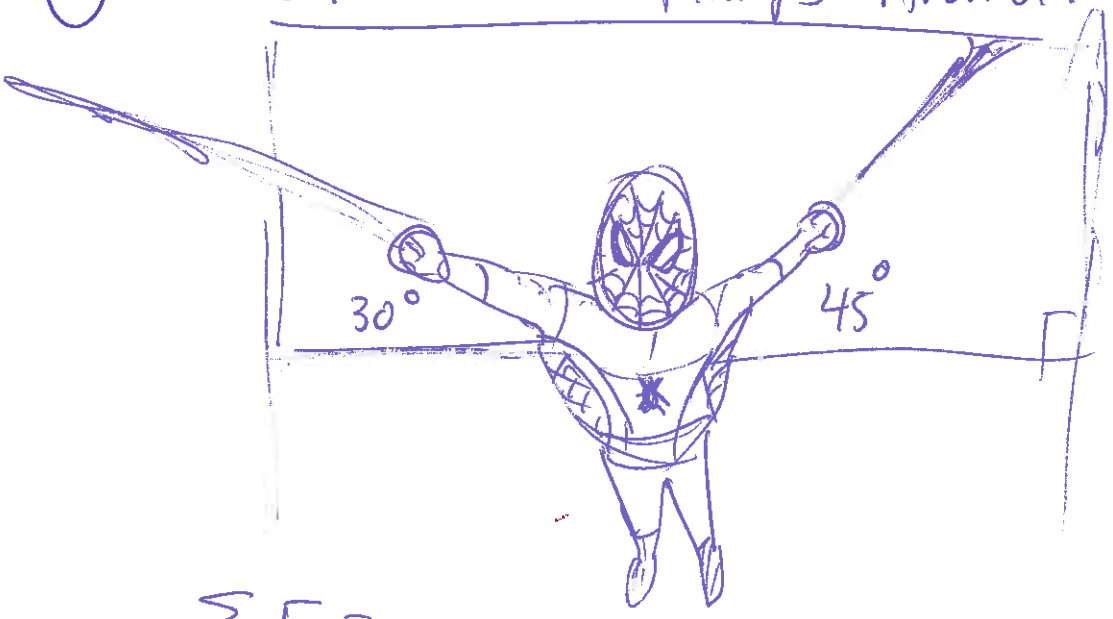
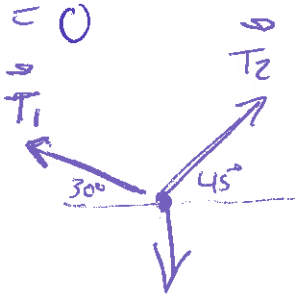
① Spider-man Hangs Around.



$\downarrow g = 10 m/s^2$

$m = 60 kg$

$\Sigma F = ma = 0$



$\vec{w} = mg \downarrow$

$\Sigma F_x = T_{1x} + T_{2x} = 0 = |T_1|\cos\theta + |T_2|\cos\phi$ (150°, 45°)

