Topic 1 – General physics

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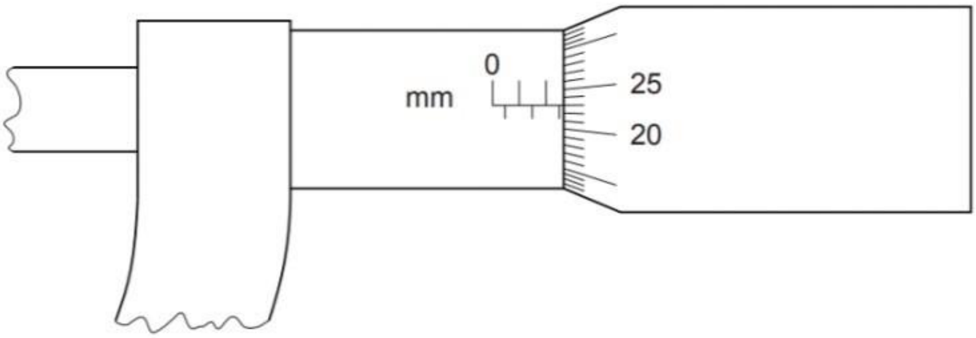
1.1 Length and time

Length

Instruments

- Tape measure
- Trundle wheel – measure long distances, km
- Rulers - measure length for distances between 1mm - 1m
- **Micrometer screw gauge** - for very small distances

4 Fig 1.1 shows part of a measuring instrument.



State the name of this instrument (1)

- Micrometer

Record the reading shown in Fig. 1.1 (1)

- 2.73mm

Describe how you would find the thickness of a sheet of paper used in a magazine (3)

- Check/set zero
- Close instrument on to paper
- Not too tight/use ratchet
- Take reading of both scales
- Use several sheets
- Divide reading by no. of sheets

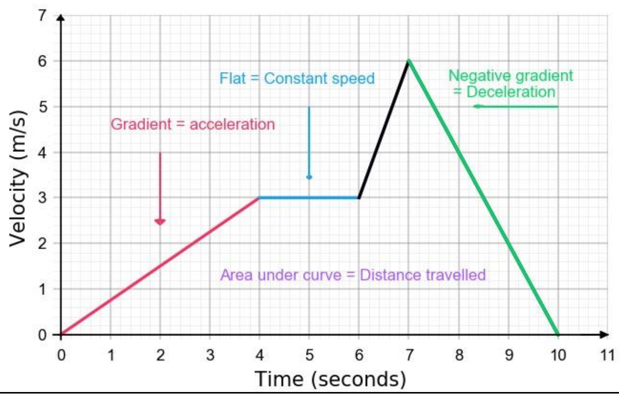
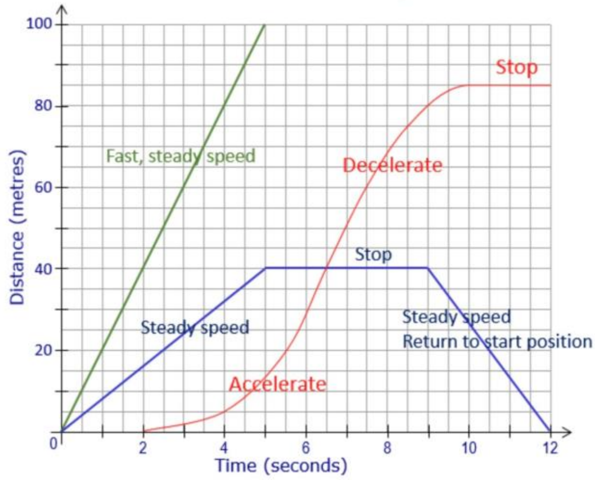
Time - stopwatch

1.2 Motion

SSddddddddddddSS SSSSSSSSSS = $\frac{\quad}{\text{ddddttSS}}$	ddhddddaaSS ooooSSddddddddddddSS MMddMMddttMMtt ddSSSSSSSS = $\frac{\quad}{\text{ddhddddaaSS oooo ddddttSS}}$

