Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

4097263582

PHYSICS **5054/21**

Paper 2 Theory **October/November 2020**

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. Blank pages are indicated.

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Section A

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

1 Fig. 1.1 is the distance–time graph for a skydiver who jumps from a balloon at time $t = 0$.

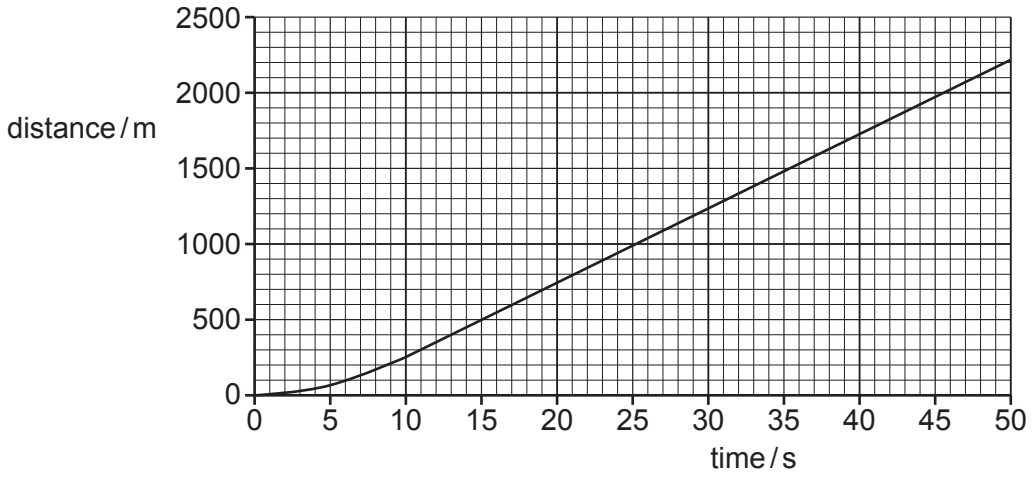


Fig. 1.1

(a) The first part of the graph shows the motion of the skydiver from when he jumps until he reaches terminal velocity.

(i) Describe the motion of the skydiver between $t = 0$ and $t = 20$ s.

.....

.....

..... [2]

(ii) Explain the motion of the skydiver between $t = 0$ and $t = 20$ s in terms of the forces acting on him.

.....

.....

.....

..... [3]

(b) Using Fig. 1.1, determine the terminal velocity of the skydiver.

On Fig. 1.1, indicate any values used for your calculation.

terminal velocity = ... [3]

[Total: 8]

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2 Fig. 2.1 shows a satellite moving at a constant speed in a circular orbit around the Earth.

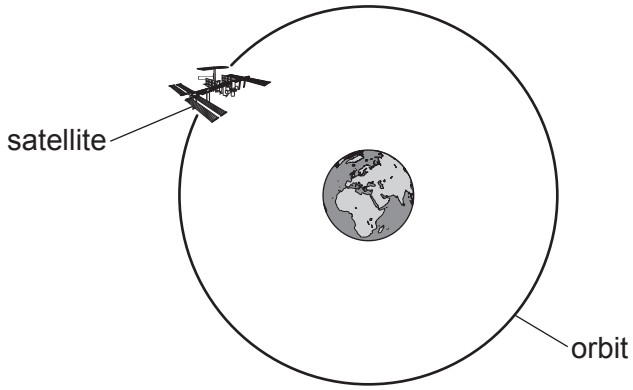


Fig. 2.1 (not to scale)

Speed is a scalar quantity but velocity is a vector quantity.

(a) State how a scalar quantity differs from a vector quantity.

.....

..... [1]

(b) Underline every vector quantity in the list.

distance **displacement** **force** **length** **mass** **time**

[1]

(c) There is a resultant force acting on the satellite in Fig. 2.1.

(i) Explain how the motion of the satellite shows that a resultant force is acting on it.

.....

.....

..... [2]

(ii) State the cause of this force.

.....

