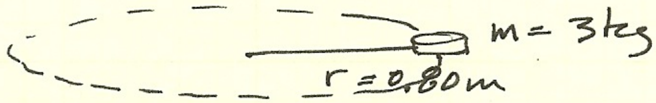
6.1 String can support static load of 25 kg $= 25 \cdot 9.8$

$= \underline{245 N}$



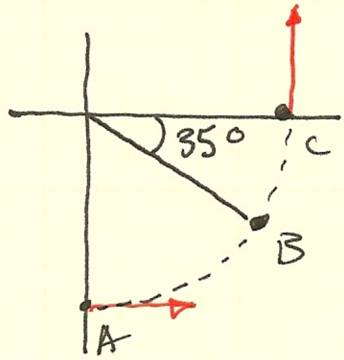
$$\Sigma F_c = \frac{mv^2}{r} = \frac{(3)\,v^2}{0.80} = F_{Tension}$$

$$F_T = \frac{mv^2}{r} \qquad v = \sqrt{\frac{F_T \cdot 0.8}{3}} = \sqrt{\frac{(245)(0.8)}{3}}$$

$$v = \boxed{8.08\ m/s}$$

This is the maximum speed the mass can have without the light spring breaking.

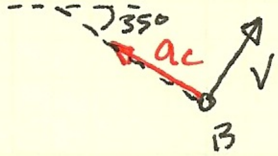
6.6



uniform speed

ABC = 235 m, $t = 36.0\,s$

a) acceleration @ B, in $\hat{i}, \hat{j}$?



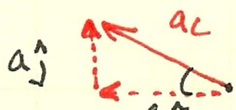
Constant speed, so acceleration is only radial, toward the center

$$a_c = \frac{v^2}{r}\ ;\quad v = \frac{d}{t} = \frac{235}{36} = 6.53\,m/s$$

$$a_c = \frac{(6.53\,m/s)^2}{150\,m}$$

$\left\{ \begin{array}{l} 2\pi r = 4 \cdot 235\,m \\ \text{so } r = 150\,m \end{array} \right.$

$$= \underline{0.284\,m/s^2}$$



Converting this to x- & y- components:

$$a_{\hat{i}} = -0.284 \cos 35 = -0.233$$
$$a_{\hat{j}} = 0.284 \sin 35 = +0.163$$

$$\vec{a} = \boxed{(-0.233\hat{i} + 0.163\hat{j})\ m/s^2}$$

b) $v_{avg} = \frac{d}{t} = \boxed{6.53\,m/s}$ calculated above.

c) The want a_c from v_A to v_B. Use definition of acceleration:

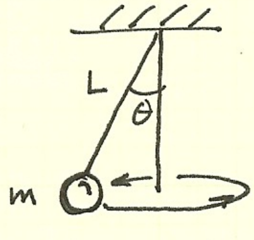
$$a = \frac{v_F - v_i}{t} =$$

$v_F = v_C = 6.53\hat{j}$ $\qquad$ $v_i = v_A = 6.53\hat{i}$

$$= \frac{6.53\,j - 6.53\,i}{36}$$

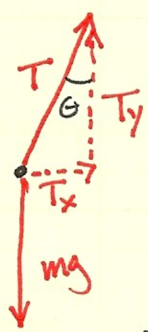
$$= \frac{-6.53\,i + 6.53\,j}{36} = \boxed{(-0.181\hat{i} + 0.181\hat{j})\ m/s^2}$$

6.8



a) Determine F_{horz} & $F_{vertical}$ exerted by string.

Free-body diagram.



