Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE

General Certificate of Secondary Education

WJEC CBAC

CYD-BWYLLGOR ADDYSG CYMRU

Tystysgrif Gyffredinol Addysg Uwchradd

200/02

SCIENCE: PHYSICS

HIGHER TIER (Grades D-A*)

A.M. FRIDAY, 16 June 2006

(2 hours 30 minutes)

For Examiner's use only	
Total Marks	

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

You are reminded to show all working. Credit is given for correct working even when the final answer given is incorrect.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

Answer **all** *the questions in the spaces provided.*

1. Some of the regions of the electromagnetic spectrum are **radio waves**, **visible light**, **microwaves, X-rays** and **gamma rays**.

(a) (i) Name the **two** regions of the electromagnetic spectrum **not** given in the sentence above. [2]

..... and .....

(ii) Name the region of the electromagnetic spectrum with the lowest frequency. [1]

.....

(iii) State **one** property common to all regions of the electromagnetic spectrum. [1]

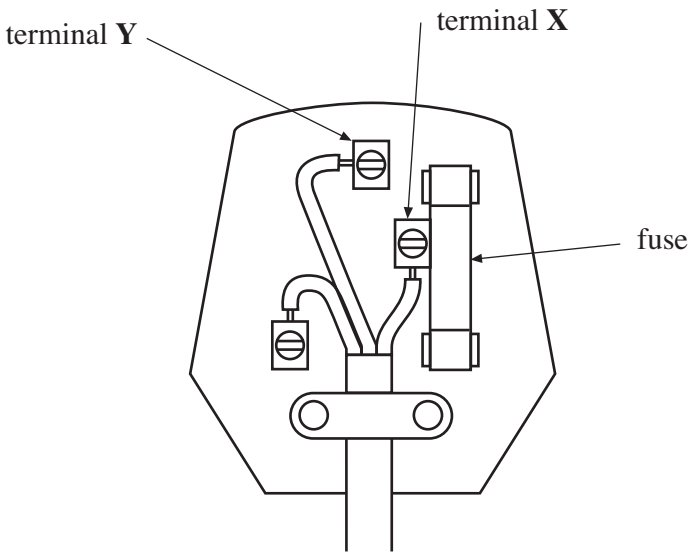
.....

(b) Microwaves are used for cooking.
Give **another** use of microwaves. [1]

.....

5

2. The diagram shows the inside of a plug.



(a) (i) State the colour of the wire connected to terminal **X**. .....

(ii) Name terminal **Y**. ..... [2]

(b) Circuit breakers are used as safety devices in many households. They 'break' the electrical circuit when a fault is detected. The most commonly used circuit breakers are the m.c.b. (miniature circuit breaker) and the e.l.c.b. (earth leakage circuit breaker).

(i) State the type of fault which would cause an m.c.b. to break the circuit.

.....

(ii) State the type of fault which would cause an e.l.c.b. to break the circuit.

.....

[2]

(c) State **two** advantages that miniature circuit breakers have over fuses. [2]

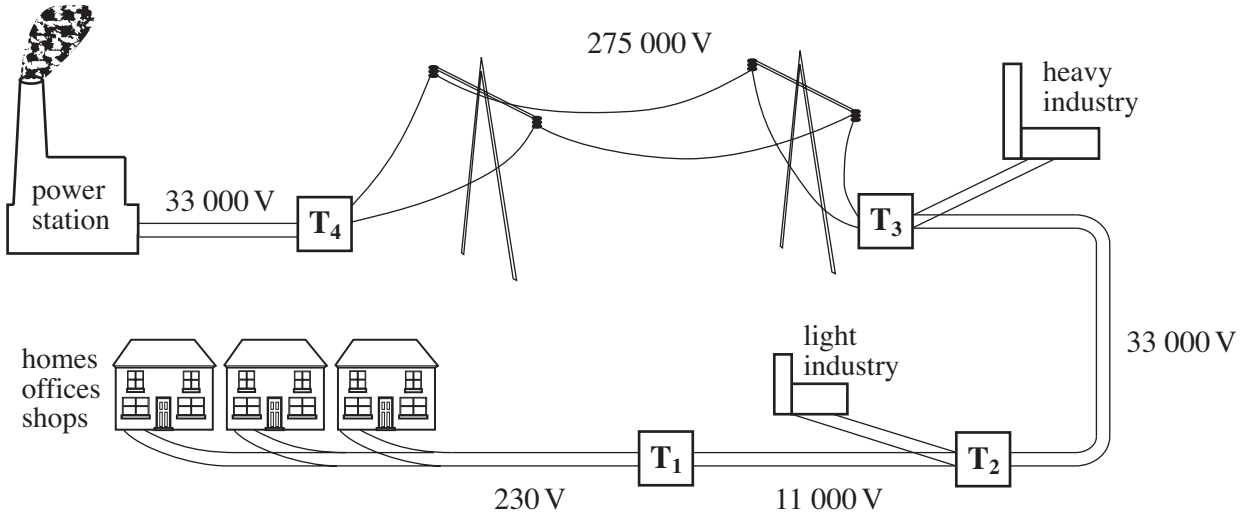
(i) .....

(ii) .....

6

Turn over.

3. The diagram shows how electricity is sent from power stations to users by the National Grid.



$\mathbf{T_1}$, $\mathbf{T_2}$, $\mathbf{T_3}$ and $\mathbf{T_4}$ are sub-stations which use transformers to 'step up' or 'step down' the alternating voltage.

(a) What is the National Grid? [2]

.....

.....

.....

(b) Use the information in the diagram to:

(i) state which substation, $\mathbf{T_1}$, $\mathbf{T_2}$, $\mathbf{T_3}$ or $\mathbf{T_4}$, uses step-up transformers; .....

(ii) state which substations use step-down transformers.

.....

[3]

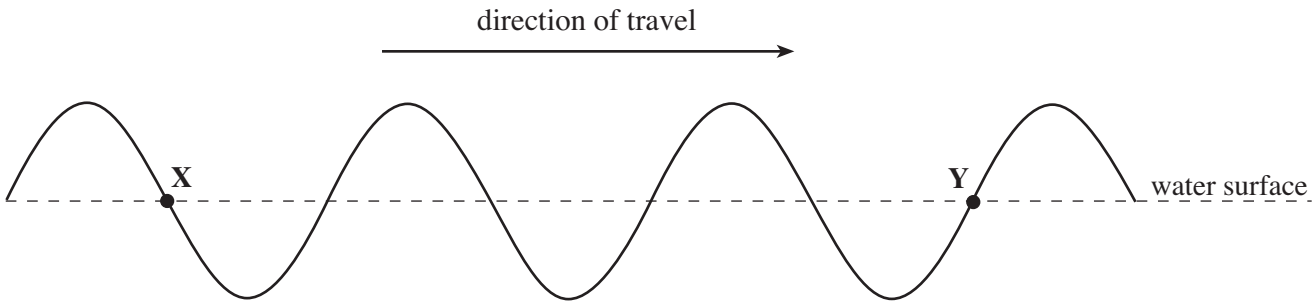
(c) Explain why alternating voltages are used throughout the National Grid. [1]

.....

