Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

1756474749

PHYSICS **5054/22**

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.

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[Turn over

Section A

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

1 **(a)** **(i)** State the difference between a scalar quantity and a vector quantity.

.....

.....

..... [1]

(ii) State **two** examples of each type of quantity.

scalar quantity	**vector quantity**
1	1 .....
2	2 .....

[2]

(b) Fig. 1.1 shows the direction and size of two vectors P and Q.

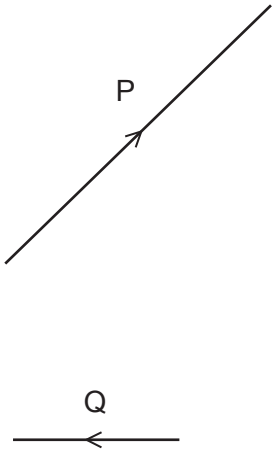


Fig. 1.1

In the space next to Fig. 1.1, draw a labelled vector diagram to show the resultant vector obtained by adding vector P to vector Q.

Draw vector P, vector Q and the resultant vector to the same scale as in Fig. 1.1.

[2]

[Total: 5]

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2 A car approaches a set of traffic lights. The lights change to red at time $t = 0$.

Fig. 2.1 shows how the speed of the car changes with time.

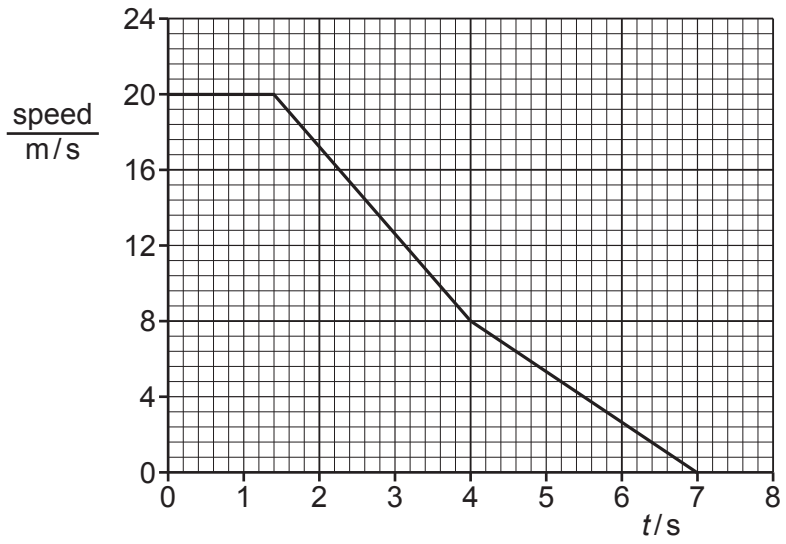


Fig. 2.1

(a) The car starts to slow down a short time after the lights change to red.

Determine the time between the lights changing to red and the car starting to slow down.

..... [1]

(b) (i) State what is meant by *uniform acceleration*.

.....

..... [1]

(ii) State how Fig. 2.1 shows that the deceleration of the car between $t = 2$ s and $t = 7$ s is *non-uniform*.

.....

..... [1]

(c) Determine the distance the car travels from the moment the car starts to slow down until it stops.

distance = ... [3]

[Total: 6]

3 Fig. 3.1 shows a small brick hanging from a newton meter.

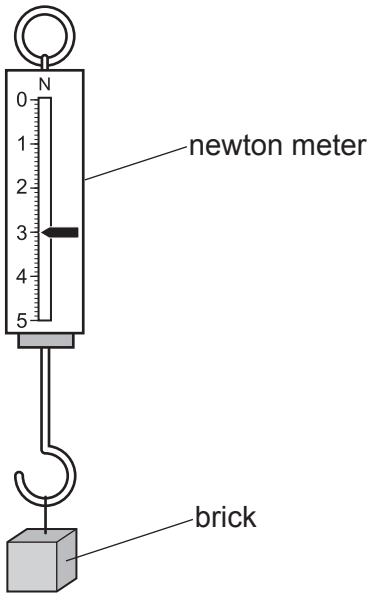


Fig. 3.1

The reading on the newton meter is 3.0 N.

(a) Describe how the reading on the newton meter is used to find the mass of the brick.

.....

