in}$$

For exam op uses a total of 100 J of energy in one hour. 12 J of energy was wasted d the rest was useful energy out. Therefore, the efficiency is:

$$\text{efficiency} = \frac{88}{100} \text{ or } 0.88$$

We can write t enta ting that the laptop has an energy efficiency of 88%.

PREVIEW

Calculate Determin iency the values below.

	Useful Energy Out	Total Energy	cimal	Efficiency – Percentage
1)	75 J	100 J		
2)	120 J	200 J		
3)	21 J	50 J		
4)	200 J	250 J		
5)	480 J	500 J		
6)	230 J	300 J		
7)	210 J	600 J		
8)	620 J	1000 J		
9)	1550 J	2000 J		
10)	5210 J	6000 J		

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Curriculum Connection
D2.4, D2.8

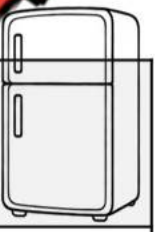
Calculate Fill in the table by finding the missing values.

	Useful Energy Out	Total Energy In	Efficiency - Decimal	Efficiency - Percentage
1)		40 J	0.5	
2)		200 J	0.75	
3)		200 J		60%
4)		350 J		80%
5)		820 J	0.45	
6)			0.90	
7)		J		35%
8)		1500 J		62%
9)		2425 J	8	
10)		3540 J		

PREVIEW

Word Problem Answer the questions below.

Mark is shopping for a new fridge. Fridge one produces 600 J of useful energy in one hour and requires 850 J of total energy in. Fridge two uses 900 J of total energy in one hour. It has an efficiency percentage of 77%.



a) How much useful energy out does fridge two produce?	
b) Which fridge is more energy efficient?	
c) Which fridge should he choose if he wants to use less energy?	
d) Which fridge should he choose if he wants an energy efficient fridge with more features?	

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Name: _____ 84

Curriculum Connection
A1.2, A1.4, A1.5

Experiment – Energy Efficiency

Research Question

What are we learning about?

What does efficiency mean? How can one lightbulb be more efficient than another light bulb? How much heat do inefficient light bulbs produce? Do light bulbs that give more light produce more wasted heat?

Materials

What will you need for the experiment?

- ❑ Lamp
- ❑ Thermometer
- ❑ 25-watt Incandescent bulb
- ❑ 100-watt Incandescent
- ❑ 2 fluorescent bulbs that produce light comparable to the incandescent bulbs



Incandescent Bulb

PREVIEW

Procedure

Complete the steps below to finish the experiment.

1) Put a 25-watt incandescent light bulb into the lamp and turn it on.

2) Hold the thermometer about 5-10 cm above the bulb for one minute and record the temperature.

3) Turn off the lamp.

4) Let the bulb cool and then take it out.

5) Repeat the procedure above using the 100-watt incandescent bulb. Record the temperature.

6) Repeat the process above using the fluorescent bulbs. Record the temperatures for both bulbs.



Fluorescent Bulb

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Name: _____ 85

Curriculum Connection
A1.2, A1.4, A1.5

Observations | What happened?

Light Bulb	Temperature
Temperature with light off	
25-watt Incandescent Bulb	
100-watt Incandescent Bulb	
Weaker Fluorescent Bulbs	
[illegible]er Fluorescent Bulbs	

Results | A[illegible]questions below.

1) Which type of lig[illegible]sipat[illegible]or[illegible]? Explain.

2) Does a light that produces more light dissipa[illegible]e hea[illegible]

3) Which lightbulb is more efficient? Explain using the terms work, energy, and dissipation.

PREVIEW

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Name: _____ 93

Curriculum Connection
D1.1, D2.9

Technological Innovations Improving Productivity

Technological Innovations Changing Industries

Innovation refers to both the creation of new technologies and to their adaption for use in a variety of industries. Businesses use technological innovations to accelerate productivity and increase profitability.

