

Centre Number	Candidate Number	Name
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CAMBRIDGE INTERNATIONAL EXAMINATIONS  
General Certificate of Education Ordinary Level

**PHYSICS**

**5054/02**

Paper 2 Theory

October/November 2003

**1 hour 45 minutes**

Candidates answer on the Question Paper.  
Additional Materials: Answer Paper

**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 a soft pencil for any diagrams, graphs or rough working.  
Do not use staples, paper clips, highlighters, glue or correction fluid.

**Section A**

Answer **all** questions.  
Write your answers in the spaces provided on the Question Paper.

**Section B**

Answer any **two** questions.  
Write your answers on the lined pages provided and, if necessary, continue on the separate Answer Paper provided.

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.

If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given at the top of this page.

Stick your personal label here, if provided.

For Examiner's Use	
<b>Section A</b>	
<b>Q9</b>	
<b>Q10</b>	
<b>Q11</b>	
<b>Total</b>	

This document consists of **19** printed pages and **1** blank page.

## Section A

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

- 1 A small spacecraft, known as Beagle 2, is to land on the planet Mars.

As the spacecraft enters the planet's atmosphere, it slows down. When the speed reaches 1600 km/h, parachutes open and the friction with the atmosphere increases. The spacecraft eventually reaches a steady speed, and then finally it hits the surface.

- (a) On the axes of Fig. 1.1, complete the speed-time graph for the spacecraft. The parachutes open at time  $t_1$ , and the spacecraft hits the surface of Mars at time  $t_2$ .

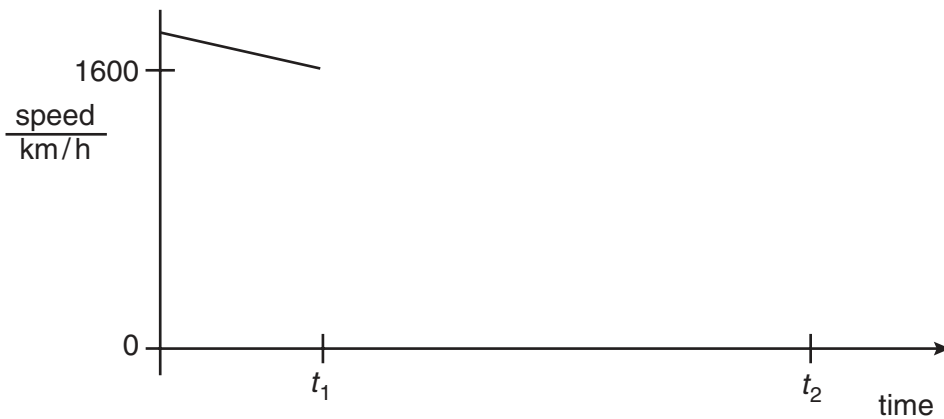


Fig. 1.1

[2]

- (b) The mass of the spacecraft is 65 kg. At one point the gravitational field strength of Mars is 3.0 N/kg and the total upwards force on the spacecraft is 500 N.

Determine

- (i) the weight of the spacecraft,

weight = .....

- (ii) the resultant force on the spacecraft,

force = .....

- (iii) the deceleration of the spacecraft.

deceleration = .....

[4]

- 2 (a) Fig. 2.1 shows the same vertical force of 200 N exerted by a cyclist on the pedal of a bicycle in three different positions **A**, **B** and **C**.

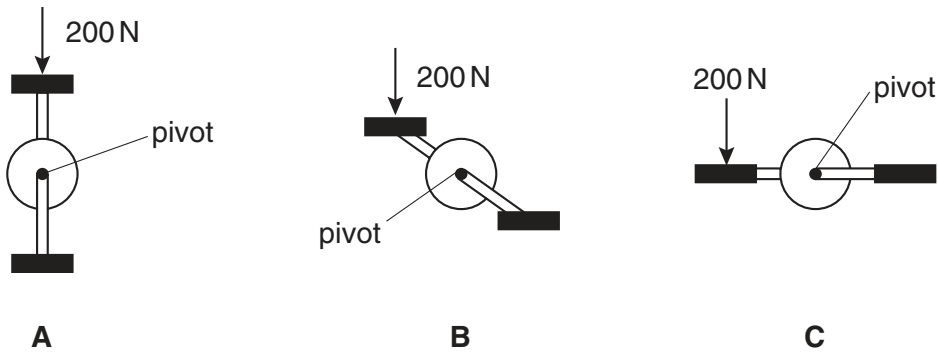


Fig. 2.1

State the position, **A**, **B** or **C**, in which the force exerts the largest moment about the pivot.

