Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

7579848741

PHYSICS **5054/21**

Paper 2 Theory **October/November 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.

© UCLES 2021
[Turn over

Section A

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

1 Fig. 1.1 shows a wooden bench of weight 2000 N.

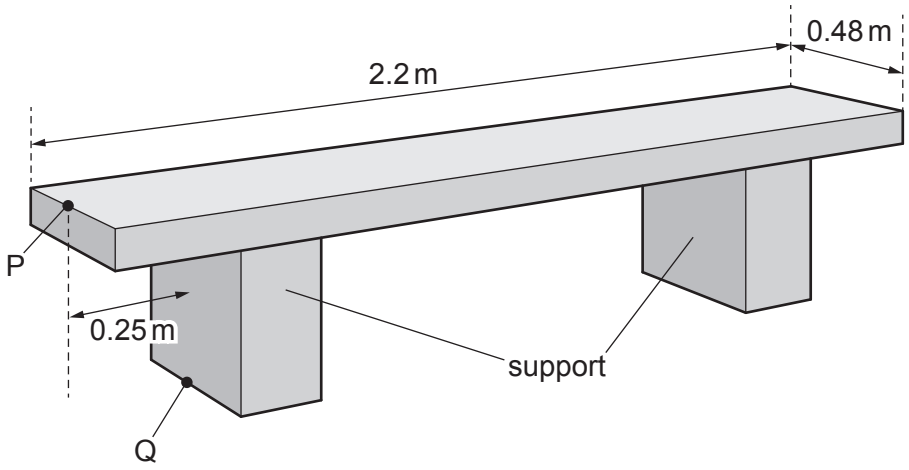


Fig. 1.1

(a) Each of the two supports has an area of 0.040 m^2 in contact with the ground.

Calculate the pressure on the ground due to the bench.

pressure = ... [2]

(b) The centre of mass of the bench is 1.1 m from the left-hand end of the bench and 0.24 m from the front.

(i) Suggest **one** reason why the centre of mass is in this position.

.....

.....

..... [2]

(ii) There is a force exerted vertically downwards from the point P shown in Fig. 1.1.

Calculate the maximum force that can be exerted vertically downwards at P without the bench rotating about the point Q shown in Fig. 1.1.

maximum force = ... [3]

[Total: 7]

2 Fig. 2.1 shows a man of mass 80 kg standing in a lift (elevator).

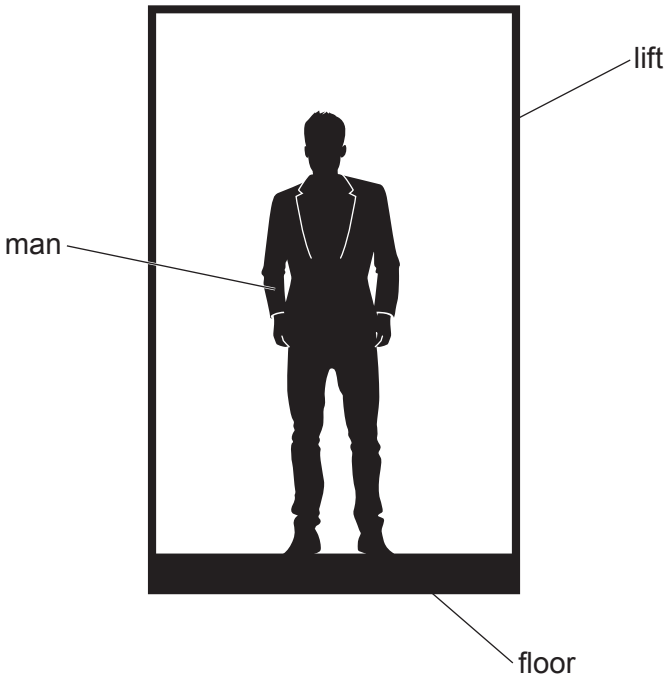


Fig. 2.1

The gravitational field strength g is 10 N / kg.

(a) Calculate the weight of the man.

weight = ... [1]

(b) The lift accelerates upwards uniformly at 0.50 m / s^2.

