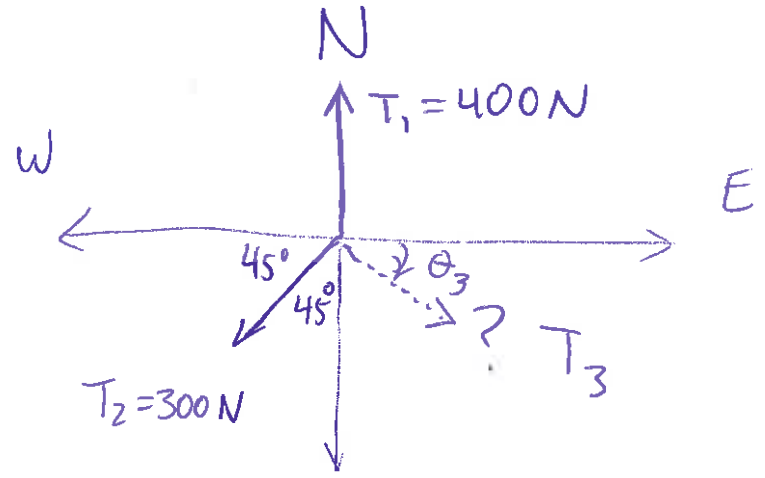
① Spiderman's Web:



$$\sum F = 0 = \vec{T}_1 + \vec{T}_2 + \vec{T}_3$$

$T_{1,y} = 400N$

$T_{2,y} = -212N = (300N)\sin 45^\circ$

$T_{3,y} = ?$

$T_{1,x} = 0$

$T_{2,x} = (300N)\cos 45^\circ$

$T_{3,x} = ?$

$400N - 212N + T_{3,y} = 0$

$T_{3,y} = -188N$

$T_{3,x} - 212N = 0$

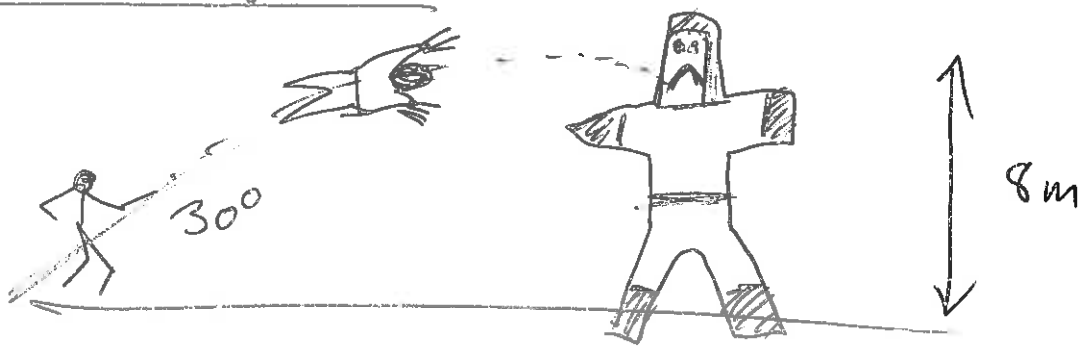
$T_{3,x} = 212N$

$$|T_3| = \sqrt{(212)^2 + (188)^2} = \boxed{283N}$$

$$\tan\theta_3 = \frac{T_{3y}}{T_{3x}} = \frac{-188}{212}$$

$$\boxed{\theta_3 = -41.6^\circ}$$

"Fastball Special"



50m

$V_0 = ?$

30° $\quad -10 m/s^2$

$$y = y_0 + V_0 \sin\theta\, t + \frac{1}{2} g t^2$$

1. $8_m = 0 + V_0(0.5)\, t - 5t^2$

2. $X = X_0 + V_0 \cos 30^\circ\, t$

$50 \quad 0 \quad 0.866$

or $V_0 t = \frac{50m}{0.866}$

$V_0 t = 57.7 m$

Subbing in:

$8m = V_0 t (0.5) - 5t^2$

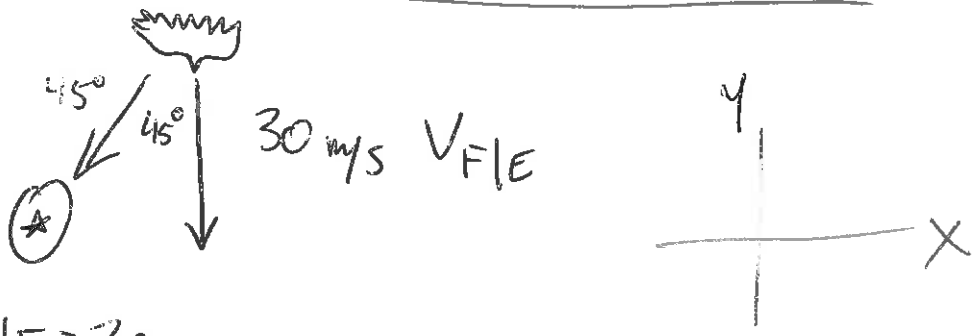
$57.7m$

$20.9m = 5t^2$

$t = \sqrt{4.2}\ s = 2.0 \text{ sec.}$

$V_0 = \frac{57.7m}{2.04s} = 28 m/s$

③ Capt. America + Falcon vs. Batroc



$V_{S|F} = 20\ m/s$

$\leftarrow V_{B|E} = 10\ m/s$

What is $V_{S|B}$?

