Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

1298459531

PHYSICS **5054/21**

Paper 2 Theory **May/June 2014**

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

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 in the spaces provided on the Question Paper.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

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.

This document consists of **17** printed pages and **3** blank pages.

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Section A

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

1 A small boat travels with a velocity of 4.0 m/s due north in an area of still water.

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

.....

.....

..... [1]

(b) The boat travels from the area of still water into an area where the velocity of the water is 2.0 m/s towards the north-east, as shown in Fig. 1.1.

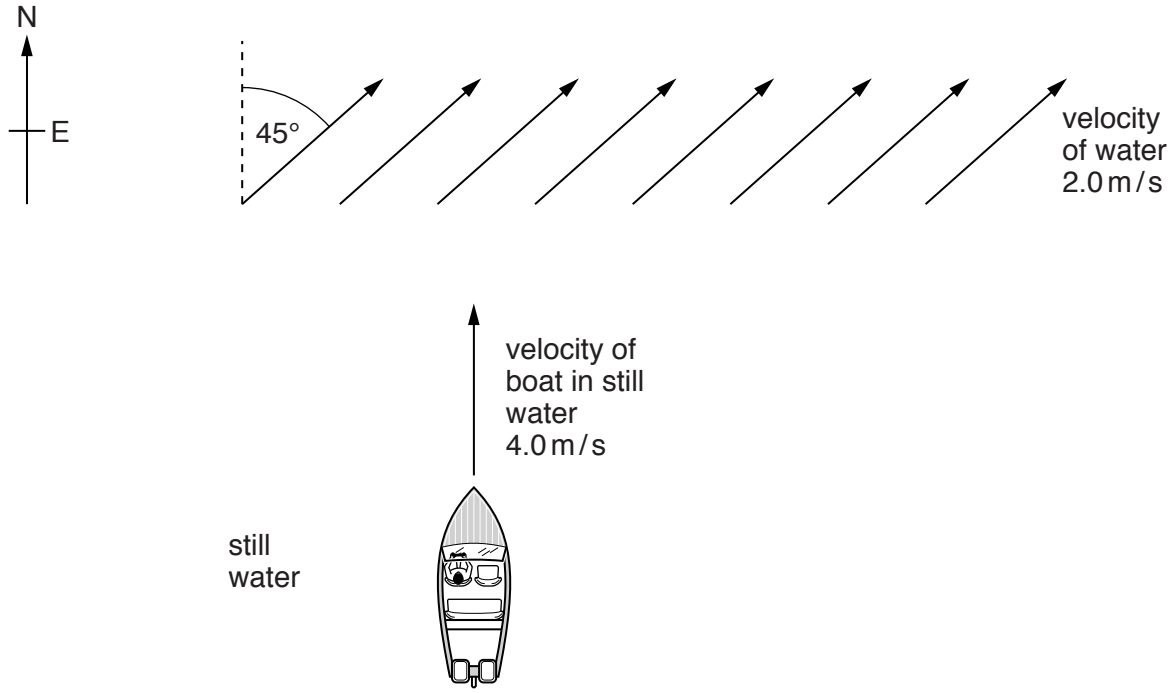


Fig. 1.1 (not to scale)

Combining the initial velocity of the boat with the velocity of the water gives the resultant velocity of the boat.

In the space on the page opposite, draw a vector diagram to show the resultant velocity.

Use your diagram to find the size and direction of the resultant velocity.

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size of resultant velocity = ...

direction of resultant velocity = ...
[4]

