Cambridge IGCSE

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	SOLVED BY SMART EXAM RESOURCES
CENTRE NUMBER	
CANDIDATE NUMBER	

4702702278

PHYSICS **0625/41**

Paper 4 Theory (Extended) **May/June 2019**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Take the weight of 1.0 kg to be 10 N (acceleration of free fall = 10 m / s^2).

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **18** printed pages and **2** blank pages.

DC (KS/TP) 169309/4

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[Turn over

1 A rocket is stationary on the launchpad. At time $t = 0$, the rocket engines are switched on and exhaust gases are ejected from the nozzles of the engines. The rocket accelerates upwards.

Fig. 1.1 shows how the acceleration of the rocket varies between time $t = 0$ and time $t = t_f$.

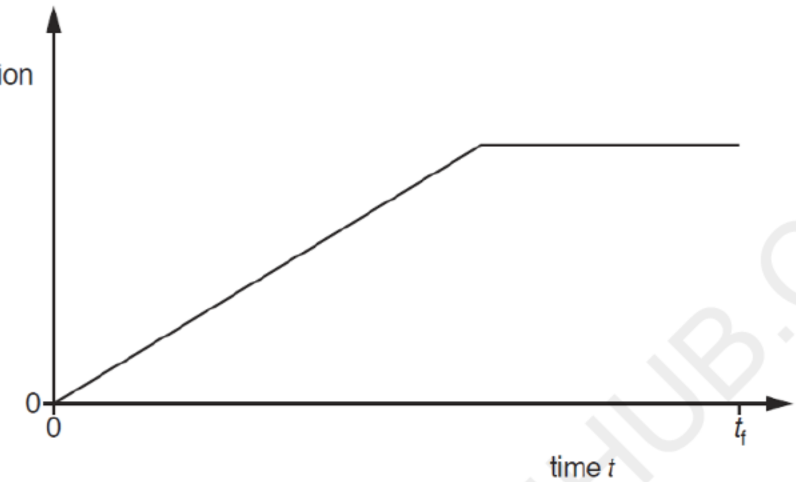


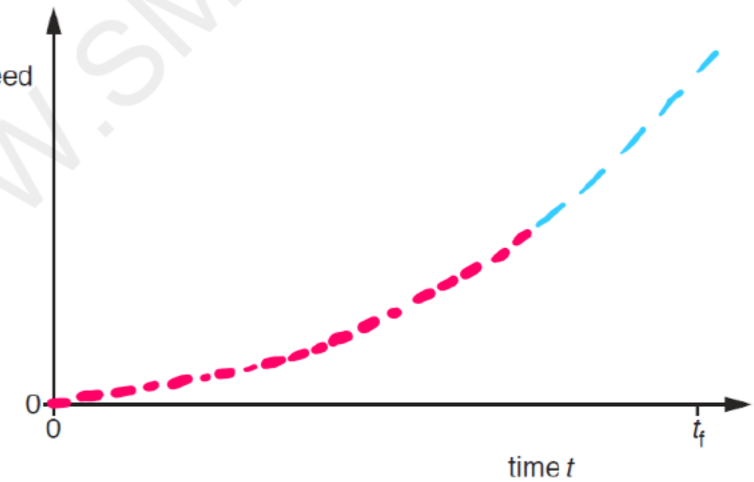
Fig. 1.1

(a) Define *acceleration*.

Acceleration is defiend as the change in velocity per unit time.

.... [1]

(b) On Fig. 1.2, sketch a graph to show how the speed of the rocket varies between time $t = 0$ and time $t = t_f$.



(c) Some time later, the rocket is far from the Earth. The effect of the Earth's gravity on the motion of the rocket is insignificant. As the rocket accelerates, its momentum increases.

(i) State the principle of the conservation of momentum.

In an isolated system , the total momentum remains constant

....

