Mechanical Systems Review

Grade 8 Science
Unit D: Topic 1.0

1. List two simple machines that can be found on a mountain bike.

2. Explain the difference between a simple machine and a complex machine and give an example of each.

3. Finish the chart

Simple Machine	Description	Picture
	A simple machine that consists of a cylinder with a groove cut in a spiral on the outside.	
Lever		
		
Wheel and axle		
		
	A simple machine that is a scientific name for a ramp.	

Draw (3)

4. ~~Pick two (2)~~ Classes of levers. Draw and label each lever and its parts. Provide an example of each lever.

5. You usually use your pencil as a writing instrument, but is could be used in different ways as a simple machine. Describe two situations where your pencil could be used as a simple machine. Identify the simple machine in your description.

6. List two types of machines that have been used in the past to move water?

7. Why are machines useful? Give at least two ways.

Systems that Transfer Forces

A linkage is used to transfer _____. Machines may use _____ or _____ to transfer energy from one place to another. Belts are more flexible but, chains have _____. Transmissions are designed to _____. When a car is in low gear the _____ _____.

How Gears Work

Gears are important because they _____ _____. Gears work together in _____ __ _____of two or more wheels. Gears are used to change the _____ and to _____.

1) Driving Gear –

2) Driven Gear –

Gears that increase the speed of rotation in a device are called _____ _____. When you turn the larger wheel (driving gear) the smaller pinion (driven gear) turns at least twice as fast.

Gears that decrease the turning speed in a device are called_____ _____. In this case, the driving gear is smaller and has fewer teeth than the driven gear.

Explain the difference between the following:

a) Design and function:

b) Efficiency and Effectiveness:

List five criteria you might research before buying a new oven for your family's home:

What are the three major factors that influence the development of new technology?

Name:_____

Unit D/Section 2 Review Sheet

Define the following and provide an example:

1) input force:

2) output force:

Mechanical Advantage

Formula:

The mechanical advantage (MA) of a machine refers to the number of times a machine _____ the force exerted on it. The trade-off for the force is distance. MA is calculated by dividing _____ by the _____. Ma is measured in_____.

Answer the following showing all work: (3 marks)

Output force = 100N

Input force= 25 N

Speed Ratio

Formula:

Speed measures the _____. The speed ratio (SR) is calculated by dividing the _____ by the _____.

Speed ratio is measured in _____.

Answer the following showing all work: (3 marks)

If we pull an item with a pulley two meters but the item moves for 8 meters calculate the speed ratio.

Efficiency

Formula:

Efficiency is_____

Calculate the efficiency using the above numbers:

Work

Formula:

_____ is needed before you can say work has been done.
The amount of work done depends on two things:
1)

2)

Work is calculated in_____.
Answer the following showing all work: (3 marks)
Lifting a box takes 20 N of energy and the box is moved 6 meters.

Please answer the following on a separate piece of paper:

SHOWING ALL WORK calculate the mechanical advantage, speed ratio, and efficiency for each of the following: (27 marks)

a) Input force = 10.2 N
Output force = 20.0 N
Input distance = 2.0 m
Output distance= 1.0 m

b) Input force = 20 N
Output force = 8 N
Input distance = 0.8 m
Output distance= 1.6 m

c) Input force = 3.5 N
Output force = 10.0 N
Input distance = 15.0 m
Output distance= 5.0 m

d) Input force = 15 N
Output force = 6 N
Input distance = 6 m
Output distance= 2 m

3) Calculate the work done when a 750N table is pushed 1.2 m (3marks)
4) A 45 N trunk is lifted .6 meters. Calculate the work performed. (3marks)
5) A student does 260 J of work to move a box 13 meters. What force is required to move the box.
6) A pulley system allows a load of 525N to be lifted by an 80 N input force. What is the MA of the system? (3marks)
7) A hydraulic lift has 2000 N applied to an input piston that has an area of 50 cm2. The output piston has an area of 200cm2. (3marks)
   a. What is the pressure on the liquid exerted by the input piston?
   b. Calculate the force on the output (large) piston.