2 Fig. 2.1 shows apparatus used when determining the specific heat capacity of aluminium.

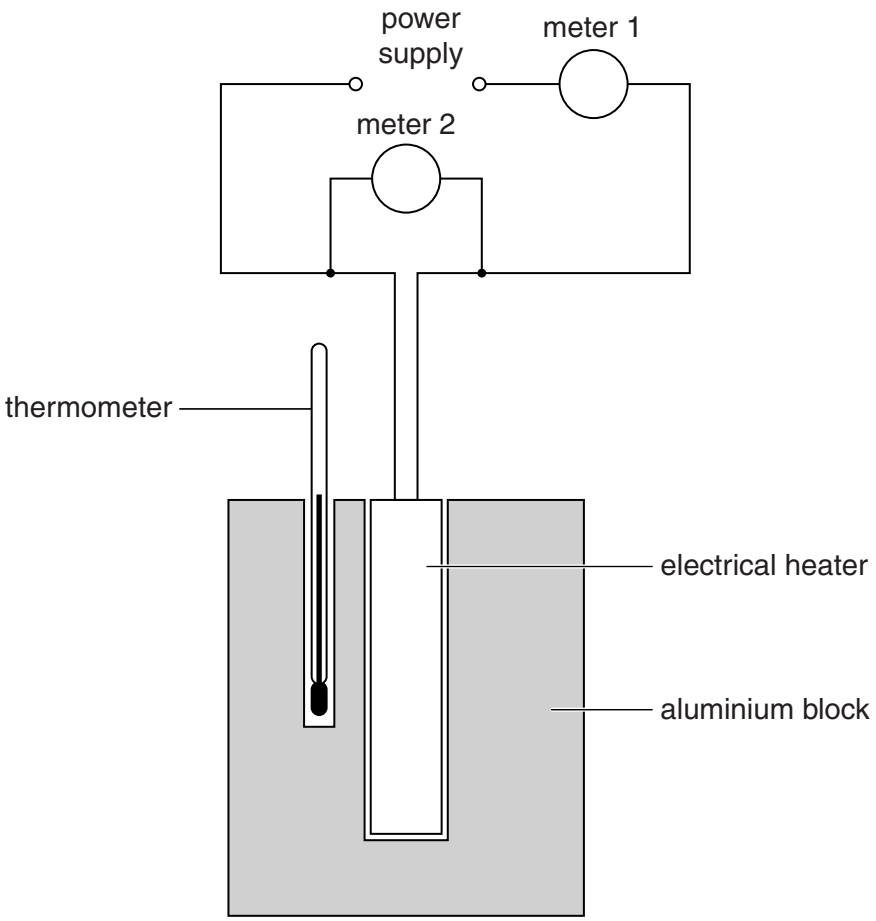


Fig. 2.1

Meter 1 and meter 2 are electrical meters.

(a) State the quantities measured by meter 1 and by meter 2.

meter 1: .....

meter 2: .....
[1]

(b) The following results are obtained in the experiment:

initial temperature of block	= 18 °C
final temperature of block	= 40 °C
mass of block	= 0.85 kg
energy supplied to heater	= 17 000 J

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Assuming that no heat is lost from the block during the experiment, calculate the specific heat capacity of aluminium.

specific heat capacity = ... [2]

(c) In practice, some heat is lost from the block and the air above it becomes hot.

(i) Describe and explain the process by which the hot air moves away from the block.

.....

.....

.....

..... [2]

(ii) Suggest how to reduce the loss of heat from the block in the experiment.

.....

..... [1]

3 A collector views a postage stamp of height 1.5 cm through a lens. The lens is 2.0 cm from the stamp. The image has a linear magnification of 3.0.

The stamp, the image of the stamp and the position of the lens are shown full scale in Fig. 3.1.