$-0.866\,T_1 + 0.707\,T_2 = 0$

$\Rightarrow T_1 = \frac{0.707}{0.866} T_2 = 0.816\,T_2 \approx 0.82\,T_2$

$\Sigma F_y = T_{1y} + T_{2y} - |w| = 0$

$mg = 600N = |T_1|\sin 150° + |T_2|\sin 45°$

$600N = 0.5\,T_1 + 0.707\,T_2$

But $T_1 \approx 0.8\,T_2$ so

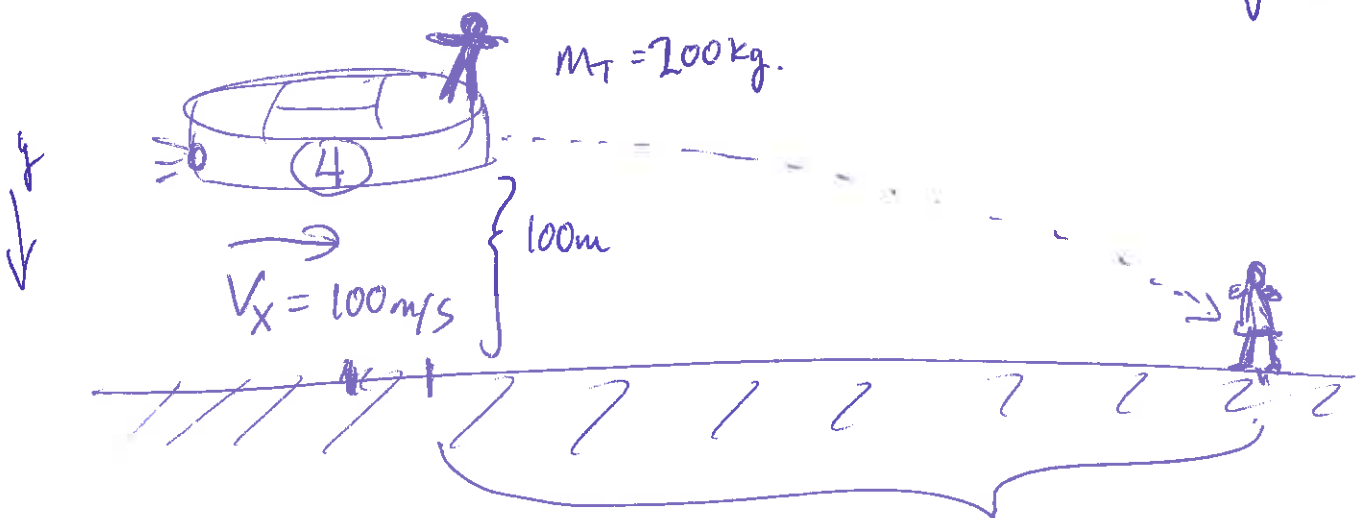
$600N = (0.8)(0.5)T_2 + 0.707\,T_2 \approx 1.1\,T_2$

$\Rightarrow$ **$T_2 \approx 550 N$** $\Rightarrow T_1 = 0.82\,T_2$

$T_1 = 450 N$

(2) The Thing Drops In

$g \downarrow 10 m/s^2$



$X = X_0 + V_{0x}t + \frac{1}{2}a_x t^2$

$X_0 \to 0$; $V_{0x} \to 100 m/s$; $a_x \to 0$

$X = ?$

$X = (100 m/s)t$ ok so what is t?

$y = 100m = \frac{1}{2}(10 m/s^2)t^2$

$t^2 = \frac{200 s^2}{10}$ so $t = \sqrt{20}\, s$

$t \simeq 4.5 sec.$

$X = (100 m/s)(4.5 s)$

$\boxed{X = 450 m}$

(3) Legion Flyers

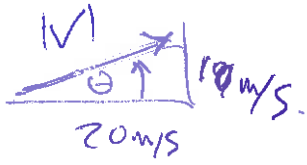
10 m/s vs. SG

→ E @ 20 m/s vs. Ground.

$\vec{V}_{SG|E} = 20\ m/s \uparrow$ $\quad V_{H|SG} = 10\ m/s \uparrow$

$\vec{V}_{H|E} = ? = \vec{V}_{H|SG} + \vec{V}_{SG|E}$

$= 10\ m/s \uparrow + 20\ m/s \uparrow$



$|\vec{V}_{H|E}| = \sqrt{(10\ m/s)^2 + (20\ m/s)^2}$

$= \sqrt{500\ m^2/s^2}$

$= \boxed{22\ m/s}$

$\tan\theta = \frac{10\ m/s}{20\ m/s} = 0.5$

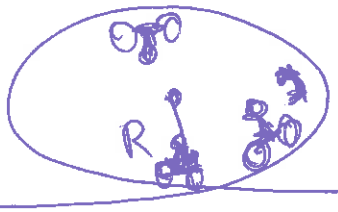
$\theta = \arctan 0.5 = 26.6^\circ \approx \boxed{27^\circ}$

North of East.

(4) Ghost Rider in a Ring.

$m = 400\,kg$.

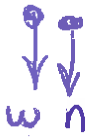
$g \downarrow 10\,m/s^2$



$R = 10m$

$|V| = 30\,m/s$

FBD at Top:



Bottom:

$$|a_{rad}| = \frac{|V|^2}{R} = \frac{30\,m/s}{10m}$$

$$|a_{rad}| = \frac{900\,m^2/s^2}{10m} = 90\,m/s^2$$

Top

$$F = ma_{rad} = -w^{=mg} - n = m(-|a_{rad}|) = -400kg \cdot 90\,m/s^2$$

$$+(400kg)(10\,m/s^2) + n = +400kg \cdot 90\,m/s^2$$

$$n_{Top} = 36000N - 4000N = \boxed{32000N}$$

down.