..... [1]

[Total: 5]

3 Fig. 3.1 shows a door and an automatic door-closer viewed from above.

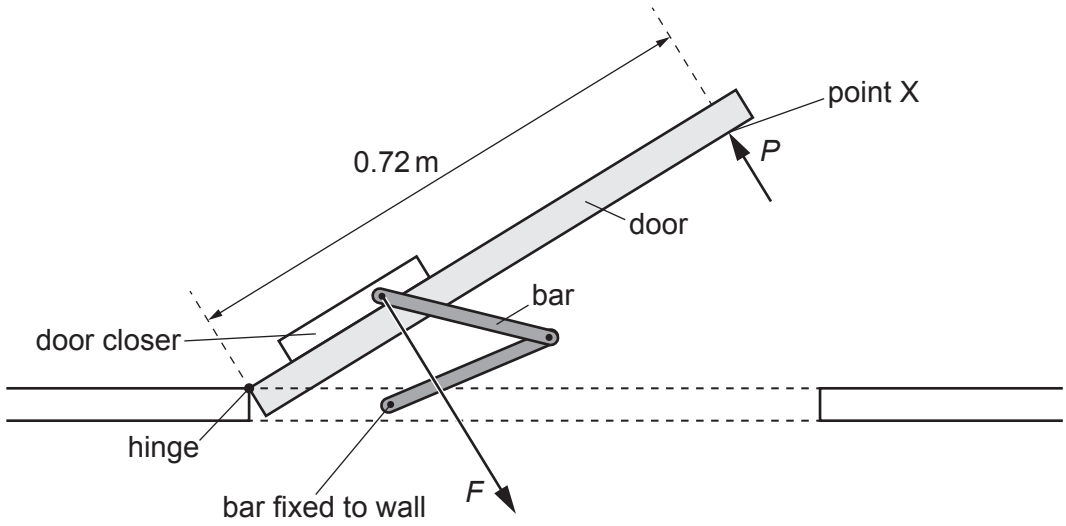


Fig. 3.1

When the door opens and closes, the hinge acts as a pivot.

A girl opens the door by exerting a force *P* at point X.

Force *P* is perpendicular to the surface of the door.

(a) Fig. 3.1 shows that point X is a distance of 0.72 m along the front of the door from the hinge. The force *P* is 25 N.

(i) Calculate the moment of force *P* about the hinge.

moment of force = ... [2]

(ii) The door rotates about the hinge by 90°. The circumference of a circle of radius 0.72 m is 4.5 m.

Calculate the work done on the door by force *P*.

work done = ... [2]

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(b) As the door opens, there is a force *F* on the door in the direction shown in Fig. 3.1.

Although force *F* is larger than force *P*, the door rotates about the hinge.

Explain why.

.....

.....

.....

..... [2]

[Total: 6]

4 The three angles of a glass prism are 45°, 45° and 90° as shown in Fig. 4.1.

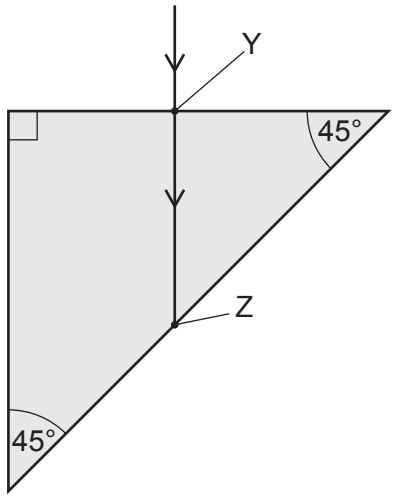


Fig. 4.1

At point Y, a ray of light of a single frequency travels in air and strikes the side of the prism at 90°. The ray passes into the glass prism.

(a) Light travels more slowly in glass than in air.

(i) State what happens to the wavelength of the light in the ray as it enters the glass.

..... [1]

(ii) State what happens to the frequency of the light in the ray as it enters the glass.

..... [1]

(b) The refractive index of glass is 1.6.

(i) Calculate the critical angle for light in glass.

critical angle = ... [2]

(ii) On Fig. 4.1, sketch the path of the light after it strikes the side of the prism at Z and after it returns to the air. [2]

[Total: 6]

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5 Fig. 5.1 shows some parts of a thermocouple thermometer that is being used to determine the temperature of a liquid.

