

Name of the Student: \_\_\_\_\_

Max. Marks : 26 Marks

Time : 26 Minutes

Mark Schemes

**Q1.**

- (a) (i) *free*: system displaced and left to oscillate **(1)**  
 (ii) *forced*: oscillation due to (external) periodic driving force [or oscillation at the frequency of another vibrating system] **(1)**

2

(b) (i)  $k = \frac{3000}{5.0 \times 10^{-2}} = 6.0 \times 10^4 \text{ Nm}^{-1}$  **(1)**

(ii)  $T = 2\pi \sqrt{\frac{m}{k}} = 2\pi \sqrt{\frac{9000}{g \times 6.0 \times 10^4}}$

giving 0.78 s **(1)**

3

(c) (i)  $t = \frac{s}{v} = \frac{16}{20} = 0.80 \text{ s}$  **(1)**

- (ii) time  $\cong$  period of free oscillations, resonance **(1)**  
 i.e. large amplitude oscillations **(1)**

3

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**Q2.**

(a) (i)  $h (= ct) (= 3.0 \times 10^8 \times 68 \times 10^{-3}) = 2.0(4) \times 10^7 \text{ m}$  **(1)**

(ii)  $g = (-) \frac{GM}{r^2}$  **(1)**  
 $r (= 6.4 \times 10^6 + 2.04 \times 10^7) = 2.68 \times 10^7 \text{ (m)}$  **(1)**  
 (allow C.E. for value of  $h$  from (i) for first two marks, but not 3rd)

$g = \frac{6.67 \times 10^{-11} \times 6.0 \times 10^{24}}{(2.68 \times 10^7)^2}$  **(1)** (= 0.56 N kg<sup>-1</sup>)

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(b) (i)  $g = \frac{v^2}{r}$  **(1)**

$v = [0.56 \times (2.68 \times 10^7)]^{1/2}$  **(1)**

$$= 3.9 \times 10^3 \text{ m s}^{-1} \text{ (1)} \quad (3.87 \times 10^3 \text{ m s}^{-1})$$

(allow C.E. for value of  $r$  from a(ii))

$$\text{[or } v^2 = \frac{GM}{r} = \text{(1)}$$

$$v = \left( \frac{6.67 \times 10^{-11} \times 6 \times 10^{24}}{2.68 \times 10^7} \right)^{1/2} \text{ (1)}$$

$$= 3.9 \times 10^3 \text{ m s}^{-1} \text{ (1)}$$

$$\text{(ii)} \quad T \left( = \frac{2\pi r}{v} \right) = \frac{2\pi \times 2.68 \times 10^7}{3.87 \times 10^3} \text{ (1)}$$

$$= 4.3(5) \times 10^4 \text{ s (1)} \quad (12.(1) \text{ hours})$$

(use of  $v = 3.9 \times 10^3$  gives  $T = 4.3(1) \times 10^4 \text{ s} = 12.0 \text{ hours}$ )

(allow C.E. for value of  $v$  from (i))

[alternative for (b):

$$\text{(i)} \quad v \left( \frac{2\pi r}{T} \right) = \frac{2\pi \times 2.68 \times 10^7}{4.36 \times 10^4} \text{ (1)}$$

$$= 3.8(6) \times 10^3 \text{ m s}^{-1} \text{ (1)}$$

(allow C.E. for value of  $r$  from (a)(ii) and value of  $T$ )

$$\text{(ii)} \quad T^2 = \left( \frac{4\pi^2}{GM} \right) r^3 \text{ (1)}$$

$$\left( = \frac{4\pi^2}{6.67 \times 10^{-11} \times 6.0 \times 10^{24}} \times (2.68 \times 10^7)^3 \right) = (1.90 \times 10^9 \text{ (s}^2) \text{ (1)}$$

$$T = 4.3(6) \times 10^4 \text{ s (1)}$$

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[9]

### Q3.

(a) magnetic field direction:  $-z$  (1)

1

(b) direction changes meaning that velocity is not constant (1)

acceleration involves change in velocity

(or acceleration is rate of change of velocity) (1)

[alternatively

magnetic force on electron acts perpendicular to its velocity (1)

$\therefore$  force changes direction of movement causing acceleration (1)

2

$$\text{(c)} \quad \text{(i)} \quad BQv = \frac{mv^2}{r} \text{ (1) gives } v \left( = \frac{BQr}{m} \right)$$

$$= \frac{0.43 \times 10^{-3} \times 1.60 \times 10^{-19} \times 74 \times 10^{-3}}{2\pi \times 74 \times 10^{-3}} \quad (1) \quad (= 5.59 \times 10^6 \text{ m s}^{-1})$$

2

(ii) angular speed  $\omega \left( = \frac{v}{r} \right) = \frac{5.59 \times 10^6}{74 \times 10^{-3}} = 7.5(5) \times 10^7 \quad (1)$

unit:  $\text{rad s}^{-1}$  (1) (accept  $\text{s}^{-1}$ )

2

(iii) frequency of electron's orbit  $f \left( = \frac{\omega}{2\pi} \right) = \frac{7.55 \times 10^7}{2\pi} \quad (1)$   
 $(= 1.20 \times 10^7 \text{ s}^{-1})$

number of transits  $\text{min}^{-1} = 1.20 \times 10^7 \times 60 = 7.2 \times 10^8 \quad (1)$

**[alternatively]**

orbital period  $\left( = \frac{2\pi r}{v} \right) = \frac{2\pi \times 74 \times 10^{-3}}{5.59 \times 10^6}$  [or  $\left( = \frac{2\pi}{\omega} \right) = \frac{2\pi}{7.55 \times 10^7}$  ]

$(= 8.32 \times 10^{-8} \text{ s})$

number of transits  $\text{min}^{-1} = \frac{60}{8.32 \times 10^{-8}} = 7.2 \times 10^8 \quad (1)$

2

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