Combined Physics
Higher
Paper 1

Name: _____

Topic 1: Energy

Topic 2: Particle Model

Topic 3: Electricity

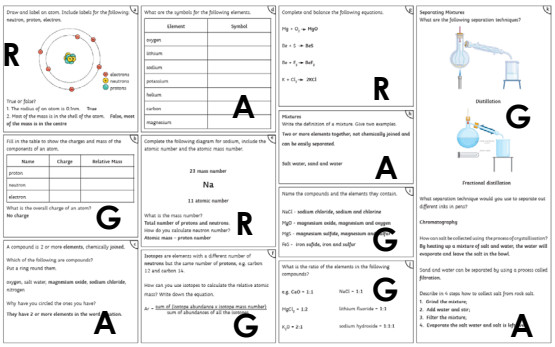
Topic 4: Atomic Structure

Exam Date: Thursday 22nd May 2025

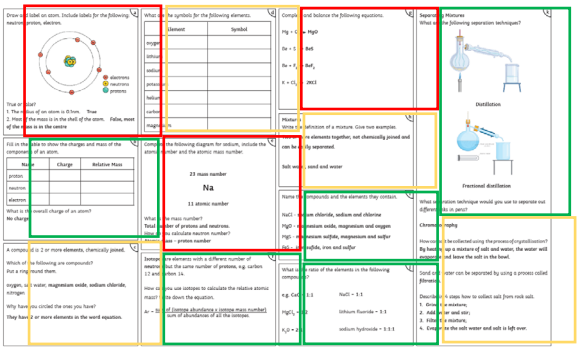
Instructions

This booklet has been separated according to the topic that will be covered in the exam.

1. Go through the revision mat for the topic and rate each box according to your understanding of that content. Use a typical RAG rating or 3 different colours of highlighter.
   For example:



OR



R = Red 😟 Low understanding

A = Amber 😐 Some Understanding

G = Green 😊 Good Understanding

2. Cut along the dotted lines of the question card template provided. Then produce a set of revision questions and answers for that topic – you should focus on those you have rated as red or amber on the revision mat. **For example:**

Front	**Back**
What is the mass number of an atom?	The total number of protons and neutrons found in the nucleus

3. Fold along the line indicated on the following page and glue where indicated to create a storage pocket for your question cards.
4. Regularly test yourself using your question cards or ask someone to test you and return them to your storage pocket for safekeeping after each use.

a

Describe what a system is.

It is an object or group of objects.

b

Describe energy store changes for the following objects:

A football that has been kicked upwards.

As the ball moves upwards, the kinetic energy store of the ball decreases and the gravitational potential energy store of the ball increases.

A squash ball hitting a wall.

When the ball hits the wall, the kinetic energy store of the ball decreases and the elastic potential energy store increases. Some of the energy is also transferred to the surroundings. The thermal energy store of the surroundings increases and some of the energy is carried by sound waves.

A car accelerating.

As the car moves, the chemical energy store of the petrol decreases and the kinetic energy store of the car increases. Some of the energy is also transferred by sound waves to the surroundings and the thermal energy store of the surroundings also increases.

A car decelerating.

As the car slows down, the kinetic energy store decreases and the thermal energy store of the surroundings and brakes increases. Some of the energy is also transferred by sound waves to the surroundings.

Bringing water to the boil.

The electrical energy from the mains is transferred and the thermal energy store of the water increases, which increases the kinetic energy stores of the particles that make up the water.

c

What is the equation linking kinetic energy, mass and speed?

kinetic energy = $\frac{1}{2}$ × mass × (speed)²

Write the units for the following:

kinetic energy: **(E_k), joules, J**

mass: **(m), kilograms, kg, grams, g**

speed: **(v), metres per second, m/s**

List some examples of objects with kinetic energy stores.

(These are just a few examples. There will be many more.)

Toy car travelling down a ramp.

Parachute falling through the air.

Gas particles moving in the air.

d

What is the equation linking elastic potential energy, spring constant and extension?

elastic potential energy

= $\frac{1}{2}$ x spring constant x (extension)²

Write the units for the following:

elastic potential energy: **(E_e), joules, J**

spring constant: **(k), newtons per metre, N/m**

extension: **(e), metres, m**

List some examples of objects with elastic potential energy stores.

(These are just a few examples. There will be many more.)

Stretched elastic band.

Tennis ball that has been squashed.

Extended spring.

e

What is the equation linking gravitational potential energy, mass, gravitational field strength and height?

gravitational potential energy

= mass x gravitational field strength x height

Write the units for the following:

gravitational potential energy: **(E_p), joules, J**

mass: **(m), kilograms, kg**

gravitational field strength: **(g), newtons per kilogram, N/kg**

height: **(h), metres, m**

List some examples of objects that have gravitational potential energy stores.

(These are just a few examples. There will be many more.)

Apple on a tree.

Plant pot on a windowsill.

Aeroplane in the sky.

f

What is the equation linking change in thermal energy, mass, specific heat capacity and temperature change?

change in thermal energy

= mass x specific heat capacity x temperature change

Write the units for the following:

change in thermal energy: **(ΔE), joules, J**

specific heat capacity: **(c), joules per kilogram per degree Celsius, J/kg °C**

Write a definition for specific heat capacity.

The amount of energy needed to increase the temperature of a 1kg material by 1°C.

g

Define Power.

The rate at which energy is transferred.

The rate at which work is done.

What is the equation linking power, energy transferred and time?

power = energy transferred ÷ time

What is the equation linking power, work done and time?

power = work done ÷ time

Write the units for the following:

power: **(P), watts, W**

energy transferred: **(E), joules, J**

time: **(t), seconds, s**

work done: **(E), joules, J**

An LED bulb has a power rating of 8W, a halogen bulb has a power rating of 28W but they both have a similar brightness. What is the difference?

The LED bulb transfers less energy per second than the halogen bulb.

The power output of a hairdryer is 2000W. How much energy is transferred per second?

2000 joules per second.

a

What is the law of conservation of energy?

Energy cannot be created or destroyed. It can be transferred, stored or dissipated.

Define dissipation.

Energy being transferred to the surroundings.

b

For the following situations, name the useful energy transfers and the type of energy that is dissipated to the surroundings (wasted):

picture on a television screen.

useful: **chemical energy stores → thermal energy stores, and light and sound carry energy to the surroundings.**

energy dissipated as: **thermal energy stores of the surroundings**

printer

useful: **chemical energy stores → kinetic energy stores**

energy dissipated as: **thermal energy stores and some is carried by sound waves to the surroundings.**

mobile phone

useful: **chemical energy stores → thermal energy stores and light and sound waves carry the energy to the surroundings**

energy dissipated as: **thermal energy stores of the surroundings**

c

For the following situations, suggest methods to reduce unwanted energy transfers and what the unwanted energy transfers are.
Hot water stored in a tank.

Insulation around the water tank. Reduces dissipation of energy to the surroundings into thermal energy stores.

Moving parts in a car.