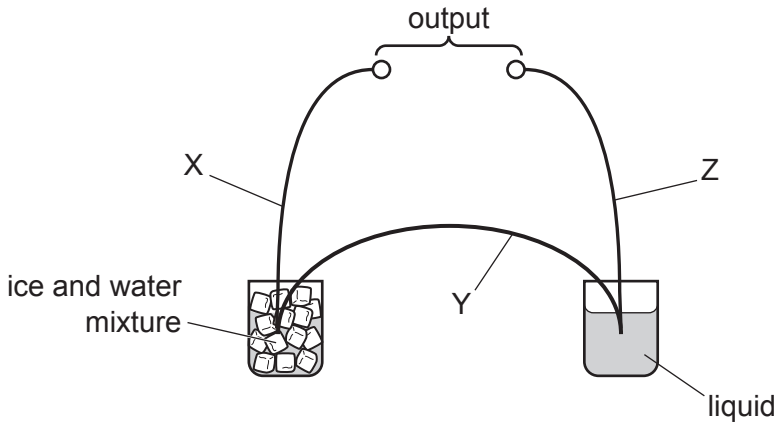


Fig. 5.1

(a) Suggest an appropriate material for:

- X .....
- Y .....
- Z. .....

[1]

(b) All types of thermometer require the measurement of a physical property that varies with temperature in order to obtain a value for the temperature.

(i) State the physical property of a thermocouple thermometer that is used in this way.

..... [1]

(ii) Discuss what is meant by the term *linearity* when applied to a thermocouple thermometer.

.....

.....

..... [2]

(c) State **two** advantages of a thermocouple thermometer over a liquid-in-glass thermometer.

1. .....

.....

2. .....

.....

[2]

[Total: 6]

6 When electricity is transmitted over large distances, a transformer is used to increase the voltage before transmission. A second transformer is used at the destination to decrease the voltage to the usual mains value.

(a) Sketch a labelled diagram to show the structure of a transformer that is used to **increase** voltage.

[2]

(b) Describe the principle of operation of a transformer.

.....

.....

.....

.....

..... [3]

(c) Explain **one** advantage of transmitting electricity at a high voltage.

.....

.....

..... [2]

[Total: 7]

7 Nuclear fusion is a reaction that occurs in the Sun and other stars.

(a) Explain what is meant by *nuclear fusion*.

.....

.....

..... [2]

(b) Describe the nuclear fusion reaction that takes place in the Sun.

.....

.....

..... [1]

(c) A star forms when the temperature of a large cloud of gas in space increases as the cloud collapses inwards.

(i) State the energy transfers that occur as the cloud collapses.

.....

.....

..... [2]

(ii) The temperature increase starts a nuclear fusion reaction.

Explain why the temperature of the star eventually reaches a steady value.

.....

.....

..... [2]

[Total: 7]

Section B

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

8 The density of water in a lake is 1000 kg / m^3.

At a depth of 25 m beneath the surface of the lake, the total pressure is 3.5×10^5 Pa.

(a) State what is meant by *pressure*.

.....

..... [1]

(b) The gravitational field strength is 10 N / kg.

Determine:

(i) the pressure due to 25 m of water

pressure = ... [2]

(ii) the atmospheric pressure.

atmospheric pressure = ... [1]

(c) An underwater depth gauge contains a small cylinder as shown in Fig. 8.1. Gas is trapped inside the cylinder by a piston. The piston is free to move.

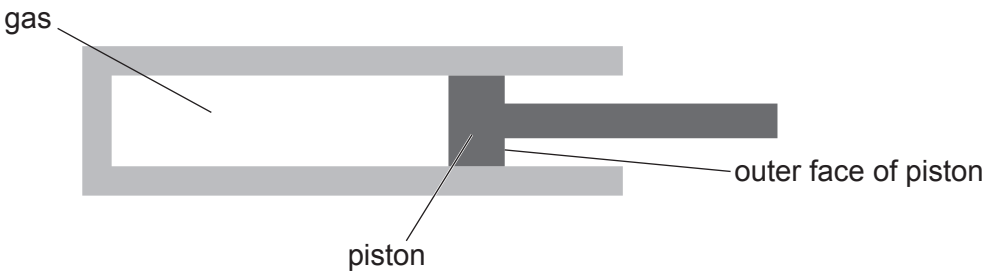


Fig. 8.1

The outer face of the piston is in contact with the water.

