1 A student is determining the spring constant k of a spring by two methods.

Fig. 1.2 shows how the apparatus is used.

Method 1

(a) On Fig. 1.1, measure the unstretched length l_0 of the spring, in mm.

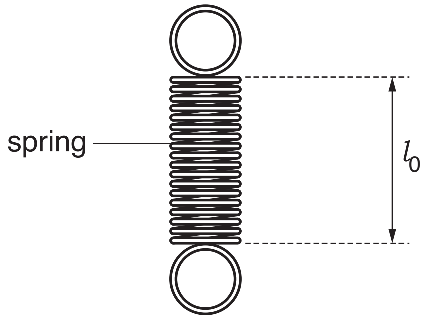


Fig. 1.1

l_0 = ... mm [1]

(b) The student attaches the spring to the clamp as shown in Fig. 1.2.

He hangs a 300 g mass on the spring.

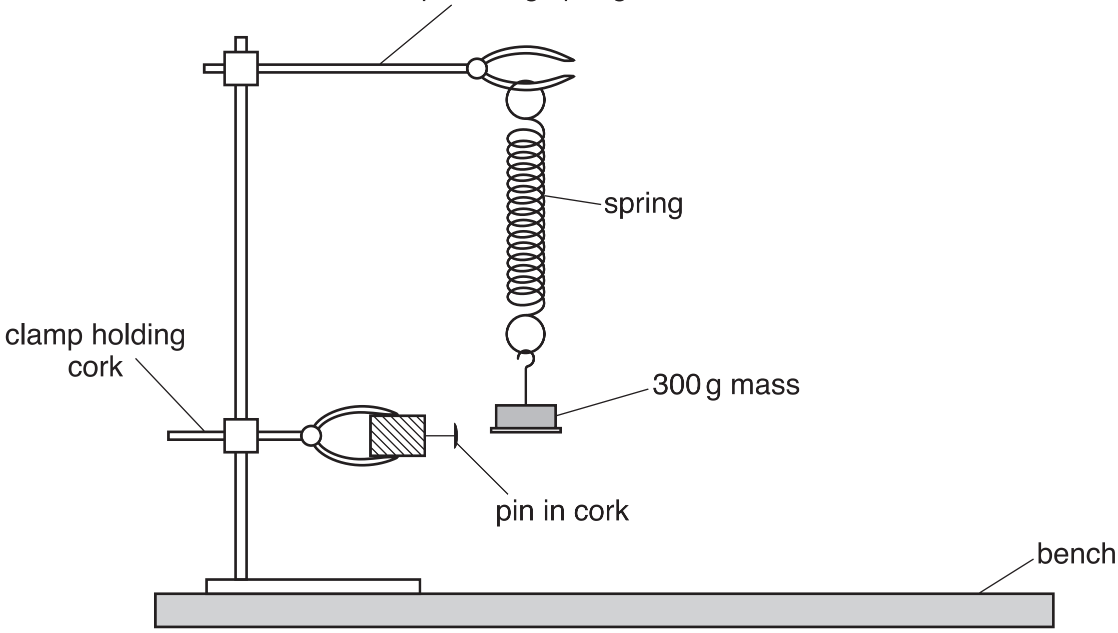


Fig. 1.2

He measures the new length l of the spring.

l = ...53.......................... mm

(i) Calculate the extension e of the spring using the equation $e = l - l_0$.

e = ... mm [1]

(ii) Calculate a value for the spring constant k using the equation $k = \frac{F}{e}$, where $F = 3.0\,N$.

k = ... N/mm [1]

Method 2

(c) The student pulls the mass down a short distance and releases it so that it oscillates up and down. Fig. 1.3 shows the time t taken for 10 complete oscillations.

Fig. 1.3

(i) Record the time t taken for 10 complete oscillations.

t = ... [1]

(ii) **1.** Calculate the time T taken for one complete oscillation.

T = ...

2. Calculate T^2.

T^2 = ...

[2]

(iii) Calculate the spring constant k using the equation $k = \frac{0.040\,m}{T^2}$, where $m = 0.300\,kg$.

k = ... N/mm [1]

(d) State and explain whether your two values for *k* are the same within the limits of experimental accuracy.

statement ....

explanation ....

....
[2]

(e) A student states that repeating Method 1 with different masses would improve the reliability of the value obtained for *k*.

Suggest additional values for the mass *m* that you would use when repeating the experiment to improve the reliability.

....

....

.... [2]

[Total: 11]

2 A student is determining the resistance of a piece of wire.

Fig. 2.1 shows the circuit she uses.