.... [2]

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

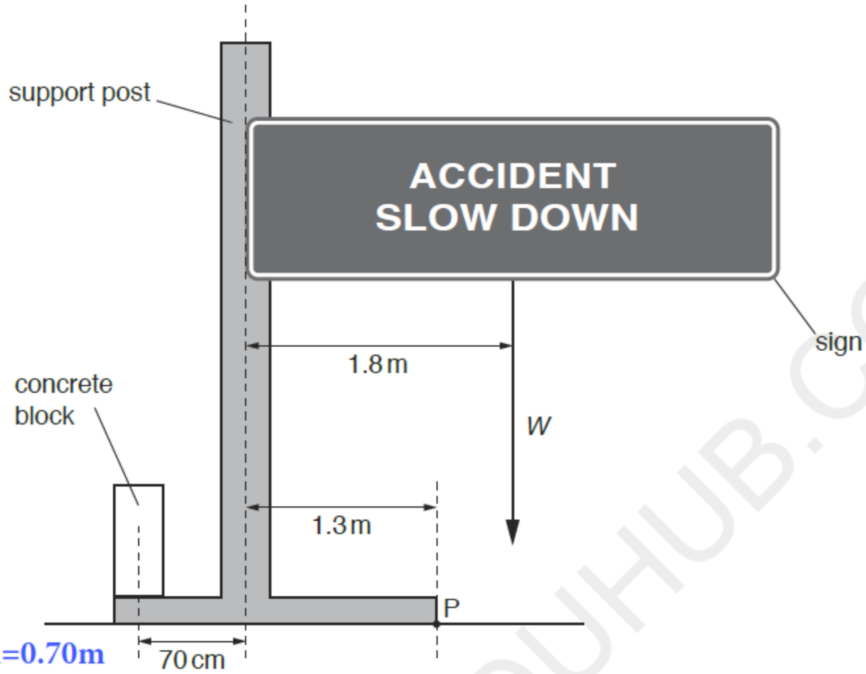
The rocket gains upward momentum as it moves up. The ejected gas gains equal momentum in the opposite direction

....

.... [2]

[Total: 8]

2 Fig. 2.1 shows a sign that extends over a road.



70cm=0.70m

<------0.7 +1.3--------->

Fig. 2.1

The mass of the sign is 3.4×10^3 kg.

(a) Calculate the weight *W* of the sign.

Weight= m x g

= $(3.4 \times 10^3) \times 10$

W = $3.4. \times 10^4$ .... [2]

(b) The weight of the sign acts at a horizontal distance of 1.8 m from the centre of the support post and it produces a turning effect about point P.

Point P is a horizontal distance of 1.3 m from the centre of the support post.

(i) Calculate the moment about P due to the weight of the sign.

Moment= Force x Perpendicular distance from the pivot

= 3.4×10^4 x (1.8-1.3)

Note:
1)The turning effect is about the point P and hence we have taken the distance as (1.8-1.3)
2) Since the weight produces a turning effect and hence the value of force has been taken here in place of Force.

moment = 1.7×10^4 .... [3]

(ii) A concrete block is positioned on the other side of the support post with its centre of mass a horizontal distance of 70 cm from the centre of the support post.

1. State what is meant by *centre of mass*.

Centre of mass is the point where all the mass can be supposed to be concentrated .... [1]

2. The weight of the concrete block produces a moment about point P that exactly cancels the moment caused by the weight *W*.
Calculate the weight of the concrete block.

Clockwise moment= Anticlockwise moment

Hence moment= 1.7×10^4

Moment= Force x Perpendicular distance from the pivot

1.7×10^4 = Force x (1.3+ 0.70)

Force= 1.7×10^4 / (1.3+0.70)

= 8.5×10^3

weight = ... 8.5×10^3 .... [2]

(c) The concrete block is removed. The sign and support post rotate about point P in a clockwise direction.

State and explain what happens to the moment about point P due to the weight of the sign as it rotates.

The moment about the point P increases because the perpendicular distance between P and the line of action of w increases.

.... [2]

[Total: 10]

3 A cube of side 0.040 m is floating in a container of liquid. Fig. 3.1 shows that the surface of the liquid is 0.028 m above the level of the bottom face of the cube.