Lubricating the moving parts. Reduces dissipation of energy to the surroundings into thermal energy stores.

d

Describe how thermal conductivity of a material affects how it transfers energy by conduction.

If a material has a high thermal conductivity, it will transfer heat via conduction at a much quicker rate.

e

How is energy lost from a building? What factors affect this?

Energy is transferred to thermal energy stores of the surroundings. The factors that affect this are the thermal conductivity of the walls and the thickness of them.

f

What is the equation linking efficiency, useful output energy transfer and total input energy transfer?

efficiency = useful output energy ÷ total imput energy transfer

What is the equation linking efficiency, useful power output and total power input?
efficiency = useful power output ÷ total power output

When energy is transferred in a closed system, what happens to the total amount of energy?
Total energy does not change.
How can the efficiency of an energy transfer be increased?
By increasing the useful output by reducing the wasted energy.

g

Which lorry is more energy efficient and why?

The red lorry is streamlined and so is more energy efficient . It wastes less energy due to air resistance and so has a higher useful output energy.

h

List the main energy resources.

Fossil fuels (coal, oil and gas) N **Nuclear fuel N** **Biofuel R**

Wind R **Hydroelectricity R** **Geothermal R**

Tidal R **Waves R** **Sun R**

i

Define renewable and non-renewable energy resources.

A renewable energy resource can be replenished.

A non-renewable energy resource will eventually run out.

j

For the energy resources that you have listed, write an R next to those that are renewable and N next to those that are non-renewable.

Except for oil, all energy resources are used for electricity generation. Which are used for heating?

Geothermal, solar, fossil fuels (coal, oil and gas)

k

My main areas for improvement are:

_____

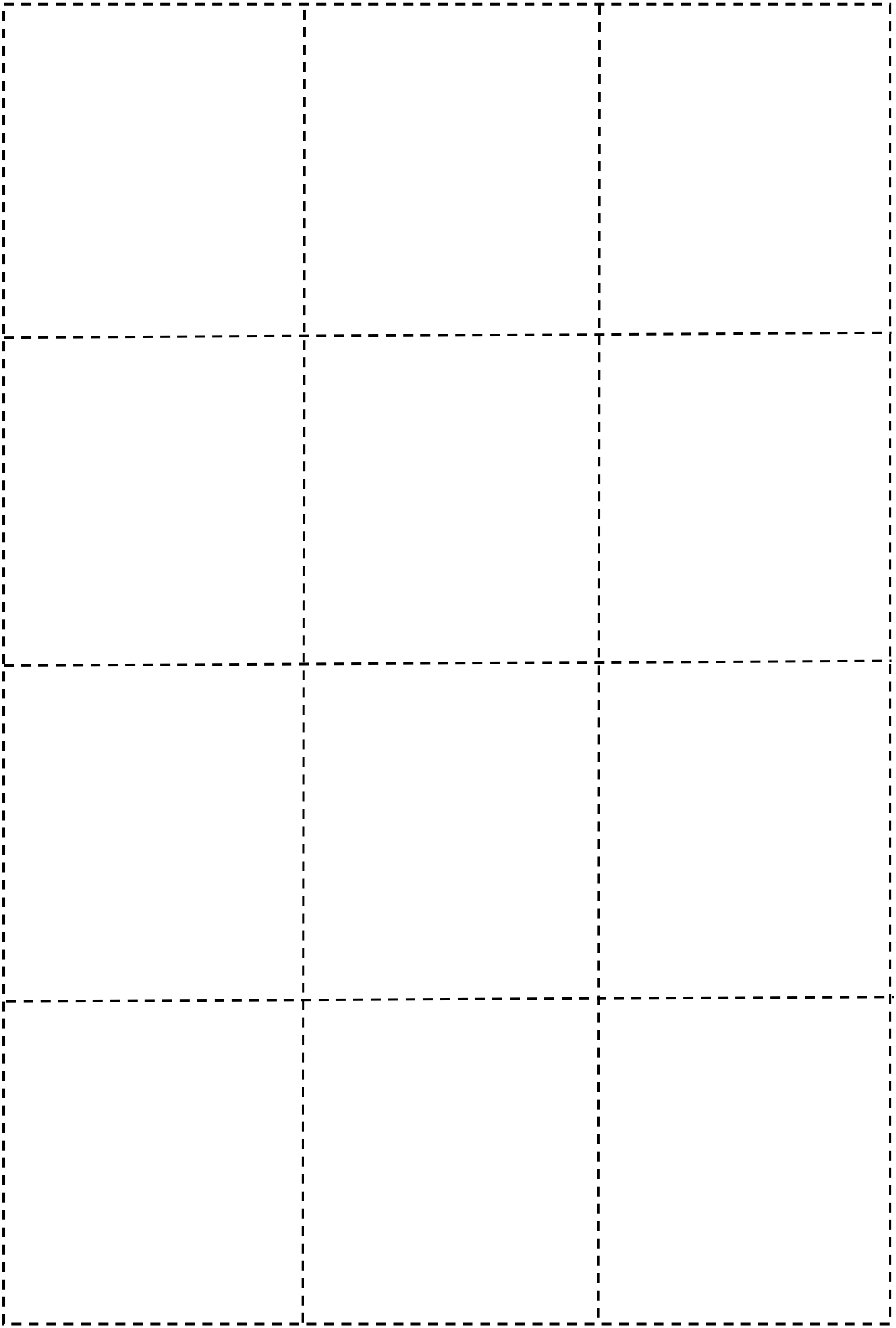
_____

_____

_____

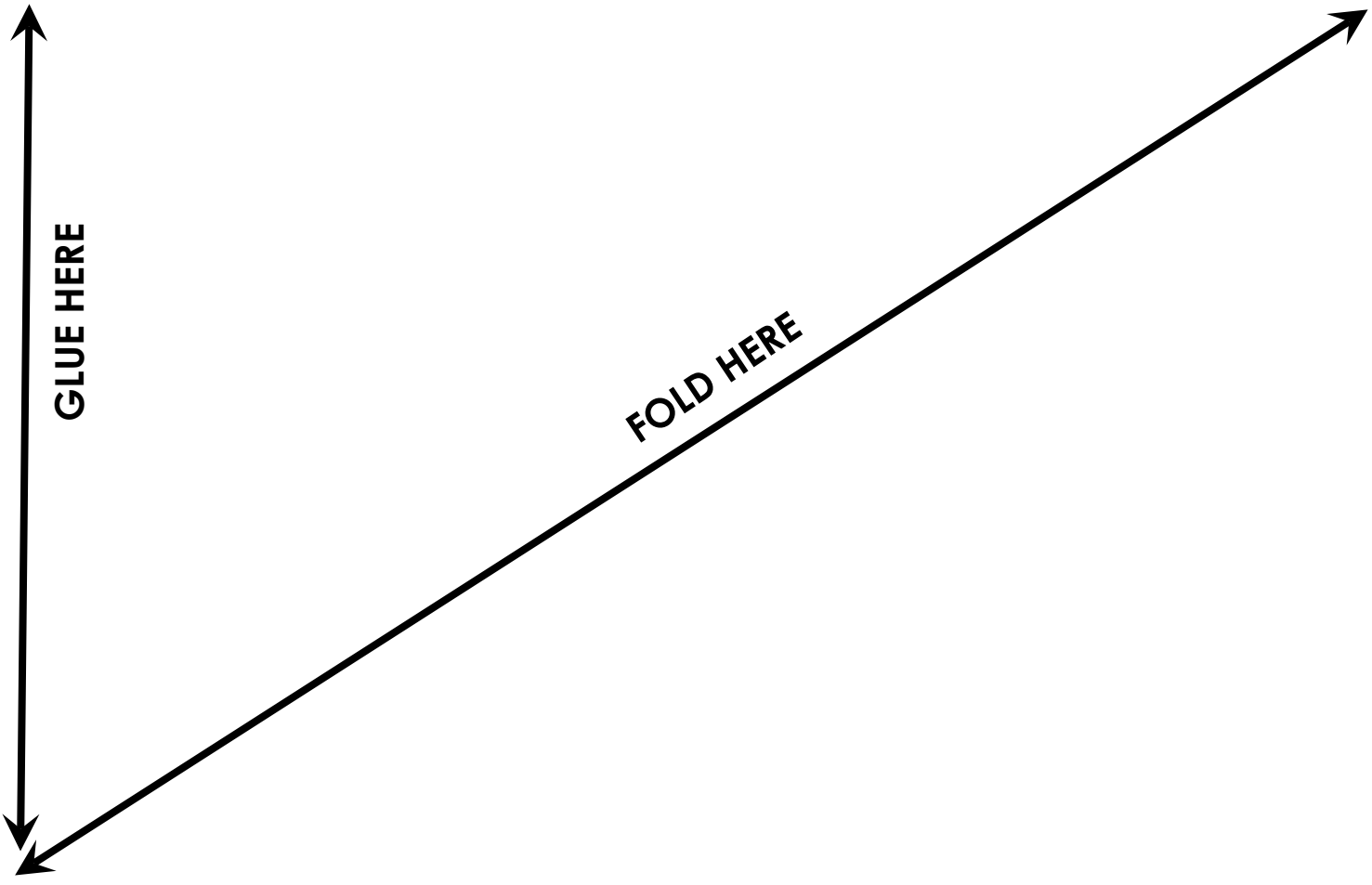
l

Energy Resource	Enviromental Impact	Reliability of Output
Coal	Produces carbon dioxide, a greenhouse gas and sulphur dioxide which contributes to acid rain.	Reliable.
Oil	Produces carbon dioxide, nitrogen dioxide and sulphur dioxide. If it is spilt there can be disastrous environmental consequences.	Reliable.
Gas	Produces carbon dioxide.	Reliable.
Nuclear	Produces radioactive waste.	Reliable.
Biofuel	A lot of land is needed for growing the fuel.	Reliable.
Wind	Can be noisy and the turbines are dangerous for birds.	Unreliable.
Hydroelectricity	Large areas of land is needed and can cause disruption to ecosystems.	Reliable.
Geothermal	None.	Reliable.
Tidal	Can affect habitats.	Not always reliable due to changing tides.
Waves	Can affect habitats.	Unreliable.
Solar	None.	Unreliable.



Topic 1: Energy

Question Card Storage



a

What is the equation linking density, mass and volume?

density = mass ÷ volume

b

Write the symbols and units for the following:

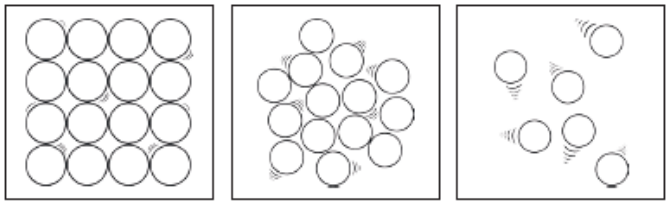
density: **(ρ) kilograms per metre cubed, kg/m³**

mass: **(m), kilograms, kg**

volume: **(V), metres cubed, m³**

c

Draw the particle models for solids, liquids and gases.



d

Describe the three states of matter in terms of structure, shape and movement of the particles.

solid – **They have a regular structure and the particles are packed closely together so they have a definite shape. The particles are in a fixed position but do vibrate.**

liquid – **They have an irregular structure and the particles are close together. They take the shape of the container but do not have a definite shape. The particles vibrate and move over one another.**

gas – **The particles are widely dispersed and do not have a definite shape. The particles move around rapidly.**

e

Why is a change of state referred to as a physical change and not a chemical change?

If the changes are reversed then the material will recover its original properties.

f

Describe the displacement technique used to determine the volume of an irregularly shaped object.

Fill a displacement vessel/eureka can with water. Put the spout of the can over a measuring cylinder. Put the irregularly shaped object into the can and measure the volume of water displaced.

g

When substances change state, their mass is conserved. What does this mean?

The mass of the substance does not change once it has changed state.

Describe how to determine the volume of a regularly shaped object.

width × length × height

h

What is an internal system?

An internal system is one in which the energy is stored by the particles within it.

i

Define internal energy.

This is the total kinetic and potential energy of the particles that make up that system.

j

List some factors that affect the increase of temperature of a system.

Mass of the substance.

Type of material being heated.

Energy input.

k

Explain the differences in density of solids, liquids and gases.

Solids are very dense because the particles are so closely packed together and there are strong forces of attraction between them. Liquids are less dense than solids, but more dense than gases because the particles are very close together and attract one another. Gases are the least dense and have very weak forces of attraction only when they collide.

l

Define specific heat capacity.

The amount of energy needed to cause a 1°C rise in 1kg of a substance.

m

What is the equation linking change in thermal energy, mass, specific heat capacity and temperature?

change in thermal energy = mass x specific heat capacity x temperature change

n

Write the units and symbols for the following:

energy: **(E), Joules, J**

mass: **(m), kilograms, kg**

specific heat capacity: **(c), Joules per kg per degree Celsius, J/kg oC**

temperature change: **(Δ), degrees Celsius, oC**

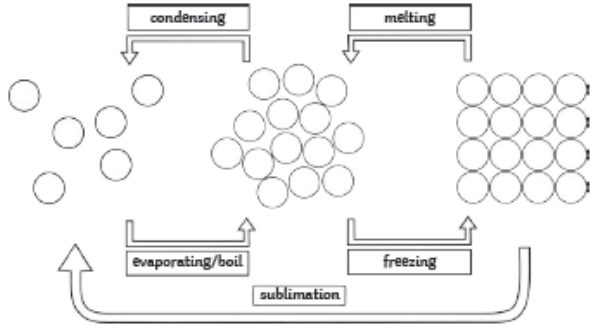
o

After a long journey, the temperature of a car tyre increases. What is the effect on the gas particles within the tyre?

