6 A metal wire is tied to a rod and clamped so that the wire hangs vertically, as shown in Fig. 6.1.

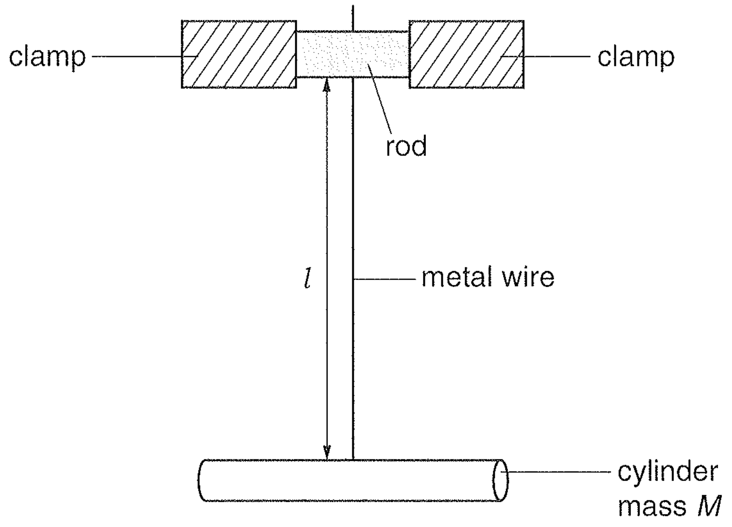

Fig. 6.1

A cylinder of mass M is attached to the lower end of the wire.
The length of the wire supporting the cylinder is l.
The cylinder is rotated through a small angle so that the wire twists. The cylinder is released and it oscillates, as illustrated in Fig. 6.2.

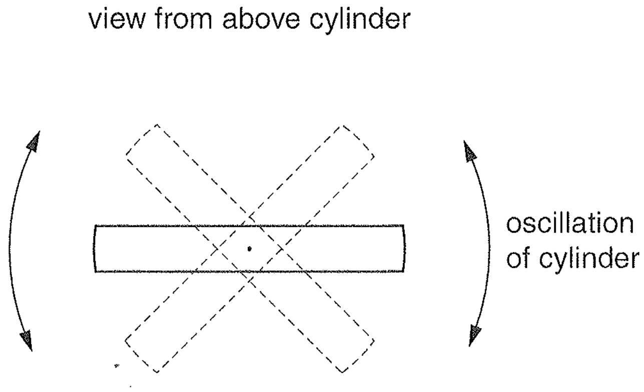

Fig. 6.2

The variation with M of the period T of the oscillations of the cylinder is shown in Fig. 6.3.

