3 One end of a light spring is fixed to a support. A mass is attached to the other end of the spring. The arrangement is shown in Fig. 3.1.

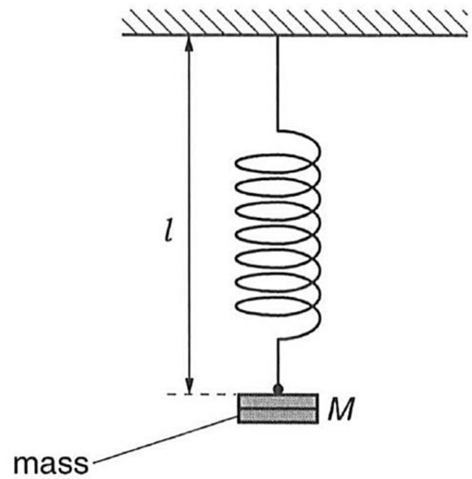

Fig. 3.1

This arrangement is used to determine the length l of the spring when mass M is attached to the spring. The procedure is repeated for different values of M. The variation of mass M with length l is shown in Fig. 3.2.

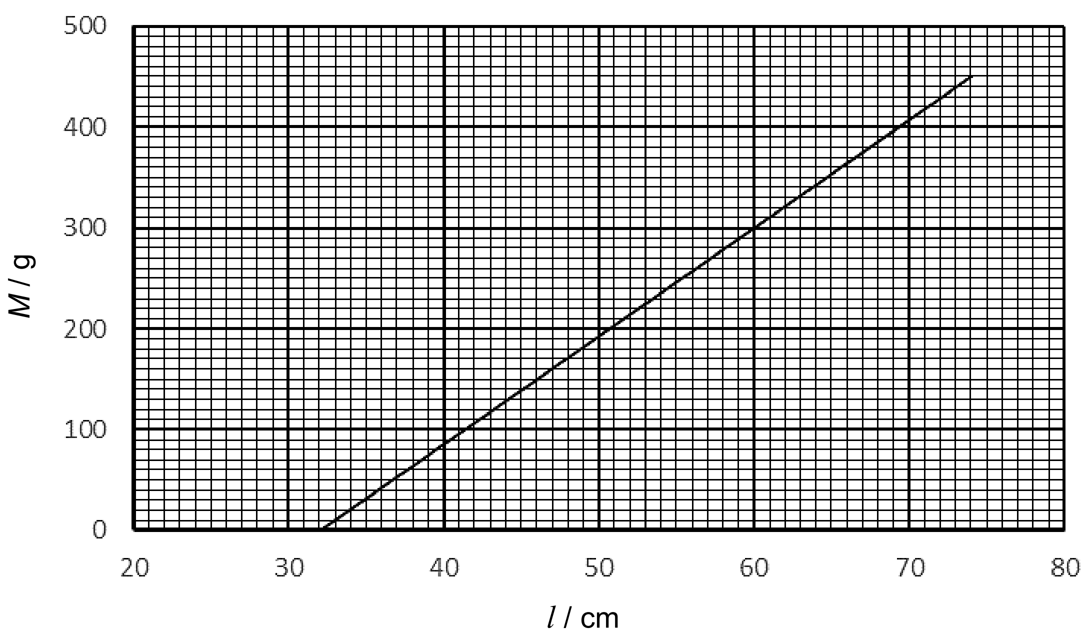

Fig. 3.2

The spring constant k of the spring is given to be 10.5 N m^{-1}.

(a) A mass of 450 g is attached to the spring and is held at rest with length l of 50.0 cm. The mass is then released and the mass oscillates freely. The angular frequency of the spring-mass system is given by the formula

$$\omega = \sqrt{\frac{k}{m}}$$

(i) Calculate the frequency of the system.

frequency = ……………..………..……..Hz [2]

(ii) Using energy considerations, calculate the speed of the mass during its oscillation when the spring is extended to a length l of 80.0 cm.

speed = ……………..…………..……….. m s^{-1} [4]

(b) **(i)** On Fig. 3.3, sketch the displacement-time curve for the system depicted in **(a)**.

Label this curve **W**.

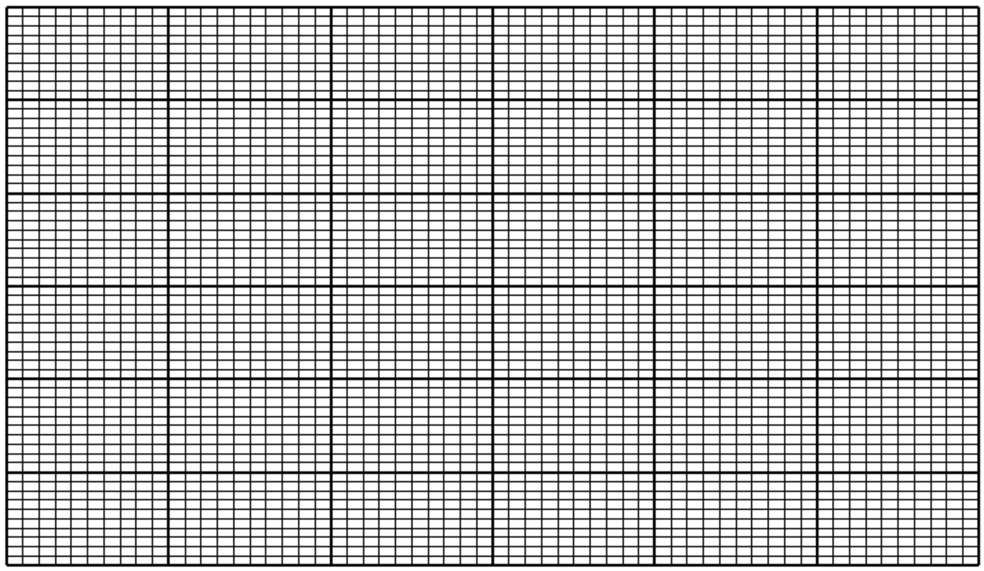

Fig. 3.3

(ii) A student affixed a piece of light cardboard beneath the mass, that extended beyond the perimeter of the mass.

Assuming that the spring constant *k* is unchanged, on the same axes in Fig. 3.3, sketch the displacement-time curve for the mass with cardboard.

Label this curve **X**. [3]