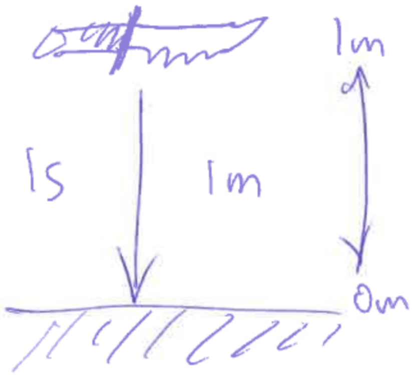
(1) Gamora's knife drop:

What is $\vec{g}_{planet}$ if $m_k = 500g = 0.5\ kg$,

$t = 1 sec$

$\Delta y = 1$ meter



$$y = y_0 + V_{0y} t + \frac{1}{2} g_p t^2$$

($y_0 \to 1m$, $V_{0y} \to 0$)

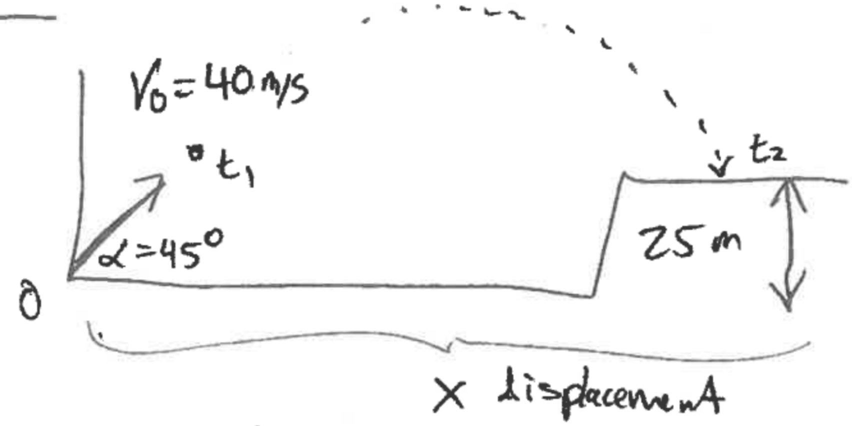
$$0 = 1m + \frac{1}{2} g_p t^2$$

($t \to 1s$)

$$\boxed{-2\ m/s^2 = g_p}$$

or $\boxed{2 m/s^2 \text{ down}}$ is acceptable.

② Hulk



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

$\sin\alpha = \cos\alpha \approx 0.70$

a) $y = y_0 + (V_0 \sin\alpha)t + \frac{1}{2}gt^2$

final: $25 = 0 + 28t - 5t^2$ in mks units.

$-5t^2 + 28t - 25 = 0$

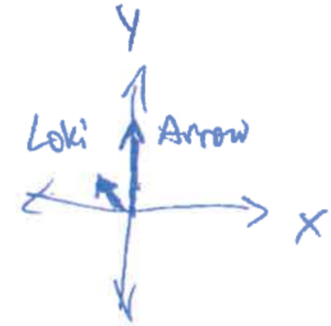
$a = -5 \quad b = 28 \quad c = -25$ for quadratic Eq

$t_1 = 1.1$ sec. $\boxed{t_2 = 4.5\ sec}$

b) $x = x_0 + v_0 \cos\alpha t = \boxed{126\ m}$

$x_0 = 0$, $v_0 \cos\alpha = 28$ m/s, $t = 4.5$ s

③ Hawkeye & Loki:



$V_{A|E}$ = 100 m/s North

$V_{L/E}$ = 40 m/s NW

$V_{A|L}$? $\vec{V}_{A|E} = \vec{V}_{A|L} + \vec{V}_{L|E}$

$\vec{V}_{A|L} = \vec{V}_{A|E} - \vec{V}_{L|E}$

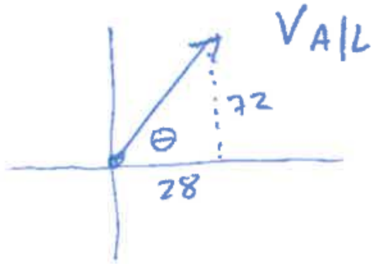
X: $|V_{L|E}|_x = (0.707)40$ m/s = 28 m/s in $-x_{dir.}$