As the depth gauge is lowered into the water, the piston moves into the cylinder. This moves a needle on a dial to indicate the depth of the gauge in the water.

(i) Explain why the piston moves into the cylinder.

.....

.....

.....

.....

..... [3]

(ii) The temperature of the gas does not change as the piston moves into the cylinder.

Explain, in terms of molecules, what happens to the pressure of the trapped gas as the piston moves into the cylinder.

.....

.....

.....

..... [3]

(iii) At the surface of the water, the volume of the trapped gas in the depth gauge is V_0.

On Fig. 8.2, sketch a graph to show how the volume of trapped gas decreases as the gauge is lowered into the water.

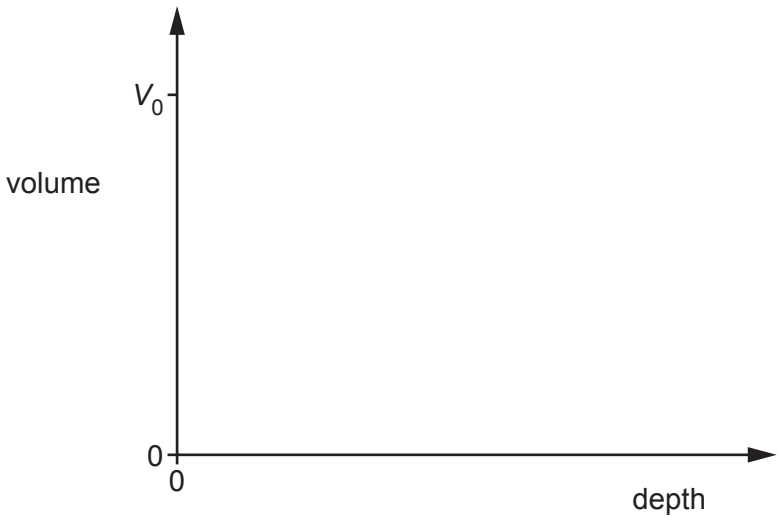


Fig. 8.2

[2]

(iv) The instructions for the depth gauge state that, each time it is used, the needle of the dial must be re-set to zero at the surface of the water.

Suggest **one** reason for this.

.....

..... [1]

(v) The density of the air trapped in the depth gauge increases. The density of the water remains constant.

Explain, in terms of the molecules of the water, why the density of the water remains constant.

.....

.....

..... [2]

[Total: 15]

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Question 9 starts over the page

9 A small glass measuring cylinder of oil is placed inside a freezer where the temperature is –18 °C. Fig. 9.1 shows how the temperature of the oil varies with time *t*.