.....

6

4. The diagram shows a wave travelling across the surface of water.



(a) **Show clearly** with a labelled arrow

(i) the amplitude of the wave [A],

(ii) the wavelength of the wave [W]. [2]

(b) (i) Write down the number of waves (cycles) between **X** and **Y**. .....

(ii) Calculate the wavelength of the wave if the distance **XY** is 250 cm.

Wavelength = ... cm
[2]

(c) (i) Explain what is meant by the frequency of a wave.

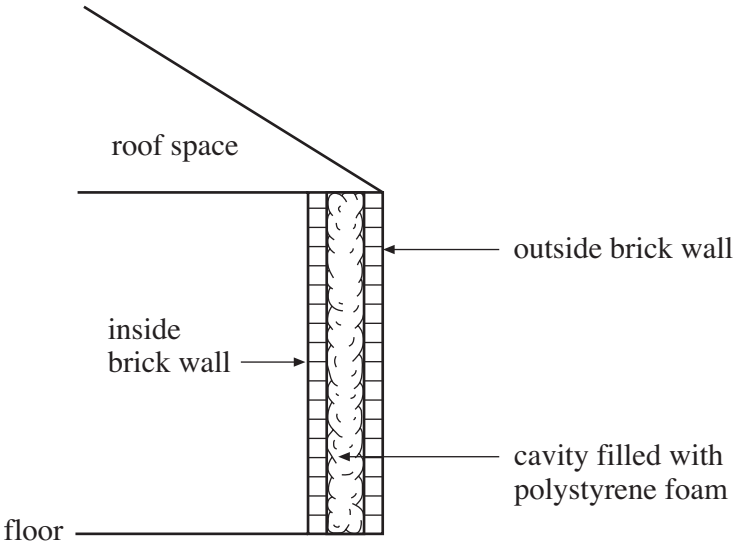
.....

(ii) If it took 0·5 s for a wave disturbance at **X** to travel to **Y**, calculate the frequency of the wave.

Frequency = ... Hz
[3]

7

5. The diagram represents a section through a building and shows the side cavity wall.



(a) Explain why polystyrene foam reduces **conduction** and **convection** in the cavity.
[*One mark is available for the quality of written communication*] [2+1]

.....

.....

.....

.....

.....

(b) State **two** other ways of reducing heat loss from the building. [2]

(i) .....

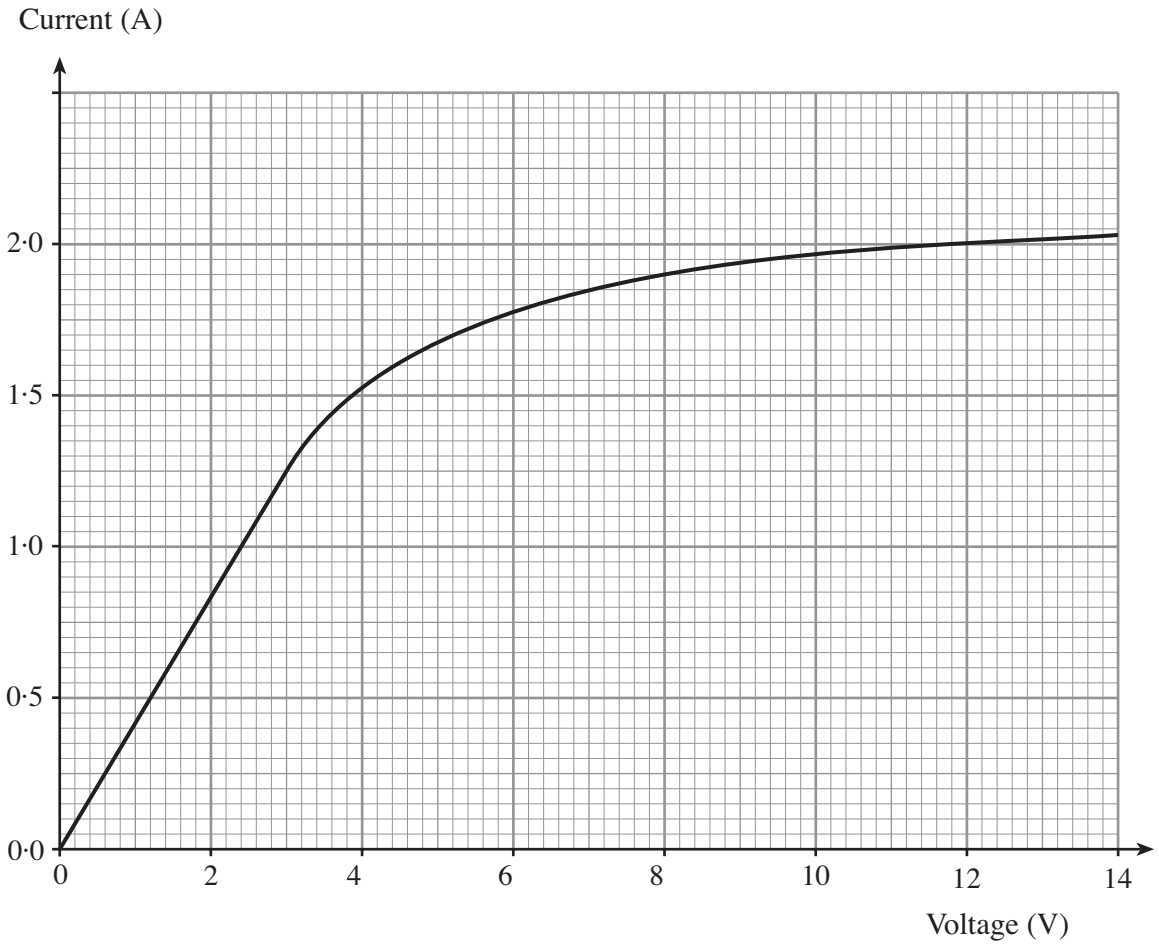
.....