Give a reason for your answer.

.....

.....

..... [2]

- (b) Fig. 2.2 shows a support for a leg in plaster and Fig. 2.3 shows a simplified diagram of the forces acting on the leg.

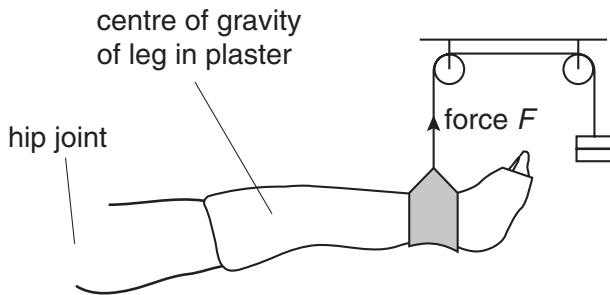


Fig. 2.2

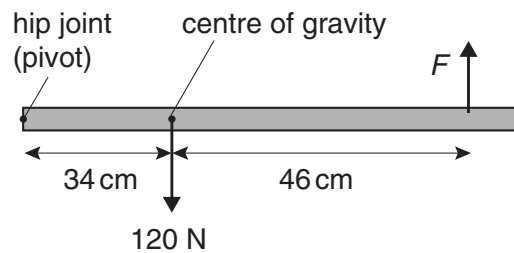
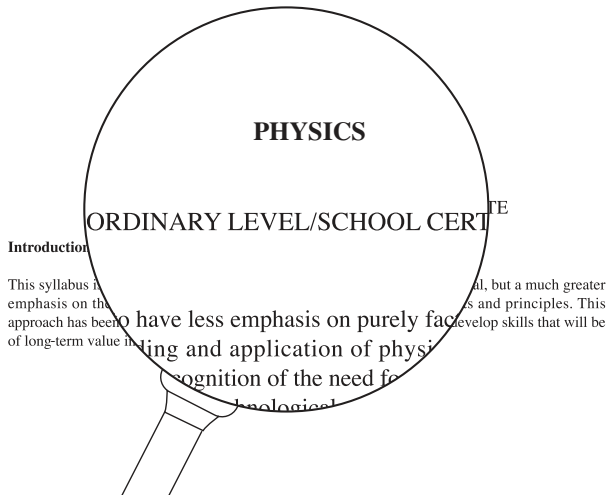


Fig. 2.3

Calculate the force  $F$  needed to keep the leg in a horizontal position.

$F = \dots\dots\dots$  [3]

3 Fig. 3.1 shows words seen through a lens. Fig. 3.2 shows the same words without the lens.



**Fig. 3.1**

**PHYSICS**

GCE ORDINARY LEVEL/SCHOOL CERTIFICATE

**Introduction**

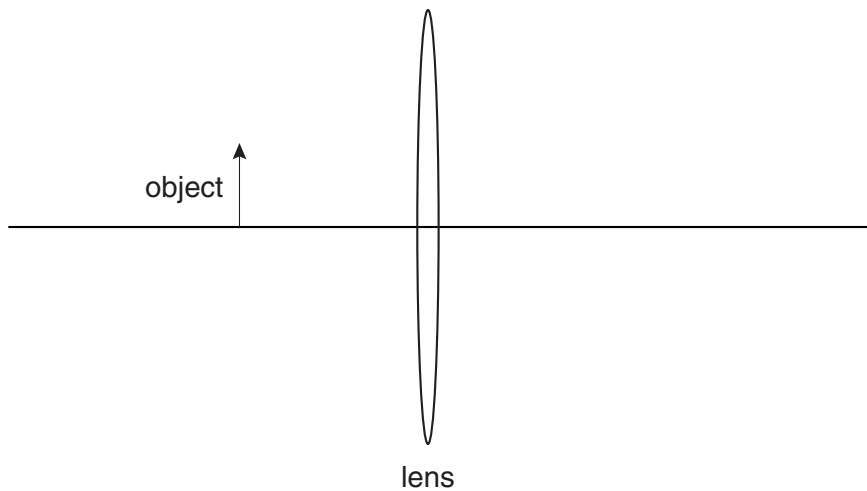
This syllabus is designed to have less emphasis on purely factual material, but a much greater emphasis on the understanding and application of physical concepts and principles. This approach has been adopted in recognition of the need for students to develop skills that will be of long-term value in an increasing technological world.