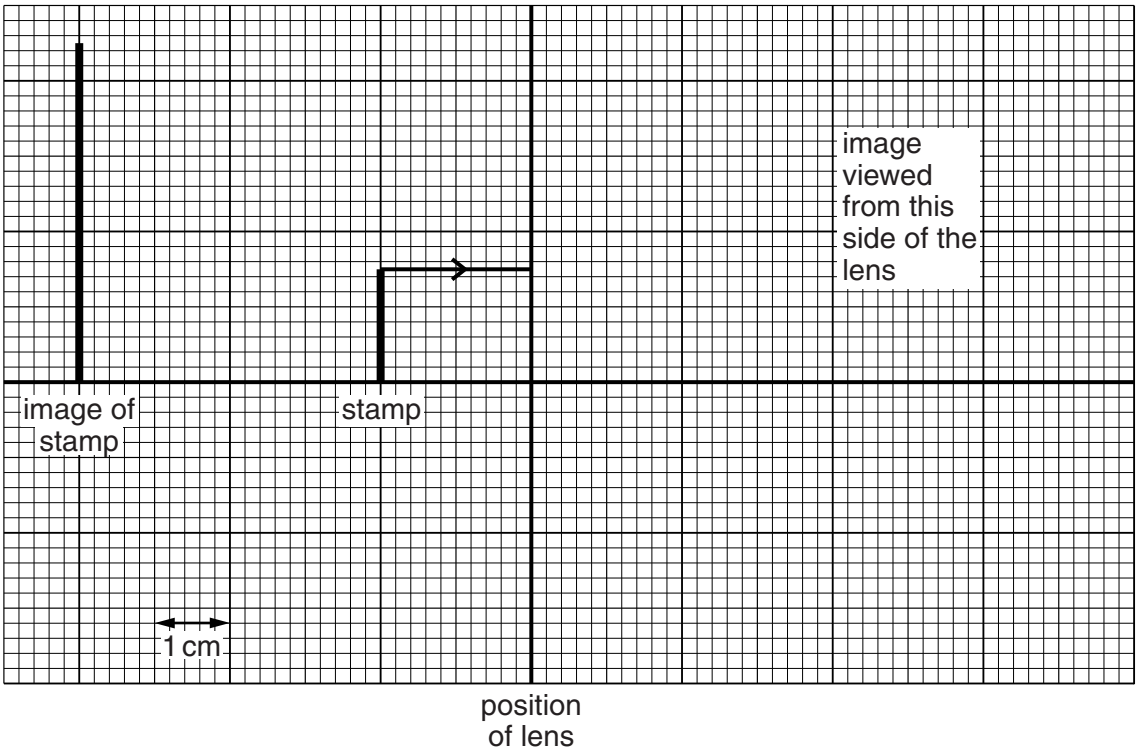


Fig. 3.1 (full scale)

A ray of light from the top of the stamp to the lens is shown on Fig. 3.1.

(a) State the type of lens used.

..... [1]

(b) State what is meant by *linear magnification*.

.....

..... [1]

(c) **(i)** On Fig. 3.1, complete the path of the ray from the top of the stamp after it passes through the lens. [1]

(ii) Use your drawing to determine the focal length of the lens.

..... [1]

(iii) On Fig. 3.1, draw two additional rays from the top of the stamp to show how the image is formed. [1]

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4 A teacher demonstrates magnetic screening. When a magnet is placed near a small cardboard box, paper clips on the other side of the box are picked up, as shown in Fig. 4.1.

When a small piece of soft iron is placed inside the box as shown in Fig. 4.2, the paper clips fall off.

Magnetic field lines in each diagram are shown as thin lines.