The gas particles will gain more kinetic energy, therefore they will move around more.

p

Label the diagram with the terms used for changes of state.



a

Define latent heat.

Latent heat is the energy required for the change of state of a substance.

b

What is the equation linking energy for a change of state, mass and specific latent heat?

Energy for a change of state = mass x specific latent heat

Write the symbol and unit for the following:

specific latent heat: **(L), joules per kilogram, J/kg**

c

Describe the difference between specific latent heat of fusion and specific latent heat of vaporisation.

Specific latent heat of fusion is the amount of energy needed to change 1kg of a substance from a solid to a liquid with no change of temperature. Specific latent heat of vaporisation is the amount of energy needed to change 1kg of a substance from liquid to gas with no change of temperature.

d

Distinguish between specific heat capacity and specific latent heat.

Specific heat capacity is the amount of energy required to increase the temperature of a substance, whereas specific latent heat is the energy needed to change the state of a substance with no temperature change.

e

What is the equation that links pressure and volume?

Pressure x volume = constant

List the symbols and units for the following:

pressure: **(p), pascals, Pa**

volume: **(V), metres cubed, m^3**

f

Explain the effect of an increase in temperature on the pressure of a gas in a container.

An increase in temperature causes more collisions of the gas particles with the walls of the container. This causes an increase in the force on the walls of the container over a particular area and so increases the pressure.

g

For the heating and cooling curve (shown in section J), what are the terms used to describe the changes of state for:

B➔C **Melting**

D➔E **Evaporating/Boiling**

E➔D **Condensing**

C➔B **Freezing**

h

What is happening to the particles between A-B, C-D and E-F?

They are gaining kinetic energy and spreading out more.

How are kinetic energy of particles and temperature related?

As the temperature increases the kinetic energy of the particles increases.

i

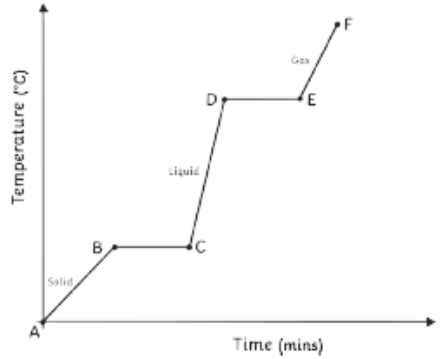
Using the diagram, explain the effect of an increase of volume on pressure.

(a) High pressure (b) Low pressure

An increase in volume causes the particles to spread out more and so the number of collisions on the walls of the container decreases. So, there is less force exerted on the container over a certain area and therefore a lower pressure.

j

What are the states of matter for the diagonal sections of the graph? Add labels to the graph below.



k

When work is done on a gas, what effect is there on the internal energy of the gas?

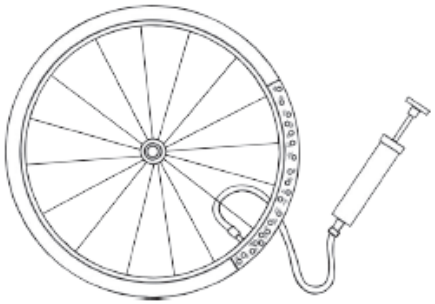
The internal energy of the gas increases.

l

When work is done on a gas what effect can there be on the temperature of the gas?

The temperature can increase.

m



Using the image above, explain what happens to:

a) The internal energy of the gas within the tyre:

The internal energy of the gas increases.

b) The energy of the particles:

The particles gain kinetic energy.

c) The temperature of the gas:

The temperature of the gas increases.

n

My main areas for improvement in this topic are:

_____

_____

_____

_____

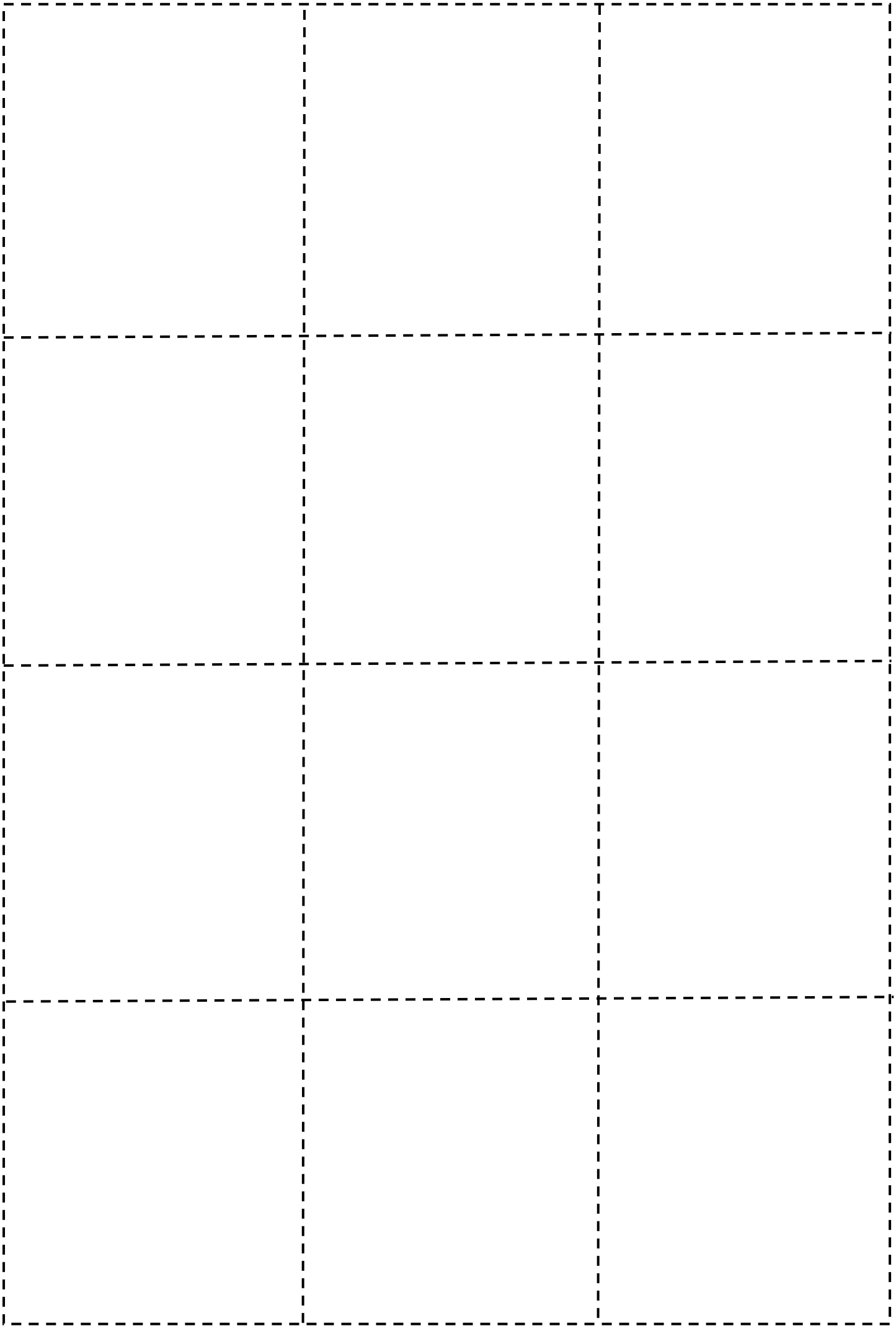
_____

_____

_____

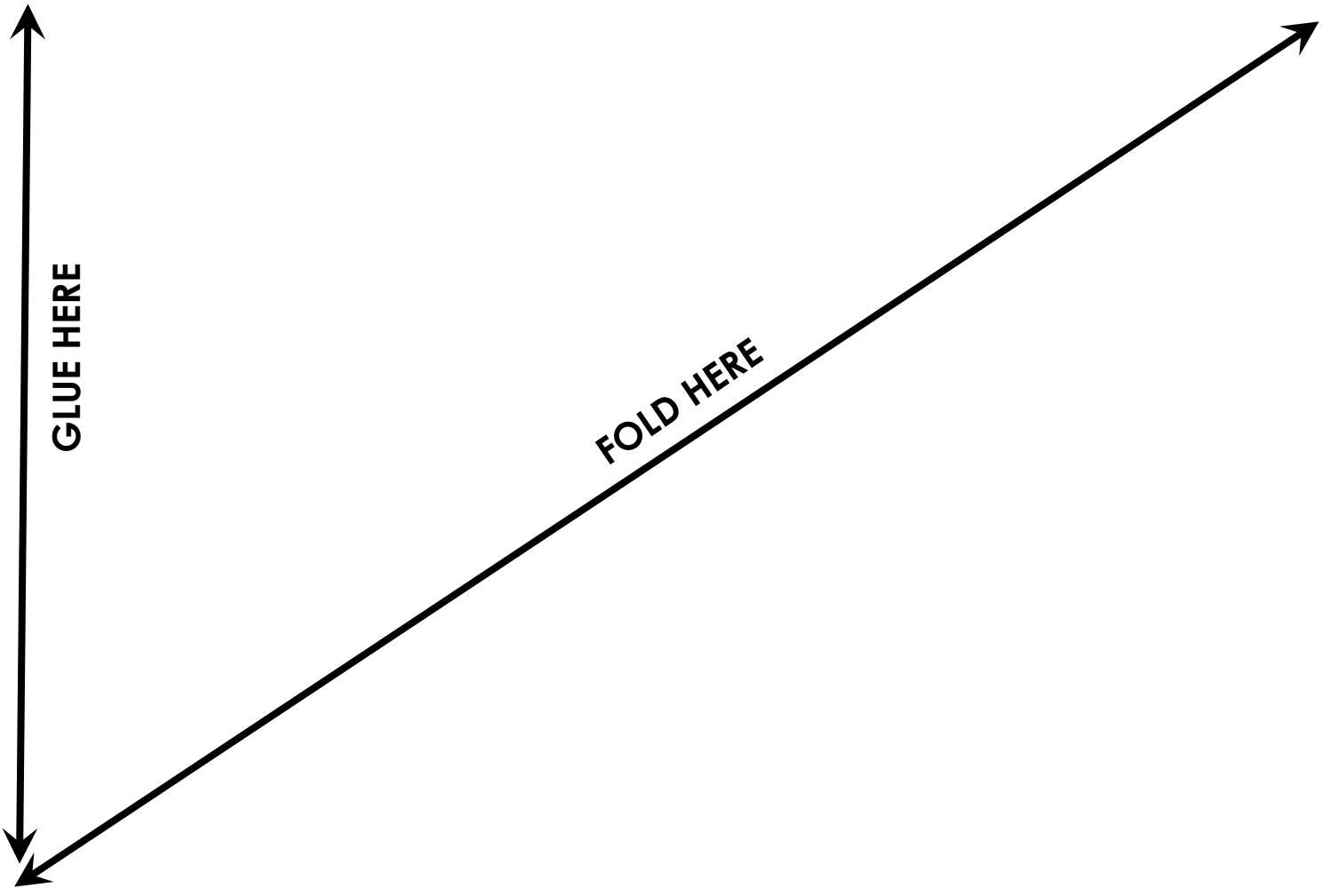
_____

Topic 2: Particle Model



Topic 2: Particle Model

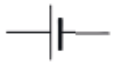
Question Card Storage



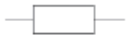
a

Draw the symbol diagrams for:

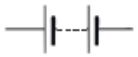
cell



resistor



battery



variable resistor

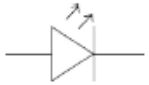
lamp (bulb)

ammeter

fuse

voltmeter

LED



diode

LDR

thermistor

b

What is electric current?

The flow of electrical charge.

State the equation that links charge, current and time.

charge = current × time

Write the symbols and units for the following:

charge: **(Q) coulombs, C**

current: **(I) amperes, A**

time: **(t) seconds, s**

c

A charge of 12A flows through an electric cooker for 1 hour. How much charge has been used?

Convert hours to minutes: 60 mins

12 × 60 = 720C

State the equation that links current, potential difference and resistance. Remember to include units.

potential difference (V) = current (A) × resistance (Ω)

A voltmeter reading is 3V and the resistance is 2Ω. What is the current?

current = potential difference ÷ resistance

3 ÷ 2 = 1.5A

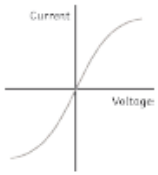
d

Use the components stated below to identify the potential difference/current graphs:

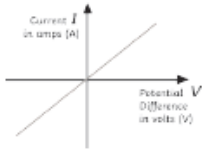
filament lamp, diode, ohmic conductor

diode

filament lamp



ohmic conductor



State Ohm's law.

The current flowing through a resistor at a constant temperature is directly proportional to the voltage across the resistor.

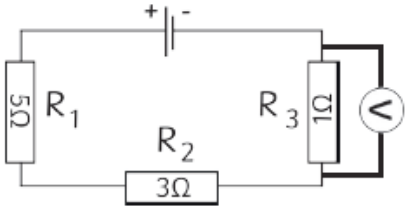
e

Complete the table.

Type of Circuit	Potential Difference Shared or the Same?	Current Same or Split?
series	shared	same
parallel	same	split between branches

For the circuit below, calculate the total resistance.

9Ω



On the diagram, draw where a voltmeter could be positioned to measure the voltage through one of the components.

f

Complete the following sentences.

For a thermistor: as the temperature increases, the resistance **decreases.**

Used in: **thermostats**

For an LDR: as the light intensity increases, the resistance **decreases.**

Used in: **street lights**

g

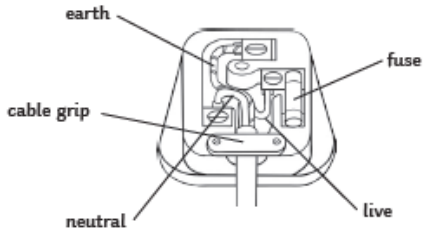
State the two different types of electricity supply.