Calculate:

(i) the resultant upward force on the man

resultant force = ... [2]

(ii) the force exerted on the man by the floor of the lift.

force = ... [1]

(c) The lift accelerates upwards uniformly from rest for 4.0 s and then decelerates uniformly to rest in 4.0 s. The total distance travelled is 8.0 m.

On Fig. 2.2, sketch the distance-time graph for this journey.

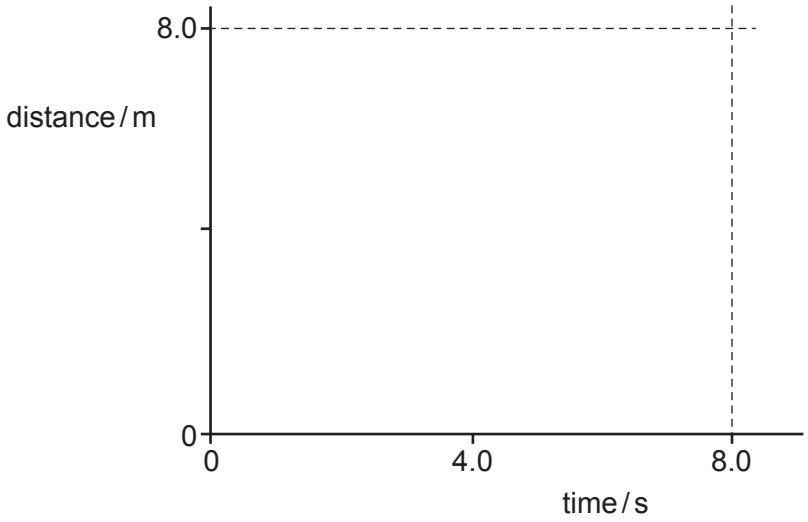


Fig. 2.2

[3]

[Total: 7]

3 A type of nuclear reaction takes place at the centre of the Sun. The reaction releases thermal energy.

(a) State the name of the type of nuclear reaction that takes place at the centre of the Sun.

..... [1]

(b) Thermal energy is emitted from the surface of the Sun into space. The energy is transferred through the vacuum of space by thermal radiation.

(i) Describe the radiation that is emitted from the surface of the Sun.

.....

.....

..... [2]

(ii) State the speed of this radiation in a vacuum.

speed = ... [1]

(iii) The Earth is 1.5×10^{11} m from the surface of the Sun.

Calculate the time taken for this radiation to travel to Earth.

time = ... [2]

(c) Explain one advantage of wearing white clothes on sunny days.

.....

.....

..... [2]

[Total: 8]

© UCLES 2021

4 In a coal-fired power station, coal is burnt and electrical energy is produced.

(a) State the form of energy in the coal that is transferred to electrical energy.

..... [1]

(b) **(i)** State the principle of the conservation of energy.

.....

.....

.....

..... [2]

(ii) The quantity of electrical energy produced by the power station is much less than the quantity of energy in the coal that is burnt to generate the electricity.

Explain why this is so.

.....

.....

.....

..... [2]

(c) State **one** environmental consequence of generating electricity in coal-fired power stations.

.....

..... [1]

[Total: 6]

5 A plastic rod that is initially neutral is rubbed with a woollen cloth. After the rod has been rubbed, it is positively charged.

(a) **(i)** Explain, in terms of particles, why the rod is now positively charged.

.....

..... [1]

(ii) State what happens to the woollen cloth.

..... [1]

(b) An uncharged, conducting sphere is suspended from an insulating thread. The positively charged rod is placed near to the sphere, as shown in Fig. 5.1.

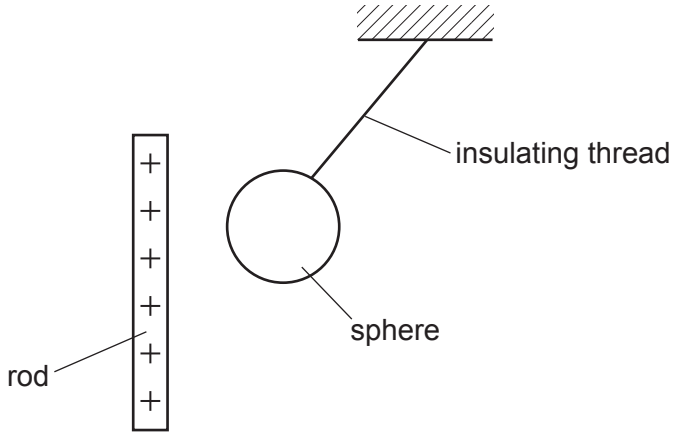


Fig. 5.1

(i) On Fig. 5.1, draw the distribution of charge on the sphere. [2]

(ii) Explain why the sphere is pulled towards the rod.

