Physics 131 Wi 2005 HW#5

ch 4.

Qu. 12

$a = \frac{v^2}{R}$. $\because R_3 > R_4 = R_1 > R_2 \Rightarrow a_3 < a_4 = a_1 < a_2$

Pro. 44.

a). $T = \left(\frac{1200\,\text{rev}}{\text{min}}\right)^{-1} = 8.3 \times 10^{-4}\,\text{min} = 0.050\,\text{s}$

$C = 2\pi r = 2\pi(0.15) = 0.94\,\text{m}$

b). $v = \frac{C}{T} = \frac{0.94}{0.050} = 19\,\text{m/s}$

c). $a = \frac{v^2}{r} = \frac{19^2}{0.15} = 2.4 \times 10^3\,\text{m/s}^2$

d). $T = 0.050\,\text{s}$

Pro. 45.

a). From: $a = \frac{v^2}{r}$, we have:

$v = \sqrt{ra} = \sqrt{(5.0\,\text{m})(7.0)(9.8\,\text{m/s}^2)} = 19\,\text{m/s}$

b). The period: $T = \frac{2\pi r}{v} = 1.7\,\text{s}$

In one minute (60s), the astronaut executes

$\frac{t}{T} = \frac{60}{1.7} = 35$ revolutions.

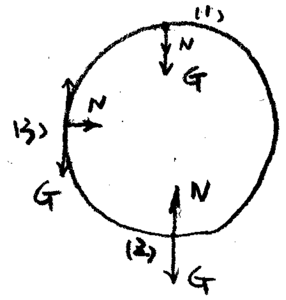
c). $T = 1.7\,\text{s}$

ch6

Qu. 10

(a). From $a=\frac{v^2}{R}$, $v=\text{constant}$,

we have: $a_{(1)}=a_{(2)}=a_{(3)}$



(b) $F=ma$

$\Rightarrow F_{(1)}=F_{(2)}=F_{(3)}$ (net centripetal force)

(c).

For (1): $F_{(1)}=N_{(1)}+G \Rightarrow N_{(1)}=F_{(1)}-G$

For (2): $F_{(2)}=N_{(2)}-G \Rightarrow N_{(2)}=F_{(2)}+G$

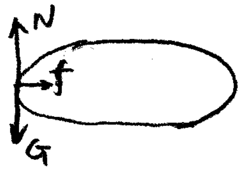
For (3): $F_{(3)}=N_{(3)}$

so, we have: $N_{(2)}>N_{(3)}>N_{(1)}$

Pro. 39

If the bicycle does not slip,

$f \leq f_{s,max}=\mu_s N=\mu_s mg$,



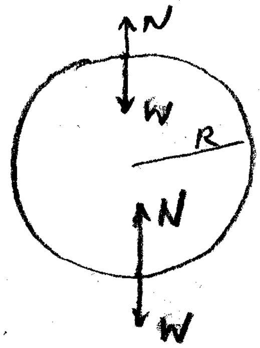
and $f=m\frac{v^2}{R}$

So, we have:

$$m\frac{v^2}{R} \leq \mu_s mg \Rightarrow R_{min}=\frac{v^2}{\mu_s g}=\frac{\left(29k\frac{1000\,m}{3600s}\right)}{(0.32)(9.8\,m/s^2)}=21\,m$$

Pro. 43.

a). At the top, $N<W$, which means the seat is pushing up with a force that is smaller than the student's weight, and we say the student experiences a decrease in his "apparant weight" at the highest point.



(b).

At the top, we have:

$$W-N=\frac{mv^2}{R}$$

$$\Rightarrow \frac{mv^2}{R}=W-N=667-556=111\ N$$

At the lowest point,

$$N-W=\frac{mv^2}{R}$$, because the Ferris wheel is "steadily rotating".

