PHYS 101: General Physics 1 | KOÇ UNIVERSITY College of Sciences | Fall Semester 2013

Section 4 | Quiz 9 | 28 November 2013

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Find how far above the Earth (in the number of times the radius of the Earth) is a satellite in geosynchronous motion around the Earth - i.e., the satellite, as viewed from Earth, seems to remain stationary at the same point in the sky.

For geosynchronous satellite we have: $T_{sat} = T_E$

From Eq.(13.12) of the book we have:

$$T = \frac{2\pi r^{3/2}}{\sqrt{GM_E}}$$ (if we take orbit circular)

$T_E = 24$ hours $= 24 \times 60 \times 60 = 86400$ s

$$\Rightarrow T_{sat} = T_E \Rightarrow \frac{2\pi r^{3/2}}{\sqrt{GM_E}} = T_E$$

$$\Rightarrow r = \left(\frac{T_E \cdot \sqrt{GM_E}}{2\pi}\right)^{2/3}$$

$$\Rightarrow r = 4.23 \times 10^7 \text{ m}$$

$$\Rightarrow \boxed{r = 42300 \text{ km} > R_E}$$

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College of Sciences

Section 5 | Quiz 9 | 28 November 2013

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Assume the Earth's mass is $M_E = 6\times10^{24}kg$ and radius is $R_E = 6000km$, and consider a *3000kg* satellite going around Earth in an orbit of radius r = 8xR_E. What is the period of the orbit?

$F_r = m a_r$

$\Rightarrow \quad G\dfrac{mM_E}{r^2} = m\dfrac{v^2}{r}$

$\Rightarrow \quad v = \sqrt{\dfrac{GM_E}{r}}$

$T = \dfrac{2\pi r}{v} = \dfrac{2\pi r}{\sqrt{\dfrac{GM_E}{r}}} = \dfrac{2\pi r\sqrt{r}}{\sqrt{GM_E}}$

$\Rightarrow \quad \boxed{T = \dfrac{2\pi r^{3/2}}{\sqrt{GM_E}}}$

$\Rightarrow \quad T = \dfrac{2\pi \times (8\times6000\times10^3)^{3/2}}{\sqrt{6.67\times10^{-11}\times6\times10^{24}}}$

$\Rightarrow \quad \boxed{T = 1.04\times10^5 \text{ sec}}$

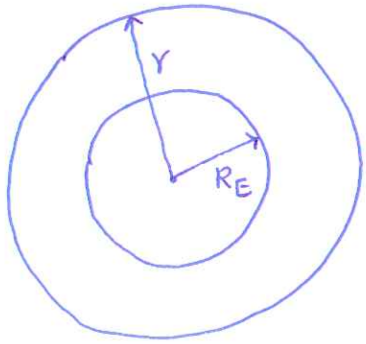
PHYS 101: General Physics 1	KOÇ UNIVERSITY College of Sciences	Fall Semester 2013
Section 1	Quiz 9	28 November 2013

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Assume the Earth's mass is $M_E = 6\times10^{24} kg$ and radius is $R_E = 6000km$, and consider a *3000kg* satellite going around Earth in an orbit of radius r = 8x R_E. That far from the Earth, how large is the acceleration due to gravity?

Earth: $\begin{cases} M_E = 6\times10^{24}\ kg \\ R_E = 6000\ km = 6\times10^{6}\ m \end{cases}$



Satellite: $\begin{cases} m = 3000\ kg \\ r = 8R_E = 48\times10^{6}\ m \end{cases}$

$\sum \vec{F} = m\vec{a}$

$\Rightarrow \quad F_r = m a_r$

$\Rightarrow \quad a_r = \frac{F_r}{m} = \frac{\frac{G m M_E}{(8R_E)^2}}{m} = \frac{G M_E}{64 R_E^2}$

$\Rightarrow \quad a_r = \frac{6.67\times10^{-11}\times 6\times10^{24}}{64\times(6\times10^{6})^2}$

$\Rightarrow \quad \boxed{a_r = 0.144\ m/s^2}$

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Section 2 — Quiz 9 — 28 November 2013

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Mercury is much less massive than Earth and closer to the Sun than Earth and orbits the Sun in only 88 days. Determine whether the following statement is true or false and explain your reasoning: If the Earth moved on the same orbit as Mercury does, it would have a period of 88 days.

The statement is true because of the following reasoning:

$M_M < M_E$

$R_M < R_E$

$T_M = 88$ days

Taking mass of Sun as M_S and mass and orbital radius of typical planet as m_p and r_p, respectively, a planet moving around sun will have the following speed and thus period:

$$F_r = ma_r \Rightarrow \frac{G m_p M_S}{r_p^2} = \frac{m_p v^2}{r_p} \Rightarrow \boxed{v = \sqrt{\frac{G M_S}{r_p}}}$$

$$\Rightarrow T = \frac{2\pi r_p}{v} = \frac{2\pi r_p^{3/2}}{\sqrt{G M_S}}$$

The formula for T indicates that, period is just dependent on r_p, the distance of planet from sun, and is independent of m_p (mass of planet).

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Section 3 | Quiz 9 | 28 November 2013

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Assume the Earth's mass is $M_E = 6\times10^{24} kg$ and radius is $R_E = 6000 km$, and consider a *3000kg* satellite going around Earth in an orbit of radius r = 8x R_E. How fast must the satellite be moving to hold the orbit?

Earth: $\begin{cases} M_E = 6 \times 10^{24} \text{ kg} \\ R_E = 6000 \text{ km} = 6 \times 10^6 \text{ m} \end{cases}$

Satellite: $\begin{cases} m = 3000 \text{ kg} \\ r = 8R_E = 48 \times 10^6 \text{ m} \end{cases}$

$F_r = ma_r \Rightarrow \frac{G m M_E}{r^2} = m \frac{v^2}{r}$

$\Rightarrow v = \sqrt{\frac{G M_E}{r}}$

$\Rightarrow v = \sqrt{\frac{6.67 \times 10^{-11} \times 6 \times 10^{24}}{48 \times 10^6}}$

$v \approx 2.89 \times 10^3 \text{ m/s}$