CIRCULAR MOTION - SOLUTIONS

1. GIVEN:

$m = 61\ kg$

$R = 4.0\ m$

$v = 4.00\ \frac{m}{s}$

$F_c = ?$

$$F_c = ma_c$$
$$= m\frac{v^2}{R}$$
$$= (61)\frac{(4.00)^2}{4.0}$$
$$= \boxed{240\ N}$$

THE FORCE IS EXERTED BY THE ICE AS SHE CUTS INTO IT WITH HER SKATES.

2. a) GIVEN:

$m = 5.0\ kg$

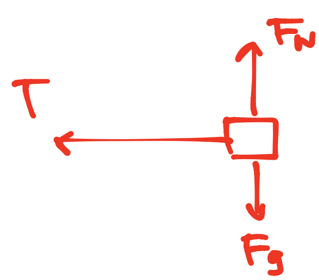
$v = 2.0\ \frac{m}{s}$

$R = 35\ cm = 0.35\ m$

$a_c = ?$

$$a_c = \frac{v^2}{R}$$
$$= \frac{(2.0)^2}{0.35}$$
$$= \boxed{11\ \frac{m}{s^2}}$$

b)



$$F_c = ma_c$$
$$T = m\frac{v^2}{R}$$
$$= (5.0)\frac{(2.0)^2}{0.35}$$
$$= \boxed{58\ N}$$

c) GIVEN:

$m = 5.0\,kg$

$v = 2.0\,\frac{m}{s}$

$R = 35\,cm = 0.35\,m$

$T = ?$

$$v = \frac{d}{t}$$

$$= \frac{2\pi R}{T}$$

$$T = \frac{2\pi R}{v}$$

$$= \frac{2\pi(0.35)}{(2.0)}$$

$$= \boxed{1.1\,s}$$

3. a) GIVEN:

$R = 40.\,cm = 0.40\,m$

$m = 0.50\,kg$

$f = 3.0\,\frac{rev}{s}$ ← $\frac{rev}{s} = Hz$

$a_c = ?$

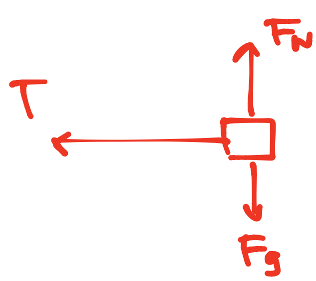
$$T = \frac{1}{f} = \frac{1}{3.0} = 0.6\overline{6}\,s$$

$$a_c = \frac{4\pi^2 R}{T^2}$$

$$= \frac{4\pi^2(0.40)}{(0.6\overline{6})^2}$$

$$= \boxed{36\,\frac{m}{s^2}}$$

b)



$$F_c = ma_c$$

$$T = m\frac{4\pi^2 R}{T^2}$$

$$= (0.50)\frac{4\pi^2(0.40)}{(0.6\overline{6})^2}$$

$$= \boxed{18\,N}$$

c) 18 N OUTWARD (TOWARDS THE ORBITTING BODY)

4. a) $a_{c_x} : a_{c_Y}$

$$\frac{4\pi^2 R_x}{T_x^2} : \frac{4\pi^2 R_Y}{T_Y^2}$$

$T_x = T_Y = T$

$$\frac{\cancel{4\pi^2} \cancel{r}}{\cancel{T^2}} : \frac{\cancel{4\pi^2}(2\cancel{r})}{\cancel{T^2}}$$

$\boxed{1 : 2}$

b) $F_{c_x} : F_{c_Y}$

$$m_x \frac{4\pi^2 R_x}{T_x^2} : m_Y \frac{4\pi^2 R_Y}{T_Y^2}$$

$$\cancel{m} \frac{\cancel{4\pi^2} \cancel{r}}{\cancel{T^2}} : (2\cancel{m}) \frac{\cancel{4\pi^2}(2\cancel{r})}{\cancel{T^2}}$$