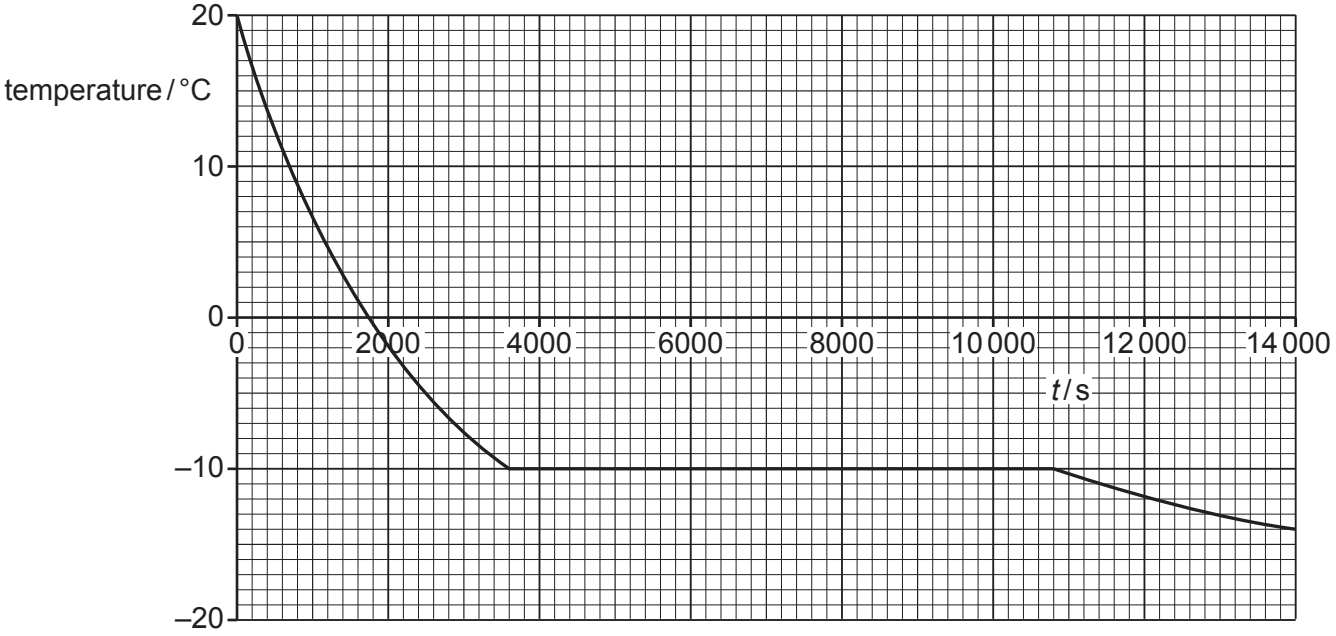


Fig. 9.1

Fig. 9.1 shows that it takes 700 s for the temperature to decrease from 20 °C to 10 °C but that it takes 1900 s to decrease from 0 °C to –10 °C.

(a) Suggest why these times are different.

.....

.....

.....

..... [3]

(b) Explain what happens to the molecules of the oil and what happens to the level of the oil in the glass measuring cylinder as the temperature decreases from 20 °C to 0 °C.

.....

.....

.....

..... [3]

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(c) **(i)** Determine the melting point of the oil.

..... [1]

(ii) Explain, in terms of molecules, why the temperature of the oil does not change between $t = 3600\,s$ and $t = 10\,800\,s$.

.....

.....

.....

..... [3]

(d) There is 45 g of oil in the glass measuring cylinder and the specific latent heat of fusion (melting) of the oil is $5.7 \times 10^4\,J/kg$.

Calculate:

(i) the energy transferred from the oil between $t = 3600\,s$ and $t = 10\,800\,s$

energy = ... [2]

(ii) the average rate at which energy is transferred from the oil between $t = 3600\,s$ and $t = 10\,800\,s$.

rate = ... [1]

(e) The graph in Fig. 9.1 is steeper before the horizontal section than it is after.

Use this observation to compare the specific heat capacity of oil in the liquid and solid states and explain your reasoning.

.....

.....

.....

..... [2]

[Total: 15]

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10 Fig. 10.1 shows a wire of length l and cross-sectional area A.

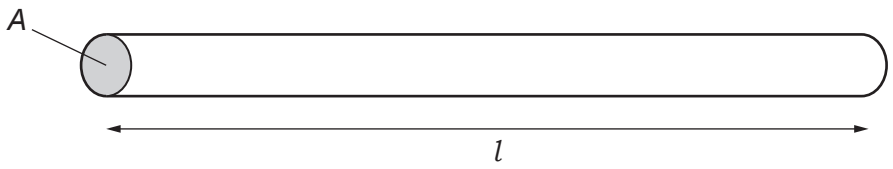


Fig. 10.1

(a) State how the resistance of the wire in Fig. 10.1 depends on:

(i) l

..... [1]

(ii) A.

..... [1]

(b) The cross-sectional area of a piece of metal wire is $7.5 \times 10^{-4}\,\text{cm}^2$. The resistance of a 1.0 m length of the same wire is 6.4 Ω.

The wire is made from metal W.

Fig. 10.2 shows a solid cube of side 1.0 cm. It is also made from metal W.

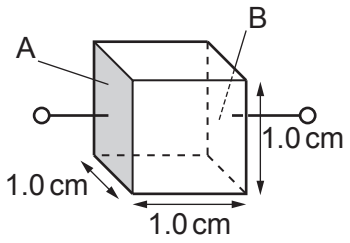


Fig. 10.2

Calculate the resistance between the two opposite faces A and B of the cube.

resistance = ... [2]

(c) The wire in part **(b)** is taped to a metre rule.