**Fig. 3.2**

(a) State two properties of the image formed by the lens.

- 1 .....
- .....
- 2 .....
- ..... [2]

(b) On Fig. 3.3, sketch a ray diagram to show how the image in Fig. 3.1 was formed by the lens. Mark clearly the focal length of the lens and the image formed.



**Fig. 3.3**

[3]

4 A sound wave in air is illustrated in Fig. 4.1.

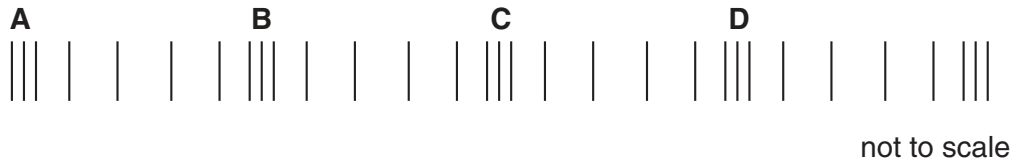


Fig. 4.1

Points **A**, **B**, **C** and **D** are at the centres of regions of compression.

(a) Describe what happens as one complete sound wave moves past a point.

.....

.....

.....

..... [2]

(b) The sound wave in Fig. 4.1 has frequency 2000 Hz and speed 320 m/s.

(i) Define the *frequency* of a wave.

.....

.....

.....

(ii) Calculate the distance between points **A** and **D**.

State clearly any equation that you use.

distance = ..... [5]

5 A thin-walled plastic bottle is sealed and contains dry air at atmospheric pressure.

(a) Explain how the molecules of air inside the bottle exert a pressure on the walls.

.....  
.....  
.....  
.....  
..... [2]

(b) Ice is placed inside the bottle, and the bottle is then sealed again. The temperature of the air inside the bottle falls and the bottle becomes partially crushed. Explain, in terms of the molecules of air inside and outside the bottle, why this happens.

.....  
.....  
.....  
.....  
..... [4]

- 6 Fig. 6.1 shows a small plotting compass placed above a copper wire. When there is no current in the wire, the plotting compass points towards the North.

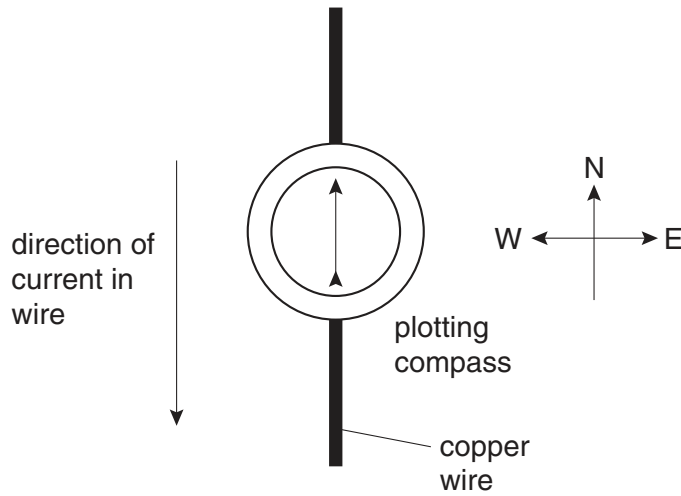


Fig. 6.1

- (a) A large current is switched on in the wire. The direction of the current is shown in Fig. 6.1.

(i) State what happens to the compass needle.

.....  
 .....

(ii) State what happens if the compass is placed under the wire.

.....  
 .....

[3]

- (b) State and explain what is observed if there is a 50 Hz alternating current in the wire.

.....  
 .....

[2]

- 7 Fig. 7.1 shows a coil ABCD that can turn between the two poles of a magnet. Bare metal paper clips support and pass current into and out of the coil.

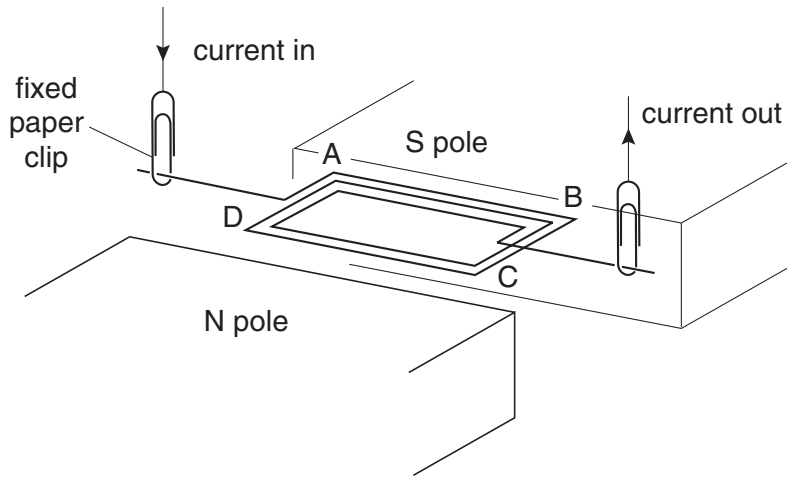


Fig. 7.1

- (a) (i) State the direction of the force on the side AB.

