Oscillations

Mark Scheme 3

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Oscillations
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 3

Time Allowed: **58 minutes**

Score: **/48**

Percentage: **/100**

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

1 **(a** energy $= \frac{1}{2}m\omega^2a^2$ and $\omega = 2\pi f$ C1

$= \frac{1}{2} \times 37 \times 10^{-3} \times (2\pi \times 3.5)^2 \times (2.8 \times 10^{-2})^2$ M1

$= 7.0 \times 10^{-3}$ J A0 [2]

(allow $2\pi \times 3.5$ shown as 7π)

Energy = $\frac{1}{2}\, mv^2$ and $v = r\omega$ (C1)

Correct substitution (M1)

Energy = 7.0×10^{-3} J (A0)

(b) $E_K = E_P$

$\frac{1}{2}m\omega^2 (a^2 - x^2) = \frac{1}{2}m\omega^2x^2$ *or* E_K or E_P = 3.5 mJ C1

$x = a/\sqrt{2} = 2.8/\sqrt{2}$ *or* $E_K = \frac{1}{2}m\omega^2 (a^2 - x^2)$ *or* $E_P = \frac{1}{2}m\omega^2x^2$ C1

= 2.0 cm A1 [3]

(E_K or E_P = 7.0 mJ scores 0/3)

Allow: k = 17.9 (C1)

$E = \frac{1}{2}\, kx^2$ (C1)

x = 2.0 cm (A1)

(c) graph: horizontal line, y-intercept = 7.0 mJ with end-points of line at +2.8 cm and –2.8 cm [1]

(ii) graph: reasonable curve B1

with maximum at (0,7.0) end-points of line at (–2.8, 0)

and (+2.8, 0) B1 [2]

(iii) graph: inverted version of **(ii)** M1

with intersections at (–2.0, 3.5) and (+2.0, 3.5) A1 [2]

(Allow marks in **(iii)**, but not in **(ii)**, if graphs K & P are not labelled)

(d) gravitational potential energy B1 [1]

2 **(a) (i)** amplitude remains constant — B1 [1]

(ii) amplitude decreases gradually — M1
light damping — A1 [2]

(iii) period = 0.80 s — C1
frequency = 1.25 Hz *(period not 0.8 s, then 0/2)* — A1 [2]

(b) (i) (induced) e.m.f. is proportional to — M1
rate of change/cutting of (magnetic) flux (linkage) — A1 [2]

(ii) a current is induced in the coil — M1
as magnet moves in coil — A1
current in resistor gives rise to a heating effect — M1
thermal energy is derived from energy of oscillation of the magnet — A1 [4]

3 (a) acceleration proportional to displacement/distance from fixed point — M1
and in opposite directions/directed towards fixed point — A1 [2]

(b) energy = $\frac{1}{2}m\omega^2 x_0^2$ and $\omega = 2\pi f$ — C1
$= \frac{1}{2} \times 5.8 \times 10^{-3} \times (2\pi \times 4.5)^2 \times (3.0 \times 10^{-3})^2$ — C1
$= 2.1 \times 10^{-5}$ J — A1 [3]

(c) (i) at maximum displacement — M1
above rest position — A1 [2]

(ii) acceleration $= (-)\omega^2 x_0$ and acceleration = 9.81 or g — C1
$9.81 = (2\pi \times 4.5)^2 \times x_0$
$x_0 = 1.2 \times 10^{-2}$ m — A1 [2]

4 **(a)** acceleration / force proportional to displacement from a fixed point — M1
acceleration / force (always) directed towards that fixed point / in opposite direction to displacement — A1 [2]

(b) (i) $A\rho g / m$ is a constant and so acceleration proportional to x — B1
negative sign shows acceleration towards a fixed point / in opposite direction to displacement — B1 [2]

(ii) $\omega^2 = (A\rho g / m)$ — C1
$\omega = 2\pi f$ — C1
$(2 \times \pi \times 1.5)^2 = (\{4.5 \times 10^{-4} \times 1.0 \times 10^3 \times 9.81\} / m)$ — C1
$m = 50\,\text{g}$ — A1 [4]

5 **(a (i)** resonance [1]

(ii) amplitude 16 mm <u>and</u> frequency 4.6 Hz [1]

(b) (i) $a = (-)\omega^2 x$ and $\omega = 2\pi f$ — C1
$a = 4\pi^2 \times 4.6^2 \times 16 \times 10^{-3}$ — C1
$= 13.4\,\text{m s}^{-2}$ — A1 [3]

(ii) $F = ma$ — C1
$= 50 \times 10^{-3} \times 13.4$
$= 2.0\,\text{N}$ — A [2]

(c) line always 'below' given line and never zero — M1
peak is at 4.6 Hz (or slightly less) and flatter — A1 [2]