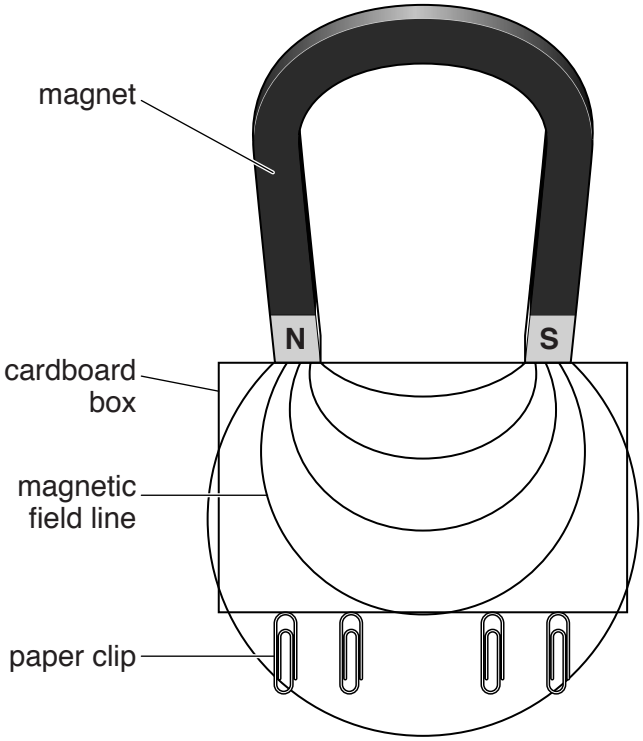


Fig. 4.1

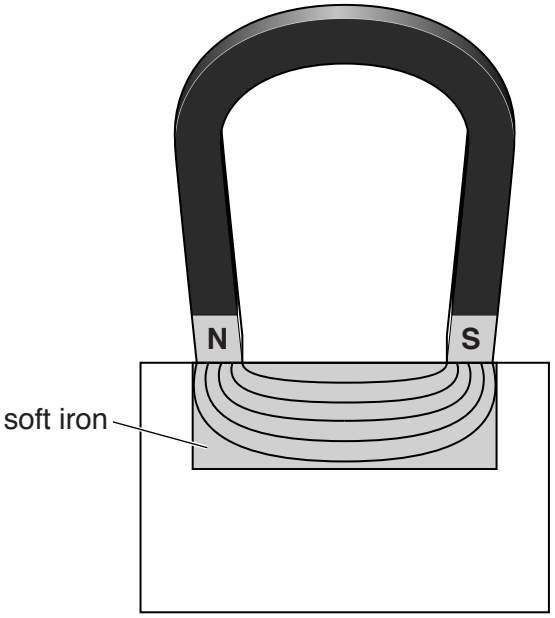


Fig. 4.2

(a) On Fig. 4.1, mark an arrow on each of the magnetic field lines to show its direction. [1]

(b) Explain why placing the soft iron inside the box causes the paper clips to fall off.

.....

.....

.....

..... [2]

(c) Explain why it is sensible to have magnetic screening around the tube of a cathode-ray oscilloscope.

.....

..... [1]

5 A positively charged sphere C is brought close to a small, uncharged metal sphere U. Sphere U is suspended from an insulating thread, as shown in Fig. 5.1.

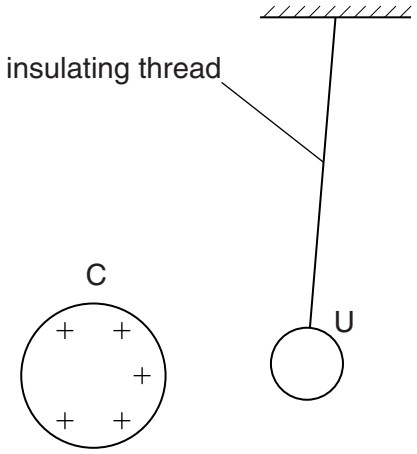


Fig. 5.1

(a) On Fig. 5.1, draw the induced charges on sphere U. [1]

(b) Sphere C is moved towards sphere U until the spheres touch. Sphere U is then repelled by sphere C, as shown in Fig. 5.2. The charges on C and U are not shown.

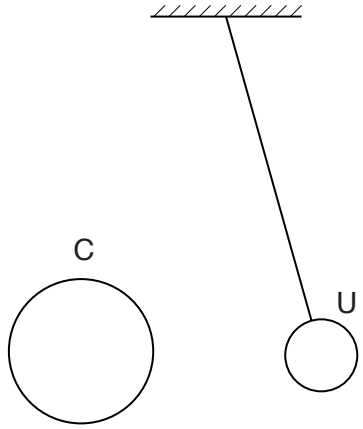


Fig. 5.2

(i) State and explain what happens to the charge on the two spheres as they touch.

charge on C: .....

.....

charge on U: .....

.....
[3]

(ii) Explain why U is repelled by C.

.....

..... [1]

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6 Fig. 6.1 shows a coil of wire connected by flexible leads to a switch and a battery.