ddhddddaaSS dddd vvSSAAoodddddddvv vv −MM AAddddSSAASSAAddddddoodd =

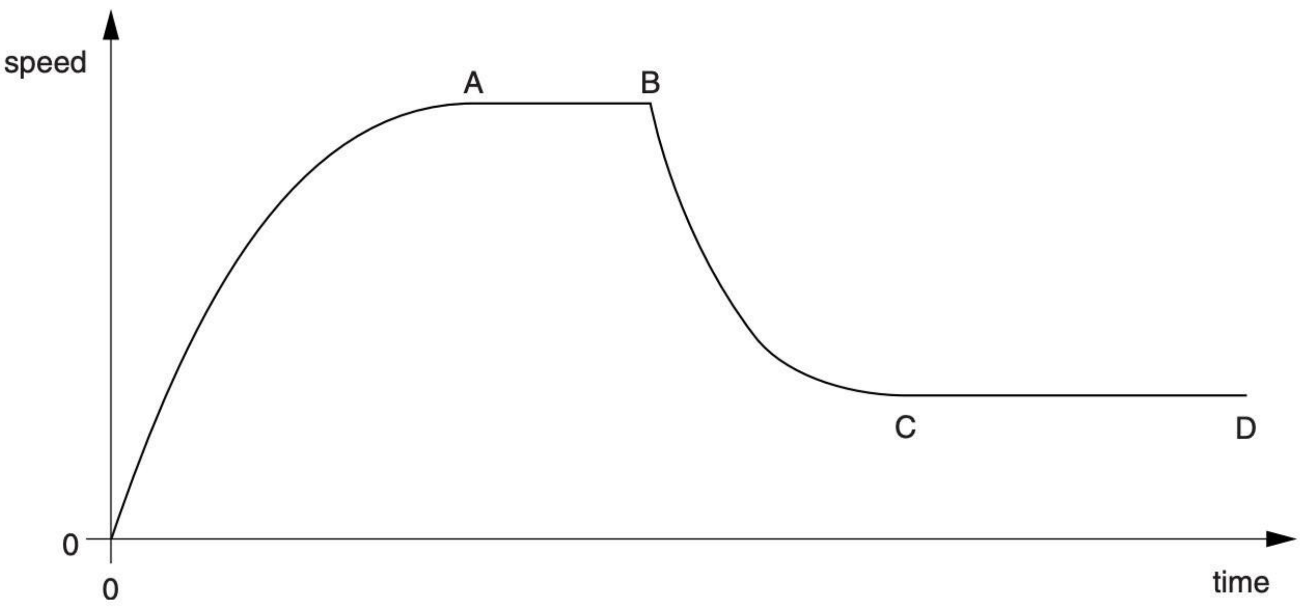
= ddddttSS dd

Velocity-time graph	Distance-time graph
	
• GGAAddSSddSSdddd = ddddddSSAASSAAdddddddoodd	• GGAAddSSddSSdddd = ddSSSSSSSS

Acceleration by gravity

6 A free-fall parachutist jumps from a helium balloon, but does not open his parachute for some time.

Fig. 1.1 shows the speed-time graph for his fall. Point B indicates when he opens his parachute.



- Initially the air resistance is very small. There is a downwards unbalanced force and the skydiver accelerates
- As the skydiver speeds up, the air resistance increases
- Eventually the air resistance balances the weight and so the skydiver travels at a constant speed – terminal velocity
- When the parachute is opened the increase air resistance on the parachute creates an upwards unbalanced force, making the parachuting the slow down

$$AAddddSSAASSAAdddddddoodd\ oooo\ ooAASSSS\ ooddAAAA\ oodd$$
$$EEddAAddh = 10tt/dd$$

1.3 Mass and weight

Mass: measure of the amount of matter in an object
Weight: force of gravity pulling on an object.
$WWSSddaahdd = ttdddddd \times aaAAddvvddddvv$

$$WW = tt \times aa$$

Find mass of object

- Use balance

1.4 Density

To find volume of regular object

$$DDSSddddddddvv = \frac{ttdddddd}{vvooAAMMttSS}$$

$$tt\ SS = \frac{\quad}{vv}$$

To find volume of irregular object

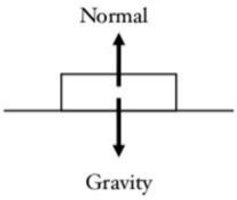
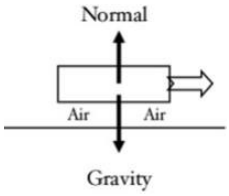
- Put object into measuring cylinder with water
- When object added, it displaces water, making water level rise
- Volume of irregular object = final volume – initial volume

An object will float in a fluid if it's less dense than the density of the liquid