Examples of Technological Innovation Involving Mechanical Systems

Robotics

The use of ts in creating machines is not new, as they have ating vehicles in assembly lines since 19 s not walking and talking robots, but r ar t can easily move heavy compo and a r adhesives quickly and efficiently. Usin so as workers are not exposed to s, or icals involved with adhesives and s.



Industrial autom robotics in handling various processes and machinery to increase pro peed, and quality. Having automatic manufacturing also cuts down ste es do not make mistakes that humans make.

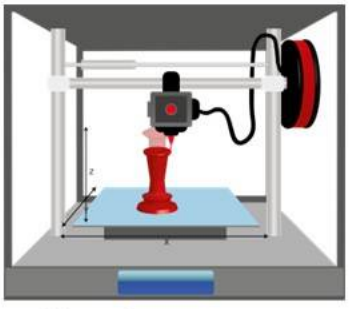
Artificial Intelligence (AI)

The use of AI can increase productivity in manuf g faci t, AI is used to perform quality checks to detect flaws in produ t are d. The AI, also known as smart robots, are able to detect flaws tha erts m t be able to see.

Second, AI has the ability to predict when machinery l. S equipment give the AI data on the movement of the machine which a understand when the machinery will fail, and when it needs mainte ictive technology AI offers is ensuring manufacturing companies are not experi shutdowns due to system failures, which is increasing their productivity and efficiency.

Additive Manufacturing (3D Printing)

The use of 3D printing by manufacturing companies is allowing them to mass-produce items to get them to market quicker and at a lower cost. **3D printing** is when a printer is connected to a computer, allowing the user to create an object on the computer and print it in 3-dimensions. The printer is a machine that creates objects by layering materials, like plastics to create objects that differ in shape, size, rigidity, and colour.



3D printing is now being used by most manufacturing companies. It's advantages include faster production, flexible designs, printing on demand, less cost, fast design, and less waste.

PREVIEW

Name: _____ 94

Curriculum Connection
D1.1, D2.9

Questions

Use information from the text to support your answer.

1) How are technologies affecting the manufacturing sector? What advantages do these technologies offer?

2) Why i… …robots to make cars than humans?

PREVIEW

Questioning

Write 3 questions you… …about… …ding.

1)	
2)	
3)	

True or False

Circle whether the statement is true or false.

1) A 3D printer wastes a lot of material when printing objects.	True	False
2) Humans are more accurate with their work than robots.	True	False
3) The use of robotics, AI, and 3D printing increases production.	True	False
4) When manufacturing is more efficient, products cost less for consumers.	True	False
5) Using robots reduces the quality of the products being made.	True	False

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Name: _____ 95

Curriculum Connection
D1.1, D2.9

Research – Industry 4.0

The manufacturing industry has undergone 4 industrial revolutions and is currently in its 4th stage, called industry 4.0. Learn more about the evolution of industrialization below.

Research Answer the questions below.

1) What does Industry 4.0 refer to?

2) Summarize the ... in the ... of industrialization.

1.0	
2.0	
3.0	
4.0	

PREVIEW

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Curriculum Connection
D1.1, D2.9

3) Draw a picture that symbolizes each stage in the evolution of industrialization.

1.0	2.0	3.0	4.0

4) What [illegible]ne Ind[illegible]net of Things (IIOT)?

5) What are smart sensors in manufacturing? How do they improve [illegible]

PREVIEW

Name: _____ 97

Curriculum Connection
D1.1, D2.9, D2.10

Autonomous Self-Driving Vehicles

What is an Autonomous Self-Driving Vehicle?
An **autonomous self-driving vehicle** is a vehicle that can sense its environment and operate without human involvement. In an autonomous vehicle, a human passenger would not need to take control of the vehicle at any time, or even be present in the vehicle at all.

How Does an Autonomous Self-Driving Vehicle Work?
Autonomous vehicles create and maintain a map of their surroundings as they drive. These cars use smart sensors situated in different parts of the vehicle that monitor the position of vehicles.