(ii) .....

.....

5

6. The current through a 12 V lamp is measured at different voltages.
The results are plotted on the graph below.



(a) Describe how the current changes as the voltage is increased from 3 V to 14 V. [2]

.....

.....

(b) (i) Find the current through the lamp at 12 V. ..... [1]

(ii) Write down, in words, an equation connecting **resistance**, **current** and **voltage**. [1]

.....

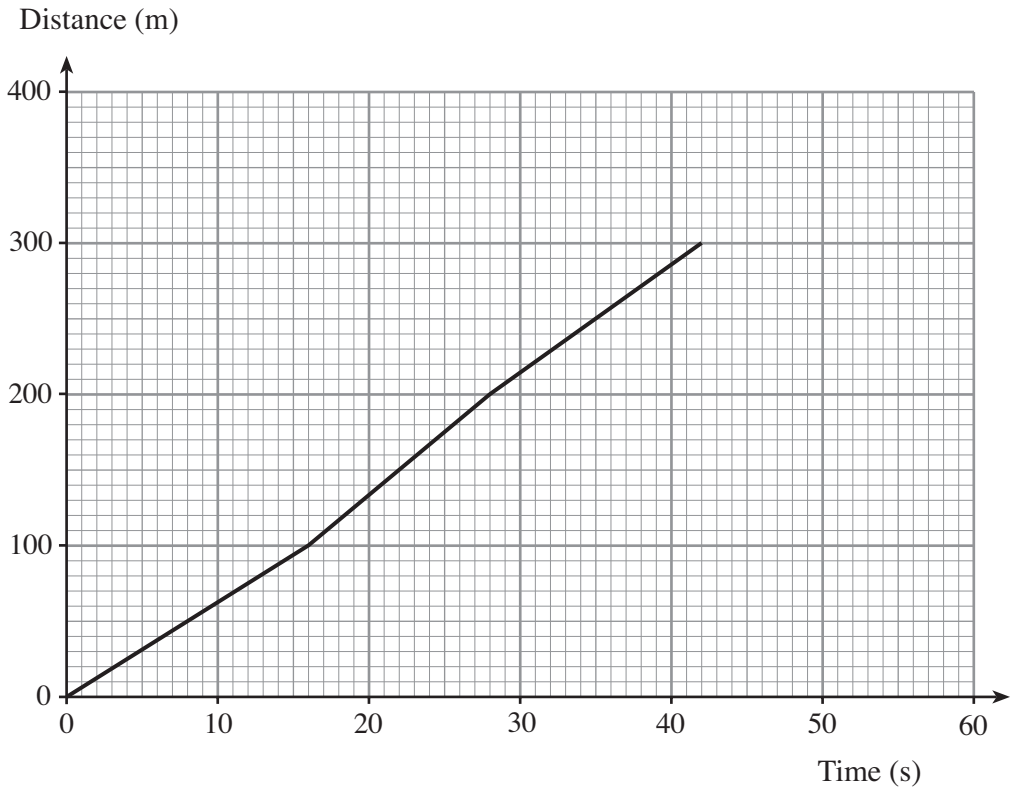
.....

(iii) Calculate the resistance of the lamp filament at its operating voltage of 12 V. [2]

Resistance = ... Ω

6

7. Four children are competing in a 400 m relay race.
Each child runs **100 m**.
The graph shows information for the first 300 m of the race.



(a) How long did it take the **first child** to run **100 m**? ..... [1]

(b) The total time to complete the 400 m race was 55 s.
Use this information to complete the graph. [1]

(c) (i) Write down, in words, an equation connecting **distance**, **speed** and **time**. [1]

.....

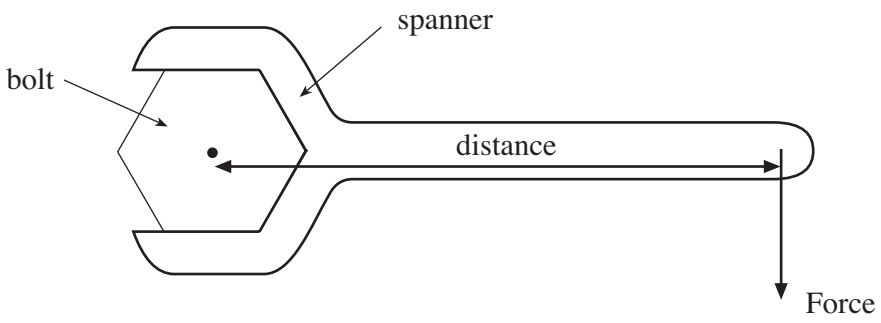
.....

(ii) Calculate the average (mean) speed for the race. [2]

Average speed = ... m/s

5

8. The diagram shows a spanner being used to tighten a bolt.



A force at the end of the spanner produces a **moment** about the bolt.

(a) (i) Complete the equation below, in words, to find the moment of a force. [1]

moment =

(ii) If, in the diagram above, the force is 60 N and the distance is 0·2 m, calculate the moment of the force about the bolt. [2]

Moment = ... Nm

(b) Explain why it is easier to tighten the bolt if a longer spanner is used. [2]

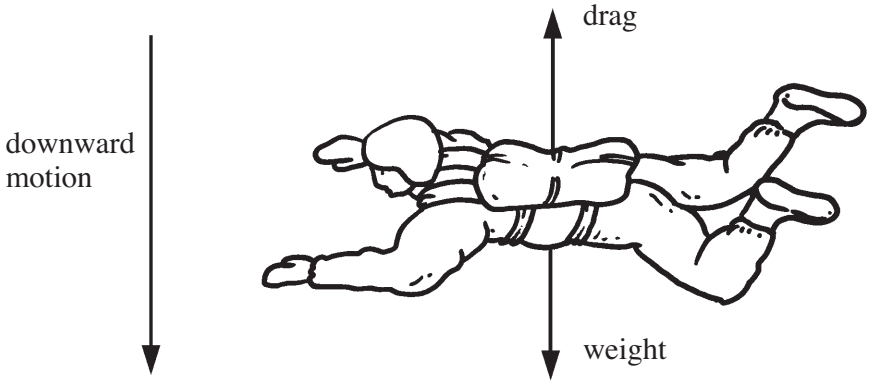
.....

.....

.....