.....

- (ii) Explain the reason for your choice of direction.

.....

.....

.....

[2]

- (b) A student turns the coil through  $180^\circ$  so that AB is close to the N pole of the magnet.

- (i) State the direction of the force on side AB of the coil.

.....

- (ii) The student releases the coil. Explain why the coil does **not** rotate continuously.

.....

.....

.....

[2]



- (c) With the coil as shown in Fig. 7.1, the top half of the wire from C to the paper clip is coated with an insulator, as shown in Fig. 7.2. Explain why the coil can now rotate continuously.

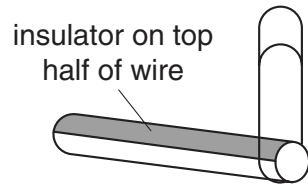


Fig. 7.2

.....

.....

.....

.....

.....

.....

..... [2]

- 8 Fig. 8.1 shows a simple transformer used to light a lamp. The lamp is labelled 24 V, 36 W.

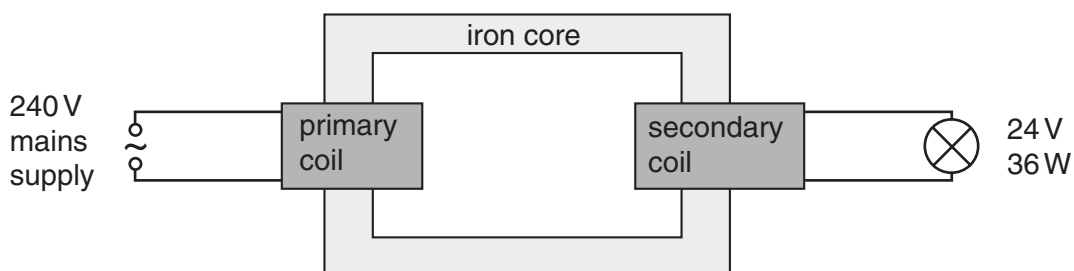


Fig. 8.1

When the mains supply is switched on, the lamp is very dim.

- (a) State two ways in which the potential difference across the lamp can be increased without changing the mains supply.

1 .....

2 ..... [2]

- (b) For the lamp operating at the correct brightness, calculate

- (i) the current in the secondary coil,

current = .....

- (ii) the current in the primary coil. Assume that the transformer is ideal.

current = .....

[3]

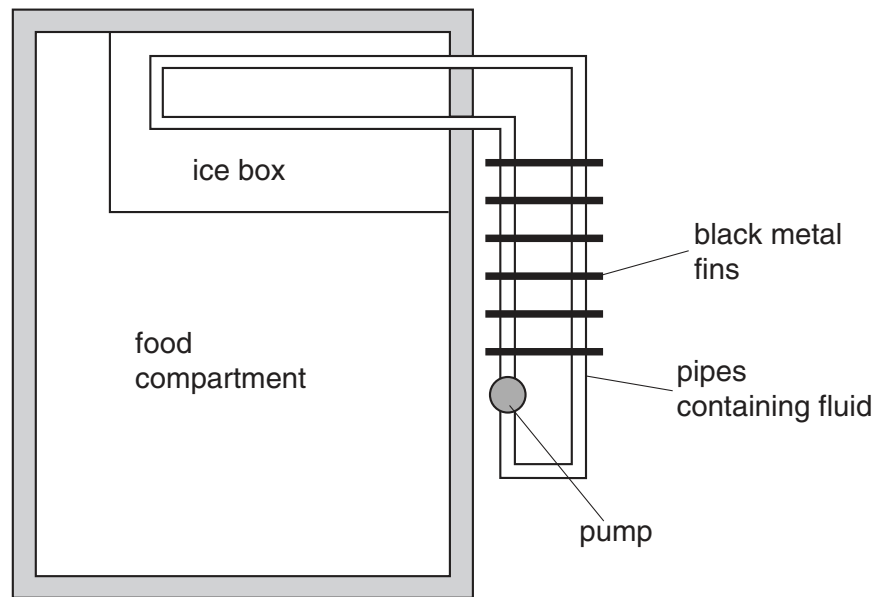


## Section B

Answer **two** questions from this section.