The car uses radar, GPS, and cameras to assist with its self-driving capabilities. Radar is used to tell the vehicle's computer how fast other vehicles are moving. It can calculate how to adjust its own speed. GPS is used to provide the position of the vehicle and to navigate the vehicle to its destination. GPS provides quality that are necessary for self-driving vehicles to stay on the road. Cameras are used to see and identify traffic lights, signs, and animals.

Impacts of Autonomous Vehicles

- Self-driving vehicles may be the most significant benefit will be to reduce car accidents. As of now, 94% of car accidents are caused by driver error. If all vehicles on the road were self-driving, they would be able to communicate with each other, which would reduce or eliminate human driver errors.
- Accidents involving unsafe drivers would be reduced. For example, impaired drivers would be off the roads, as well as drivers who are distracted.
- People with disabilities, like the blind would be able to use self-driving vehicles. Seniors who have lost their license could continue to be independent and use self-driving vehicles. Self-driving vehicles would enhance the independence of anyone who cannot currently drive a vehicle.
- Riding in a self-driving vehicle allows you to be more productive. Instead of driving, you can focus on getting things done, or enjoy watching a movie.
- Less traffic will be a result of fewer accidents. When humans drive in traffic, they make it worse by braking too often, which creates a chain reaction of braking. Self-driving vehicles will all communicate with each other, ensuring they move quickly with a consistent distance between vehicles.



- Fewer traffic jams means less greenhouse gases because cars are not idling. This will have a positive impact on the environment.

PREVIEW

Name: _____ 98

Curriculum Connection
D1.1, D2.9, D2.10

Questions
Use information from the text to support your answer.

1) What is an autonomous self-driving vehicle? How does it work?

2) How wil[illegible]elf-driving vehicle impact our society?

PREVIEW

Reaction
What do you t[illegible]ld b[illegible]est impact of autonomous vehicles?

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

1) Self-driving cars would need to be driven by people who can drive now.	True	False
2) Autonomous vehicles can drive without someone in the car.	True	False
3) Self-driving vehicles will cause more accidents than we have now.	True	False
4) Autonomous vehicles use sensors, radar, GPS and cameras.	True	False
5) They will allow people with disabilities to be more independent.	True	False

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Name: _____ 99

Curriculum Connection
D1.1, D2.9, D2.10

Impacts of Automated Systems

Impacts of Automated Systems
The automation of systems has affected society, the economy, and the environment in many ways.

Society – Social Impacts
Automation has affected people positively and negatively. On one hand, automation has improved the quality of life for many people. Automation has made more things affordable for more p because of the mass production in the manufacturing sector. It has also led to new tec and better quality products for people to enjoy.

Au ade workplaces safer. Machines can complete unsafe work, like lifting or machines to handle dangerous chemicals.

autom hanged the hours people need to work. Before automation, in the early 1900s, th ork week was 70 hours. Today, the average work week is about 40 hours e can b in less time with automation.

Automation drawb ople. Mainly, machines can take jobs from people, causing more unemplo ent more wealth inequality, as a small number of business owners can crea and mor tion, making them more wealthy and their former employees unem

Economic Impacts
Automation has impacted the economy i ways ed the costs of production, which has made products and services more afford has new jobs that are more creative and less repetitive. For example, r es can boring, repetitive jobs that people used to do all day long. Industries a mployees with specialized skills to create software for machines and n e equi

If businesses make more money, they will be taxed a y, w nabl s the government to earn more money to spend on public goods, like ads Automation also ensures that manufacturing jobs can stay in countrie ere high-skilled workers can be paid a proper wage. Without automation, many facturing jobs were sent to third-world countries where people could be paid a fract what they are paid here.