5

9. The diagram shows the forces acting on a skydiver **during his fall**.



(a) Put a tick (✓) in the box, under the phrase which correctly completes each sentence. The first sentence has been completed for you. [2]

		zero	upwards and increasing	upwards and decreasing	upwards and constant	downwards and increasing	downwards and decreasing	downwards and constant
(i)	When the skydiver is accelerating his weight is...							✓
(ii)	When the skydiver is accelerating his speed is...							
(iii)	When the skydiver is accelerating the drag on him is...							

(b) Using **one** of the headings from the above table, complete **each** of the sentences below.

(i) The speed at terminal velocity is .....

(ii) The accelerating force on the skydiver when travelling at terminal velocity is

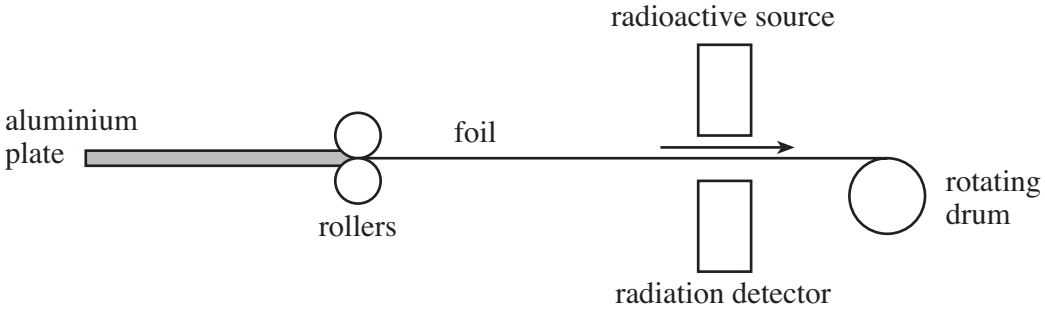
.....

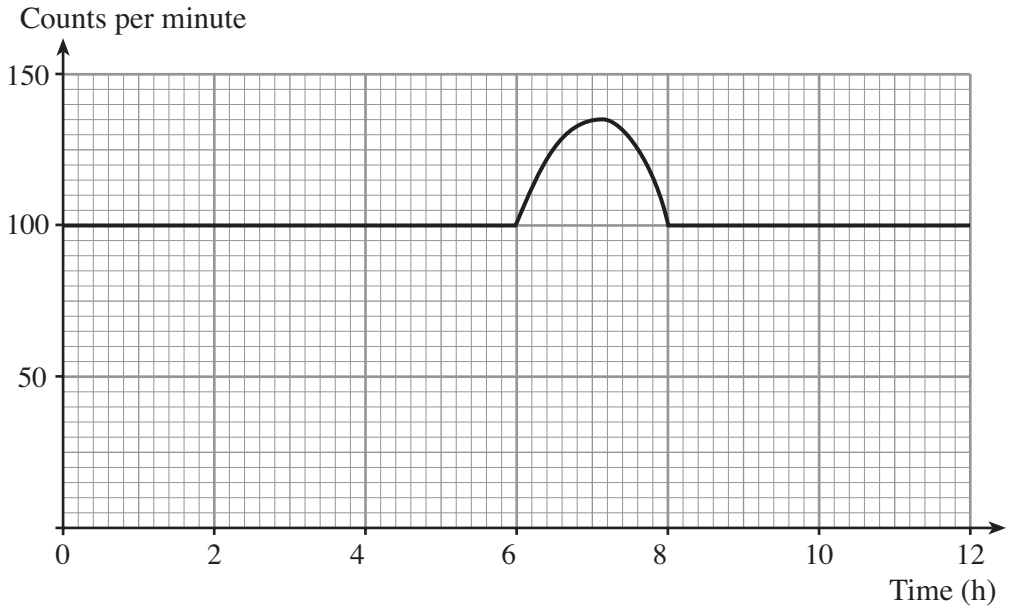
(iii) The drag force on the skydiver when travelling at terminal velocity is

.....

[3]

10. When aluminium foil is made, its thickness is often checked using the following arrangement.





The graph shows the readings produced on the detector over a period of 12 hours when producing a batch of foil.

(a) (i) Estimate, from the graph, the time when the foil thickness first changed. [1]

Time = ... hours

(ii) Use information from the graph to explain how the thickness changed. [2]

.....

.....

.....

(b) (i) Explain why an α source would be unsuitable for this application.

.....

.....

(ii) Explain why a γ source would also be unsuitable for this application.

.....

.....

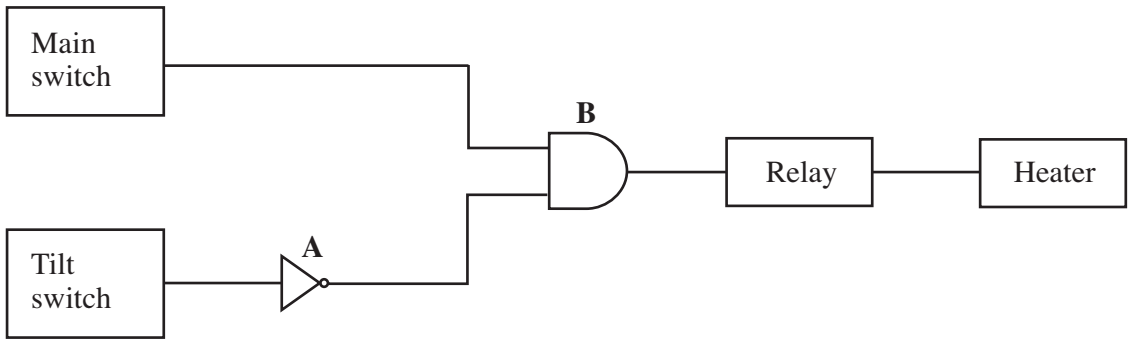
[2]

5

11. An electric heater is fitted with a safety device called a **tilt switch**. If the heater is knocked over, it automatically switches off.

When the heater is upright, the tilt switch is off (logic **0**). When the heater is knocked over, the tilt switch is on (logic **1**).

The heater control is shown in the following block diagram.



(a) In the block diagram:

(i) name an input sensor; .....

