Solutions for Ch 6

5) $78\,rpm = 78\,\frac{rev}{min}\left(\frac{2\pi\,rad}{1\,rev}\right)\left(\frac{1\,min}{60\,s}\right) = 8.17\,rad/s = \omega\hat{z}$

$\theta_f = \theta_i + \omega t = 0.45\,rad + (8.17\,rad/s)\,8.0\,s = 2.98\,rad$ (drop multiples of 2π)

10) $r = 1.5 \times 10^{11}\,m$

a) $v = \frac{2\pi r}{T}$ ← circumference, ← period $= \frac{2\pi(1.5\times10^{11}\,m)}{365\,days\left(\frac{24\,hrs}{day}\right)\left(\frac{3600\,s}{hr}\right)}$

$= 3.0\times10^{4}\,m/s$

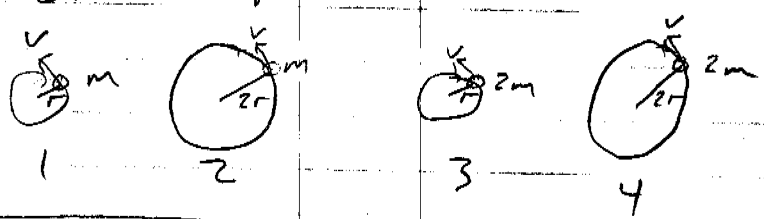
b) $\omega = \frac{2\pi}{T}$ where $v = \omega r$

$\omega = \frac{3.0\times10^{4}\,m/s}{1.5\times10^{11}\,m} = 2.0\times10^{-7}\,rad/s$

c) $a_{centripetal} = \frac{v^2}{r} = r\omega^2$

$= (1.5\times10^{11}\,m)(2.0\times10^{-7}\,rad/s)^2 = 6.0\times10^{-3}\,m/s$

13) $Tension = \frac{mv^2}{r}$



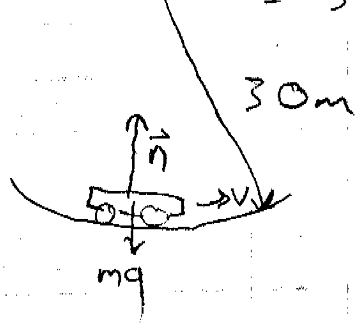
$\boxed{3 > 1 = 4 > 2}$

16) a) $a_c = \frac{v^2}{r} = \frac{\left(70\,mph \times 1.6\frac{kph}{mph} \times \frac{hr}{3600s} \times \frac{1000m}{km}\right)^2}{0.5m}$

$= 1960\,m/s^2$

b) $F = ma_c + mg = 0.19kg\,(1960\,m/s^2) + 0.19kg\,(9.8\,m/s^2)$

$= 370\,N$

19) 

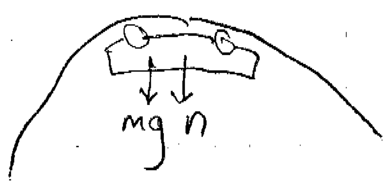
normal force $= \frac{mv^2}{r} + mg$

normal force $= \frac{3}{2}mg$

$\frac{mv^2}{r} = \frac{1}{2}mg$

$v^2 = \frac{1}{2}(30m)g = (15m)(9.8m/s^2)$

$v = 12\,m/s$

21) 

$n = mg$

diagram

$F_c = \frac{mv^2}{r} = 2mg$

$v^2 = 2rg \qquad v = 2(20m)(9.8m/s^2) = 20\,m/s$

27) $\dfrac{\frac{GmM_{sun}}{r^2_{sun}}}{\frac{GmM_{earth}}{r^2_{earth}}} = \frac{M_{sun}}{M_{earth}}\frac{r^2_{earth}}{r^2_{sun}}$

$= \frac{(1.99\times10^{30}kg)}{(5.98\times10^{24}kg)}\frac{(6.37\times10^{6}m)}{(1.5\times10^{11}m)} = 6.0\times10^{-4}N$

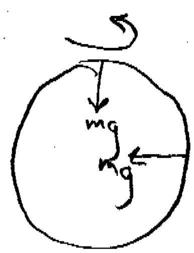
32) $$\frac{GmM}{r^2} = \frac{mv^2}{r}$$

$$\frac{GM}{r} = v^2 \qquad v = \sqrt{\frac{GM}{r}}$$

$$v_B = \sqrt{\tfrac{1}{2}}\, v_A = \sqrt{\tfrac{1}{2}}\,(10{,}000\, m/s) = 7{,}000\, m/s$$

35) $$\frac{GM}{r} = v^2 \qquad r = \frac{GM}{v^2} = \frac{(6.67\times10^{-11}\, N\cdot \frac{m^2}{kg^2})(5.98\times10^{24}\, kg)}{(5500\, m/s)^2}$$
$$= 1.32\times10^{7}\, m$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi r}{v} = \frac{2\pi(1.32\times10^{7}\, m)}{5500\, m/s} = 1.51\times10^{4}\, s = 4.2\, hrs$$

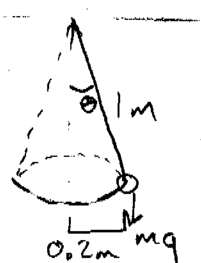
39) 

at equator part of gravitational force goes to centripetal ~~accel~~ force.

at pole $n_p = mg = (75\, kg)(9.8\, m/s^2) = 735\, N$

$$n_{eq} = mg - mr\omega^2 = 735\, N - (75\, kg)(6.37\times10^{6}\, m)\left(\frac{2\pi}{24\times3600\, s/hr}\right)$$
$$= 733\, N$$

about 2N less at equator than pole

45) 

vertical component of T = mg

$$T\cos\theta = mg \qquad \theta = \sin^{-1}\left(\frac{.2}{1}\right) = 11.54°$$
$$T = \frac{mg}{\cos(11.54°)} = \frac{(.5\, kg)(9.8\, m/s^2)}{\cos(11.54°)} = 5.0\, N$$

horizontal component of tension necessary to keep ball moving in circle.

$$T\sin\theta = \frac{mv^2}{r} \qquad v = \sqrt{\frac{T\sin\theta\, r}{m}} = \sqrt{\frac{5.0\, N\left(\frac{0.2m}{1m}\right)(.2\, m)}{0.5\, kg}} = 0.633\, m/s$$

$$\omega = \frac{v}{r} = \frac{0.633\, m/s}{0.2\, m} = 3.165\, rad/s \times \frac{60\, s}{1\, min}\,\frac{1\, rev}{2\pi\, rad} = 30\, rpm$$