No acceleration in vertical direction, so

$$\Sigma F_y = ma_y = 0$$
$$T_y - mg = 0$$
$$T_y = mg = 80 \cdot 9.8 = \boxed{784\,N}$$

$$\frac{T_x}{T_y} = \tan 5^\circ, \text{ so}$$
$$\cancel{T_y = \frac{T_x}{\tan 5} = \frac{784}{\tan 5} = \boxed{8.96e3\,N}}$$

$$T_x = T_y \tan 5$$
$$= 784 \tan 5 = \boxed{68.6\,N}$$

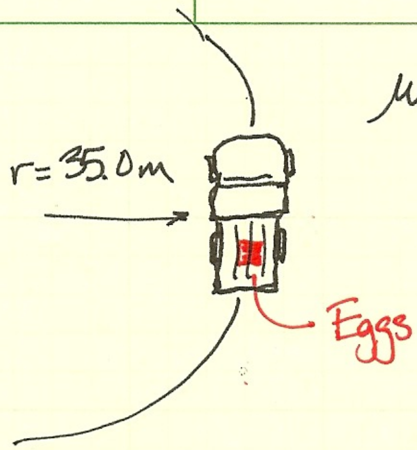
b) Radial (centripetal) acceleration of bob = ?

$$a_c = \frac{v^2}{r} \; ? \quad \text{Don't know } v!$$

$\Sigma F_c = ma$?! Ah, yes!

$$T_x = ma$$
$$68.6 = (80\,kg)\, a$$
$$a = \boxed{0.858\,m/s^2}$$

6.9

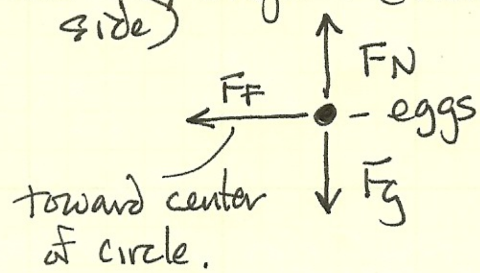


$\mu = 0.600$

$V_{max} = ?$

Not sure where to go with this, but its a truck traveling in a circle, & force of friction is involved, so that gives us a place to start!

Free-body diagram (from side)



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

$$F_F = \frac{mv^2}{r}$$

$$F_F = \mu F_N, \text{ so}$$

$$\mu F_N = \frac{mv^2}{r}$$

Here $\Sigma F_y = ma_y = 0$, so $F_N = F_g = mg$

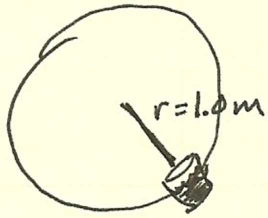
$$\mu \cancel{m} g = \frac{\cancel{m} v^2}{r}$$

$$v = \sqrt{r\mu g}$$

$$v = \sqrt{(35)(0.6)(9.8)}$$

$$V_{max} = \boxed{14.3 \text{ m/s}}$$

6.12

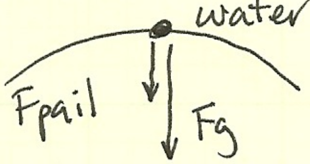


a) Two external forces acting on the water in the pail are the pail, & gravity.

b) To keep water moving in a circle, the pail force is most important – gravity only acts down, but pail force can act as needed in any direction.

c.) Minimum speed at top of circle for no water to be spilled?

At top, F_c (centripetal force) will come from F_g & Fpail. At minimum speed, Fpail will be 0 – only Fg will act centripetally to accelerate water in a circle.



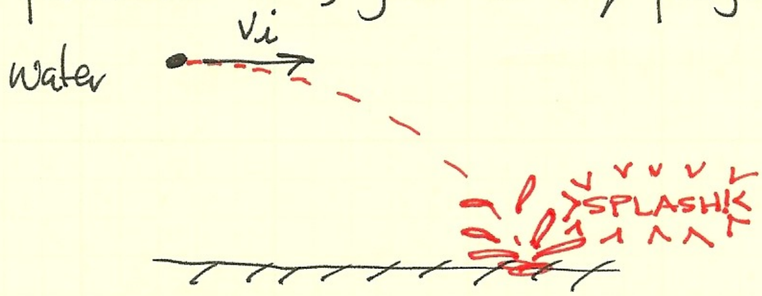
$$\Sigma F_c = \frac{mv^2}{r}$$

$$F_g = \frac{mv^2}{r}$$

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

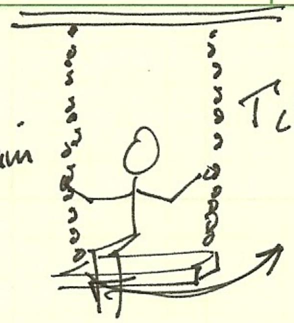
$$v = \sqrt{rg} = \sqrt{1 \cdot 9.8} = \boxed{3.13\ m/s}$$

d. If the pail disappears at the top of the circle, the only force acting on the water will be the force of gravity. The water will travel in a parabolic arc, just as any projectile would.



