HW 7

1) a) $(2\,ft)(\text{total angle of rotation}) = (60{,}000 \text{ miles})\cdot(5280\, ft/mile)$

$\Rightarrow$ tires will rotate through 3.2×10^8 radians before the warranty expires

b) $(3.2 \times 10^8 \text{ radians})\cdot(1 \text{ rev.}/2\pi \text{ radians}) = 5.0 \times 10^7$ revolutions

13) 30 flashes per second corresponds to 30π radians per second.

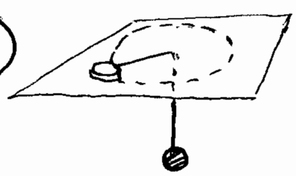
$$\Rightarrow \left(\frac{30\pi \text{ radians}}{1\,s}\right)\cdot R_{max} = 3.0 \times 10^8\, m/s$$

$$\Rightarrow R_{max} = 3.2 \times 10^6\, m$$

19) $ma_{centripetal} = \frac{v^2}{r} m = \frac{(4.0\, m/s)^2}{.8\, m}(55\, kg) = 1100\, N$

is the force exerted by the rope on her hands.

$(1100\, N)/[(55\, kg)\cdot(9.8\, m/s^2)] = 2.04$ is the ratio of the force exerted by the rope to the force exerted by gravity.

25) 

For the hanging mass, $\vec{a} = 0$, so:

$$\Sigma F_y = T - (1.0\, kg)\cdot(9.8\, m/s^2) = 0$$

$\Rightarrow T = 9.8\, N$. (This is also the force on the puck.)

For the revolving mass, $\Sigma F_{horizontal} = T = (.25\, kg)\cdot a_{centripetal}$

But $a_{centripetal} = v^2/1\,m$, so, by substitution,

$$\left(\frac{9.8\, N}{.25\, kg}\right) = \frac{v^2}{1\, m} \quad \Rightarrow v = 6.3\, m/s$$

30) a) $F_{sm} = G\frac{m_s m_m}{r_{sm}^2} = (6.673\times10^{-11})\frac{(1.991\times10^{30})\cdot(7.36\times10^{22})}{(1.496\times10^{11} - 3.84\times10^{8})^2}$ N

$= 4.39 \times 10^{20}$ N

b) $F_{em} = (6.673\times10^{-11})\cdot\frac{(5.98\times10^{24})\cdot(7.36\times10^{22})}{(3.84\times10^{8})^2}$ N

$= \cancel{1.31\times10^{15}\ N}\ 1.99\times10^{20}$ N

c) $F_{se} = (6.673\times10^{-11})\cdot\frac{(1.991\times10^{30})(5.98\times10^{24})}{(1.496\times10^{11})^2}$ N

$= 3.55\times10^{22}$

35) a) $F_{es} = \frac{mv_s^2}{r} \longleftrightarrow G\frac{m_e m_s}{(r_e+h_s)^2} = \frac{m_s V_s^2}{(r_e+h_s)}$

where r_e is earth's radius, and h_s is satellite altitude.

Plugging in: $(6.673\times10^{-11})\frac{(5.98\times10^{24})}{(6.38\times10^6+h_s)^2} = \frac{(5000)^2}{(6.38\times10^6+h_s)}$

$\Longrightarrow 9.58\times10^6$ m is the satellite altitude

b) Kepler's 3rd Law says that

$T^2 = \left(\frac{4\pi^2}{Gm_e}\right)\cdot(6.38\times10^6\text{ m} + 9.58\times10^6\text{ m})^3$

$\Longrightarrow T = 5.57$ h

42) a) The acceleration due to gravity at earth's surface we know is $9.8\ m/s^2$, and by the law of gravitational force, this must equal:

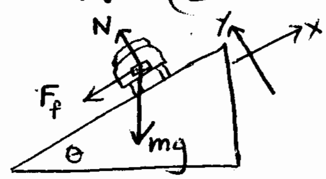
$G\frac{m_e}{r_e^2}$. Thus, gravitational acceleration on mars is given by: $\frac{(.1074)}{(.5282)^2}\cdot(9.8\ m/s^2) = 3.77\ m/s^2$

b) $20\ m = \frac{1}{2}(3.77\ m/s^2)t^2 \Longrightarrow t = 3.26\ s$

43) a) $V_{tangential} = (.5\ rev/s)\cdot(2\pi\ radians/rev)\cdot(.8\ m) = 2.51\ m/s$

b) $a_{centripetal} = \frac{V_t^2}{r} = \frac{(2.51\ m/s)^2}{.8\ m} = 7.90\ m/s^2$

c) $100\ N = (5.00\ kg)\cdot\frac{V_{max}^2}{.8\ m} \Longrightarrow V_{max} = 4.00\ m/s$

46) a) 

For v_{max}, $\sum F_x = -\cancel{m}g\sin\theta - \mu\cancel{m}g\cos\theta = -\frac{\cancel{m}V_{max}^2}{R}$

$\Longrightarrow V_{max} = [Rg(\sin\theta + \mu\cos\theta)]^{1/2}$

For v_{min}, $\sum F_x = -mg\sin\theta + \mu mg\cos\theta = -\frac{mV_{min}^2}{R}$

$\Longrightarrow V_{min} = [Rg(\sin\theta - \mu\cos\theta)]^{1/2}$

($V_{min} = 0$ if $\mu \geq \tan\theta$)

b) $8.6\ m/s < v < 16.3\ m/s$

(just plug in)

51) $F_{centripetal} = m\frac{v^2}{r} = m\frac{[(3\,m)\cdot(5\,rad/s)]^2}{3\,m} = m \cdot 75\,m/s^2$

So $\Sigma F_{vertical} = -\cancel{m}g + (\cancel{m}\cdot 75\,m/s^2)\mu_{min} = 0$

$\Longrightarrow \mu_{min} = .131$

54) a) $F = G\frac{(1.991\times 10^{32}\,kg)(1000\,kg)}{(10000\,m)^2} = 1.33\times 10^{17}\,N$

b) ΔF per kilogram =

$G(1.991\times 10^{32}\,kg)(1000\,kg)\left[\frac{1}{(10000\,m)^2} - \frac{1}{(10100\,m)^2}\right]$

$= 2.62\times 10^{15}\,N/kg$