Paper 1 Physics Combined

This booklet contains all knowledge organisers for the content AND for the required practicals. This is everything you need for the Physics mock exam. Follow the plan below and you will have revised the WHOLE Paper 1 thoroughly by the time the mocks start.

You can watch cognito videos if you prefer rather than the knowledge organisers.

It is broken down week by week. The quiz will appear on satchel. Aim for at LEAST 80% and redo as you need.

Adjust the days if you need to fit in with your other subjects or your hobbies.

Good luck, Dr Thompson

Work Set	**Read and Self-test**	**Quiz**	**Due**
24-Sep	Energy KO Page 1-2	Energy	01-Oct
01-Oct	RP Specific Heat Capacity KO	SHC	08-Oct
08-Oct	Electricity KO Page 1-3	Electricity	15-Oct
15-Oct	RP IV curves KO	RP IV curves	22-Oct
22-Oct	*Half term*		
29-Oct	Resistance of wire KO	RP Resistance	05-Nov
05-Nov	Atomic Structure KO Page 1-3	Atomic Structure	12-Nov
12-Nov	Particles KO Page 1-2	Particles	19-Nov
19-Nov	RP Density KO	RP Density	26-Nov

KNOWLEDGE	Physics Paper 1 Topic 1: Energy	ORGANISER

Physics Paper 1 Topic 1: Energy

Section 1: Key Terms and Definitions

1.	Closed System	No net (overall) change in the energy of a system. All energy transfers take place within the system only.
2.	System	Object or group of objects
3.	Conservation of Energy	This law states that energy cannot be created or destroyed, it can only be transferred from one energy store to another.
4.	Joules	Unit of energy: One joule (1J) of work is done when a force of one Newton (1N) causes a displacement of (1M) 1 Joule – 1 Newton-metre
5.	Specific Heat Capacity	The energy needed to raise the temperature of 1kg of a material by 1°C.
6.	Friction	A contact force. Work to overcome this is mainly transferred to thermal energy. Friction in machines always results in unwanted energy transfers.
7.	Work Done	Another way of describing energy transfer, work is done when a force moves an object
8.	Output Energy	The energy given out by a device, can be useful or wasted.
9.	Input Energy	The energy supplied to a device
10.	Useful Energy	Energy transferred in device into the intended energy store to allow it function.
11.	Wasted Energy	Energy that is not transferred in a way that is useful. In most devices, the wasted energy will be transferred to the thermal energy store.
12.	Non-Renewable	A resource for which there is a limited supply which cannot be easily replaced. These resources will run out.
13.	Renewable	Resources that can replenish themselves or for which the supply is so large it isn’t believable that they could run out.
14.	Dissipation	Energy being transferred to the stores of surrounding objects (usually wasted thermal energy)
15.	Lubrication	A method of reducing unwanted energy transfers by application of a lubricant (e.g. oil) to reduce friction. Occurs in machines.
16.	Insulation	A method of reducing energy transfers by the use of insulators (non-conductive material) Occurs in buildings.

Section 2: Energy Stores

1.	Chemical	Energy stored in chemical bonds waiting to react. Fuels and foods store energy this way.
2.	Elastic	Describes the energy stored in a springy object when you stretch or squash it
3.	Electrostatic	Energy stored by the attraction or repulsion of electric charges
4.	Gravitational	Energy stored by raising objects up against the force of gravity
5.	Kinetic	Energy stored as a result of objects moving.
6.	Magnetic	Energy stored as a result of attraction or repulsion in a magnetic field.
7.	Nuclear	Energy stored in the nuclei of atoms. Can be released by the fusing or splitting of nuclei.
8.	Thermal	Energy stored as a result of the temperature of a substance. Often stored as a result of the vibrations of movement of particles within the substance.

Section 3: Reducing Heat Loss from a House

Roof
25% of the heat lost from a house is lost through the roof.

This can be reduced by installing loft insulation

Wall
35% of the heat lost from a house is lost through the walls.

This can be reduced by installing cavity wall insulation

Doors
15% of the heat lost from a house is lost straight through the doors

This can be reduced by fitting draught excluders

Floors
15% of the heat lost from a house is lost through the floors

This can be reduced by re-sealing wooden floors or laying carpets

Windows
10% of the energy lost from a house is lost through the windows.

This can be reduced by installing double glazed windows

KNOWLEDGE

Physics Paper 1 Topic 1: Energy

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Section 4: Energy Pathways

1.	Mechanical	Energy transferred by forces acting on objects
2.	Electrical	Energy transferred when an electrical charge moves
3.	Radiation	Energy transferred by electromagnetic radiation
4.	Heating	Energy transferred when an object is heated.

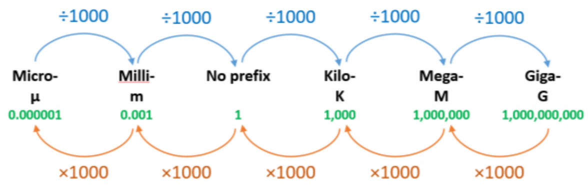
Section 5: Internal Energy

Internal Energy is slightly different, it is a combination multiple energy stores within a substance. All objects have internal energy. This includes:

- energy caused by the movement of particles in the object, sometimes called thermal energy
- energy due to the bonds between particles, sometimes called chemical energy

Section 6: Power

Power is the rate of energy transfer. It is usually measured in Watts, one Watt is the transfer of one joule of energy per second. More powerful devices can transfer a lot of energy and it is necessary to be able to convert units of different sizes



Section 7: Efficiency

- The efficiency of a device is the proportion of the total input energy that is transferred in useful ways given as a decimal or percentage.
- No device can be 100% efficient.
- Machines waste energy due to friction between moving parts, resistance in electrical circuits and noise.
- To improve efficiency, it is important to reduce the amount of energy wasted. For example, car engines use oil as a lubricant to reduce the friction between the moving parts of the engine.

Section 8: Energy Resources

Resource	Renewable?	Uses	Advantages	Disadvantages
Fossil Fuels (coal, oil, gas)	Non-renewable	Electricity, Transport, Heating	Reliable – electricity can be generated all of the time. Relatively cheap	Produces carbon dioxide, a greenhouse gas that causes global warming Can produce sulphur dioxide, a gas that causes acid rain
Nuclear Fuel	Non-renewable	Electricity	Produces no Carbon Dioxide when generating electricity. Reliable – electricity can be generated all of the time.	Produces nuclear waste that remains radioactive for thousands of years. Expensive to build and decommission power stations
Biofuels	Renewable	Heating, Electricity	Carbon Neutral Reliable – electricity can be generated all of the time.	Production of fuels may damage ecosystems and develop a monoculture.
Wind	Renewable	Electricity	No CO_2 produced whilst generating electricity.	Unreliable – may not produce electricity during low wind. Expensive to construct.
Hydroelectricity	Renewable	Electricity	No CO_2 produced whilst generating electricity.	Blocks rivers stopping fish migration. Unreliable – may not produce electricity during a drought.
Geothermal	Renewable	Electricity, Heating	Does not damage ecosystems. Reliable method of electricity generation	Fluids from the ground may contain greenhouse gases such as CO2 and Methane. These contribute to global warming.
Tidal	Renewable	Electricity	No CO_2 produced whilst generating electricity.	Unreliable – tides vary May damage tidal ecosystem e.g. mudflats.
Waves	Renewable	Electricity	No CO_2 produced whilst generating electricity.	Unreliable – may not produce electricity during calm seas
Solar	Renewable	Electricity, Heating	No CO_2 produced whilst generating electricity.	Unreliable – does not produce electricity at night. Limited production on cloudy days. Expensive to construct.

KNOWLEDGE | # Physics RP: Specific Heat Capacity | **ORGANISER**

Section 1: Aim of the Practical

Investigation to determine the specific heat capacity of one or more materials.
In this practical you will:

- heat up blocks of different metals using an electric heater
- measure the mass and temperature of the block
- calculate the work done by the heater
- plot a graph of temperature change against work done and use the gradient to calculate the specific heat capacity of the metal.

Section 2: Link to the Syllabus

4.1.1.3 Energy changes in systems

- The amount of energy stored in or released from a system as its temperature changes can be calculated using the specific heat capacity equation.
- The specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.

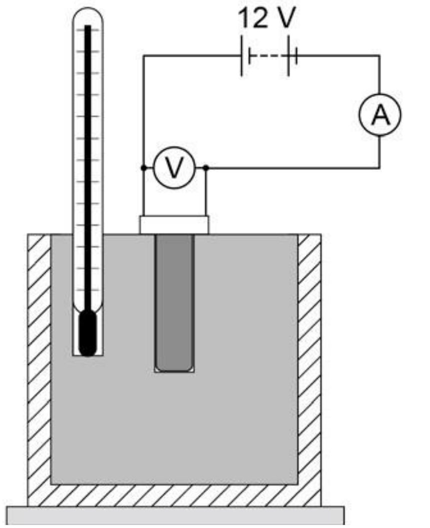
Section 3: Key Terms

1.	Specific Heat Capacity	The energy needed to raise the temperature of 1kg of a material by 1°C.
2.	Thermal Conduction	The transfer of thermal energy by microscopic collisions of particles and movement of electrons within a body. The process is most effective in solids.