Then, $N=W+\frac{mv^2}{R}=667+111=778\ N$

(c). If the speed is doubled,

$$\frac{m(2v)^2}{R}=4\frac{mv^2}{R}=4\times 111=444\ N$$

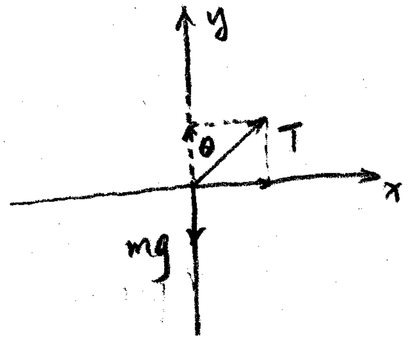
At the highest point,

$W-N=444\,(N) \Rightarrow N=667-444=223\ N$

At the lowest point,

$N-W=444\,(N) \Rightarrow N=667+444\doteqdot 1.1\ kN$

Pro. 44.



$v=16\ km/h=4.4\ m/s$

x-direction:

$$T\sin\theta=m\frac{v^2}{R} \quad ①$$

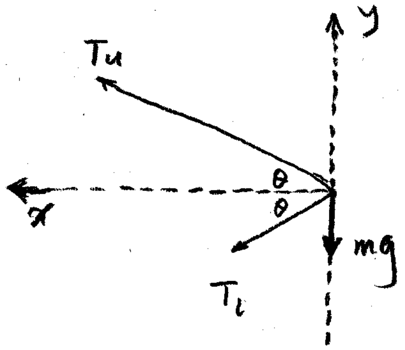
y-direction:

$$T\cos\theta=mg \quad ②$$

Solving Eqs. ① and ②, we get: $\theta=\tan^{-1}\left(\frac{v^2}{Rg}\right)=\tan^{-1}\left(\frac{4.4^2}{9.1\times 9.8}\right)=12^\circ$

pro. 47.

a) Free-body diagram.



T_u : tension exerted by the upper string

T_l : tension exerted by the lower string.

b). Take the $+x$ direction to be leftward, $+y$ upward.

x-direction:

$$T_u \cos\theta + T_l \cos\theta = \frac{mv^2}{R} \quad ①$$

y-direction:

$$T_u \sin\theta - T_l \sin\theta - mg = 0 \quad ②$$

Solving Eq. ②, we got.

$$T_l = T_u - \frac{mg}{\sin\theta} = 35 - \frac{1.34 \times 9.8}{\sin 30^\circ} = 8.74\,N$$

c). The net force is leftward,

$$F_{net} = T_u \cos\theta + T_l \cos\theta = (T_u + T_l)\cos\theta = (35 + 8.74)\cos 30^\circ = 37.9\,N$$

d).

$$\tan\theta = \frac{\left(\frac{1.7}{2}\right)}{R} \Rightarrow R = \frac{\left(\frac{1.7}{2}\right)}{\tan 30^\circ} = 1.47\,m$$

$$F_{net} = m\frac{v^2}{R} \Rightarrow v = \sqrt{\frac{R F_{net}}{m}} = \sqrt{\frac{1.47 \times 37.9}{1.34}} = 6.45\,m/s$$

ch. 14.

pro. 16.

a). The gravitational acceleration at the surface of the Moon:

$$g_{moon} = 1.67\ m/s^2 \quad (\text{see Appendix C})$$

and, we have:

$$W_{earth} = m\, g_{earth}$$

$$W_{moon} = m\, g_{moon}$$

so,

$$\frac{W_{earth}}{W_{moon}} = \frac{g_{earth}}{g_{moon}} \Rightarrow W_{moon} = 100N \frac{1.67}{9.8} = 17N$$

b). For the force on that object caused by Earth's gravity to equal 17N, then the free-fall acceleration at its location must be $a_g = 1.67\ m/s^2$,

Thus,

$$a_g = \frac{GM_E}{r^2} \Rightarrow r = \sqrt{\frac{GM_E}{a_g}} = 1.5\times10^7\ m$$

So, the object would need to be a distance of $\frac{r}{R_E} = 2.4$ "radii" from Earth's center.

Pro. 21

From Eq. 14-13, we see the extreme case is when "g" becomes zero, and plugging in Eq. 14-14 leads to

$$0 = \frac{GM}{R^2} - R\omega^2 \Rightarrow M = \frac{R^3\omega^2}{G}$$

Thus, with $R = 20000\ m$ and $\omega = 2\pi$ rad/s,

we find $M = 4.7\times10^{24}$ kg.