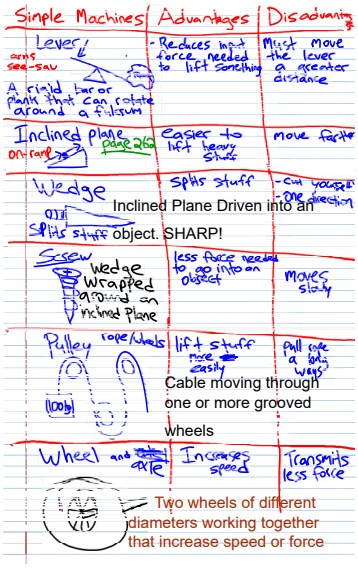
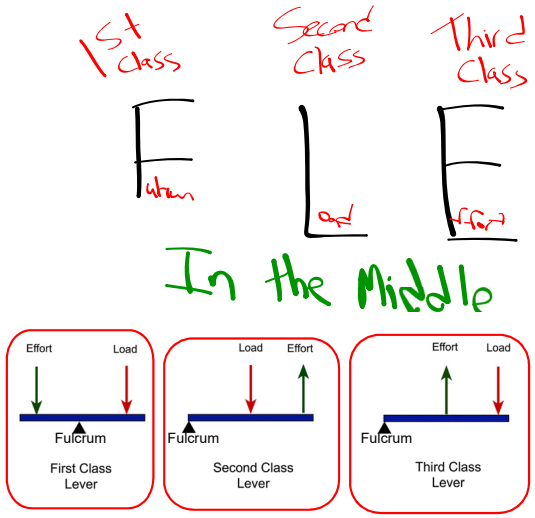

THE EFFECTS OF SIMPLE MACHINES p268

1. Change the direction of a force
2. Multiply Force
3. Increase or Decrease Speed
4. Transfer Force

Notes bottom page 3

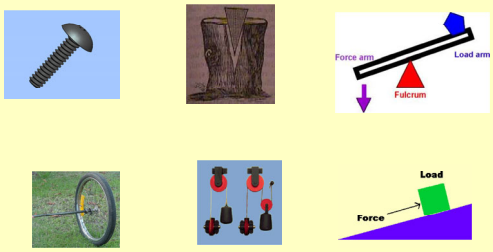
Please copy into notes under "Simple Machines" near the bottom of the front page.




**There are six simple machines we learned about in class. Please match the simple machine with its picture.**

Screw
Pulley
Lever
Wedge
Inclined Plane
Wheel & Axle



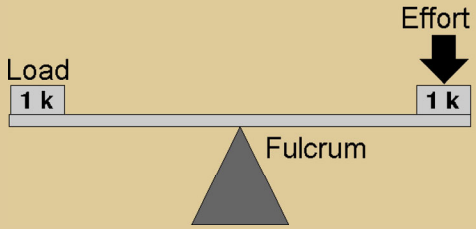

C/R p268: All

**Check And Reflect**

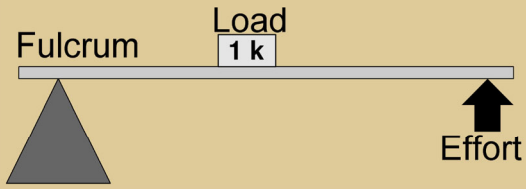
1. Identify which simple machines you would use in each of the following situations:
   a) digging a deep hole
   b) moving a heavy rock from one side of your yard to the other
2. a) Give examples of energy sources used for modern machines, such as cars and sewing machines.
   b) Are the energy sources in question 2a) the same as those used in machines before the 1900s? Explain your answer.
3. When a simple machine increases the force you exert, what other factor changes?
4. One of the most important tools for pioneers in Canada was the axe. What two simple machines make up the axe?

**Figure 1.20** Question 4

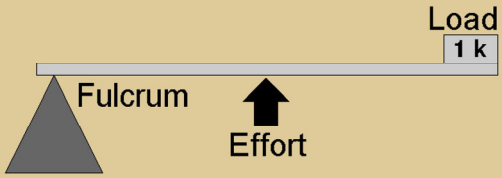
**First-class lever**



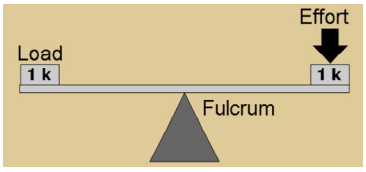

**Second-class lever**



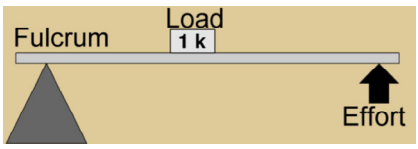

**Third-class lever**



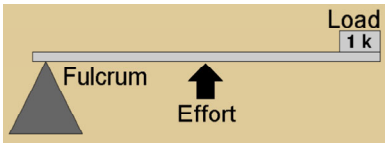

1st class:



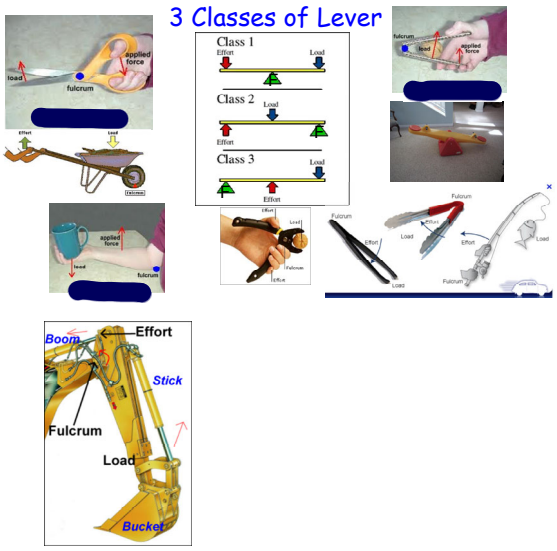

2nd class



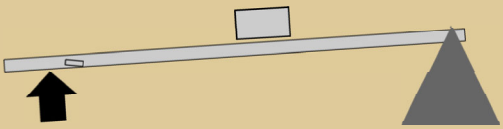

3rd class



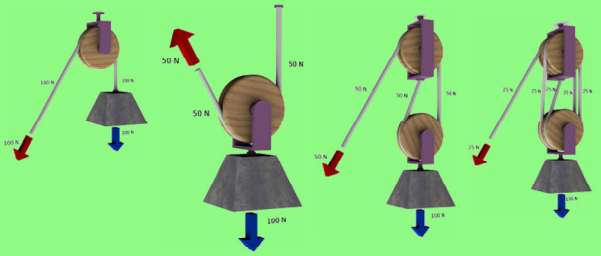

3 Classes of Lever




**Use the objects on this page to show each of the levels of levers.**



## Drag the labels to the correct pulleys.



block and tackle pulley system

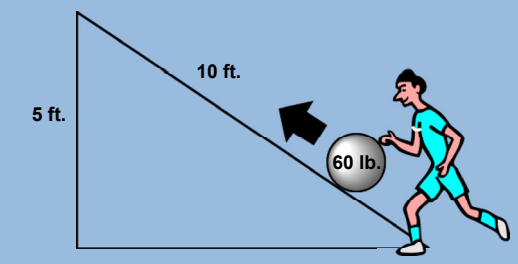
moveable pulley

compound pulley system

fixed pulley

http://www.walter-fendt.de/ph11e/pulleysystem.htm

## Inclined plane




## Screw

The screw will lift, push, fasten, or cut. Match each type of screw with its function.


propeller


bolt and nut


drill bit


jar lid


fan blades


spiral staircase

lifts
lifts
pushes
pushes
fastens
fastens
cuts
cuts

## Wedges

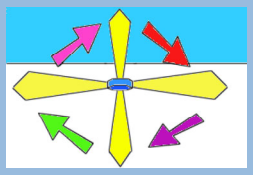
Wedges split, cut, or fasten.





| wedges that split | wedges that cut | wedges that fasten |
|---|---|---|
| | | |

## Wheel and axle

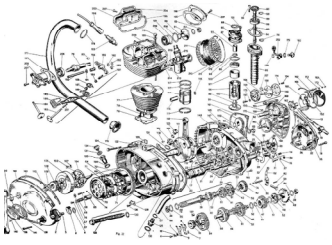


A wheel turning on an axle is a simple machine made up of a small wheel attached to the center of a large wheel. The small wheel is the axle (usually a rod) and turns as the large wheel turns.

Examples of wheels and axles.

## Complex Machines

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



Complex Machines

A system of simple machines working together

System:

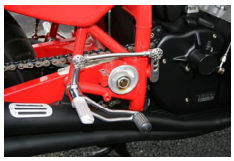
A group of parts that work together to perform a general function that make up a complex machine. Ex: A bicycle is a system for moving people

Subsystem

Smaller group of parts within a complex machine that perform a specific function. Example on a bicycle: Wheel and Axles, Gears., Chain, Pedals, Brakes, etc.