Section 4: Equations used within the Practical

1.	change in thermal energy = mass × specific heat capacity × temperature change	[$\Delta E = mc\Delta\theta$]	ΔE Joules (J) m kilograms (kg) c Joules per kilogram per degree Celsius (J/kg°C) $\Delta\theta$ degrees Celsius (°C)	
2.	Power = Potential Difference × Current	[$P = VI$]	P Watts (W) V Volts (V) I Amps (A)	
3.	Energy Transferred = Power × Time	[$E = Pt$]	E Joules (J) P Watts (W) t seconds (s)	

Section 5: Apparatus Diagram



Section 6: Apparatus

1.	three metal blocks, one copper, one iron and one aluminium, each with two holes for a thermometer and heater
2.	some insulation material to wrap around the blocks
3.	a thermometer
4.	a pipette to put water in the thermometer hole
5.	a 12 V immersion heater (30 – 110W)
6.	a 12 V power supply
7.	an ammeter and a voltmeter
8.	five connecting leads
9.	a stopwatch or stopclock
10.	a balance.

Section 7: Method

1.	Measure and record the mass of the copper block in kg.
2.	Wrap the insulation around the block.
3.	Place the heater in the larger hole in the block.
4.	Connect the ammeter, power pack and heater in series.
5.	Connect the voltmeter across the heater.
6.	Use the pipette to put a small amount of water in the other hole.
7.	Put the thermometer in this hole.
8.	Set the power pack to 12 V. Switch on the power pack to turn on the heater.
9.	Record the ammeter and voltmeter readings. These shouldn't change during the experiment.
10.	Measure the temperature and start the stopclock.
11.	Record the temperature every minute for 10 minutes.
12.	Calculate the power of the heater in watts.
13.	Calculate the energy transferred (work done) by the heater. To do this, multiply the time in seconds by the power of the heater. Record these values in your table.
14.	Plot a graph of the temperature in °C against work done in J.
15.	Draw a line of best fit. Take care as the beginning of the graph may be curved.
16.	Calculate the gradient of the straight part of your graph. The gradient = change in temperature rise in °C/change in work done in J
17.	The **heat capacity** of the copper block is calculated using the formula: $heat\ capacity = \frac{1}{gradient}$
18.	Calculate the specific heat capacity of the copper block using the equation

KNOWLEDGE — Physics RP: Specific Heat Capacity — ORGANISER

Section 8: Risk Assessment

- Do not touch electrical equipment, plugs, or sockets with wet hands.
- Do not touch the heater: it becomes very hot when in use, and can stay hot for a long time after it is switched off.
- Switch the heater off it you think it is overheating.
- Switch the heater off after use.

Section 9: Possible Points for the Exam

1.	Why do you need to insulate the block? ▪ To stop thermal energy dissipating to the atmosphere
2.	Why is your answer not the true value? ▪ Because not all the thermal energy was transferred into the block and through to the thermometer
3.	Why is the temperature increase slower at first? ▪ Because it takes some time for the block to heat up and for the thermal energy to reach the thermometer
4.	Explain how to measure the specific heat capacity of water ▪ Place the immersion heater into a beaker with a fixed volume of water, measure the temperature increase and the amount of energy given to the water.
5.	What is the resolution of the temperature measurements? ▪ What is the smallest difference in value that the thermometers could accurately measure?
6.	How is the experiment repeatable? ▪ The exact same method could be repeated by the same person to obtain a similar set of results.
7.	Why would you take repeat readings? ▪ To calculate a mean ▪ To identify anomalous results ▪ To reduce the effect of random errors.

Section 10: Accepted Specific Heat Capacity Values

Metal	Copper	Aluminium	Iron	Lead	Steel	Brass
Specific heat capacity in J/kg/°C	385	913	500	126	452	380

Section 11: Sample Data

Aluminium block of 0.8kg

Time in seconds, s	Energy Transferred, J	Temperature, °C
0	0	21
120	3568.8	24
240	7137.6	29
360	10,706.4	34
480	14,275.2	39
600	17,844	44

Section 12: Sample Specific Heat Capacity Calculation

Energy Transferred = 17,844J

Mass = 0.8 kg

Starting Temperature = 21°C

Final Temperature = 44°C

$$Energy\ Transferred = Mass \times Specific\ Heat\ Capacity \times Change\ in\ Temperature$$

$$17{,}844 = 0.8 \times Specific\ Heat\ Capacity \times (44 - 21)$$

$$17{,}844 = 0.8 \times Specific\ Heat\ Capacity \times 23$$

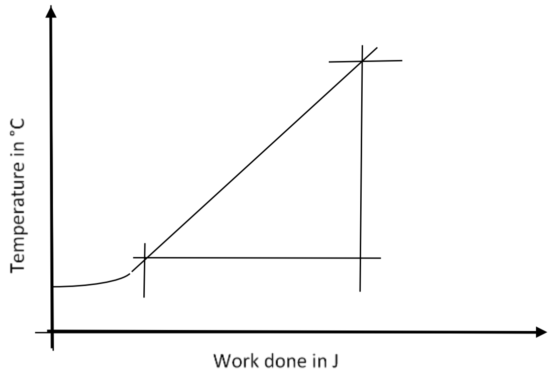
$$17{,}844 = Specific\ Heat\ Capacity \times 18.4$$

$$Specific\ Heat\ Capacity = \frac{17{,}844}{18.4}$$

$$Specific\ Heat\ Capacity = 969.78\ J$$

Section 13: Calculating Specific Heat Capacity from a graph

Assuming all energy from the heater is transferred to the block, then the gradient of the graph can be used to calculate the specific heat capacity.



$$Gradient = \frac{Change\ in\ Temperature}{Energy\ Transferred}$$

As the Heat Capacity is the amount of energy transferred to raise the temperature by 1°C, then the gradient is the inverse of the heat capacity.

$$Heat\ Capacity = \frac{1}{Gradient} = \frac{Energy\ Tansferred}{Temperature\ Change}$$

The specific heat capacity is simply the heat capacity divided by the mass of the block:

$$Specific\ Heat\ Capacity = \frac{Heat\ Capacity}{Mass\ of\ block}$$

KNOWLEDGE — Physics Paper 1 Topic 2: Electricity — ORGANISER

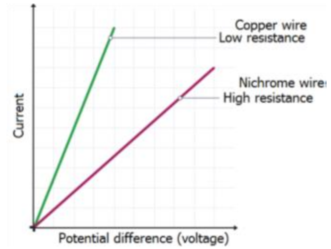
Section 1: Key Terms and Definitions

1	Electric Current	The rate of flow of electric charge. Measured in Amperes (A)
2	Potential Difference	The potential difference between two points in an electric circuit is the work done when a coulomb of charge passes between the points. Potential difference causes charge to flow. Measured in Volts (V)
3	Resistance	Resistance is the measure of the opposition to the flow of electric charge. It is measured in Ohms (Ω)
4	Charge	The electrical state of an object, which can be positively or negatively charged. In circuits it is measured in Coulombs (C). 1 Coulomb is the equivalent of the amount of charge carried by 6.25 x 10^{18} electrons.
5	Series	A circuit with only one route around the circuit for the charge to take.
6	Parallel	A circuit with more than one route around the circuit for the charge to take.

Section 3: Resistance in a Wire

Length of Wire	The longer the length of a wire, the greater the resistance of the wire. Electrons passing through the wire are more likely to collide with the nuclei of the atoms the wire consists of.
Thickness of Wire	As the cross-sectional area of the wire increases, the resistance of the wire decreases. The larger the area, the more electrons can flow through the wire.
Temperature	As the temperature increases, the nuclei of the wire vibrates more, making it more likely electrons with collide with it. This increases the resistance.

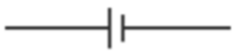
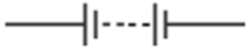
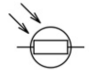
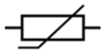
Section 4: Current-Potential Difference Graphs



Increasing Potential Difference allows a greater Current to flow around a circuit. Resistance of a wire can be determined from plotting a current-potential difference graph for different wires.

The greater the gradient of the line, **the lower the resistance** of the wire.

Section 2: Circuit Symbols

						
A Switch enables the current in the circuit to be switched on or off.	A cell is required to push electrons around a complete circuit.	A Battery is multiple cells working together in a circuit.	A lamp emits light when a current passes through it.	A voltmeter is used to measure potential difference (i.e. voltage) within a circuit	An ammeter is used to measure current within a circuit	A fixed resistor limits the electric current flowing in a circuit.
						
A diode only allows current to flow through it in one direction.	An Light Emitting Diode (LED) behaves like a diode but also emits light when a current passes through it.	A Variable Resistor allows the current in the circuit to be varied.	A fuse is designed to melt and therefore “break” the circuit if the current through it gets too high.	A heater is designed to transfer the energy from an electric current to heat the surroundings.	A Light Dependent Resistor has a very high resistance in the dark, but less when the resistor is lit.	A thermistor is a temperature dependent resistor. Its resistance decreases if the temperature increases.