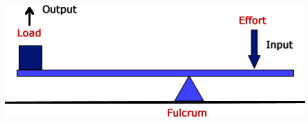
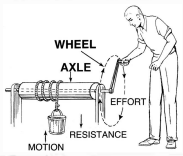
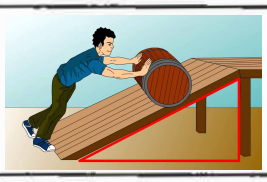
Mechanical Systems Review

Grade 8 Science
Unit D: Topic 1.0

1. List two simple machines that can be found on a mountain bike.
   Levers, Wheel and Axel, Screw

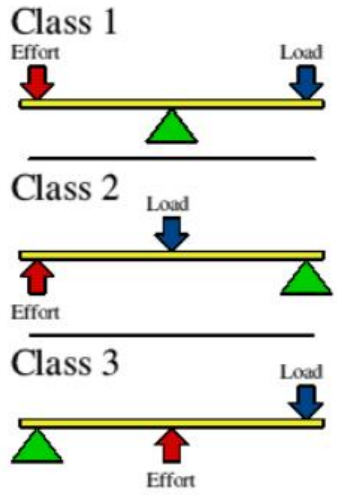
2. Explain the difference between a simple machine and a complex machine and give an example of each.
   Complex machines are made up of two or more simple machines.
   Simple Machine: Lever
   Complex Machine: Axe

3. Finish the chart

Simple Machine	Description	Picture
Screw	A simple machine that consists of a cylinder with a groove cut in a spiral on the outside.	
Lever	Rigid board that pivots on a fulcrum	
Wedge	Blunt at one end, sharp at the other, can be forced into an object	
Wheel and axle	A large diameter wheel attached to a smaller diameter wheel	
Pulley	A series of grooved wheels with rope or cable running through them	
Inclined Plane	A simple machine that is a scientific name for a ramp.	

Draw (3)

4. ~~Pick two (2)~~ Classes of levers. Draw and label each lever and its parts. Provide an example of each lever.



5. You usually use your pencil as a writing instrument, but is could be used in different ways as a simple machine. Describe two situations where your pencil could be used as a simple machine. Identify the simple machine in your description.

A wedge to punch a hole in your paper

A lever to pry a staple out of your paper

A lever to catapult an eraser across the room

6. List two types of machines that have been used in the past to move water?

Archimedes Screw

Various pumps, ex) Diaphragm Pump

7. Why are machines useful? Give at least two ways.

Help make difficult tasks easier; help efficiency in the production of materials

Explain the difference between the following:

a) Design and function:

See next page

b) Efficiency and Effectiveness:

See next page

List five criteria you might research before buying a new oven for your family's home:

Use, purpose, brand reputation, warranty, service accessibility

efficiency, appearance, cost, etc

What are the three major factors that influence the development of new technology?

Advancements in Science

Changes in Society

Changes in the environment

Key

Systems that Transfer Forces

A linkage is used to transfer Energy. Machines may use belts or chains to transfer energy from one place to another. Belts are more flexible but, chains have less chance of slipping. Transmissions are designed to transfer energy from engine to wheels. When a car is in low gear the transmission connects a small gear to a large gear.

How Gears Work

Gears are important because they control the transfer of energy. Gears work together in gear trains of two or more wheels. Gears are used to change the speed and to direction. and force

Bike: Pedal sprocket

1) Driving Gear – where force is applied: large = faster

2) Driven Gear – where force is transferred to: small = faster

rear sprocket

- Gears that increase the speed of rotation in a device are called multiplying gears. When you turn the larger wheel (driving gear) the smaller pinion (driven gear) turns at least twice as fast.
- Gears that decrease the turning speed in a device are called reducing gears. In this case, the driving gear is smaller and has fewer teeth than the driven gear.

Name:_____

Unit D/Section 2 Review Sheet

Define the following and provide an example:

1) input force: where you put force on the machine

2) output force: where the machine puts force on the object

Mechanical Advantage

Formula:

The mechanical advantage (MA) of a machine refers to the number of times a machine multiplies the force exerted on it. The trade-off for the force is distance. MA is calculated by dividing output force by the input force. Ma is measured in _____.

Answer the following showing all work: (3 marks)

Output force = 100N

Input force= 25 N

$MA = \frac{F_{out}}{F_{in}} = \frac{100N}{25N} = 4$

$SR = \frac{\text{distance input}}{\text{distance output}}$

Speed Ratio

Formula:

Speed measures the distance an object travels in an amount of time. The speed ratio (SR) is calculated by dividing the input distance by the output distance.

Speed ratio is measured in _____.

