UNIT LEARNING PACKS

FOCUS IN ACTION

Grade 8 Science in Action

Unit 4 - Mechanical Systems

EDQUEST
MIDDLE SCHOOL SCIENCE RESOURCES

http://www.edquest.ca

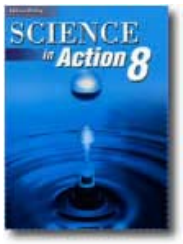
'Focus in Action' UNIT LEARNING PACKS

These booklets are designed to provide Grade 8 students with all the resources needed to review or reinforce concepts, covered in the Alberta Science Curriculum, and included in the Grade 8 Science Final Exam in June. There are circumstances in which **an entire unit** may be missed and covering the concepts from that unit (for the final exam) can be difficult. This can happen for a number of reasons:

- Students – new to the school – register throughout the year (from other provinces, school jurisdictions or countries)
- Students may be ill or have surgery and often can miss one or more units
- Students have extended holidays throughout the year
- Transfers from another school, who have completed the units in a different order

For additional support, students are directed to the **Edquest Middle School Science Website** or, Scienceman Resource (www.scienceman.com/scienceinaction/pgs/hot_8u4.html)

Unit 4 – Mechanical Systems



- **Section 1 Notes**
- **Section 1 Quiz**
- **Section 2 Notes**
- **Section 2 Quiz**
- **Section 3 Notes**
- **Section 3 Quiz**
- **Unit Summary**
- **Review Booklet**
  (Covered in class, prior to the Final Achievement Exam)
- **Unit 1 Test**
- **Answer Key for Section Quizzes and Unit Test**

The Elements of Machines:
http://www.mos.org/sln/Leonardo/InventorsToolbox.html

Additional support will be provided, in the form of practice Achievement Test Questions, during the course review in June. Multiple Choice Questions and Numerical Response Questions will be reviewed, as these are the types that will make up the Science 8 Final Exam

Handouts and other activities, to reinforce the concepts covered in this Unit, will be made available based on need. If you require further information or resources, email Edquest directly: edquest@gmail.com.

Finding Solutions to Problems, instead of Making Excuses

Student Instructions for use of this Learning Pack

The purpose of this Learning Unit Pack is to provide you with the resources that will help you cover the material from the curriculum that will be tested on the Final Exam in June.
Follow these steps to successfully complete this Unit Learning Pack:

Step 1 – Read the **Topic Notes**

Step 2 – Use a **highlighter** to identify the key words or phrases in the Topic Notes and reread the material again paying close attention to those words that you highlighted. If necessary, modify your highlights to make sure you understand the material in the notes.

Step 3 – Complete the **Topic Quiz**

Step 4 – Correct the Topic Quiz by **checking the answers** in the back of this Learning Pack.

Step 5 – Using your **textbook** and the **completed quiz**, find the page where the question and correct answer can be found and write it next to the question number in your Learning Pack.

Step 6 – **Repeat Steps 1-5** for each of the other Topics in this Unit.

Step 7 – Look over the **Unit Outline** to review the **Key Concepts** once you have completed all of the Topics.

Step 8 – Complete the **Unit Review**, using your **Learning Pack** and **Textbook**.

Step 9 – **Highlight** those sections of the Review that you had difficulty with and review those sections with your teacher prior to taking the Unit Test.

Step 10 – Take the **Unit Test** and correct it using the answer key provided in the back of the Learning Pack.

Step 11 – You should now be ready to answer any questions on the **Final Exam** related to this Unit.

Anything you still do not understand should be discussed with your teacher. Congratulations on your **Independent Study**, and Good Luck on the Final Exam. I hope you have made good use of this resource. Please provide feedback to your teacher, so that this resource can be improved.

Additional support is available in the form of practice Achievement Test Questions. **Multiple Choice Questions** and **Numerical Response Questions** will be made available on request, as these are the types that will make up the **Alberta Science 9 Achievement Exam**.

Handouts and other activities, to reinforce the concepts covered in this Unit may be acquired by visiting the Edquest Middle School Science Resource Website

http://www.edquest.ca

1.0 – Machines are tools that help humans do work

1.1 – Simple Machines - Meeting Human Needs

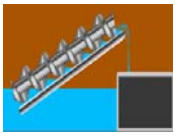
Machines help people use energy more efficiently. A machine helps us do work.

The earliest machines were simple devices to make work easier; like moving a large rock or moving a load up an incline, splitting wood or lifting materials up to a working area above the ground. These simple machines depended on people or animals as their source of energy.

Meeting the Same Need In Different Ways
Machines were built to satisfy basic human needs, such as getting water. Three devices used to get water in earlier times included:


Sakia (or, Persian wheel)


Roman aquaduct

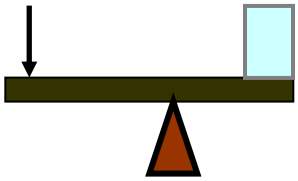

Achimedes screw

Simple Machines
A simple machine is a tool or device made up of one basic machine. There are six types of basic machines. http://www.fi.edu/qa97/spotlight3/spotlight3.html
http://www.usoe.k12.ut.us/curr/science/sciber00/8th/machines/sciber/intro.htm

Lever – is a rigid bar or plank that can rotate around a fixed point called a pivot, or fulcrum. Levers are used to reduce the force need to do a particular task. You can move a very large load, but you must move a greater distance than the load moves.
http://207.10.97.102/elscizone/lessons/land/simplmachines/3classes.htm

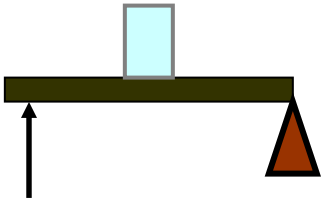
There are 3 classes of levers.  (a prybar can be all three classes of lever, depending on how it is used.)

Moving heavy loads



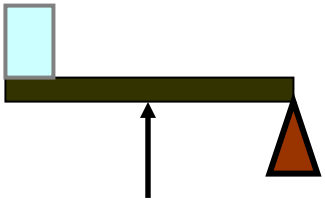
First Class Lever
crowbars and pliers

Lifting heavy loads



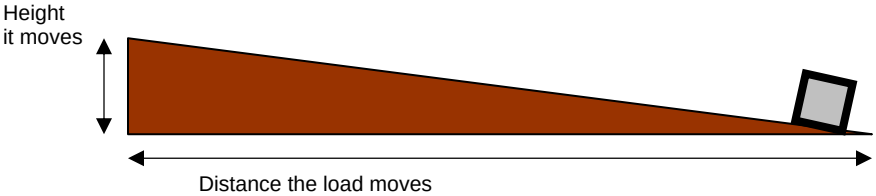
Second Class Lever
wheelbarrow

Gaining speed

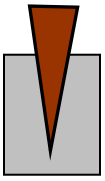


Third Class Lever
Hammer, your arm

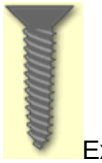
Inclined plane or ramp makes it easier to move a load higher than it is, but it has to be moved over a much longer distance. An inclined plane makes it possible to lift heavy objects using a smaller force (examples: loading ramp, wheelchair access ramp)



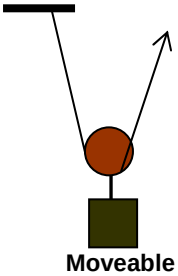
Wedge is similar in shape to an inclined plane, but is used in a different way (and can only be used in one direction). It is forced into an object to split it apart. The wedge increases the force applied to the object, but it moves a greater distance into the object than it splits apart.

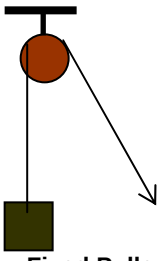
Examples:
axe blade  or, a knife

A **Screw** is a cylinder with a groove cut in a spiral on the outside. (It is actually an inclined plane that winds around itself) It helps you increase the force you use. It can be used to convert rotational (turning) motion to linear motion (movement in a straight line). It moves objects in a straight line very slowly.

 Examples include: jar lids, light bulbs, and spiral staircases

A **Pulley** consists of a wire, rope, or cable moving on a grooved wheel. One or more combinations of wheels and ropes can be fixed in place or moveable. Pulleys help you lift larger loads.