Bottom

$$n - w^{=mg} = m|a_{rad}| = 36000\,N$$

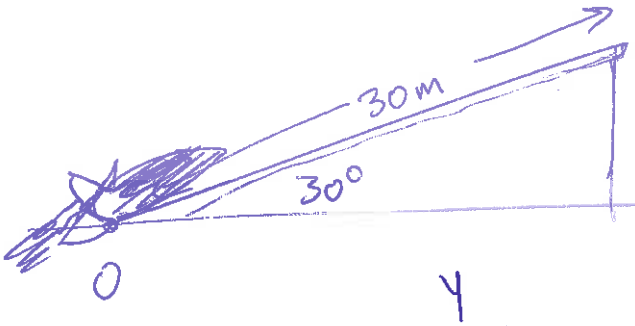
$$n = 36000\,N + 4000\overset{=w}{N} = \boxed{40000\,N}$$

up.

Don't Try this at Home!

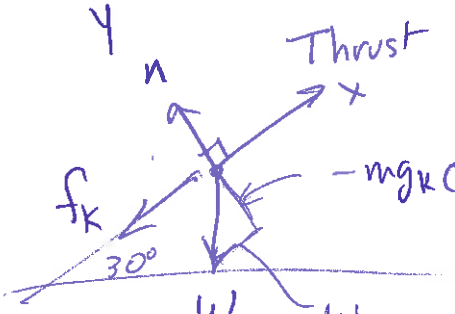
(5) Kryptonian Rockets

$g_K = 12\ m/s^2 \downarrow$



$\mu_K = 0.1$

FBD:



$\Sigma F_x = ma_x$ $\quad$ $\Sigma F_y = 0$

$\text{Thrust} - f_K - mg_K \sin 30^\circ = ma_x$ $\quad$ $n + -mg_K\cos 30^\circ = 0$

$20{,}000N - (n)(\mu_K) - 1000kg\ 12m/s^2(0.5) = 1000kg\ a_x$ $\quad$ $n = mg_K\cos 30^\circ$

$n = 1000kg \quad 12\ m/s^2 \quad 0.866$

0.1

$20000N - (10392)0.1N - 6000N = 1000kg\ a_x$

$n = 10392\ N$

(keep figs for now)

$20000N - 1039N - 6000N = 1000kg\ a_x$

$22000N$ to 2 sig figs

$13000N = 1000kg\ a_x$

$a_x = 13\ m/s^2$

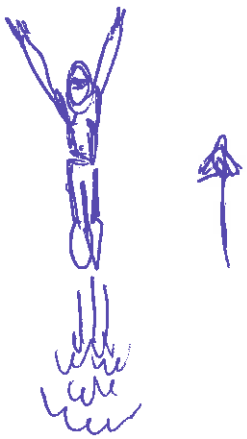
$V = V_0 + a_x t$ $\quad$ $V_0 = 0$ $\quad$ $a_x = 13\ m/s^2$ $\quad$?

$x = 30m = \frac{1}{2} a_x t^2$

$t \approx 2.1$ sec.

$V_{final} = 27\ m/s$ to two sig figs

(6) Captain Marvel Flies.



$a = 2\,m/s^2 + 10\,m/s^4\, t^2$

at $t = 10$ sec. what is V, x?

what is a_{ave}, V_{ave}?

$a = \frac{dv}{dt}$ so $V = \int_0^{10s} (2\,m/s^2 + 10\,m/s^4\, t^2)\, dt$

$V = (2\,m/s^2)t + \frac{10}{3}\,m/s^4\, t^3 \Big|_0^{10s}$

$V = 20\,m/s + \frac{10{,}000}{3}\,m/s \simeq$ 3333 m/s

$\frac{dx}{dt} = V$ so $x = \int_0^{10s} \left((2\,m/s^2)t + \frac{10}{3}\,m/s^4\, t^3\right) dt$

$x = 1\,m/s^2\, t^2 + \frac{10}{12}\,m/s^4\, t^4 \Big|_0^{10s}$

$x = 100\,m + 8333\,m$

$x =$ 8400 m to two sig figs.

$a_{ave} \simeq 350\,m/s^2 = \frac{\Delta V}{\Delta t} = \frac{3500\,m/s}{10\,s} = 350\,m/s^2$

$V_{Ave} = \frac{\Delta x}{\Delta t} =$ 840 m/s