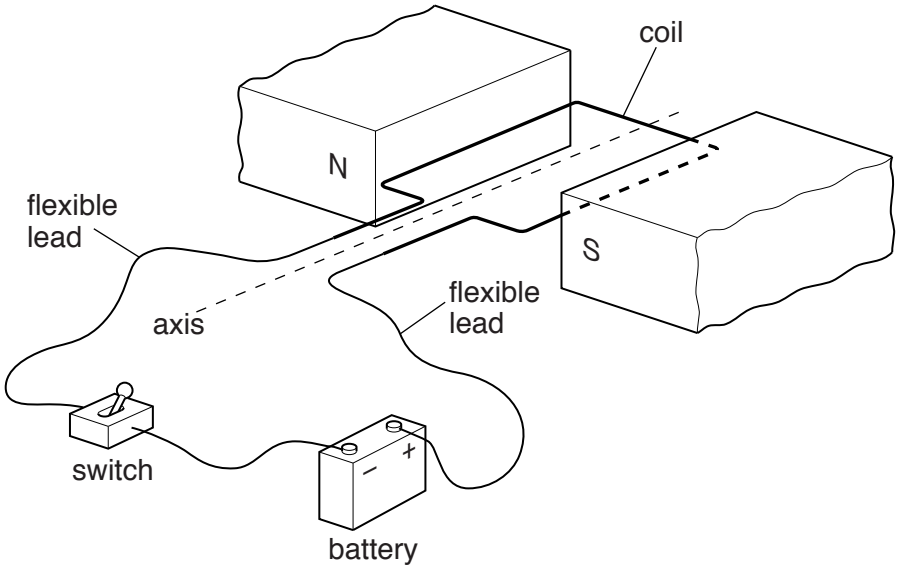


Fig. 6.1

The coil is placed between the poles of a permanent magnet and is free to turn about the axis.

When the switch is closed, forces due to the current act on the sides of the coil. The coil starts to turn.

(a) On Fig. 6.1, draw arrows to show the directions of the forces. [2]

(b) The coil stops when it is vertical. Explain why the turning effect of the forces is zero at this position.

.....

..... [1]

(c) In order for the coil to rotate continuously, a split-ring commutator is connected between the battery and the coil.

Explain how the split-ring commutator enables the coil to rotate continuously. Include a diagram in your answer.

.....

.....

.....

..... [4]

7 **(a)** Fig. 7.1 shows a variable potential divider (potentiometer) connected to a 6.0 V battery.

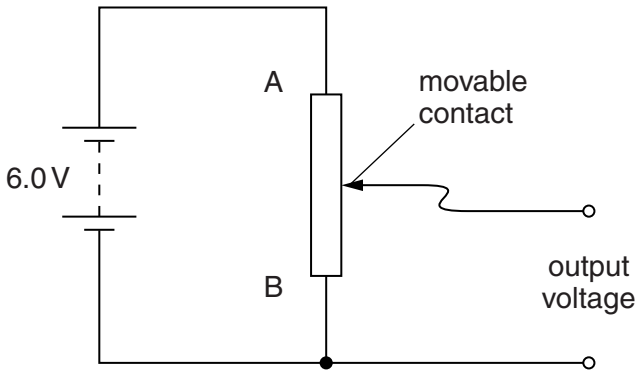


Fig. 7.1

The movable contact can slide between A and B. As it moves, the output voltage changes.

Complete the table below to show the output voltage when the contact is at A and at B.

position of movable contact	A	B
output voltage		

[2]

(b) Fig. 7.2 shows a thermistor in a potential divider circuit that is used to monitor temperature. The fixed resistor has a resistance of 2000 Ω.

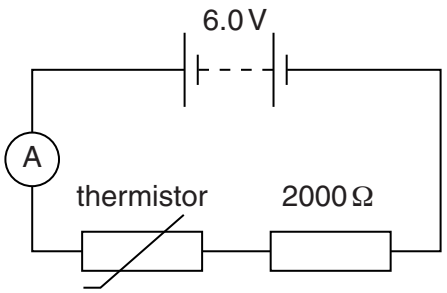


Fig. 7.2

(i) Explain why the voltage across the thermistor decreases as its temperature rises.

.....

..... [2]

(ii) At one temperature, the thermistor has a resistance of 1000 Ω. Calculate the current in the thermistor.

current = ... [2]

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8 A hospital laboratory uses a small sample of a radioactive isotope of iodine, $^{131}_{53}\mathrm{I}$.

(a) (i) Describe the structure of the nucleus of an atom of this isotope.

.....

..... [2]

(ii) The sample is radioactive. Describe what happens in radioactive decay.

.....

.....

..... [2]

(b) The count in one minute from the source is measured several times. Fig. 8.1 shows the readings obtained.