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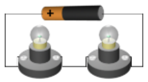
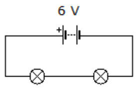
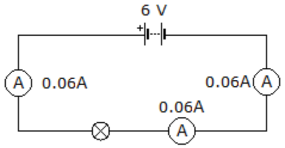
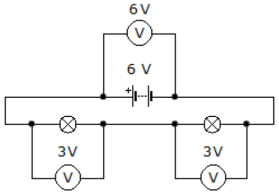
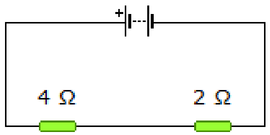
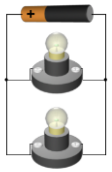
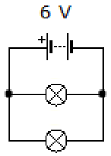
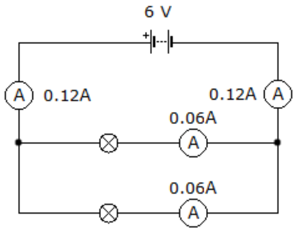
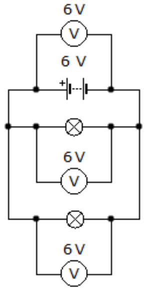
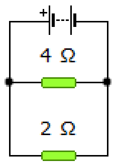
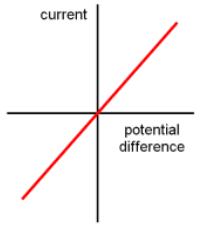
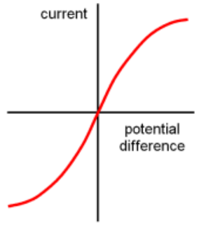
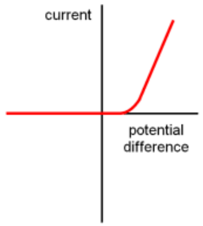
Section 5: Series and Parallel Circuits

Circuit type…	Current	Potential Difference	Resistance
Series  	The **current** is the **same at every point in the circuit** and in every component. 	The total **potential difference** of the power supply **is shared between the components**. 	The **more resistors, the greater the resistance**. The **total** resistance is the **sum** of the **resistance of all the individual components**. $R_{Total} = R_1 + R_2 + ...$ 3 V 
Parallel  	The **total current** through the whole circuit is the **sum of the current through the separate components or routes** in the circuit 	The **potential difference** across each route is the **same**. 	Adding more resistors in parallel decreases the resistance. The **total resistance** of two resistors is **less than** the **resistance** of the **smallest** individual **resistor**. 3 V 

Section 6: IV Graphs

Graph	Example	Explanation
	Fixed Resistor – Ohmic Conductor	Current and potential difference are directly proportional. Resistance is constant
	Filament Lamp Non-ohmic Conductors	Resistance of a filament lamp is not constant. As temperature increases, resistance increases. Ions within the lamp vibrate more, increasing collisions with electrons.
	Diodes and LEDs	The current through the diode flows in one direction only. The diode has a very high resistance in the reverse direction.

KNOWLEDGE

Physics Paper 1 Topic 2: Electricity

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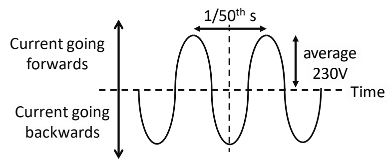
Section 14: Key Terms for Mains Electricity

1	Electric Current	The flow of electric charge. Measured in Amperes (A)
2	Alternating Current (a.c.)	The current alternates (regularly changes direction). Used for Mains Electricity.
3	Direct Current (d.c.)	Current flows in one direction only. Typically from cells or batteries.
4	Mains Electricity	Electricity provided to our homes is provided by the National Grid. It has an alternating current of 230V and a frequency of 50Hz

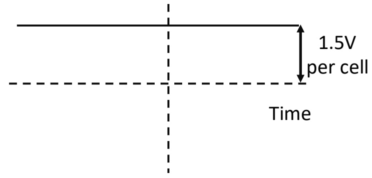
Section 15: Alternating and Direct Current

Alternating Current



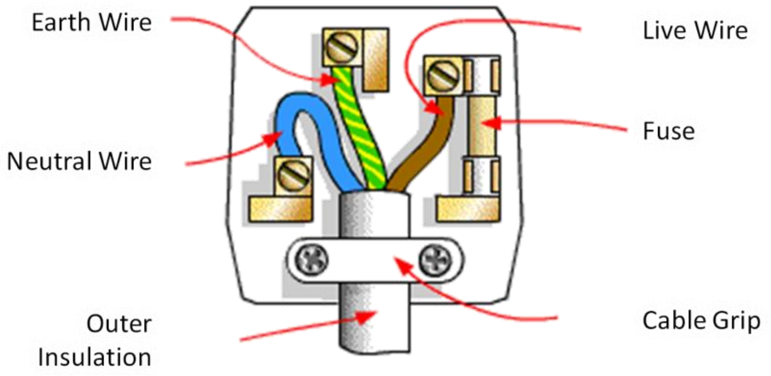
The current changes direction 50 times a second.

Direct Current



The current flows in the same direction all of the time.

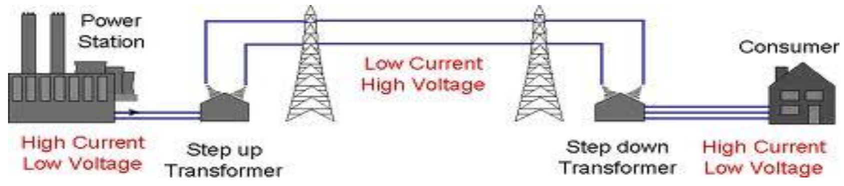
Section 16: Plugs, Sockets and Cables



Live Wire	Copper wire coated with brown plastic along which the current enters the device
Neutral Wire	Copper wire coated with blue plastic that also connects to the cable in the wall and completes the circuit
Earth Wire	Copper wire coated in striped plastic that provides a path for current to flow from the case of the device to the ground if there is a fault
Fuse	A glass or ceramic canister containing a thin wire that melts if the current gets too high
Cable Grip	This holds the cable tightly in place so that wires do not become loose
Outer Insulation	All three wires in the cable are bundled together and there is extra plastic insulation wrapped round them all for safety
Sockets and plug Cases	Always made of an insulator such as plastic to prevent the danger or receiving an electric shock.

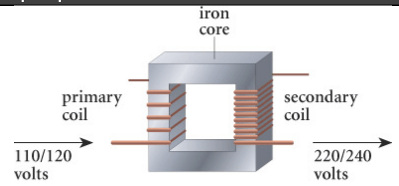
Section 17: The National Grid

The national grid supplies electricity from power stations via a series of cables and transformers to customers at high voltages to reduce energy loss.



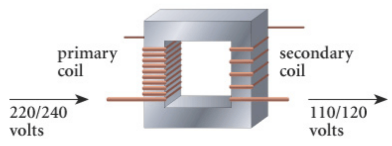
Transformers within the national grid change the potential difference of the current flowing through the grid. Current produces a heating effect so raising the potential difference reduces the current and therefore the amount of energy lost due to heating.

Step Up Transformers



More coils on secondary coil than on the primary coil which increases the potential difference.
Higher potential difference means lower current and therefore less resistance.

Step Down Transformers



More coils on primary coil than on the secondary coil which decreases the potential difference.
Lower potential difference means higher current and therefore more resistance.

KNOWLEDGE

Physics RP: I-V Characteristics

ORGANISER

Section 1: Aim of the Practical

Investigating the I-V characteristics of circuit components.
What happens to the current through a component when the potential difference across it changes?

For some circuit components, the value of resistance can change as the current changes. You can use the graph of current against potential difference to help identify the component in a circuit.

In this practical you will:

- construct circuits and draw circuit diagrams
- measure the current across a component as you change the potential difference
- plot graphs of current against potential difference for each component.

Section 2: Link to the Syllabus

4.2.1.4 Resistors

- explain the design and use of a circuit to measure the resistance of a component by measuring the current through, and potential difference across, the component
- draw an appropriate circuit diagram using correct circuit symbols. (pd) across the component.

Section 3: Key Terms

1.	Electric Current	The rate of flow of electric charge. Measured in Amperes (A)
2.	Potential Difference	The potential difference between two points in an electric circuit is the work done when a coulomb of charge passes between the points. Potential difference causes charge to flow. Measured in Volts (V)
3.	Ohm's Law	A resistor obeys Ohm's law if the current through the resistor (at a constant temperature) if directly proportional to the potential difference across it.
4.	Directly Proportional	If one variable will change, the other one will change by the same amount each time
5.	Variable Resistor	A resistor where the resistance can be varied, this will affect the current of the circuit
6.	Diode	A non-ohmic conductor that has a much higher resistance in one direction than the other

Section 4: Equations used within the Practical

1.	Potential Difference = Current × Resistance	[$V = IR$]	*V* Volts (V) *I* Amps (A) *R* Ohms (Ω)

Section 5: Apparatus

1.	suitable power supply
2.	ammeter and milliammeter, or multimeter
3.	voltmeter or multimeter
4.	component holders
5.	12 V, 24 W lamp eg a ray box lamp
6.	resistor
7.	diode and protective resistor (eg 10 Ω)
8.	rheostat eg 10 Ω, 5 A
9.	connecting leads.

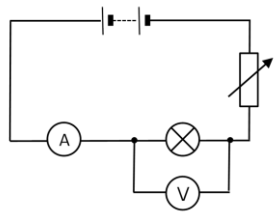
Section 6: Risk Assessment

- Components may get hot after being on for a while, so you should not touch them.
- Do not allow the current to go above 1.0 A, as this could cause overheating.
- Always switch off the power supply or disconnect the batteries before building or changing your circuit and switch off the power supply between measurements.