Environmental Impacts
Automation has both positive and negative effects on the environment. Automation has reduced the amount of waste created in manufacturing facilities as the machines do not make errors that humans make. The machines used to manufacture goods are efficiently using materials, which minimizes waste.

A negative impact on the environment is the mass production of goods. Our landfills and recycling centres are growing out of control due to the mass production of products that can be discarded because of their inexpensive nature.

PREVIEW

Name: _____ 100

Curriculum Connection
D1.1, D2.9, D2.10

Advantages/Disadvantages Fill in the table below.

1) What are the advantages and disadvantages of automation on society/people?	
Advantages of Automation	**Disadvantages of Automation**

2) What are the advantages and disadvantages of automation on the economy?	
Advantages of Automation	**Disadvantages of Automation**

3) What are the positive and negative impacts of automation on the environment?	
Positive Impacts	**Negative Impacts**

PREVIEW

Question How would life be different if we didn't have automated systems?

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Name: _____ 102

Curriculum Connection
D1.1, D1.2, D2.9, D2.10

Automation – Different Points of View

Points of View Below are different points of view about the impacts of automated systems. Write a different point of view that contrasts the views below.

1) People will lose their jobs to robots if automation takes over.

2) Mac will m mistakes in the manufacturing sector than humans make.

3) Factories make a lot of pollut , so a eate more factories, and will therefore be worse for the environmen

4) Automation increases production and decreases prices on product . Th ead to more waste in landfills.

5) Automation will cause the rich to get richer, and the poor poorer.

PREVIEW

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Name: _____

Curriculum Connection
A2.1, A2.2, A3.1, A3.2, A3.3

Coding – Autonomous Vehicles

Autonomous Vehicles and Coding

A self-driving vehicle needs around one billion lines of computer code for the car to drive safely. That is nearly 1,000 times more than the 145,000 NASA needed to land Apollo 11 on the moon.

Coding a S[illegible]ing Vehicle

With a[illegible] of code, it is obvious that coding a self-driving vehicle is compl[illegible]. Usin[illegible]rams to perform functions that the car needs to do is important in r[illegible]umb[illegible]ines of code used.

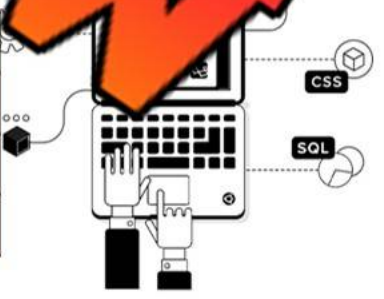
For example, [illegible] write [illegible]s for two common driving tasks – driving the speed limit and staying in [illegible]ane.

define speed
fetch speed limit data from GPS
drive speed limit

[illegible]ane
[illegible]tivate s[illegible]ht side of vehicle
keep [illegible] insi[illegible]ight side
activate s[illegible] side [illegible]cle
keep vehicle ins[illegible]on [illegible]



Self-Driving Vehicle Program
when destination is selected
run speed
run lane



As you can see, the actual program that drives the vehicle now uses very few commands as it simply refers to the larger sub-programs. We only need to write the sub-program once and we can refer back to it over and over.

This program is clearly not complete, but it will allow the car to drive the speed limit and stay in its lane.

PREVIEW

Name: _____ 104

Curriculum Connection
A2.1, A2.2, A3.1, A3.2, A3.3

True or False

Circle whether the statement is true or false.

1) A self-driving vehicle doesn't use a lot of code.	True	False
2) Apollo 11 used more code than a self-driving vehicle.	True	False
3) A sub-program is used so that the programmer can write less lines of code.	True	False
4) You can name your sub-program any name you'd like.	True	False
5) A self-d vehicle uses 145 thousand times more code than Apollo 11.	True	False

Questic estions below using evidence from the text.

1) Why would pro when writing code for a self-driving vehicle?

2) What does a sensor do? Why are they useful i g?

PREVIEW

Directions

Choose a task that a self-driving vehicle must do. Write a sho sub-program for the task.