(ii) name a processor. ..... [2]

(b) Complete the truth table for the circuit.
The first two lines have been completed for you. [2]

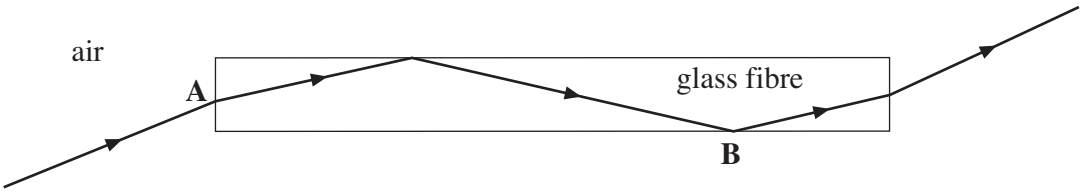
Main switch	Tilt switch	Output of gate **A**	Output of gate **B**	State of heater (OFF/ON)
0	0	1	0	OFF
0	1	0	0	OFF
1	0	.....	.....	.....
1	1	0	.....	.....

(c) State the purpose of the relay. [1]

.....

.....

12. The diagram shows the path of a signal through an optical fibre.



(a) State the name given to the change in direction of the signal

(i) at **A**; .....

(ii) at **B**. ..... [2]

(b) Explain why the signal changes direction

(i) at **A**;

.....

(ii) at **B**.

.....

.....

[3]

(c) State **three** ways in which the development of optical fibre technology has improved the global communications network. [3]

.....

.....

.....

.....

.....

8

13. An electric shower takes in cold water, heats it up and delivers it through the shower head. The shower is marked **230 V, 7000 W**.

(a) (i) Write down, in words, an equation connecting **voltage**, **power** and **current**. [1]

.....

.....

(ii) Calculate the current flowing through the shower when operating normally. [2]

Current = ... A

(b) Use the equations

number of kWh = power (kW) × time (h)

cost = number of units × cost per unit

to calculate the cost of taking a shower, which lasts 5 minutes, if one unit of electricity costs 10 p. [3]

Cost = ... p

(c) The shower delivers 7000 J of energy every second to cold water at 12°C. The water is heated to 37°C.

The specific heat capacity of water is 4200 J/kg°C.

Use the equation

Energy transferred (J) = **mass** (kg) × **specific heat capacity** (J/kg°C) × **temperature change**

to calculate the mass of water used in the **5-minute** shower. [3]

Mass = ... kg

(d) Apart from cost give **three** reasons why taking a shower is more energy efficient and environmentally friendly than using a bath full of hot water. [3]

.....

.....

.....

.....

.....

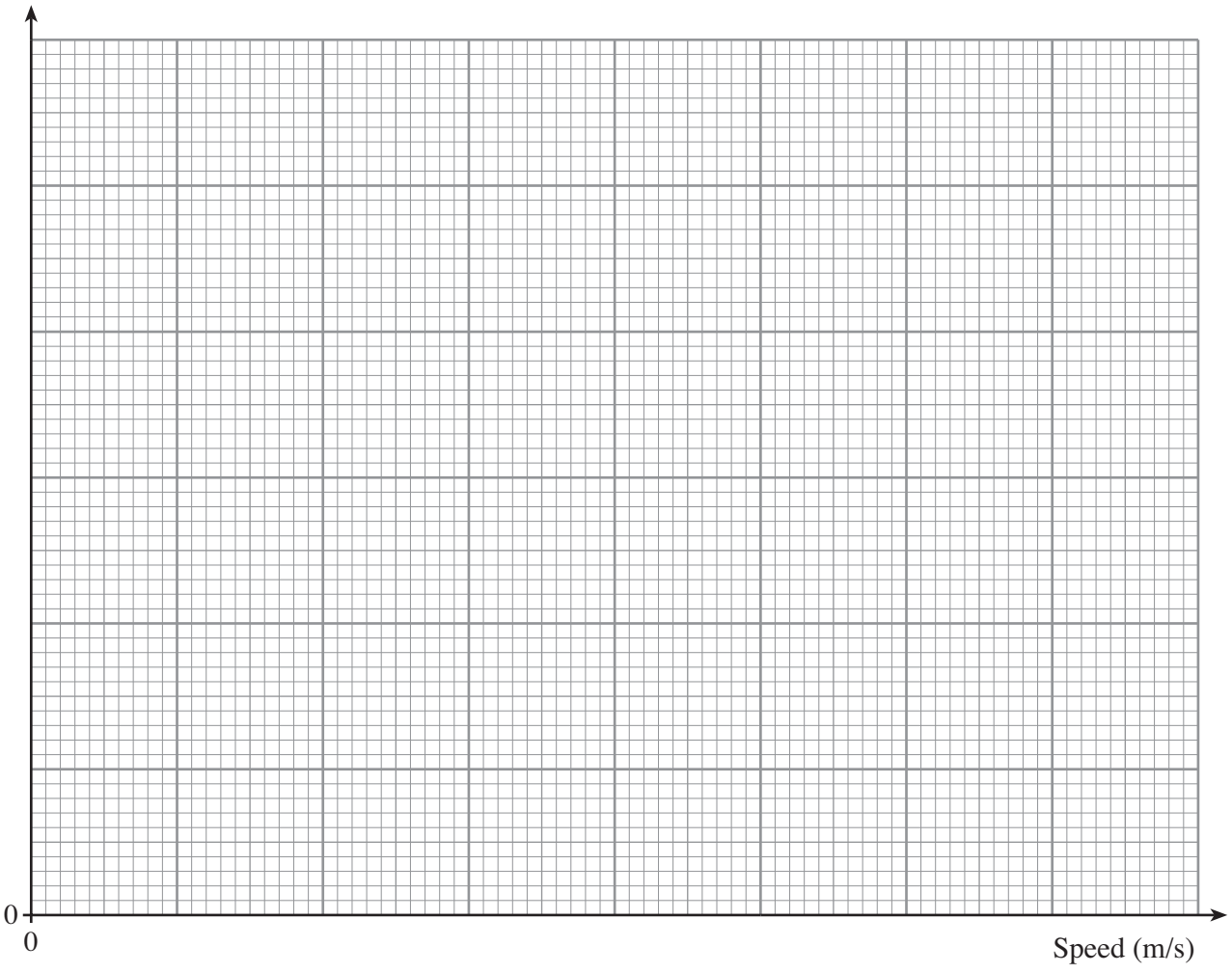
12

14. When the driver of a car sees an obstruction ahead, the brakes are applied after a short reaction time (thinking time).
The table shows how the distance travelled by the car during this reaction time, the distance travelled after the brakes have been applied and the total stopping distance depend upon the speed of the car.

Speed (m/s)	**Reaction (thinking) distance** (m)	**Braking distance** (m)	**Total stopping distance** (m)
0	–	–	0
15	9	15	24
25	15	42	57
35	21	82	103

(a) Plot a graph showing how the total stopping distance depends upon the speed of the car. [3]

Total stopping distance (m)



(b) Use the graph to find:

(i) the total stopping distance for a car travelling at 5 m/s;

Distance = ... m

(ii) the maximum speed from which a car could be stopped within 50 m.