- E.g. ice float on water as it's less dense than water

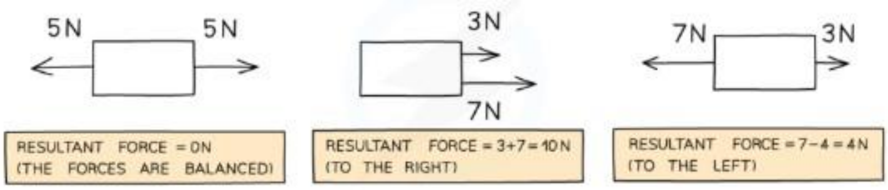
1.5 Forces

1.5.1 Effects of forces

1st law -	if no external force is acting on it...   Remain stationary Keep moving at constant speed
2nd law -	$FFooAAddSS = ttdddddd \times ddddddSSAASSAAddddddoodd$ $FF = ttdd$
3rd law -	Every action force has an equal and opposite reaction force

Resultant force (net force / unbalanced force)

$$FF = ttdd$$



When an unbalanced (resultant) force acts on an object, it can affect its motion, such as

- Speed up
- Slow down
- Change direction

Friction

- Force between 2 surfaces which impedes motion & results in heating
- Results in energy loss due to transfer of energy from KE to heat energy

Air resistance (drag): form of friction caused by a body moving through the air

Hooke's Law

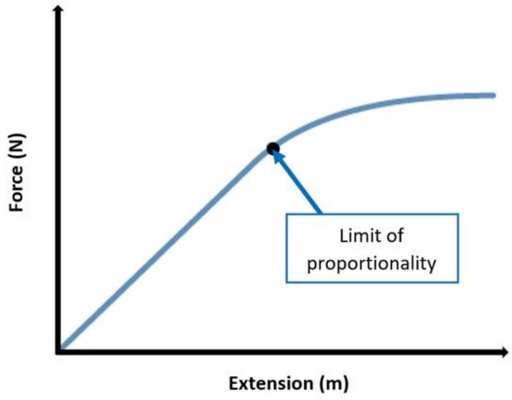
$$LLooddSS = ddSSAAddddaa\ ddooddddddddddd \times SSMMddSSddddddoodd$$

$$TTSSddddddoodd =$$

- **Limit of proportionality:** pt which load & extension are no longer proportional
- **Elastic limit:** pt which spring won't return to its original shape after being stretched
- **Elastic deformation:** object returns to its original shape when the load removed
- **Plastic deformation:** object doesn't return to its original shape when the load removed

$F = kM$

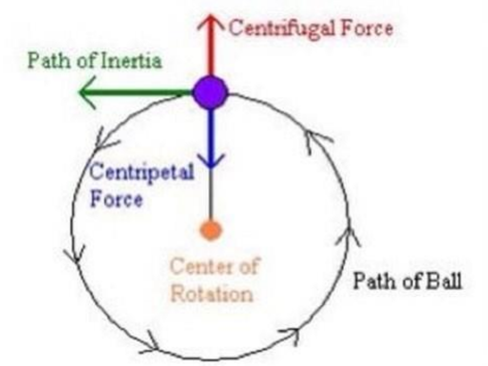
ooooA
aaAAddvvdddddddoA



Energy stored: Elastic energy

Circular motion

- Constant speed
- Direction of motion & velocity always changing
- A force eg friction perpendicular to its velocity towards centre of the circle



Force needed to make something follow a circular path depends on

- **Mass of the object** - ↑ mass requires ↑ force
- **Speed of the object** - faster moving object requires greater force
- **Radius of the circle** - smaller radius requires greater force