Moveable Pulley


Fixed Pulley

The **Wheel and Axle** is a combination of to wheels of different diameters that turn together - a lever that rotates in a circle around a center point or fulcrum. A longer motion on the wheel produces a more powerful motion on the axle. They can be used to increase the size of the force (steering wheel in a car) or the speed (bicycle wheels).

The Effects of Simple Machines


Change the direction of a force (a pulley on a flagpole)

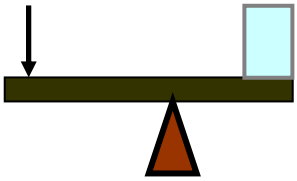
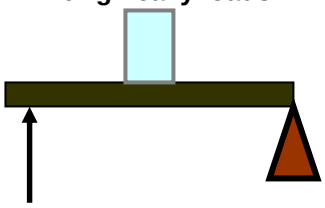
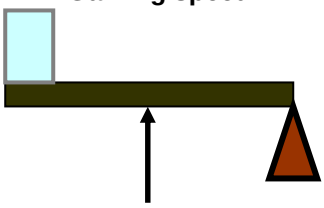
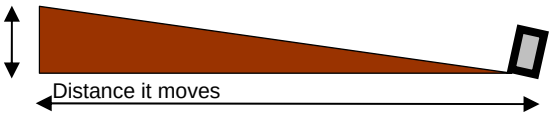
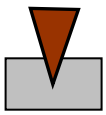
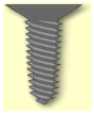
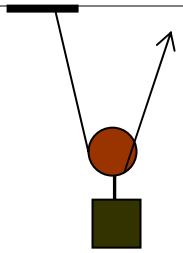
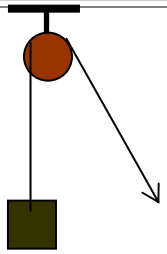
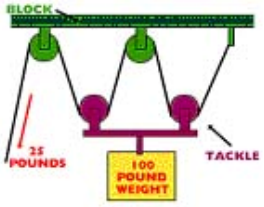

Multiply force (a screwdriver)


Increasing or decreasing speed (scissors)


Transferring force (removing staples)

See also the review notes here: http://www.connect.ab.ca/~lburns/students_eightunit2notes.html

Simple Machines (a brief summary)

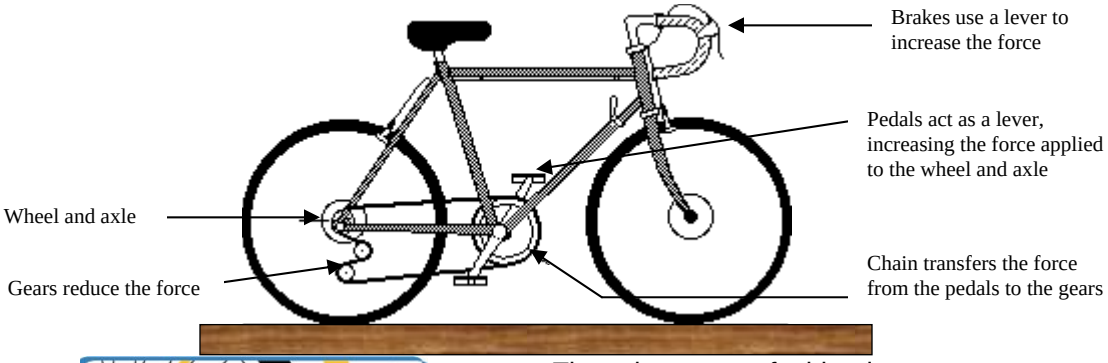
SIMPLE MACHINE	Function & Action	Applications
LEVER	A stiff bar resting on a fulcrum - lifts or moves loads	Shovel, nutcracker, seesaw, crowbar, elbow, tweezers
Moving heavy loads  **First Class Lever** *crowbars and pliers*	**Lifting heavy loads**  **Second Class Lever** *wheelbarrow*	**Gaining speed**  **Third Class Lever** *Hammer, your arm*
INCLINED PLANE	A slanted surface connecting a lower level to a higher level Things move up or down it	Slide, stairs, , ramp, escalator, slope
Height it moves  Distance it moves		
WEDGE	An object with at least one slanted side ending in a sharp edge Cuts or spreads an object apart	Knife, pin, nail, chisel, axe, snowplow, front of a boat
W E D G E 	S C R E W 	
SCREW	An inclined plane wrapped around a pole that holds things together or lifts	Screw, jar lid, vise, bolt, drill, corkscrew
PULLEY	A grooved wheel with a rope or cable around it, moving things up, down, or across	Curtain rod, tow truck, mini-blind, flag pole, crane
 **Moveable Pulley**	 **Fixed Pulley**	 **Block and Tackle**
WHEEL and AXLE	A wheel with a rod (axel) through its center: both parts move together to lift or move loads 	Car, wagon, door knob, pencil sharpener, bike, screwdriver 

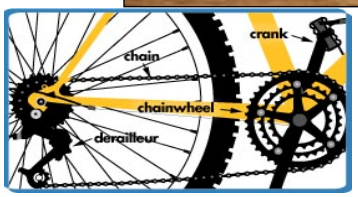
1.2 The Complex Machine – A Mechanical Team

As time passed, people expected more and more difficult tasks to be completed by machines. Machines became more complex. Power sources had to be developed to run these complicated machines. Over the last two centuries - coal, oil and electricity powered complicated machines were developed to do work in large factories. The industrial revolution used these large complicated machines to mass-produce goods for use by consumers.
The **steam engine** moved these good across countries in a very short time, giving people more and better access to food, clothing, tools and raw materials than previously. The standard of living had improved. The continual development of new technologies has lead to our virtual dependence on machines.

Complex Machines

Several simple machines all working together in a system are called **complex machines**. A **system** is a group of parts that work together to perform a function.
The **bicycle** is a good example of a complex machine because it is a system for moving a person from one place to another. Within the bicycle are groups of parts that perform specific functions, such as braking or steering. These groups of parts are called **subsystems**. Each subsystem in a complex machine contains a simple machine and usually has just one function.





The subsystems of a bicycle are:

- Wheel and axle
- Drivers & Gears
- Frames & Materials
- Brakes & Steering
- Aerodynamic design

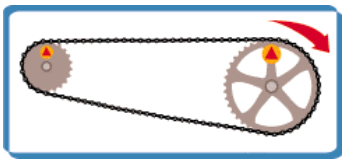
Explore the Science of Cycling at this website: http://www.exploratorium.edu/cycling/index.html
Build your Dream Bicycle: http://www.thetech.org/exhibits/online/topics/54j.html

Subsystems That Transfer Forces

The subsystems in a mechanical device that produce motion, such as in a bicycle, play a role in how energy is transferred within the system. The subsystems are called **linkages** and **transmissions**.

Linkages

The linkage is the part of the subsystem that transfers your energy from the pedals to the back wheel. In the bicycle, the chain is the linkage. In a car, the fan belt is the linkage from the engine to the cooling fan – to prevent the engine from overheating. Chains or belts form a direct link between two wheels – one that drives the motion and the other will follow in the same direction.



Transmissions

Machines that are more complex than a bicycle move much larger loads. A special type of linkage is needed. It is called a **transmission**. It transfers energy from the engine to the wheels. A transmission contains a number of different gears. This enables the operator to move the object slowly with a large force, or quickly with a smaller force.

Gears

Gears are essential components of most mechanical systems. They consist of a pair of wheels that have teeth that interlink. When they rotate together, one gearwheel transfers turning motion and force to the other.
There are many different types of gears. This website has just a few:
http://www.fi.edu/time/Journey/Time/Escapements/geartypes.html

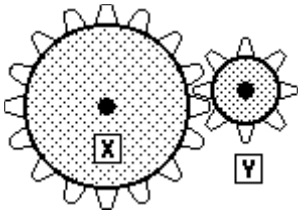
. Gears can also be used to change the direction of motion in a mechanical device, such as in an ***eggbeater.***

Gears can be used to increase or decrease force or speed

How Gears Work

Gears transfer energy in a mechanical system. Gear wheels – which are wheels with precisely manufactured, identical teeth around its edge - work together in gear trains of two or more wheels transferring rotary motion and force from one part of a complex machine to another part.

