Questions

1. Determine the attractive force between the Moon and the Earth.

$$F_{grav} = G\frac{m_M m_E}{r^2} = \frac{(6.67 \times 10^{-11}\ Nm^2/kg^2)(7.35\times10^{22}kg)(5.98 \times 10^{24}\ kg)}{(3.84 \times 10^{8}\ m)^2}$$

$$=1.99\times10^{20}N \text{ toward}$$

2. It takes Jon 10 minutes to run around the circular track at the high school. If Jon can run 2.5 m/s, what is the radius of the circle? [Hint: Convert time to seconds.]

$$10 \text{ min}\left(\frac{60 \text{ s}}{1 \text{ min}}\right) = 600 \text{ s}$$

$$r = \frac{vT}{2\pi} = \frac{(2.5 \text{ m/s})(600 \text{ s})}{2\pi} = 240 \text{ m}$$

3. A 500. kg car enters a traffic circle with a radius of 23 meters at a speed of 17 m/s. Determine the frictional force that keeps the car in its circular path.

$a = \frac{v^2}{r} = \frac{(17\ \frac{m}{s})^2}{23\ m} = 13\frac{m}{s^2}$ in

$F = ma = (500.kg)(13\frac{m}{s^2}) = 6500N$ in

OR $F = \frac{mv^2}{r} = \frac{(500.\text{ kg})(17\ \frac{m}{s})^2}{23\text{ m}} = 6300$ N in

4. An object of mass *m* is traveling in a circle of radius *r* with a speed *v*.

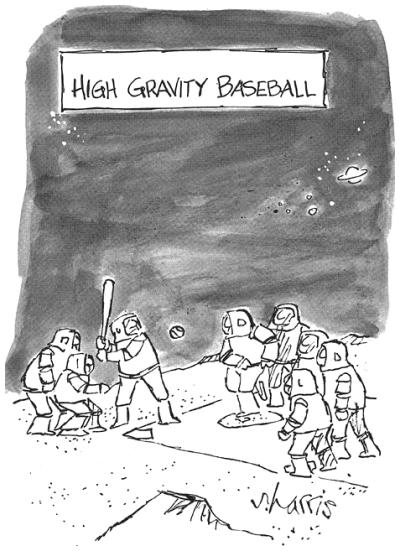
   a. What happens to the centripetal force when the speed doubles?

$$F = \frac{mv^2}{r} = \frac{1(2)^2}{1} = 4$$ Quadruple

   b. What happens to the centripetal acceleration when the radius is cut in third?

$$a = \frac{v^2}{r} = \frac{1^2}{\frac{1}{3}} = 3$$ Triple

Universal Gravitation, Circular Motion, & Kepler's Laws



Definitions

1. Law of Gravitation - Every body in the universe exerts a force of attraction (gravity) on every other body in the universe.
2. Uniform Circular Motion - the motion of an object in a circle with a constant or uniform speed.
3. Period - time it takes to complete one cycle around a circle
4. Linear velocity - the direction of the velocity vector at any instant is in the direction of a tangent. The tangent is a line that touches at one point but does not intersect.
5. Centripetal - Motion directed inward (toward center)
6. Centrifugal - Motion directed outward (away from center)
7. Torque (τ) – the tendency of a force to cause a rotation about an axis
8. Kepler's 1st Law - The path of the planets is elliptical is shape, with the center of the sun being located at one of the foci.
9. Kepler's 2nd Law - An imaginary line drawn from the center of the planet will sweep out equal areas in equal time intervals.
10. Kepler's 3rd Law - The ratio of the squares of the periods of any two planets is equal to the ratio of the cubes of their average distances from the sun.

Equations (on Reference Tables)

1. $F_{grav} = \frac{Gm_1m_2}{r^2}$

2. $a_c = \frac{v^2}{r}$

3. $F_c = ma_c$

Equations (NOT on Reference Tables)

4. $T = \frac{\text{time}}{\text{\# revolutions}}$

5. $v = \frac{2\pi r}{T}$

6. $g = G\frac{m}{r^2}$

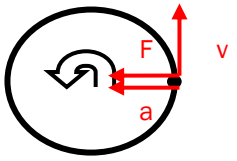
7. $e = \frac{c}{a} = \frac{\text{foci to center}}{1/2 \text{ semi-major}}$

8. $F_c = ma_c = \frac{mv^2}{r}$

9. $\frac{T_A^2}{R_A^3} = \frac{T_B^2}{R_B^3}$

10. $\tau = Fr$

On the diagram below, draw arrows to represent the direction of the rubber stopper's velocity, acceleration, and centripetal force.



Sketch in the shapes of the graphs below.