1.5.2 Turning effect

Pivot point: pt which object can rotate about

MMoottSSdddd = ooooAAddSS × SSSSAASSSSddSSddddMMAAddAA SSddddddddddddSS

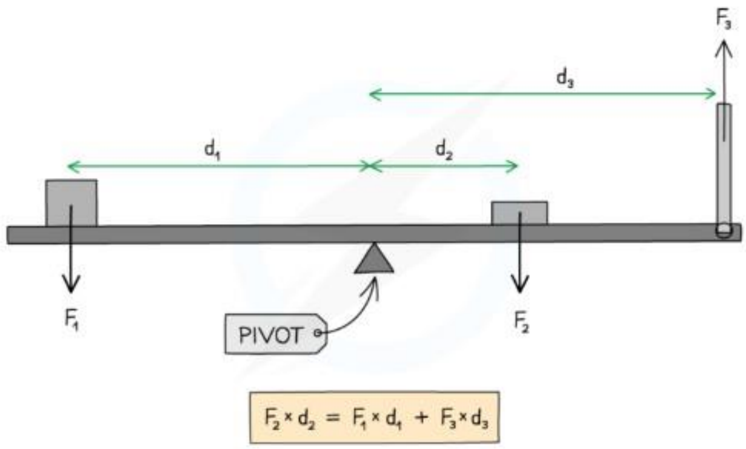
MMoottSSdddd = FFSS

UUSSUUddAASS ooooAAddSS = SSooUUddUUddAASS ooooAAddSS

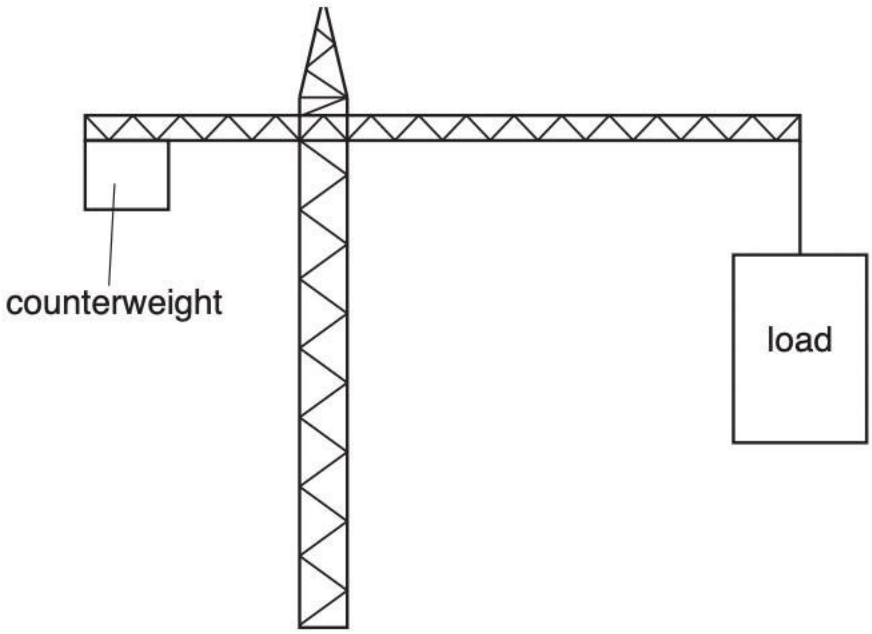
Principle of moments

- For a system to be balanced, sum of clockwise moments = sum of anticlockwise moments

ddMMtt oooo ddAAooddkkUUddddSS ttoottSSdddddd = ddMMtt oooo ddddddddddAAooddkkUUddddSS ttoottSSdddddd



(b) Fig. 2.1 shows a tower crane used to lift a load on a construction site.



Explain how the counterweight prevents the crane from toppling over (2)

- Sum of clockwise moments must be equal to sum of anticlockwise moments
- Counterweight provides anticlockwise moment

1.5.3 Conditions for equilibrium

- Sum of clockwise moment = sum of anticlockwise moment
- No resultant force

1.5.4 Centre of mass

Centre of mass: pt which all of its mass acts on

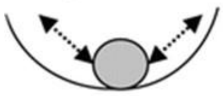
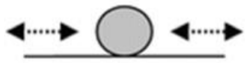
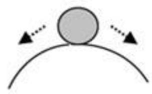
- For a symmetrical object of uniform density, centre of mass is located at the point of symmetry

- When an object is suspended from a point, the object will always settle so that its centre of mass comes to rest below the pivoting point

Stability

- An object is stable when its centre of mass lies above its base • Stable objects - low centre of mass & wide base

States of equilibrium

Stable	Unstable	Neutral
		

1.5.5 Scalars and vectors

Scalar - magnitude eg distance, speed, time, energy, mass
Vector - magnitude & direction eg acceleration, velocity, displacement, force, weight, momentum

1.6 Momentum

Momentum	$ttoottSSddddMMtt = ttdddddd \times vvSSAAooddddddvv$ $SS = ttvv$
Change in momentum = impulse	$ddttSSMMAAddSS = ooooAAddSS \times ddhddddaaSS\ dddd\ ddddttSS$ $FF\Delta dd = ttvv - ttMM$

Principle of conservation of momentum

- In a collision, total momentum before = total momentum afterwards
- No external forces
- Total momentum remains constant

(ii) Explain how the principle of the conservation of momentum applies to the accelerating rocket and the exhaust gases.