Activity 1: Filament Bulbs

Section 7: Circuit Diagram

Filament Bulb



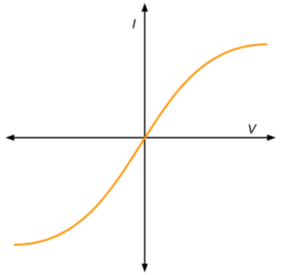
Section 8: Method

1.	Use the circuit diagram to set up your circuit.
2.	Record the readings on the ammeter and voltmeter in a suitable table.
3.	Adjust the variable resistor and record the new readings on the ammeter and voltmeter.
4.	Repeat this to obtain several pairs of readings.
5.	Swap the connections on the battery/power supply. The ammeter is now connected to the negative terminal and variable resistor to the positive terminal. The readings on the ammeter and voltmeter should now be negative.
6.	Continue to record pairs of readings of current and potential difference with the battery reversed.
7.	Plot a graph of current against potential difference. As the readings include negative values the origin of your graph will be in the middle of the graph paper. You should be able to draw a line of best fit through the origin. **This is the characteristic of a filament lamp.**

Section 9: Filament Bulb Sample Data

Potential Difference, V	Current, A
-2.4	
-2.0	
-1.6	
-1.2	
-0.8	
-0.4	
0.0	
0.4	
0.8	
1.2	
1.6	
2.0	
2.4	

Section 10: Graph



Filament Bulb

When an electrical charge flows through a filament lamp, it transfers some energy to thermal energy store of the filament, which is designed to heat up and glow.
Resistance increases with temperature, so as more current flows through the lamp, the lamp heat up more and the resistance increases.

KNOWLEDGE

Physics RP: I-V Characteristics

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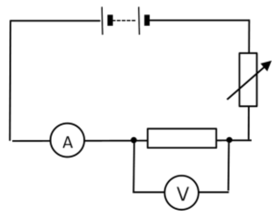
Activity 2: Fixed Resistors

Section 11: Circuit Diagram

Fixed Resistor



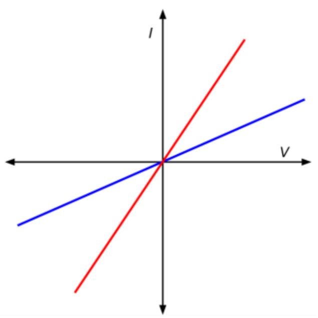
Section 12: Method

1.	Swap the leads on the battery/power supply back to their original positions.
2.	Replace the filament lamp with the resistor.
3.	Record the readings on the ammeter and voltmeter in a suitable table.
4.	Adjust the variable resistor and record the new ammeter and voltmeter readings. Repeat this to obtain several pairs of readings.
5.	Swap the connections on the battery/power supply. Now the ammeter is connected to the negative terminal and variable resistor to the positive terminal. The readings on the ammeter and voltmeter should now be negative.
6.	Continue to record pairs of readings of current and potential difference with the battery reversed.
7.	Plot a graph of current against potential difference. As the readings include negative values the origin of your graph will be in the middle of the graph paper. You should be able to draw a straight line of best fit through the origin. **This is the characteristic of a resistor.**

Section 13: Fixed Resistor Sample Data

Potential Difference, V	Current, A
-2.4	-0.24
-2.0	-0.20
-1.6	-0.16
-1.2	-0.12
-0.8	-0.08
-0.4	-0.04
0.0	0.00
0.4	0.04
0.8	0.08
1.2	0.12
1.6	0.16
2.0	0.20
2.4	0.24

Section 14: Graph



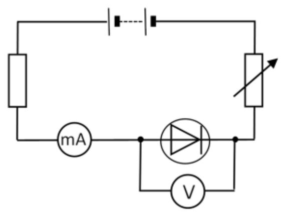
Resistors at a constant temperature

The current through an ohmic (fixed resistor) conductor (at constant temperature) is directly proportional to potential difference, so you get a straight line I-V characteristic.
A fixed resistor (or length of wire) is an ohmic conductor, so you could test a few different resistors (or different wires). Different resistors result in straight lines with different slopes.

Activity 3: Diodes

Section 15: Circuit Diagram

Diode



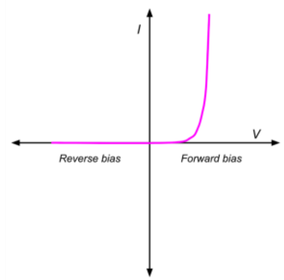
Section 16: Method

1.	Swap the leads on the battery/power supply back to their original positions.
2.	If you can, reduce the battery/power supply potential difference to less than 5 V.
3.	Connect the extra resistor labelled P.
4.	Replace the ammeter with a milliammeter.
5.	Replace the resistor used in activity 2 with the diode.
6.	Record the readings on the milliammeter and voltmeter in a suitable table.
7.	Adjust the variable resistor and record the new milliammeter and voltmeter readings.
8.	Repeat this to obtain several pairs of readings.
9.	Swap the connections on the battery/power supply. Now the milliammeter is connected to the negative terminal and variable resistor to the positive terminal. The readings on the milliammeter and voltmeter should now be negative.
10.	Continue to record pairs of readings of current and potential difference with the battery reversed.
11.	Plot a graph of current against potential difference. As the readings include negative values the origin of your graph will be in the middle of the graph paper. You should be able to draw a line of best fit through the origin. This is the characteristic of a diode.

Section 17: Diode Sample Data

Potential Difference, V	Current, A
-1.0	0.00
-0.5	0.00
0	0.00
0.2	0.00
0.4	0.00
0.6	0.00
0.7	0.00
0.8	0.02
0.9	0.13
1.0	0.34
1.1	0.56
1.2	0.73

Section 18: Graph



Semiconductor Diode

A diode is a component that only lets current pass through it in one direction. The resistance of a diode depends on the direction of the current – it will let current flow through it one way but will have a very large resistance if the current is reversed.

KNOWLEDGE

Physics RP: Resistance of a Wire

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Section 1: Aim of the Practical

Investigate factors that affect the resistance of electrical circuits:

- length of a wire at constant temperature
- combination of resistors in series and parallel.

In this practical you will:

Activity 1:

- set up a circuit which can measure the potential difference and current across a wire at different lengths along the wire
- calculate the resistance for different lengths of wire and state the relationship between resistance and length.

Activity 2:

- use circuit diagrams to construct circuits with resistors in series and in parallel
- measure the potential difference and current in circuits with resistors in series and then in parallel.

Section 2: Link to the Syllabus

4.2.1.3 Current, resistance and potential difference

- The current (I) through a component depends on both the resistance (R) of the component and the potential difference (V) across the component. The greater the resistance of the component the smaller the current for a given potential difference (pd) across the component.

Section 3: Key Terms

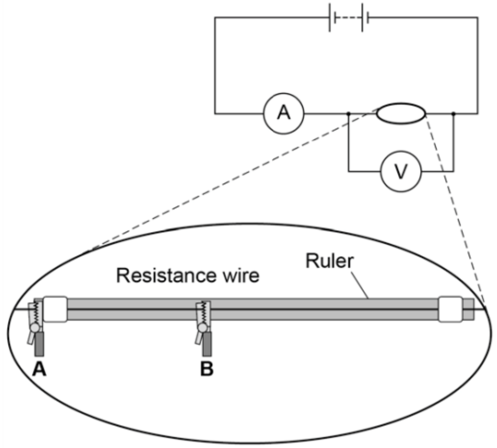
1.	Electric Current	The rate of flow of electric charge. Measured in Amperes (A)
2.	Potential Difference	The potential difference between two points in an electric circuit is the work done when a coulomb of charge passes between the points. Potential difference causes charge to flow. Measured in Volts (V)
3.	Resistance	Resistance is the measure of the opposition to the flow of electric charge. It is measured in Ohms (Ω)

Section 4: Equations used within the Practical

1.	Potential Difference = Current × Resistance	[$V = IR$]	V I R	Volts (V) Amps (A) Ohms (Ω)

Activity 1: How does the length of the wire affect the resistance at a constant temperature?

Section 5: Apparatus Diagram



Section 6: Apparatus

1.	suitable power supply	4.	resistance wire e.g. constantan attached to a metre ruler
2.	ammeter	5.	connecting leads
3.	voltmeter	6.	crocodile clips

Section 7: Risk Assessment

- Do not connect the wire directly to the mains supply – this could cause a fatal electric shock.
- Use a low potential difference in the wire, ideally 2V to prevent the wire getting too hot and reduce the risk of burns.
- Disconnect the circuit as soon as the measurements are taken, to stop the wire getting hot.
- After the circuit has been on, do not touch the wire without checking first whether you can feel heat coming off it from a distance, using the back of your hand.

Section 8: Method

1.	Use the circuit diagram to set up and connect the circuit.
2.	Connect a lead from the negative side of the ammeter to the crocodile clip at the zero end of the ruler. Connect a lead from the other crocodile clip to the negative side of the battery. Use this lead as a switch to disconnect the battery between readings.
3.	Decide the interval distance (e.g. 10cm) you will investigate and connect the first distance to be tested between crocodile clips A and B.
4.	Measure the readings on the voltmeter and ammeter at this distance.
5.	Record your results in a table
6.	Move crocodile clip B and record the readings for the different lengths of wire e.g. 20cm, 30cm etc.
7.	Calculate the resistance for each length of wire using the equation from Section 4.

Section 9: Sample Data

Length of wire, cm	Potential Difference, V	Current, A	Resistance, Ω
10	0.13	0.98	0.13
20	0.20	0.83	0.22
30	0.27	0.74	0.37
40	0.31	0.66	0.47
50	0.35	0.59	0.55
60	0.36	0.53	0.68
70	0.40	0.50	0.80
80	0.42	0.47	0.89

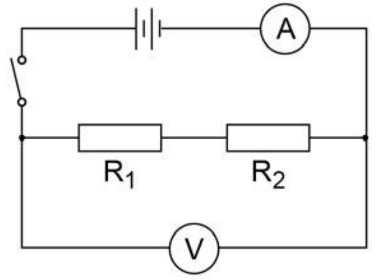
KNOWLEDGE

Physics RP: Resistance of a Wire

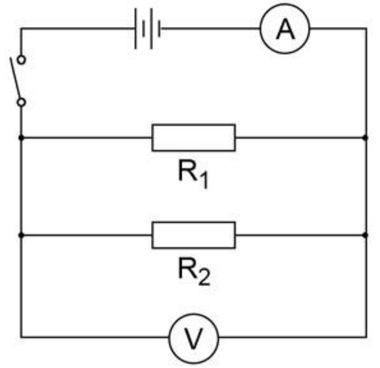
ORGANISER

Activity 2: How does the arrangement of resistors in series and in parallel affect resistance?