..... [1]

(b) The same brick and newton meter are used in the apparatus shown in Fig. 3.2. The meter rule is pivoted at its centre and is balanced. The reading on the newton meter is not shown.

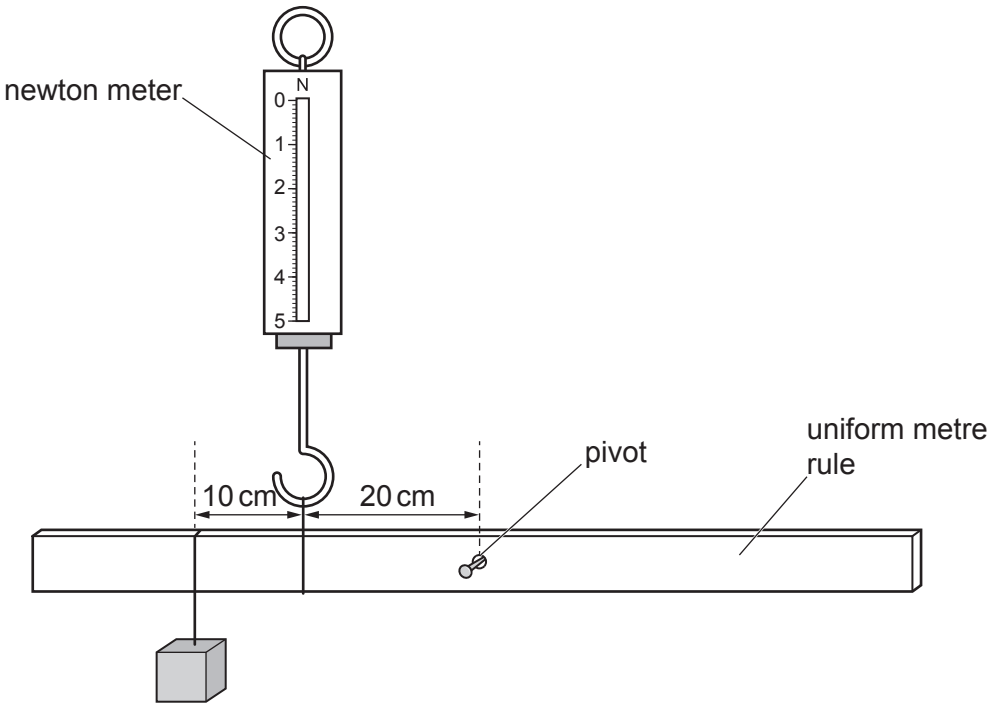


Fig. 3.2

(i) State the *principle of moments* for a body in equilibrium.

.....

.....

..... [1]

(ii) Determine the reading on the newton meter shown in Fig. 3.2.

reading = ... [2]

(c) A beaker of water is placed so that the brick is partly submerged in the water, as shown in Fig. 3.3. The apparatus is adjusted to keep the rule horizontal.

