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5054/42

May/June 2019

1 hour

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

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

The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **10** printed pages and **2** blank pages.

- 1 A student determines an approximate value for the specific heat capacity of water by an electrical method.

The specific heat capacity of a substance is the amount of thermal energy needed to raise the temperature of 1 g of the substance by 1 °C.

He sets up the apparatus as shown in Fig. 1.1.

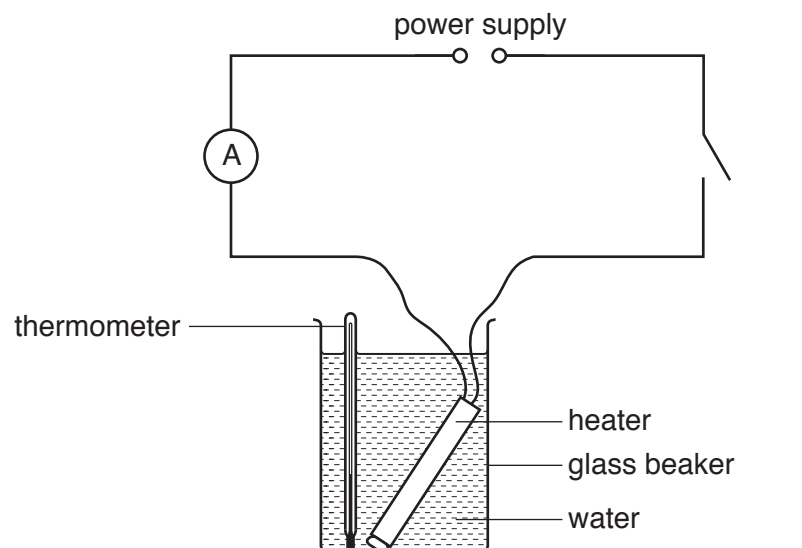


Fig. 1.1

- He pours a mass m of water into a beaker, where $m = 100\text{ g}$.
 - He places a heater into the water in the beaker.
 - He connects a voltmeter to measure the potential difference across the heater.
- (a) Draw a voltmeter symbol on the circuit diagram of Fig. 1.1 to show the voltmeter measuring the potential difference across the heater. [1]

- (b) The student measures the initial temperature of the water and records it at time $t = 0$ in Table 1.1.

Table 1.1

time t/s	temperature $\theta/^\circ\text{C}$
0	21.5
60	27.0
120	32.0
180	37.0
240	
300	45.5
360	48.5

- He closes the switch, starts a stopwatch and records the temperature θ of the water every 60 s for 6 minutes.
- He records the current I in the heater and the potential difference V across the heater.

His measurements are:

$$I = 4.0\text{ A}$$

$$V = 14.8\text{ V.}$$

- He opens the switch.

- (i) The reading of the thermometer at time $t = 240\text{ s}$ is shown in Fig. 1.2.

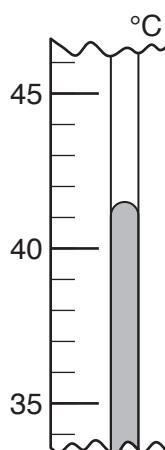


Fig. 1.2

Read the thermometer and record the temperature in Table 1.1.

[1]

- (ii) State why it is important to:

1. ensure that the heating coil is completely immersed in the water

.....

..... [1]

2. stir the water before recording each temperature.

.....
 [1]

- (c) (i) On the grid in Fig. 1.3, plot the graph of $\theta/^\circ\text{C}$ (y-axis) against t/s (x-axis).
Start the temperature axis at 20°C .

Draw the smooth curve of best fit.