y: $|V_{A|E}|_y = 100$ m/s

$|V_{L/E}|_y = 28$ m/s

X: $|V_{A|L}|_x = 0 + 28$ m/s, x

$|V_{A|L}|_y = 100$ m/s $- 28$ m/s $= 72$ m/s, y

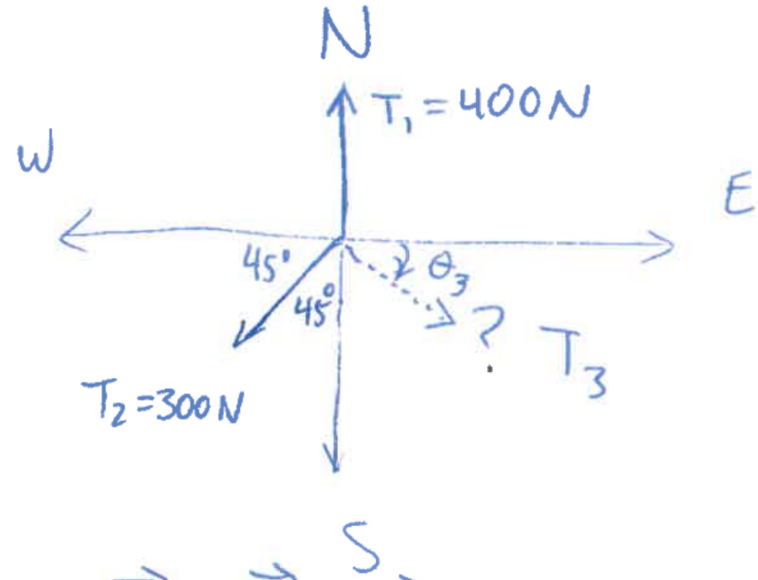


$R = \sqrt{72^2 + 28^2} =$ **77 m/s**

$\tan\theta = \frac{72}{28}$

$\theta = 69°$

④ Spiderman's web:



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

$T_{1,y} = 400N$

$T_{2,y} = -212N = (300N)\sin 45°$

$T_{3,y} = ?$

$T_{1,x} = 0$

$T_{2,x} = (300N)\cos 45°$

$T_{3,x} = ?$

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

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

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

$T_{3,x} = 212N$

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

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

$$\boxed{\theta_3 = -41.6°}$$

(5) Ironman restarting Helicarrier turbine

Rotation rate $= 1.3\ s^{-1} = T$

$m_I = 180\ kg$

$d = 52\ m$

$r = 26\ m$

$$a = \frac{v^2}{r} \qquad F = ma = \frac{mv^2}{r}$$

(m = 180 kg, v^2 = ?, r = 26 m)

$$V = \frac{2\pi r}{t = T^{-1}} = \frac{2\pi\, 26\,m}{(1.3)^{-1}}$$

$$= 212\ m/s$$

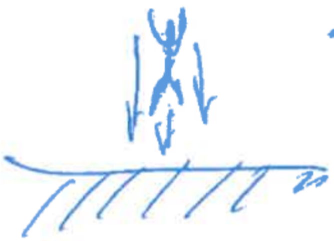
$$F = \frac{(180\ kg)(212\ m/s)^2}{26\ m}$$

$$F = 312242 \approx 310{,}000\ N$$

$$\boxed{F \approx 310\ kN}$$

Toward center.

(6) Ms. Marvel flying



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

$\Delta t = 10$ sec.

$t_0 = 0,\ y_0 = 0$

v & y at 10 sec?

$$a = \frac{dv}{dt} = 2\,m/s^2 + 10\,m/s^4\, t^2$$

$$v = \int_0^{10s} (2\,m/s^2 + 10\,m/s^4)\,dt$$

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

$$v = 20\,m/s + 3333\,m/s$$

$$\boxed{v = 3353\,m/s}$$

$$y = \int_0^{10} v\,dt = \int_0^{10} (2\,m/s^2\, t)\,dt + \int_0^{10} \frac{10t^3}{3}\,m/s^4\,dt$$

$$y = \left(\frac{1}{2}\right)(2\,m/s^2)\,t^2 \Big|_0^{10} + \frac{10}{3}\left(\frac{1}{4}\right) t^4\, m/s^4 \Big|_0^{10}$$

$$y = \left[\, t^2 \Big|_0^{10} + \frac{10}{12}\, t^4 \Big|_0^{10} \right] m$$

$$\boxed{y = 100\,m + 8333\,m = 8433\,m}$$