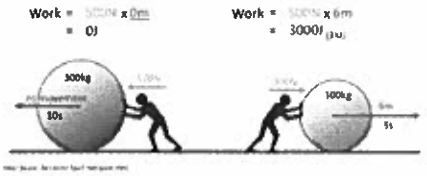
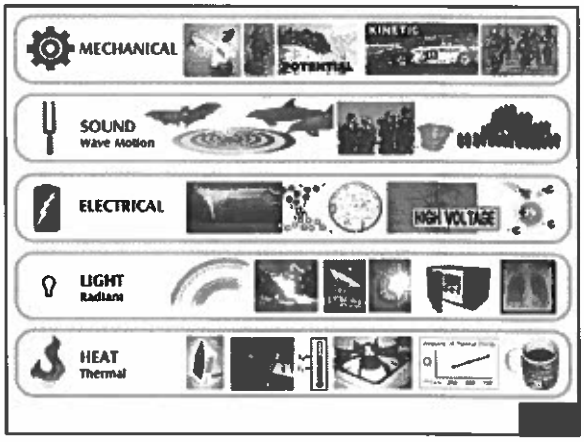
3.0 WHAT IS ENERGY?

Energy: the ability to do work or effect change

- Work = force x distance
- Change = changes the form (liquid to vapour)

Who has done the most work?





DIFFERENT FORMS OF ENERGY

- Kinetic/Mechanical energy (motion)
- Elastic energy (springs)
- Electrical energy (batteries)
- Thermal energy (combustion)
- Radiant/Luminous energy (light)
- Chemical energy (food/batteries)
- Sound energy (sound waves)
- Hydraulic energy
- Nuclear energy (atomic nuclei, the sun)

3.1 LAW OF CONSERVATION OF ENERGY

Energy cannot be created or destroyed; it can only be transferred or transformed.

- **Energy transfer: changing location**
  - You warm up in front of a heater.
  - Heat energy is transferred to you!
- **Energy transformation: changing type of energy**
  - An iPod changes electrical energy into sound energy.

3.2 ENERGY EFFICIENCY

Write the tit

- When humans create machines, some of the energy they use is wasted
  - Light bulbs waste energy as heat
  - Car engines waste energy through friction & heat
    - Only 12% of the energy from gasoline is used to run the car (p72)

Write this

$$\text{Energy efficiency (in \%)} = \frac{\text{Amount of useful energy (used)}}{\text{Amount of energy consumed (used+lost)}} \times 100$$

USUALLY IN JOULES!

ENERGY EFFICIENCY QUESTIONS

Ex 1

A fan uses 264 J of energy to rotate the blades. Energy is lost to heat, vibration and friction. The total electrical energy consumed is 480 J. What is the energy efficiency of this machine?

$$\text{\% Efficiency} = \frac{\text{useful energy (used)}}{\text{energy consumed (used+lost)}} \times 100$$

$$= \frac{264\ \text{J}}{480\ \text{J}} \times 100$$

$$= 55\%$$

ENERGY EFFICIENCY QUESTIONS

Ex 2

A bicycle is 90% efficient. 180 000 J of energy is consumed. How much mechanical energy is used to move forward?

$$\text{\% Efficiency} = \frac{\text{useful energy (used)}}{\text{energy consumed (used+lost)}} \times 100$$

$$\frac{90\%}{100} = \frac{\text{used}}{180\,000\ \text{J}}$$

162 000 J used to move forward

ENERGY EFFICIENCY QUESTIONS

Ex 3

A light is found to be 60% efficient. It is found that 45 000 J of luminous energy is produced, 28 600 J is lost as thermal energy and that some energy is lost due to a slight vibration.

Find the amount of vibrational energy that is lost.

$$\text{\% Efficiency} = \frac{\text{useful energy (used)}}{\text{energy consumed (used+lost)}} \times 100$$

$$\frac{60\%}{100} = \frac{45\,000\ \text{J}}{\text{total}}$$

Total = 75 000 J

Total = 75 000
- 45 000 useful
- 28 600 thermal
1 400 J vibrational

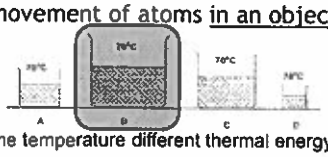
3.3 THERMAL ENERGY

- Is the heat energy contained in a substance.
- It results from the random movement of atoms in that substance.
- It depends on the number of atoms and their temperature

more particles + higher temperature = more thermal energy

WHAT IS THE DIFFERENCE BETWEEN HEAT AND TEMPERATURE?

- Heat is the transfer of thermal energy from warmer objects to cooler objects.
- Temperature is a measure of the degree of movement of atoms in an object.



Same temperature different thermal energy.