Linkage

Part of a system that transfers energy. Ex. In a bike, the chain transfers energy from your legs to the back wheel. Ex: The chain on a bicycle is a linkage.



Transmission

A special type of linkage for transferring energy from the engine to the wheels in trucks and cars.

Science Please The Internal Combustion Engine.mp4

Gears

A pair of wheels with teeth that interlink; when they rotate together, one gearwheel transfers turning motion and force to the other.

Internal combustion Engine

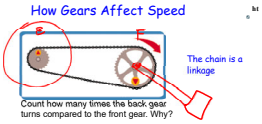
# How Gears Work

An force is applied to the DRIVING GEAR.

The driving gear then transmits that force to the DRIVEN GEAR

Two or more gears meshed together make a GEAR TRAIN

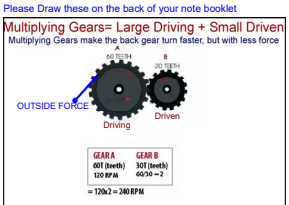
## How Gears Affect Speed




Please Draw these on the back of your note booklet

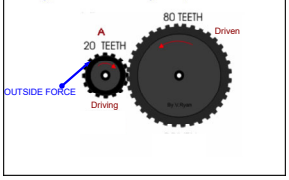
**Multiplying Gears= Large Driving + Small Driven**

Multiplying Gears make the back gear turn faster, but with less force




**Reducing Gears = Small Driving + Large Driven**

Reducing Gears make the machine go slower, but with more force




## 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 (Human force)

Output Force

Force the machine applies to an object

Calculating Mechanical Advantage Formula:

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

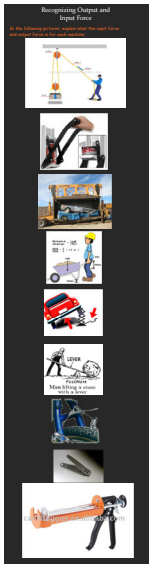
- or -

$$MA = \frac{OF}{IF}$$

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?

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




## Mechanical Advantage Practice

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

1. 2000 N of force is put on the input piston of a car crusher, resulting in 6000N of force to crush the car. Find M.A.

2. Marina exerts 35 N of force on a screw driver handle. The head of the screw is turned by the screw driver with 70N of force. Find M.A.

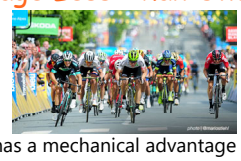
3. The head of an axe exerts 500N of force on a log. Larry swung the axe with 100N of force. Find M.A.

4. The engine of a car exerts 8000N of force on the drive shaft. By the time the force reaches the tires it has been multiplied by 3. Find the M.A. of the car's drive-train

5. Calculate the Input Force the following machine: Mechanical Advantage = 4, Output Force = 36N

## Mechanical Advantage Less Than One

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



Think about the bicycle again. It has a mechanical advantage less than 1. For example, a cyclist may apply an input force of 650 N to the pedals. Through the bicycle's linkages, this results in an output force of 72 N. Recall the formula for calculating mechanical advantage: MA = Output force ÷ Input force = 72 ÷ 650 = 0.1. The mechanical advantage of the bicycle is 0.1.

MA less than one means the machine increases speed or distance by reducing force.

## P282 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 -

$$SR = \frac{ID}{OD}$$

Figure 2.3 shows the input distance and output distance for the same pulley that was used in Figure 2.2. The calculation of this pulley's speed ratio is shown below.

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

$$SR = \frac{d_{input}}{d_{output}}$$

Where $d$ = distance

$$SR = \frac{4\text{ m}}{1\text{ m}}$$

$$SR = 4$$

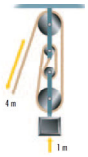
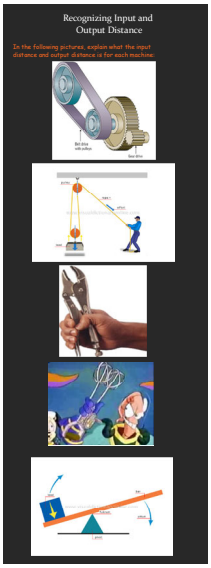



**Figure 2.3** This pulley has a speed ratio of 4.

A speed ratio greater than one actually means the machine's output is moving slower than its input, but with greater force. This seems weird, but a greater speed ratio actual means the device moves slower.

