Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

PHYSICS **5054/21**

Paper 2 Theory **May/June 2021**

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Section A: answer **all** questions.
- Section B: answer **two** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Any blank pages are indicated.

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Section A

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

1 An aircraft flies at a constant height.

Air drag and the force from the aircraft's engines together produce a force on the aircraft of 36 kN due north, as shown in Fig. 1.1.

The wind produces a force of 12 kN towards the east.

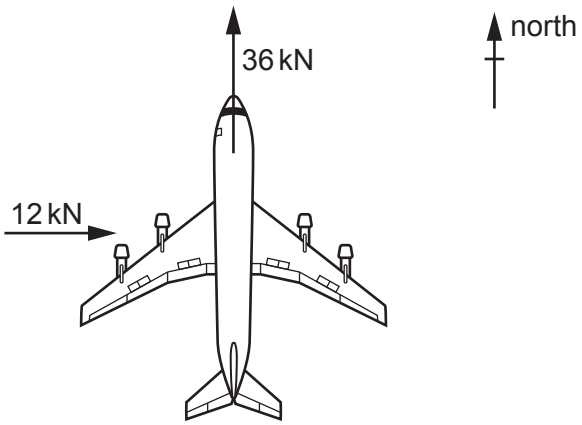


Fig. 1.1 (not to scale)

(a) Draw a scale drawing to show the resultant force acting on the aircraft.

Use your drawing to determine the size of the resultant force and the angle between the resultant force and north.

size of resultant force = ...

angle = ...
[3]

(b) The acceleration of the aircraft is uniform.

(i) Describe how a uniform acceleration differs from a non-uniform acceleration.

.....

.....

.....

..... [2]

(ii) The mass of the aircraft is 60 000 kg.

Calculate the acceleration of the aircraft.

acceleration = ... [2]

[Total: 7]

2 Fig. 2.1 shows a hollow metal cube filled with boiling water. The temperature of the four vertical surfaces are equal but each surface has a different colour or texture.

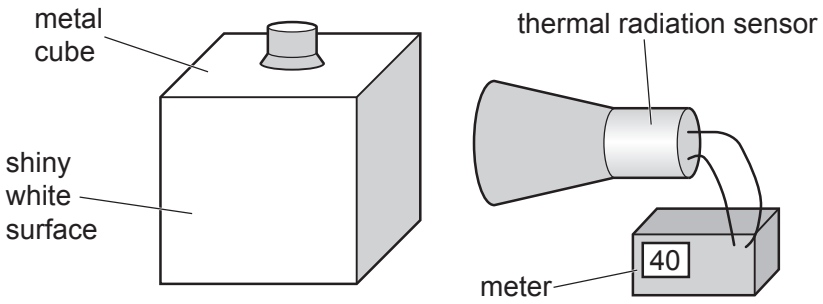


Fig. 2.1

A thermal radiation sensor is placed the same distance from each surface and the meter reading measures the thermal radiation emitted from each surface.

(a) The results are shown in **Fig. 2.2**.

Draw a line linking each type of surface with the appropriate meter reading. One line has been drawn for you.

type of surface	meter reading
dull black	40
dull white	60
shiny black	80
shiny white	100

Fig. 2.2

[2]

(b) The hot surfaces produce a convection current in the air outside the metal cube.

Describe how the convection current is produced.

.....

.....

.....

.....

..... [3]

[Total: 5]

3 A hot steel rod is cooled by plunging it into cold water, as shown in Fig. 3.1.

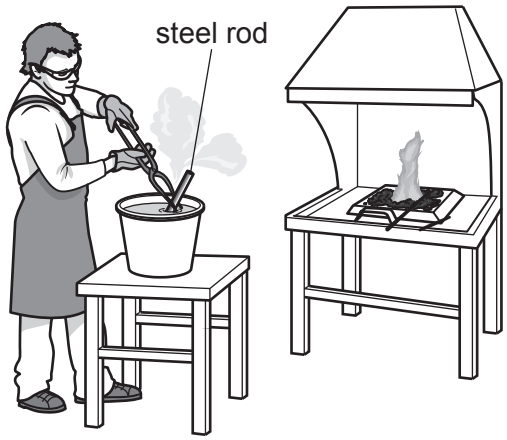


Fig. 3.1

(a) The steel rod has a mass of 2.0 kg and is initially at a temperature of 500 °C. It cools to 50 °C when placed in the water.