Answer the following showing all work: (3 marks)

If we pull an item with a pulley two meters but the item moves for 8 meters calculate the speed ratio.

$SR = \frac{d_{in}}{d_{out}} = \frac{2}{8} = 0.25$

Efficiency

Formula:

Efficiency is a measure of how well a device uses energy

Calculate the efficiency using the above numbers:

MA = 1.9

SR = 2.0

$Eff = \frac{MA}{SR} \times 100 = \frac{1.9}{2.0} \times 100 = 95\%$

Work

Formula:

Two things are ~~is~~ needed before you can say work has been done.

The amount of ~~work done~~ depends on two things:

1) Must put (force) on an object

2) Object must move a (distance)

Work is calculated in J or N·m.

Answer the following showing all work: (3 marks)

Lifting a box takes 20 N of energy and the box is moved 6 meters.

$W = F \times d \quad W = 20N \times 6m = 120\ N \cdot m = 120\ J$

Please answer the following on a separate piece of paper:

SHOWING ALL WORK calculate the mechanical advantage, speed ratio, and efficiency for each of the following: (27 marks)

a) Input force = 10.2 N
Output force = 20.0 N
Input distance = 2.0 m
Output distance= 1.0 m

b) Input force = 20 N
Output force = 8 N
Input distance = 0.8 m
Output distance= 1.6 m

c) Input force = 3.5 N
Output force = 10.0 N
Input distance = 15.0 m
Output distance= 5.0 m

d) Input force = 15 N
Output force = 6 N
Input distance = 6 m
Output distance= 2 m

3) Calculate the work done when a 750N table is pushed 1.2 m (3marks)
4) A 45 N trunk is lifted .6 meters. Calculate the work performed. (3marks)
5) A student does 260 J of work to move a box 13 meters. What force is required to move the box.
6) A pulley system allows a load of 525N to be lifted by an 80 N input force. What is the MA of the system? (3marks)
7) A hydraulic lift has 2000 N applied to an input piston that has an area of 50 cm2. The output piston has an area of 200cm2. (3marks)
   a. What is the pressure on the liquid exerted by the input piston?
   b. Calculate the force on the output (large) piston.

a) $MA = \frac{F_{out}}{F_{in}} = \frac{20.0\,N}{10.2\,N} = 1.96$

$SR = \frac{d_{in}}{d_{out}} = \frac{2.0\,m}{1.0\,m} = 2$

$Ef = \frac{MA}{SR} \times 100 = \frac{1.96}{2} \times 100 = 98\%$

b) $MA = \frac{F_{out}}{F_{in}} = \frac{8N}{20N} = 0.4$

$SR = \frac{d_{in}}{d_{out}} = \frac{0.8\,m}{1.6\,m} = 0.5$

$Ef = \frac{MA}{SR} \times 100 = 80\%$

c) $MA = \frac{F_{out}}{F_{in}} = \frac{10.0\,N}{3.5\,N} = 2.86$

$SR = \frac{d_{in}}{d_{out}} = \frac{15\,m}{5.0\,m} = 3$

$Eff = \frac{MA}{SR} \times 100 = \frac{2.86}{3} \times 100 = 95\,\%$

d) $MA = \frac{F_{out}}{F_{in}} = \frac{6\,N}{15\,N} = 0.4$

$SR = \frac{d_{in}}{d_{out}} = \frac{6\,m}{2\,m} = 3$

$Ef = \frac{MA}{SR} \times 100 = \frac{0.4}{3} \times 100 = 13\,\%$

3. $W = F \times d = 750\,N \times 1.2\,m = 900\,N \cdot m = 900\,J$

4. $W = F \times d = 45\,N \times 0.6\,m = 27\,N \cdot m = 27\,J$

5. $F = \frac{W}{d} = \frac{260\,J}{13\,m} = 20\,N$

MA = $\frac{F_{out}}{F_{in}}$

6) $\frac{525\ N}{80\ N} = 6.6$

7.) a) $P = \frac{F}{A} = \frac{2000\ N}{50\ cm^2} = 40\ \frac{N}{cm^2}$

b) $\frac{F\ input}{A\ input} = \frac{F\ output}{A\ output}$

$\frac{2000\ N}{50\ cm^2} \times \frac{F\ output}{200\ cm^2}$

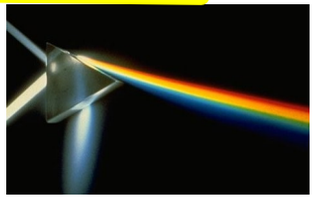
$\div$

$2000\ N \times 200\ cm^2 \div 50\ cm^2 = 8000\ N$

Output Force = 8000 N

3 Factors that influence the development of new technology

1. Advances in science



2. Changes in Society

3. Changes in the Environment

Unit D Calculation Review

1. You put 10 newtons of force on the handle of a can crusher. The crusher outputs 40 N of pressure on the can. What is the mechanical advantage?

