Oscillations

Question paper 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Oscillations
Sub Topic	
Paper Type	Theory
Booklet	Question paper 1

Time Allowed: **59 minutes**

Score: **/49**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** For an oscillating body, state what is meant by

(i) forced frequency,

.....

..... [1]

(ii) natural frequency of vibration,

.....

..... [1]

(iii) resonance.

.....

.....

..... [2]

(b) State and explain one situation where resonance is useful.

.....

.....

.....

..... [2]

(c) In some situations, resonance should be avoided.

State one such situation and suggest how the effects of resonance are reduced.

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..... [2]

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

.....

.....

.....[2]

(b) The variation with time ***t*** of the displacement ***x*** of two oscillators P and Q is shown in Fig. 4.1.

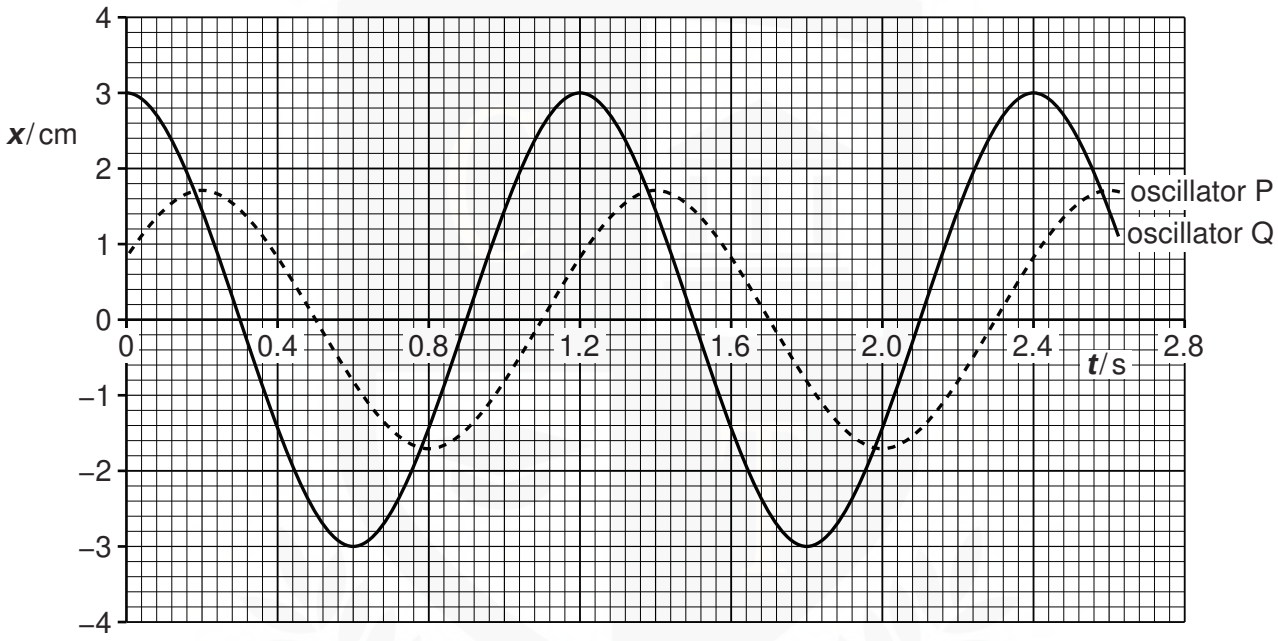

Fig. 4.1

The two oscillators each have the same mass.

Use Fig. 4.1 to determine

(i) the phase difference between the two oscillators,

phase difference = ... rad [1]

(ii) the maximum acceleration of oscillator Q,

maximum acceleration = ... $m s^{-2}$ [2]

(iii) the ratio

$$\frac{\text{maximum kinetic energy of oscillations of Q}}{\text{maximum kinetic energy of oscillations of P}}.$$

ratio = ... [2]

(c) Use data from **(b)** to sketch, on the axes of Fig. 4.2, the variation with displacement ***x*** of the acceleration ***a*** of oscillator Q.