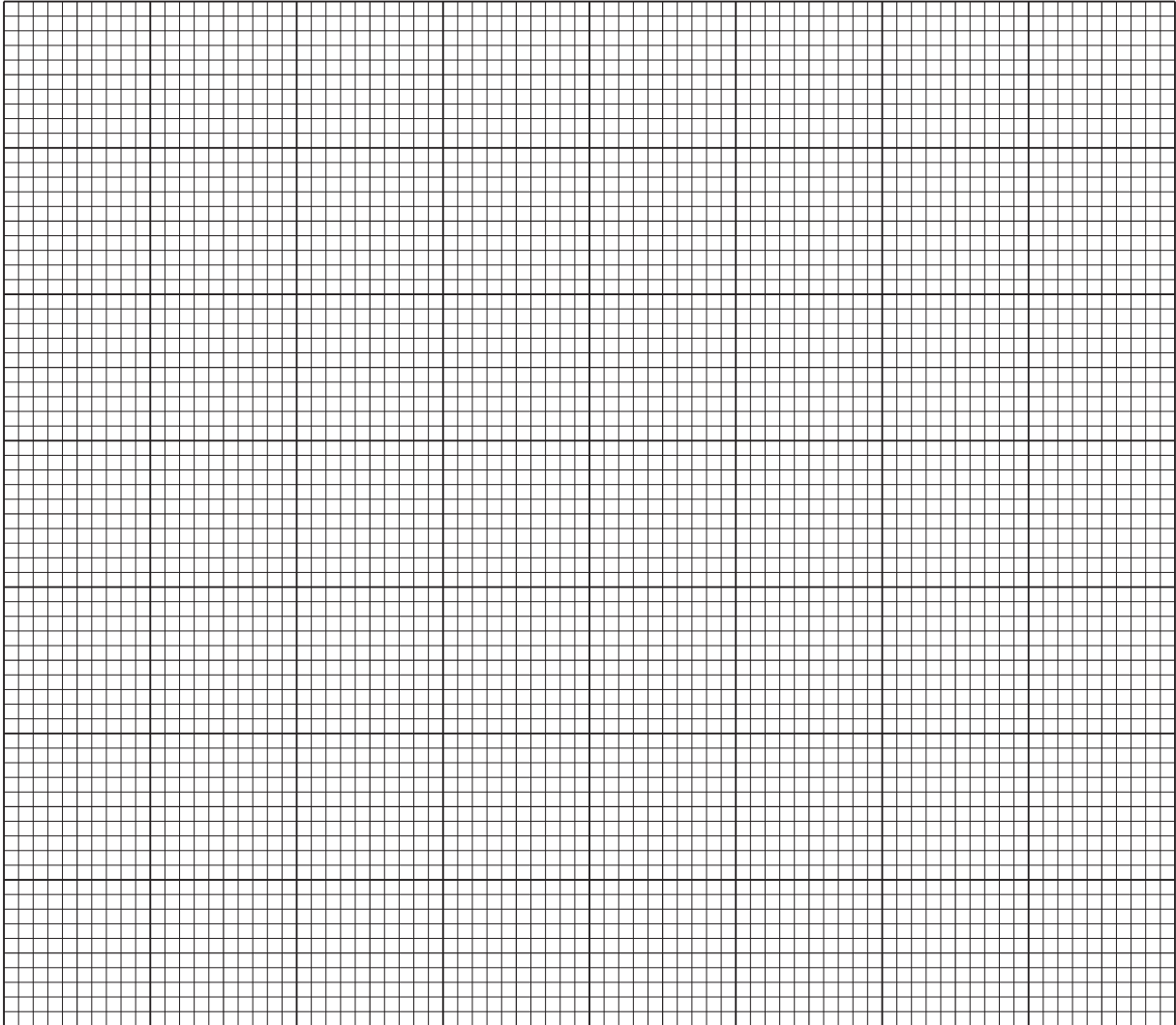


Fig. 1.3

[4]

- (ii) Use your graph to calculate the temperature rise $\Delta\theta$ of the water in the first 200 s of heating.

$\Delta\theta =$ [2]

- (d) (i) Calculate the thermal energy E supplied by the heater in the first 200 s and give the unit. Use the equation shown:

$$E = V \times I \times t$$

$$E = \dots\dots\dots [1]$$

- (ii) Calculate a value for the specific heat capacity c of water. Use the mass given at the start of this question, your answers to (c)(ii) and (d)(i), and the equation:

$$E = m \times c \times \Delta\theta$$

$$c = \dots\dots\dots \text{J/(g } ^\circ\text{C)} [2]$$

- (e) (i) The specific heat capacity of water is $4.2 \text{ J/(g } ^\circ\text{C)}$.

Examine the apparatus set-up shown in Fig. 1.1.

Suggest one practical reason why your calculated value of c is inaccurate.

.....
 [1]

- (ii) State one improvement to the apparatus that produces a more accurate result.

.....
 [1]

- (f) Another student repeats the experiment and forgets to switch off the heater at the end of the experiment. The temperature of the water continues to rise until it reaches 82°C and then remains constant at this value.

Suggest one reason why the temperature of the water stops increasing when it reaches 82°C .

.....
 [1]

[Total: 16]

- 2 A student uses a ray box to investigate the refraction of a ray of blue light as it passes through a glass prism.

He sets up the apparatus as shown in Fig. 2.1 on a piece of paper.