The specific heat capacity of steel is 460 J / (kg °C).

Calculate the thermal energy (heat) lost by the steel rod as it cools to 50 °C.

thermal energy = ... [3]

(b) A small mass of water boils when the rod is placed in the water. The remaining water then cools to room temperature and some of it evaporates.

In both boiling and evaporation, water molecules escape into the air.

(i) State **one** way in which boiling is *different* from evaporation.

.....

.....

..... [1]

(ii) The rate of evaporation decreases as the water cools.

Explain why this happens, using ideas about molecules.

.....

.....

..... [2]

[Total: 6]

4 **(a)** Fig. 4.1 shows a wave on a rope and Fig. 4.2 shows a wave on a spring. Both waves are moving in the direction shown by the arrows.



Fig. 4.1

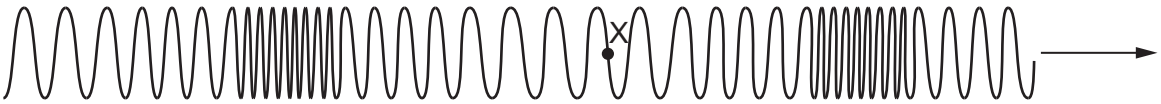


Fig. 4.2

(i) State the name of each of the two types of wave shown.

Fig. 4.1 .....

Fig. 4.2 .....
[1]

(ii) On Fig. 4.1, draw a wave which has a smaller frequency than the wave shown. [1]

(iii) Describe the movement of point X on the spring in Fig. 4.2 as the wave passes.

.....

..... [1]

(b) Table 4.1 shows some sentences that a student writes about waves.

His teacher places a ring around each mistake.

Write a suitable correction for each mistake in Table 4.1. One has been done for you.

Table 4.1

sentence	correction
Sound travels at 3.0×10^8 m / s in air.	330
Sound with a higher pitch has a larger amplitude.	
X-rays are used for pre-natal scanning.	
In the electromagnetic spectrum, microwaves have the highest frequency.	

[3]

[Total: 6]

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5 Fig. 5.1 shows part of the ray diagram of a lens being used as a magnifying glass.

Three rays are shown coming from the top of an object O.

The points labelled F are one focal length from the lens.

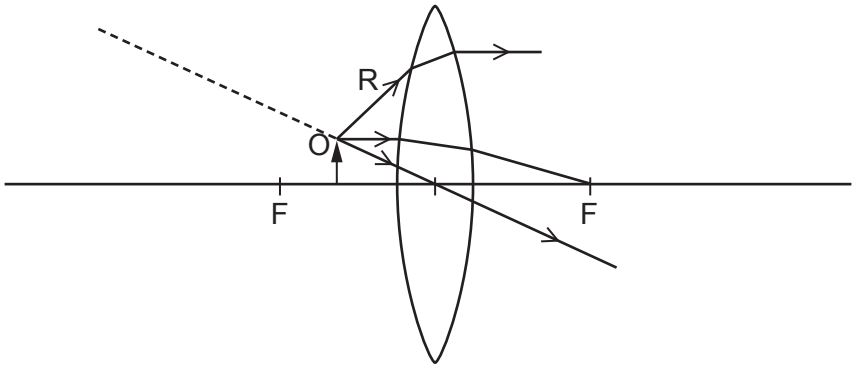


Fig. 5.1

(a) State the name of the type of lens shown in Fig. 5.1.

..... [1]

(b) Describe what happens to the ray of light R:

• as it enters the lens .....

.....

• as it leaves the lens. .....

.....

[2]

(c) Using all three rays from O, complete Fig. 5.1 to show the image formed. [2]

(d) Underline **all** of the words in the list that describe the image formed in **(c)**.

inverted upright real virtual

[1]

[Total: 6]

6 A student moves a metal bar upwards between the poles of a magnet, as shown in Fig. 6.1.

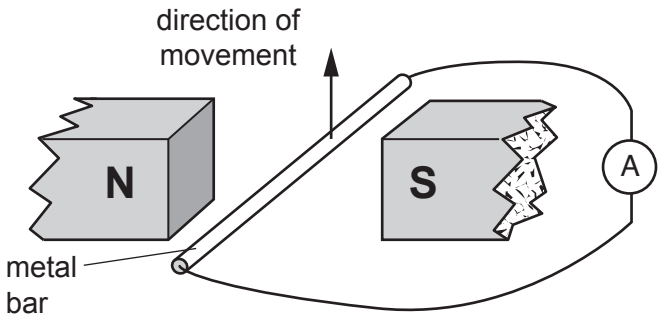


Fig. 6.1

The ammeter connected to the metal bar shows a small positive reading as the bar moves.