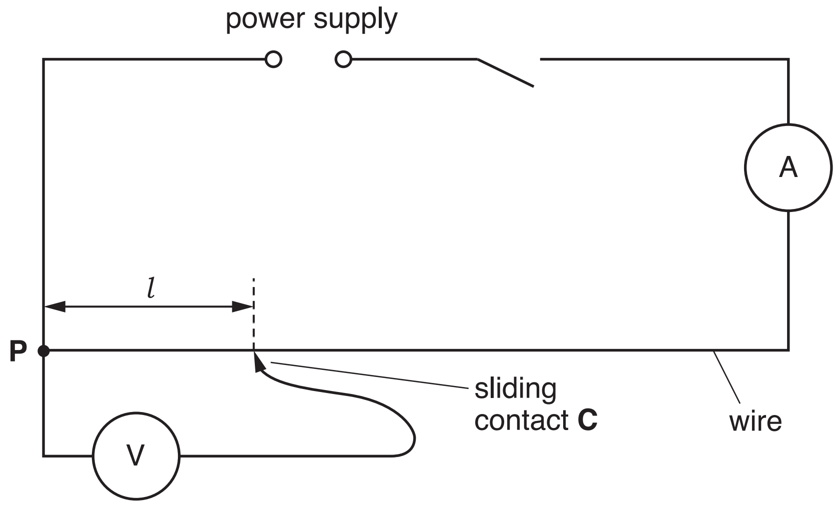


Fig. 2.1

(a) Record the current I in the circuit, as shown on the ammeter in Fig. 2.2.

I = ... [1]

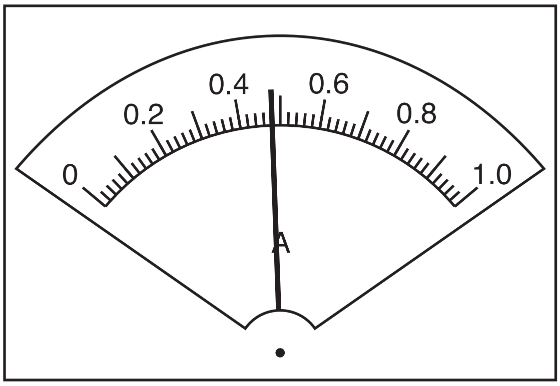


Fig. 2.2

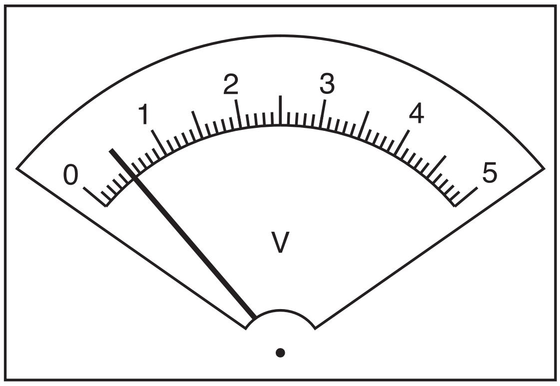


Fig. 2.3

(b) The student places the sliding contact **C** at a distance l = 20.0 cm from **P**. The voltmeter reading is shown in Fig. 2.3. Record the voltmeter reading in Table 2.1 for l = 20.0 cm. [1]

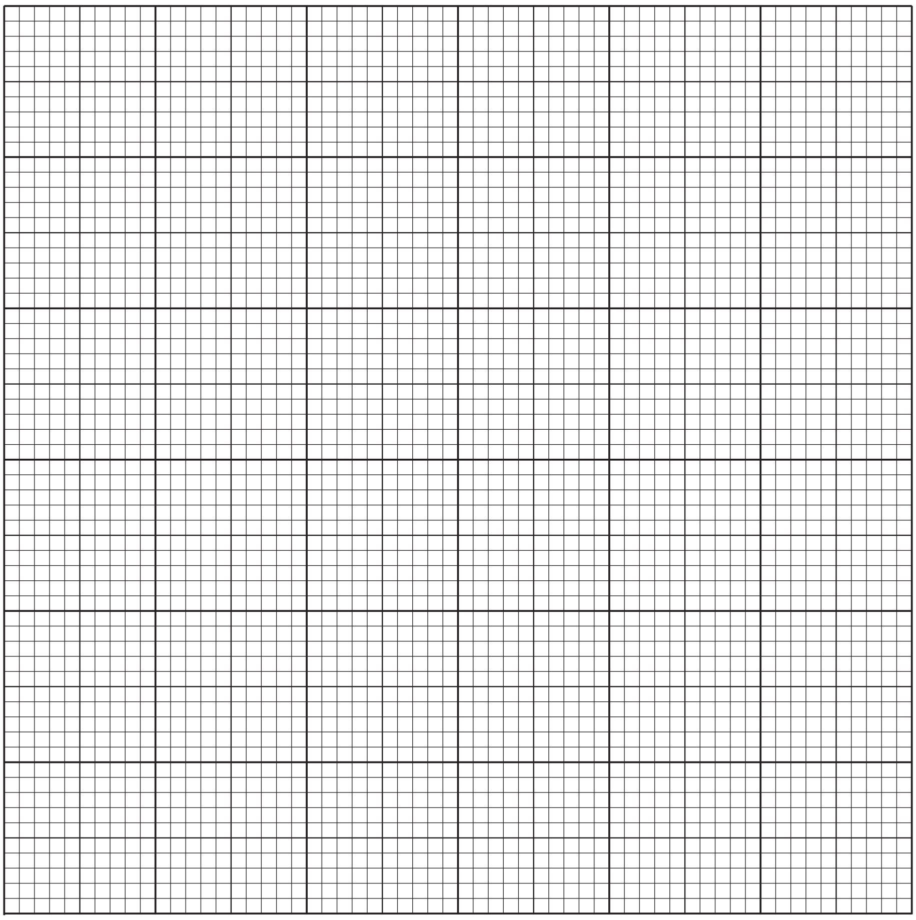
(c) The student repeats the procedure using values of $l = 40.0\,\text{cm}$, $60.0\,\text{cm}$, $80.0\,\text{cm}$ and $100.0\,\text{cm}$. The readings are shown in Table 2.1.