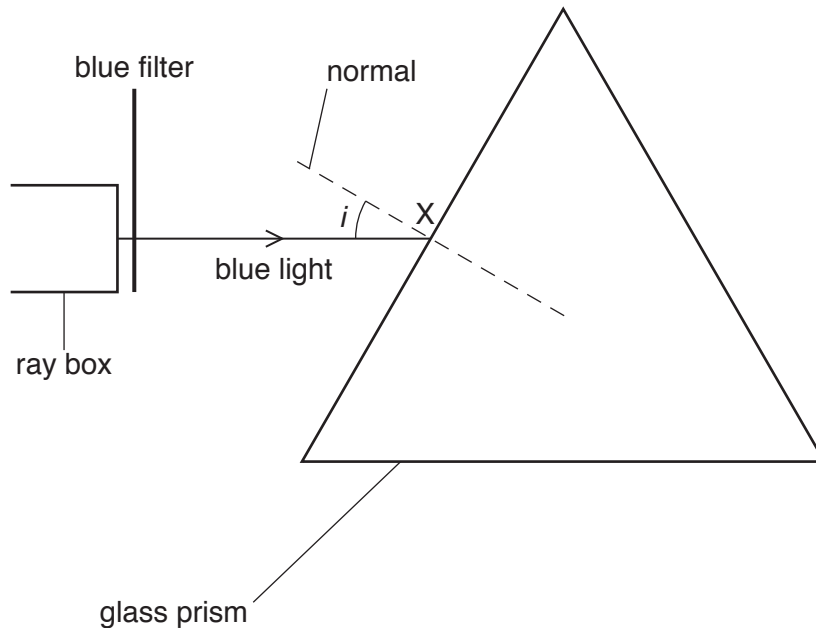


Fig. 2.1

- (a) Measure the angle of incidence i of the ray on the prism at point X.

$i =$ [1]

- (b) The angle of refraction at X is 19° .

On Fig. 2.1:

- (i) Draw the refracted ray inside the prism. [1]

- (ii) Mark with the letter Y, the point where the refracted ray emerges from the prism. Draw the normal at point Y. [1]

- (c) The ray emerges from the prism at Y.

Describe how the student can mark the path of the emergent ray accurately on the paper.

.....

 [1]

[Total: 4]

- 3 A student investigates the maximum height h to which a ball bounces after hitting a laboratory bench.

She sets up her apparatus as shown in Fig. 3.1.