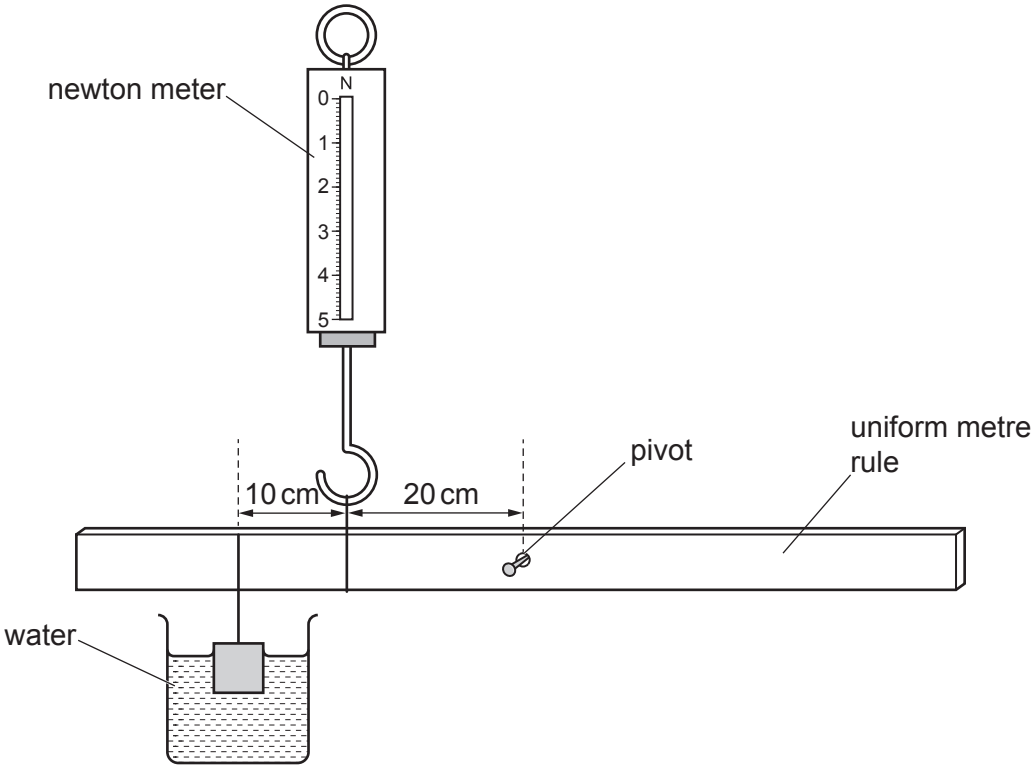


Fig. 3.3

Suggest why the reading on the newton meter is less than your answer in **(b)(ii)**.

.....

.....

..... [2]

[Total: 6]

4 **(a)** In a demonstration, a teacher uses a loud ticking clock, two hollow tubes A and B, a barrier and a smooth surface. The clock is used as a source of sound.

Fig. 4.1 shows tube A and the clock, both fixed in position on the left of the barrier.

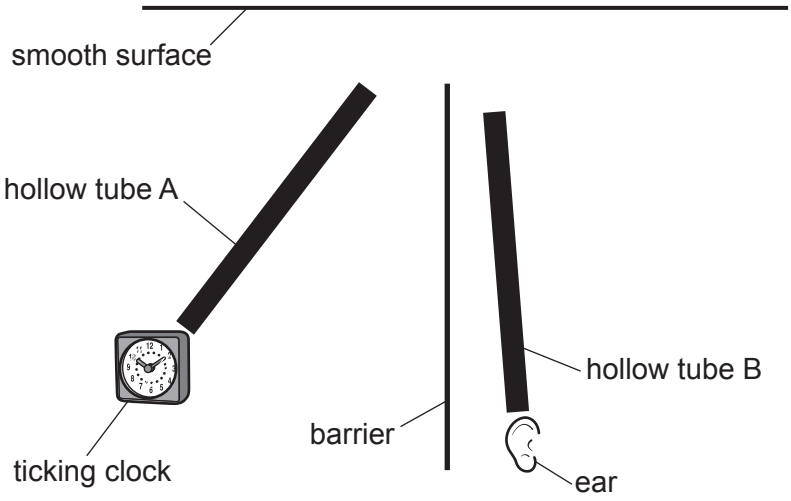


Fig. 4.1

Sound from the ticking clock passes along tube A and is incident on the smooth surface.

A student listens to the sound passing along tube B, which is on the right of the barrier.

(i) On Fig. 4.1, draw tube B in the position where the sound heard by the student is loudest. [1]

(ii) Explain your answer to **(i)**.

.....

.....

..... [2]

(b) The speed of sound in air is 330 m / s.

State a typical value for the speed of sound in a solid.

..... [1]

[Total: 4]

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Question 5 begins over the page

