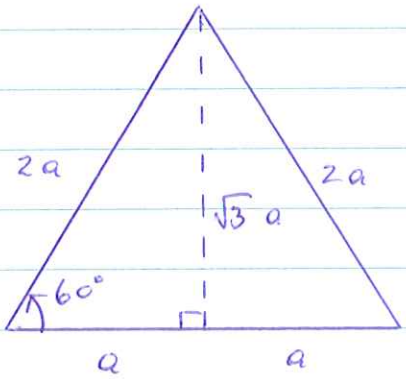
Assignment 2 Solutions

1.



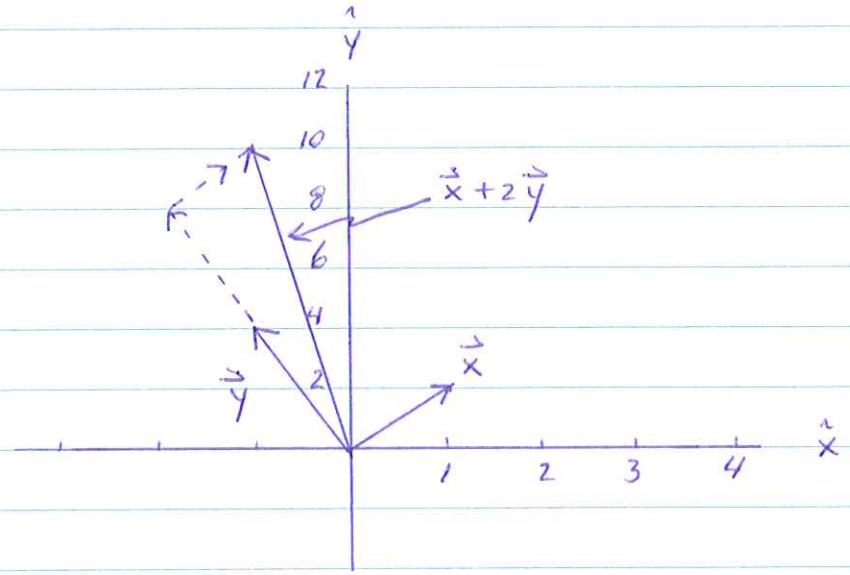
$$\cos 60^\circ = \frac{a}{2a} = \frac{1}{2}$$

$$\sin 60^\circ = \frac{\sqrt{3}a}{2a} = \frac{\sqrt{3}}{2}$$

$$\tan 60^\circ = \frac{\sqrt{3}a}{a} = \sqrt{3}$$

2a) $\vec{x} + 2\vec{y} = (1,2) + 2(-1,4) = (-1,10)$

b)



c) $|\vec{x}| = \sqrt{1^2 + 3^2} = \sqrt{10}$

$|\vec{y}| = \sqrt{(-1)^2 + 4^2} = \sqrt{17}$

3a) $\vec{v} = \vec{a}t$

$= (1, 2, 3) \times 5$

$= (5, 10, 15)$ m/sec

b) $|\vec{v}| = \sqrt{5^2 + 10^2 + 15^2}$

$= 18.7$ m/sec

c) $\vec{r} = \frac{1}{2}\vec{a}t^2$

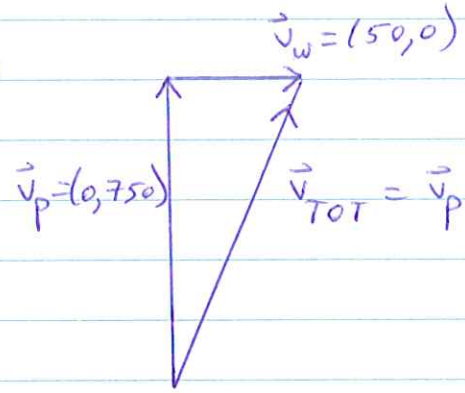
$= \frac{1}{2}(1, 2, 3) \times 5^2$

$= \left(\frac{25}{2}, 25, \frac{75}{2}\right)$ meters

d) $|\vec{r}| = \sqrt{\left(\frac{25}{2}\right)^2 + 25^2 + \left(\frac{75}{2}\right)^2}$

$= 46.8$ meters

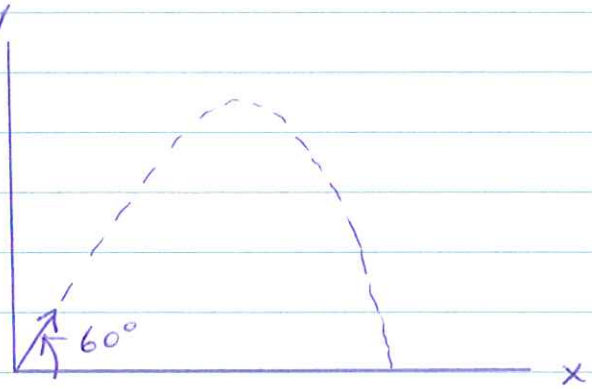
4a)



$= (0, 750) + (50, 0) = (50, 750)$ km/hr.

b) In two hours plane is deflected by wind a distance $50 \frac{\text{km}}{\text{hr}} \times 2\,\text{hr} = 100$ km East.

5a)



$\vec{r}_0 = (0, 0)$

$\vec{u} = (v_0 \cos 60°, v_0 \sin 60°)$

$\vec{a} = (0, -g)$

$\therefore x = x_0 + u_x t + \frac{1}{2} a_x t^2 \Rightarrow \quad x = v_0 \cos 60° \, t \qquad (1)$

$y = y_0 + u_y t + \frac{1}{2} a_y t^2 \Rightarrow \quad y = v_0 \sin 60° \, t - \frac{g}{2} t^2 \qquad (2)$

Velocity $v_x = u_x + a_x t \Rightarrow \quad v_x = v_0 \cos 60° \qquad (3)$

$v_y = u_y + a_y t \Rightarrow \quad v_y = v_0 \sin 60° - gt \qquad (4)$

a) At max. height $0 = v_y$

$= v_0 \sin 60° - gt$

$t = \frac{v_0 \sin 60°}{g}$

b) Height at $t = \frac{v_0 \sin 60°}{g}$ is $y = v_0 \sin 60° \, \frac{v_0 \sin 60°}{g} - \frac{g}{2} \frac{v_0^2 \sin^2 60°}{g^2}$

$= \frac{v_0^2}{2g} \sin^2 60°$

c) Earth is hit when $0 = y$

$= v_0 \sin 60° \, t - \frac{g}{2} t^2$

$= t \left(v_0 \sin 60° - \frac{g}{2} t \right)$

$\therefore t = \frac{2 v_0 \sin 60°}{g}$

d) Bullet hits Earth at $x = \frac{2 v_0^2}{g} \sin 60° \cos 60° = \frac{v_0^2}{g} \sin 120°$