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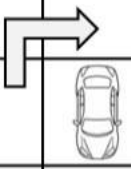
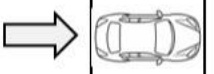
Name: _____ 105

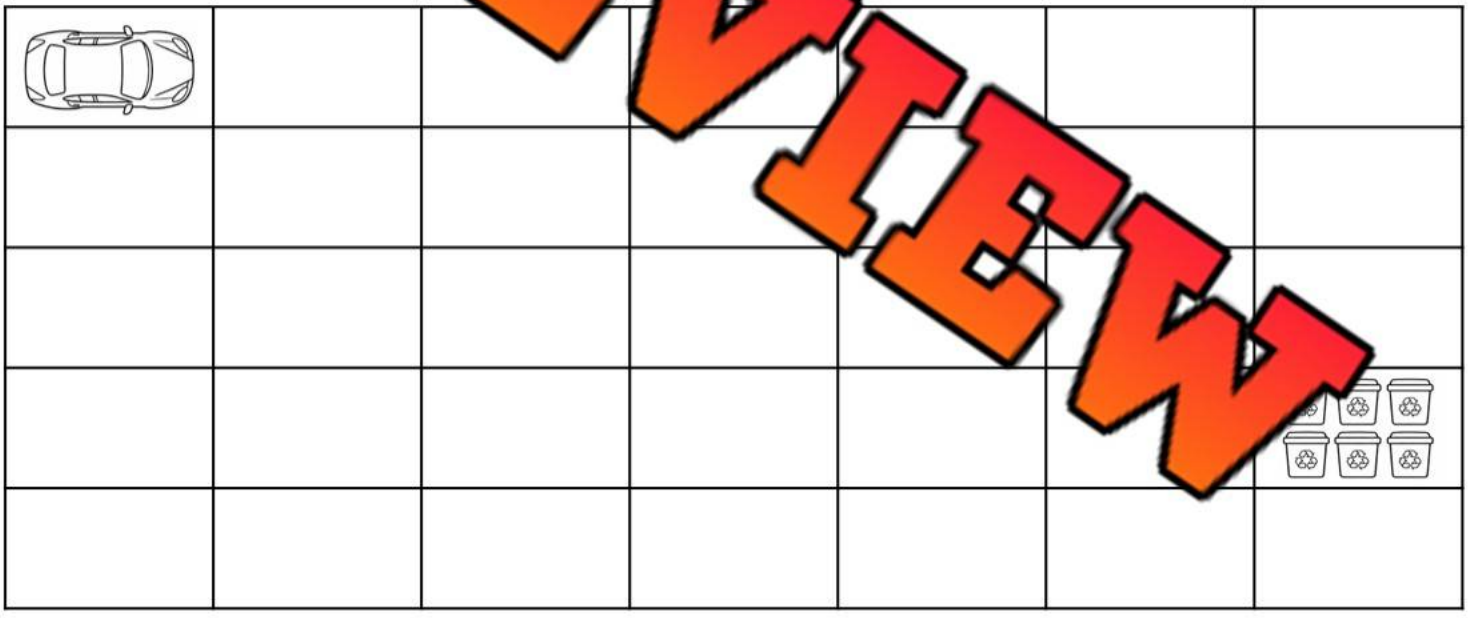
Curriculum Connection
A2.1

Self Driving Car – Writing Code

This is a self-driving car.	Right makes it turn right	Left makes it turn right	Forward makes the car move forward by the number shown
			
It und[illegible]and 3 commands	**Right**	**Left**	**Forward 1**

PREVIEW

Directions Write th[illegible] get the car full of recycling to the bins.



Code #1 – 2 Codes	Code #1 – 3 Codes	Code #3 – 3 Codes
_____	_____	_____
_____	_____	_____
_____	_____	_____

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Name: _____ 106

Curriculum Connection
A2.1

If Then Conditional Statements - Activity



PREVIEW

Directions Will the code get the car to the [illegible]ot, re[illegible]the code.

