1 A student investigates a pendulum. Fig. 1.1 and Fig. 1.2 show some of the apparatus used.

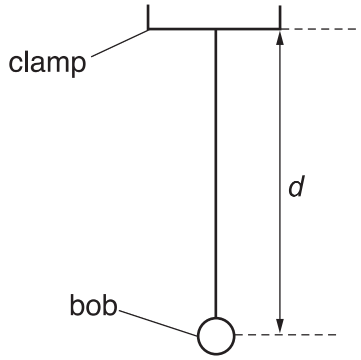


Fig. 1.1

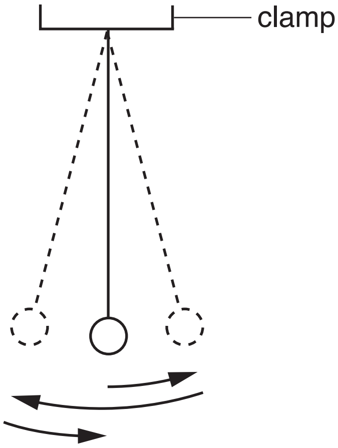


Fig. 1.2

(a) The student adjusts the length of the pendulum until the distance *d*, measured to the centre of the bob, is 50.0 cm. State one precaution that you would take to obtain the length of 50.0 cm as accurately as possible.

....

.... [1]

(b) The student displaces the bob slightly and releases it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum.

(i) He measures the time *t* for 20 complete oscillations. The time *t* is shown on the stopwatch in Fig. 1.3.

Fig. 1.3

In the first row of Table 1.1, record the time *t* shown in Fig. 1.3. [1]

(ii) Calculate, and record in Table 1.1, the period *T* of the pendulum. The period is the time for one complete oscillation. [1]

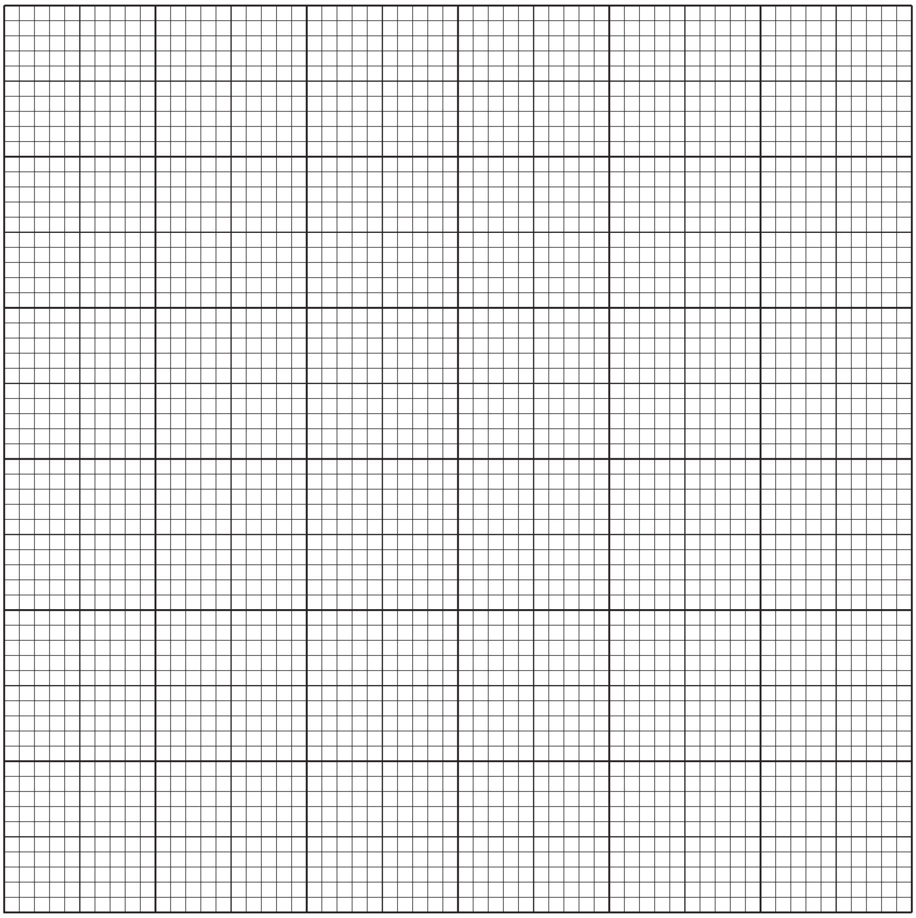
(iii) Calculate T^2. Record its value in Table 1.1. [1]

(c) The student repeats the procedure in **(b)** using d = 60.0 cm, 70.0 cm, 80.0 cm and 100.0 cm. The readings are shown in Table 1.1.