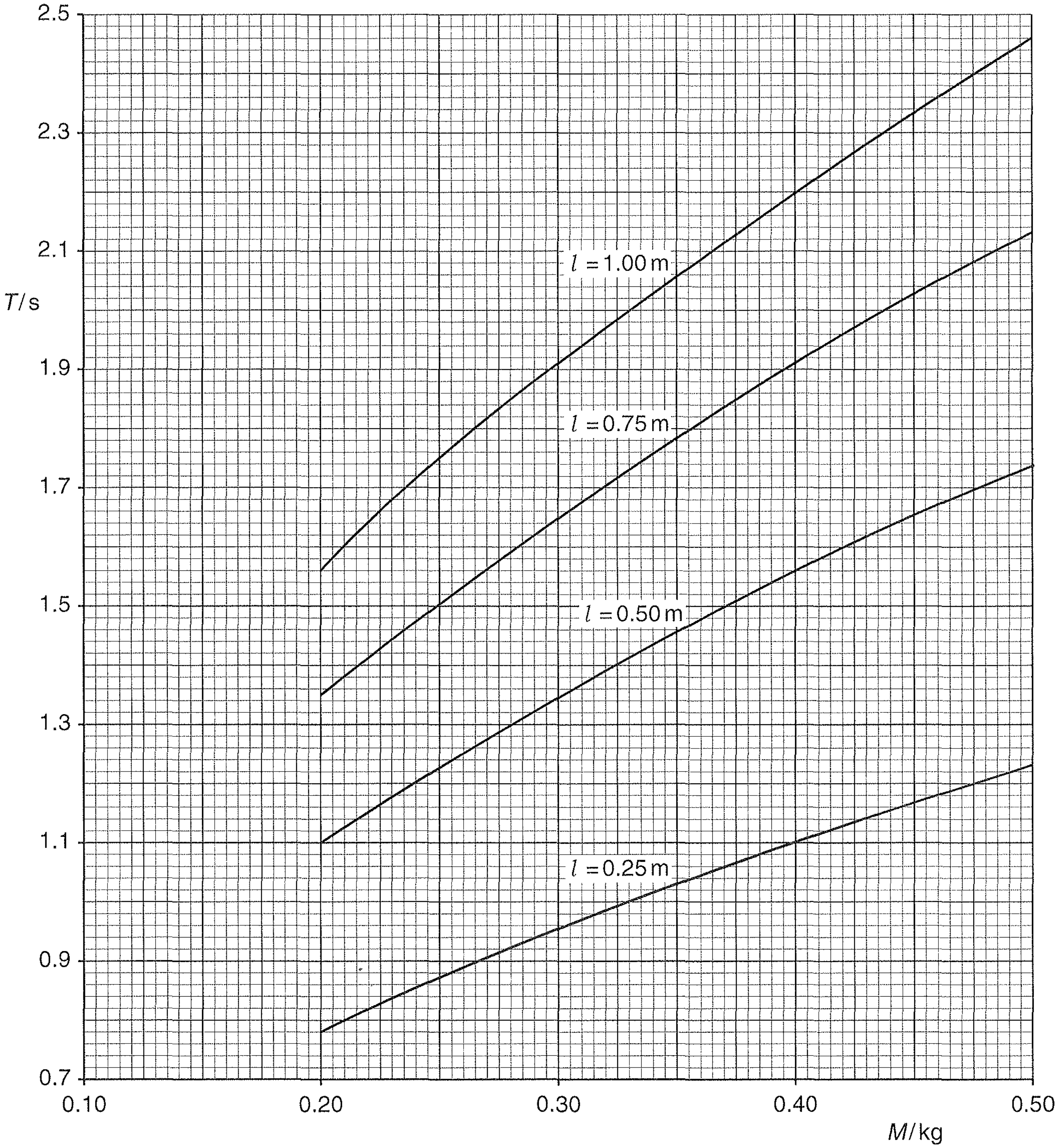

Fig. 6.3

The variation with M of the period T is shown for lengths l of 0.25 m, 0.50 m, 0.75 m and 1.00 m. The diameter of the wire is 1.20 mm.

(a) **(i)** Use Fig. 6.3 to describe qualitatively the variation of period T with the length l of the wire.

....

.... [1]

(ii) Use data from Fig. 6.3 to show, without drawing a graph, that T is proportional to $\sqrt{M}$.

[2]

(iii) Use data from Fig. 6.3 to show, without drawing a graph, that T is proportional to $\sqrt{l}$.

[1]

(b) The quantities T, M and l are thought to be related by

$$T = Kd^{\mathrm{n}}(Ml)^{1/2}$$

where K is a constant, d is the diameter of the wire and n is an integer.

An experiment is carried out to determine n and K.
The values of M and l are kept constant at 0.40 kg and 0.50 m respectively.

Fig. 6.4 shows the readings obtained.

T/s	d/mm	lg(T/s)	lg(d/m)
0.56	2.02	–0.25	–2.69
0.83	1.64	–0.08	–2.79
1.10	1.42	0.04	–2.85
	1.20		
2.65	0.92	0.42	–3.04
4.31	0.72	0.63	–3.14

Fig. 6.4

(i) Complete Fig. 6.4 for the diameter of 1.20 mm. [1]

(ii) Fig. 6.5 is a graph of some of the data of Fig. 6.4.