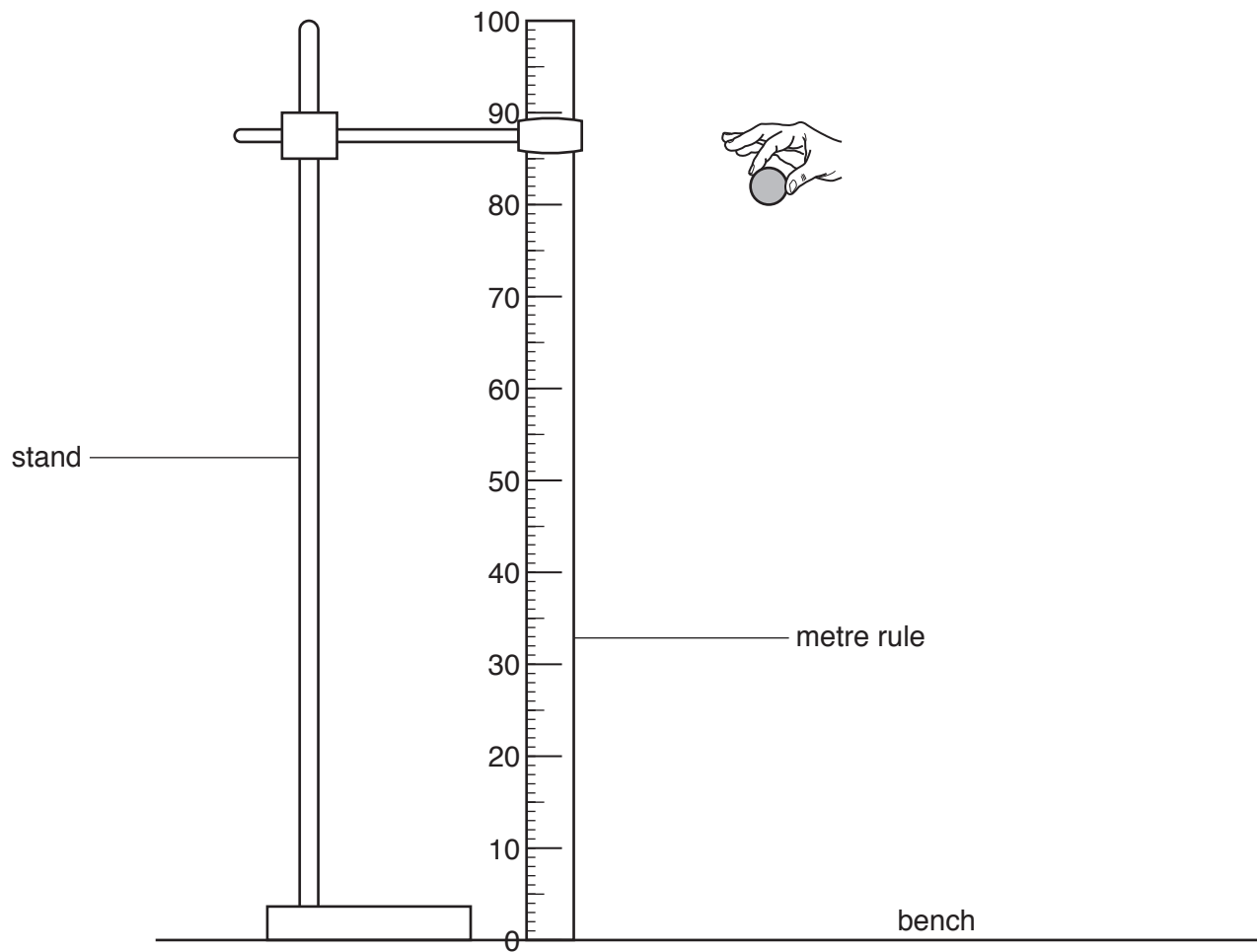


Fig. 3.1

- (a) She drops the ball from a height of 80 cm above the bench, as shown in Fig. 3.1.

After one bounce, the ball reaches a maximum height h of 55 cm.

- (i) On Fig. 3.1, draw the ball when $h = 55$ cm. [1]

- (ii) On Fig. 3.1, draw the position of the student's eye placed correctly to view the ball at a height of 55 cm. [1]

- (b) She repeats this procedure three more times and obtains the following results for h :

54 cm

57 cm

53 cm

- (i) Use **all** her results to find the mean value of the maximum height h reached.

Give your answer to an appropriate number of significant figures.

mean value for $h =$ cm [2]

- (ii) The student uses a metre rule graduated in millimetres.

Suggest why her results are **not** recorded to the nearest millimetre.

.....
 [1]

- (c) The student repeats the procedure but now drops the ball from a height of 10 cm.

Suggest why she now finds the maximum height reached difficult to measure.

.....
 [1]

[Total: 6]

- 4 A box contains an unknown electrical component. This component is connected to two terminals P and Q on the outside of the box.

A battery, an ammeter, a switch, a lamp and two crocodile clips are connected as shown in the circuit diagram of Fig. 4.1.

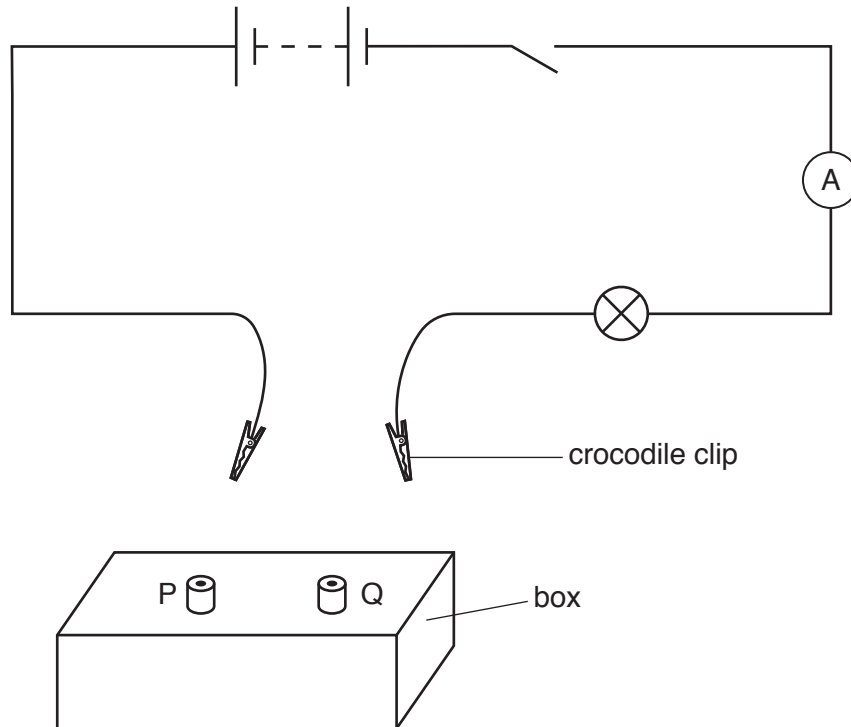


Fig. 4.1

The unknown component is either a broken wire or a connecting wire or a diode.

- (a)** Describe how to use the apparatus to determine whether the component in the box is:

- (i)** a broken wire

.....
 [1]

- (ii)** a connecting wire

.....
 [1]

- (iii)** a diode.

.....
 [1]

- (b) The component in the box is a low resistance connecting wire. A second box looks identical, but contains a higher resistance resistor.

Describe how to use the apparatus to determine which box contains the resistor.

.....
..... [1]

[Total: 4]

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