5 Fig. 5.1 shows a method of producing sandpaper using static electricity.

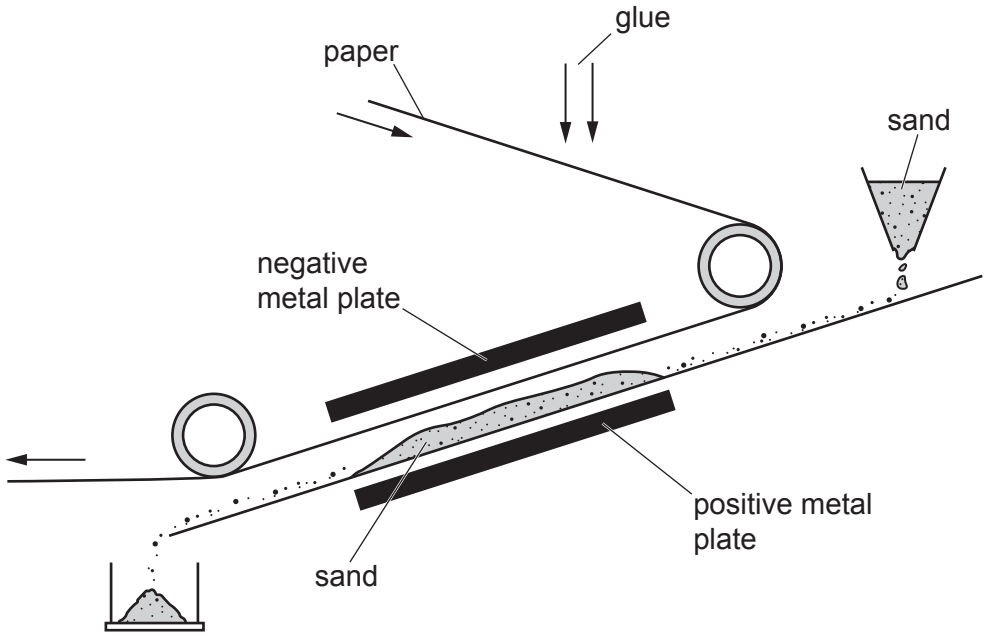


Fig. 5.1

Glue is sprayed on to moving paper. The sticky paper then passes between two metal plates.

One of the plates is positive and the other plate is negative.

There is an electric field between the plates.

(a) On Fig. 5.2, draw the electric field between the two metal plates. Show the direction of the electric field.

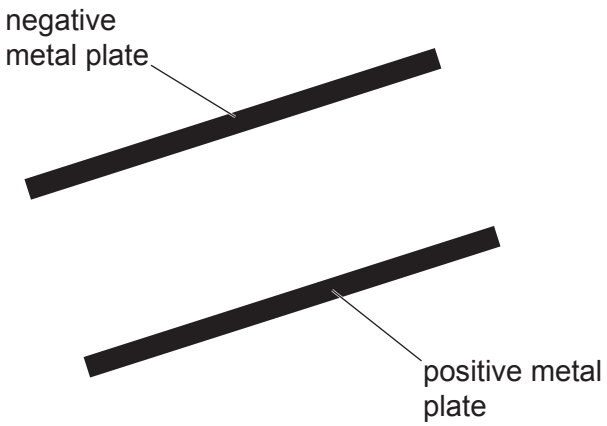


Fig. 5.2

[2]

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(b) Grains of sand are present just below the sticky paper.

Each grain of sand is a conductor of electricity.

Fig. 5.3 shows two layers of sand grains in the space between the two plates.

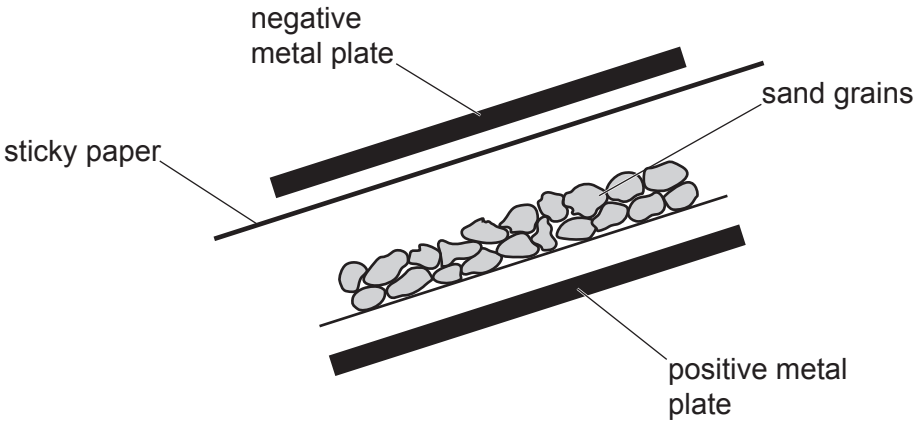


Fig. 5.3

(i) Explain, using ideas about the movement of charge, why the top layer of sand becomes positively charged.

.....

..... [1]

(ii) State why the top layer of sand moves towards the sticky paper.

.....