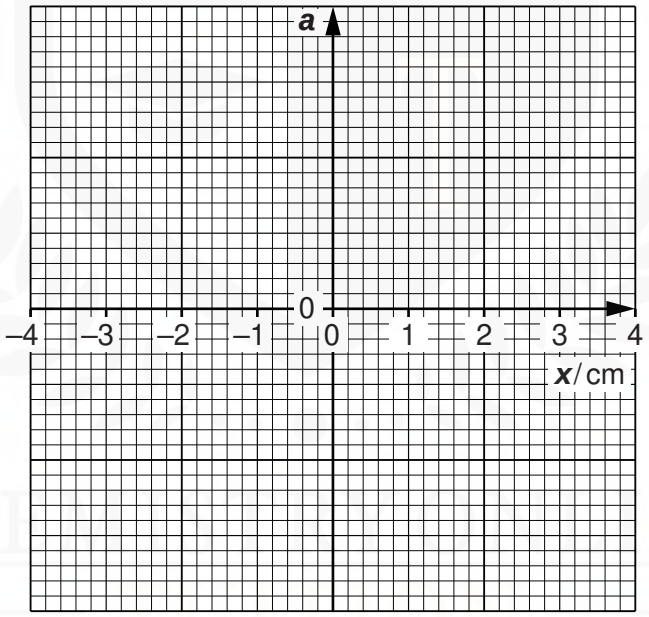

Fig. 4.2

[2]

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

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..... [2]

(b) A small ball rests at point P on a curved track of radius ***r***, as shown in Fig. 4.1.

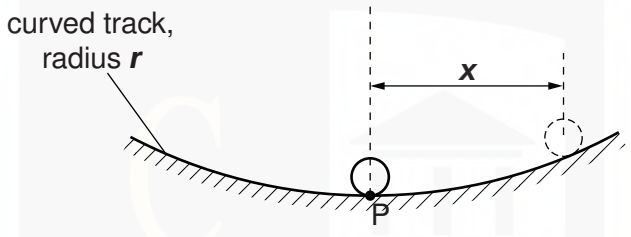

Fig. 4.1

The ball is moved a small distance to one side and is then released. The horizontal displacement ***x*** of the ball is related to its acceleration ***a*** towards P by the expression

$$a = -\frac{gx}{r}$$

where ***g*** is the acceleration of free fall.

(i) Show that the ball undergoes simple harmonic motion.

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.....

..... [2]

(ii) The radius ***r*** of curvature of the track is 28 cm.

Determine the time interval τ between the ball passing point P and then returning to point P.

τ = ... s [3]

(c) The variation with time ***t*** of the displacement ***x*** of the ball in **(b)** is shown in Fig. 4.2.

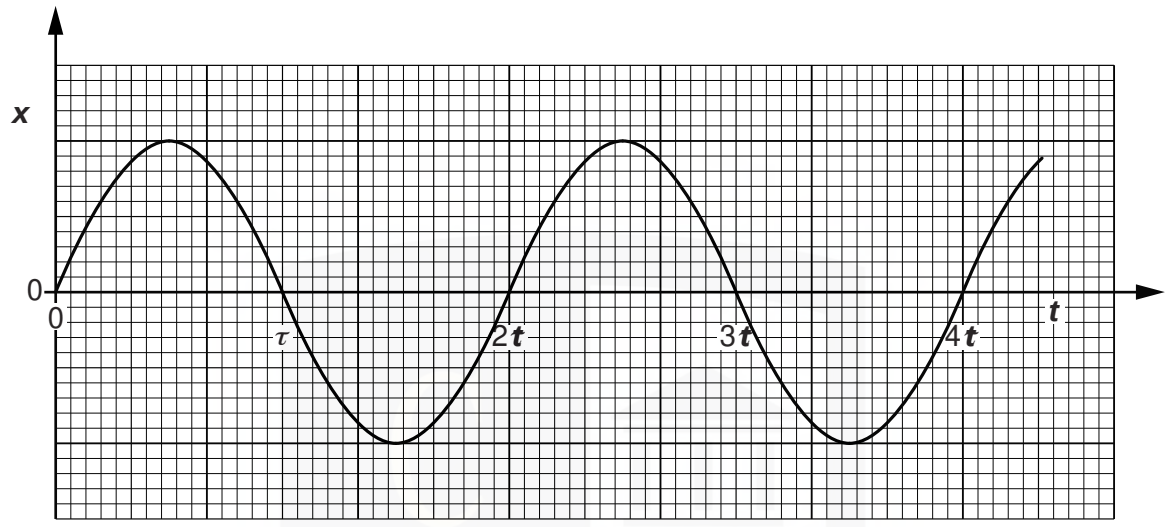

Fig. 4.2

Some moisture now forms on the track, causing the ball to come to rest after approximately 15 oscillations.