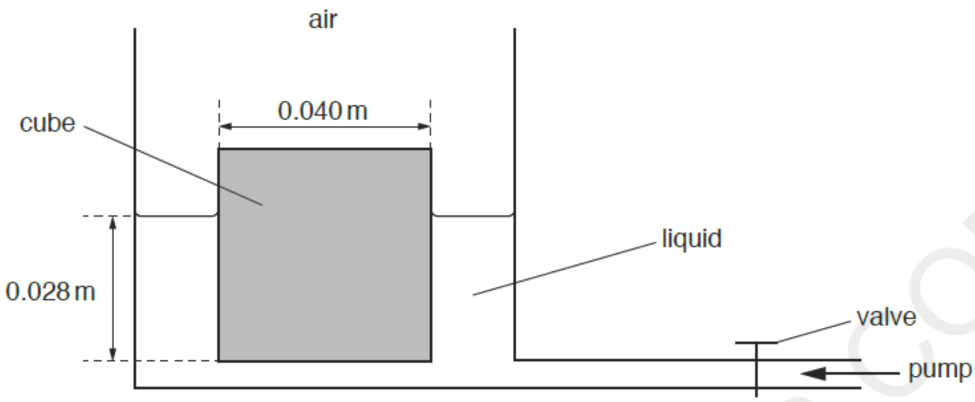


Fig. 3.1

The pressure of the air above the cube exerts a force on the top face of the cube. The valve is closed.

(a) Explain, in terms of air molecules, how the force due to the pressure of the air is produced.

Air molecules collide with each other.They also collide with the upper surface of the wall of the cube. Thus causes an impule on the surface.

.... [3]

(b) The density of the liquid in the container is 1500 kg / m^3.

Calculate:

(i) the pressure due to the liquid at a depth of 0.028 m

Preesure= hρg
= 0.028 x 1500 x 10

pressure = 420 Pa [2]

(ii) the force on the bottom face of the cube caused by the pressure due to the liquid.

Force = Pressure x area
= 420 x 0.040^2

force = 0.67N [2]

(c) The valve is opened and liquid is pumped into the container. The surface of the liquid rises a distance of 0.034 m.

The cube remains floating in the liquid with its bottom face 0.028 m below the surface of the liquid.

(i) Calculate the work done on the cube by the force in **(b)(ii)**.

Work= Force x distance

= 0.67 x 0.034

= 0.023

work done = 0.23 [2]

(ii) Suggest **one** reason why this is **not** an efficient method of lifting up the cube.

Because there exists friction between the liquid and the container

[1]

[Total: 10]

4 Gas of mass 0.23 g is trapped in a cylinder by a piston. The gas is at atmospheric pressure which is 1.0×10^5 Pa. Fig. 4.1 shows the piston held in position by a catch.

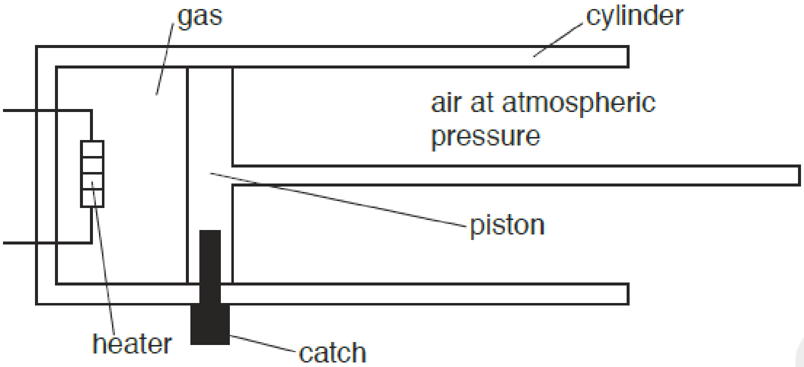


Fig. 4.1

The volume of the trapped gas is $1.9 \times 10^{-4}\,m^3$.

An electrical heater is used to increase the temperature of the trapped gas by 550 °C.

(a) The specific heat capacity of the gas is 0.72 J / (g °C).

(i) Calculate the energy required to increase the temperature of the trapped gas by 550 °C.

$E = mc\,(\Delta)T$
$= 0.23 \times 0.72 \times 550$
$= 91$ J

energy = 91J [2]

(ii) The power of the heater is 2.4 W.

1. Calculate how long it takes for the heater to supply the energy calculated in **(a)(i)**.

$P = E/t$
$t = E/P$
$= 91/2.4$
$= 38$

time = 38s [2]

2. In practice, it takes much longer to increase the temperature of the gas by 550 °C using the heater.

Suggest **one** reason for this.

