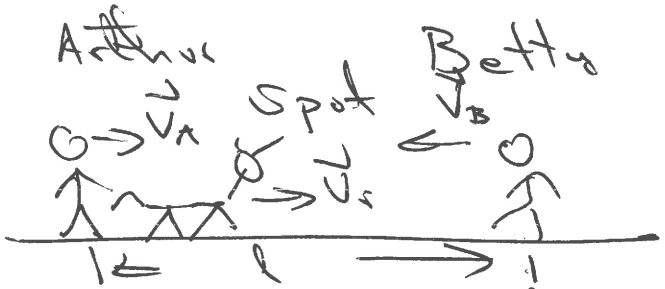
Test #1 Solutions.

① 

$V_A = 3.0\,m/s$

$V_B = 2.0\,m/s$

$V_s = 5.0\,m/s$

$l = 100.\,m$

$V_A = \frac{d_A}{t}$ $\quad V_B = \frac{d_B}{t}$ $\quad$ b.t.:

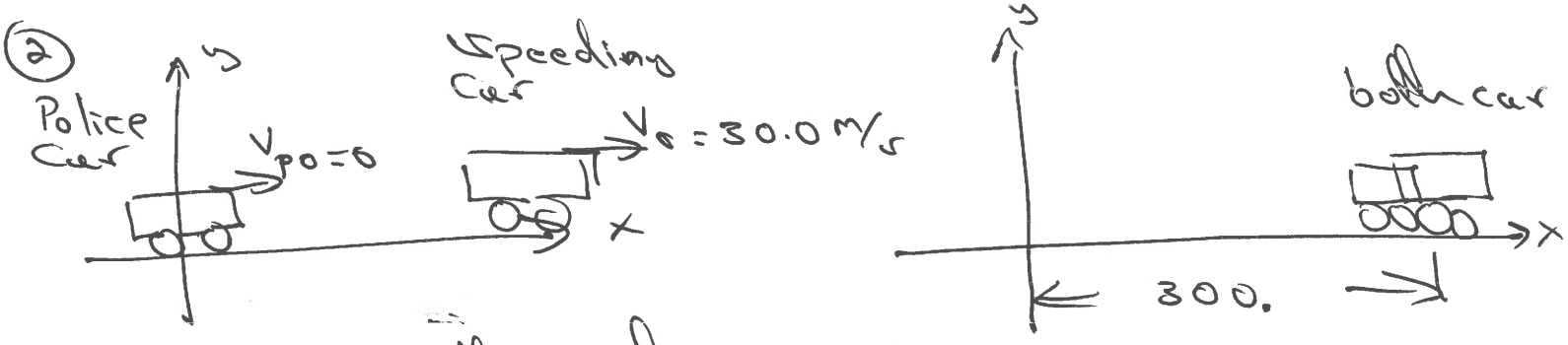
$d_A + d_B = l \rightarrow V_A t + V_B t = l$

$t = \frac{l}{V_A + V_B} = \frac{100.}{3.0+2.0} = 20.\,sec.$

During this time spot has covered a distance.

$d_s = V_s t = (5.0)(20.)$

$\boxed{d_s = 1.0 \times 10^2\,m}$ → Ans

② 

* Let's find the time the speeding car takes to cover 300.m

$V_s = \frac{x}{t} \Rightarrow t = \frac{x}{V_s} = \frac{300.}{30.0} = 10\,s$

* then the Police car need the following acceleration:

$t_p = 10 - 1.00 = 9.0\,s$

$x - x_0 = 300.\,m$

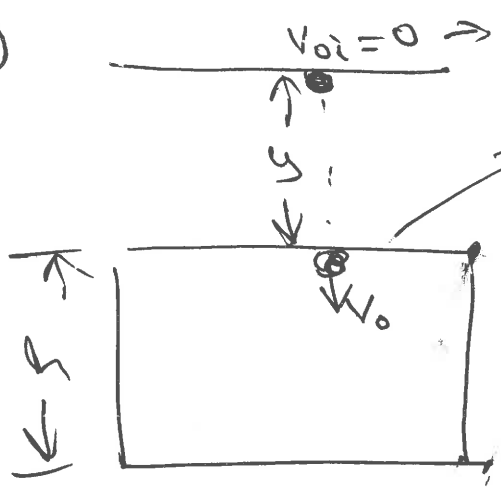
$a = ?, \; V_{P0} = 0$

$\rightarrow x - x_0 = V_{P0} t_p + \frac{1}{2} a t_p^2.$

$a = \frac{2(x-x_0)}{t_p^2} = \frac{2(300.)}{(9.0)^2}$

$\boxed{a = 7.41\,m/s^2}$ → Ans

(3)



$v_0^2 = \cancel{v_{0i}^2}^{\,0} + 2ay$

$v_0^2 = 2ay$

Now: $a = 9.8\ m/s^2$.