On the axes of Fig. 4.2, sketch the variation with time ***t*** of the displacement ***x*** of the ball for the first two periods after the moisture has formed. Assume the moisture forms at time ***t*** = 0. [3]

4 A light spring is suspended from a fixed point. A bar magnet is attached to the end of the spring,

as shown in Fig. 1.1.

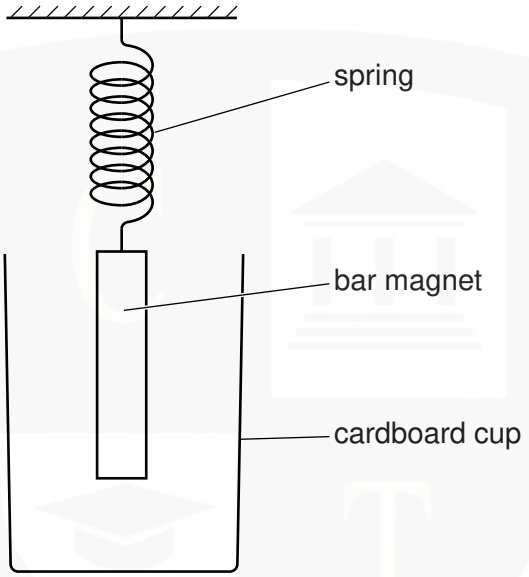

Fig. 1.1

In order to shield the magnet from draughts, a cardboard cup is placed around the magnet but does not touch it.

The magnet is displaced vertically and then released. The variation with time ***t*** of the vertical displacement ***y*** of the magnet is shown in Fig. 1.2.

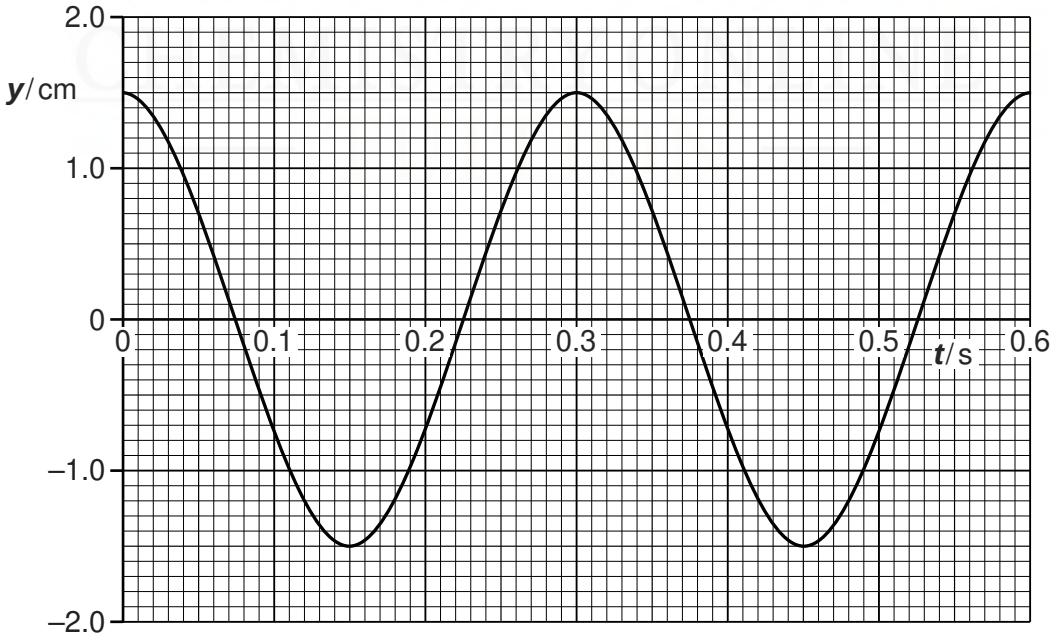

Fig. 1.2

The mass of the magnet is 130 g.

(a) For the oscillations of the magnet, use Fig. 1.2 to

(i) determine the angular frequency ω,

ω = ... rad s^{-1} [2]

(ii) show that the maximum kinetic energy of the oscillating magnet is 6.4 mJ.

[2]

(b) The cardboard cup is now replaced with a cup made of aluminium foil.
During 10 complete oscillations of the magnet, the amplitude of vibration is seen to decrease to 0.75 cm from that shown in Fig. 1.2. The change in angular frequency is negligible.

(i) Use Faraday's law of electromagnetic induction to explain why the amplitude of the oscillations decreases.

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.....

..... [3]

(ii) Show that the loss in energy of the oscillating magnet is 4.8 mJ.