Which beaker has the most thermal energy???

How does the temperature change when you add an ice cube?

3.4 MOTION AND FORCES (P.79-92)

Write this title ☺

Speed or Velocity (v)

- How fast an object is travelling
- Measured in km/h or most often in science as m/s

Write this formula ☺

÷

x

What is the speed of a car that travels 10 km in 12 minutes? In km/h & m/s?

- Distance traveled (d) = 10km = **10 000m**
- Travel time (t) = 12 min = **720 sec Or 0.2 h**

v (km/h) = d (km) / Δt(h) = [redacted]

v (m/s) = d (m) = / Δt(sec) [redacted]

How to do conversions

Add to formula sheet☺

km	x 1000	days	x 24
m	x 100	hours	x 60
cm	x 10	min	x 60
mm		sec	

Acceleration (a)

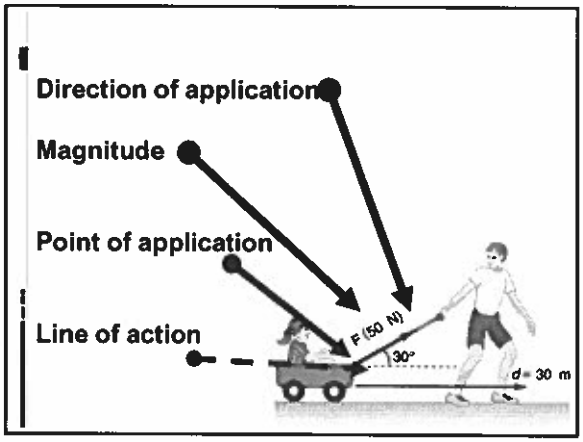
Write this ☺

- **The change in speed over a given time**
- **Measured in m/s²**

Write the title & ☺

3.5 Forces and Changes in Motion

- A force is a push or a pull on an object that can change its motion (see p80)
- On diagrams use:
  - Dotted line = line of action (on x, y or z axis)
  - Arrow = direction of application
  - Starting point of the arrow = Point of application
  - Length of the line = magnitude or strength



Unit of Force

Write this ☺

- Force is measured in Newtons (N)
- 1 Newton (N) is the amount of force required to accelerate a 1 kg object at a rate of 1 m/s²

Forces cause an object to:

Write this ☺

1. Acceleration (start moving or speed up)
2. Deceleration (stop moving or slow down)
3. Change direction.

Types of Forces

3.6 Gravitational
3.7 Electromagnetic
3.8 Frictional
3.9 Strong and Weak Nuclear

3.6 Gravitational Force

Write this ☺

- An attraction between **all** objects, caused by their masses and distances between them.
- High mass + short distance = strong gravity.
- Small mass + larger the distance = weak gravity.

3.6 Gravitational Force

Write this ☺

- An attraction between **all** objects, caused by their masses and distances between them.
- High mass + short distance = strong gravity.
- Small mass + larger the distance = weak gravity.

Mass vs. Weight

Write this ☺

- **Mass** is the amount of matter (1 kg)
- **Weight** is result of the gravitational force acting on an object (N).

$F_g = mg$

Write this ☺

m = mass (kg)

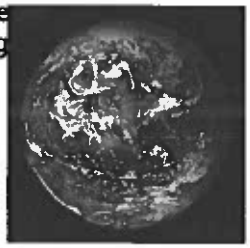
g = gravity at the earth's surface is 9.8 m/s² (9.8N/kg)

F_g = downward force (N)

(See p82)

Example

- What is the gravitational force (weight) of a 60 kg astronaut on the earth's surface?



F = mg
F = 60 X 9.8
F = 588 N

Example

- What is the gravitational force (weight) of a 60 kg astronaut on the Moon's surface?

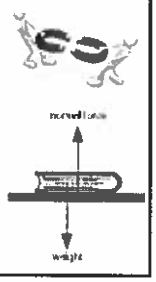
F=mg
F= 60 X 1.62 (force of gravity on the Moon)
F= 97.2 N

Write this ☺

3.7 Electromagnetic Force

- Attraction or repulsion between two objects with **electrical charge** or **magnetic poles**.

- Electromagnetic Force
  - Also known as the "normal force" F_n
  - In the opposite direction of the gravitational force F_g (Weight)
  - Is the force between molecules, holding them in together.