Section 10: Series Circuit Diagram



Section 11: Parallel Circuit Diagram



Section 12: Apparatus

1.	a battery or suitable power supply
2.	ammeter or multimeter
3.	voltmeter or multimeter
4.	crocodile clips
5.	three 10Ω resistors
6.	connecting leads

Section 13: Risk Assessment

- Ensure that the ammeter is correctly wired in series to prevent a short circuit being made and danger of overheating the circuit.
- Use low potential differences to avoid the risk of burning the resistors out.

Section 14: Method

1.	Connect the circuit for two resistors in series, as shown in the diagram.
2.	Switch on and record the readings on the ammeter and the voltmeter.
3.	Use these readings to calculate the total resistance of the circuit using the equation from section 4.
4.	Now set up the circuit for two resistors in parallel.
5.	Switch on and record the readings on the ammeter and the voltmeter.
6.	Use these readings to calculate the total resistance of the circuit again using the equation from section 4.

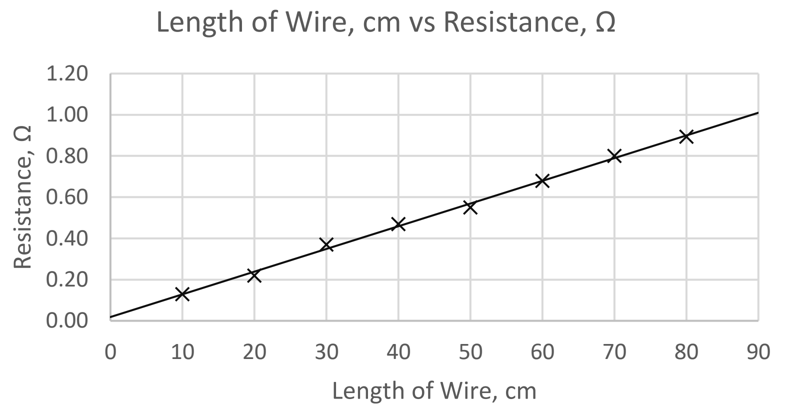
Section 15: Sample Data for the Series Circuit

Number of Resistors in Series	Potential Difference, V	Current, A	Resistance, Ω
2	1.38	0.07	19.71
3	1.38	0.05	27.6

Section 16: Sample Data for the Parallel Circuit

Number of Resistors in Parallel	Potential Difference, V	Current, A	Resistance, Ω
2	1.21	0.24	5.04
3	1.21	0.36	3.36

Section 17: Graph Analysis for Activity 1



The graph should be a straight line through the origin, which means resistance is directly proportional to length.

Section 18: Possible Points for the Exam

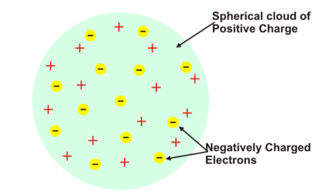
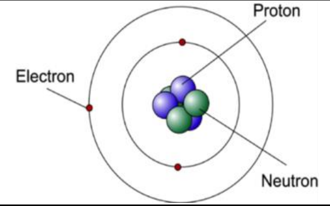
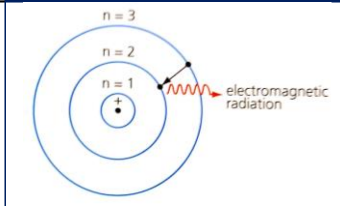
1.	Explain why the graph might not pass exactly through the origin. ▪ There may be resistance elsewhere within the circuit. This would cause systematic errors in results.
2.	Why must the power pack be kept on a low potential difference? Or, What are the hazards? ▪ The wire will get very hot and could burn you.
3.	Explain how the temperature affects the resistance. ▪ As the wire gets hotter, the ions inside the wire vibrate faster, the electrons are more likely to collide with the ions so cannot flow as easily.
4.	Why is it important to switch the circuit off between each reading? ▪ To let the wire cool down, as temperature affects resistance.
5.	What sort of error could cause all the ammeter/voltmeter readings to be too high? ▪ A zero error – the meters need to be set at zero to start with
6.	What's the **resolution** of ammeter or voltmeter? ▪ What is the smallest value the meters can measure?
7.	This experiment could be repeated and you'd get slightly different readings. This means you could be asked about **repeatability** and ask you to calculate the **mean** or the **uncertainty**.

KNOWLEDGE — Physics Paper 1 Topic 4: Atomic Structure — ORGANISER

Section 1: Key Terms and Definitions

1	Atom	The smallest part of an element that can exist. All substances are made of atoms. Atoms have no overall electrical charge. They are very small with a radius of 0.1nm.
2	Element	An element contains only one type of atom. Found on the periodic table. There are over 100 elements.
3	Isotope	An atom of the same element with a different number of neutrons. All isotopes of a particular element have the same atomic number
4	Radioactive Decay	When an unstable nucleus changes to become more stable and emits radiation. Happens randomly
5	Radiation Dose	Measure of the exposure to radiation, measured in sieverts (Sv).
6	Activity	The rate at which decay occurs. Measured in Becquerel (Bq). 1 Becquerel is 1 decay per second.
7	Count Rate	Number of decays recorded each second by a Geiger-Muller Tube
8	Half Life	The time it takes for the number of nuclei of the isotope in a sample to halve. **Or,** The time it takes for the count rate (or activity) from a sample containing the isotope to fall to half its initial level.
9	Ionisation	Radiation can ionize by removing the electrons from atoms to form ions. If this happens in DNA it could lead to a mutation that causes cancer
10	Proton	Positively charged particle found in the nucleus
11	Neutron	Neutral (not charged) particle found in the nucleus
12	Electron	Negatively charged particle found orbiting the nucleus at different distances depending which shell it is in.
13	Nucleus	Centre of the atom 1/10,000 of the size of the atom but contains most of the mass of the atom.
14	Ion	An atom with either more or less electrons than the protons, giving it an overall positive or negative charge.
15	Background Radiation	Radiation present in the environment around us, comes from: • Natural sources such as rocks, soil and cosmic rays. • Man-made sources such as fallout from nuclear weapons exploding, radiation leaks from accidents at nuclear power stations.

Section 2: Development of the Atomic Model

Thomson's Plum Pudding Model	Rutherford's Nuclear Model	Bohr's Model
		
Thomson's Plum Pudding model of the atom showed that the atom was a **sphere of positive charge with negatively charged electrons** spread through it. **This model was** proven to be **incorrect** by Rutherford.	Rutherford's model suggested that **most of** the **atom** must be **empty space**. A **very small positively charged nucleus** surrounded by **electrons orbiting** it. Over time, this model was **refined by** the **discovery of** the **neutron**.	Bohr suggested a model of the atom where **electrons move round the nucleus in circular orbits**. In this model electrons can change their orbits. This further refined the work of Rutherford.

Energy Levels: Absorption of radiation may lead to electrons moving further from the nucleus (higher energy level)
Emission of radiation may lead to electrons moving closer to the nucleus (lower energy level)

Section 3: Atomic Number and Mass Number

Mass Number:
The total number of **protons and neutrons** → 132.91

Atomic Number: The number of protons within an atom.
(In an atom, the number of electrons would be the same) → 55

132.91
Cs
55

Section 4: Properties of Sub Atomic Particles

Sub-atomic Particle	Mass	Charge	Location in Atom
Proton	1	+1 (Positive)	In Nucleus
Neutron	1	0 (Neutral)	In Nucleus
Electron	$\frac{1}{2000}$	-1 (Negative)	Orbiting Nucleus

KNOWLEDGE

Physics Paper 1 Topic 4: Atomic Structure

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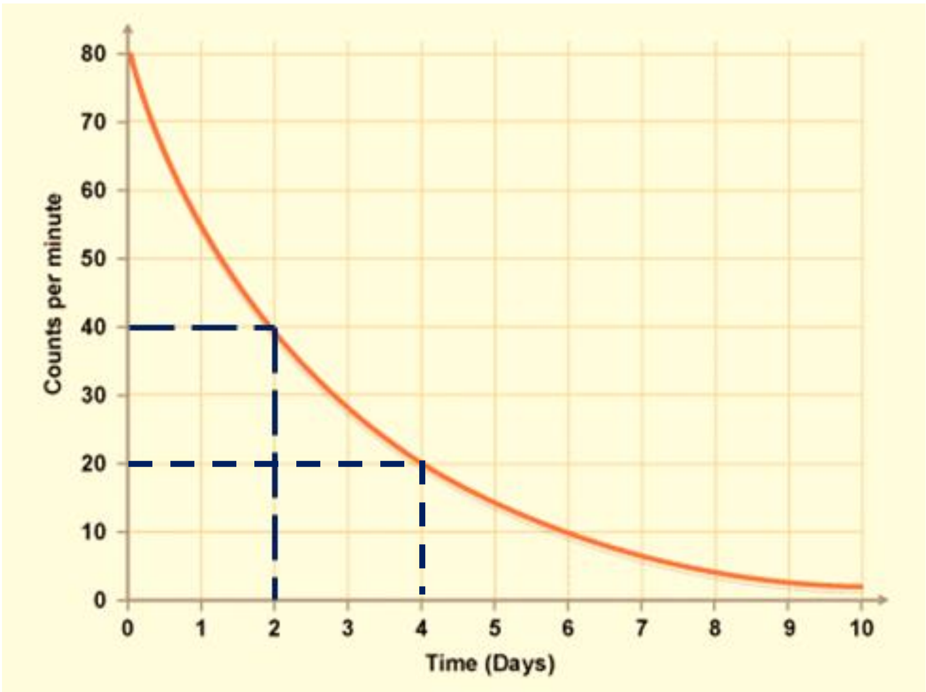
Section 5: Nuclear Radiation