..... [1]

(c) A student receives an electric shock by walking across a certain type of carpet and then nearly touching a piece of earthed metal with his hand.

The potential difference between the hand and the metal is 2000 V and the charge transferred is 4.0×10^{-4} C.

Calculate the energy transferred when the spark jumps across the air gap from the metal onto his hand.

energy = ... [2]

[Total: 6]

6 The power input to a filament lamp when connected to a 12 V supply is 20 W.

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

.....

..... [1]

(b) Calculate:

(i) the current in the filament

current = ... [2]

(ii) the resistance of the filament.

resistance = ... [1]

(c) The filament in another lamp is made from thinner wire of the same length and made from the same material. Both lamps are connected to a 12 V supply.

State and explain how using thinner wire in the filament affects the power input to the lamp.

.....

.....

..... [2]

[Total: 6]

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7 Fig. 7.1 shows part of a simple d.c. electric motor.

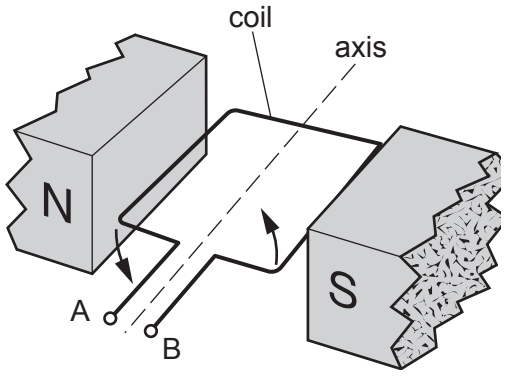


Fig. 7.1

The motor is connected to a battery with the positive terminal of the battery connected to terminal A.

(a) Explain why the coil turns in the direction shown.

.....

.....

.....

.....

..... [3]

(b) The turning effect is increased when the coil is wound around a soft-iron cylinder.

(i) Explain why this happens.

.....

.....

..... [2]

(ii) Suggest **one** other way to increase the turning effect of the motor.

..... [1]

[Total: 6]

8 Fig. 8.1 shows a potential divider circuit containing two resistors R_1 and R_2.

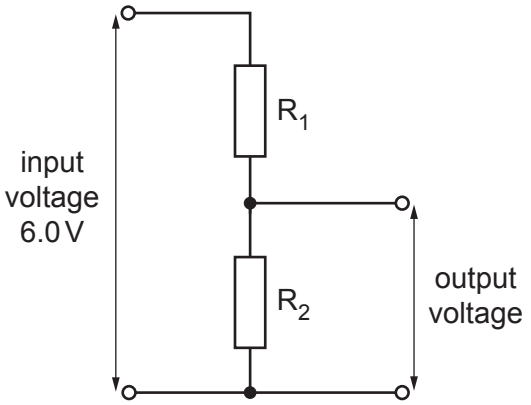


Fig. 8.1

(a) There is an input voltage of 6.0 V.

Complete Table 8.1 to show the output voltage for different values of the resistances of the two resistors.

Table 8.1

resistance of R_1 / Ω	resistance of R_2 / Ω	output voltage / V
8.0	8.0	.....
800	1200	.....

[3]

EITHER

(b) In the circuit shown in Fig. 8.1, resistor R_1 is replaced by a light dependent resistor (LDR).

(i) In the space below, draw the circuit symbol for an LDR.

[1]

(ii) The LDR is moved from darkness into daylight.

State what happens to the resistance of the LDR and the output voltage.

resistance .....

output voltage .....
[1]

(iii) A potential divider circuit can also be used to produce an output voltage that changes with temperature.

State the name of the component that is used instead of the LDR.

..... [1]

OR

(b) A simple bistable circuit contains NOR gates.

(i) In the space below, draw the circuit symbol of a NOR gate.

[1]

(ii) Describe what is meant by a *bistable circuit*.

.....

.....

.....

..... [2]

[Total: 6]

Section B

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

9 **(a)** Fig. 9.1 represents the conversion of energy in a mobile phone.

