5 A steel ball on the end of a thin string oscillates with small oscillations, as shown in Fig. 5.1.

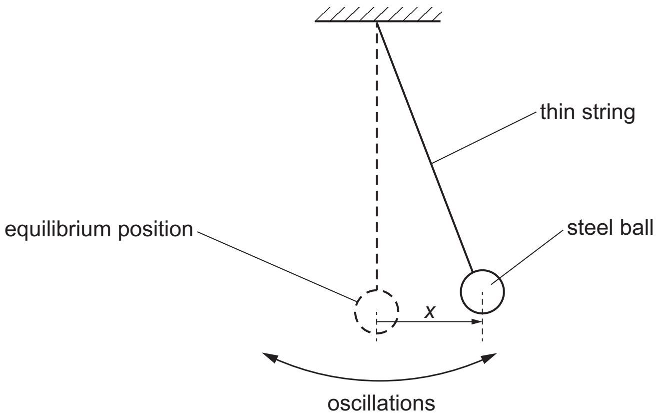

Fig. 5.1 (not to scale)

The displacement of the centre of the ball from its equilibrium position is x.

(a) Fig. 5.2 shows the variation with x of the acceleration a of the ball.

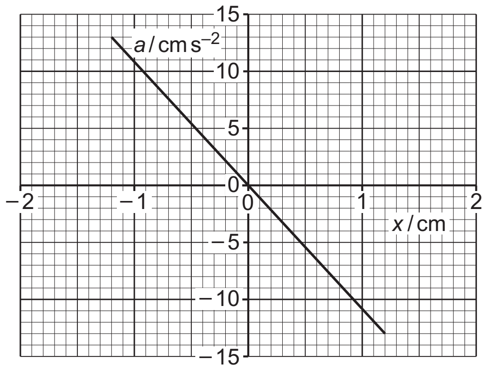

Fig. 5.2

(i) Explain how Fig. 5.2 shows that the oscillations of the ball are simple harmonic.

....

....

.... [2]

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(ii) Determine the period T of the oscillations.

T = ... s [3]

(b) At time $t = 0$, when the displacement of the ball has its maximum value, the ball is immersed in a trough containing thick oil so that the ball is just below the surface of the oil. This results in the subsequent motion of the ball being heavily damped.

(i) State what is meant by damping.

....

....

.... [2]

(ii) On Fig. 5.3, sketch a possible variation of the displacement x of the ball with t between $t = 0$ and $t = 2T$.

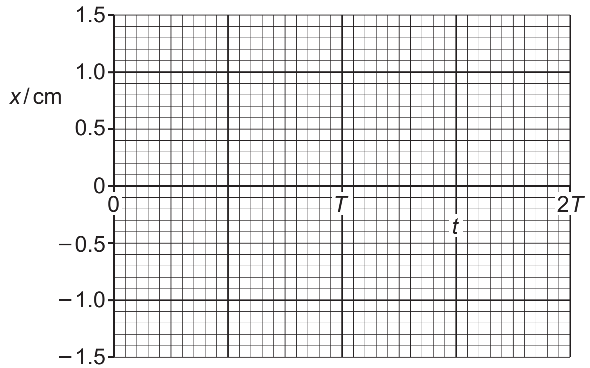

Fig. 5.3

[3]

[Total: 10]

7 A bar magnet is suspended from a spring. One pole of the magnet oscillates freely in a coil of wire, as shown in Fig. 7.1.

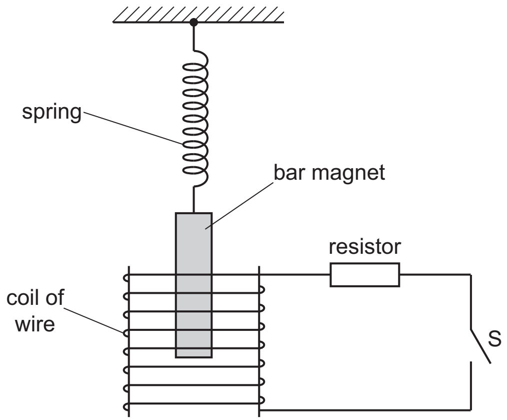

Fig. 7.1

The switch S is initially open.

(a) The switch S is now closed. As a result, the oscillations of the magnet are lightly damped.

(i) State what is meant by damping.

....

....

.... [2]

(ii) Describe what is observed to indicate that the damping is light.

....

.... [1]

(iii) By reference to electromagnetic induction and to conservation of energy, explain why the oscillations are damped.

....

....

....

.... [3]

(b) The procedure in **(a)** is repeated after replacing the resistor with one of greater resistance.

Suggest, with a reason, the effect of this change on the oscillations.

....

....

.... [2]

[Total: 8]

4 A heavy metal sphere of mass 0.81 kg is suspended from a string. The sphere is undergoing small oscillations from side to side, as shown in Fig. 4.1.

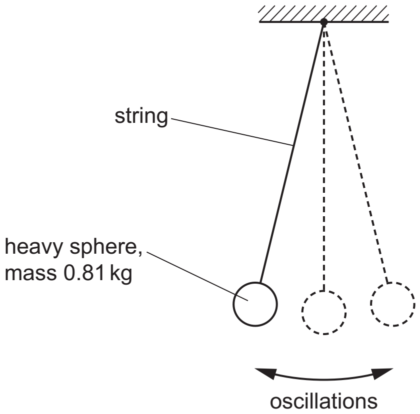

Fig. 4.1

The oscillations of the sphere may be considered to be simple harmonic with amplitude 0.036 m and period 3.0 s.

(a) State what is meant by simple harmonic motion.

....

....

.... [2]

(b) Calculate:

(i) the angular frequency of the oscillations

angular frequency = ... rad s^{-1} [2]

(ii) the total energy of the oscillations.

total energy = ... J [2]

(c) The suspended sphere is now lowered into water. The sphere is given a sideways displacement of +0.036 m from its equilibrium position and is then released at time t = 0. The water causes the motion of the sphere to be critically damped.

On Fig. 4.2, sketch the variation of the displacement x of the sphere from its equilibrium position with t from t = 0 to t = 6.0 s.

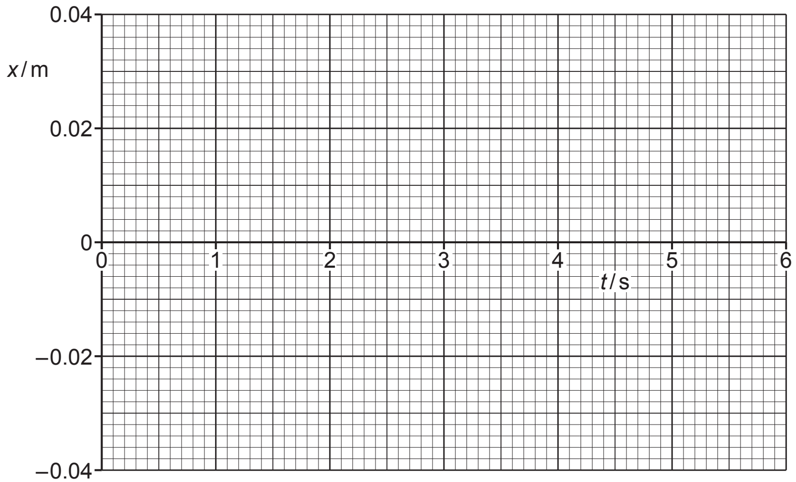

Fig. 4.2

[3]

[Total: 9]