Code
Right
Forward 3
Left
Forward 5
Right
Forward 1
Left
Forward 1
Will it work?
Yes No

Code

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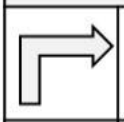
Name: _____ 107

Curriculum Connection
A2.1

Coding – Robot Lawn Mower

This is a self-driving lawn mower	Right makes it turn right	Left makes it turn right	Forward makes the car move forward by the number shown
	 	 	
It und... c...	**Right**	**Left**	**Forward 2**

PREVIEW

Directions code ... he lawn mower to cut the field of grass.

Codes – Forward, Tu... Tu...	
Line 1	
Line 2	
Line 3	
Line 4	
Line 5	
Line 6	
Line 7	
Line 8	
Line 9	



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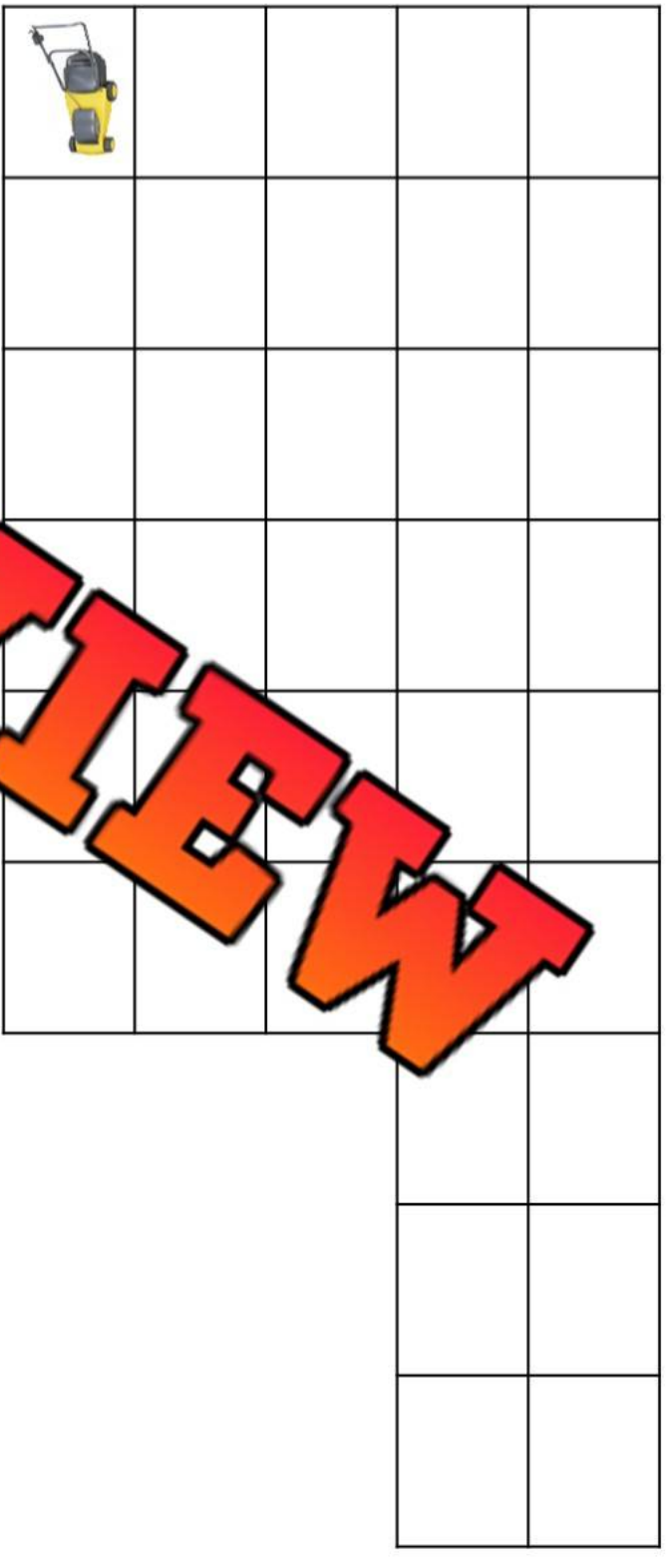
Name: _____ 108

Curriculum Connection
A2.1

Coding – Robot Lawn Mower

Directions Write code to get the lawn mower to cut the field of grass.

