

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

Max. Marks : 22 Marks

Time : 22 Minutes

Mark Schemes

**Q1.**

- (a) period = 24 hours or equals period of Earth's rotation **(1)**  
 remains in fixed position relative to surface of Earth **(1)**  
 equatorial orbit **(1)**  
 same angular speed as Earth or equatorial surface **(1)**

max 2

(b) (i)  $\frac{GMm}{r^2} = m\omega^2 r$  **(1)**

$$T = \frac{2\pi}{\omega} \quad \mathbf{(1)}$$

$$r \left( = \frac{GMT^2}{4\pi^2} \right)^{1/3} = \left( \frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times (24 \times 3600)^2}{4\pi^2} \right)^{1/3} \quad \mathbf{(1)}$$

(gives  $r = 42.3 \times 10^3$  km)

(ii)  $\Delta V = GM \left( \frac{1}{R} - \frac{1}{r} \right)$  **(1)**

$$= 6.67 \times 10^{-11} \times 6 \times 10^{24} \times \left( \frac{1}{6.4 \times 10^6} - \frac{1}{4.23 \times 10^7} \right)$$

$$= 5.31 \times 10^7 \text{ (J kg}^{-1}\text{)} \quad \mathbf{(1)}$$

$$\Delta E_p = m\Delta V (= 750 \times 5.31 \times 10^7) = 3.98 \times 10^{10} \text{ J} \quad \mathbf{(1)}$$

(allow C.E. for value of  $\Delta V$ )

[alternatives:

$$\text{calculation of } \frac{GM}{R} \text{ (} 6.25 \times 10^7 \text{) or } \frac{GM}{r} \text{ (} 9.46 \times 10^6 \text{)} \quad \mathbf{(1)}$$

$$\text{or calculation of } \frac{GMm}{R} \text{ (} 4.69 \times 10^{10} \text{) or } \frac{GMm}{r} \text{ (} 7.10 \times 10^9 \text{)} \quad \mathbf{(1)}$$

calculation of both potential energy values **(1)**subtraction of values or use of  $m\Delta V$  with correct answer **(1)**

6

**[8]**

**Q2.**

(a)

quantity	SI unit	
(gravitational potential)	$\text{J kg}^{-1}$ or $\text{N m kg}^{-1}$	scalar
(electric field strength)	$\text{N C}^{-1}$ or $\text{V m}^{-1}$	vector
(magnetic flux density)	T or $\text{Wb m}^{-2}$ or $\text{N A}^{-1} \text{m}^{-1}$	vector

6 entries correct **(1) (1) (1)**4 or 5 entries correct **(1) (1)**2 or 3 entries correct **(1)**

3

(b) (i)  $mg = EQ$  **(1)**

$$E \left( \frac{mg}{Q} = \frac{4.3 \times 10^{-9} \times 9.81}{3.2 \times 10^{-12}} \right) = 1.32 \times 10^4 \text{ (V m}^{-1}\text{)} \text{ (1)}$$

(ii) positive **(1)**

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**[6]****Q3.**

(a)  $\omega \left( = \frac{2\pi}{T} \right) = \frac{2\pi}{97 \times 60}$  [or  $\omega \left( = \frac{360}{T} \right) = \frac{360}{97 \times 60}$ ]

$= 1.1 \times 10^{-3} \text{ (} 1.08 \times 10^{-3}\text{)} \text{ (1)} \text{ [= } 6.2 \text{ (} 6.19\text{)} \times 10^{-2}\text{]}$

rad  $\text{s}^{-1}$  [accept  $\text{s}^{-1}$ ] **(1)** [degree  $\text{s}^{-1}$ ]

3

(b) (i)  $\frac{GMm}{r^2} = m\omega^2 r$  or  $r^3 = \frac{GM}{\omega^2}$  **(1)**

gives  $r^3 = \frac{6.67 \times 10^{-11} \times 5.98 \times 10^{24}}{(1.08 \times 10^{-3})^2}$  **(1)**

$\therefore r = 6.99 \times 10^6 \text{ (m)} \text{ (1)}$

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(ii)  $F (= m\omega^2 r) = 1.1 \times 10^4 \times (1.08 \times 10^{-3})^2 \times 6.99 \times 10^6$  **(1)**

$= 9.0 \times 10^4 \text{ (} 8.97 \times 10^4\text{)} \text{ (N)} \text{ (1)}$

[or  $F \left( = \frac{GMm}{r^2} \right) = \frac{6.67 \times 10^{-11} \times 5.98 \times 10^{24} \times 1.1 \times 10^4}{(6.99 \times 10^6)^2}$  **(1)**]

$= 9.0 \times 10^4 \text{ (} 8.98 \times 10^4\text{)} \text{ (N)} \text{ (1)}$

2

**[8]**