A speed ratio less than one means the machine's output is moving faster than the input, but with less force - like a bicycle.




## Speed Ratio Practice

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

1. The handles of a pair of pliers are moved 6 cm, the other end moves 3 cm. Find S.R.

2. The effort end of a class 1 lever is moved 3 feet, while the load end is moved 1 foot. Find S.R.

3. The rope of a pulley is pulled 8 feet for every 3 feet the load is moved. Find S.R.

4. The input gear of a bike rotates 800 times for every 600 revolutions of the rear wheel. Find S.R.

5. Find Input Distance of a machine that has: Speed ratio of 0.25 and an Output Distance of 8 meters.

## Efficiency

Why is no mechanical system 100% efficient? (Hands together demo)

The Effect of Friction

Friction is any force that opposes motion (usually creating heat)



Efficiency

A measure of how well a device uses energy

Formula:

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

- or -

$$\text{Eff} = \frac{MA}{SR} \times 100$$

## 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?

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?

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

## Work Practice

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

W=Force x Distance W=F x D

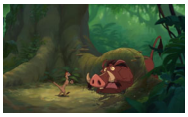
## Your Assignment

- C / R p 286 #'s 1-5


## Wednesday Nov 24th

1. Ten minutes to finish C/R p 286 (See my example)
2. The Science of Work

## What is Work???

Are any of these work???

## What about the blue chair?

Bobby Knight accomplished plenty of work using chairs:

**http://web.mac.com/bradgreve/Site/Audio_and_Video/Entries/2008/2/26_Ed_4765_audio_assignment.html**

**http://www.youtube.com/watch?v=7Qxu5cvW-ds**

## The Meaning of Work

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

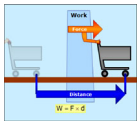
**Calculating Work**

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

Force in N, Distance in m




work video:
http://app.discoveryeducation.ca/player/?assetGuid=1af35e04-a932-49ef-b7de-ea66e0b32066&fromMyDe=0&isPrinterFriendly=0&provider=&isLessonFromHealth=0&productcode=US&isAssigned=false&includeHeader=YES&homeworkGuid=

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?

W = F x d
W = 320N x 5m
W = 1600N·m
W = 1600J

## What is Work Efficiency?

### We first need to know:

Work input: The amount of energy put into a machine to make it function

Work output: The amount of energy the machine exerts on an object

Think: What would work input and output be in the following machines:

A race car  A hot air baloon  A trampoline

## Work Efficiency

Your Hair Straightener uses 1600J of electricity, but only outputs 1200J of heat. How efficient is the straightner?

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

$$\text{Work Eff} = \frac{W_{output}}{W_{input}} \times 100$$

$$\text{Work Eff} = \frac{1200\ J}{1600\ J} \times 100$$

Work Eff = 0.75 X 100

Work Eff = 75%

## Your Assignment

Use the formulas on the board to answer C/R p 292 # 1-3, 6, 9

## Your Assignment

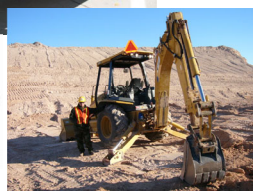
Please complete the calculation work sheet

Questions should be answered in the following format:

| STEP | EXAMPLE |
|---|---|
| 1. Write the formula: | $MA = \frac{F_{output}}{F_{Input}}$ |
| 2. Substitute Values: (Include Units) | $MA = \frac{50\ N}{10\ N}$ |
| 3. Calculate Answer: (Include Units when applicable) | MA = 5 |

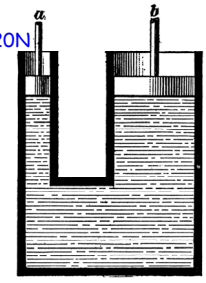
Hydraulic System: system that uses a liquid under pressure to move loads; device that uses liquids in a confined space to transfer forces. See Pascal's Law

Hydraulics



## Hydraulic Systems

Calculate Mechanical Advantage




Finput = 20N

Foutput = 500N

Pascal's law (pa) states that: In a fluid, pressure is transmitted equally in all directions, undiminished

plc

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

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

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

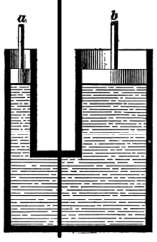
Calculate pressure

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

## Hydraulic Systems THE LAST FORMULA!! :)

Pascal's law states that hydraulic pressure is exerted equally in all directions, therefore:

***The pressure at the input piston must be equal to the pressure at the output piston***




INPUT PISTON (small)

Force: 20N

Area: 4$cm^2$

OUTPUT PISTON (Large)

Force: ??N

Area: 8$cm^2$

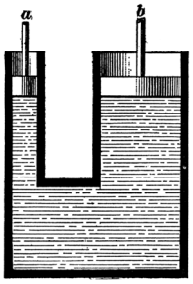
$$\frac{\text{Force of input piston}}{\text{Area of input piston}} = \frac{\text{Force of output piston}}{\text{Area of output piston}}$$

$$\frac{F\ \text{input}}{A\ \text{input}} = \frac{F\ \text{output}}{A\ \text{output}}$$

INPUT PISTON (small)

Force: 35N

Area: 7$cm^2$




OUTPUT PISTON (Large)

Force:

Area: 10$cm^2$

We want FORCE at the output piston

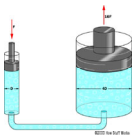
$$\frac{\text{Force of input piston}}{\text{Area of small piston}} = \frac{\text{Force of output piston}}{\text{Area of output piston}}$$

$$\frac{F\ \text{input}}{A\ \text{input}} = \frac{F\ \text{output}}{A\ \text{output}}$$

## Hydraulic Example Question

A thin pipe full of water connects two pistons. The first piston has a surface area of 20$cm^2$. The second piston has a surface area of 40$cm^2$. A force of 300N is applied to the first piston

a) How much pressure does the first piston create in the water pipe?



b) What is the output force on the second piston?

$$\frac{F\ \text{input}}{A\ \text{input}} = \frac{F\ \text{out ?}}{A\ \text{output}}$$

## Your Assignment

C/R p 300 #'s 1-4

## Mechanical Calculation Formulas

| | |
|---|---|
| Mechanical Advantage = $\frac{\text{Output Force (N)}}{\text{Input Force (N)}}$ | $MA = \frac{OF}{IF}$ |
| Speed Ratio = $\frac{\text{Input distance (m)}}{\text{Output distance (m)}}$ | $SR = \frac{ID}{OD}$ |
| Efficiency = $\frac{\text{Mechanical Advantage}}{\text{Speed Ratio}} \times 100$ | $Eff = \frac{MA}{SR} \times 100$ |
| Work = Force (N) X Distance (m) | $W = F \times D$ |
| Pressure = $\frac{\text{Force (N)}}{\text{Area } (m^2)}$ | $P = \frac{F}{A}$ |
| $\frac{\text{Force of input piston}}{\text{Area of small piston}} = \frac{\text{Force of output piston}}{\text{Area of output piston}}$ | $\frac{F\ \text{input}}{A\ \text{input}} = \frac{F\ \text{output}}{A\ \text{output}}$ |

## Inventions

| Invention | One Way its changed human life | What would life be like if it wasn't invented | Meets a human need or solves a problem created by another invention |
|---|---|---|---|
|  Muffler | Prevents Noise pollution | Cars would be really noisy | The Muffler was created to solve a problem of another invention: The car! |
|  Ear Plugs | Keep unwanted destructive noise out of your ear | | Meets a human need and solves the problem of noisy machinery |
|  Nuclear Power Plants | | | |
|  Bike Helmet | | | |
|  Radar Gun | | | |
|  Bath Tub | | | |

## 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?

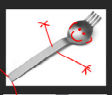
**Function**
What is the machine supposed to do, what tasks does it perform?

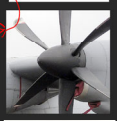
## Design Versus Function

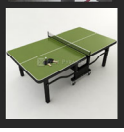
Design
The physical form of a device that makes it useful

Function
What the device is supposed to do

Explain the design and function of these chairs



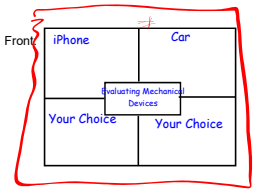




## Evaluating Mechanical Devices

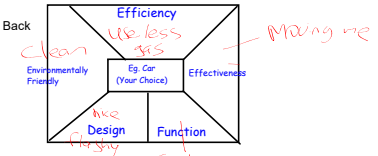
In Groups of 4:

Front




Use
Purpose
Cost
Esthetics
Workmanship
Reputation
Warranty
Accessible Service

Back




**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?

## Evaluating Mechanical Devices


On a piece of paper, draw this chart and use information on page 309-312 to fill it in. On the back, list 5 Criteria for Evaluation (found on page 312)

| Design Name | Advantages | Disadvantages | How it changed |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

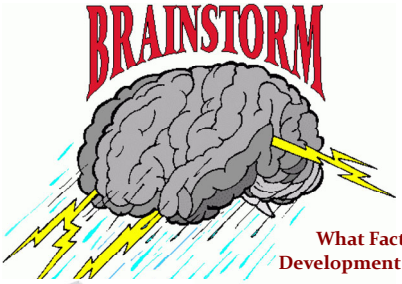
Which Design do you think is the best? Why?

Criteria For Evaluation

1. Efficient: Quickly and Easily (Uses energy Well)?
2. Effective: Does it do it's job?
3. Is it safe: (Design)?
4. Is it convenient (practical)( Function )?
5. Is it Environmentally Friendly?


## Evaluating Mechanical Devices

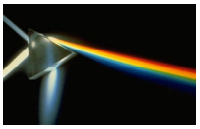
| Opener Design | Advantages | Disadvantages | Changes |
|---|---|---|---|
| Church Key | | | |
| Removable Tab Top | | | |
| Buttons | | | |
| Non-Removable Tab Top | | | |




**What Factors Lead To the Development of new technology?**

## 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?

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

3. Calculate the efficiency of the can crusher

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

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

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

## 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

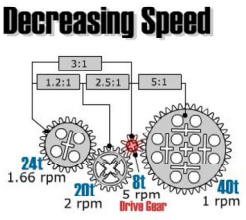
A measure of how the speed of an object is affected by a machine

Formula

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

- or -

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




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?

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?

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

## The Meaning of Work

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

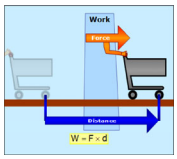
**Calculating Work**

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:

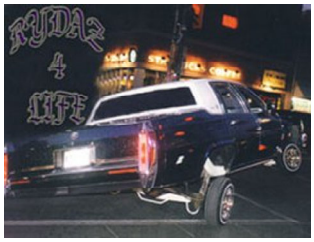
http://player.discoveryeducation.com/index.cfm?guidAssetId=1AF35E04-A932-49EF-B7DE-EE66E0B32066&blnFromSearch=1&productcode=US

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 $m^2$

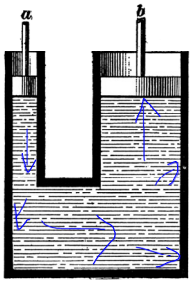
Calculate pressure




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

INPUT PISTON
(small)

Force: 35N
Area: 10$cm^2$




OUTPUT PISTON
(Large)

Force: ??N
Area: 7$cm^2$

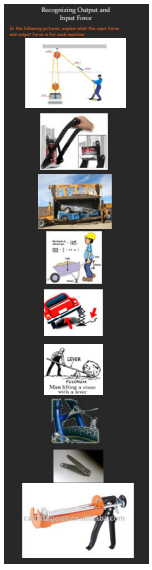
We want FORCE at the output piston

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

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

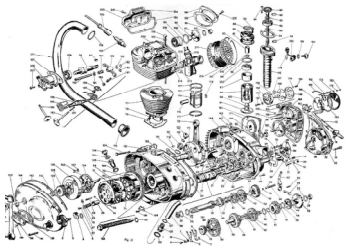
## Subsystems

Identify 3 subsystems on this mountain bike:




## Complex Machines

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



Complex Machines

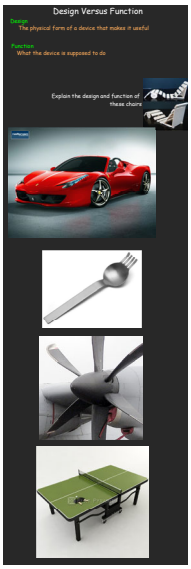
A system of simple machines working together

System:

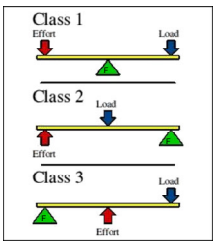
A group of parts that work together to perform a function
Eg, A bike is a system to move people

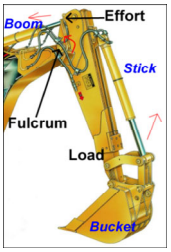
Subsystem

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**
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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

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

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.

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

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?

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

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?

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

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