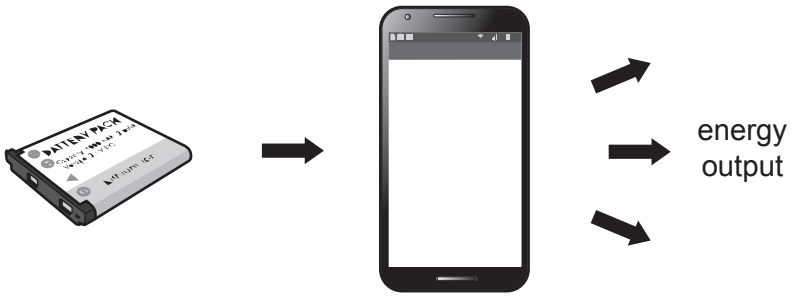


Fig. 9.1

(i) State the form of energy stored in the battery.

..... [1]

(ii) State the useful form of output energy from the battery.

..... [1]

(iii) State **two** useful forms of output energy from the mobile phone.

..... [2]

(b) When the battery is in use, the average current is 1.3 mA.

Determine the charge that passes through the battery in a time of 2.0 minutes.

charge = ... [2]

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(c) A student estimates the thermal energy produced in the battery when the mobile phone is used and uses this value to estimate the efficiency of the battery.

He measures a temperature rise of 5.0 °C within the battery in a period of time when the useful energy output from the battery is 5200 J.

The mass of the battery is 110 g and its specific heat capacity is 830 J / (kg °C).

(i) Calculate the thermal energy (heat) needed to raise the temperature of the battery by 5.0 °C.

thermal energy = ... [3]

(ii) State what is meant by *efficiency*.

.....

..... [2]

(iii) Calculate the efficiency of the battery.

efficiency = ... [2]

(iv) Suggest and explain **one** reason why the value for the efficiency calculated in **(iii)** is larger than the actual efficiency of the battery.

.....

.....

.....

..... [2]

[Total: 15]

10 **(a)** Fig. 10.1 shows a water wave moving from shallow into deep water. The wavefronts shown represent the crests of the wave.

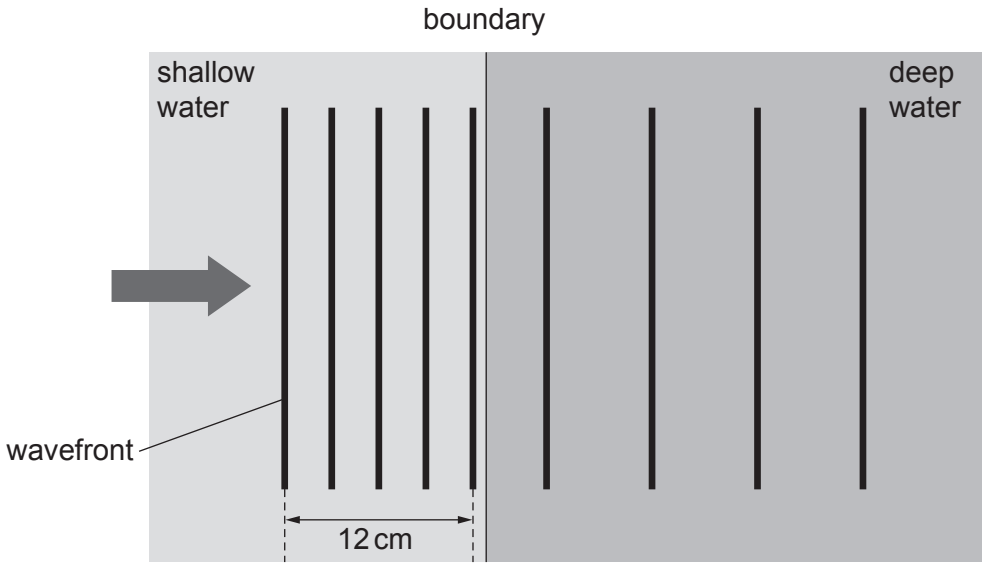


Fig. 10.1 (not to scale)

The water wave is made by dipping a wooden bar up and down in the water. The bar makes 10 complete up and down movements in 5.0 s.

(i) Determine the wavelength of the wave in the shallow water.

wavelength = ... [1]

(ii) Calculate the frequency of the wave produced.

frequency = ... [2]

(iii) Determine the speed of the water wave in the shallow water.

speed = ... [2]

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(iv) On Fig. 10.2, draw lines to show what happens to the wavelength, the frequency and the speed of the water wave as it enters the deep water.