Thermal energy is used to increase the temperature of the surroundings

[1]

(b) When the temperature of the gas has increased by 550 °C, its pressure is 2.9×10^5 Pa. The catch is then released allowing the piston to move. As the piston moves, the temperature of the gas remains constant.

(i) State and explain what happens to the piston.

The piston moves to the right because the resultant force is to the right.

.... [2]

(ii) Determine the volume of the gas when the piston stops moving.

$V_2 = p_1 \times V_1 / p_2$

$= 2.9 \times 10^5 \times 1.9 \times 10^{-4} / 1.0 \times 10^5$

Note : $P_2 = 1.0 \times 10^5$ because the piston stops moving when the pressure of the gas equals the air pressure

volume = 5.5×10^{-4} m^3 [2]

[Total: 9]

5 Liquids and gases are two states of matter.

(a) In both boiling and evaporation, a liquid changes into a gas.

(i) State **two** ways in which boiling differs from evaporation.

1. Boiling happens throughout the liquid

2. Boiling happens at one temperature

[2]

(ii) Before injecting a patient, a doctor wipes a small amount of a volatile liquid on to the patient's skin.

Explain, in terms of molecules, how this procedure cools the patient's skin.

More energetic molecules escape from the liquid bevcause they overcome the intermolecular forces.

[4]

(b) Gases can be compressed but liquids are incompressible.

Explain, in terms of molecules, why liquids are incompressible.

Liquids are incompressible because the molecules touch each other. Hence large repulsive forces exist when the molecules are moved closer together

[2]

[Total: 8]

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6 Green light of frequency 5.7×10^{14} Hz is travelling in air at a speed of 3.0×10^{8} m/s. The light is incident on the surface of a transparent solid.

Fig. 6.1 shows the wavefronts and the direction of travel of the light in the air.

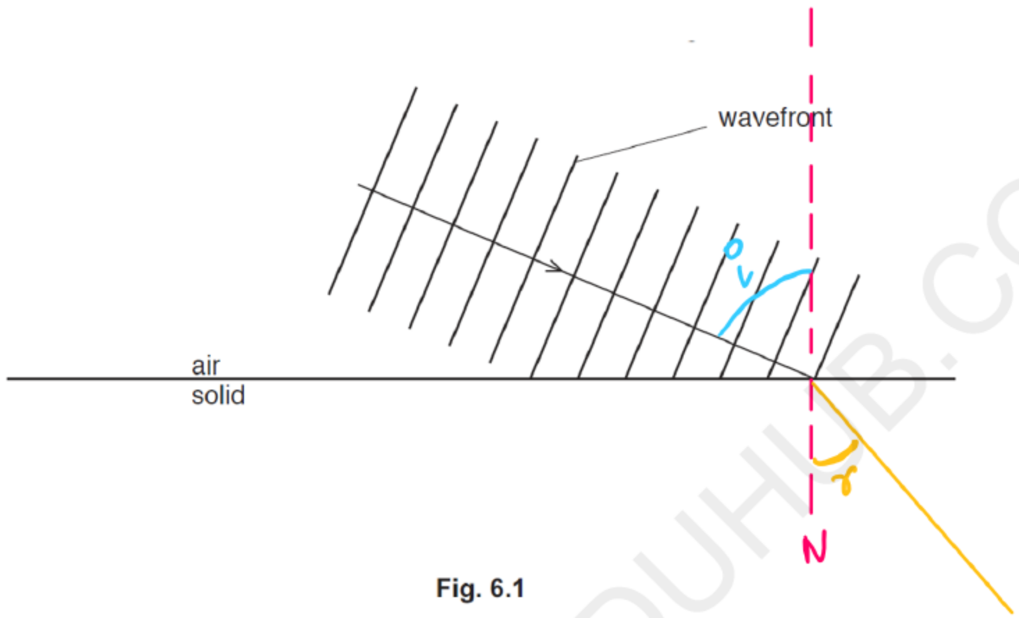

Fig. 6.1

(a) Explain, in terms of the wavefronts, why the light changes direction as it enters the solid. You may draw on Fig. 6.1 as part of your answer.