Radiation	Range in Air	Absorbed by	Ionising Power	Consists of
Alpha, α	Short – up to 5cm	Paper and skin	Very High	2 protons and 2 neutrons (Helium nucleus)
Beta, β	Medium – about 1m	About 5mm of Aluminium	Medium	Electron
Gamma, γ	Unlimited	Several Centimetres of lead	Low	Electromagnetic Wave

Section 6: Decay Equations

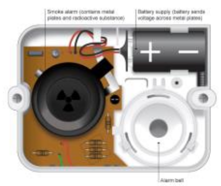
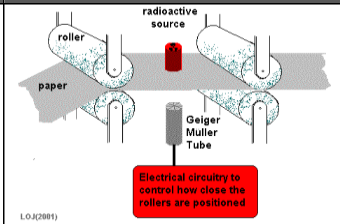
Alpha Decay	$^{219}_{86}Rd \rightarrow {}^{215}_{84}Po + {}^{4}_{2}He$ In alpha decay a helium nucleus (**2 protons and 2 neutrons**) is emitted. The new element formed has a **mass number** that has **decreased by 4** (219 – 215 = 4) and **atomic number** that has **decreased by 2** (86 – 84 = 2).
Beta Decay	$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$ In beta decay a neutron turns into a proton. An electron is emitted. The new element formed has a **mass number** that **stays the same** and an **atomic number** which **increased by 1**(6 + 1 = 7).
Gamma Ray Emission	Decay by Gamma emission causes no change in the mass or structure of the nucleus.

Section 7: Half-Life and Activity Counts



Halve the initial activity (80 ÷ 2 = 40)
Draw a line across on the graph until you reach the curve
Draw a line down (half-life = 2 days)
However, the activity **never** reaches zero.

Section 8: Uses of Radioactivity

Smoke Detectors	Thickness Control	Carbon Dating
		
Smoke detectors contain a small amount of Americium-241, an alpha emitter. Smoke in the detector blocks alpha particles, triggering the alarm.	A beta emitter with very long half-life is used. Radiation from the source is continually monitored. If the count rate drops, the thickness is too great and the rollers separate.	Used to find the age of ancient materials. Living wood has a tiny proportion of radioactive carbon C-14. The lower the proportion of C-14, the older the object being tested.

Section 9: Irradiation vs Contamination

Irradiation	Contamination
Objects that are near a radioactive source are irradiated by it. The object is exposed to the radiation, but irradiating it does not make the object radioactive.	If unwanted radioactive atoms get onto or into a material, then it is said to be contaminated. The radioactive atoms will then decay, releasing radiation which could cause harm.

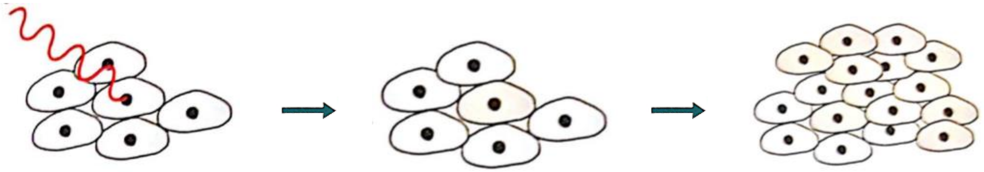
KNOWLEDGE

Physics Paper 1 Topic 4: Atomic Structure

ORGANISER

Section 10: Dangers of Radiation

Ionising Radiation

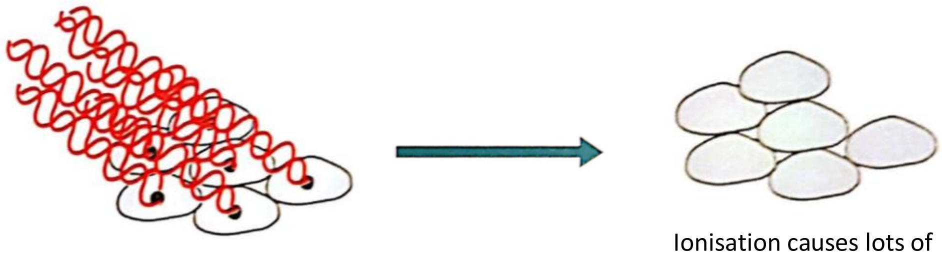


Normal cells exposed to a low dose of radiation.

Ionisation inside the cell leads to cell damage.

Damaged (mutant) cell divides uncontrollably forming cancer.

- Radiation can enter living cells and ionise atoms and molecules within them. This can lead to tissue damage.
- Lower dose tend to cause damage without killing the cells. This can lead to mutant cells which divide uncontrollably. (Cancer)



Normal cells exposed to a high dose of radiation.

Ionisation causes lots of damage to the cells, causing them to die.

- Higher doses kill cells completely, causing radiation sickness if a lot of cells get the dose at once.

Section 11: Uses of Radiation in Medicine

Radioactive Tracers

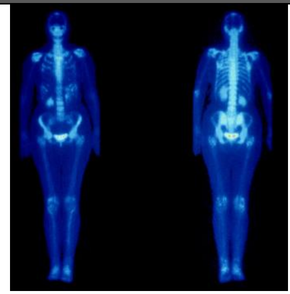


Image of a bone scan using radioactive technetium as a tracer.

Patients are injected with a radioactive isotope. The isotope should:

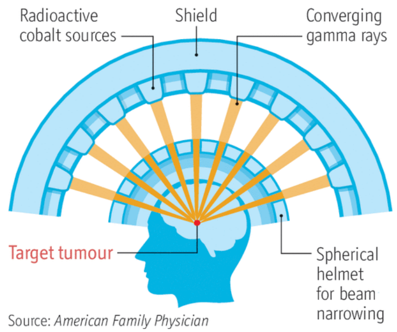
- Decay by gamma emission (to be detectable outside the body and reduce ionisation)
- Have a short half-life (long enough to complete the test, not long enough to leave patient irradiated for days)
- Decay into a stable isotope (so that there a no further dangers from alpha or beta decay within the body)

Common tracers include Iodine-123 and Technetium-99m.

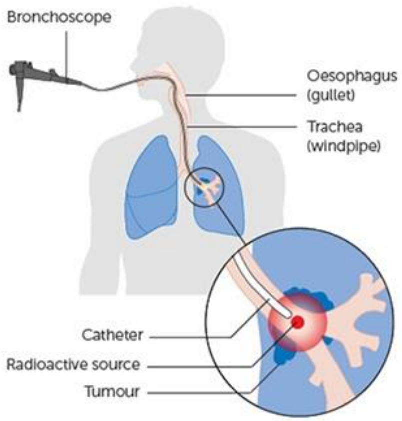
Radiotherapy – Cancer Treatment

High doses of radiation will kill cells. Cancers can be treated by bombarding tumours with high doses of radiation.

- Gamma rays can be used to target the tumour from different angles to minimise the damage to healthy cells.



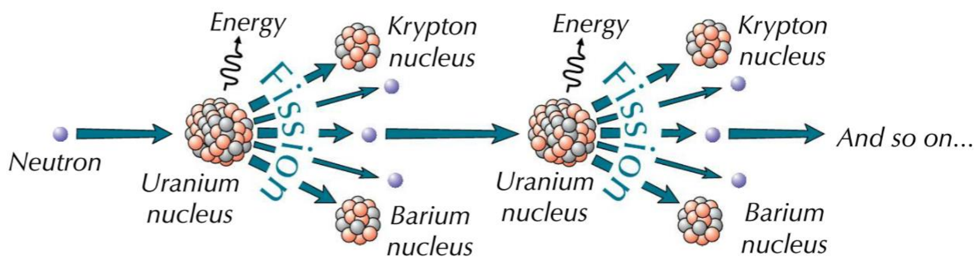
- Radioactive compounds (usually beta emitters) can be injected into tumours.