One line has been drawn for you.

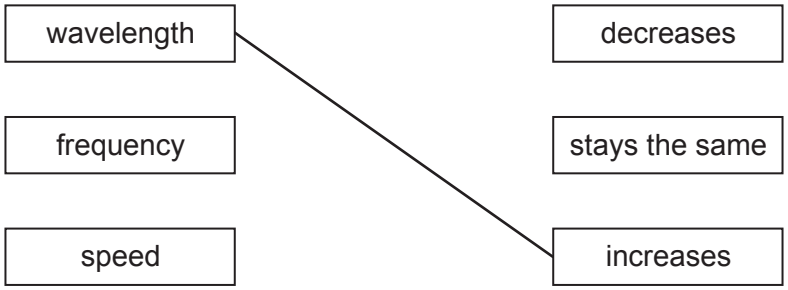


Fig. 10.2

[1]

(v) The direction of the boundary is now altered. The water wave now enters the deep water from the shallow water at an angle, as shown in Fig. 10.3.

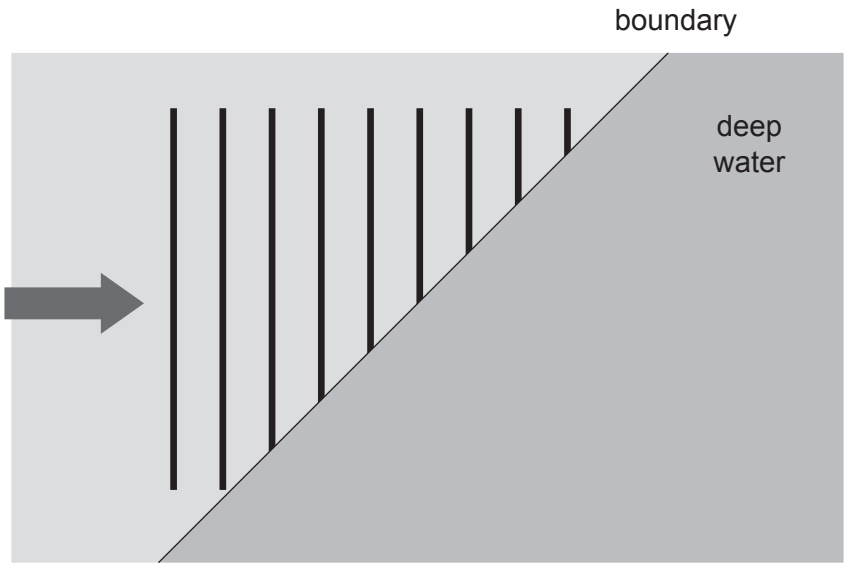


Fig. 10.3

On Fig. 10.3, draw the wavefronts in the deep water. [3]

(b) White light is made up of different colours.

(i) State the name of four of the colours in the visible spectrum and place them in order from the smallest wavelength to the largest wavelength.

smallest wavelength .....

.....

.....

largest wavelength .....

[2]

(ii) A narrow beam of white light can be split into different colours.

Fig. 10.4 shows rays of white light emitted from a lamp.

Complete Fig. 10.4 to show how a narrow beam is produced from these rays and how a spectrum is shown on the screen. Label your diagram.

