**8** Fig. 8.1 shows block A of mass $m$ at rest on a frictionless horizontal surface and connected to a mechanical oscillator through a horizontal light spring with spring constant $k$. The mechanical oscillator is fixed in position.

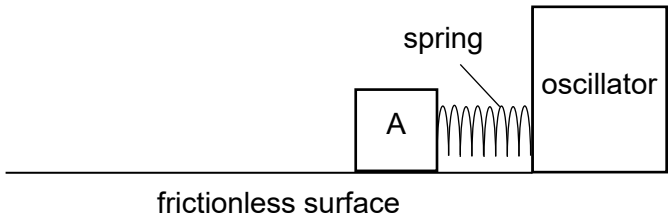


**Fig. 8.1**

**(a)** The mechanical oscillator is not switched on.
Block A is displaced from its original position along the axis of the spring and set into oscillation.

**(i)** For a displacement $x$, write down an expression for the force $F$ exerted by the spring on block A.

.....

[1]

**(ii)** Use Newton's second law of motion to show that block A will oscillate with simple harmonic motion. Assume that air resistance on block A is negligible.

[2]

**(iii)** Show that the period $T$ of the oscillations of block A is given by:

$$T = 2\pi\sqrt{\frac{m}{k}}.$$

[2]

**(b)** Block A is now brought to rest at the equilibrium position. Block B of mass 18 g travels to the right with speed 5.3 m $s^{-1}$ as shown in Fig. 8.2.

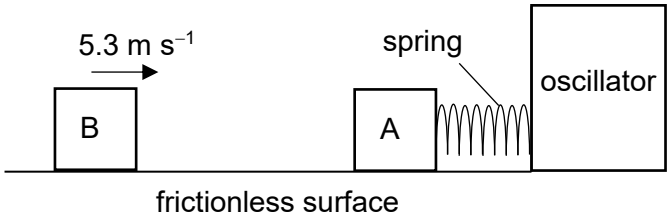


**Fig. 8.2**

The two blocks collide and stick together.
The mass of block A is 35 g and the force constant of the spring is 25 N $m^{-1}$.

**(i)** Determine:

**1.** the maximum compression of the spring

maximum compression = ..... m [3]

**2.** the time it takes after the collision to reach this maximum compression.

time = ..... s [2]

**(ii)** On Fig. 8.3, sketch the variation with time $t$ of the magnitude of the acceleration $a$ of the blocks just after they collide to the time when the spring is at its maximum compression. Label the axes with appropriate values.

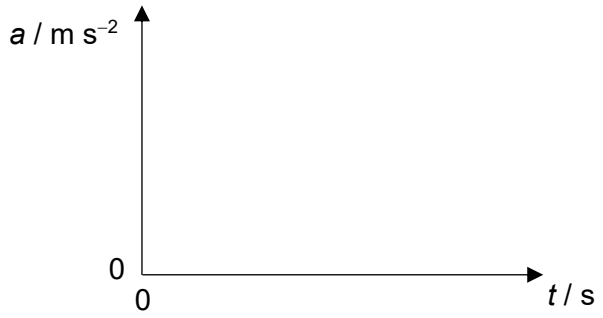


**Fig. 8.3**

[2]

**(c)** Block B is now placed on top of block A as shown in Fig. 8.4. Block A is again displaced from its original position and set into oscillation.

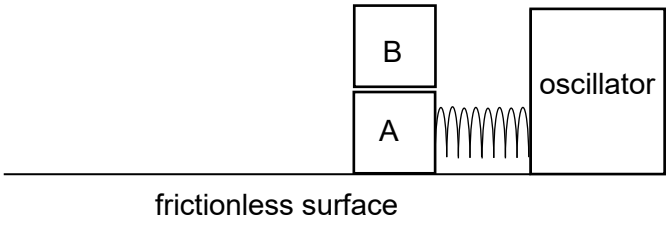


**Fig. 8.4**

**(i)** The maximum frictional force between the two blocks is $9.5 \times 10^{-2}$ N.

Determine the maximum amplitude of oscillations $x_0$ such that block B remains stationary relative to block A.

$x_0$ = ..... m [3]

**(ii)** Block B is now attached to block A. The two blocks are set into oscillation by the mechanical oscillator such that both blocks move together. As the frequency *f* of the mechanical oscillator is varied, the amplitude is recorded.

**1.** It is observed that the amplitude becomes very large at a particular value of *f*.

Explain this phenomenon.

.....

.....

.....

..... [2]

**2.** On Fig. 8.5, sketch the variation of the amplitude with *f*.

Label the frequency axis with an appropriate value and label this line P.

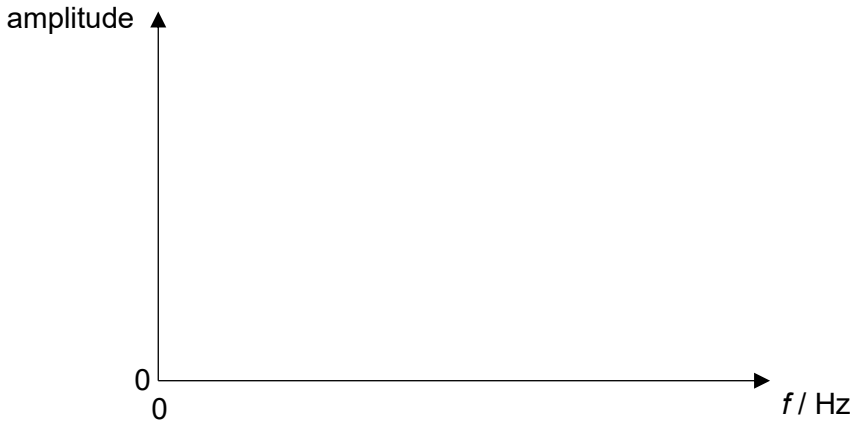

**Fig. 8.5**

[2]

**3.** A sheet of cardboard of negligible mass is now fixed to the blocks to cause greater damping.

On Fig. 8.5, sketch the variation of the amplitude with *f* to show the effect of this change. Label this line Q.

[1]

[Total: 20]