1. **alternating current**
2. **direct current**

The UK mains supply has an AC supply of **-230V** and frequency of **50Hz.**

h

Label the diagram of the three pin plug.



What is the purpose of:

the neutral wire?

It completes the circuit and carries away the current.

the live wire?

It provides alternating potential difference.

the earth wire?

It is a safety feature to prevent the application from becoming live.

a

Complete the energy transfers for the following electrical appliances.

mains-powered kettle:

electrical → thermal + sound

hairdryer:

electrical → kinetic + thermal + sound

toaster

electrical → thermal + light

b

What is the equation linking energy transferred, power and time?
energy transferred = power × time

what are the units for:

energy? **joules**

power? **watts**

time? **seconds**

c

Most devices have a power rating. Describe the relationship between the power rating and the changes in stored energy when a device is used.
A device with a higher power rating will transfer stored energy to other types of energy at a faster rate.

d

Explain how a fuse works.
A fuse is a tube with a piece of wire running through it. If the current becomes too high, the fuse wire melts and creates a break in the circuit.

Calculate the current flowing through a 2kW electric fire at a potential difference of 230V.
current = 2000 ÷ 230
8.69A

e

State the equation that links power, current and potential difference.
power (W) = potential difference (V) × current (A)

A 2.4kW kettle is connected to the mains power supply (230V). Calculate the current through the kettle.

You will need to rearrange your equation above.

2.4 × 1000 = 2400

Current = power ÷ potential difference
= 2400 ÷ 230
= 10.43A

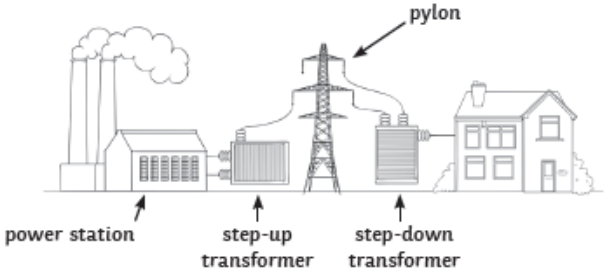
f

True or false:

- The current in a circuit can be altered by a variable resistor. **true**
- A voltmeter is connected in parallel with a component. **true**
- An ammeter is connected in parallel with a component. **false**

g

Label the national grid diagram.



Give two examples of when the demand for electricity is likely to be high.

1. **At half-time or the end of large sporting events.**
2. **First thing in the morning when people are getting up, or later when arriving home.**

h

Why is energy transferred at such high voltage in cables?
High voltage means that the energy is transferred at low currents. This results in less resistance, therefore less energy is lost as heat, so the transmission is more efficient.

Describe how the following work:

step-up transformer.

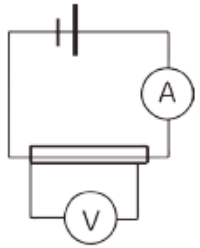
Potential difference is increased.

step-down transformer.

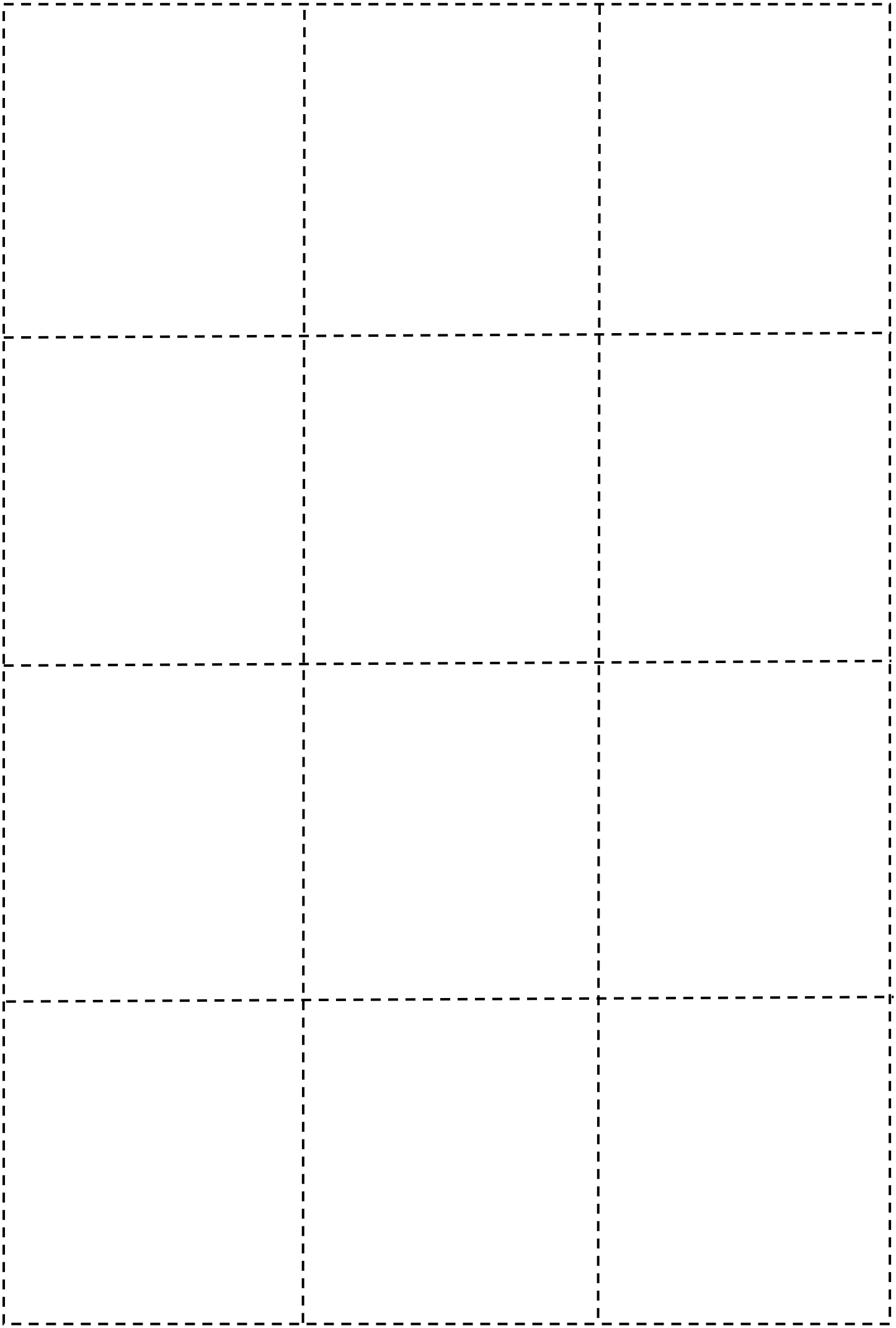
Potential difference is decreased.

i

Describe an experiment to show how the length of a wire affects its resistance.