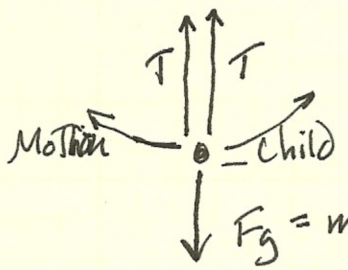
6.14

T_{chain}



$T_{chain} = 350N$ at low point, $L = 3.00m$

From side:



$F_g = mg = 40 \cdot 9.8 = 392N$

a) $\Sigma F_c = \frac{mv^2}{r}$

$2T - F_g = \frac{mv^2}{r}$

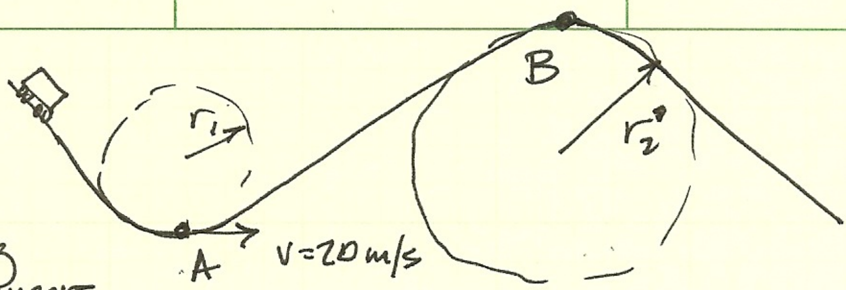
$2(350) - 392 = \frac{40\,v^2}{3}$

$v \doteq \boxed{4.81\,m/s}$ at lowest point.

b) F_{Normal} exerted on child is the same as the total Tension in the chains $= \boxed{700N}$.

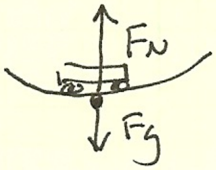
The tension in those chains is transmitted to the child via the Normal force of the seat.

6.16



$m_{car} = 500\,kg$ w/ passengers.

a) Force exerted by track on car at Point A?



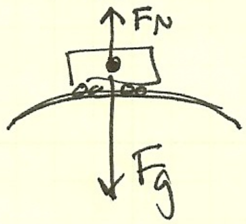
$$\Sigma F_c = \frac{mv^2}{r}$$

$$F_N - F_g = \frac{mv^2}{r}$$

$$F_N = \frac{mv^2}{r} + mg = \frac{(500)(20)^2}{10m} + 500(9.8)$$

$$= \boxed{2.49e4\ N}$$

b) Assuming roller coaster car isn't attached to track at B, its max speed would be?