Fig. 10.3 shows that a 1.0 m length of the wire (resistance 6.4 Ω) is connected in series with a switch, a cell of electromotive force (e.m.f.) 1.2 V and a resistor of resistance 9.6 Ω.

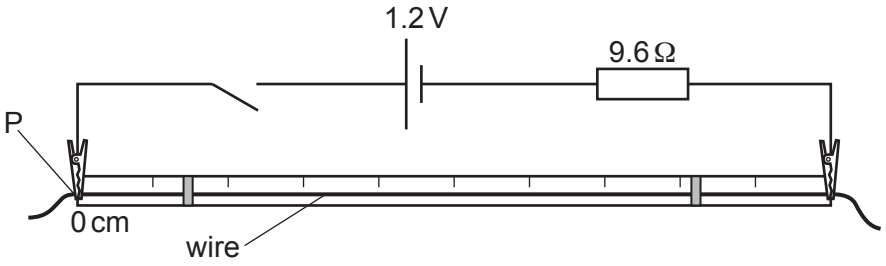


Fig. 10.3

The switch is closed.

(i) Explain what is meant by *electromotive force* (*e.m.f.*).

.....

.....

..... [2]

(ii) Calculate the potential difference (p.d.) across the 1.0 m length of the wire.

p.d. = ... [3]

(iii) One input terminal of an oscilloscope is connected to the wire at point P, the 0 cm mark of the metre rule.

The other terminal of the oscilloscope is connected to a sliding contact. Initially, this contact touches the wire at point P.

The Y-gain setting on the oscilloscope is 0.20 V / cm.

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Fig. 10.4 shows the screen of the oscilloscope with a horizontal trace across the middle of the screen.

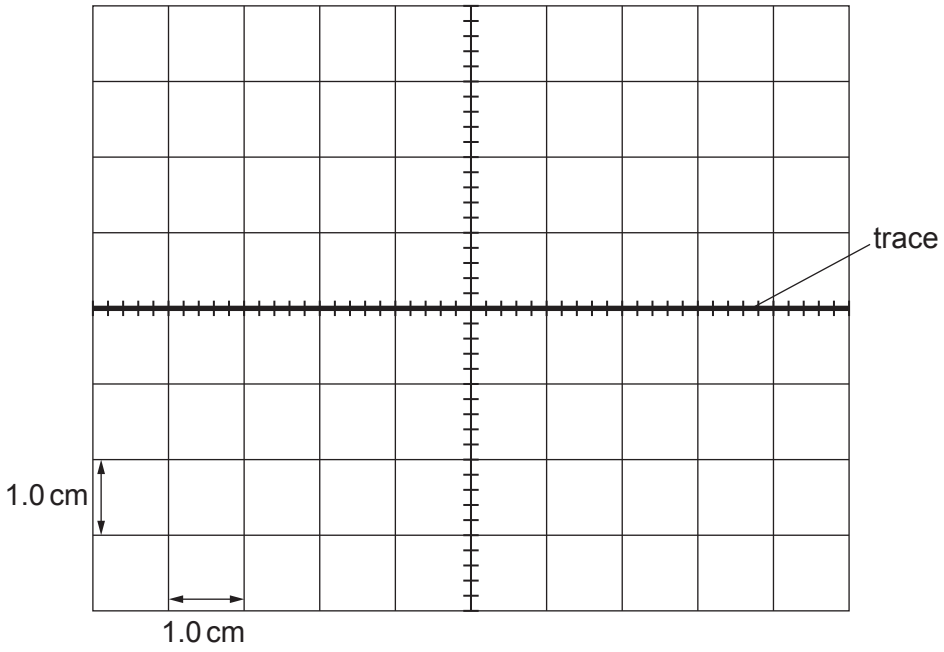


Fig. 10.4

The sliding contact is slowly moved along the wire until it reaches the other end of the metre rule.

Describe and explain what happens to the trace on the screen.

.....

.....

.....

..... [3]

(d) A second, identical 1.2 V cell is connected in parallel with the cell in the circuit in Fig. 10.3.

(i) State **one** advantage of using two cells in parallel rather than a single cell.

.....

..... [1]

(ii) State and explain the effect on the trace in **(c)(iii)** of adding the second cell in parallel.

.....

.....

..... [2]

[Total: 15]

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