A smaller gear (Y) is called a **pinion**. The gear that supplies the energy is called the **driving gear** (X). The gear to which the force is directed is called the **driven gear** (Y).



How Gears Affect Speed

A ***large gear (X) driving a smaller gear (Y)*** decreases torque and **increases speed** in the driven gear. Gears such as these are called **multiplying gears**.

A ***small gear (Y) driving a larger gear (X)*** increases torque and **reduces speed** in the driven gear. Gears like these are called **reducing gears**. When the driving gear has fewer teeth than the driven gear, the driven gear then rotates more slowly than the driving gear. A car or bicycle in low gear uses reducing gears.

When the driving and the driven gears are the same size they are known as **parallel gears**.

Mechanical Systems - Section 1 Quiz

1.1 Simple Machines – Meeting Human Needs

1. The first machines depended on these for their source of energy …
A electricity and coal
B natural gas and wood
C humans and animals
D steam and wood

2. Mechanical systems for transporting water were developed by Roman engineers thousands of years ago. These systems supplied water to cities that were many kilometers from the water supply. The systems were known as …
A sakias
B aqueducts
C mill wheels
D Persian wheels

3. Archimedes designed a system for moving water from one place to another. His machine is still used today. It is based on the simple machine - the …
A lever
B wedge
C screw
D inclined plane

4. Scissors are a combination of what two machines?
A lever and wedge
B lever & inclined plane
C wheel and axle
D wedge and inclined plane

5. A teeter-totter an example of what class of lever?
A Class 1 lever
B Class 2 lever
C Class 3 lever
D Class 4 lever

6. A simple machine that converts rotational motion to linear motion is called …
A Class 1 lever
B Inclined plane
C Wedge
D Screw

7. A diving board is an example of a first class lever. The fulcrum is …
A between the load and the effort force
B at one end with the effort force in the middle
C at one end with the load in the middle
D at one end with the effort force at the other end

8. A simple machine, similar in shape to the inclined plane, but used to increase the force of moving an object is the …
A Class 1 lever
B Screw
C Wheel and axle
D Wedge

9. In most simple machines, you don't get something for nothing. When you gain a force advantage, you usually lose …
A effort
B speed
C distance
D resistance

10. Simple machines can be used for 4 different purposes. The purpose of a screwdriver is to ...
A Transfer the force
B Multiply the force
C Increase or decrease the speed
D Change the direction of a force

1.2 The Complex Machine – A Mechanical Team

11. The penny farthing was an early bicycle design that used only these types of simple machines …
A Levers and pulleys
B Incline plane & Screw
C Levers & wheel and axle
D Pulleys & wheel and axle

12. Devices that help that are made up of several simple machines are called complex machines. Because all the simple machines work together in these devices, they are considered to be a …
A system
B subsystem
C new technology
D complicated device

13. Within the bicycle, there are many different parts that have very different functions. Each of these parts performs a specific function so that the bicycle can perform its overall function – to move you around. The many different parts of the bicycle are called …
A subsystems
B system components
C technological devices
D complicated device

14. Linkages and transmissions are parts of a system that perform a specific function. The function they perform is to …
A increase torque
B increase speed
C transfer weight
D transfer force

15. In a bicycle, the part that transfers your energy from the pedals back to the wheel is the …
A axle
B gears
C chain
D sprockets

16. Transmissions are special types of linkages. It is used to transfer energy from the engine to the wheels in a car. A transmission contains a number of these that allow the driver to apply a large force to move objects slowly or a small force to move objects quickly. They are …
A chains
B fan belts
C gears
D linkages

17. An essential component of most mechanical systems, gears transfer motion and force to other gears and wheels. If the gear wheels are the same size they are called …
A Equal gears
B Twin gears
C Copy gears
D Parallel gears

18. Gears can also change the direction of motion. In an eggbeater, the crank turns the driving gear, which in turn makes the beaters rotate. The transfer of motion is …
A vertical to horizontal
B horizontal to vertical
C linear to rotational
D rotational to linear

19. Gears work together in trains of two or more gear wheels. The gear that has the force applied to it is called the …
A reduction gear
B multiplying gear
C driving gear
D driven gear

20. If a smaller gear is used to drive a larger gear, the gear train is a reducing gear. If a larger gear is used to turn a smaller gear, the gear train is a …
A parallel gear
B multiplying gear
C linear gear
D rotational gear

21. On a bicycle, gears are made up of flat, toothed disks called …
A linkages
B sprockets
C pinions
D torques

2.0 – An understanding of mechanical advantage and work helps in determining the efficiency of machines

2.1 –Machines Make Work Easier

Machines help people do things that they normally couldn't do on their own.

Mechanical Advantage
A machine makes work easier for you by increasing the amount of force that you exert on an object. This produces a **mechanical advantage**, which is the amount of force that is multiplied by the machine. The force applied to the machine (by you) is the ***input force***. The force that is applied to the object (by the machine) is the ***output force***.

Calculating Mechanical Advantage
The mechanical advantage of a machine is the output force divided by the input force.

$$\text{MA} = \frac{\text{Output Force}}{\text{Input Force}}$$

The mechanical advantage is the *force ratio* of a machine.

$$\text{MA} = \frac{\mathbf{F}_{\text{output}}}{\mathbf{F}_{\text{input}}}$$

$\mathbf{F}$ = Force in Newtons (**N**)

The more a machine multiplies the force, the greater is the mechanical advantage of the machine.

Speed Ratio
Speed measures the distance an object travels in a given amount of time. The measure of how a machine affects speed is called the **speed ratio**. It is calculated by dividing the ***input distance*** by the ***output distance***.

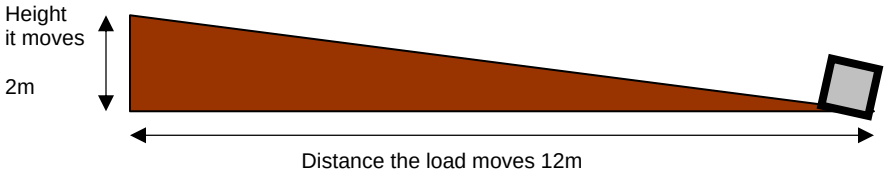
$$\text{SR} = \frac{\text{Input distance}}{\text{Output distance}}$$

$$\text{SR} = \frac{\mathbf{d}_{\text{input}}}{\mathbf{d}_{\text{output}}}$$

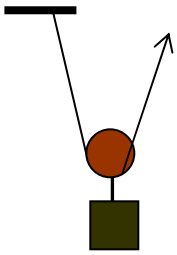
$\mathbf{d}$ = distance (**m**)

Using the formula provided, you can calculate the speed ratio of any device.

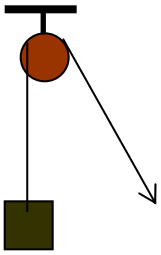
Less Force But Greater Distance
You do not get something for nothing when using a machine. The *advantage* to **gaining force** is offset by the *disadvantage* of **losing distance**.
An inclined plane makes it possible to lift heavy objects using a smaller force (examples: loading ramp, wheelchair access ramp), but you have to move the object over a much longer distance.



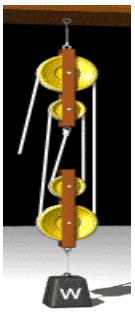
A **Pulley system** consists of one or more combinations of wheels and ropes, which can be fixed in place or movable. Pulleys help you lift larger loads. To calculate the **MA** of a pulley, count the number of ropes/cables **supporting the load**.



A single movable pulley
MA = **2**



A single fixed pulley
MA = **1**



Pulley System
MA = **4**

Pulley System
MA = **3**

A Mechanical Advantage Less Than 1
In the case of machines where the mechanical advantage is greater than 1 the machine is multiplying the input force to create a larger output force. If a machine has a mechanical advantage that is **less than 1**, it is useful for tasks that don't require a large output force. A bicycle is a machine with a mechanical advantage of less than 1. Even though it has a mechanical advantage of less than 1, the output force causes the bicycle to move faster than the rider could walk, so it is a very useful machine.