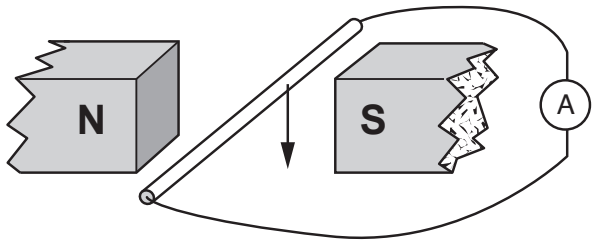
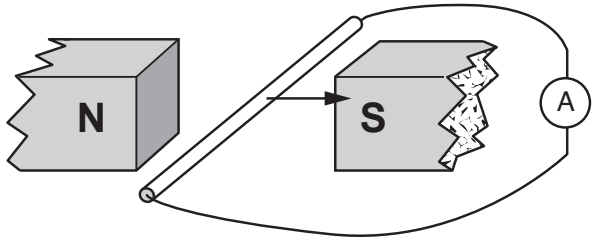
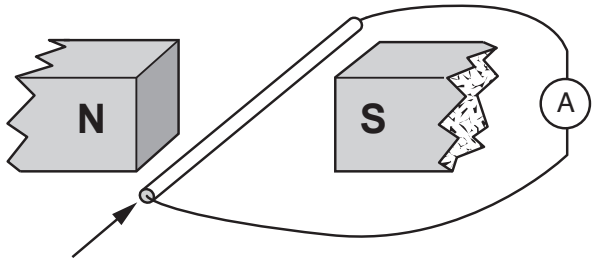
(a) Explain why there is a reading on the ammeter.

.....

..... [2]

(b) Complete Table 6.1 by stating what the ammeter shows when the metal bar moves in the direction shown by the arrow in each diagram.

Table 6.1

	reading shown on the ammeter
	.....
	.....
	.....

[3]

(c) The student finds that using a stronger magnet increases the reading on the ammeter.

State **one** other way in which the student can produce a larger reading on the ammeter, using the same rod.

.....

..... [1]

(d) Describe how Lenz's law applies when the bar is moved upwards.

.....

.....

..... [1]

[Total: 7]

7 **(a)** Fig. 7.1 shows two circuit components.



Fig. 7.1

For each of these components state what causes an **increase** in its resistance.

thermistor .....

.....

LDR .....

.....

[2]

(b) Fig. 7.2 shows a battery connected to a diode, an ammeter and a resistor.

Fig. 7.3 shows the current – voltage graph for the diode.

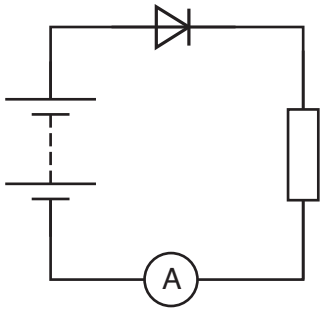


Fig. 7.2

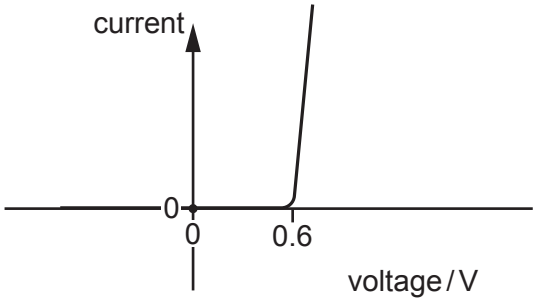


Fig. 7.3

The current in the resistor is 2.0 A and the potential difference across the resistor is 5.4 V.

(i) State what is meant by the *electromotive force* (e.m.f.) of the battery.

.....

..... [1]

(ii) Explain why the e.m.f. of the battery must be greater than 5.4 V.

.....

.....

..... [2]

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(iii) Calculate the electrical energy input to the resistor in 5.0 minutes.

energy input = ... [2]

(iv) The circuit is reconnected with the diode in the opposite direction, as shown in Fig. 7.4.