$F_N = 0$ at v_{max}, so

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

$$F_N - F_g = -\frac{mv^2}{r}$$

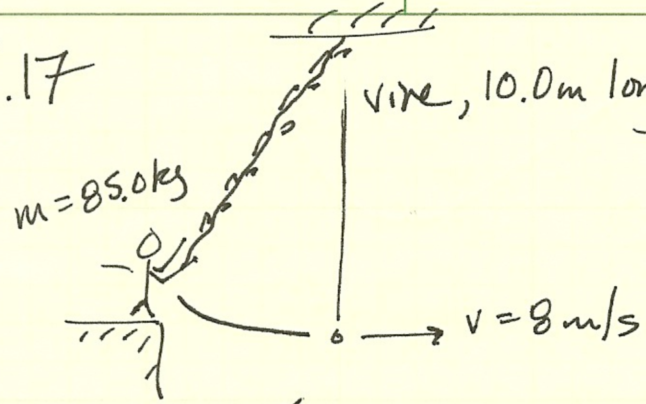
$$0 - mg = -\frac{mv^2}{r}$$

$$v = \sqrt{rg} = \sqrt{15 \cdot 9.8} = \boxed{12.1\ m/s}$$

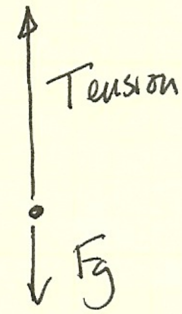
Faster than this speed, there won't be enough Force downward to keep the car going in its vertical circle, unless the wheels are restrained by the track which will apply additional F_{Normal} to help out.

6.17

vine, 10.0m long, $F_{Tension}\ max = 1000N$.



Free-body diagram at bottom.



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

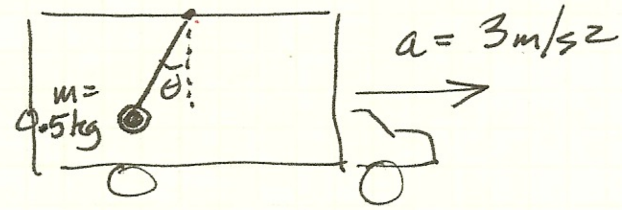
$$T - mg = \frac{mv^2}{r}$$

$$T = \frac{mv^2}{r} + mg = \frac{(85)(8)^2}{10} + (85)(9.8)$$

$$= \boxed{1380N}$$

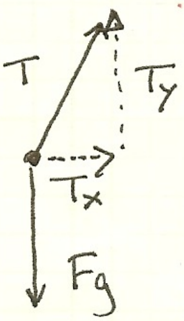
This is greater than the 1000N max strength of the vine, so it breaks!

6.21



Find θ & T in string.

Free-body diagram.



Truck is accelerating in x-direction, so

$\Sigma F_x = ma_x$

$T_x = ma_x$

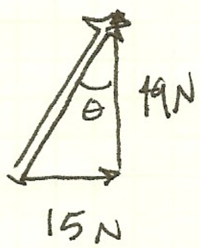
$T_x = (0.5 \text{ kg})(3 \text{ m/s}^2) = \underline{\underline{1.5 \text{ N}}}$

Truck is <u>not</u> accelerating in y-direction, so

$\Sigma F_y = ma_y = 0$

$T_y - F_g = 0$

$T_y = mg = (0.5 \text{ kg})(9.8 \text{ m/s}^2) = \underline{\underline{4.9 \text{ N}}}$



Put T_x & T_y together.

a) Angle $\theta = \tan^{-1}\left(\frac{1.5}{4.9}\right)$
$= \boxed{17.0°}$

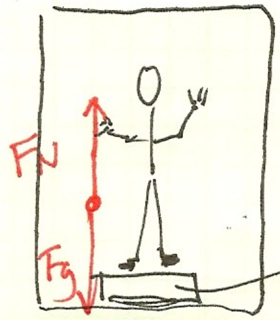
b) Tension T in string

$T = \sqrt{T_x^{\,2} + T_y^{\,2}}$

$= \sqrt{1.5^2 + 4.9^2}$

$= \boxed{5.12 \text{ N}}$

6.23



Scale (measures Normal force)

When accelerating, $F_N = 591N$
When decelerating, $F_N = 391N$

Find W, m, & a.

When accelerating upwards: $\Sigma F_y = ma_y$

$$F_N - F_g = ma$$
$$591 - W = ma$$
$$591 - mg = ma$$

When decelerating: $\Sigma F_y = ma_y$

$$391 - mg = -ma$$

Notice sign change

Combine equations & solve:

$$\begin{array}{r} 591 - mg = ma \\ +\ 391 - mg = -ma \\ \hline 982 - 2mg = 0 \end{array}$$

$$m = \frac{982}{2g} = \boxed{50.1\ kg}$$

$$W = mg = (50.1\ kg)(9.8\ m/s^2) = \boxed{491\ N}$$

$$a = \frac{591 - (50.1)(9.8)}{50.1} = \boxed{2.00\ m/s^2}$$