Comparing Real Mechanical Advantage With Speed Ratio
When people calculate mechanical advantage and speed ratio they may find that they are the same. In real situations however, when they are calculated, they can be very different. This is because of friction.

The Effect of Friction
The difference between the calculated value and the real (actual) value of mechanical advantage is friction, which is **a force that opposes motion**. Friction is caused by the roughness of materials. Because friction is a force in any device, additional force must be applied to overcome the force of friction. The mechanical advantage of the device will be less because of this added force that must be overcome. The speed ratio will not be affected. In fact, the speed ratio represents the *ideal mechanical advantage* of a machine – as if friction didn't exist. Friction in a system also causes heat, which can cause additional concerns.

Efficiency
Efficiency is a measure of how well a machine or a device uses energy. The more energy that is lost, the less efficient a machine is. Efficiency is represent in %.

$$\text{Efficiency} = \frac{\text{Mechanical Advantage}}{\text{Speed Ratio}} \times 100$$

In complex machines, there are many subsystems that are affected by friction and other factors. Because of this, most complex machines are not very efficient.

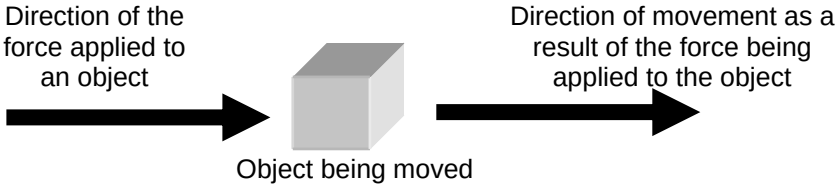
NO MACHINE CAN BE 100% EFFICIENT !!!!

2.2 The Science of Work

The Meaning of Work

Scientifically, work is done when **a force** acts on an object to make that object **move**.

In order to say that work is being done, there must be movement. If there is no movement, no matter how much force is used, no work is done.



For example; a worker uses force to move a large carton up a ramp. Energy (pushing) is transferred to the carton from the worker. Thus, we say that the worker did work on the carton as long as the carton moved up the ramp as a result of the worker's pushing action (force).

Calculating Work

The amount of work is calculated by multiplying the force times the distance the object moves.

The formula looks like this: $\mathbf{W = F \times d}$

Force is measured in Newtons and distance is measured in meters. The resulting work unit is called a **joule**, named after the English scientist James Joule.

Energy and Work

Energy and work are closely related, because without energy there would be no work. Work is done when there is a transfer of energy and movement occurs. Energy provides the force needed to make an object move. The energy can be in the form of human energy (muscle power – chemical reactions in the body producing energy) or it can be in the form of another energy source, such as gasoline (for a car). A machine transfers energy from its source to the object, causing the object to move. There is a very complicated chain of events that make a car move - beginning with it being fueled up with gasoline - all the way through its many subsystems (each doing work) - to eventually the tires rotating to make the car move forward or backward.

Work and Machines

There are different types of simple machines that can help us do work. The work done with a machine is the same as the work done without it. This can be shown by calculating work input and work output.

Work input is the work needed to use, or operate the machine

$$\text{Work}_{\text{input}} = \text{Force}_{\text{input}} \times d_{\text{input}}$$

Work output is the work done by the machine.

$$\text{Work}_{\text{output}} = \text{Force}_{\text{output}} \times d_{\text{output}}$$

Work and Friction

Friction is the reason that work input does not equal work output in real situations. Friction affects the machine's efficiency. Efficiency can be calculated using work input and work output.

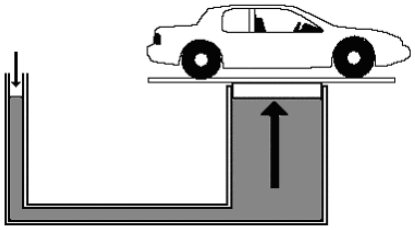
$$\textbf{Efficiency} = \frac{\textbf{Work}_{\text{output}}}{\textbf{Work}_{\text{input}}} \times 100$$

2.3 The Big Movers – Hydraulics

Most machines that move very large, very heavy objects use a hydraulic system that applies force to levers, gears or pulleys. A **hydraulic system** uses a liquid under pressure to move loads. It is able to increase the mechanical advantage of the levers in the machine.

Modern construction projects use hydraulic equipment because the work can be done quicker and safer. There are many practical applications of hydraulic systems that perform tasks, which makes work much easier.

A **hydraulic lift** is used to move a car above the ground, so a mechanic can work underneath it.



Pressure in Fluids
Pressure is a measure of the amount of force applied to a given area.

$$p = F / A$$

p is pressure **F** is Force and **A** is Area

The unit of measurement for pressure is a pascal (Pa), named after Blaise Pascal who did important research on fluids.

1 **Pa**scal is equal to the force of 1 **N**ewton over an area of 1 $\mathbf{m^2}$

Pascal discovered that pressure applied to an enclosed fluid is transmitted equally in all directions throughout the fluid. This is known as **Pascal's Law** and it makes **hydraulic** (liquid) and **pneumatic** (air) systems possible. A common application of Pascal's law is illustrated above, with the hydraulic jack.

A Piston Creates Pressure
In hydraulic systems, the pressure is created using a piston. Pistons can be different sizes and hydraulic devices use pistons that are different sizes attached to each other with a flexible pipe. The Input piston is used to apply force to the fluid, which creates pressure in the fluid. The fluid transfers this pressure to the output piston. This pressure exerts a force on the output piston and the result is a mechanical advantage that makes the hydraulic system very useful.

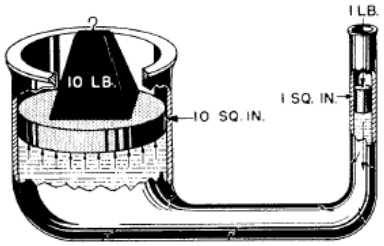
Mechanical Advantage In Hydraulic Systems
The mechanical advantage in a hydraulic system comes from the fluid pressure in the system.

Calculating the input force and the output force will give you the Mechanical advantage of the system.

MA = Output force / Input force

$MA = F_o x d_o / F_i x d_i$

MA = 10 / 1 = 10



This hydraulic system has a mechanical advantage of 10

Mechanical advantages in hydraulic systems are usually quite high, showing how useful they are.

Pressure and Mechanical Advantage

The reason for the large mechanical advantage in a hydraulic system is the ability of the fluid to transmit pressure equally. It allows you to use a small force on the small piston to produce a larger force on the large piston.

$$p = F / A$$

From Pascal's law, we know that the pressure the small piston creates is the same everywhere in the fluid. So the large piston has a larger area and is able to multiply the pressure because of its larger area. The force and area at each piston act as ratios that have to be equal.

$$\frac{\text{Force of the small piston}}{\text{Area of the small piston}} = \frac{\text{Force of the large piston}}{\text{Area of the large piston}}$$

$$\frac{F_{small}}{A_{small}} = \frac{F_{large}}{A_{large}}$$

By solving this ratio you will find that the forces created within a hydraulic system provides very large mechanical advantages - making them useful in many applications.

Larger Force – Greater Distance To Move

Mechanical advantage in hydraulic systems has a cost. That cost is the increased distance the smaller force must go through to make the large force move a small distance.

To increase the force on the output piston ,
the input piston must move through a greater distance.

Amusement park rides make extensive use of hydraulic systems

Mechanical Systems - Section 2 Quiz

2.1 Machines Make Work Easier

1. Roads in the mountains have sections to help vehicles up a steep incline, by making sharp turns back and forth in opposite directions, after raising the vehicle a little higher in altitude. These roads are an example of a simple machine – the inclined plane, and are called …

A reversals
B switchbacks
C zig zags
D turnabouts

2. Your car has a flat tire, but you don't have a jack to lift it up, so you can change the tire. What machine could you make that would make it possible to lift the car …

A lever
B wedge
C pulley
D ramp

3. Mechanical advantage is the amount by which a machine can multiply a force. The force that the machine applies to the object is called the …

A input force
B output force
C force ratio
D Newton force

4. To calculate mechanical advantage, or force ratio, you divide the output force by the input force. A machine that is able to move an object that weighs 36 Newtons with 6 Newtons of force has a mechanical advantage of …

A 6
B 30
C 36
D 42

5. A pulley system can provide a mechanical advantage.

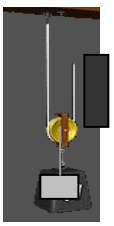
Look at the illustration and identify what the mechanical advantage of this pulley system is.