2686	2759	2847	2799

Fig. 8.1

(i) Suggest why the readings are different.

.....

..... [1]

(ii) The half-life of $^{131}_{53}\mathrm{I}$ is 8.0 days. Estimate the count in one minute obtained from the sample after 24 days.

count = ... [2]

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[Turn over

Section B

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

9 A garden pond contains a small fountain. An electric pump in the water causes the water to rise above the surface of the pond, as shown in Fig. 9.1.

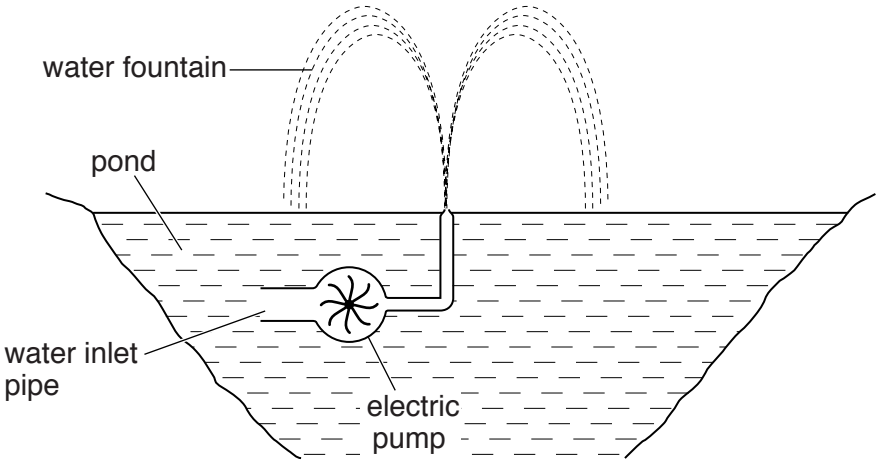


Fig. 9.1

(a) The pressure of the water in the pond increases with depth.

(i) Explain what is meant by *pressure*.

.....

..... [1]

(ii) Explain why the pressure below the surface of the water increases with depth.

.....

..... [2]

(iii) State the unit of pressure.

..... [1]

(b) Describe the energy changes that occur within the pump.

.....

.....

..... [3]

(c) A volume of 0.78 m^3 of water passes through the pump in one hour. The density of water is 1000 kg / m^3.

(i) Calculate the mass of water that passes through the pump in one hour.

mass = ... [2]

(ii) The water rises 1.5 m. The gravitational field strength *g* is 10 N / kg.

Calculate the useful work done in one hour raising the water to the top of the fountain.

work done = ... [2]

(iii) Calculate the minimum power output of the pump.

power = ... [2]

(d) Describe an experiment to check that the density of water is 1000 kg / m^3.

.....

.....

.....

.....

..... [2]

10 A sound wave travels through air.

(a) Explain what is meant by the *wavelength* of a wave.

.....

..... [1]

(b) Fig. 10.1 represents air molecules in the sound wave at one instant.

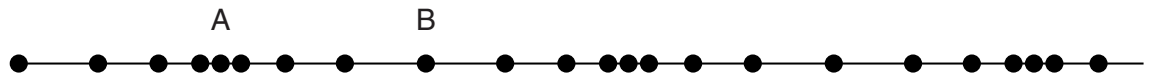


Fig. 10.1

(i) Describe the motion of a molecule of air due to the sound.

.....

..... [2]

(ii) State one difference between the motion of molecule A and the motion of molecule B.

.....

..... [1]

(c) Describe an experiment that shows that a medium is needed to transmit sound waves. Draw a labelled diagram of the apparatus.

.....

.....

.....

.....

.....

..... [4]

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(d) A short pulse of sound waves produces an echo from a wall 20 m away. The echo arrives back at the source of the sound 0.12 s after the pulse is produced.

The wavelength of the sound wave is 30 mm.

(i) State what is meant by an *echo*.

.....

..... [1]

(ii) Calculate the speed of the sound.

speed = ... [2]

(iii) Calculate the frequency of the sound.

frequency = ... [3]

(iv) The sound wave produces compressions and rarefactions in the air as it passes.