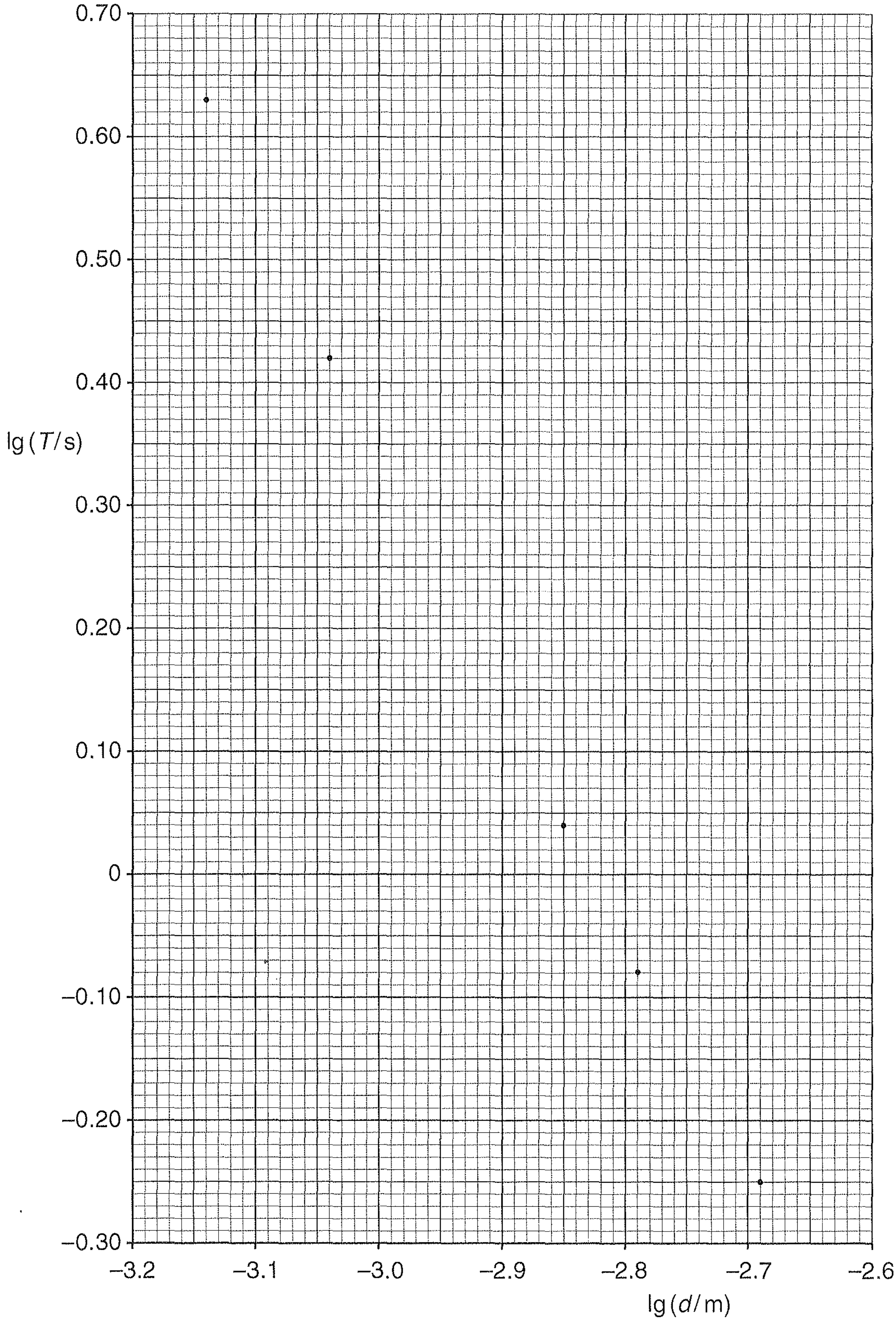

Fig. 6.5

On Fig. 6.5,

1. plot the point corresponding to d = 1.20 mm,

2. draw the line of best fit for all the points.

[2]

(iii) Determine the gradient of the line you have drawn on Fig. 6.5.

gradient = ... [2]

(c) **(i)** Explain how n is related to the gradient.

....

.... [1]

(ii) State the value of n. n = ... [1]

(d) Use Fig. 6.5 and the data given for the wires used in the experiment in **(b)** to determine K in SI units.

K = ...SI units [2]

(e) The oscillations of the cylinder shown in Fig. 6.2 are thought to be simple harmonic.

(i) State the measurements that could be made to support this theory.

....

....

....

.... [1]

(ii) Explain how the measurements in **(i)** are used to support this theory.

....

....

.... [1]