One point of the wavefront hits the solid first and is also slowed down first. Therefore the angle of the wavefront changes

.... [3]

(b) The refractive index of the transparent solid is 1.3.

(i) The light is incident on the surface of the solid at an angle of incidence of 67°. Calculate the angle of refraction of the light in the solid.

$n = \frac{\sin i}{\sin r}$

$n(\sin r) = \sin i$

$\sin r = \sin i / n$

$r = \sin^{-1}(\sin i / n)$

$(r =)\sin^{-1}(\sin 67° / 1.3)$

$1.3 = \frac{\sin 67°}{\sin r}$

$(r =)\sin^{-1}(\sin 67° / 1.3)$

$r = 45^0$

angle of refraction = 45^0 [2]

(ii) Determine the wavelength of the green light in the transparent solid.

V_{ts} = c / n
= 3.0×10^8 / 1.3

Note: V_{ts}=Velocity of transparent solid

= 2.3×10^8

λ = v / f

= 2.3×10^8 / 5.7×10^{14}

= 4.0×10^{-7} m

wavelength = 4.0×10^{-7} m [4]

[Total: 9]

7 Fig. 7.1 shows a circuit diagram that includes component X.

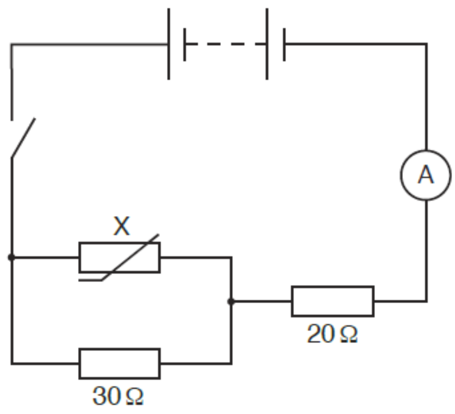

Fig. 7.1

(a) State the name of component X.

Thermistor .... [1]

(b) The electromotive force (e.m.f.) of the battery is E. The switch is closed.

The potential difference (p.d.) across the 30 Ω resistor is V_{30}.
The p.d. across the 20 Ω resistor is V_{20}.
The p.d. across component X is V_X.

State an equation that relates V_X to:

(i) V_{30}

[Note: Parallel components have the same voltage]

$V_x = V_{30}$ .... [1]

(ii) E and V_{20}.

$V_X = E - V_{20}$ .... [1]

Note: [Explanation for b(ii)]

1)The thermistor and the 30 Ω resistor are in parallel to each other and hence they each operate at the same battery voltage of 30 Ω

But together they are in series with the 20 Ω resistor. Hence ;

Emf= (voltage across the parallel resistors) + (Voltage across the 20 Ω resistor)

Hence;

$E = V_x +$ (Voltage across the 20 Ω resistor)

Hemce ; $V_X = E - V_{20}$

(c) The e.m.f. of the battery is 6.0 V and the resistance of component X is 15 Ω.

Calculate:

(i) the total resistance of the circuit

Resistance across the parallel combination
Hence: $1/R_1 + 1/R_2 = 1/R_{tot}$
Hence : $1/15 + 1/30 = 1/R_{tot}$
Hence: $(30+15)/(30 \times 15) = 1/R_{tot}$
$R_{tot}\ (30+15) = (30 \times 15)$
Hence; $R_{tot} = (30 \times 15) / (30+15)$
Hence; $R_{tot} = (15 \times 30) / (15 + 30) = 10\Omega$

Total circuit resistance= (resistance across parallel combination) + 20 Ω =30 Ω

resistance = ...30 Ω............ [3]

(ii) the ammeter reading.

$I = V / R$
$= 6.0 / 30$
$= 0.20$ A

Use Ohm's Law and Use the emf as V and the total circuit resistance as R

reading = ...0.20 A............ [2]

(d) The temperature of component X increases.

State and explain what happens to the ammeter reading.

The ammeter reading increases . This is because the total circuit resistance decreases.

....

.... [2]

Note: [Explanation for (d) above]
V= IR and hence
I= V/ R; so logically if the denominator value decreases then the value of the fraction always increases

[Total: 10]

8 A student turns the handle of an alternating current (a.c.) generator and the coil rotates.

Fig. 8.1 represents the structure of the a.c. generator.