Calculate the distance between a compression and the nearest rarefaction.

distance = ... [1]

11 (a) A torch contains a filament lamp connected to a battery. The battery contains four 1.5V cells connected in series.

Fig. 11.1 shows the current/potential difference (voltage) graph for the filament lamp.

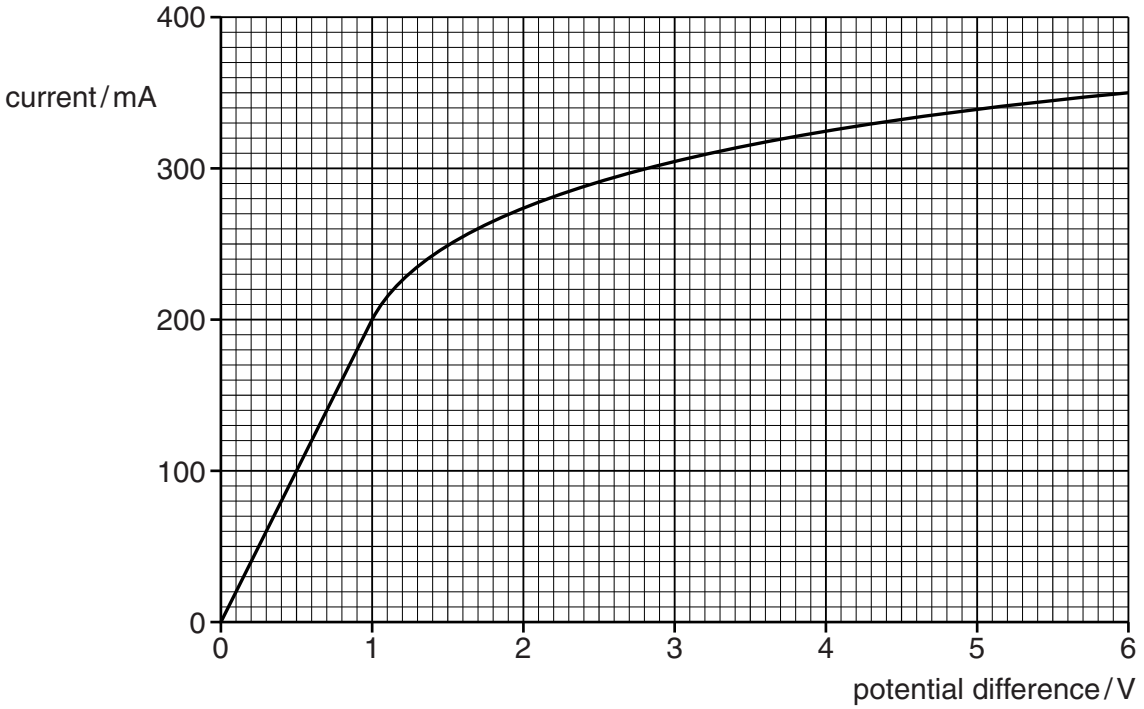


Fig. 11.1

(i) State what is meant by the *potential difference* (p.d.) across the lamp.

.....

..... [2]

(ii) Fig. 11.1 shows that the current in the lamp is not proportional to the p.d.

1. State how Fig. 11.1 shows this.

.....

..... [1]

2. Suggest why the current is not proportional to the p.d.

.....

..... [1]

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(iii) The lamp is at normal brightness and there is a p.d. of 6.0 V across the lamp.

1. Use Fig. 11.1 to find the current in the lamp.

current = ... [1]

2. Calculate the charge that passes through the lamp in 2.0 hours.

charge = ... [2]

3. The battery in the torch is able to keep the lamp lit for 2.0 hours.
Estimate the initial energy stored in the battery.

energy = ... [2]

4. Explain why your value is only an estimate.

.....

..... [1]

(b) Suggest and explain an advantage of using two cells in parallel rather than a single cell.

.....

.....

..... [2]

(c) Another torch contains a light-emitting diode (LED) instead of a filament lamp.
The battery in the torch uses four 1.5 V cells, some in series and some in parallel.
The p.d. across the LED when in operation is 3.0 V.

In the space below, draw a circuit diagram showing how the four cells, a switch and the LED are connected.

[3]

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