Speed = ... m/s
[2]

(c) (i) Use the equation connecting **speed**, **distance** and **time**, with data from the table, to find the reaction time.

Reaction time = ... s

(ii) Give a reason why the reaction time does not depend upon the speed of the car.

.....

.....
[3]

(d) For a car travelling at 25 m/s, use the equations

$$v = u + at$$

$$s = ut + \frac{1}{2} at^2$$

$$s = \frac{u + v}{2} t$$

$$v^2 = u^2 + 2as$$

where u = initial speed
v = final speed
s = distance
t = time
a = acceleration

to calculate:

(i) the braking time to bring the car to rest;

Time = ... s

(ii) the braking deceleration.

Deceleration = ... m/s^2

[4]

12

15. The table gives information about some radioactive isotopes.

Radioactive Isotope	Half-life	Radiation emitted
^{60}Cobalt	5 years	γ
^{32}Phosphorus	14 days	β
^{90}Strontium	28 years	β
^{99}Technetium	6 hours	γ
^{133}Xenon	5 days	γ
^{220}Radon	54·5 seconds	α

(a) Select the most appropriate radioactive isotope to be used in each of the following tasks. State clearly a reason for your selection.

(i) Studying the blood flow through the organs of the body.

Radioactive isotope .....

Reason .....

.....

(ii) The detection of leaks in underground water pipes.

Radioactive isotope .....

Reason .....

.....

[4]

(b) ^{220}Radon is a gas. Explain why it is safe outside the body, but extremely dangerous if breathed into the body. [2]

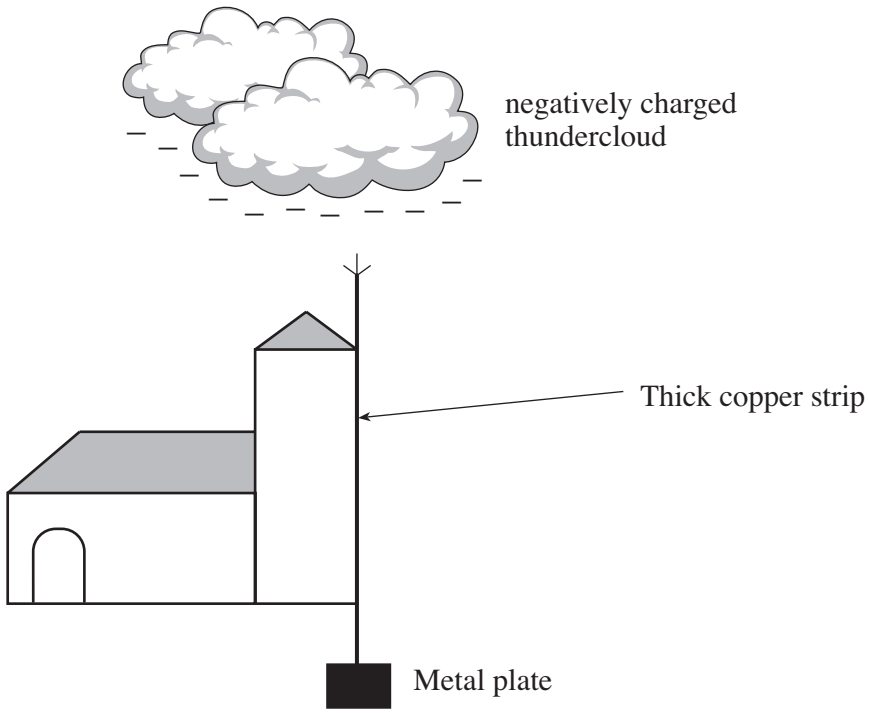
.....

.....

.....

6

16. A lightning conductor is a **very thick** strip of **copper**, which connects some sharp points above the top of a building to a metal plate buried deep in the ground.



The negative thundercloud causes a movement of charge in the lightning conductor. Positive and negative ions are produced in the air around the sharp points. The movement of these ions reduces the build up of charge on the cloud making a lightning strike less likely.

(a) (i) Explain how a positve charge is produced at the points of the lightning conductor.

.....

.....

.....

(ii) Explain how the ions produced in the air around the points help to prevent the build up of charge in the cloud.

.....

.....

.....

[4]

(b) In a lightning strike, 15 C of charge is transferred from the cloud, via the lightning conductor, in 0·0005 s.

(i) Write, in words, the equation connecting **current**, **charge** and **time**. [1]

.....

.....

(ii) Calculate the current produced by the charge transfer. [2]

Current = ... A

(c) Give **two** reasons why the lightning conductor, shown in the diagram, minimises the damage to the building by the lightning strike described in *(b)*. [2]

.....

.....

.....

.....

9

17. The table gives information about 4 planets in the Solar System.

Planet	**Orbital speed** (km/h)	**Time to orbit the Sun** (years)	**Diameter of planet** (km)	**Circumference of planet's orbit**
Earth	$10{\cdot}7 \times 10^4$	1	12 800	6·28 AU
Mars	$8{\cdot}1 \times 10^4$	2	6 784	9·43 AU
Jupiter	$4{\cdot}7 \times 10^4$	12	143 360	32·68 AU
Saturn	$3{\cdot}5 \times 10^4$	(approx) 30	120 320	59·71 AU

The circumference of the planets' orbits is given in AU [Astronomical units].

1 AU = 150 000 000 km

(a) Use data from the table to:

(i) give a reason why the Earth has a smaller mass than Saturn;

.....

.....

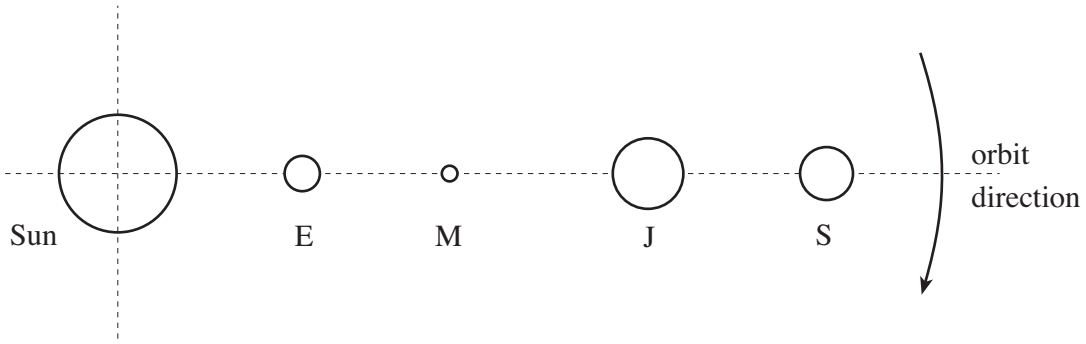
(ii) give **two** reasons why Jupiter takes longer than Mars to orbit the Sun.