A 2 **B** 3 **C** 4 **D** 5

6. If it takes 45 N of force to lift a 180 N carton using a pulley system, what would the pulley system look like …

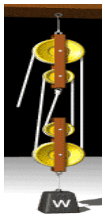
A

B



C

D



7. Speed Ratio is calculated by dividing the …
A Output distance by the input distance
B Input distance by the output distance
C Output force by the input distance
D Input force by the output distance

8. To calculate the speed ratio of a pulley system, you count…
A all the ropes
B only the ropes supporting the load
C only the ropes applying force
D all ropes that are movable

9. In most machines, you don't get something for nothing. When you gain a mechanical advantage, you are gaining …
A force
B speed
C distance
D resistance

10. A bicycle is a useful machine because it gets us from place to place much faster than we could walk. As a machine it has a mechanical advantage of less than one, but what about speed ratio? The speed ratio of a bicycle is ...
A 1
B more than 1
C less than 1
D cannot be determined

11. What can account for the fact that mechanical advantage and speed ratio are different in real situations?
A Improper calculations
B Faulty equipment
C Force of friction
D Loss of energy

12. Efficiency is a measure of how well a machine does work. Dividing the mechanical advantage by the speed ratio and multiplying the result by 100 will determine the efficiency of the machine. A pulley system that has a speed ratio of 3 and a mechanical advantage of 2 has an efficiency of ....
A 33%
B 67%
C 60%
D 30%

2.2 The Science of Work

13. The scientific definition of work is … "Work is done when a force acts on an object to make the object move." Which statement below describes work being done.
A Hank worked very hard to get all his homework done.
B Doing math is hard work if you don't like numbers.
C It was hard work for Sam to move the desk two meters.
D It was hard work trying to move the car, but it wouldn't budge.

14. Work is calculated using the formula – W = F x d. If you lift a box onto your desk that is .4 meters off the floor, using 50 Newtons of force, how much work are you doing?
A 20 Joules
B 125 Joules
C 50.4 Joules
D 49.6 Joules

15. In a car, what provides the force (energy source) that makes work (the car moving) possible?
A engine
B transmission
C gasoline
D wheels

16. Using a machine does not mean that less work is done. This is because …
A Work input is never equal to work output
B Work input is equal to work output
C Less force means less distance
D More force means more distance

17. When determining the efficiency of a certain machine, the students found that 1600J of work were needed to get 1200J of work from the machine. The efficiency of this machine was …
A 2800J
B 400J
C 75 %
D 25%

2.3 The Big Movers - Hydraulics

18. A hydraulic system is able to move heavy loads because it uses this under pressure …
A air
B water
C liquid
D nitrogen

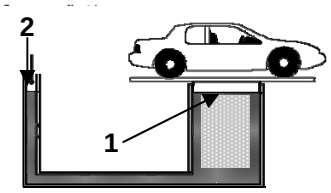
19. Hydraulic systems are used in many different applications. A hair stylist would use hydraulics in their shop to do this …
A mix chemicals and dyes
B operate electric shears
C run the neon signs
D raise and lower the chair

20. Pressure is the measure of the force applied to a specific area. The unit of measurement is named after Blaise Pascal who worked with fluids. The unit of measure is the …
A blaise
B pascal
C kilogram
D cubic centimeter

21. **Pascal's Law** states that pressure applied to an enclosed fluid is transmitted …
A to the walls of the container which double the pressure
B equally in all directions throughout the fluid
C by the transfer force in the fluid
D to the opposite piston where it increases the force

22. Pascal's law enables these types of systems to work very effectively – hydraulics, which use a liquid and pneumatics, which use …
A air
B oil
C water
D grease

23. A common application of the hydraulic system is the hydraulic jack, like the one shown here …

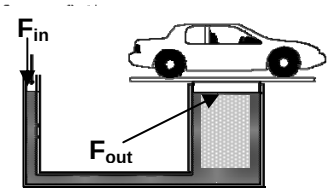


The piston identified by # 1 is the …
A syringe piston
B hoist piston
C output piston
D input piston

24. The mechanical advantage in a hydraulic system is provided by the …
A small piston
B large piston
C flexible connection
D pressure in the fluid

25. A good example of a hydraulic system at work inside the body is the …
A Respiratory system
B Digestive system
C Circulatory system
D Excretory system

26. The hydraulic jack, like the one shown here, identifies the input force piston and the output force piston …
F_{in} = 50N
F_{out} = 1500N



The mechanical advantage of this hydraulic jack is …
A 30
B 300
C 1000
D 2000

27. If the area of the ***input piston***, in the hydraulic lift shown in the question above, is $5cm^2$, what would be the area of the ***output piston***?
A $10cm^2$
B $30\ cm^2$
C $150\ cm^2$
D $300\ cm^2$

28. The disadvantage of the hydraulic system is similar to the disadvantage of levers and pulleys. To increase the force on the output piston, the input piston has to …
A have less fiction
B create more pressure
C move a greater distance
D be attached to the load

3.0 – Science, society, and the environment are all important in the development of mechanical devices and other technologies.

3.1 –Evaluating Mechanical Devices

Mechanical devices have evolved over time because of science and the development of new technologies. The design and function of a mechanical device is related to its efficiency and effectiveness. What effect it has on the environment and how advancements in science through knowledge, trial and error can also help to stimulate change. Mechanical devices are constantly being evaluated to find ways they can be improved.

Using Criteria To Evaluate A Device

When a device has broken down or become ineffective in performing its function, making decisions as to what new device will replace the broken device have to be made with specific criteria in mind. The list of criteria you decide on will determine how well the replacement will meet your needs.

The criteria might include:

- Use
- Purpose
- Cost
- Esthetics
- Workmanship
- Reputation

Efficiency and Effectiveness

Mechanical devices are designed to work efficiently, which can be calculated by, dividing its mechanical advantage and by its speed ratio. This is a **quantitative measure** of efficiency, because it gives you a number or quantity of how efficient the device is.

Efficiency can also be described in **qualitative** terms. In other words, words can describe how quickly or easily the device performs the task it is designed for. It is efficient, if it does the task well enough to meet your needs.

Efficiency and effectiveness can be compared when analyzing the designs of different devices that do the same task (such as the bicycle). Usually you are looking for the best combination of efficiency and effectiveness at a cost you can afford.

Function and Design

Scientists, engineers and inventors want to develop mechanical devices that work the best for the work they are designed to do. The function is the purpose and the design is the form. The design should suit the function.

Evaluation For Development

Another reason for evaluating a device is to determine how it can be improved. The environment can have an impact on the design of a device as well. The development of mountain terrain bicycles came as a result of how the bicycle would best function in the rough terrain it would be used in.

Considering The Environment
The effect of a device on the environment should also be considered in evaluating it. The negative impact on the environment should not outweigh the usefulness or effectiveness of the device.

Evaluating A Mechanical Device – A Case Study
The pop can opener has changed over the years and these changes can help to explain how evaluation can lead to improvement. The improvements can make the device more convenient and can affect the people using it as well as the environment. The history of this device show how trial and error can play a role in improving technology.

The pop can opener went through four distinct designs:
- The church key
- The removable tab
- The buttons
- The non-removable tab

Each new design was the result of improving upon the previous design – which had a problem.

Evolution Of A Mechanical Device – The Pop Can Opener
To pour a liquid out of any container, you need two holes or one large hole. With two holes, the first hole allows air into the can, the second hole lets the liquid flow out.