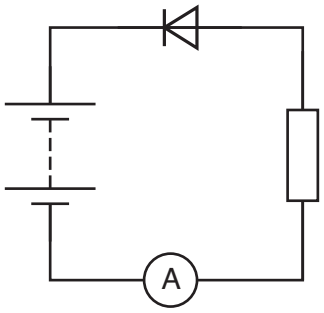


Fig. 7.4

Explain what is observed.

.....

.....

..... [1]

[Total: 8]

Section B

Answer **two** questions from this section. Answer in the spaces provided.

8 Fig. 8.1 shows a stationary horse and its rider, about to jump over two fences.

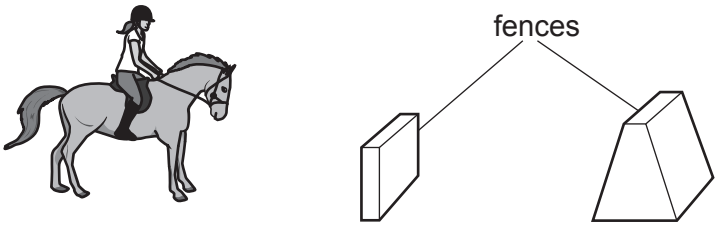


Fig. 8.1

(a) Fig. 8.2 shows a side view of the horse.

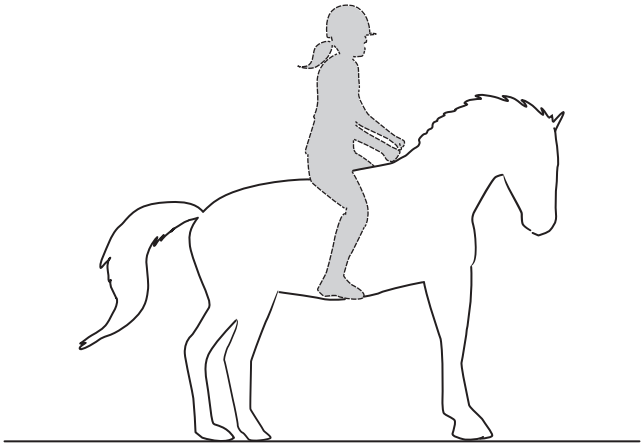


Fig. 8.2

(i) On Fig. 8.2, draw and label the forces acting on the horse.

Include the force that the rider exerts on the horse. Label this force *F*. [3]

(ii) Explain how Newton's third law applies to force *F*.

.....

.....

..... [2]

(b) Fig. 8.3 shows a side view of the two fences. They both have the same height and a uniform density.

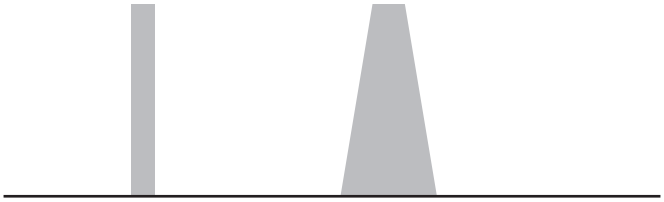


Fig. 8.3

(i) On each fence in Fig. 8.3, mark with a cross the centre of mass. [2]

(ii) Explain why a wider base makes the fence more stable.

.....

.....

..... [2]

(c) The total mass of the horse and rider is 520 kg.

(i) As they approach a fence, the horse and rider have a total kinetic energy of 4000 J.

Calculate their speed.

speed = ... [3]

(ii) The centre of mass of the horse and rider is 1.4 m above the ground.

The maximum potential energy gained by the horse and rider as they jump over the fence is 3000 J.

Calculate the maximum height above the ground of the centre of mass during the jump.