$y - y_0 = h = 2.00\ m$

Use ↓ $t = 200.\ ms$

$h = y - y_0 = v_0 t + \frac{1}{2} a t^2$.

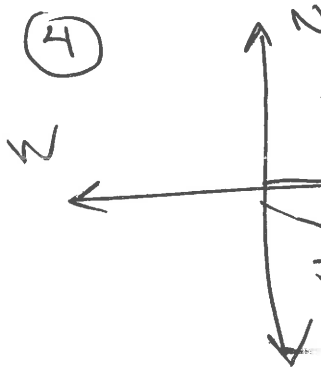
$h = \sqrt{2ay}\, t + \frac{1}{2} a t^2$.

$\sqrt{2ay}\, t = h - \frac{1}{2} a t^2$.

$$y = \frac{(h - 1/2\, a t^2)^2}{2a t^2} = \frac{\left(2 - 0.5 \times 9.8 \times (200 \times 10^{-3})^2\right)^2}{2(9.8)(200 \times 10^{-3})^2}$$

$\boxed{y = 4.15\ m}$ → Ans

(4)



$\vec{v}_{PW}$ → Velocity of plane w.r.t the wind.

$\vec{v}_{WG}$ → Velocity of wind w.r.t the ground.

$\vec{v}_{PG}$ → Velocity of plane w.r.t the ground.

$|\vec{v}_{PW}| = 156\ m/s$.

$|\vec{v}_{WG}| = 20.0\ m/s$.

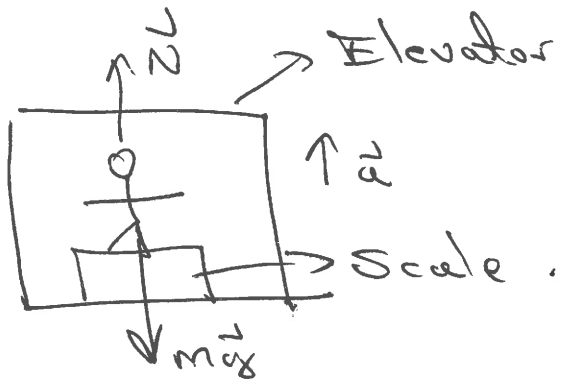
$v_{PG} = \sqrt{v_{PW}^2 + v_{WG}^2} = \sqrt{156^2 + 20.0^2}$

$\boxed{v_{PG} = 157\ m/s}$ ↓ Ans

$\theta = \tan^{-1}\left(\frac{20}{156}\right)$

$\boxed{\theta = 7.31^\circ \text{ South of East}}$

(5)



$a = 2.00\ m/s^2$ ↑

$\Sigma F_y = ma$

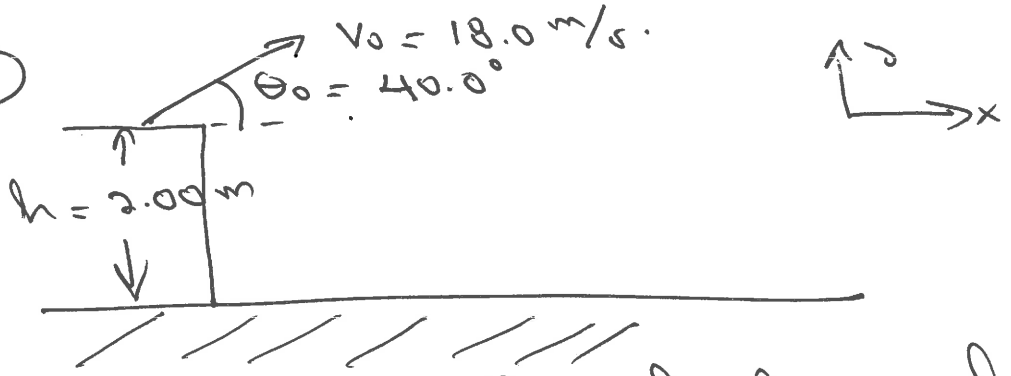
$N - mg = ma$

$N = m(a+g)$

$N = (60.0)(2.00 + 9.8)$

$\boxed{N = 708\ N}$

(6)



* Let's find the height reached when $v_y = 0$

$v_{0y} = v_0 \sin\theta_0$

$v_y = 0$

$y - y_0 = ?$

$a = +9.8\ m/s^2$.