Complete the column headings in the table. [1]

Table 2.1

l /	V /
20.0	
40.0	0.9
60.0	1.6
80.0	2.0
100.0	2.4

(d) Plot a graph of V/V (y-axis) against l/cm (x-axis). Start both axes at the origin (0, 0).



[4]

(e) **(i)** Determine the gradient G of the graph. Show clearly on the graph how you obtained the necessary information.

G = ... [2]

(ii) Calculate the resistance R of each centimetre of the wire. Use the equation $R = \frac{Gk}{I}$, where $k = 1.0\,V/cm$ and where I is the current recorded in **(a)**.

Include the unit.

R = ... [2]

[Total: 11]

3 A student is determining the refractive index *n* of the material of a transparent block.

Fig. 3.1 shows the outline **ABCD** of the transparent block.

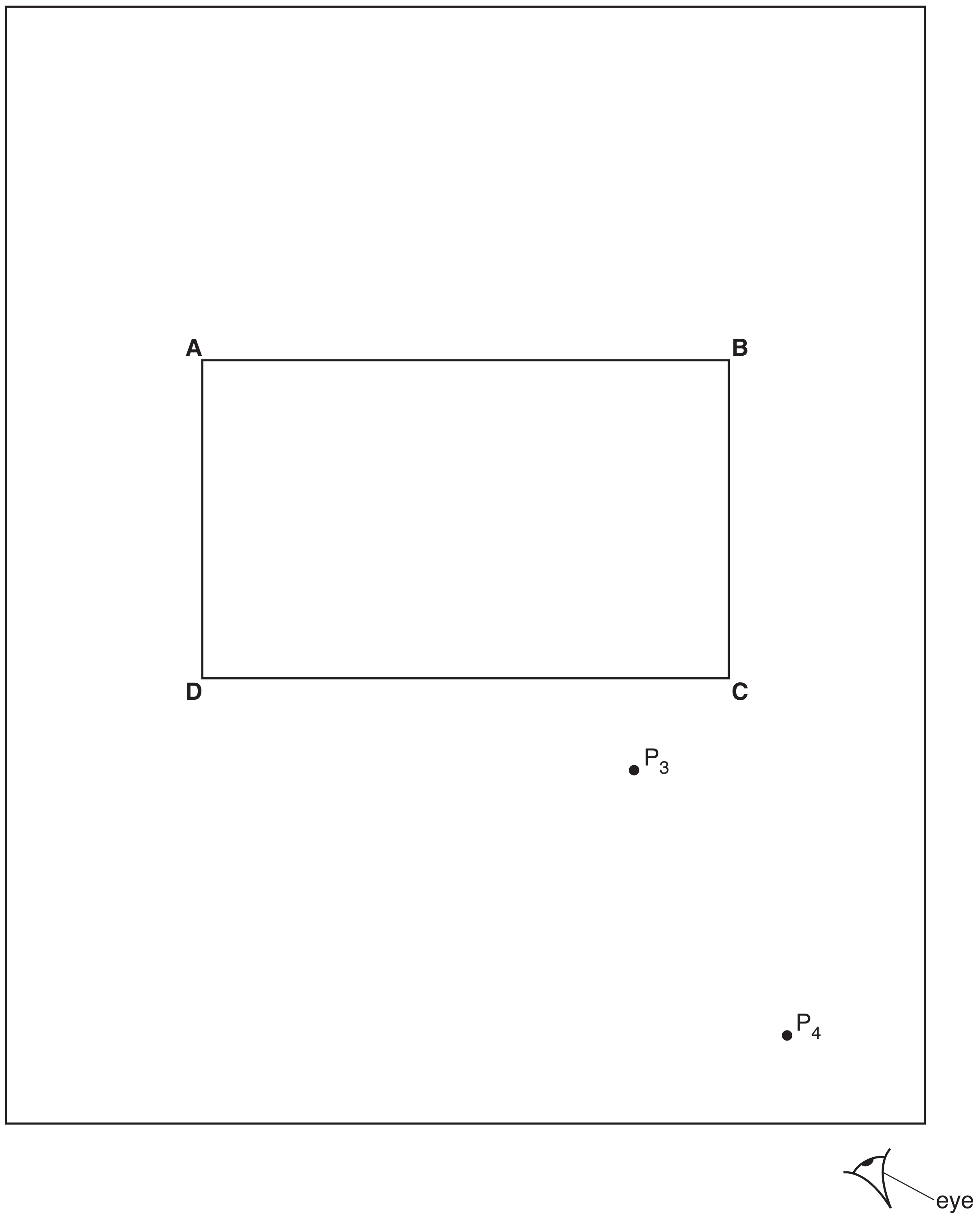


Fig. 3.1

(a) **(i)** On Fig. 3.1:

- draw a normal **NL** at the centre of side **AB**
- continue the normal so that it passes through side **CD** of the block
- label the point **F** where **NL** crosses **AB**
- label the point **G** where **NL** crosses **CD**. [1]

(ii) Draw a line **EF** at an angle $i = 30°$ to the left of the normal and above side **AB**. [1]

(iii) Mark the positions of two pins P_1 and P_2 on line **EF** placed at a suitable distance apart for this type of ray-tracing experiment. [1]

(b) The student observes the images of P_1 and P_2 through side **CD** of the block so that the images of P_1 and P_2 appear one behind the other.

He places two pins P_3 and P_4 between his eye and the block so that P_3, P_4 and the images of P_1 and P_2 seen through the block, appear one behind the other.

The positions of P_3 and P_4 are marked on Fig. 3.1.

(i)
- Draw a line joining the positions of P_3 and P_4. Continue the line until it meets the normal **NL**.
- Label the point **H** where the line meets side **CD**. Draw the line **FH**.

[1]

(ii) Measure and record the length *a* of the line **GH**.

a = ... [1]

(iii) Measure and record the length *b* of the line **FH**.

b = ... [1]

(iv) Calculate the refractive index *n* using the equation $n = \frac{0.5b}{a}$.