Use the lined pages provided and, if necessary, continue on the separate sheets available from the Supervisor.

- 9 Fig. 9.1 shows a refrigerator.



**Fig. 9.1**

Inside the pipes in the ice-box, a liquid boils and takes in latent heat. The gas condenses in the pipes at the back of the refrigerator and thermal energy (heat) leaves through the black metal fins.

- (a) (i) State **one** similarity and **one** difference between boiling and evaporation.  
 (ii) Explain, in terms of the molecules involved, why latent heat is needed to boil the liquid. [5]
- (b) (i) Explain how the ice box at the top of the refrigerator keeps the whole of the food compartment cool.  
 (ii) Explain why the fins are black. [4]

- (c) A plastic ice tray has 16 sections filled with water. When placed in the ice box, the water freezes to form ice cubes. Each section contains a mass of 20 g of water that is initially completely liquid at a temperature of  $0^{\circ}\text{C}$ . The specific latent heat of fusion of ice is 330 J/g.
- (i) Calculate the amount of energy that must be taken from the tray of water to enable all the water in the tray to become ice at  $0^{\circ}\text{C}$ .
  - (ii) State why the heat capacity of the plastic tray does not affect the answer to (i).
  - (iii) The ice box takes energy from the water at a rate of 30 W. Estimate the time taken for all the water in the tray to become ice.

[6]

**DO NOT WRITE IN THIS SPACE**

10 Read the article below and answer the questions that follow.

### Undersea cable systems transport telephone conversations

Telephone conversations are carried across the oceans of the world as brief pulses of light in cables that contain hair-thin fibre optic strands. These strands are made from glass covered by a cladding that is protected by an outer casing, as shown in Fig. 10.1. If the speed of light in the cladding is greater than in the core, total internal reflection occurs and all the light is then confined to the core.

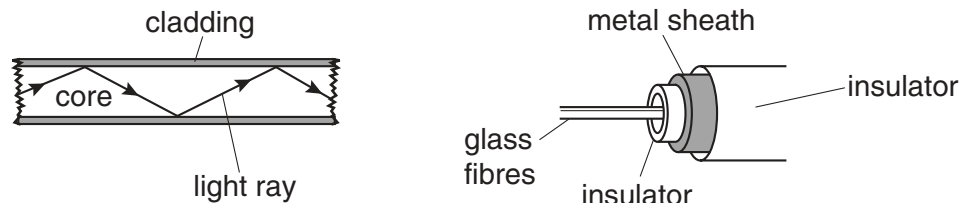


Fig. 10.1

The transmission of light is not 100% efficient as it passes down the fibre since light is absorbed by impurities in the glass. If light travels through 75 km of glass, then only 10% of the signal arrives at the other end. Over long distances, the light signal has to be boosted at underwater repeaters that are powered by an electric current sent along a metal sheath inside the cable. The repeaters are connected in series with the same current of 0.80 A through each and a potential difference of 40 V across each repeater. In a typical 7500 km undersea cable there are 100 repeaters. Each kilometre of the metal sheath has a resistance of  $0.70\ \Omega$  and some of the energy provided by the supply is lost as thermal energy (heat) in the sheath.

