TUTORIAL ANSWERS (GRAVITATIONAL FIELD)

2002 (Page 3)

Question 1

a.) i.) Since the satellite is a geostationary satellite which means it will always be positioned at a fixed point above the earth surface, thus we do not need to track this satellite with a dish aerial.

ii.) $\omega = 2\pi / (24 \times 3600) =$ **7.27×10^{-5} rads^{-1}**

iii.) **$a = \omega^2 R$**

b.) i.) $F = - GMm / R^2$

ii.) $R = (GM / \omega^2)^{\frac{1}{3}} =$ **4.23×10^7 m**

c.) $g = - GM / r^2 =$ **9.43 MJ kg^{-1} (negative sign can be ignored)**

9702/4 (J / 02)

Question 1

a.) $g = GM / r^2$

$M = gr^2 / G =$ **5.99×10^{24} kg**

b.) i.) $\omega = 2\pi / (24 \times 3600) =$ **7.27×10^{-5} rads^{-1}**

ii.) $r = (GM / \omega^2)^{\frac{1}{3}} =$ **4.23×10^7 m**

Nov 2003 / P3

Question 2

a.) i.) rate of change of angular displacement OR angle turned through per unit time.

ii.) 1 orbit takes 1 year,

$\omega = 2\pi / (365 \times 24 \times 3600) =$ **1.99×10^{-7} rads^{-1}**

b.) i.) 1.) $F_{\text{earth on satellite}} = Gm_{\text{earth}}m_{\text{satellite}} / r^2$

$= (6.67 \times 10^{-11} \times 425 \times 5.98 \times 10^{24}) / (1.60 \times 10^{9})^2$

= **6.62×10^{-2} N**

i.) 2.) $F_{\text{sun on satellite}} = Gm_{\text{sun}}m_{\text{satellite}} / r^2$

$= (6.67 \times 10^{-11} \times 425 \times 1.99 \times 10^{30}) / ((1.50 - 0.016) \times 10^{11})^2$

= **2.56 N**

ii.)

iii.) 1.) Resultant force, F = **2.494 N (towards the Sun)**

2.) Acceleration, a = F /m = (2.494) / 425

= **5.87×10^{-3} ms^{-2}**

iv.) $\omega = \sqrt{(a / r)} = \sqrt{(5.87 \times 10^{-3} / 1.484 \times 10^{11})}$

= **1.99×10^{-7} rads^{-1}**

v.) Angular velocity of the satellite around the Sun is same as the Earth around the Sun. The satellite will travels around the Sun with the Earth. It would therefore always stays between Earth and Sun. Thus, the earth will never block the satellite in observing the Sun continuously.

vi.) This satellite has to be placed further away from the Earth, so it is expensive to put it into this orbit. (More fuel needed.)

The communication between the satellite and earth station will be delay and more difficult as the earth station is not always located below the satellite.

J 96 / P3

Question 2

c.) i.) $F = GMm / r^2 =$ **9.83 N**

ii.) $F = mr\omega^2 / =$ **0.034 N**

iii.) Reading = 9.83 – 0.034 = **9.796 N or 9.80 N**

d.) i.) **$9.83\ ms^{-2}$**

ii.) **$9.796\ ms^{-2}$ or $9.80\ ms^{-2}$**

e.) Statement is not correct. Some of the gravitational force is used to provide the centripetal force.