Can Opener Design	Advantages	Disadvantages
Iron Can **1810**	Kept things sealed	Had to be opened with a hammer and a chisel
Steel Can Late **1800's**	Opened with a **church key**  A simple lever	Needed to have a church key handy to open it
Aluminum Can **1958**	Can opened by wrapping the metal around a key the 'side-seamer' (1877) Lightweight	Sharp edges 
Removable Pull Tab **1963**	Ringed tab made it easy to open	Sometimes the ring detached from the tab and the can couldn't be opened It also caused a **litter** problem and a safety hazard – because of the sharp edges of the tab
Push Button Tabs Mid **1970's**	Litter problem was solved	Hard to push the small button open, consumers didn't like using cans with two buttons
Non-removable Pull Tab **1980** 	The **'ecology top'** – because the tab stayed attached to the can By wiggling it back and forth, it could be broken off	The ring would not puncture the tab, but would break off, but it is the best solution thus far

Criteria For Evaluation
The changes to the pop can didn't happen by accident. Careful evaluation and improved designs to perform the function help make the can opening changes more effective and efficient. Questions about safety, convenience, environmental effect and recycling potential were all factors that contributed to improvements being made. What are you looking for in the device? is one of the first questions you should answer when evaluating a device.

3.2 Technology Develops Through Change

New materials and technology, human and environmental needs all contribute to the development of changes to current devices. When failure occurs, modifications must also be made to ensure the device performs its intended function effectively and efficiently. Trail and error also can play a role in technology development. Early devices were usually operated by hand. Improvements to the device, by making it perform its task more easily, came as people tried to make the device perform more efficiently with less effort. The invention of electricity also contributed to improvements.

Advances In Science Result In New Technology
Charles Coulomb first identified electric charges in the 1700's, but it took almost 100 years to make electricity widely available to major Canadian cities, and it took until the 1940's to make it available to most communities in Canada. As scientists and engineers learned more about this new energy source, they found ways to use it in new technologies, such as the light bulb and the electron microscope.

From Particles To Trains
New technology can also develop from unrelated research. The **MAGLEV** (Magnetic Levitation) trains in Japan operate on super-conductive magnets, powered by electricity. They can travel at speeds over 350 km/h floating on the rails. The technology for the MAGLEV resulted from physics experiments using particle accelerators (huge machines used to break apart atoms and other particles of matter) which use large mounts of electricity to create powerful; magnetic and electric fields.

Changes In Society Result In New Technology
New technology can also result from changes to human society. Robots were originally popularized in movies and comic books. The word robot comes from the Czech word ***'robotnik'***, meaning workers, or slaves. They were thought to be 'human-like' machines that could do the work of humans. It was originally used in a play where millions were manufactured to work as slaves in factories. Most robots today don't really appear to be human-like, but they do the work of many humans, mostly in industry. The first practical robots were developed in the 1960's. Robots today weld car bodies together, diffuse bombs, perform surgery, help the handicapped and even explore other planets.

Changing Society – Changing Technology
The drive to develop more effective and efficient robots came from the need to replace humans in the workplace. This was because humans were demanding more money for less hours of work and production costs were soaring. Industry decided to replace humans with robots – and most of these were just 'smart arms'.

The Anatomy of a Robot This website will give you a comprehensive look at robots past and present.
http://www.bbc.co.uk/science/robots/index.shtml

Robots have 6 basic components:
A Body, Motor devices, Power Source, Sensors, Output devices and Microprocessors. (p. 318)

Changes In The Environment Result In New Technology
Since the early 1960's the environment has impacted technological development because people wanted to repair the negative impacts they had made on the environment. New technologies (like *recycling*) were needed to prevent more damage. Processing materials over and over or making them *biodegradable* would address some of the issues. Other technologies (like *oil skimmers*) would help make environmental clean-up more effective and prevent further damage.

Mechanical Systems - Section 3 Quiz

3.1 Evaluating Mechanical Devices

1. During the research phase, when a device is improved upon, certain criteria are taken into account. Of the criteria listed below, which would be the least important ...
   - **A** function
   - **B** efficiency
   - **C** effectiveness
   - **D** convenience

2. Mechanical devices are evaluated so that the consumer who is ultimately going to use it can make a better choice. Another important reason to carefully evaluate a mechanical device is to ...
   - **A** determine how it can be improved
   - **B** lower its cost
   - **C** make it more fashionable
   - **D** find its esthetic value

3. The design of mountain bikes to handle the rough terrain they would be used in, is considered to be evaluating a function because of this influence ...
   - **A** mass appeal
   - **B** mass demand
   - **C** environment
   - **D** ergonomics

4. Opening a can has evolved from the earliest cans which were made from iron in 1810. These can were opened by using a …
   - **A** church key
   - **B** hammer and chisel
   - **C** push button
   - **D** removable tab

5. The design and development of opening mechanisms for aluminum cans went through four distinct designs. To get the liquid out of the can you need one large hole or two smaller holes. If two holes are needed, the first is designed to let air into the can, and the second hole is designed to …
   - **A** create pressure
   - **B** restrict the flow
   - **C** let the fluid out
   - **D** be just for show

6. The church key was the first practical design for opening a can. It was a simple machine that multiplied the force needed to open the can. The simple machine it was designed after was the …
   - **A** wedge
   - **B** 1st class lever
   - **C** 2nd class lever
   - **D** 3rd class lever

7. Another simple machine was built into the removable tab top. It consisted of a small ring that acted like a lever and would make the necessary hole by removing the tab from the can. This was a huge improvement, but it also created a huge problem. The problem it created was …

A scientific
B environmental
C industrial
D commercial

8. By pressing on one of the buttons first - to release the pressure of the contents - before pressing on the second one - to have a hole large enough to drink out of - button cans were less problematic. The pressure in the can came from ...

A atmospheric pressure
B force applied to the button
C the contents of the can
D external force causing internal pressure

9. Environmental concerns created further improvements in can-opening devices throughout the 20th century. The 'ecology top' was the name given to the …

A Church Key
B Removable Tab Top
C Button Top
D Non-removable Tab Top

10. **CSA** is a non-government association that tests and approves a wide range of products to ensure they are safe for use by the consumer. CSA stands for ...

A Consumer Standards Agency
B Consumer Safety Association
C Canadian Standards Agency
D Canadian Standards Association

11. In a real evaluation of a mechanical device, designers always begin with ...

A a list of things that they want in the device
B ideas of how to start mass production of the device
C cost-effectiveness issues and marketing strategies
D ways that safety and efficiency can be improved upon

3.2 Technology Develops through Change

12. Sometimes a new device is designed when someone who thinks there can be an easier way to do something makes an observation. An inventor observed a driver manually cleaning snow and ice off the windshield of a streetcar in freezing cold weather, this observation prompted the invention of this ...

A windshield heater
B windshield washer
C windshield wiper
D windshield defroster

13. Advances made in the technological improvement of mechanical devices came as a result electricity. The widespread use of electricity outside of Canadian towns and cities didn't occur until the ...

A 1700's
B 1800's
C 1920's
D 1940's

14. New technologies often develop from scientific research that seems to be unrelated. Particle accelerator research experiments led to the technology behind trains powered by electricity and magnets. These trains 'float' on the tracks. They are known as …

A MAGIC
B MALLEG
C MAVEEG
D MAGLEV

15. A particle accelerator is a huge complex machine that does this …

A creates new particles
B breaks up atoms
C makes new elements
D creates space in particles

16. Robot technology is widely available and in use today, mainly in industry. The first use of the term **'*robotnik*'**, which is a Czech word meaning 'workers' or 'slaves', was in a Czechoslovakian …

A factory
B school
C play
D storybook

17. Improvements in robot technology came as a result of industry trying to …

A Improve the assembly of consumer products
B Improve the margin of safety in all products
C Reducing the workload of the workers
D Replace workers because of high wages

18. Robots are extremely complex devices and vary widely in appearance, depending on the job they are designed to do. A simple robot however has some or all of these basic parts: body, motor devices, power source, sensors, output devices, microprocessors. **Spirit** and **Opportunity** are robot rovers on the planet Mars. The solar panels on the robots are examples of these basic parts …