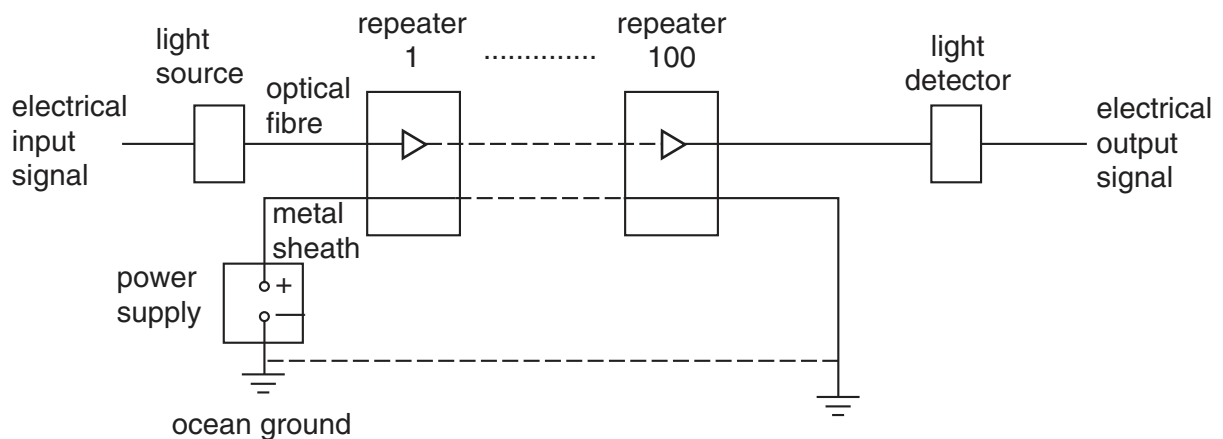


Fig. 10.2

- (a) (i) State why repeaters are necessary along an undersea cable.  
(ii) State **two** advantages of using optical fibre rather than copper wires for transmitting telephone conversations. [3]
- (b) (i) Describe briefly an experiment that shows total internal reflection.  
(ii) Explain how the difference in speed of light between the glass and the cladding causes total internal reflection to occur. You may use diagrams to help your explanation. [6]
- (c) Determine, for a 7500 km undersea cable,  
(i) the total potential difference across all the repeaters,  
(ii) the total potential difference across the resistance of the metal sheath,  
(iii) the potential difference provided by the power supply,  
(iv) the thermal energy (heat) lost per second from each kilometre of the metal sheath. [6]

**DO NOT WRITE IN THIS SPACE**

11 This question is about the measurement and dangers of radioactivity.

- (a) A student measures the radioactive emissions from a source with the apparatus shown in Fig. 11.1. The counter records the number of particles entering the detector in any specified time interval.

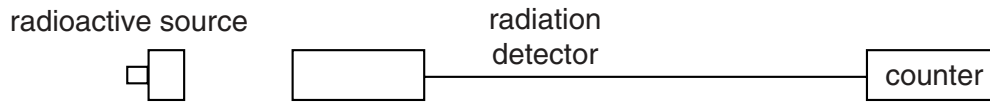


Fig. 11.1

The student has a source emitting alpha particles. The source is known to have a half-life of about one hour. Suggest how the student can measure this half-life.

You should

- (i) suggest how background radiation is taken into account,
- (ii) suggest what readings should be taken,
- (iii) suggest how long the experiment should last,
- (iv) explain how the half-life is found from the readings.

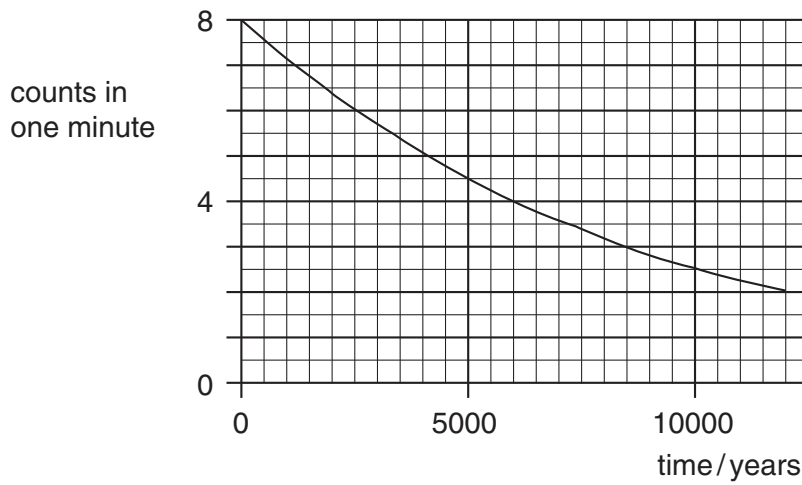
[6]

- (b) (i) State **two** precautions the student should take when handling or storing radioactive sources.
- (ii) The effects of radiation on the human body depend on the properties of the radiation. Explain why a source emitting alpha particles **inside** the body is **more** dangerous than a source of the same activity emitting gamma rays inside the body.

[5]



- (c) Carbon-14 is used to find the age of objects. A 10 g sample of carbon is taken from a young plant. Fig. 11.2 shows how the number of counts in one minute from the sample decreases with time.



**Fig. 11.2**

The number of counts **per hour** from an identical sample of carbon taken from an old piece of wood is 380.

- (i) Use Fig. 11.2 to determine the age of this piece of wood. Explain how you obtained your answer.
- (ii) Explain why it is important to take background radiation into account in this measurement.

[4]



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