.....

.....

.....

..... [2]

[Total: 6]

6 A circuit contains a battery of electromotive force (e.m.f.) 4.5 V, a 28 Ω resistor and a variable resistor. Fig. 6.1 is the circuit diagram.

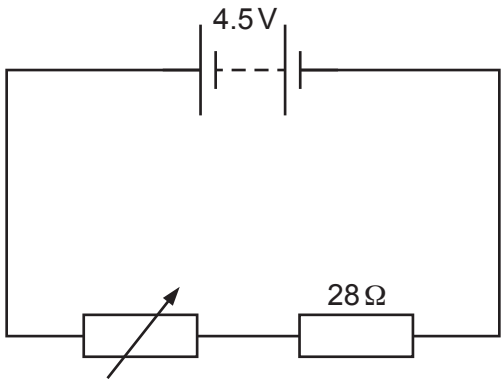


Fig. 6.1

(a) The battery consists of three identical cells in series.

Determine the e.m.f. of each cell.

e.m.f. of each cell = ... [1]

(b) The potential difference (p.d.) across the variable resistor is 2.5 V.

(i) State what is meant by *potential difference*.

.....

.....

.....

..... [2]

(ii) Calculate the resistance of the variable resistor.

resistance = ... [3]

[Total: 6]

7 EITHER

Fig. 7.1 shows a solenoid connected to an ammeter.

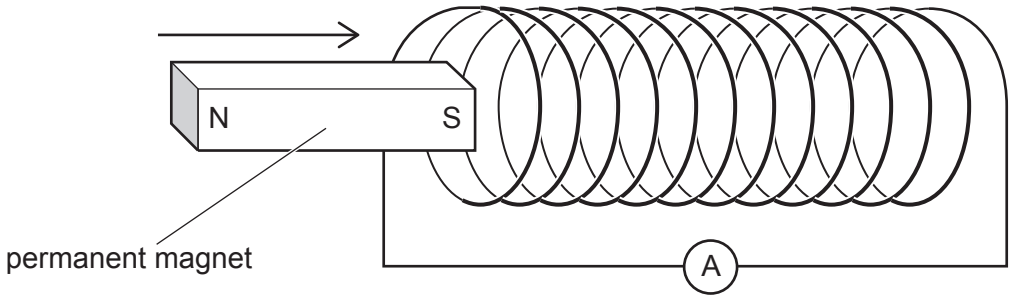


Fig. 7.1

The S-pole of a permanent magnet moves into the left-hand end of the solenoid.

The ammeter reading shows that there is a small positive current in the circuit.

(a) Explain why there is a current in the circuit when the magnet moves.

.....

.....

.....

..... [3]

(b) When the magnet is inside the solenoid, it stops moving. It is then pulled back out of the solenoid.

Explain what happens to the ammeter reading as the magnet moves out of the left-hand end of the solenoid.

.....

.....

..... [2]

[Total: 5]

OR

Fig. 7.2 shows the symbol for a logic gate and its truth table.



input		output
0	0	1
0	1	0
1	0	0
1	1	0

Fig. 7.2

(a) State the name of the logic gate shown in Fig. 7.2.

..... [1]

(b) Fig. 7.3 shows two of these logic gates connected to make a bistable circuit.

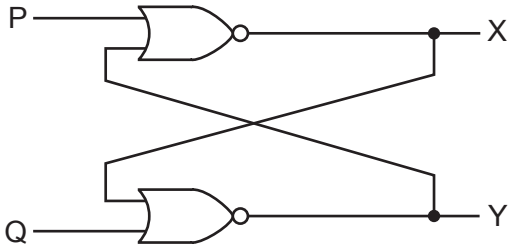


Fig. 7.3

Terminals P and Q each have the logic level 0.