.....

.....

[3]

(b) The diagram (not to scale) shows one alignment of the 4 planets with respect to the Sun.

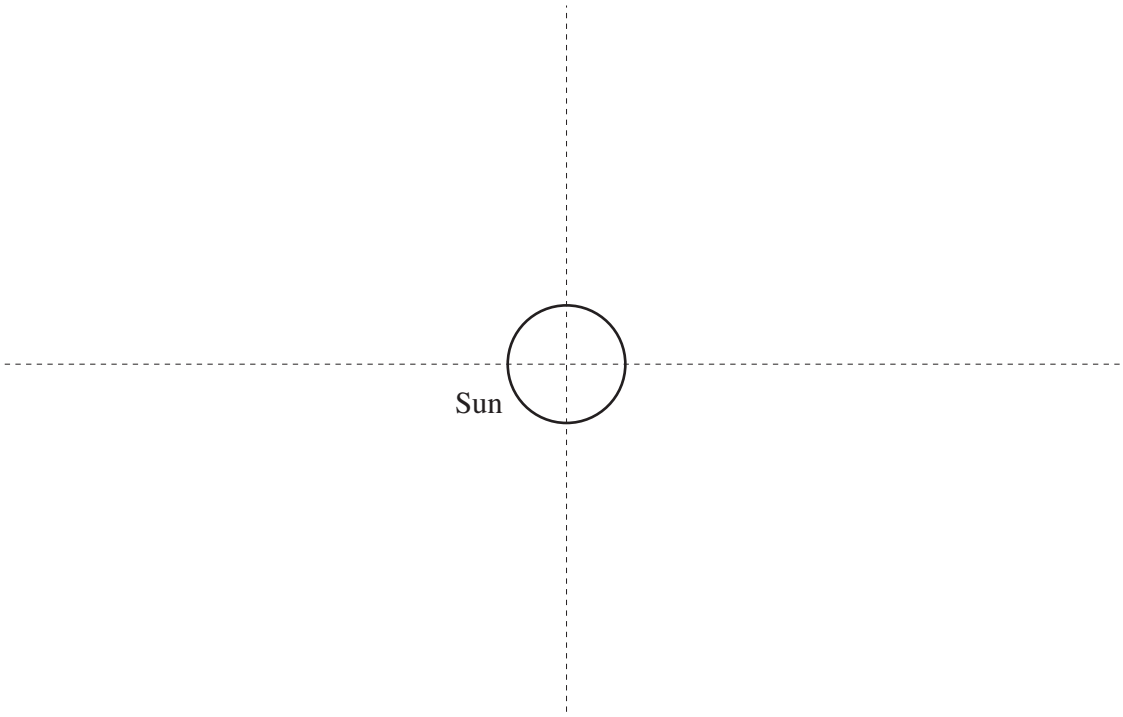


Use information in the table:

(i) to find the number of years it will take for the alignment to occur again;

Number of years = ...

(ii) to complete the diagram below to show how the planets are placed with respect to the Sun 15 years after the alignment on the previous page.



[4]

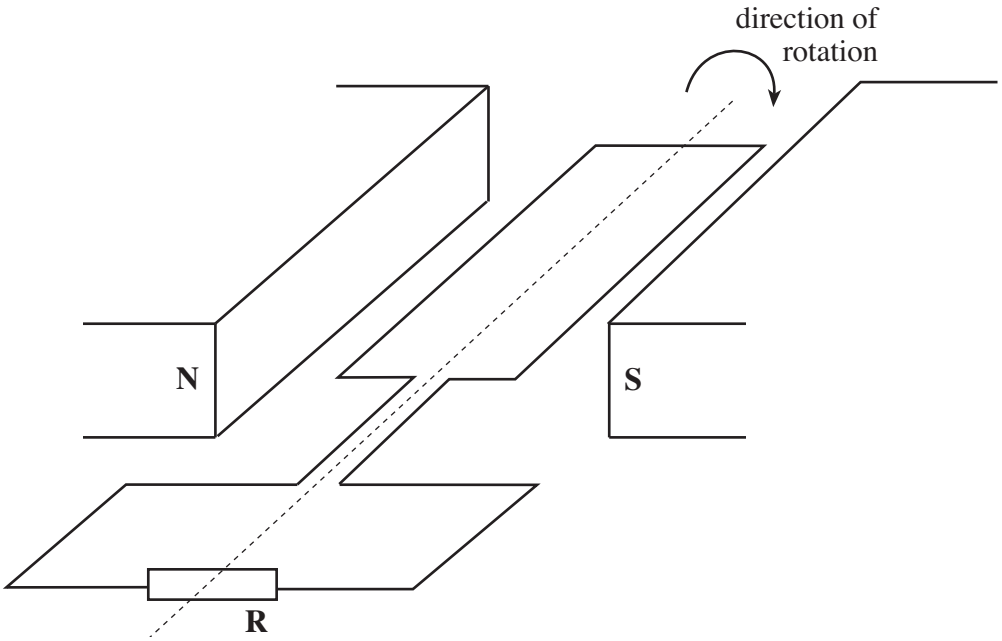
(c) (i) Use information from the table to calculate the circumference of Saturn's orbit in km. [1]

Circumference of orbit = ... km

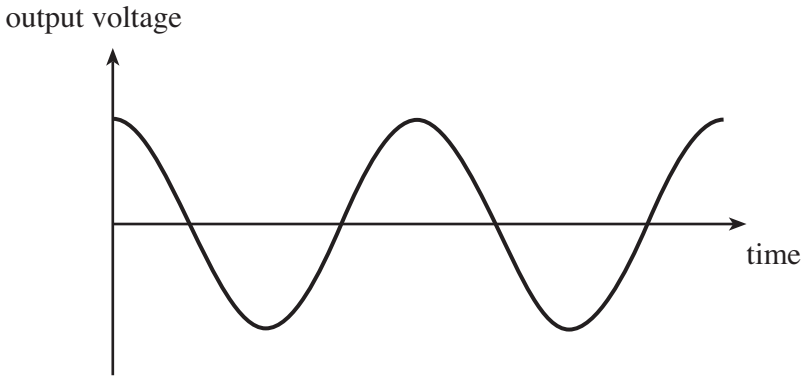
(ii) Use the orbit speed and circumference for Saturn, together with an equation connecting **speed**, **distance** and **time**, to calculate a more exact value for the time taken (in years) for Saturn to orbit the Sun. [3]

Orbital time = ... years

18. The diagram shows a simple a.c. generator. It consists of a single coil, which is rotated at a constant speed in a magnetic field.