KNOWLEDGE — Physics Paper 1 Topic 4: Atomic Structure — ORGANISER

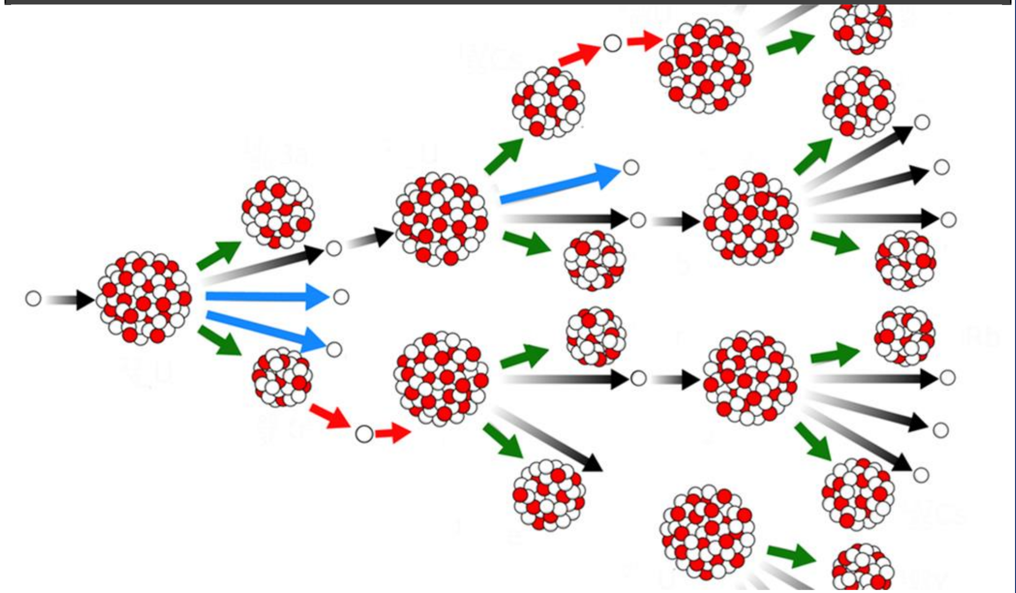
Section 12: Nuclear Fission

Heavy atomic nuclei such as Uranium-235 and Plutonium-239 can be split when struck by a fast moving neutron. These isotopes are said to be "fissionable materials".



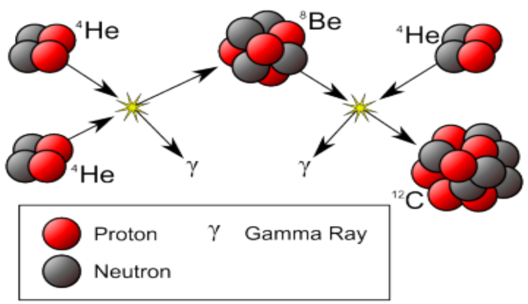
- Unstable nuclei are bombarded with neutrons.
- The nuclei undergo fission and split.
- Two smaller nuclei are formed plus neutrons.
- Energy is released.
- Released neutrons cause more nuclei to split which produces a chain reaction.
- The reaction is controlled using control rods which absorb the neutrons (slowing down the chain reaction).
- A water coolant removes the heat energy.

Section 13: Chain Reactions



When fissionable material is split, it produces 2 smaller atomic nuclei plus 2 or 3 extra neutrons.
These extra neutrons can collide with other fissionable nuclei to cause further fission reactions.
This is known as a chain reaction. In a nuclear reactor the chain is controlled so that each nuclei split only releases neutrons to split one further nuclei.

Section 14: Nuclear Fusion



- Two light nuclei join (fuse) to form a single heavier nucleus.
- For example, two Helium nuclei fuse to form a Beryllium nucleus.
- Energy is released when the nuclei fuse – more energy than when heavy nuclei split due to fission.

The sun releases energy due to the nuclear fusion reaction of fusing hydrogen into helium.

Section 15: Comparing Nuclear Fission and Nuclear Fusion

Nuclear Fission	Nuclear Fusion
Been used for over 50 years	A developing technology. Needs to be at a high temperature and pressure for reaction take place and generate electricity
Uses uranium (only found in some parts of the world)	Hydrogen fuel easily available as present in sea water.
Produces radioactive nuclear waste which has to be stored safely and securely	Produces no harmful waste.

KNOWLEDGE

Physics Paper 1 Topic 3: Particles

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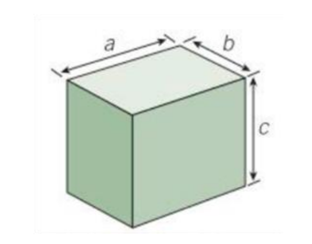
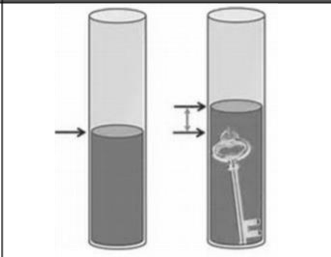
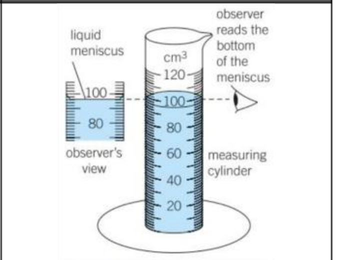
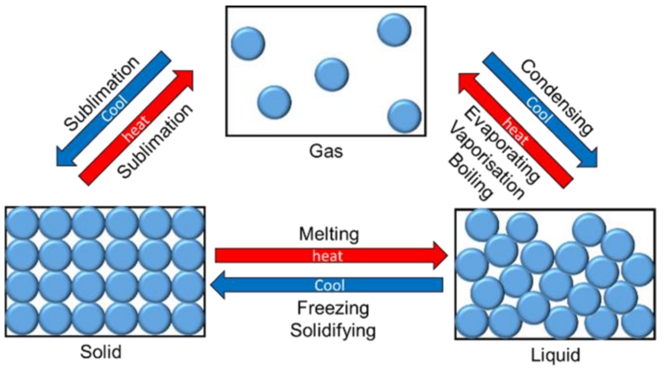
Section 1: Key Terms and Definitions

1	Density	How much mass a substance contains compared to its volume. Solids are usually dense because the particles are closely packed. Measured in kg/m^3 (or g/cm^3).
2	Volume	The amount of space a liquid takes up. Measured in cm^3.
3	Mass	A measure of how many particles are in a substance. Measured in kg (or g).
4	Float	Objects float on water if the density of the object is less than $1000kg/m^3$ ($1 g/cm^3$).
5	Sink	Objects sink in water if the density of the object is more than $1000kg/m^3$ ($1 g/cm^3$).
6	State of Matter	The way in which the particles are arranged – solid, liquid or gas
7	Change of State	When a substance changes from one state of matter to another (e.g. melting is the change from a solid to a liquid) Energy changes the state, not the temperature.
8	Physical Change	A change that can be reversed to recover the original material. e.g. a change of state.
9	Chemical Change	A change that creates new products. It cannot be reversed. e.g. a chemical reaction
10	Internal Energy	The energy stored inside a system by the particles (atoms and molecules) that make up the system. Internal energy is the total kinetic energy and potential energy of all the particles.
11	Kinetic Energy	Energy stored within moving objects (e.g. particles)
12	Potential Energy	Energy stored in particles because of their position. The further apart the particles are, the greater the potential energy.
13	Specific Heat Capacity	The specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.
14	Temperature	The average kinetic energy of the particles.
15	Specific Latent Heat	The amount of energy required to change the state of one kilogram of the substance with no change in temperature.
16	Latent Heat of Fusion	Energy required to change state from solid to liquid.
17	Latent Heat of Vaporisation	Energy required to change state from liquid to gas.
18	Work Done on a Gas	When a gas is compressed, a force is used to compress it. Energy is transferred in compressing the gas, so work is done on the gas.

Section 2: Techniques for Measuring Density

Measuring a Regular Solid	Measuring an Irregular Solid	Using a Measuring Cylinder Correctly
		
Measure volume of a cuboid = a x b x c	Volume of an irregular object can be found by dropping in a liquid and measuring Displacement.	When reading a meniscus the observer must read the bottom of the meniscus.

Section 3: States of Matter



Condensation	Process in which a gas turns into a liquid
Evaporation	Process in which a liquid turns into a gas
Freezing	Process in which a liquid turns into a solid
Melting	Process in which a solid turns into a liquid
Sublimation	Process in which a solid turns into a gas without going through a liquid stage

Solid
Particles held in fixed pattern but vibrating

Liquid
Particles packed together in a random fashion, free to move

Gas
Particles widely separated, moving freely at speed

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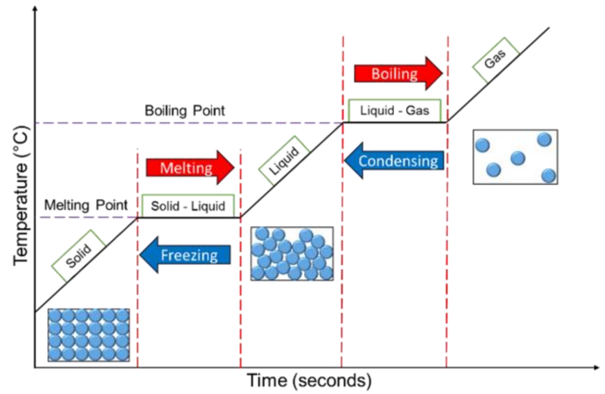
Section 4: The Heating Curve



Solid	Particles are closely packed, fixed and arranged in regular layers. As more energy is absorbed the kinetic energy and therefore the internal energy of the material increases.
Melting	Temperature doesn't change. Energy is used to weaken the forces between particles. As more energy is absorbed the potential energy and therefore the internal energy of the material increases.
Liquid	Particles are touching but no longer arranged regularly. They are able to move past each other. As more energy is absorbed the kinetic energy and therefore the internal energy of the material increases.
Evaporation	Temperature doesn't change. Energy is used to weaken the forces between particles. As more energy is absorbed, the potential energy and therefore the internal energy of the material increases.
Boiling Point	The temperature at which a liquid boils and turns to vapour
Melting Point	The temperature at which a solid melts and turns to a liquid
Gases	Gas particles have the most energy, they have chaotic random movements in all directions. They can be compressed.

