Oscillations

Mark Scheme 6

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Oscillations
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 6

Time Allowed: **75 minutes**

Score: **/62**

Percentage: **/100**

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

1 **(a)** acceleration proportional to displacement (from a fixed point) **M1**
<u>or</u> a = - $\omega^2 x$ with *a*, ω and *x* explained
and directed towards a fixed point **A1** **[2]**
<u>or</u> negative sign explained

(b) for s.h.m., $a = (-)\omega^2 x$ **B1**
identifies ω^2 as $A\rho g/M$ and therefore s.h.m. (may be implied) **B1**
$2\pi f = \omega$ **B1**
hence $f = \frac{1}{2\pi}\sqrt{\frac{Apg}{M}}$ **A0** **[3]**

(c) **(** $T = 0.60$ s <u>or</u> $f = 1.7$ Hz **C1**
$0.60 = (2\pi\sqrt{M})/\sqrt{(\pi \times \{1.2 \times 10^{-2}\}^2 \times 950 \times 9.81)}$ **C1**
$M = 0.0384$ kg **A1** **[3]**

(ii) <u>decreasing</u> peak height/amplitude **B1** **[1]**

2 **(a)** **(i)** reasonable shape as 'inverse' of k.e. line 1

(ii) straight line, parallel to x-axis at 15 mJ 1 **[2]**

(b) *either* (max) kinetic energy (= ½ mv^2) = ½ m $\omega^2 a_0^2$ 1
$15 \times 10^{-3} = ½ \times 0.15 \times \omega^2 \times (5.0 \times 10^{-2})^2$ 1
$\omega = 8.9(4)$ rad s^{-1} 1

or (k.e. = ½ mv^2), $v = 0.44(7)$ m s^{-1} 1
$\omega = v/a = (0.447)/(5.0 \times 10^{-2})$ 1
$\omega = 8.9(4)$ rad s^{-1} 1 **[3]**

(c) **(i)** *either* loss of energy (from the system) *or* amplitude decreases
or additional force acting (on the mass) 1
either continuous/gradual loss *or* force always opposing motion 1 **[2]**

(ii) *either* (now has 80% of its) p.e./k.e. = 12 mJ *or* loss in k.e. = 3 mJ 1
new amplitude = 4.5 cm (allow ± 0.1 cm) 1 **[2]**

3 **(a)** e.g. amplitude is not constant or wave is damped B1
do not allow 'displacement constant'
should be (-)cos, (not sin) B1 **[2]**

(b) T = 0.60 s C1
$\omega = 2\pi/T$ = 10.5 rad s^{-1} *(allow 10.4 → 10.6)* A1 **[2]**

(c) same period B1
displacement always less M1
amplitude reducing appropriately A1 **[3]**
for 2nd and 3rd marks, ignore the first quarter period

Total **[7]**

4 **(a) (i)** a, ω and x identified ………(-1 each error or omission) B2

(ii) (-)ve because a and x in opposite directions
OR a directed towards mean position/centre................................ B1 [3]

(b) (i) forces in springs are $k(e + x)$ and $k(e – x)$ C1
resultant $= k(e + x) – k(e – x)$ M1
$= 2kx$ .... A0 [2]

(ii) $F = ma$ B1
$a = -2kx/m$ A0
(-)ve sign explained.. B1 [2]

(iii) $\omega^2 = 2k/m$ C1
$(2\pi f)^2 = (2 \times 120)/0.90$ C1
f = 2.6 Hz .... A1 [3]

(c) atom held in position by attractive forces
atom oscillates,
not just two forces *OR* 3D not 1D
force not proportional to x
any two relevant points, 1 each, max 2 .... B2 [2]

5 **(a)** f_0 is at natural frequency of spring (system) B1
this is at the driver frequency .... B1 [2]
(allow 1 mark for recognition that this is resonance)

(b) line: amplitude less at all frequencies B1
peak flatter B1
peak at f_0 or slightly below f_0.. B1 [3]

(c) (aluminium) sheet cuts the magnetic flux/field............................. B1
(so) currents/e.m.f. induced in the (metal) sheet B1
these currents dissipate energy M1
less energy available for the oscillations A1
so amplitude smaller .... A0 [4]
('current opposes motion of sheet' scores one of the last two marks)

6 (a) (i) constant amplitude ………………………………………………... B1
(ii) period = 0.75 s …(allow ±0.2 s)…………………………………… Cl
w = 2rc/T ………………………………………………,……… ..…. Cl
w = 8.4 rad s-1 …(-1 for 1 sf)………………………………… Al
(iii) either use of gradient or v = o ……………………………… C1
v = Ql68 m s-1 ……………………………………………………… Al [6]
(allow ±0.02 for construction: gradient drawn at wrong place 0/2)

(b) (i) 1.3 Hz ……………………………………………………………. **B** 1
(ii) at ½Jo, 'pulse' provided to mass on alternate/some oscillations ..... Ml
so 'pulses' build up the amplitude ……..….…….……..…..…..….….…. Al [3]

7 **(a)** **(i)** (induced) e.m.f proportional/equal to rate of change of flux (linkage) B1
(allow 'induced voltage, induced p.d.)
flux is cust as the disc moves M1
hence inducing an e.m.f A0 [2]

(ii) field in disc is not uniform/rate of cutting not same/speed of disc not same (over whole disc) B1
so different e.m.f.'s in different parts of disc M1
lead to eddy currents A0 [2]

(b) eddy currents dissipate thermal energy in disc B1
energy derived from oscillation of disc B1
energy of disc depends on amplitude of oscillations B1 [3]