Table 1.1

d / cm	t / s	T / s	T^2 / s^2
50.0			
60.0	30.00	1.50	2.25
70.0	33.20	1.66	2.76
80.0	35.80	1.79	3.20
100.0	39.80	1.99	3.96

Plot a graph of T^2 / s^2 (y-axis) against d / cm (x-axis). You do **not** need to start your axes at the origin (0,0).



[4]

(d) Determine the gradient G of the line. Show clearly on the graph how you obtained the necessary information.

G = ... [2]

(e) Calculate the acceleration of free fall g in m/s^2 using the equation $g = \frac{0.395}{G}$, where G is your gradient from **(d)**.

Write down the value of g to a suitable number of significant figures for this experiment.

g = ...m/s^2 [2]

[Total: 12]

2 A student determines the resistance of a resistance wire.

She uses the circuit shown in Fig. 2.1.

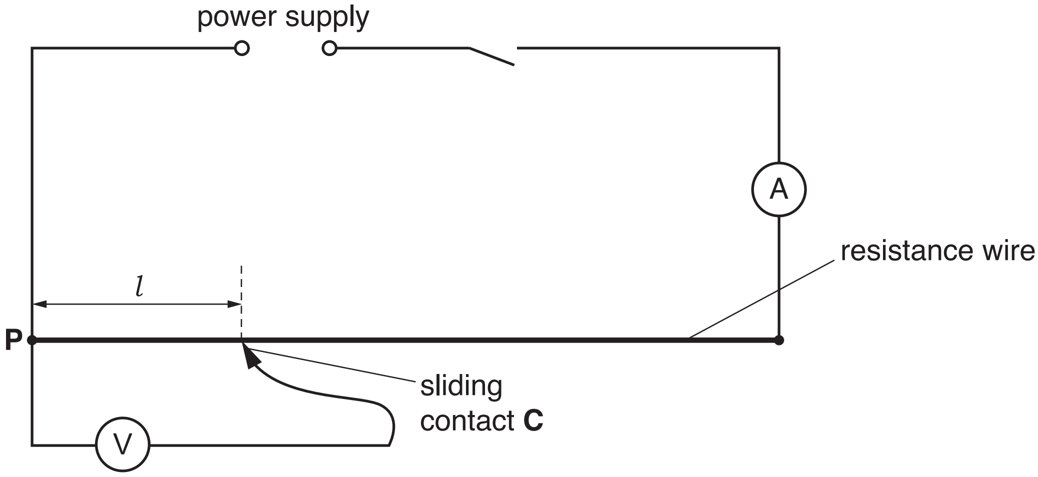


Fig. 2.1

(a) She measures the current I in the circuit. Write down the current reading shown in Fig. 2.2.

I = ... [2]

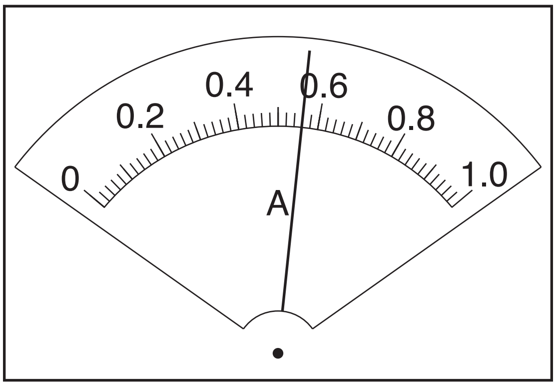


Fig. 2.2

(b) She places the sliding contact **C** at a distance l = 20.0 cm from **P**.

She records the potential difference V across the length l of the resistance wire.

She repeats the procedure using l values of 40.0 cm, 60.0 cm, 80.0 cm and 100.0 cm.

The readings are shown in Table 2.1.

Table 2.1

l / cm	V /	R /
20.0	0.60	
40.0	1.10	1.96
60.0	1.71	3.05
80.0	2.30	4.11
100.0	2.78	4.96

(i) Calculate, and record in Table 2.1, the resistance R of 20.0 cm of the resistance wire. Use the equation $R = \frac{V}{I}$.

[2]

(ii) Complete the column headings in Table 2.1. [1]

(c) Look carefully at the values of l and R in Table 2.1.

(i) Tick **one** box to show your conclusion from the results.