Section 5: Properties of Solids, Liquids and Gases

State	Particle Arrangement	Distance between particles	Strength of forces	Movement of Particles	Internal Energy
Solid	Fixed	Closely packed together	Strong	Vibrates about fixed position	Lowest Internal Energy
Liquid	Not fixed	Touching but irregularly arranged	Weak	Move past each other	More than solids, less than gases
Gas	Not fixed	Far apart	Very Weak (Insignificant)	Moves freely	Highest Internal Energy

Section 6: Internal Energy

The energy stored by the particles of a substance is called the substance's internal energy.
This is the energy of the particles that is caused by their individual motion and positions.
The internal energy of the particles is the sum of:

- the kinetic energy they have due to their individual motions relative to each other,

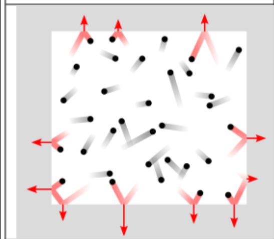
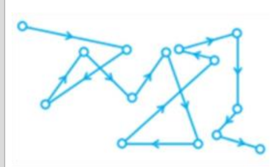
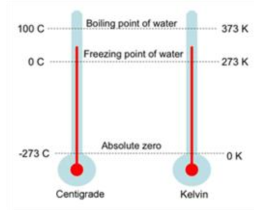
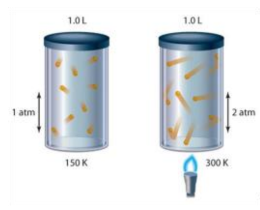
and;

- the potential energy they have due to their individual positions relative to each other.

Heating the substance can increase the internal energy in one of two ways:

- Increasing the temperature increases the kinetic energy of each particle.
- Changing the state of the substance (melting or boiling), increases the potential energy of the substance.

Section 7: Gas Pressure

Collisions	Brownian Motion	Temperature	Guy-Lussac's Law	Boyles's Law
				
The force exerted by gases on a surface as the particles collide with it. The greater the number of collisions with a surface, the greater the pressure.	The unpredictable motion of smoke particles is evidence of the random motion of gas particles. Each change of direction is caused by a collision with another particle.	For Gas Laws, temperature should always be measured in Kelvin (Celsius + 273)	For a fixed mass of gas at a constant volume, the pressure is proportional to the temperature. Increasing the temperature increases the volume.	For a fixed mass of gas at a constant temperature, the pressure is inversely proportional to the volume. Decreasing the volume increases the pressure.

KNOWLEDGE — Physics RP: Density — ORGANISER

Section 1: Aim of the Practical

Investigating density of regularly and irregularly shaped solids and liquids using a range of appropriate apparatus.

In this practical you will:

- use a ruler and a balance to determine the density of a regularly shaped object
- use a displacement method to determine the density of an irregularly shaped object
- use measurements of volume and mass to determine the density of a liquid.

Section 2: Link to the Syllabus

4.3.1.1 Density of materials

- The density of a material is defined by the equation:

$$density = \frac{mass}{volume}$$

- Students should be able to explain the differences in density between the different states of matter in terms of the arrangement of atoms or molecules.

Section 3: Key Terms

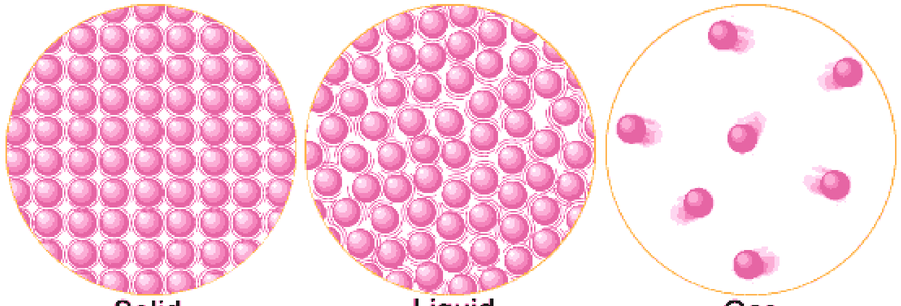
1.	Density	How much mass a substance contains compared to its volume. Solids are usually dense because the particles are closely packed. Measured in kg/m^3 (or g/cm^3).
2.	Volume	The amount of space a liquid takes up. Measured in cm^3.
3.	Mass	A measure of how many particles are in a substance. Measured in kg (or g).

Section 4: Equations used within the Practical

1.	Density = Mass ÷ Volume	[ρ = m/V]	ρ m V	kilograms per cubic metre (kg/m^3) kilograms (kg) cubic metres (m^3)
2.	volume = length × width × height	[V = lwh]	V l w h	cubic metres (m^3) metres (m) metres (m) metres (m)

Section 5: Density Summary

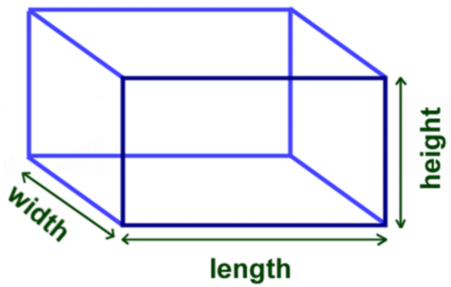
- Density is a measure of the 'compactness' of a substance.
- It relates the mass of a substance to how much space it takes up.
- It is a substance's mass per unit volume.
- Density of an object depends on what it is made of. It can be explained using the particle model of matter.
- A dense material has its particles packed tightly together. The particles in a less dense material are more spread out.



- The density of a substance is generally its highest when it is solid form as the particles are closest together. Liquids tend to be less dense than solids. Gases are the least dense as their particles are spaced apart.

Activity 1: Determine the density of a regularly shaped object

Section 6: Apparatus Diagram



Section 7: Apparatus

1.	30 cm ruler marked off in mm
2.	digital balance
3.	a selection of regularly shaped objects

Section 8: Method

1.	For each of your selected objects measure and record the: • length • width • height
2.	Calculate the volume of each object.
3.	Record your results in a table.
4.	Measure the mass of each object using the digital balance. Record the results in the table.
5.	Calculate and record the density of each object using the equation from section 4.
6.	Standard units of density are kg/m^3. Use the data to calculate the density of the object in these units

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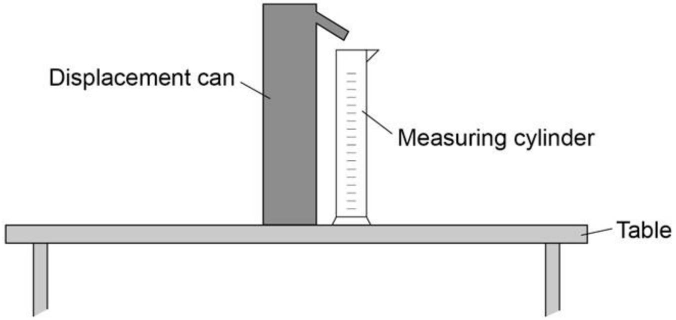
Activity 2: Determining the density of an irregularly shaped object

Section 9: Apparatus Diagram



Section 10: Apparatus

1.	a digital balance
2.	a displacement can
3.	various measuring cylinders
4.	a beaker of water and an extra empty beaker
5.	paper towels
6.	a selection of irregularly shaped objects.

Section 11: Method

1.	Measure the mass of one of the irregular shaped objects.
2.	Record your results in a simple table.
3.	Put the displacement can on your desk. Put an empty beaker under the spout and fill the can with water. Water should be dripping from the spout and you should wait until you see this stop.
4.	Then put a measuring cylinder that you think will give the most accurate reading under the spout instead of the beaker.
5.	Very carefully lower the object into the displacement can so that it is completely submerged. Collect all of the water that comes out of the spout in the measuring cylinder.
6.	Measure the volume of the collected water. This volume is equal to the volume of the object.
7.	Calculate and record the density of the object.
8.	Repeat the activity for some other objects. Remember to refill the can with water each time.

Activity 3: Determining the density of a liquid

Section 12: Apparatus

1.	a digital balance	2.	a 100 cm^3 measuring cylinder	3.	a sugar solution of unknown concentration.

Section 13: Method

1.	Measure the mass of the empty measuring cylinder.
2.	Record your results in a table
3.	Pour about 100 cm^3 of the sugar solution into the measuring cylinder. Record the volume accurately.
4.	Measure and record the mass of the measuring cylinder and liquid. From this calculate and record the mass of just the liquid.
5.	Calculate the density of the liquid.
6.	Standard units of density are kg/m^3. Use the data above to calculate the density of the liquid in these units.

Section 14: Risk Assessment

- Handle glass equipment with care to avoid breakages
- Ensure any spills are mopped up quickly to avoid the risk of slipping.

Section 15: Possible Points for the Exam

1.	Accuracy
	▪ To improve accuracy you would need to take more readings and calculate an average and compare that to the true value.
	▪ You could also improve techniques to ensure systematic or random errors are not affecting the measurements:
	  ▪ measuring the meniscus at exactly eye level
	  ▪ ensuring the mass balance is on a flat stable surface

2.	Precision ▪ To improve precision you could improve the resolution of your equipment.
3.	What is the **resolution** of the balance? ▪ What is the smallest value the balance can measure?
4.	What errors could occur when using the Eureka can? ▪ Water may spill out of the sides if you drop the object in too quickly ▪ There may already be some water in the measuring cylinder ▪ The water might not be at exactly the level of the spout
5.	How could you get errors when measuring the mass? ▪ The balance may not be calibrated correctly (not reading zero before the mass is added)
6.	What is the **uncertainly** of the measurements? ▪ The uncertainly is plus or minus half the value of the resolution