$v_y^2 = v_{0y}^2 - 2a(y - y_0)$

$y - y_0 = \frac{v_{0y}^2}{2a} = \frac{(v_0 \sin\theta_0)^2}{2a}$

$y - y_0 = \frac{(18 \sin 40)^2}{2(9.8)}$

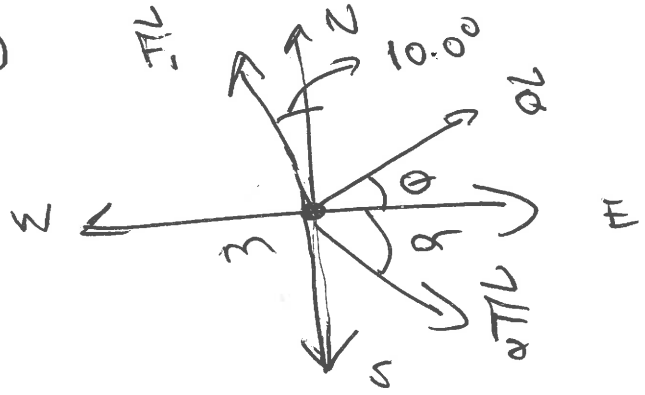
$y - y_0 = 6.83\ m$

Hence:

Maximum height $= 6.83\ m + 2.00\ m$

$\boxed{h_{max} = 8.83\ m}$ → Ans

(7)



$m = 4.00\ kg$

$a = 3.00\ m/s^2$

$\theta = 20.0°$

$|\vec{F}_1| = 15.00\ N$

$|\vec{F}_2| = ?$

$\vec{F}_{net} = m\vec{a} = \vec{F}_1 + \vec{F}_2$

$m(a\cos\theta\,\hat{i} + a\sin\theta\,\hat{j}) = -F_1\sin 10°\,\hat{i} + F_1\cos 10°\,\hat{j} + \vec{F}_2$

$\vec{F}_2 = F_1\sin 10°\,\hat{i} - F_1\cos 10°\,\hat{j} + ma\cos 20°\,\hat{i} + ma\sin 20°\,\hat{j}$

$\vec{F}_2 = -\begin{pmatrix} 15\sin 10° \\ +12\cos 20° \end{pmatrix}\hat{i} + \begin{pmatrix} -15\cos 10° \\ +12\sin 20° \end{pmatrix}\hat{j}$

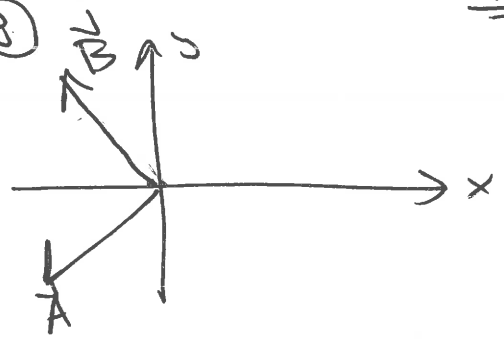
$\vec{F}_2 = (13.9\,\hat{i} - 10.7\,\hat{j})\ N$

$|\vec{F}_2| = \sqrt{F_{2x}^2 + F_{2y}^2} = 17.5\ N$ ⇒ $\boxed{|\vec{F}_2| = 17.5\ N}$ → Ans

Ans ← $\boxed{\alpha = \tan^{-1}\left(\frac{10.7}{13.4}\right) = 37.6°}$

⇒ S 0.0 E, South of East.

(8)



From the Graph.

$\vec{A} = -3\hat{i} - 3\hat{j}$

$\vec{B} = -2\hat{i} + 2\hat{j}$

$-5\vec{A} + 4\vec{B} = -5(-3\hat{i} - 3\hat{j}) + 4(-2\hat{i} + 2\hat{j})$

$= 15\hat{i} - 8\hat{i} + 15\hat{j} + 16\hat{j} = 7\hat{i} + 31\hat{j}$

⇒ $|-5\vec{A} + 4\vec{B}| = |7\hat{i} + 31\hat{j}| = \sqrt{49 + 31^2}$

$= 31.8$ → Ans