☐ R is constant within the limits of experimental accuracy.

☐ R is directly proportional to l within the limits of experimental accuracy.

☐ R decreases as l increases.

☐ There is no simple relationship between R and l.

[1]

(ii) Justify your conclusion by reference to the results.

....

....

.... [1]

(d) **(i)** Use the values in Table 2.1 to estimate the potential difference V_e across 50.0 cm of the resistance wire.

V_e = ... [1]

(ii) Calculate the resistance of 50.0 cm of the resistance wire using the equation $R = \frac{V_e}{I}$.

Use the value of current I from part **(a)**. Give your answer to a suitable number of significant figures for this experiment and include the unit.

R = ... [2]

(e) In this type of experiment, it is sensible to keep the temperature of the resistance wire as close to room temperature as possible. Suggest **one** simple way to minimise the rise in temperature of the resistance wire.

....

.... [1]

[Total: 11]

3 A student determines the focal length *f* of a lens.

Fig. 3.1 shows the set-up.

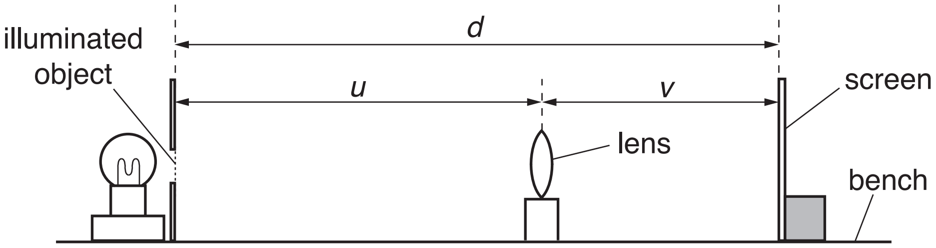


Fig. 3.1

(a) • He places the screen at a fixed distance from the illuminated object.

• He places the lens between the object and the screen so that the lens is very close to the screen.

• He moves the lens slowly away from the screen until a clearly focused image is formed on the screen.

• He measures the distance *u* between the object and the centre of the lens and the distance *v* between the centre of the lens and the screen. The readings are shown in Table 3.1.

(i) On Fig. 3.1, measure the distance *d* between the illuminated object and the screen.

d = ... [1]

(ii) Fig. 3.1 is drawn 1/10th actual size. Calculate the actual distance *D* between the illuminated object and the screen.

D = ... [1]

(b) Calculate, and record in Table 3.1, the focal length *f* of the lens using the equation $f = \frac{uv}{D}$. [1]

(c) • The student keeps the screen at the same fixed distance *D* from the illuminated object.

• He moves the lens slowly away from the screen. The image goes out of focus.

• He continues to move the lens slowly away from the screen until another clearly focused image is formed on the screen.

• He records the new readings of *u* and *v* in Table 3.1.

(i) Calculate, and record in Table 3.1 the new value for the focal length *f* of the lens using the equation $f = \frac{uv}{D}$. [1]

Table 3.1

u/cm	v/cm	f/cm
59.8	20.4	
19.8	60.0	

(ii) Calculate the average value f_A of the focal length of the lens. Give your answer to a suitable number of significant figures for this experiment.

f_A = ... cm [2]

(d) State **one** precaution that you would take to obtain accurate readings in this experiment.

....

.... [1]

(e) Another student wants to obtain more measurements for u and for v to check the value for the focal length f of the lens. The student moves the screen a distance of 40.0 cm to the right.

(i) Calculate the new value for the distance D between the illuminated object and the screen.

D = ... cm [1]

(ii) The student moves the lens to a new position which is a distance from the object u = 22.2 cm. He observes the image on the screen and says it is clearly focussed at a distance v = 97.9 cm.

Calculate the new value of the focal length f of the lens using $f = \frac{uv}{D}$.

f = ... cm [1]

(iii) State and explain briefly whether the values for f_A and f in **(e)(ii)** are the same within the limits of experimental accuracy.

....

....

.... [1]

[Total: 10]

4 A student investigates the time taken for ice cubes in a container to melt using different insulating materials on the container.

The following apparatus is available:

a copper container
a variety of insulating materials that can be wrapped round the copper container
a thermometer
a stopwatch
a supply of ice cubes

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

Plan an experiment to investigate the time taken for ice cubes to melt using different insulating materials.

In your plan, you should:

- draw a diagram of the apparatus used
- explain briefly how you would carry out the investigation
- state the key variables that you would control
- draw a table, or tables, 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 readings to reach a conclusion.

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