Oscillations

Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Oscillations
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed: **63 minutes**

Score: **/52**

Percentage: **/100**

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

1 **(a)** kinetic (energy)/KE/E_K B1 [1]

(b) *either* change in energy = 0.60 mJ
or max E proportional to (amplitude)^2/equivalent numerical working B1
new amplitude is 1.3 cm B1
change in amplitude = 0.2 cm B1 [3]

2 **(a (i)** any two from 0.3(0) s, 0.9(0) s, 1.50 s (*allow 2.1 s etc.*) B1 [1]

(ii) *either* $v = \omega x$ and $\omega = 2\pi/T$ C1
$v = (2\pi/1.2) \times 1.5 \times 10^{-2}$ M1
$= 0.079\ \text{m s}^{-1}$ A0 [2]
or gradient drawn clearly at a correct position (C1)
working clear (M1)
to give $(0.08 \pm 0.01)\ \text{m s}^{-1}$ (A0)

(b) (sketch: curve from (±1.5, 0) passing through (0, 25) M1
reasonable shape (*curved with both intersections between y = 12.0→13.0*) A1 [2]

(ii) at max. amplitude potential energy is total energy B1
total energy = 4.0 mJ B1 [2]

3 (a (i) 1. amplitude = 1.7 cm [1]

2. period = 0.36 cm
frequency = 1/0.36
= 2.8 Hz A1 [2]

(ii) $a = (-)\omega^2 x$ and $\omega = 2\pi/T$ C1
acceleration = $(2\pi/0.36)^2 \times 1.7 \times 10^{-2}$ M1
$= 5.2\ \text{m s}^{-2}$ A0 [2]

(b) graph: straight line, through origin, with negative gradient M1
from $(-1.7 \times 10^{-2}, 5.2)$ to $(1.7 \times 10^{-2}, -5.2)$ A1 [2]
(if scale not reasonable, do not allow second mark)

(c) *either* kinetic energy = $\frac{1}{2}m\omega^2(x_0^2 - x^2)$
or potential energy = $\frac{1}{2}m\omega^2x^2$ and potential energy = kinetic energy B1
$\frac{1}{2}m\omega^2(x_0 - x^2) = \frac{1}{2} \times \frac{1}{2}m\omega^2x_0^2$ or $\frac{1}{2}m\omega^2x^2 = \frac{1}{2} \times \frac{1}{2}m\omega^2x_0^2$ C1
$x_0^2 = 2x^2$
$x = x_0 / \sqrt{2} = 1.7 / \sqrt{2}$
$= 1.2$ cm A1 [3]

4 **(a) (i)** $\omega = 2\pi / T$
$= 2\pi / 0.69$ C1
$= 9.1$ rad s^{-1} A1 [2]
(allow use of $f = 1.5$ Hz to give $\omega = 9.4$ rad s^{-1})

(ii) 1. $x = 2.1 \cos 9.1t$
2.1 and 9.1 numerical values B1
use of cos B1 [2]

2. $v_0 = 2.1 \times 10^{-2} \times 9.1$ (allow ecf of value of x_0 from **(ii)1.**)
$= 0.19$ m s^{-1} B1
$v = v_0 \sin 9.1t$ (allow $\cos 9.1t$ if sin used in **(ii)1.**) B [2]

(b) energy = either ½ mv_0^2 or ½ $m\omega^2 x_0^2$
= either ½ × 0.078 × 0.19^2 or ½ × 0.078 × 9.1^2 × $(2.1 \times 10^{-2})^2$ C1
$= 1.4 \times 10^{-3}$ J A1 [2]

5 **(a)** straight line through origin M1
shows acceleration proportional to displacement A1
negative gradient M1
shows acceleration and displacement in opposite directions A1 [4]

(b) **(i)** 2.8 cm A1 [1]

(ii) *either* gradient = ω^2 and $\omega = 2\pi f$ *or* $a = -\omega^2 x$ and $\omega = 2\pi f$ C1
gradient = $13.5 / (2.8 \times 10^{-2}) = 482$
$\omega = 22$ rad s^{-1} C1
frequency = $(22/2\pi =)$ 3.5 Hz z [3]

(c) e.g. lower spring may not be extended
e.g. upper spring may exceed limit of proportionality / elastic limit
(*any sensible suggestion*) B1 [1]

6	**(a)**	**(i)**	**1.** 0.1 s, 0.3 s, 0.5 s, etc (*any two*)	A	[1]
			2. either 0, 0.4 s, 0.8 s, 1.2 s or 0.2 s, 0.6 s, 1.0 s (*any two*)	A	[1]
		(ii)	period = 0.4 s	C	
			frequency = (1/0.4 =) 2.5 Hz	A1	[2]
		(iii)	phase difference = 90 ° *or* ½ π rad	B1	[1]
	(b)		frequency = 2.4 – 2.5 Hz		[1]
	(c)		e.g. attach sheet of card to trolley	M1	
			increases damping / frictional force	A1	
			e.g. reduce oscillator amplitu	(M1)	
			reduces power/energy input to system	(A1)	[2]

7	**(a)**		$a = (-)\omega^2 x$ and $\omega = 2\pi/T$	C1	
			$T = 0.60$ s	C1	
			$a = (4\pi^2 \times 2.0 \times 10^{-2}) / (0.6)^2$ $= 2.2\ \text{m s}^{-2}$	A1	[3]
	(b)		sinusoidal wave with all values positive	B1	
			all values positive, all peaks at E_K and energy = 0 at t = 0	B1	
			period = 0.30 s	B1	[3]