The graph shows how the output voltage across the resistor, **R**, changes as the coil rotates.



When the coil moves through the position shown in the diagram, the output voltage is a maximum.

(a) Explain how the voltage is produced. [2]

.....

.....

.....

(b) State how the voltage changes when:

(i) the coil is rotated through 90° from the position shown in the diagram;

.....

.....

(ii) the coil is rotated through 180° from the position shown in the diagram.

.....

.....

[3]

(c) State **two** differences in design, apart from size, between the industrial generators used in power stations and the simple generator described above. [2]

.....

.....

.....

.....

7

19. A railway truck, **A**, travelling at 5 m/s, collides with truck **B**, travelling in the opposite direction. After the collision, truck **A** travels with the speed shown in the diagram. The mass of each truck is 5000 kg.

(a) Use the Principle of Conservation of Momentum to calculate the velocity of truck **B** after the collision. Show your working. [3]

Velocity of **B** = ... m/s

(b) (i) Write down the equation for the kinetic energy of a body of mass **m**, moving with a velocity **v**. [1]

.....

.....

(ii) Show that truck **A** loses 60 000 J of kinetic energy during the collision. [2]

.....

.....

.....

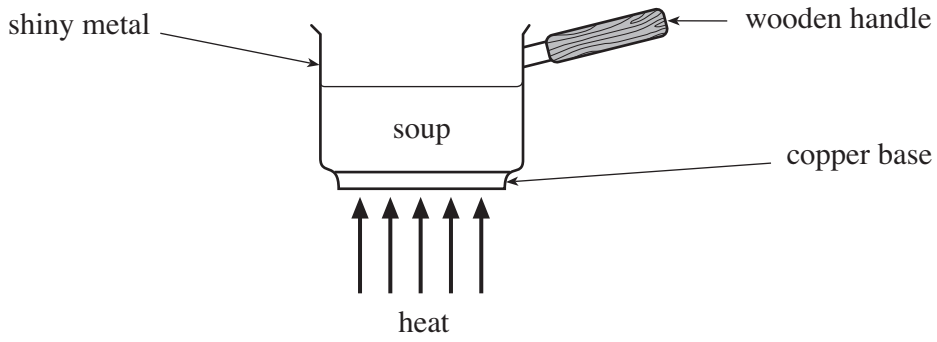
.....

(iii) State what has happened to this lost energy. [2]

.....

.....

20. The diagram shows some soup being heated in a **wooden-handled**, **copper-based**, **shiny metal** saucepan.



(a) **In terms of heat transfer**, explain why the labelled materials have been used in the construction of the saucepan. [4]

.....

.....

.....

.....

.....

.....

(b) (i) Explain, in terms of particles, how the heat is conducted through the base of the saucepan.

.....

.....

.....

.....

(ii) Explain how all the soup in the saucepan becomes hot.

.....

.....

.....

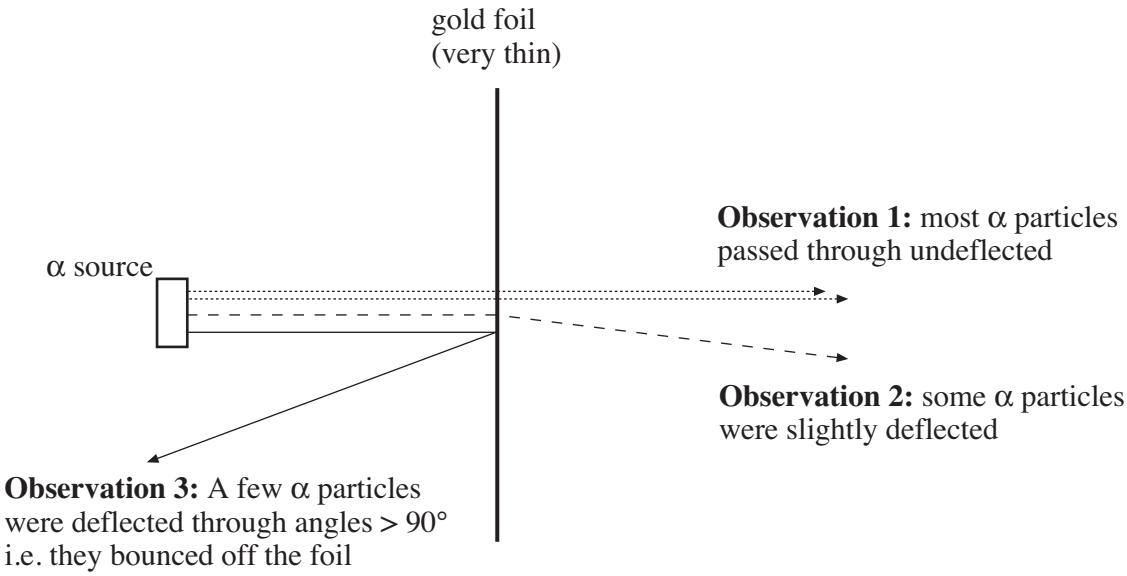
.....

[4]

8

21. Read the following passage carefully and answer the questions that follow.

In 1911 Marsden and Geiger bombarded very thin gold foil with α (alpha) particles.



The three main observations, written on the diagram, could not be explained by the Thomson 'plum pudding' model of the atom.
Rutherford produced a new model of the atom in order to account for Marsden and Geiger's observations. Rutherford's nuclear model stated that the mass of an atom is contained in a very small, positively charged central nucleus. This central nucleus is surrounded by empty space which contains sufficient negatively charged electrons to make the atom electrically neutral.

(a) Explain what an alpha particle is and state its charge. [2]

.....

.....

(b) How does Rutherford's nuclear model account for:

(i) observation 1;

.....

.....

(ii) observation 2;

.....

.....

(iii) observation 3?

.....

.....

.....

[5]

(c) Suggest reasons why the Thompson plum pudding model was unable to explain the observations of the scattering experiment. [2]

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.....

.....

9