A Motor devices
B Sensors
C Power source
D Microprocessors

REVIEW Outline

Unit 4 – Mechanical Systems

1.0 Machines are tools that help us do work

- A **machine** is a device that helps us do work
- Energy for machines to operate is provided by people, animals, electricity, fossil fuels
- Six simple machines: the **lever**, **inclined plane**, **wedge**, **screw**, **pulley** and **wheel and axle**
- **Complex machines** are made up of two or more simple machines
- **Gears, linkages** and **transmissions** connect subsystems and help to transmit the force in complex machines

2.0 Mechanical Advantage

- **Mechanical Advantage** is a measure of how much a machine can increase an applied force
- **Speed Ratio** – how speed is affected by a machine
- **Work** is done when a force acts on an object to make it ***move***
- Machines help us do work by transferring energy
- **Efficiency** is a measure of how well a machine uses energy and can be calculated **quantitatively** (mechanical advantage divided by speed ratio multiplied by 100)
- **NO MACHINE can be 100% efficient** (because of friction)
- Hydraulic systems work because of **Pascal's Law** (Unit 1 – 3.0)

3.0 Science, Society and The environment

- Function (what it is supposed to do) and design (physical form that makes it useful) are two important aspects of mechanical devices
- Evaluation criteria: efficiency, effectiveness, impact on humans and the environment
- Efficiency described **qualitatively –** *efficiency is when a task is easier and quicker to do using a machine*
- Technology development is influenced by scientific knowledge, trial and error and changes in society and the environment

Review Booklet

1.0 Machines are tools that help humans do work

Key Concepts
- systems and subsystems
- transmission of force and motion
- simple machines

What is a machine designed to do?

_____

How did ancient machines pave the way for improvements?

_____

What is a simple machine?

_____

Describe the different types of simple machines and give examples of each type

Machine	Description	Illustration	Examples
lever			
inclined plane			
wedge			
screw			
pulley			
wheel and axle			

Illustrate and give examples of the three classes of levers.

Lever Type	Illustration	Examples
1st Class		
2nd Class		
3rd Class		

Simple machines can be used to obtain 4 different effects! Briefly describe each effect.

1 _____

2 _____

3 _____

4 _____

Identify the different machines that make a bicycle

What are the functions of **linkages**?

_____

_____

What are the functions of **transmissions**?

_____

_____

What are **gears** used for in mechanical devices?

_____

_____

Illustrate the following types of **gear trains** and briefly explain what they would be used for.

Parallel Gears	Multiplying Gears	Reducing Gears
Uses		
_____ _____ _____	_____ _____ _____	_____ _____ _____

2.0 ***An understanding of mechanical advantage and work helps to determine the efficiency of machines.***

Key Concepts
- mechanical advantage, speed ratios and force ratios
- mechanical advantage and hydraulics
- measurement of work in joules

What is **mechanical advantage**?

_____

_____

How do you calculate **mechanical advantage**?

What is **speed ratio**?

_____

_____

How do you calculate **speed ratio**?

What is the **disadvantage of a force advantage** in a machine?

_____

_____

What machine has a **mechanical advantage of less than 1** – why would it be useful?

Describe the difference between **real mechanical advantage** and speed ratio.

What effect does **friction** have on a machine?

How is the **efficiency** of a machine calculated?

What is the **scientific definition of work**?

How is **work** calculated?

Why is **work done with a machine** is **the same** as **work done without a machine**?

How does **friction** affect the equality between **work input and work output** in real situations?

_____

_____

What is a **hydraulic system**?

_____

How does it work?

_____

_____

What does **Pascal's Law** state in relation to fluids in an enclosed system?

_____

_____

How is **mechanical advantage** determined in hydraulic systems?

_____

_____

Illustrate and Calculate the mechanical advantage of a sample hydraulic lift:

Input piston has an area of 1.5m2 - **Output piston** has an area of 30m2
Force applied on the **Input piston** is 25N - How much of a load can be lifted?

What is the **mechanical advantage** of this hydraulic system?

3.0 ***Science, society, and the environment are all important in the development of mechanical devices and other technologies.***

Key Concepts
- design and function
- social and environmental impacts

What criteria are usually used to evaluate a mechanical device?

_____

_____

_____

Describe the evolution of the pop can opener which lead to improvements in design.

Can Opener Design	Advantage (What improvement it made)	Disadvantage (Reason for Redesign)
Hammer and Chisel  **1800's**		
Church Key  **1950's**		
Removable Pull Tab  **1963**		
Push Button Tabs  **Mid 1970's**		

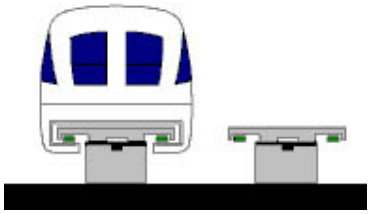
Efficiency described **qualitatively –** *efficiency is when a task is easier and quicker to do using a machine*

Your new and Improved Pop Can Design

Technology develops through change!

Technology development is influenced by scientific knowledge, trial and error and changes in society and the environment

Describe how each of the following results in new technologies being developed.

Invention	
Windshield wiper blade 	
Advances in Science	
Magnetic Levitation Trains 	
Changes in Society	
Robots 	
Changes in the environment	
Oil Spill Skimmer 	

Mechanical Systems Unit Test

1.1 Simple Machines – Meeting Human Needs

1. Mechanical systems for transporting water were developed by Roman engineers thousands of years ago. These systems supplied water to cities that were many kilometers from the water supply. The systems were known as …

A sakias
B aqueducts
C mill wheels
D Persian wheels

2. Archimedes designed a system for moving water from one place to another. His machine is still used today. It is based on the simple machine - the …

A lever
B wedge
C screw
D inclined plane

3. Scissors are a combination of what two machines?

A lever and wedge
B lever & inclined plane
C wheel and axle
D wedge and inclined plane

4. A simple machine that converts rotational motion to linear motion is called …

A Class 1 lever
B Inclined plane
C Wedge
D Screw

5. A simple machine, similar in shape to the inclined plane, but used to increase the force of moving an object is the …

A Class 1 lever
B Screw
C Wheel and axle
D Wedge

6. Simple machines can be used for 4 different purposes. The purpose of scissors is to ...

A Transfer the force
B Multiply the force
C Increase or decrease the speed
D Change the direction of a force

1.2 The Complex Machine – A Mechanical Team

7. The penny farthing was an early bicycle design that used only these types of simple machines …

A Levers and pulleys
B Incline plane & Screw
C Levers & wheel and axle
D Pulleys & wheel and axle

8. Devices that help that are made up of several simple machines are called complex machines. Because all the simple machines work together in these devices, they are considered to be a …
A system
B subsystem
C new technology
D complicated device

9. Linkages and transmissions are parts of a system that perform a specific function. The function they perform is to …
A increase torque
B increase speed
C transfer weight
D transfer force

10. Transmissions are special types of linkages. It is used to transfer energy from the engine to the wheels in a car. A transmission contains a number of these that allow the driver to apply a large force to move objects slowly or a small force to move objects quickly. They are …
A chains
B fan belts
C gears
D linkages

11. Gears can also change the direction of motion. In an eggbeater, the crank turns the driving gear, which in turn makes the beaters rotate. The transfer of motion is …
A vertical to horizontal
B horizontal to vertical
C linear to rotational
D rotational to linear

12. If a smaller gear is used to drive a larger gear, the gear train is a reducing gear. If a larger gear is used to turn a smaller gear, the gear train is a …
A parallel gear
B multiplying gear
C linear gear
D rotational gear

13. On a bicycle, gears are made up of flat, toothed disks called …
A linkages
B sprockets
C pinions
D spokes

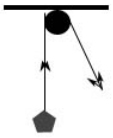
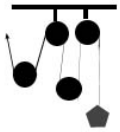
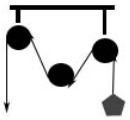
2.1 Machines Make Work Easier

14. What accounts for mechanical advantage and speed ratio being different in real situations?
A Improper calculations
B Faulty equipment
C Force of friction
D Loss of energy

15. Mechanical advantage is the amount by which a machine can multiply a force. The force that the machine applies to the object is called the …
A input force
B output force
C force ratio
D Newton force

16. Roads in the mountains have sections to help vehicles up a steep incline, by making sharp turns back and forth in opposite directions, after raising the vehicle a little higher in altitude. These roads are an example of a simple machine – the inclined plane, and are called …
A zig zags
B reversals
C turnabouts
D switchbacks

17. If it takes 90 N of force to lift a 270 N carton using a pulley system, what would the pulley system look like …

A  **B**  **C**  **D** 

18. Speed Ratio is calculated by dividing the …
A Output distance by the input distance
B Input distance by the output distance
C Output force by the input distance
D Input force by the output distance

19. Efficiency is a measure of how well a machine works. Divide the mechanical advantage by the speed ratio and multiply the result by 100 to determine the efficiency of a machine. A pulley system with a speed ratio of 5 and a MA of 3 has an efficiency of ....
A 30%
B 33%
C 40%
D 60%

2.2 The Science of Work

20. The scientific definition of work is … "Work is done when a force acts on an object to make the object move." Which statement below describes work being done.
A Hank worked very hard to get all his homework done.
B Doing math is hard work if you don't like numbers.
C It was hard work for Sam to move the desk two meters.
D It was hard work trying to move the car, but it wouldn't budge.