$$\vec{V}_{S|E} \Rightarrow \vec{V}_{S|F} + \vec{V}_{F|E}$$

$$\vec{V}_{S|B} = \vec{V}_{S|E} + \vec{V}_{E|B} = \vec{V}_{S|F} + \vec{V}_{F|E} - \vec{V}_{B|E}$$

$$\vec{V}_{E|B} = -\vec{V}_{B|E}$$

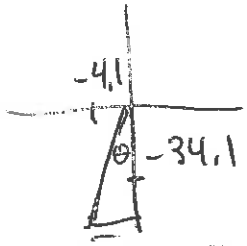
$$x: (V_{S|B})_x = -(20\ m/s)\underbrace{\cos 45^\circ}_{0.707} + 0 + -10\ m/s$$

$$= -4.1\ m/s$$

$$y: (V_{S|B})_y = (-20\ m/s)\underbrace{\sin 45^\circ}_{0.707} + -30\ m/s = -34.1\ m/s$$

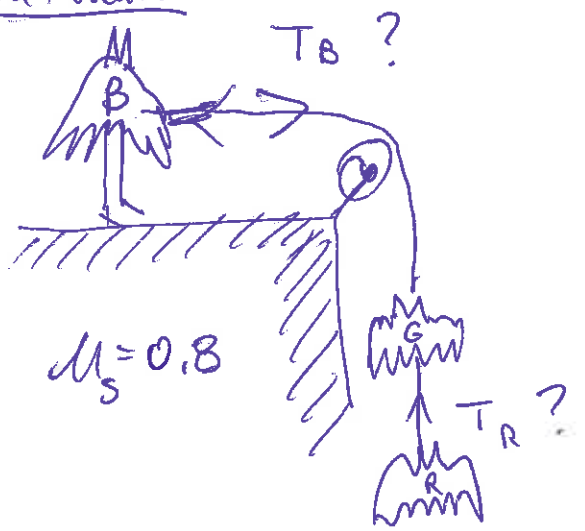
$$|V_{S|B}| = \sqrt{(4.1)^2 + (34.1)^2}\ m/s$$

$$= \boxed{34.3\ m/s}$$



$$\theta = \tan^{-1}\left(\frac{4.1}{34.1}\right) \approx \underline{6.9^\circ \text{ West of South}}$$

(4) Batman



$m_{BM} = 150\ kg$

$m_{BG} = m_R = 50\ kg$

A) $T_{BM} = (w_G + w_R) = (100\ kg)(10\ m/s^2) = 1000N$

$\boxed{T_{BM} = 1000N}$

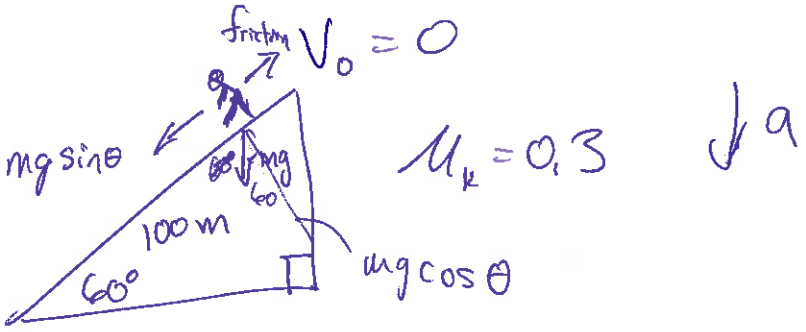
Static friction same and opposite as T_B.

Not $\mu_s N_{BM}$!

B) $T_R = w_R = (50\ kg)(10\ m/s^2) = \boxed{500N}$

(5) **Black Widow:**

$m_{BW} = 50\ kg$



A) $\Sigma F_{\parallel} = ma$

$\Sigma F_{\parallel} = mg\sin\theta - (mg\cos\theta)\mu_k = ma$

$0.87 \approx \sin\theta$, $0.5 \approx \cos\theta$, $\mu_k = 0.3$, $g \approx 10$

$8.7 - (5.0)(0.3) = a \quad [m/s^2]$

$8.7 - 1.5 = a$

Constant.

$\boxed{a = 7.2\ m/s^2}$

$a = 7$ is ok!

B) V_{Bottom}?

$\frac{dx}{dt} = V_0 + at$

$x = x_0 + V_0 t + \frac{1}{2} a_x t^2$

x: 100 m; x_0: 0; V_0: 0; a_x: 7

$100\ m = 3.5 t^2$

$t^2 = 29\ sec. \Rightarrow t = 5.4\ sec.$

$V = at = (7)(5.4) =$

$\boxed{V = 38\ m/s}$

(6)

given:

a) $v_0 = 400\ m/s$

acc. func. is $a = 10t^2$

w.k.t

$$a = \frac{dv}{dt} \Rightarrow dv = 10t^2\,dt$$

take integral on both sides

i.e., $$\int dv = \int_0^{10} 10t^2 \cdot dt$$

$$v = 10\,\frac{t^3}{3}\Big|_0^{10} = \frac{10}{3}\left[1000 - 0\right]$$

$$= 3,333.33\ m/s$$

$v + v_0 = 3,733.33\ m/s$.

Velocity at the end of 10s is $\boxed{3,733.33\ m/s}$.

b) we also know that,

$$v = \frac{dx}{dt} \Rightarrow \int dx = \int v\,dt = \int_0^{10} 10\,\frac{t^3}{3}\,dt$$

Acceleration term:

$$\text{or } x_1 = \frac{10}{3}\int_0^{10} t^3 \cdot dt = \frac{10}{3}\,\frac{t^4}{4}\Big|_0^{10}$$

$$x_1 = \frac{10}{12}\left[10,000 - 0\right] = \frac{100,000}{12} = \boxed{8,333\ m.}$$

Not final!

Constant velocity term: $x_2 = v_0 t = 10_s = 4000\ m$.

$v_0 = 400\ m/s$

Total $x = x_1 + x_2 = (4000 + 8,333)_m = \boxed{12,333\ m.}$