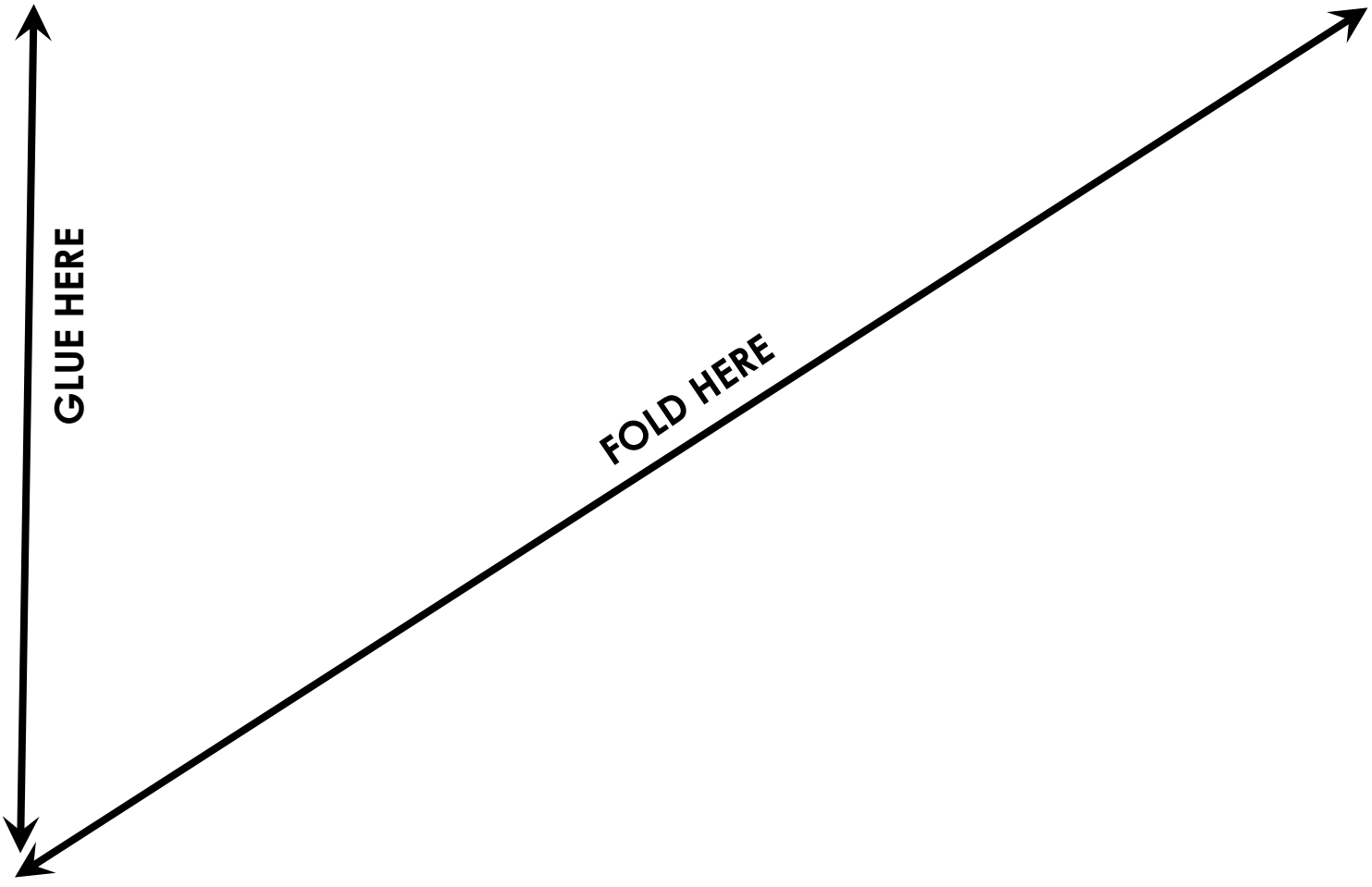


Set up the apparatus as shown.
Attach the first crocodile clip at 0cm.
Attach the second crocodile clip at 10cm.
Record the potential difference and the current.
Connect the second crocodile clip at different lengths (20cm, 30cm) and repeat the process.
Use the results to calculate resistance at different lengths, using the formula:
resistance = potential difference ÷ current



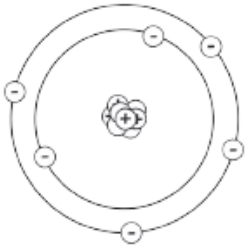
Topic 3: Electricity

Question Card Storage



a

Complete the diagram below to show where in an atom you would find the protons, neutrons and electrons.



⊖ **electrons**

⊕ **protons**

◯ **neutrons**

Explain why atoms have no overall charge.

Atoms have no overall charge because the number of protons equals the number of electrons. This means the positive charges (protons) are equal to the negative charges (electrons).

b

Complete the sentences by deleting the incorrect answer.

Most of the mass of an atom is concentrated in the nucleus/~~electron shells~~. The radius of the nucleus is ~~1000~~/10 000 times smaller/~~larger~~ than the radius of the atom.

The element sodium is shown below.

$^{11}_{23}Na$

Sodium has the following number of...

protons: **11**

neutrons: **12**

electrons: **11**

c

Two isotopes of carbon are shown below:

$^{12}_{6}C$ $^{14}_{6}C$

Define the term isotope.

Different versions of the same element with the same number of protons but different numbers of neutrons.

Explain why alpha radiation would not be used as a medical tracer.

It is the most ionising radiation so would cause the most damage to cells/DNA in the body.

Explain the effect that half-life has on the choice of medical tracer.

The half-life needs to be long enough to ensure that the medical staff can get the results required, but not so long that the patient is left radioactive for a long time.

d

Describe the plum pudding model of the atom.

Atoms are spheres of positive charge with negatively charged electrons stuck in them.

e

Radioactive decay is the process of the nucleus emitting ionising radiation.

The unit for radioactivity is...

Bq (becquerels)

Explain the term count rate.

The number of radiation counts per second.

Name the piece of equipment used to determine count rate.

Geiger-Müller tube.

Name three safety precautions to be taken when handling a radioactive source.

1. **wear gloves.**
2. **Use tongs to hold the source.**
3. **wear protective clothing.**

f

State the difference between irradiation and contamination.

keywords: exposed, radioactive, contaminated, harmful

Irradiation means an object has been exposed to a radioactive source but is not radioactive.

Contamination involves radioactive particles getting onto an object. It is contaminated and is harmful.

Complete the following equation for the alpha decay of uranium-234:

$$^{234}_{92}U \rightarrow ^{230}_{90}Th + ^{4}_{2}He$$

Complete the following equation for the beta decay of lead-214:

$$^{214}_{82}Pb \rightarrow ^{214}_{83}Bi + ^{0}_{-1}e$$

a

Complete the following table.

