Name of the Student:_____
Max. Marks : 22 Marks **Time : 22 Minutes**

Mark Schemes

Q1.

C

[1]

Q2.

(a) Equatorial orbit ✓

Moving west to east ✓

Period 24 hours✓

ANY TWO

2

(b) $T \left(= \frac{2\pi}{\omega} = \frac{2\pi}{2.5(4)\times10^{-4}}\right)$ = 2.5 × 10^4 s ✓

1

(c) $\lambda \left(= \frac{c}{f} = \frac{3.0 \times 10^8}{1100 \times 10^6}\right)$ =0.27 (3)m)✓

$\theta \left(= \frac{\lambda}{d} = \frac{0.27(3)}{1.7}\right)$ = 0.16(1) rad = 92 ° ✓

(linear) width = $D\theta$ = 12000 km 0.16(1) rad) = 1.9(3) × 10^3 km ✓

3

(d) Angle subtended by beam at Earth's centre

= beam width / Earth's radius = 1.9(3) × 10^3 / 6400) ✓

0.30 rad (or 17°) ✓

Time taken = α / ω = 0.30 / 2.5(4) × 10^{-4} = 1.18 × 10^3 s

= 20 mins ✓

Alternative:

Speed of point on surface directly below satellite = ωR

= 2.5(4) × 10^{-4} × 6400 × 10^3)

= 1.63 × 10^3 m s^{-1} ✓

Time taken = width / speed

= 1.93 × 10^6 m / 1.63 × 10^3 m s^{-1} ✓

$= 1.18 \times 10^3$ s

(accept 1.2×10^3 s or 20 mins) ✓

or

Satellite has to move through angle of 1900 / 6400 radian = 0.29 rad ✓

Fraction of one orbit = 0.30 / 2 × 3.14 ✓

Time = $0.048 \times 2.5 \times 10^4 = 1.19 \times 10^3$ s ✓

Time= $\frac{17}{360} \times 2.5 \times 10^4 = 1.18 \times 10^3$ s

or

Circumference of Earth = $2\pi \times 6370$ ✓

$= 40023$ km

Width of beam at surface = 1920 km ✓

Time = $\frac{1920}{40023} \times 2.48 \times 10^4$

$= 1180$ s $= 19.6$ min ✓

3

(e) Signal would be weaker ✓ (as distance it travels is greater)

Energy spread over wider area/intensity decreases with increase of distance ✓

Signal received for longer (each orbit) ✓

Beam width increases with satellite height/satellite moves at lower angular speed ✓)

4

[13]

Q3.

(a) (i) $M = \frac{4}{3}\pi R^3 \rho$ ✔

combined with $g_s = \frac{GM}{R^2}$ (gives $g_s = \frac{4}{3}\pi GR\rho$) ✔

Do not allow r instead of R in final answer but condone in early stages of working.

Evidence of combination, eg cancelling R^2 required for second mark.

2

(ii) $R = \left(\frac{3g_s}{4\pi G\rho}\right) = \frac{3 \times 8.87}{4\pi 6.67 \times 10^{-11} \times 5.24 \times 10^3}$ ✔

gives $R = 6.06 \times 10^6$ (m) ✔

answer to **3SF** ✔

SF mark is independent but may only be awarded after some working is presented.

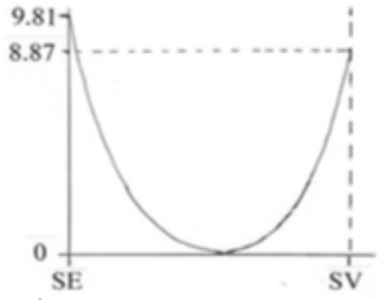
3

(b) line starts at 9.81 and ends at 8.87 ✔

correct shape curve which falls and rises ✔

falls to zeo value near centre of and to right of centre of distance scale ✔

[*Minimum of graph in 3rd point to be >0.5 and <0.75 SE-SV distance]*



For 3rd mark accept flatter curve than the above in central region.

3

[8]