Terminal X has the logic level 1.

(i) Explain why terminal Y has the logic level 0.

.....

..... [1]

(ii) Terminal P is briefly connected to a supply of logic level 1.

State the effect of this on the logic level of terminal X and the logic level of terminal Y.

.....

..... [1]

(iii) Terminal P returns to logic level 0 again.

State the effect of this return to value 0 on the logic level of terminal X and on the logic level of terminal Y.

.....

..... [1]

(iv) State how this circuit exhibits the property of memory.

.....

..... [1]

[Total: 5]

Section B

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

8 A loudspeaker is made from a coil of wire fixed to a cardboard tube. The tube is attached to a cardboard cone.

Fig. 8.1 shows part of the arrangement of the loudspeaker.

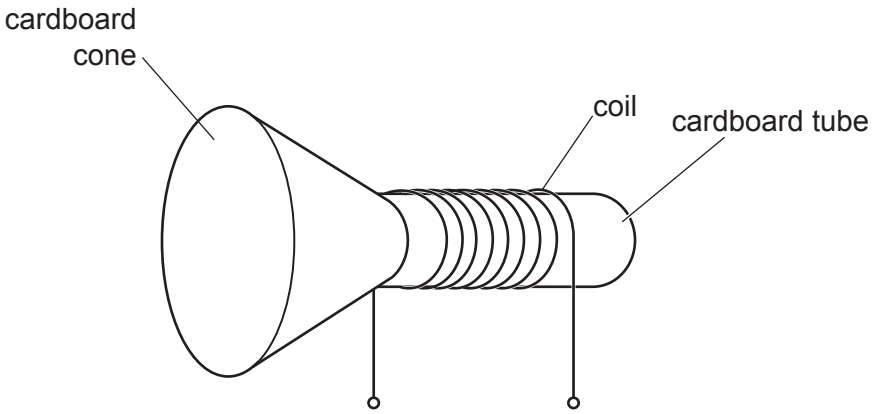


Fig. 8.1

When there is a current in the coil, the coil experiences a force.

(a) State what else is needed in a loudspeaker to make a current-carrying wire experience a force.

..... [1]

(b) A student connects the coil to the output of an alternating current (a.c.) generator. Fig. 8.2 shows how the electromotive force (e.m.f.) produced by the generator varies with time.

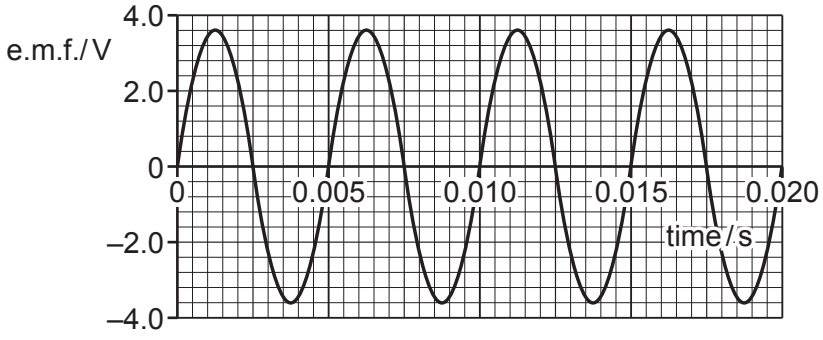


Fig. 8.2

The coil, tube and cone vibrate backwards and forwards.

(i) Explain why the e.m.f. shown in Fig. 8.2 makes the coil vibrate.

.....

.....

..... [2]

© UCLES 2021

(ii) The vibrating cone produces sound in the surrounding air.

Explain, in terms of molecules, how the cone produces a sound wave that travels through the air.

.....

.....

.....

.....

..... [3]

(iii) Sound is a longitudinal wave.

Describe the difference between a longitudinal wave and a transverse wave.

.....

.....

.....

..... [2]

(iv) Using Fig. 8.2, determine the number of times that the cone reverses its direction of motion in 1.0 s.

number = ... [2]

(v) The speed of sound in air is 340 m / s.