$1 : (2)(2)$

$\boxed{1 : 4}$

c) $v_x : v_Y$

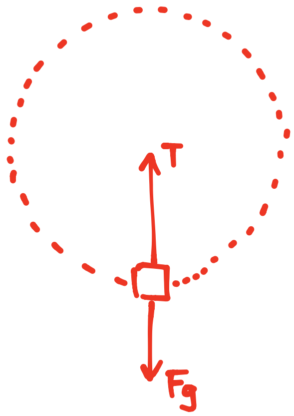
$$\frac{d}{t} : \frac{d}{t}$$

$$\frac{2\pi R_x}{T_x} : \frac{2\pi R_Y}{T_Y}$$

$$\frac{\cancel{2\pi} \cancel{r}}{\cancel{T}} : \frac{\cancel{2\pi}(2\cancel{r})}{\cancel{T}}$$

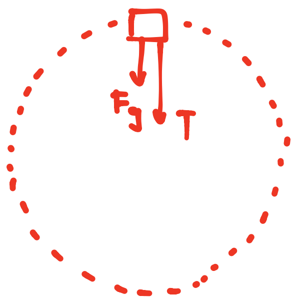
$\boxed{1 : 2}$

5. a)



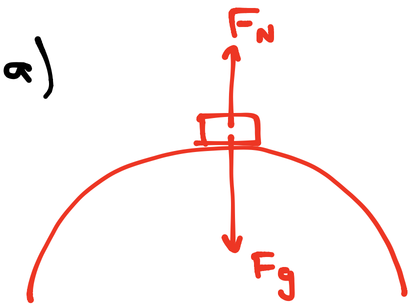
$$F_c = ma_c$$
$$T - F_g = m\frac{v^2}{R}$$
$$T - mg = m\frac{v^2}{R}$$
$$T = m\frac{v^2}{R} + mg$$
$$= m\left(\frac{v^2}{R} + g\right)$$
$$= 3.0\left(\frac{(20.)^2}{1.5} + 9.8\right)$$
$$= 830\text{ N}$$

b)



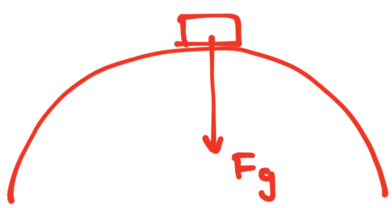
$$F_c = ma_c$$
$$T + F_g = m\frac{v^2}{R}$$
$$T + mg = m\frac{v^2}{R}$$
$$T = m\frac{v^2}{R} - mg$$
$$= m\left(\frac{v^2}{R} - g\right)$$
$$= 3.0\left(\frac{(20.)^2}{1.5} - 9.8\right)$$
$$= 770\text{ N}$$

6. a)



$$F_c = ma_c$$
$$F_g - F_N = m\frac{v^2}{R}$$
$$mg - F_N = m\frac{v^2}{R}$$
$$F_N = mg - m\frac{v^2}{R}$$
$$= m\left(g - \frac{v^2}{R}\right)$$
$$= (70.)\left(9.8 - \frac{(5.0)^2}{5.0}\right)$$
$$= 340\text{ N}$$

b)



$$F_c = ma_c$$
$$F_g = m\frac{v^2}{R}$$
$$\cancel{m}g = \cancel{m}\frac{v^2}{R}$$
$$v = \sqrt{gR}$$
$$= \sqrt{(9.8)(5.0)}$$
$$= 7.0\,\frac{m}{s}$$

7. TENSION IS THE GREATEST AT THE BOTTOM OF THE SWING WHEN T MUST INCREASE TO OPPOSE THE FORCE OF GRAVITY

$$F_c = ma_c$$

$$T - F_g = m\frac{v^2}{R}$$

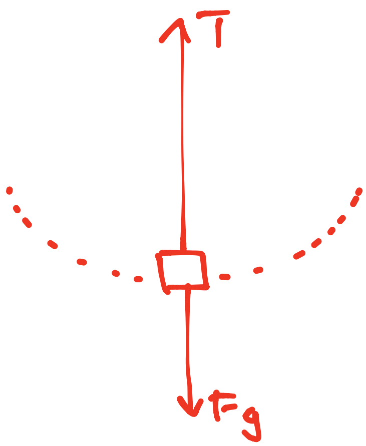
$$T - mg = m\frac{v^2}{R}$$

$$v^2 = \frac{R}{m}(T - mg)$$

$$v = \sqrt{\frac{R}{m}(T - mg)}$$

$$= \sqrt{\frac{(5.0)}{(1.00\times10^2)}\left[2.0\times10^3 - (1.00\times10^3)(9.8)\right]}$$

$$= \boxed{7.1\ \frac{m}{s}}$$



8. a) GIVEN:

$m = 1200\ kg$

$R = 50.0\ m$

$v = 80.0\ \frac{km}{h} = 22.\bar{2}\ \frac{m}{s}$

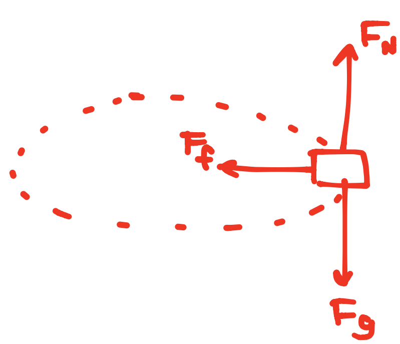
$a_c = ?$

$$a_c = \frac{v^2}{R}$$

$$= \frac{(22.\bar{2})^2}{50.0}$$

$$= \boxed{9.9\ \frac{m}{s^2}}$$

b)



$$F_c = ma_c$$

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

$$= (1200)\frac{(22.\bar{2})^2}{50.0}$$

$$= \boxed{12\ 000\ N}$$

c) $F_N = F_g$

$= mg$

$F_f = \mu F_N$

$= \mu mg$

$= (0.25)(1200)(9.8)$

$= 2900\ N$

$F_f < F_c$

NO

9. a) GIVEN:

$m = 1.0 \times 10^3\ kg$

$R = 40.\ m$

$v = 48\ \frac{km}{h} = 13.\bar{3}\ \frac{m}{s}$

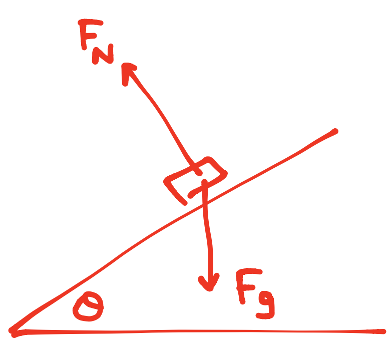
$F_c = ?$

$F_c = m\frac{v^2}{R}$

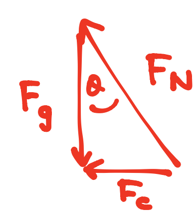
$= (1.0 \times 10^3)\frac{(13.\bar{3})^2}{40.}$

$= 4\ 400\ N$

b)



$\vec{F_c} = \vec{F_N} + \vec{F_g}$



$$\tan\theta = \frac{F_c}{F_g}$$

$$= \frac{\cancel{m}\frac{v^2}{R}}{\cancel{m}g}$$

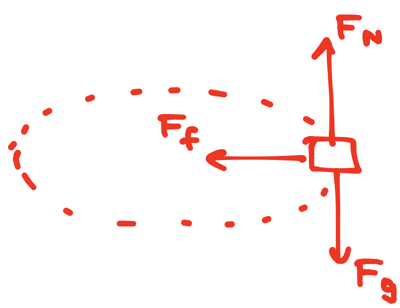
$$= \frac{v^2}{Rg}$$

$$\theta = \tan^{-1}\left(\frac{v^2}{Rg}\right)$$

$$= \tan^{-1}\left(\frac{(13.\bar{3})^2}{(40.)(9.8)}\right)$$

$$= 24^\circ$$

10.



$$F_N = F_g$$
$$= mg$$

$$F_c = m a_c$$

$$F_f = m\frac{v^2}{R}$$

$$\mu \cancel{m} g = \cancel{m}\frac{v^2}{R}$$

$$R = \frac{v^2}{\mu g}$$

$$v = 50\ \frac{km}{h}$$
$$= 13.\overline{8}\ \frac{m}{s}$$

$$= \frac{(13.\bar{8})^2}{(0.60)(9.8)}$$

$$= 33\ m$$