21. Work is calculated using the formula – W = F x d. If you lift a box onto your desk that is .4 meters off the floor, using 50 Newtons of force, how much work are you doing?
A 20 Joules
B 125 Joules
C 50.4 Joules
D 49.6 Joules

22. Using a machine does not mean that less work is done. This is because …
A Work input is never equal to work output
B Work input is equal to work output
C Less force means less distance
D More force means more distance

23. When determining the efficiency of a certain machine, the students found that 1600J of work were needed to get 1200J of work from the machine. The efficiency of this machine was …
A 2800J
B 400J
C 75 %
D 25%

24. (***Efficiency = work output / work input*** X ***100***) A pulley system that lifts a 100N load with a force of 20N. requires an input distance is 3m with an output distance of 0.5m. The efficiency of this pulley system is ...
A 62.5%
B 75.0%
C 83.3%
D 92.75%

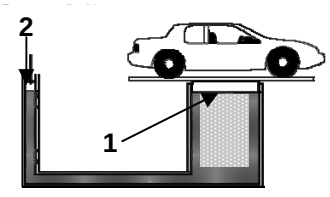
25. Crash test dummies are used to test safety in vehicles. The **main reason** for this is because they are ....
A inexpensive to use
B realistic
C easily repaired
D non-living

2.3 The Big Movers - Hydraulics

26. **Pascal's Law** states that pressure applied to an enclosed fluid is transmitted …
A to the walls of the container which double the pressure
B equally in all directions throughout the fluid
C by the transfer force in the fluid
D to the opposite piston where it increases the force

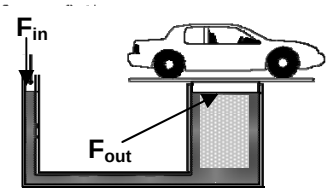
27. Pneumatic systems use air and are used in many different applications. Dentists would use pneumatics in their office to do this …
A run the tooth drill
B run the amalgum mixer
C operate x-ray machine
D raise and lower the chair

28. A common application of the hydraulic system is the hydraulic lift, like the one shown here …



The piston identified by # 2 is the …
A syringe piston
B hoist piston
C output piston
D input piston

29. The hydraulic jack, like the one shown here, identifies the input force piston and the output force piston …
F_{in} = 50N
F_{out} = 1500N



The mechanical advantage of this hydraulic jack is …

A 30
B 300
C 1000
D 2000

30. If the area of the ***input piston***, in the hydraulic lift shown in the question above, is 5cm^2, what would be the area of the ***output piston***?

A 10cm^2
B 30 cm^2
C 150 cm^2
D 300 cm^2

3.1 Evaluating Mechanical Devices

31. During the research phase, when a device is improved upon, certain criteria are taken into account. Of the criteria listed below, which would be the least important ...

A function
B efficiency
C effectiveness
D convenience

32. The design of mountain bikes to handle the rough terrain they would be used in, is considered to be evaluating a function because of this influence ...

A mass appeal
B mass demand
C environment
D ergonomics

33. Opening a can has evolved from the earliest cans which were made from iron in 1810. These can were opened by using a …

A church key
B push button
C removable tab
D hammer and chisel

34. The design and development of opening mechanisms for aluminum cans went through four distinct designs. To get the liquid out of the can you need one large hole or two smaller holes. If two holes are needed, the first is designed to let air into the can, and the second hole is designed to …

A create pressure
B restrict the flow
C let the fluid out
D be just for show

35. Another simple machine was built into the removable tab top. It consisted of a small ring that acted like a lever and would make the necessary hole by removing the tab from the can. This was a huge improvement, but it also created a huge problem. The problem it created was …
A scientific
B environmental
C industrial
D commercial

36. **CSA** is a non-government association that tests and approves a wide range of products to ensure they are safe for use by the consumer. CSA stands for ...
A Consumer Standards Agency
B Consumer Safety Association
C Canadian Standards Agency
D Canadian Standards Association

3.2 Technology Develops through Change

37. A particle accelerator is a huge complex machine that does this …
A creates new particles
B breaks up atoms
C makes new elements
D creates space in particles

38. Sometimes a new device is designed when someone who thinks there can be an easier way to do something makes an observation. An inventor observed a driver manually cleaning snow and ice off the windshield of a streetcar in freezing cold weather, this observation prompted the invention of this ...
A windshield heater
B windshield washer
C windshield wiper
D windshield defroster

39. New technologies often develop from scientific research that seems to be unrelated. Particle accelerator research experiments led to the technology behind trains powered by electricity and magnets. These trains 'float' on the tracks. They are known as …
A MAGIC
B MALLEG
C MAVEEG
D MAGLEV

40. Robots are extremely complex devices and vary widely in appearance, depending on the job they are designed to do. A simple robot however has some or all of these basic parts: body, motor devices, power source, sensors, output devices, microprocessors. **Spirit** and **Opportunity** are robot rovers on the planet Mars. The solar panels on the robots are examples of these basic parts …
A Motor devices
B Sensors
C Power source
D Microprocessors

41. Robot technology was originally designed to …
A Entertain comic book readers
B Improve the margin of safety in all products
C Improve the assembly of consumer products
D Replace workers because of high wages

Numerical Response Questions

NR1 - To test the success of a protective egg carton (with a mass of 100g), Jackson (who mass is 80kg), carried it up to the roof. It was dropped from a height of 4m.
How much work was done by Jacobs to test the egg protection device?
(**Show your work)**

	.	.	
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

NR2 - A hydraulic lift was used to lift a load of 564N up three shelves high in a warehouse. The operator found that the distance it moved was 2.8m. If the mechanical advantage of the hydraulic lift was 10.
How much effort force was needed to lift the load?
(**Show your work**)

	.	.	
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Mechanical Systems Section Quiz - Answer Keys

Section 1 Quiz		Section 2 Quiz				Section 3 Quiz	
1	C	1	B	15	C	1	D
2	B	2	A	16	B	2	A
3	C	3	B	17	C	3	C
4	A	4	A	18	C	4	B
5	A	5	B	19	D	5	C
6	D	6	D	20	B	6	B
7	A	7	B	21	B	7	B
8	D	8	B	22	A	8	C
9	C	9	A	23	C	9	D
10	B	10	C	24	D	10	D
10	C	11	C	25	C	11	A
11	A	12	B	26	A	12	C
12	A	13	C	27	C	13	D
13	D	14	A	28	C	14	D
14	C					15	B
15	C					16	C
16	D					17	D
17	A					18	C
18	C						
19	B						
20	B						

Mechanical Systems Unit Test - Answer Key

1	B	9	D	17	C	25	D	33	D	41	D
2	C	10	C	18	B	26	B	34	C	NR1	3204
3	A	11	A	19	D	27	A	35	B	NR2	56.4
4	D	12	B	20	C	28	D	36	D		
5	D	13	B	21	A	29	A	37	B		
6	C	14	D	22	B	30	C	38	C		
7	C	15	B	23	C	31	D	39	D		
8	A	16	D	24	C	32	C	40	C		