Calculate the wavelength of the sound.

wavelength = ... [2]

(c) The student adjusts the generator so that the maximum voltage of the output is now 3.0 V. Everything else stays the same as the output shown on the graph in Fig. 8.2.

(i) Explain any effect on the loudness of the sound.

.....

..... [2]

(ii) Explain any effect on the pitch of the sound.

.....

..... [1]

[Total: 15]

Question 9 starts over the page

9 Liquid-in-glass thermometers use the expansion of a liquid to indicate the temperature.

(a) Fig. 9.1 shows the molecular structure of a solid and a gas.

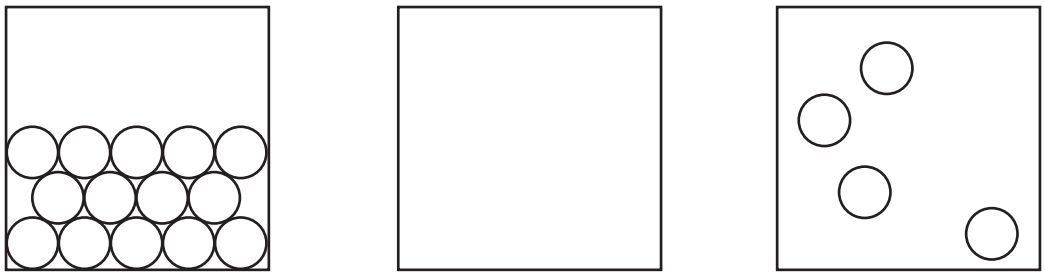


Fig. 9.1

(i) In the middle box of Fig. 9.1, sketch a diagram to show the molecular structure of a liquid. [2]

(ii) Explain why it is easier to compress a gas than to compress a solid.

.....

.....

..... [2]

(iii) The temperature of a liquid-in-glass thermometer increases.

State **two** ways in which the molecules of the liquid in the thermometer are affected.

1. .....

2. .....
[2]

© UCLES 2021

(b) Fig. 9.2 shows the liquid-in-glass thermometer.

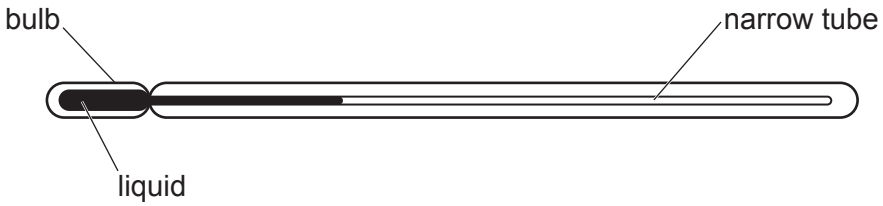


Fig. 9.2

There is no scale on the thermometer.

(i) State what is meant by the *ice point* and the *steam point*.

ice point .....

.....

steam point .....

..... [2]

(ii) Describe how the *ice point* and the *steam point* are used on the thermometer.

.....

.....

.....

..... [2]

(c) Explain how the range of a liquid-in-glass thermometer is affected by:

(i) increasing the mass of liquid in the bulb

.....

.....

..... [2]

(ii) increasing the diameter of the narrow tube.

.....

.....

.....

..... [3]

[Total: 15]

10 The isotope yttrium-90 ($^{90}_{39}Y$) is radioactive. It is a beta-particle emitter that decays to product Q. Product Q is stable.

(a) State one feature that is common to all isotopes of yttrium.

..... [1]

(b) Describe how a **neutral atom** of Q differs from a **neutral atom** of yttrium-90.

.....

.....

.....

..... [3]

(c) A sample of yttrium-90 is placed close to a radiation detector in a laboratory. There are no other radioactive samples in the laboratory. A counter records the count rate.

Fig. 10.1 is a graph of the count rate plotted against time.