[2]

(c) The mass of the aluminium cup in **(b)** is 6.2 g. The specific heat capacity of aluminium is $910\,J\,kg^{-1}\,K^{-1}$.
The energy in **(b)(ii)** is transferred to the cup as thermal energy.
Calculate the mean rise in temperature of the cup.

temperature rise = ... K [2]

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

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..... [2]

(b) A trolley is attached to two extended springs, as shown in Fig. 4.1.

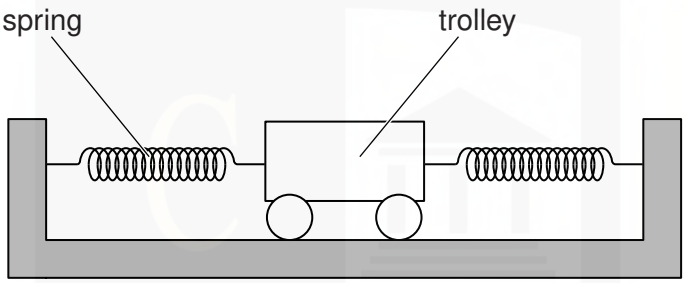

Fig. 4.1

The trolley is displaced along the line joining the two springs and is then released. At one point in the motion, a stopwatch is started. The variation with time ***t*** of the velocity ***v*** of the trolley is shown in Fig. 4.2.

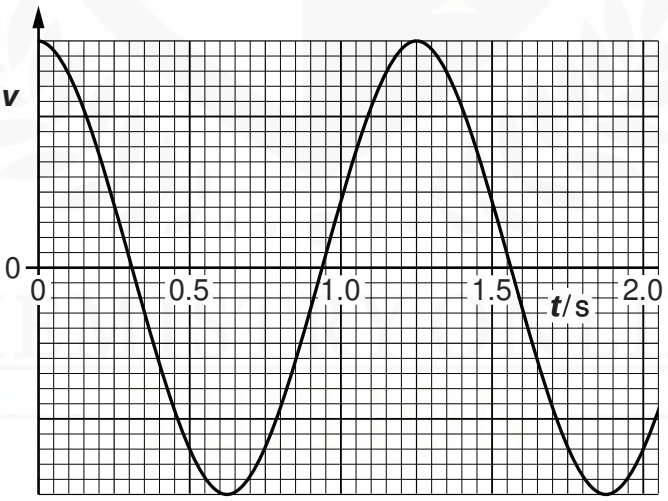

Fig. 4.2

The motion of the trolley is simple harmonic.

(i) State one time at which the trolley is moving through the equilibrium position and also state the next time that it moves through this position.

.....s and .....s [1]

(ii) The amplitude of vibration of the trolley is 3.2 cm.

Determine

1. the maximum speed v_0 of the trolley,

v_0 = ... $cm\,s^{-1}$ [3]

2. the displacement of the trolley for a speed of $\frac{1}{2}v_0$.

displacement = ... cm [2]

(c) Use your answers in **(b)** to sketch, on the axes of Fig. 4.3, a graph to show the variation with displacement x of the velocity v of the trolley.

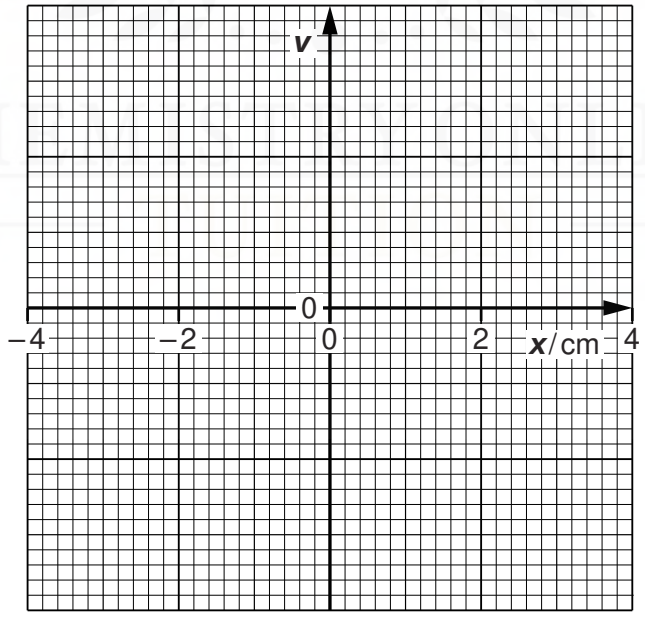

Fig. 4.3

[2]