- Rocket gains upward momentum
- Ejected gas gains same quantity of momentum in opposite direction

Principle of conservation of linear momentum

- When bodies in a system interact, total momentum remains constant provided no external force acts on the system

$$tt_1MM_1 + tt_2MM_2 = tt_1vv_1 + tt_2vv_2$$

$tt_1 = ttdddddd\ oooo\ 1^{ssss}\ ooooooSSdddd$

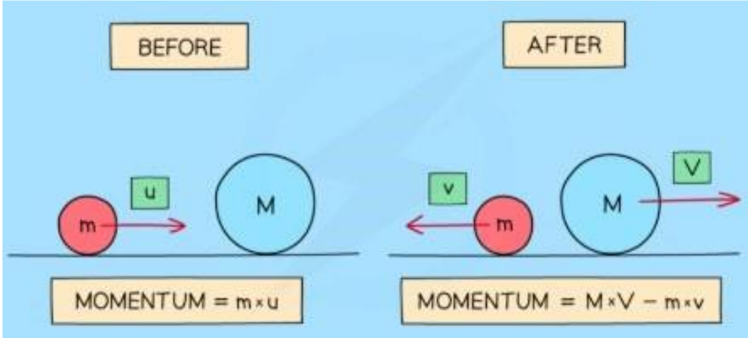
$tt_2 = ttdddddd\ oooo\ 2^{nnnn}\ ooooooSSdddd$

$MM_1 = ddddddddddddAA\ vvSSAAooddddddvv\ oooo\ 1^{ssss}\ ooooooSSdddd$

$MM_2 = ddddddddddddAA\ vvSSAAooddddddvv\ oooo\ 2^{nnnn}\ ooooooSSdddd$

$vv_1 = ooddddddAA\ vvSSAAooddddddvv\ oooo\ 1^{ssss}\ ooooooSSdddd$

$vv_2 = ooddddddAA\ vvSSAAooddddddvv\ oooo\ 2^{nnnn}\ ooooooSSdddd$



1.7 Energy, work and power

1.7.1 Energy

Kinetic (ke)	Motion
Gravitational potential (gpe)	Up
Chemical	Chemical bonds
Elastic / Strain	Compress/stretch
Nuclear	Atoms rearranged/split
Internal	Motion of molecules
Electrical	Carried by electrons
Light	Carried in light waves
Sound	Carried in sound waves

Kinetic energy

$$kkddddSSdddddd\ SSddSSAAaavv = \frac{1}{2} \times ttdddddd \times (vvSSAAooddddddvv)^2$$

$$kkSS = \frac{1}{2}ttvv^2$$

Gravitational potential energy

$$aaAAddvvddddddddddooddddAA\ SSooddSSddddddddAA\ SSddSSAAaavv = ttdddddd \times ddddddSSAASSAAdddddddoodd\ oooo\ ooAASSSS\ ooddAAAA \times hSSddaahdd$$

$$aaSSSS = ttaah$$

Kinetic energy = gravitation potential energy

$$\frac{1}{2}ttvv^2 = ttaah$$

Principle of conservation of energy

- Energy can't be made/destroyed, but can be changed from one form to another
- Total energy remains constant

1.7.2 Energy resources

Non-renewable

Types	Adv	Dis	Power station processes
Fossil fuels	• Relatively cheap • Reliable supply of electricity • High power output	• Release CO_2 → global warming • Release SO_2 → acid rain	• Sun produces energy • Plants take in energy from sun • Plants change to coal over millions of years • Coal burnt in O_2 • Water heated → steam • Steam turns turbine & generator • Electricity generated
Nuclear fuels	(same)	• Produce radioactive waste → long-lasting, dangerous • Nuclear power station expensive to build	• Nuclei split apart in reactor • Fission produce thermal energy • Water in boiler becomes hot & produce steam • Steam turns turbine & generator • Electricity generated

Renewable

- Replenished at a faster rate than rate at which it's being used, cannot run out

