Oscillations

Mark Scheme 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Oscillations
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 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) (i)** frequency at which object is made to vibrate/oscillate — B1 [1]

(ii) frequency at which object vibrates when free to do so — B1 [1]

(iii) maximum amplitude of vibration of oscillating body — B1
when forced frequency equals natural frequency (of vibration) — B1 [2]

(b) e.g. vibration of quartz/piezoelectric crystal (*what is vibrating*) — M
either for accurate timing
or maximise amplitude of ultrasound waves (*why it is useful*) — A [2]

(c) e.g. vibrating metal panels (*what is vibrating*) — M
either place strengthening struts across the panel
or change shape/area of panel (*how it is reduced*) — A [2]

2 **(a)** displacement (directly) proportional to acceleration/force — M1
either displacement and acceleration in opposite directions
or acceleration (always) towards a (fixed) point — A1 [2]

(b) (i) ⅓π rad or 1.05 rad (*allow 60° if unit clear*) — A [1]

(ii) $a_0 = -\omega^2 x_0$
$= (-)\ (2\pi / 1.2)^2 \times 0.030$ — C1
$= (-)\ 0.82\ \text{m s}^{-2}$ — A1 [2]
(*special case: using oscillator P gives $x_0 = 1.7$ cm and $a_0 = 0.47\ \text{m s}^{-1}$ for 1/2*)

(iii) max. energy $\propto x_0^2$
ratio $= 3.0^2 / 1.7^2$ — C1
$= 3.1$ *(at least 2 s.f.)* — A1 [2]
(*if has inverse ratio but has stated max. energy $\propto x_0^2$ then allow 1/2*)

(c) graph: straight line through (0,0) with negative gradient — M1
correct end-points (–3.0, +0.82) and (+3.0, –0.82) — A1 [2]

3 **(a** acceleration / force proportional to displacement (from a fixed point) M1
either acceleration and displacement in opposite directions
or acceleration always directed towards a fixed point A1 [2]

(b) **(** *g* and *r* are constant so *a* is proportional to *x* B1
negative sign shows *a* and *x* are in opposite directions B1 [2]

(ii) $\omega^2 = g / r$ and $\omega = 2\pi / T$ C1
$\omega^2 = 9.8 / 0.28$
$= 35$ C1
$T = 2\pi / \sqrt{35} = 1.06\,\text{s}$
time interval $\tau = 0.53\,\text{s}$ A [3]

(c) sketch: time period constant (or increases very slightly) M1
drawn line always 'inside' given loops A1
successive decrease in peak height A1 [3]

4 **(a** **(i)** *either* $\omega = 2\pi / T$ *or* $\omega = 2\pi f$ and $f = 1 / T$ C1
$\omega = 2\pi / 0.30$
$= 20.9\,\text{rad s}^{-1}$ (*accept 2 s.f.*) A1 [2]

(ii) kinetic energy $= \frac{1}{2} m\omega^2 x_0^2$ *or* $v = \omega x_0$ and $\frac{1}{2} mv^2$ C1
$= \frac{1}{2} \times 0.130 \times 20.9^2 \times (1.5 \times 10^{-2})^2 = 6.4 \times 10^{-3}\,\text{J}$ A1 [2]

(b) **(i)** as magnet moves, flux is cut by cup / aluminium giving rise to induced e.m.f. (in cup) B1

induced e.m.f. gives rise to currents and heating of the cup B1
thermal energy derived from oscillations of magnet so amplitude decreases B1
or
induced e.m.f. gives rise to currents which generate a magnetic field (B1)
the magnetic field opposes the motion of the magnet so amplitude decreases (B1) [3]

(ii) *either* use of $\frac{1}{2} m\omega^2 x_0^2$ and $x_0 = 0.75\,\text{cm}$ *or* x_0 is halved so ¼ energy C1
to give new energy = 1.6 mJ

either loss in energy = 6.4 – 1.6 *or* loss = ¾ × 6.4 giving loss = 4.8 mJ A [2]

(c) $q = mc\Delta\theta$
$4.8 \times 10^{-3} = 6.2 \times 10^{-3} \times 910 \times \Delta\theta$ C1
$\Delta\theta = 8.5 \times 10^{-4}\,\text{K}$ A [2]

5 **(a** acceleration / force proportional to displacement (from a fixed point) M1
either acceleration and displacement in opposite directions
or acceleration always directed towards a fixed point A1 [2]

(b) (zero & 0.625 s *or* 0.625 s & 1.25 s *or* 1.25 s & 1.875 s *or* 1.875 s & 2.5 s A1 [1]

(ii) 1. $\omega = 2\pi / T$ and $v_0 = \omega x_0$ C1

$\omega = 2\pi / 1.25$
$= 5.03\ \text{rad s}^{-1}$ C1

$v_0 = 5.03 \times 3.2$
$= 16.1\ \text{cm s}^{-1}$ (*allow 2 s.f.*) A1 [3]

2. $v = \omega\sqrt{(x_0^2 - x^2)}$

either $\frac{1}{2}\omega a = \omega\sqrt{(x_0^2 - x^2)}$ *or* $\frac{1}{2} \times 16.1 = 5.03\sqrt{(3.2^2 - x^2)}$ C1

$x_0^2 / 4 = x_0^2 - x^2$ $2.58 = 3.2^2 - x^2$

$x = 2.8\ \text{cm}$ $x = 2.8\ \text{cm}$ A1 [2]

(c) sketch: loop with origin at its centre M1
correct intercepts & shape based on **(b)(ii)** A1 [2]