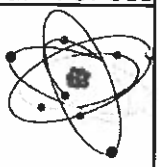


3.8 Frictional Force

Write this ☺

- The force that prevents two objects from slipping over each other
- Air resistance is also a force of friction
- Friction depends on:
  - How smooth the surface is.
    - rougher surface = greater friction
  - The pressure between the surfaces.
    - greater pressure = greater friction

3.9 Strong & Weak Nuclear Forces



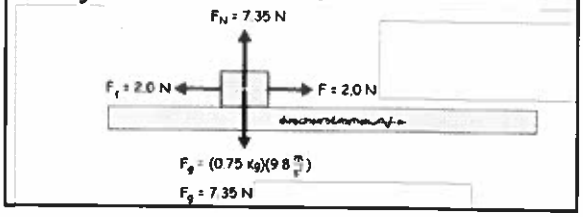
- **Are short range forces that hold the nucleus together**
  - **Strong nuclear force**
    - holds protons & neutrons together.
  - **Weak nuclear force**
    - Hold subatomic particles together (boson, quirks, quarks, etc)
    - related to radioactivity/light

Write this ☺

3.10 Combination of Forces

Write this ☺

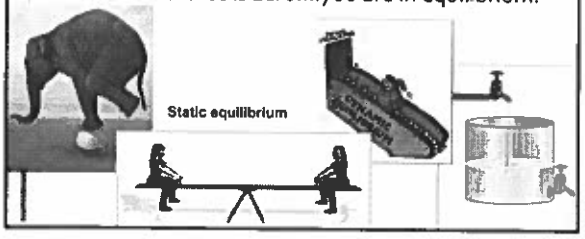
- **Objects are usually subjected to several forces at once.**
- **The RESULTANT force is equal to the combination of all forces acting on an object at the same time.**



- **Equilibrium** of forces is achieved when the resultant force is zero.

Write this

  - The object will remain at rest or remain at the same velocity.
  - Ex: When you ride a bike at a constant speed, the resultant force is zero....you are in equilibrium.



PLEASE WRITE THIS ☺

Forces in Fluids

p. 92-98

3.11 What is Pressure?

- Since fluids take different shapes, the concept of a force on a fluid is better described as **PRESSURE**.
- You can't really "push" a fluid but you can exert pressure on it.
- **Pressure is the amount of force applied to a fluid per unit of surface area**
  - Bike tire has 60 psi (pounds per square inch)
  - Car tire has 35 psi (pounds per square inch)

☺ PLEASE WRITE THE TITLE AND

Formula to calculate pressure

Pressure (Pa) = Force (N) / Area (m^2)

OR

$$P = \frac{F}{A}$$

P = pressure measured in Pascals (Pa)
F = force exerted measured in Newtons (N)
A = surface area measured in m^2

PLEASE WRITE THIS ☺

What does this mean????

P = ?

$P = \frac{F}{A} = \frac{10\ N}{1\ m^2}$

P = 10 Pa

P=?

$P = \frac{F}{A} = \frac{10\ N}{2\ m^2}$

P = 5 Pa

Spread out on ice!!!!

PLEASE WRITE THIS ☺

Pressure exerted by a liquid depends on:

- **Its Density**
  Higher density = increased pressure
- **Depth**
  Increased depth = increased pressure

SCUBA divers experience increased pressure the deeper they dive....you can feel it in your ears!!!

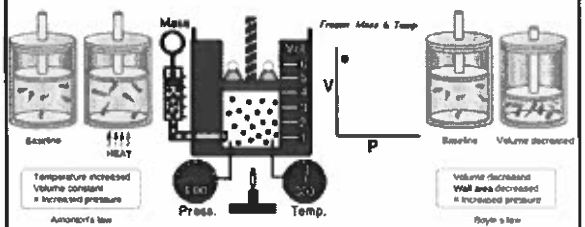
PLEASE WRITE THIS ☺

Pressure exerted by a gas depends on:

- Temperature
- Volume
- Concentration (# of particles)

PLEASE WRITE THIS ☺

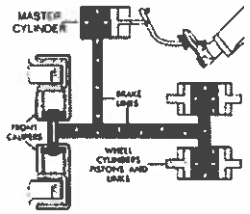
As temperature increase, pressure increases.
As volume decreases, pressure increases.
As concentration increases, pressure increases.



PLEASE WRITE THIS ☺

3.12 Pascal's Principle:

- An increase in the pressure on a fluid is transmitted uniformly in all directions
- Used in:
  - water pistols,
  - hydraulic brakes, &
  - Hydraulic jacks.