$MA = \frac{F_{out}}{F_{in}} = \frac{40N}{10N} = 4$

2. The can crusher requires an input distance of 4 m to move 0.5m. Find the Speed Ratio

$SR = \frac{d_{in}}{d_{out}} = \frac{4m}{0.5m} = 8$

3. Calculate the efficiency of the can crusher

$Eff = \frac{MA}{SR} \times 100 = \frac{4}{8} \times 100 = 50\%$

4. 80 N of force is required to move the can crusher 4 meters Calculate the Work done on the crusher.

$W = Fxd = 80N \times 4m = 320 N \cdot m = 320 J$

5. A force of 350N is applied to the input piston of this a ram. The piston has an area of .15m^2. How much pressure created?

$P = \frac{F}{A} = \frac{350N}{0.15m^2} = 2333.3 \frac{N}{m^2} = 2333.3 Pa$

6. A thin pipe full of water connects two pistons. The first piston has a surface area of 20cm^2. The second piston has a surface area of 15cm^2. A force of 300N is applied to the first piston Input piston output piston

$\frac{300N}{20cm^2} = \frac{F_{out}}{15cm^2}$ $= 225N$

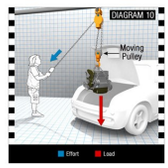
Mechanical Advantage

Machines make work easier

Machines can help us do things we could not normally do on our own.

Mechanical Advantage

Amount by which a machine can multiply a force. Calculated by dividing the output force by the input force



Input Force

Force applied to operate the machine

Output Force

Force the machine applies to an object

Calculating Mechanical Advantage Formula:

$\text{Mechanical Advantage} = \frac{\text{Output Force}}{\text{Input Force}}$

- or -

$MA = \frac{F_{output}}{F_{input}}$

Where force is measured in newtons

Example:

You put 10 newtons (N) of force on the handle

The can crushing machine exerts 40 newtons (N) of force on the can

What is the mechanical advantage of the can crusher?? In other words, how many times does it multiply force?

$\text{Mechanical Advantage} = \frac{\text{Output Force}}{\text{Input Force}}$

Speed Ratio

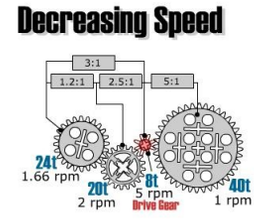
A measure of how the speed of an object is affected by a machine

Formula

$\text{Speed Ratio} = \frac{\text{Input distance}}{\text{Output distance}}$

- or -

$SR = \frac{d_{input}}{d_{output}}$ where d is distance



To **reduce speed** and **increase torque** use a small Lego gear turning a larger gear. For the 40 tooth gear in this example the gear ratio is 8/40, or 1/5. This gear ratio can also be written as 40:8 or 5:1.

So for every five rotations of the 8 tooth gear, the 40 tooth gear will have turned only once. The motor has been **geared down.**

s to achieve

lying the successive t would be:

:)

If a pulley has a speed ratio of 3, it mean the rope is being pulled 3 times faster than the speed of the load moving

Efficiency Practice

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

1. A small pulley has a Mechanical Advantage of 6 and a speed ratio of 12. How efficient is the pulley?

$\frac{6}{12} \times 100$

$0.5 \times 100 = 50\%$ eff.

2. A see-saw requires 18 N of force on the input side to transmit 30 N of force on the output side. The speed ratio of the see-saw is 2. How effecient is the see-saw?

MA = output force / input force

MA = $\frac{30\text{ N}}{18\text{ N}} = 1.67$

Eff = $\frac{MA}{SR} \times 100$ $\frac{1.67}{2} \times 100 = 0.835 \times 100$

$= 83.5\%$ eff.