n = ... [1]

(c) The student repeats the procedure using the angle of incidence $i = 45°$.

a = ...3.2.......... cm

b = ...6.9.......... cm

Calculate the refractive index n, using the equation $n = \frac{0.71b}{a}$.

n = ... [1]

(d) The student expected the two values of refractive index n obtained in this experiment to be equal.

State **two** difficulties with this type of experiment that could explain any difference in the two values of n.

1. ....

....

2. ....

.... [2]

(e) A student suggests precautions to take in this experiment to obtain reliable results.
Tick **one** box to indicate the most sensible suggestion.

☐ Carry out the experiment in a darkened room.

☐ Use pins that are taller than the height of the block.

☐ View the bases of the pins.

☐ View the pins with one eye closed.

[1]

[Total: 11]

4 A student is investigating the relationship between the power produced by an electrical heater and the time taken to heat a beaker of water. The power of the heater is given by the equation $P = VI$, where V is the potential difference (p.d.) across the heater and I is the current in the heater.

Plan an experiment to investigate the relationship between the power produced by an electrical heater and the time taken to heat a beaker of water.

The following apparatus is available:

ammeter
voltmeter
0–12 V variable power supply
250 cm^3 beaker
heater
thermometer
stopwatch

The student can also use other apparatus and materials that are usually available in a school laboratory.

You should:

- complete the diagram in Fig. 4.1 to show the circuit that you would use
- explain briefly how you would carry out the investigation
- state the key variables that you would control
- draw a table with column headings, to show how you would display your readings (you are **not** required to enter any readings in the table)
- explain how you would use your results to reach a conclusion.

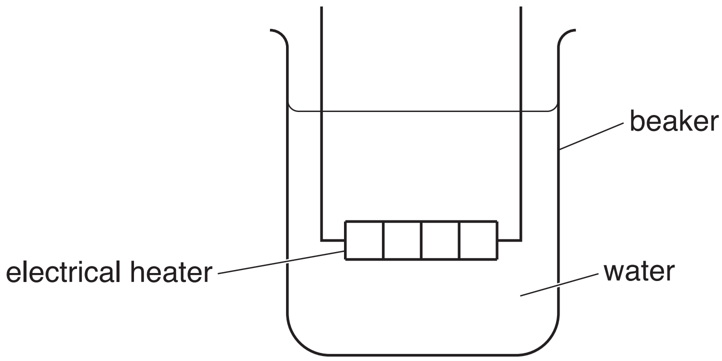


Fig. 4.1

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