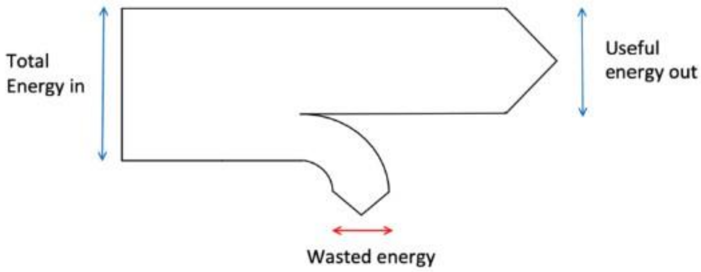
Why renewable? Nothing is used up

Types	Adv	Dis	Power station processes

Solar	• No fuel cost • No atmospheric pollution	• Unreliable • Low power output • Visual pollution / pollution during manufacturing	
Wind	(same)	• Unreliable • Need suitable location	
Hydroelectric	(same)	• Flood large area to build dams → affect ecosystem • Expensive	• Sun evaporate water from sea • Water forms clouds & produce rain • Water collected behind dam • Moving water through dam turns turbine • Turbine drives generator • Electricity generated
Wave	(same)	• Unreliable • Low power output	
Biofuel	(same)	• Limited by location	
		• Cause flooding → affect ecosystem	
Tidal	(same)	• Limited location • Expensive	• Moon obits around Earth • Gravitational pull of Moon causes tides • Water falls to dam • Moving water turns turbine & generator • Electricity generated
Geothermal	(same)	• Limited location • Expensive	• Water pumped into ground • Hot rocks heat & turn water into steam • Steam rise back to surface & drives turbine • Turbine drives generator • Electricity generated

Efficiency

$$SSoooodddddSSddddvv = \frac{MMddSSooMMAA\ SSddSSAAaavv\ ooAA\ SSooUUSSAA\ ooMMddSSMMdd}{SSddSSAAaavv\ ooAA\ SSooUUSSAA\ ddddSSMMdd} \times 100\%$$



1.7.3 Work

- Energy: capacity of smth to do work
- Work done: a force acts on an object that moves (or is moving) in the direction of the force
- Usually, if a force acts in the direction that an object is moving then the object will gain energy.
- If the force acts in the opposite direction to the movement then the object will lose energy

$$UUooAAkk\ SSooddSS = ooooAAddSS \times SSddddddddddddSS = SSddSSAAaavv\ ddAAddddddooSSAAAASSSS$$

$$WW = FFSS =$$

ΔEE

1.7.4 Power

Power: rate at which the machine transfers energy

$$SSooUUSSAA = \frac{UUooAAkk\ SSooddSS}{ddddttSS\ ddddkkSSdd}$$

$$PP = \frac{EE}{dd}$$

- Total energy before = total energy after

1.8 Pressure

$$SSAASSddddMMAASS = \frac{ooooAAddSS}{ddAASSdd}$$

$$PP = \frac{FF}{AA}$$

A window in the room is open. The next day, the temperature of the room has increased, but the pressure of the air has stayed the same. State and explain what has happened to the mass of air in the room (3)

- Due to ↑temp, particles gain more KE, move faster & leave the room
- This causes the mass of air in the room to decrease while pressure of air stayed the same
- (If air particles don't leave the room, pressure will increase)

In liquid

- Acts in all directions
- ↑ with depth
- Depends on density of liquid
- Doesn't depend on shape of container

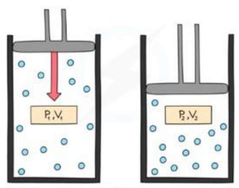
$$SSAASSddddMMAASS = hSSddaahdd \times SSSSddddddddvv \times aaAAddvvddddvv$$

$$SS = hSSaa$$

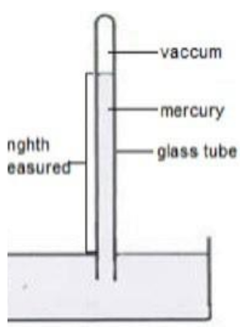
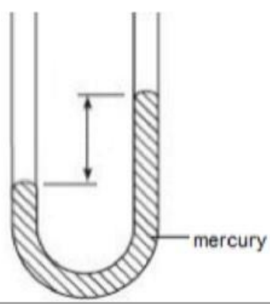
- Salt water is denser than clean water

- When an object is immersed in a liquid, the liquid will exert a pressure, squeezing the object
- This pressure is exerted evenly across the whole surface of the liquid, and in all directions.

Gas pressure

 $PP_1VV_1 = PP_2VV_2$	Double pressure, halve volume
$\frac{VV_1}{TT_1} = \frac{VV_2}{TT_2}$	Double temp, double volume
$\frac{PP_1}{TT_1} = \frac{PP_2}{TT_2}$	Double pressure, double temp

Measurements

Barometer	Manometer
	

• Measures the pressure difference Height • difference = excess pressure + atmospheric pressure	• Measures atmospheric pressure • Pressure of the air pushes down on reservoir, forcing mercury up the tube • Measure height of mercury