**1** **(a)** A student uses the following setup in Fig. 1.1 to find the spring constant $k$ of a spring.

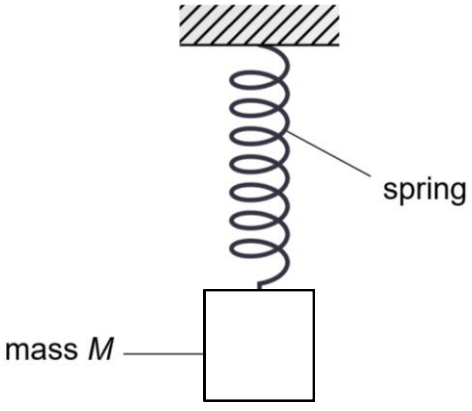


**Fig. 1.1**

The student obtained the following results from his experiment:

Length of spring when no mass is added: $L_1$ = (1.3 ± 0.1) cm

Length of spring when mass $M$ is added: $L_2$ = (3.7 ± 0.2) cm

Mass of $M$ = (98.5 ± 0.2) g

You may assume that the elastic limit of the spring has not been exceeded in his experiment.

**(i)** Show that the spring constant $k$ of the spring is 40.3 N m$^{-1}$.

[2]

**(ii)** Calculate the actual uncertainty in $k$.

actual uncertainty in $k$ = ................................ N m$^{-1}$ [2]

**(iii)** State the value of $k$ and its actual uncertainty to the appropriate precision.

$k$ = ( ............................ ± ................................ ) N m$^{-1}$ [1]

**(b)** Fig. 1.2 shows a wooden cube P of volume *V* floating on the surface of a liquid with density $\rho$. 30% of the volume of the cube is above the surface of the liquid.

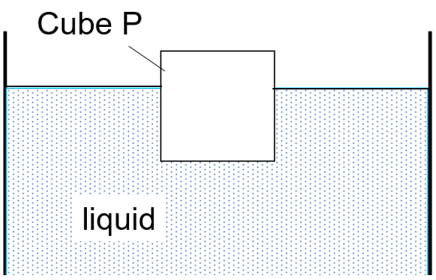


**Fig. 1.2**

The top face of cube P is now connected to a light string, which passes over a smooth pulley and supports an identical cube Q at its other end, which rests on a smooth inclined plane at an angle $\theta$ to the horizontal, as shown in Fig 1.3.

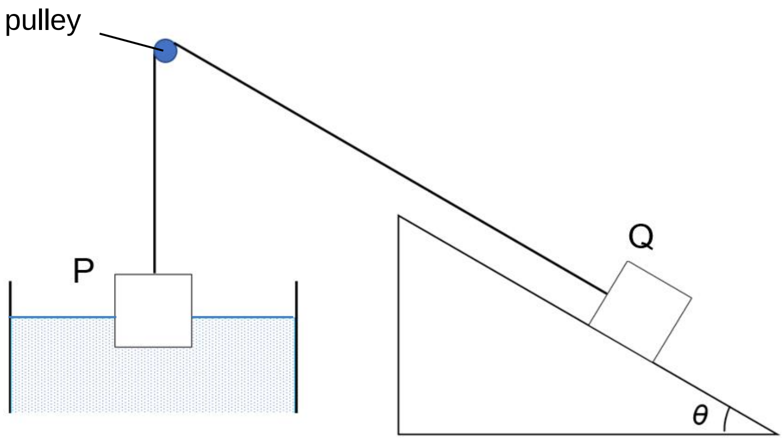


**Fig. 1.3**

At its new equilibrium position, 60% of the volume of Cube P is now above the surface of the liquid.

**(i)** On Fig. 1.4, label clearly all forces acting on Cube P when it is at its new equilibrium position.

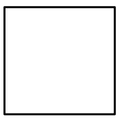

**Fig. 1.4** [2]

**(ii)** State the expression for the weight $W$ of cube P in terms of $V$ and $\rho$.

[1]

**(iii)** Hence, show that the tension in the string is $\frac{3}{7}W$.

[2]

**(iv)** Determine the value of $\theta$.

$\theta$ = ................................ ° [1]

[Total :11]