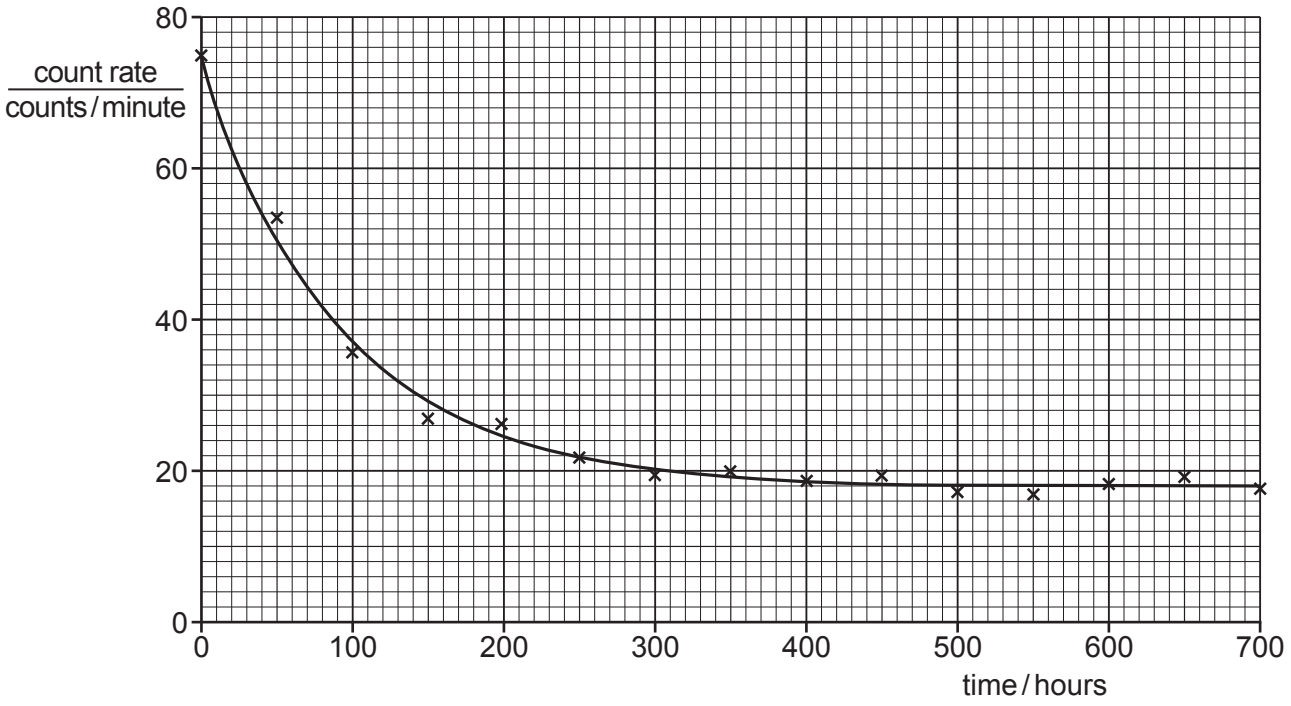


Fig. 10.1

(i) Using Fig. 10.1, determine the average background count rate.

average background count rate = ... [1]

© UCLES 2021

(ii) Suggest **two** different origins for the background count.

1. .....

2. .....
[2]

(iii) Using Fig. 10.1, determine the half-life of yttrium-90. Show how the answer is obtained.

half-life = ... [4]

(iv) Many of the points plotted in Fig. 10.1 do not lie on the best-fit line.

Explain why.

.....

.....

..... [2]

(d) A beam of beta-particles, travelling in a vacuum, enters the region between two parallel, metal plates. One plate is negatively charged and the other is positively charged.

Fig. 10.2 shows the arrangement.

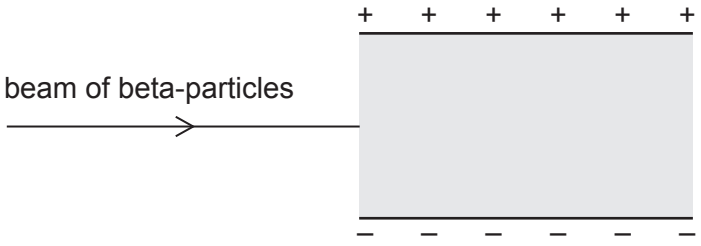


Fig. 10.2

On Fig. 10.2, draw the path taken by the beta-particles as they travel between the two plates.
[2]

[Total: 15]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.

© UCLES 2021