Oscillations

Mark Scheme 5

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Oscillations
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 5

Time Allowed:	**80 minutes**
Score:	**/66**
Percentage:	**/100**

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

1 **(a (i)** (θ =) ωt *(allow any subject if all terms given)* B1 [1]

(ii) (SQ =) $r \sin\omega t$ *(allow any subject if all terms given)* B1 [1]

(b) this is the solution of the equation $a = -\omega^2 x$ M1
$a = -\omega^2 x$ is the (defining) equation of s.h.m. A1 [2]

(c) (i) $f = \omega / 2\pi$ C1
$= 4.7 / 2\pi$
$= 0.75$ Hz A1 [2]

(ii) $v = r\omega$ (r must be identified) C1
$= 4.7 \times 12$
$= 56 \text{ cm s}^{-1}$ A1 [2]

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

(b) (i) maximum / minimum height / 8 mm above cloth / 14 mm below cloth | B1 [1]

(ii) 1. $a = 11$ mm | A1 [1]
2. $\omega = 2\pi f$ | C1
$= 2\pi \times 4.5$
$= 28.3$ rad s^{-1} (*do not allow 1 s.f.*) | A1 [2]

(c) ($v = \omega a$ | C1
$= 28.3 \times 11 \times 10^{-3}$
$= 0.31$ m s^{-1} (*do not allow 1 s.f.*) | A [2]

(ii) $v = \omega \sqrt{(a^2 - y^2)}$
$y = 3$ mm | C1
$= 28.3 \times 10^{-3} \sqrt{(11^2 - 3^2)}$ | C1
$= 0.30$ m s^{-1} (*allow 1 s.f.*) | A1 [3]

3 (a (i) amplitude = 0.5 cm | A1 [1]

(ii) period = 0.8 s | A1 [1]

(b) (i) $\omega = 2\pi / T$ | C1
$= 7.85$ rad s^{-1}
correct use of $v = \omega \sqrt{(x_0^2 - x^2)}$ | B1
$= 7.85 \times \sqrt{(\{0.5 \times 10^{-2}\}^2 - \{0.2 \times 10^{-2}\}^2)}$
$= 3.6$ cm s^{-1} | A1 [3]
(if tangent drawn or clearly implied (B1)
3.6 ± 0.3 cm s^{-1} (A2)
but allow 1 mark for > ±0.3 but ⩽ ±0.6 cm s^{-1})

(ii) $d = 15.8$ cm | A1 [1]

(c) (i) (continuous) loss of energy / reduction in
amplitude (from the oscillating system) | B1
caused by force acting in opposite direction to the motion / friction /
viscous forces | B1 [2]

(ii) same period / small increase in period | B1
line displacement always less than that on Fig.3.2 *(ignore first T/4)* | M1
peak progressively smaller | A1 [3]

4 **(a (i)** 0.8 cm .... B1 [1]

(ii) (max.) kinetic energy = 2.56 mJ C1
$v_{(MAX)} = \omega a$ C1
(max.) kinetic energy = $½m\omega^2a^2$ or $½m\omega^2(a^2 - x^2)$ C1
$2.56 \times 10^{-3} = ½ \times 0.130 \times \omega^2 \times (0.8 \times 10^{-2})^2$ M1
ω = 24.8 rad s^{-1} C1
$f = \omega/2\pi$ M1
= 4.0 Hz (3.95 Hz) .... A0 [6]

(b) (i) line parallel to *x*-axis at 2.56 mJ .... B1 [1]

(ii) **1** 4.0 Hz B1

2 0.50 cm (*allow ±0.03 cm*) .... B1 [2]

5 **(a)** use of $a = -\omega^2 x$ clear C1
either $\omega = \sqrt{(2k/m)}$ *or* $\omega^2 = (2k/m)$ B1
$\omega = 2\pi f$ C1
$f = (1/2\pi)\sqrt{(2 \times 300)/0.240}$ B1
= 7.96 ≈ 8 Hz A0 [4

(b) (i) resonance B1 [1

(ii) 8 Hz B1 [1

(c) (increase amount of) damping B1
without altering (*k* or) *m* …(some indirect reference is acceptable) B1
sensible suggestion B1 [3]

6 **(a** **(i)** 1.0 B1 **[1]**

(ii) 40 Hz B1 **[1]**

(b) **(i)** speed $= 2\pi fa$ C1
$= 2\pi \times 40 \times 42 \times 10^{-3}$
$= 10.6 \text{ m s}^{-1}$ A1 **[2]**

(ii) acceleration $= 4\pi^2 f^2 a$ C1
$= (80\pi)^2 \times 42 \times 10^{-3}$
$= 2650 \text{ m s}^{-2}$ A1 **[2]**

(c) **(i)** S marked correctly (on 'horizontal line through centre of wheel) B1

(ii) A marked correctly (on 'vertical line' through centre of wheel) B1 **[2]**

7 **(a)(i)** $\omega = 2\pi f$ …………………………………………………………… C1
$= 2\pi \times 1400$
$= 8800 \text{ rad s}^{-1}$ …………………………………………………… A1 **[2]**

(ii) $a_0 = (-)\omega^2 x_0$ …………………………………………………… C1
$= (8800)^2 \times 0.080 \times 10^{-3}$
$= 6200 \text{ m s}^{-2}$ …………………………………………………… A1 **[2]**

(b) straight line through origin with negative gradient ……………………… M1
end points of line correctly labelled ……………………………………… A1 **[2]**

(c)(i) zero displacement …………………………………………………… B1 **[1]**

(ii) $v = \omega x_0$ …………………………………………………… C1
$= 8800 \times 0.080 \times 10^{-3}$
$= 0.70 \text{ m s}^{-1}$ …………………………………………………… A1 **[2]**