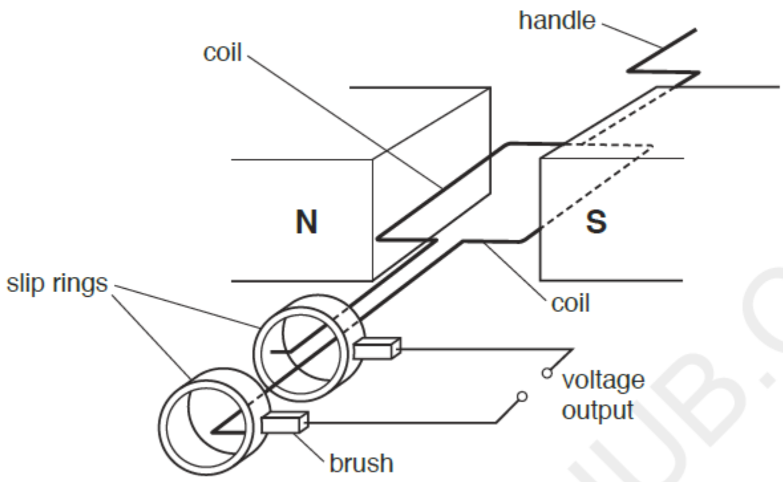

Fig. 8.1

(a) There is an alternating voltage output between the two terminals.

(i) Explain why rotating the coil produces an output voltage.

The magnetic field exists between the two poles of the magnet.

The coil cuts the magnetic field and hence an emf is induced in the coil.

....

.... [3]

(ii) State the position of the rotating coil when the alternating output voltage is at a maximum value and explain why the maximum output occurs at this position.

The maximum output voltage occurs when the plane of the coil is horizontal.

This is because , it is in this position that the magnetic field cuts the coil, the

fastest. [2]

(b) A lamp and an open switch are connected in series to the output terminals of the a.c. generator.

The switch is closed and the lamp lights up. The student has to apply a greater force on the handle.

Explain why a greater force is needed to keep the lamp lit.

The energy is lost to the lamp. Hence the student needs to supply more energy. Also a greater force is needed to do this work

[3]

[Total: 8]

9 **(a)** Fig. 9.1 shows a beam of α-particles moving towards a thin sheet of gold in a vacuum.

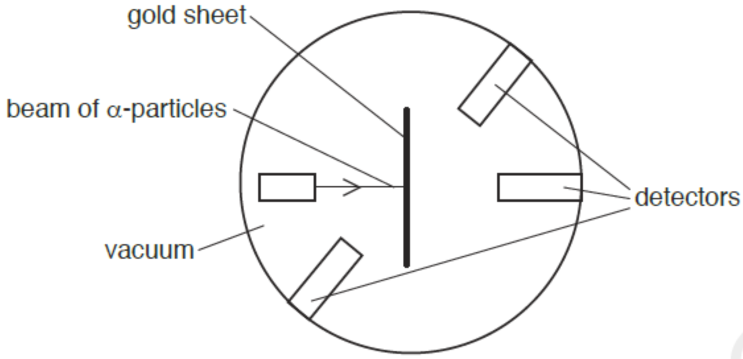

Fig. 9.1

Detectors in the region surrounding the thin gold sheet detect the α-particles and determine the number of particles that travel in various directions.

State and explain what can be deduced from the following observations.

(i) The majority of the α-particles pass through the gold sheet undeflected and are detected on the far side.

deduction Nucleus is very small

explanation very few α-particles hit or pass near to a nucleus

[2]

(ii) A small number of α-particles are deflected as they pass through the gold sheet.

deduction The nucleus is charged

explanation Charged alpha particles experience a force

[2]

(iii) A very small number of α-particles are deflected through very large angles or return back the way they came.

deduction Nucleus includes most of the mass of the atom

explanation α-particles move and the nucleus stays still

[2]

(b) A beam that consists of both α-particles and β-particles is passed through a region of space where there is a magnetic field perpendicular to the direction of the beam.

State **two** ways in which the deflection of the α-particles differs from that of the β-particles.

1. Opposite direction

2. Much smaller deflection

[2]

Or: Undergo eflections of smaller magnitude

[Total: 8]

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