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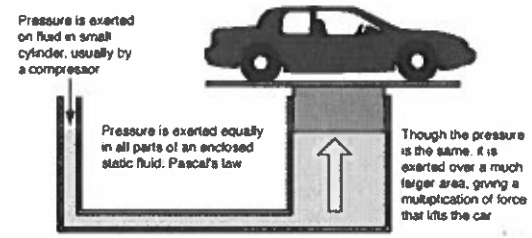
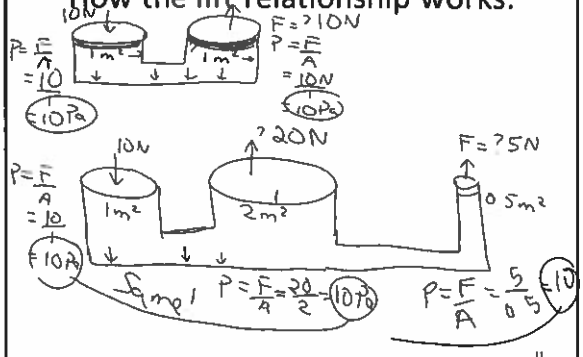
A small force applied to a small piston makes a strong force on the large piston.



The force in the small cylinder must be exerted over a much larger distance. A small force exerted over a large distance is traded for a large force over a small distance

How the lift relationship works:

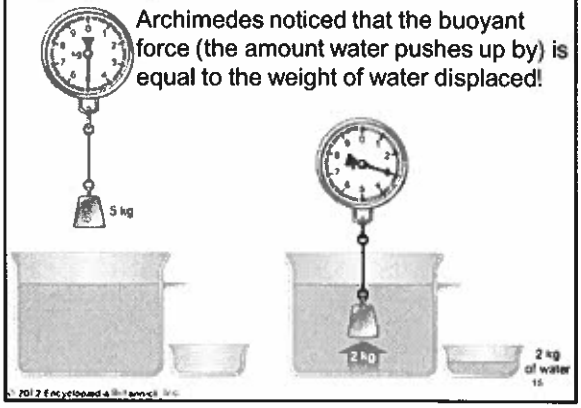


Review questions

1. What is the energy efficiency of a device that consumes a total of 720 000 J of energy with 230 000 J of this energy lost as heat? **68%**
2. An incandescent light bulb lasts 10 000 hrs & its energy efficiency is 5%. How much energy did this light bulb consume if 144 000 J was transformed into luminous energy? **2 880 000J**
3. The rating plate on a microwave has the following information: 8.3A 75Hz 110V. It takes 1.5 minutes to heat up a bowl of soup. The heat energy of your warm soup is 35 000J. What is the energy efficiency of this microwave? **43% (42.6%)**

Archimedes' principle

Archimedes noticed that the buoyant force (the amount water pushes up by) is equal to the weight of water displaced!



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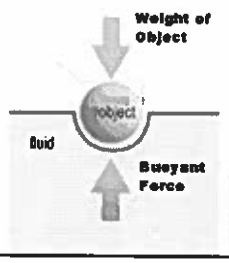
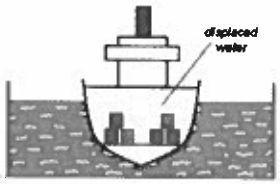
3.13 Archimedes' Principle:

- the magnitude of the buoyant force (F_b) will equal the weight(N) (F_g) of the fluid displaced by the object.
- Comparing the F_g with F_b determines if the item floats.



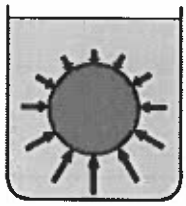


As long as the ship displaces more water (in N) that weight of its cargo .... It will stay floating!

- Since the pressure in a liquid increases with depth, an upward force called "buoyancy" is exerted on objects placed in liquids.

PLEASE WRITE THIS ☺

- Archimedes' Principle explains
  - why some objects will float in water and others don't
  - why objects feel "lighter" when underwater.



Archimedes' Principle

1. If the **buoyant force is less** than the force of gravity ($F_b<F_g$), the object will **sink**
2. If the **buoyant force is greater** than the force of gravity ($F_b>F_g$), the object will **float**
3. If the **buoyant force is equal** to the force of gravity ($F_b=F_g$), the object will maintain the **same depth**

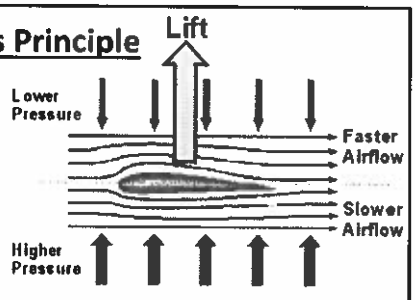
PLEASE WRITE THIS ☺

PLEASE WRITE THIS ☺

3.14 Bernoulli's Principle:

- When a liquid or gas is in motion, like the wind in the air, its pressure varies with its speed
- **Bernoulli's Principle: the higher the speed of the liquid or gas, the lower its pressure**
- This partialy explains how a plane can fly
  - Fig. 3.38, p. 98

Bernoulli's Principle



When the force from the lift exceeds that of gravity, the plane rises into the air.

There's more to lift! Click here!

Explaining wing shape (6:22) link