3. Calculate the efficiency of this egg beater:

Input Force: 4.6 N
Output Force: 16 N
Input Distance: 35 cm
Output Distance: 3 cm

$MA = \frac{F_{out}}{F_{in}} = \frac{16\text{ N}}{4.6\text{ N}} =$ [illegible]

$SR = \frac{d_{in}}{d_{out}} = \frac{35\text{ cm}}{3\text{ cm}} =$ [illegible]

$Eff = \frac{MA}{SR} \times 100 =$ [illegible] $\times 100 = 0.30 \times 100$

$= 30\%$ efficaint

The Meaning of Work

Work is done when a force acts on an object to make that object move.

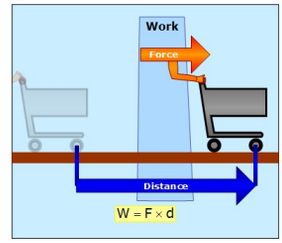
Calculating Work

Work can be calculated using the equation: W=F x D. The amount of work done depends on:

- The amount of force exerted on the object
- The distance the object moved in the direction of the applied force

Formula:

W=F x D: Put in formula sheet



work video:

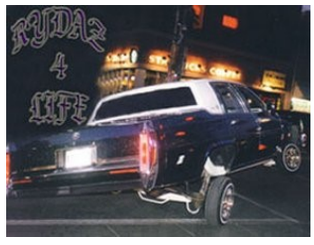
http://player.discoveryeducation.com/index.cfm?guidAssetId=1AF35E04-A932-49EF-B7DE-EE66E0B32066&blnFromSearch=1&productcode=US

Work must always be measured in Newton-Meters, therefore distance must always be converted to meters. One Newton-meter is equal to one joule (J)

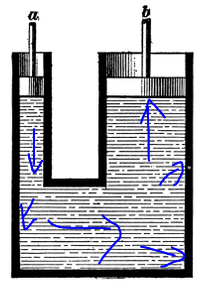
Example: You exert 320N of force on a brick that moves 5m.
How much work has been done?

The Hydraulics in this Caddy uses 4000 N of force on hydraulic pistons with an area of 0.5 m^2

Calculate pressure



$P = \frac{F\ (N)}{A\ (m^2)}$



INPUT PISTON (small)

Force: 35N
Area: 10cm^2

OUTPUT PISTON (Large)

Force: ??N
Area: 7cm^2

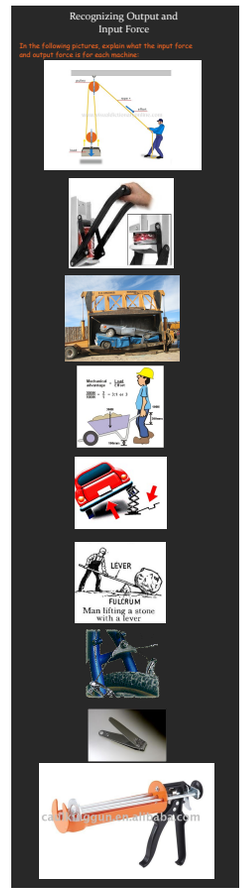
We want FORCE at the output piston

$$\frac{\text{Force of input piston}}{\text{Area of small piston}} = \frac{\text{Force of output piston}}{\text{Area of output piston}}$$

$$\frac{F_{input}}{A_{input}} = \frac{F_{output}}{A_{output}}$$

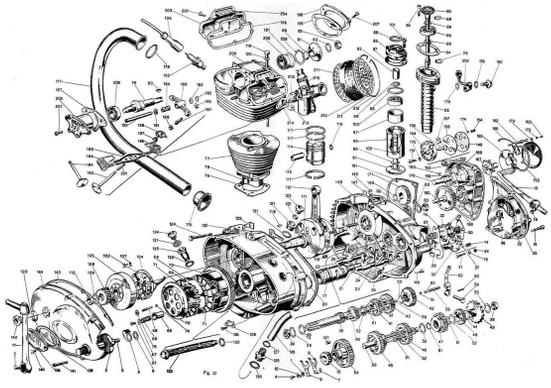
Subsystems

Identify 3 subsystems on this mountain bike:



Complex Machines

Large factories were built that used powerful machines to create new goods



Complex Machines

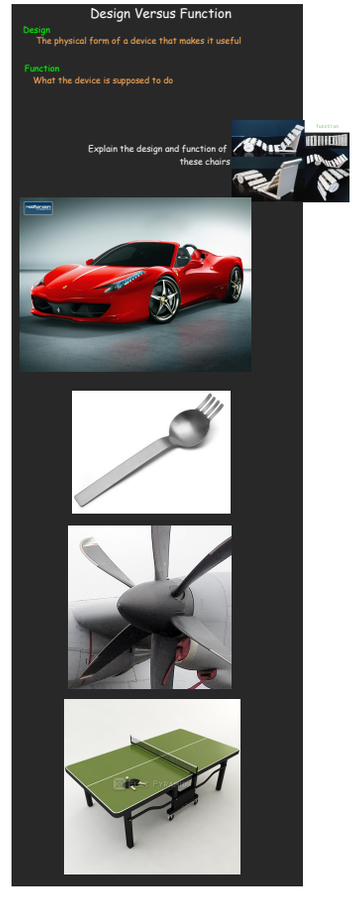
A system of simple machines working together

System:

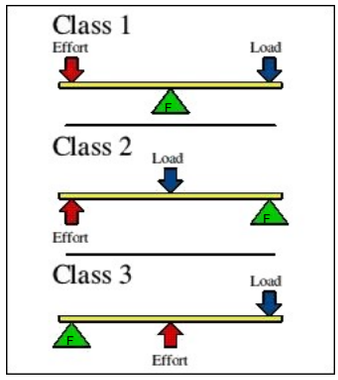
A group of parts that work together to perform a function
Eg, A bike is a system to move people

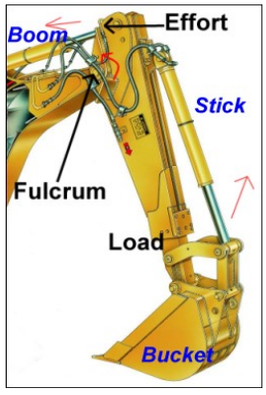
Subsystem

Groups of parts within a system:
Example: Gears of a bike



3 Classes of Lever

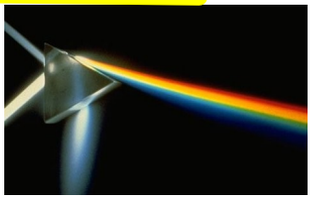




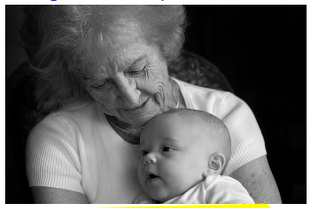
Simple Machines

3 Factors that influence the development of new technology

1. Advances in science



2. Changes in Society



3. Changes in the Environment

Evaluating Mechanical Devices

Efficiency
How well a machine uses energy (higher efficiency = less waste

Effectiveness
Does the mechanical device do what it was designed to?

Environmentally Friendly
Does the machine contribute to light, air, noise, or physical pollution?

Design
What is the physical form (shape) of the device that makes it useful?

Function
What is the machine supposed to do, what tasks does it perform?

Unit D Calculation Review

1. You put 10 newtons of force on the handle of a can crusher. The crusher outputs 40 N of pressure on the can. What is the mechanical advantage?

$$MA = \frac{F_{output}}{F_{input}} = \frac{40N}{10N} = 4$$

2. The can crusher requires an input distance of 4 m to move 0.5m. Find the Speed Ratio

$$SR = \frac{d_{input}}{d_{output}} = \frac{4\,m}{0.5m} = 8$$

3. Calculate the efficiency of the can crusher

$$Eff = \frac{MA}{SR} \times 100 = \frac{4}{8} \times 100 = 50\%$$

4. 80 N of force is required to move the can crusher 4 meters Calculate the Work done on the crusher.

$$W = F \times d = 80N \times 4m = 320\,N\cdot m = 320\,J$$

5. A force of 350N is applied to the input piston of this a ram. The piston has an area of .15m^2. How much pressure created?

$$P = \frac{F}{A} = \frac{350N}{0.15m^2} = 2333\,\frac{N}{m^2} = 2333\,Pa$$

6. A thin pipe full of water connects two pistons. The first piston has a surface area of 20cm^2. The second piston has a surface area of 15cm^2. A force of 300N is applied to the first piston. What is the force of the output piston?

$$\frac{F_{input}}{A_{input}} = \frac{F_{output}}{A_{output}}$$

$$\frac{300N}{20cm^2} \times \frac{?}{15cm^2} = 225\,N$$