Name______________________________

Ap. 6, 2010

Phys 2112, Spring 2010
Quiz #2

1. Suppose a satellite orbits the earth in a circular orbit with a period equal to one day (24.0 hours). What is the distance of the satellite from the earth's center?

Use the relation between orbit radius and period derived in class; get

$$r^3 = \frac{GMT^2}{4\pi^2} = \frac{(6.67\times 10^{-11}\,\frac{\mathrm{N\cdot m^2}}{\mathrm{kg^2}})(5.97\times 10^{24}\,\mathrm{kg})(8.64\times 10^4\,\mathrm{s})^2}{4\pi^2} = 7.53\times 10^{22}\,\mathrm{m}^3$$

Then:

$$r = 4.22\times 10^7\,\mathrm{m}$$

b) How does the distance found in (a) compare with the radius of the earth itself?

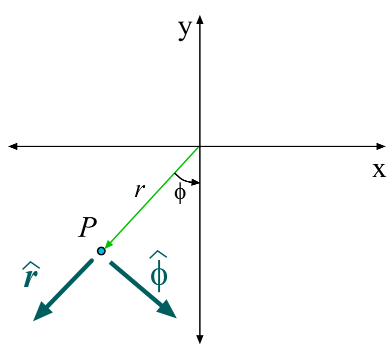
Compared to the radius of the earth this is

$$\mathrm{Ratio} = \frac{(4.22\times 10^7\,\mathrm{m})}{(6.37\times 10^6\,\mathrm{m})} = 6.6$$

So a geostationary satellite is actually way the heck out there!

2. On the figure at the right, show the direction of the unit vectors $\hat{\mathbf{r}}$ and $\hat{\boldsymbol{\phi}}$.

Shown, added to the figure here.



3. a) Find value of g on surface of Mars' tiny moon Phobos, which though it is irregularly shaped, can be taken to be a sphere of mass 1.08×10^{16} kg and radius 11 km.

g is the force from the entire planet with the mass of the object divided out, thus

$$g = G\frac{M}{R^2} = (6.67 \times 10^{-11}\,\tfrac{\mathrm{N \cdot m^2}}{\mathrm{kg^2}})\frac{(1.08 \times 10^{16}\,\mathrm{kg}}{(1.1 \times 10^4\,\mathrm{m})^2} = 5.95 \times 10^{-3}\,\tfrac{\mathrm{m}}{\mathrm{s^2}}$$

Small compared to that of the earth!

b) Find the escape speed for Phobos.

Use escape speed formula derived in class,

$$v_{\mathrm{esc}} = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{2((6.67 \times 10^{-11}\,\tfrac{\mathrm{N \cdot m^2}}{\mathrm{kg^2}})(1.08 \times 10^{16}\,\mathrm{kg}}{(1.1 \times 10^4\,\mathrm{m}}} = 11.4\,\tfrac{\mathrm{m}}{\mathrm{s}}$$

If you were on the surface of Phobos you could undoubtedly throw a rock and it would never return!

Show work for all problems and include the right units!

$$F = G\frac{m_1 m_2}{r^2} \qquad G = 6.67 \times 10^{-11}\,\tfrac{\mathrm{N \cdot m^2}}{\mathrm{kg^2}} \qquad a_c = \frac{v^2}{r} \qquad U(r) = -G\frac{m_1 m_2}{r}$$

$$F_c = \frac{mv^2}{r} \qquad \frac{4\pi^2 r^3}{T^2} = GM \qquad v_{\mathrm{esc}} = \sqrt{\frac{2GM}{R}} \qquad M_{\mathrm{earth}} = 5.97 \times 10^{24}\,\mathrm{kg} \qquad R_{\mathrm{earth}} = 6.37 \times 10^6\,\mathrm{m}$$