Codes – Forward, Turn Left, Turn Right	
Line 1	
Line 2	
Line 3	
Line 4	
Line 5	
Line 6	
Line 7	
Line 8	
Line 9	
Line 10	
Line 11	
Line 12	
Line 13	
Line 14	
Line 15	
Line 16	
Line 17	
Line 18	
Line 19	
Line 20	
Line 21	



PREVIEW

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Name: _____ 109

Curriculum Connection
A2.1, A2.2

Coding – A Bulldozer's Displacement vs Distance



PREVIEW

Coding

Write code to move the bulld to the i e. T find the distance and displacement travelled. The bulldozer s from to another. Each square is 1cm squared. To find the dis ment d to use a ruler.

Job Site	Code		ment
1	Move left 13, up 8	21 cm	
2			
3			
4			
5			
6			
7			
8			
Total Distance		**Displacement at End**	

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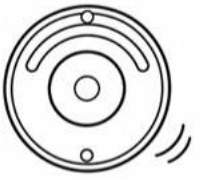
Curriculum Connection
A2.1, A2.2

Coding – Robot Vacuum and Mop

A robot mop/vacuum has three main functions – move around, vacuum up dust and dirt, and mop up spills and messes. To write a program that allows a robot mop/vacuum to work, we'll need three subprograms.



Sub-Programs

Write 3 sub-programs for each of the tasks below. Use sensors to sense if there is a spill or if the vacuum needs to move from a wall or stairs.

Sub-Program for Moving Around

Sub-Pr m for M g

Sub-Program for Vacuuming

PREVIEW

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Curriculum Connection
A2.1, A2.2

Now that we have our sub-programs defined, we'll need if/then statements to tell the vacuum when to perform the sub-programs. For example, if the on button is pressed, run move (sub-program for moving around). The next line of code might be another if statement, stating that if a spill is detected, use the mop, else, use the vacuum.

Programming Write the program for the robot vacuum/mop.

Program for Robot Mop/Vacuum

PREVIEW

Draw Sketch a picture of your robot vacuum. Make sure to inclu
any buttons that are needed for the user to input a command.



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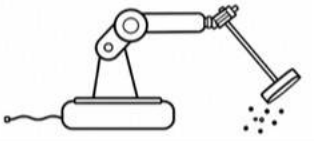
Curriculum Connection
A1.1, A3.1, A3.2, A3.3

STEM – Robot Technology

Robot technologies are improving people's lives by making our work easier. Robot vacuum's clean up our floors with the touch of a button. Robot lawn mowers will cut our grass without us even moving.

Think of another job that you don't like doing at home that a robot could do for you. Invent the robot by writing code that allows it to complete the job. Then decide how much you will sell it for and how much it will cost you.

You [illegible] think of an original idea or research robot technologies online. You could innovate a [illegible]isting idea by making it better.



Rese[illegible] A[illegible] questions below.

1) Which robot [illegible]y have [illegible]sen?

2) How will this robot techn[illegible]ke p[illegible]s easier?

3) How does your technology work? Write at least 2 th[illegible]u techno[illegible]oes. For example, a robot lawn mower moves and spins a blade. [illegible]ter[illegible]e sub[illegible]rograms for each of these things your robot does.

PREVIEW

Name: _____ 113

Curriculum Connection
A1.1, A2.1, A2.2

Coding Write the code that allows your technology to work.