The gravitational field strength g = 10 N / kg.

height = ... [3]

[Total: 15]

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[Turn over

9 Fig. 9.1 is the current – voltage graph for a filament lamp.

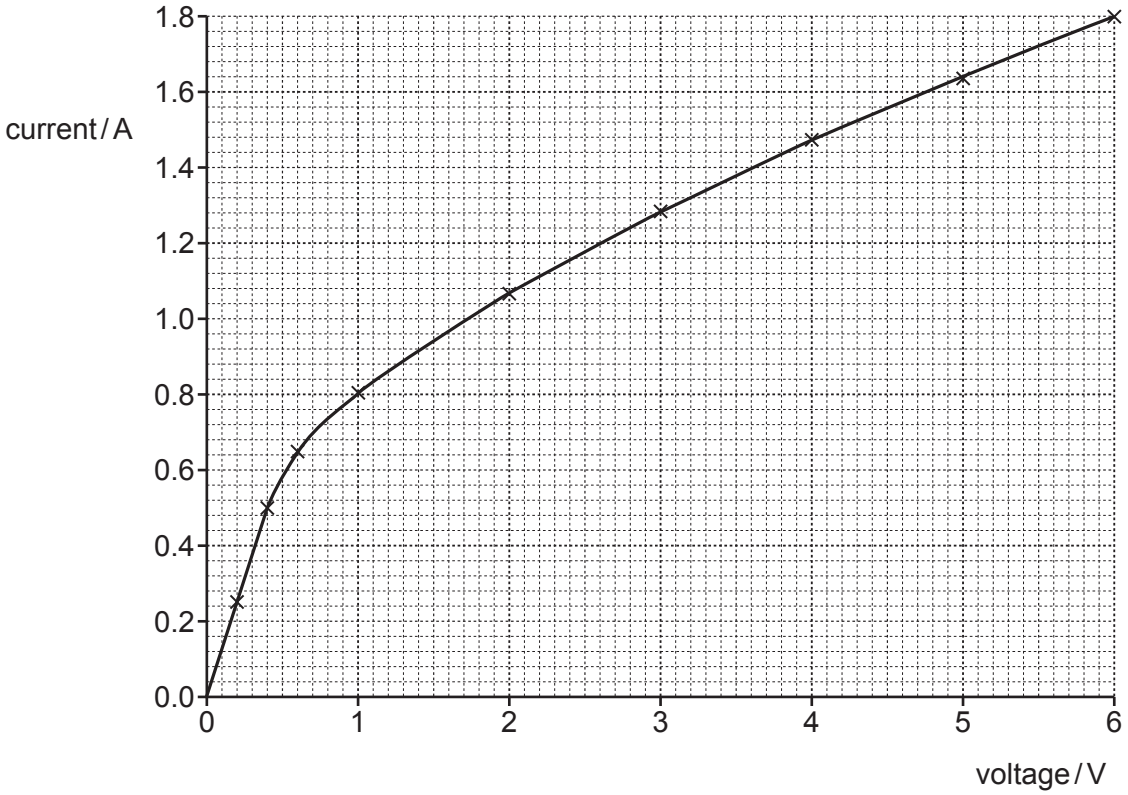


Fig. 9.1

(a) Fig. 9.2 shows an incomplete circuit diagram of the circuit that a student uses to obtain the readings for the graph.

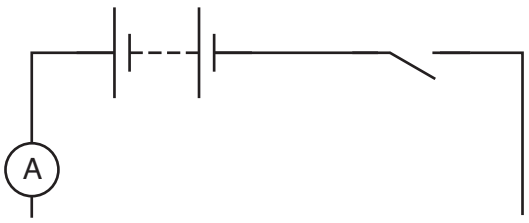


Fig. 9.2

Complete the circuit diagram using suitable circuit symbols for the lamp, a voltmeter and a variable resistor. [3]

(b) The ammeter used by the student has ranges 0−10 A, 0−1 A, 0−100 mA and 0−10 mA.

Describe how the student uses the different ranges to obtain readings which allow all nine points to be plotted precisely on the graph while using the ammeter safely.

.....

.....

.....

..... [2]

(c) State how Fig. 9.1 shows that the lamp does **not** obey Ohm's law.

.....

..... [1]

(d) Using Fig. 9.1, determine the resistance of the lamp when:

(i) the voltmeter reading is 0.40 V

resistance = ...

(ii) the voltmeter reading is 6.0 V.

resistance = ...
[3]

(e) (i) Explain why the resistance of the lamp changes as the voltage changes.

.....

.....

..... [2]

(ii) State how the resistance of a wire depends upon its length and how it depends on its cross-sectional area.

length .....

.....

cross-sectional area .....

.....
[2]

(iii) The student obtains a long sample of the same type of wire as the filament in the lamp.

The wire he obtains has the same cross-sectional area as the filament.

He cuts a 1.0 m length of the wire and measures its resistance at room temperature.

He obtains the value 16 Ω.

