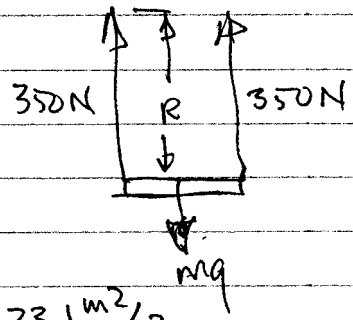
Child on a Swing

mass child and swing seat = 40.0 kg.
length of swing cables/rods = 3.0 m
tension on each swing cable = 350 N while swinging

a)? while swinging, if T = 350 N, what is v at the bottom?

$\Sigma F = 2T - mg = \frac{mv^2}{R}$ (centripetal)
(up) (down) (up)



$v^2 = (2T - mg)(R/m)$
$= (700 - (40.0)(9.80))\frac{3.00}{40.0} = 23.1\ m^2/s^2$

$\boxed{v = 4.81\ m/s}$

b) ? force exerted by seat on child at bottom?

$f_n - mg = F = mv^2/R$
$f_n = mg + mv^2/R = (40.0)(9.80 + 23.1/3.00)$
$\boxed{f_n = 700\ N}$

c)? if child stopped swinging, what would T be?

$2T = mg$
$\boxed{T = mg/2 = 392\ N/2 = 196\ N \text{ on each rope/chain}}$

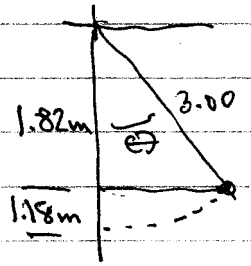
d)? how high at the top of the arc, if y = 0 at the bottom?

$v_{bottom} = 4.81\ m/s \quad v^2 = 23.136$

$KE = \frac{1}{2}mv^2 = (20.0)(23.136) = 462.7\ J$

$mgh = 462.7\ J$
$h = 462.7/(9.8)(40.0)$
$\boxed{h = 1.18\ m \text{ up from bottom}}$

e) ? what angle from vertical?



$\theta = \cos^{-1}(1.82/3)$
$\boxed{\theta = 52.65°}$

f) ? what speed at bottom enables child to just reach top?
if steel rods support swing, not chains or rope?

bottom to top = $\Delta y = 6m$ $2R$

to top, $mgh = (40)(9.8)(6.0m) = 2352J$

$\frac{1}{2}mv^2 = mgh$ $h=2R$

$v^2 = (2)(9.8)(6.0) = 117.6$ $= 4gR$

$v = 10.8$ m/s at bottom $= 2\sqrt{gR}$

$v = 0.0$ at top

g) ? what speed at bottom for child at top, if chains/ropes.

$mg = \frac{mv^2}{R}$ at the top, gravity provides a_c

$v^2 = gr$ at top $= 29.4\ m^2/s^2$

$v = 5.4222$ m/s at the top. $= \sqrt{gR}$

So, to get to the top,

$\frac{1}{2}mv^2_{bot} = \frac{1}{2}mv^2_{top} + mgh$

$v_b^2 = v_t^2 + 2gh$

$= 29.4 + (2)(9.8)(6.0)$ $gR + 4gR$

$v_{bott} = 12.12$ m/s

h) ? 1) Energy to get up $mgh = \frac{1}{2}mv^2$

$v_1^2 = 2gh = 4gR$

2) Energy to go in circle at top. $a_c = \frac{v_2^2}{r} = g$

$v_2^2 = gR$

Velocity needed at bottom

$\frac{1}{2}mv_3^2 = \frac{1}{2}m(v_1^2) + \frac{1}{2}m(v_2^2)$

$v_3^2 = v_1^2 + v_2^2$

NOT $v_3^2 = (v_1 + v_2)^2$ if one "just added velocities"

for $v_3^2 = v_1^2 + 2v_1v_2 + v_2^2$ gives answer too large