Write subprograms for each of the things your technology does.



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Name: _____ 114

Curriculum Connection
A1.1, A2.1, A2.2

Programming	Write code that gets your technology to work. Refer to the sub-programs you already have written.



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Curriculum Connection
A1.1, A3.1, A3.2, A3.3

Draw Draw a sketch of your technology. Label the important parts that allow it to work.



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Curriculum Connection
A1.1, A3.2

STEM Math connection – answer the questions below.



1) If you were making this robot, how much would it cost you to make?

2) How many units will you make at first?

3) How much will this cost you in total?

4) How much will you sell each unit for?

5) How much money will you gross (earn) if you sell 20,000 units? For gross earnings, do not factor in the cost of each unit.

6) How much net profit will you earn if you sell 20,000 units? For net profit, you'll find the gross and subtract the cost to build the 20,000 units.

7) If you want to make $20 million in net profits, how many units will you need to sell?

PREVIEW

Name: _____ Date: _____

Unit Test – Systems in Action

Multiple Choice Circle the best answer.

1) What type of energy is released from splitting atoms? a) Chemical b) Mechani c) Electric d) Nucl	2) Which non-contact force involves the movement of charged particles. a) Gravitational Force b) Electrostatic Force c) Magnetism d) None of the above
3) A ta xerts w to support a water bottle on t a) Applied Force b) Normal Force c) Spring Force d) Tension Force	4) Which term is a vector quantity, meaning it requires both magnitude and direction? a) Displacement b) Distance ed Dire
5) If 500 N of force was applied and pus for 300 m, how much work is done? a) 1000 b) 1 500 c) 15 000 d) 150 000	6) A l m a heavier load by moving the um cl which end? a) tan b) Effor c) Middle d) None of the above

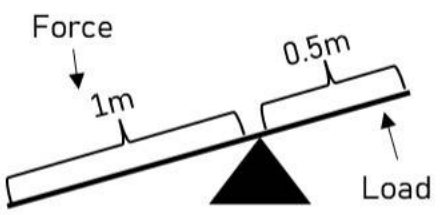
PREVIEW

Calculate Calculate the mechanical advantage below.

	Simple Machine	Input	Output	Mechanical Advantage
1)	Pulley	300 N	600 N	
2)	Lever	800 N	3 200 N	
3)	Inclined Plane	210 N	840 N	
4)	Screw	740 N	4 440N	
5)	Wedge		1 435N	3.5

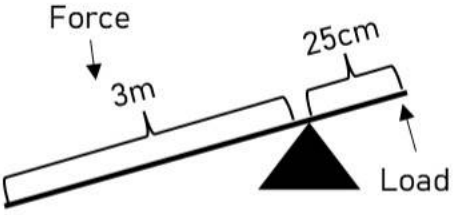
Calculate | Calculate the MA and output force in the examples below.

1)



MA	
Input Force	625 N
Output Force	

2)

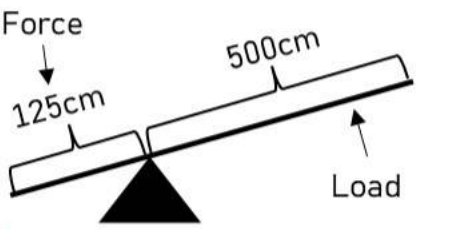


MA	
Input Force	775 N
Output Force	

3)



MA	
Input Force	
Output Force	1500 N



MA	
Input Force	
Output Force	1 220 N

PREVIEW

Questions | Answer the questions below.

1) Describe a system you know well. What is the purpose, inputs, and outputs of the system.

2) How is energy dissipated from a mechanical system?

Long Answer (5 marks each) **/10**

1) What technological innovations have improved productivity in manufacturing? How do these technologies improve productivity?

2) What are the impacts of automate[illegible]ns? H[illegible] they impact people, the economy, and the environment?

PREVIEW