Using the appropriate resistance value from **(d)**, estimate the length of the filament wire in the lamp.

length = ... [2]

[Total: 15]

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Question 10 begins over the page

10 Table 10.1 contains details of the nature and some properties of alpha, beta and gamma emissions.

Table 10.1

	alpha	beta	gamma
nature	2 protons and 2 neutrons		
charge		negative	
penetrating power		stopped by 5 mm of aluminium	

(a) Complete Table 10.1 by filling in the missing details. [6]

(b) Surgical instruments in sealed plastic bags are placed in thin plastic boxes. A conveyor belt takes the boxes close to a cobalt-60 source which sterilises the instruments.

This is shown in Fig. 10.1.

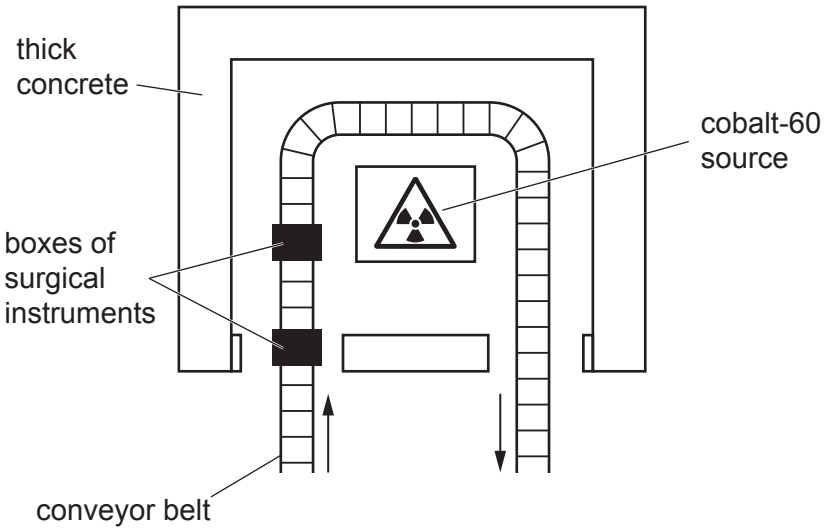


Fig. 10.1 (viewed from above)

The cobalt-60 source is a radioactive isotope of cobalt that emits gamma-radiation.

(i) Describe what is meant by the term *isotope*.

.....

..... [2]

(ii) Suggest a property of gamma-radiation that enables it to sterilise the instruments in the bags in the boxes.

..... [1]

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(iii) State why a source emitting only alpha-radiation cannot be used in this way.

.....

..... [1]

(iv) The half-life of cobalt-60 is 5.3 years.

Explain why a source with a half-life of 5.3 minutes is unsuitable for use in this application.

.....

..... [1]

(c) Geiger and Marsden performed an experiment in which alpha-particles were fired at a thin film of gold.

(i) Fig. 10.2 shows an alpha-particle passing close to the nucleus of a gold atom.

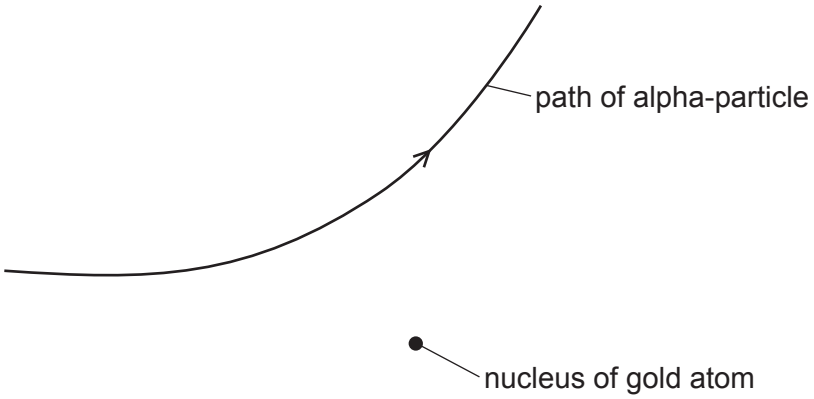


Fig. 10.2

Explain why the alpha-particle is deflected.

.....

..... [2]

(ii) In the experiment, most of the alpha-particles pass straight through the foil without deflection.

Explain, using ideas about the structure of the atom, why this happens.

.....

..... [2]

[Total: 15]

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