Type of Radiation	Description	Penetration	Range in Air	Ionising Power
alpha	helium nucleus	stopped by **paper**	a few **cms**	**strong**
beta	high-speed electron	stopped by **aluminium**	several **metres**	**medium**
gamma	EM radiation	stopped by **lead**	at least a **km**	**weak**

b

Cobalt-60 has an activity rate of 1000Bq and a half-life of 5 years. What will be the activity after 10 years?

250

c

Fill in the blanks:

Electrons are arranged in different **energy** levels around the **nucleus**. If electromagnetic **radiation** is absorbed, then electrons move **further** from the **nucleus** (to a higher energy level). If electromagnetic **radiation** is emitted, then the electrons move to a **lower energy level** (closer to the nucleus).

d

The equations below show the alpha decay of radon and the beta decay of carbon-14.

$$^{219}_{86}\text{radon} \rightarrow {}^{215}_{84}\text{polonium} + {}^{4}_{2}\text{He}$$

$$^{14}_{6}\text{carbon} \rightarrow {}^{14}_{7}\text{nitrogen} + {}^{0}_{-1}\text{e}$$

What effect do alpha and beta decay have on the mass of the nucleus?

alpha:

The mass is reduced.

beta:

The mass is unchanged because a neutron changes into a proton.

e

Define the term half-life

The time taken for the radioactivity of a specified isotope to fall to half its original value.

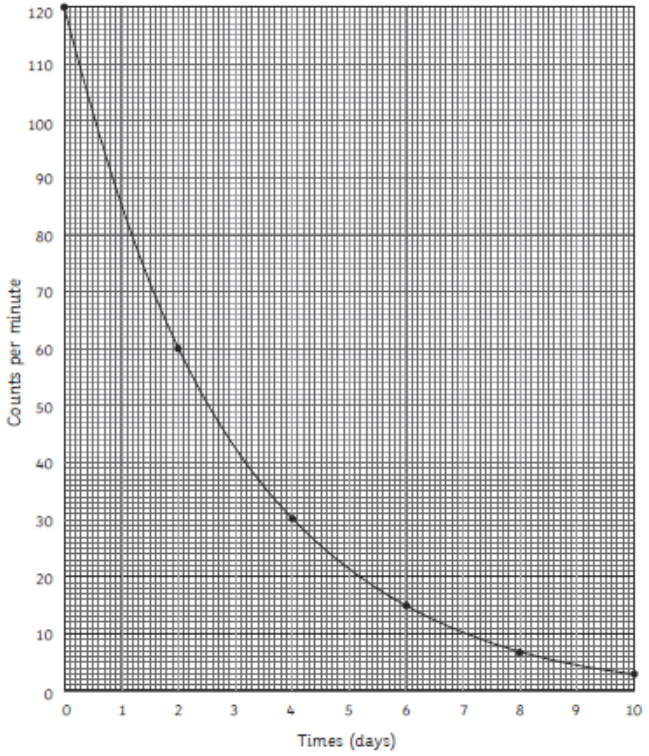
Substance A is a radioactive material that will change with time. The data below shows the radioactivity of substance A.

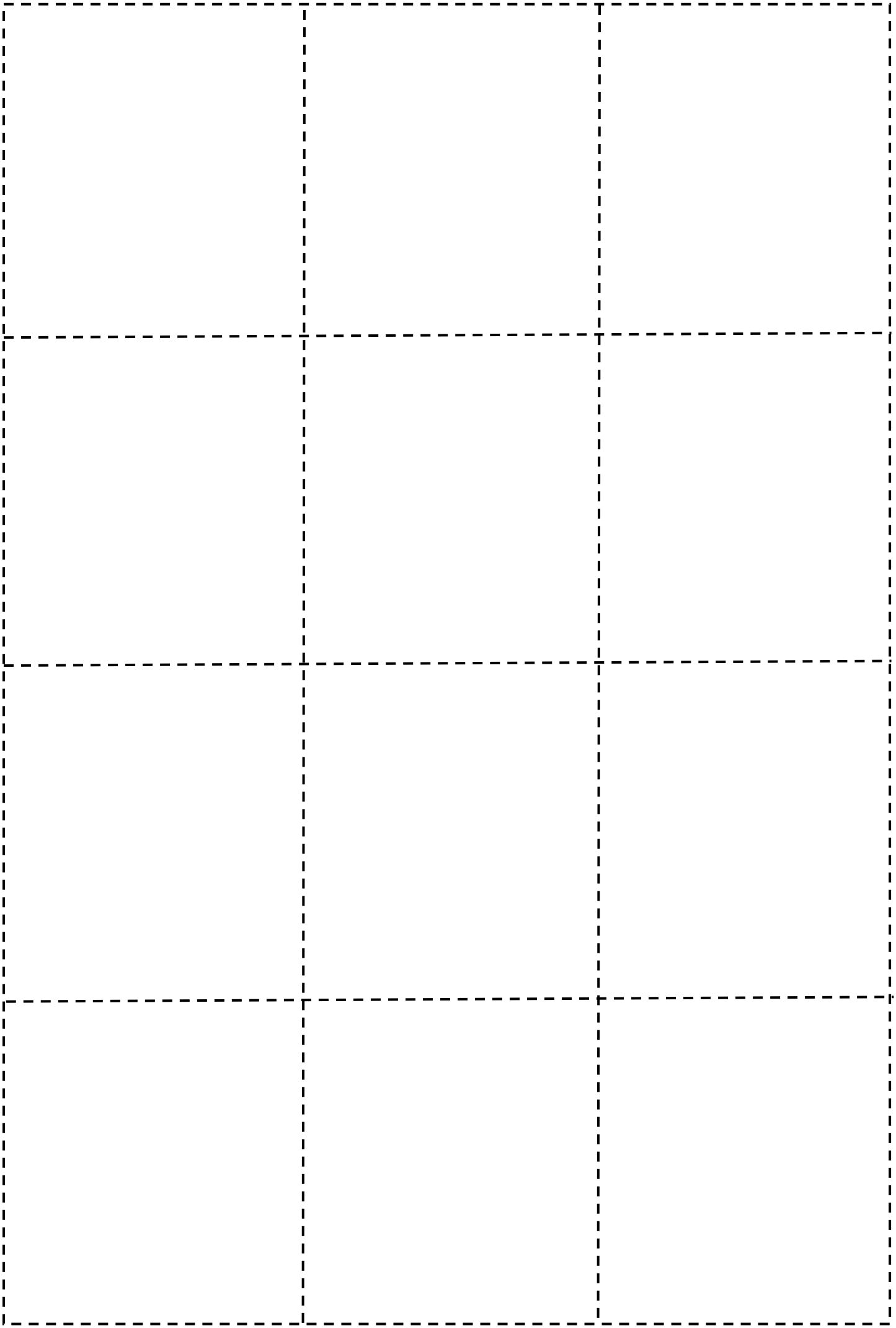
Time (days)	0	2	4	6	8	10
Count rate (counts/second)	120	60	30	15	7.5	3.75

Plot a half-life graph on the graph paper.

Use your graph to calculate the half-life.

2 days





Topic 4: Atomic Structure

Question Card Storage