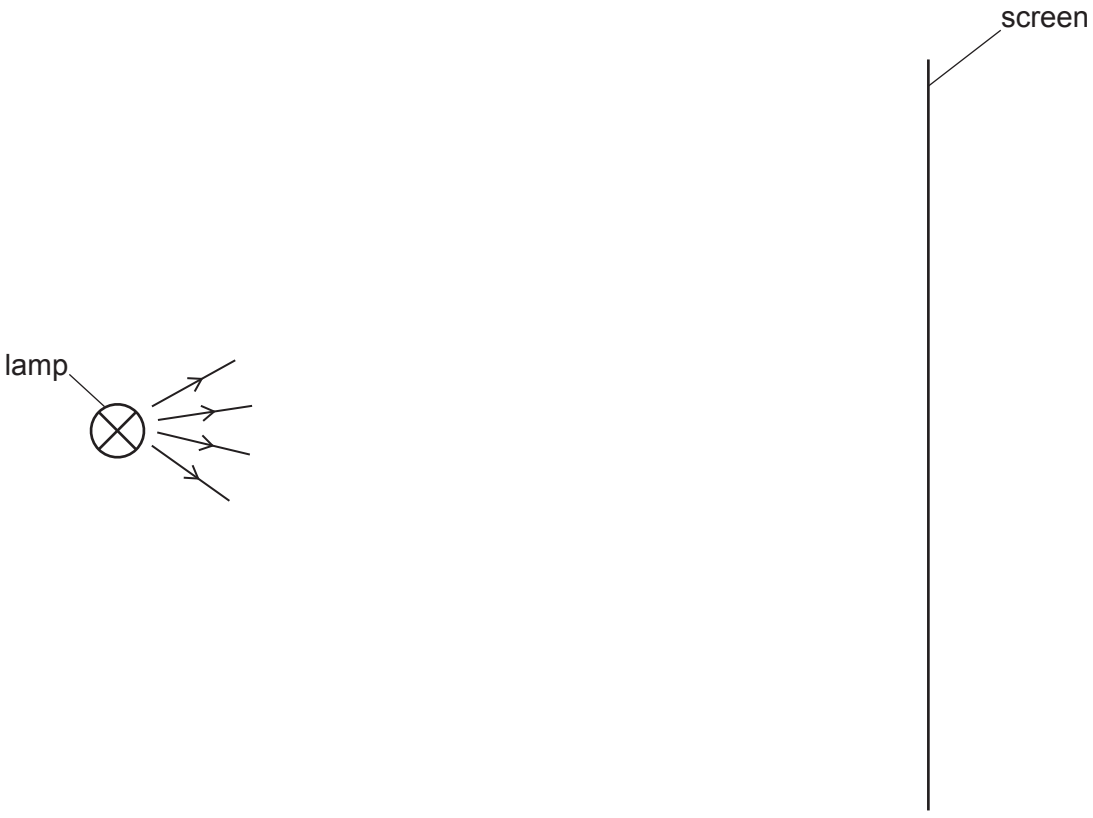


Fig. 10.4

[4]

[Total: 15]

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11 A highly radioactive source that emits beta-particles is placed a few centimetres away from a detector, as shown in Fig. 11.1.

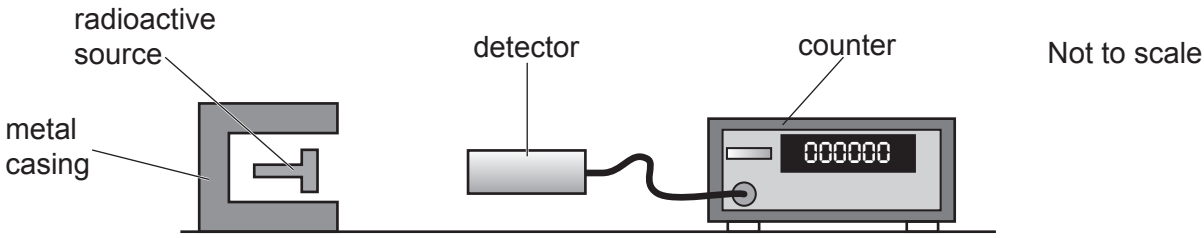


Fig. 11.1

(a) State the name of the particle which has the same mass and charge as a beta-particle.

..... [1]

(b) State and explain why the metal casing in Fig. 11.1 is used.

.....

..... [2]

(c) State and explain what happens to the number of particles detected in a minute as the radioactive source is moved:

(i) a few centimetres **further** away from the source

.....

.....

..... [2]

(ii) more than a metre away from the source.

.....

.....

..... [2]

(d) A nucleus of strontium-90 (Sr-90) decays by beta emission to a nucleus of yttrium (Y).

Complete the decay equation for this decay.

$$^{90}_{38}\text{Sr} \rightarrow \begin{matrix}\ldots\ldots\\ \ldots\ldots\end{matrix}\text{Y} + \begin{matrix}\ldots\ldots\\ -1\end{matrix}\beta$$

[3]

(e) Nuclear fusion and nuclear fission both release large amounts of energy.

(i) Describe how the process of nuclear fusion differs from the process of nuclear fission.

.....

.....

.....

.....

..... [3]

(ii) Describe the conditions needed for nuclear fusion to take place.

.....

.....

.....

..... [2]

[Total: 15]

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