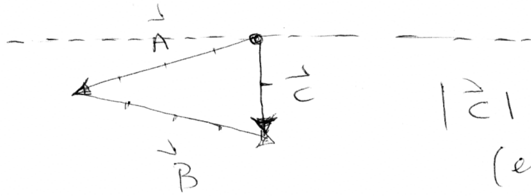
Problems 4 ch.3

(3)

$\vec{C} = \vec{A} + \vec{B}$

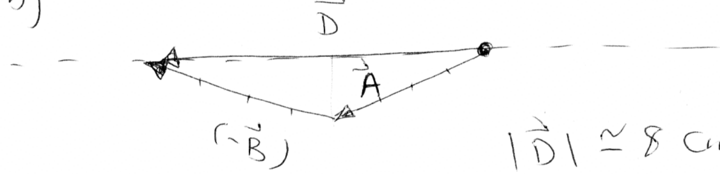
a)



$|\vec{C}| \simeq 2$ cm

(exact value = 1.4 cm)

b)



$|\vec{D}| \simeq 8$ cm (exact value = 7.9 cm)

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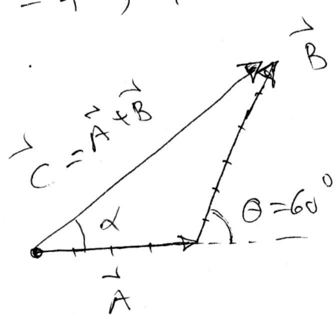
(9) $|\vec{A}| = 4$; $|\vec{B}| = 6$ $\quad \theta = 60^\circ$



$\vec{C} = \vec{A} + \vec{B}$

$C_x = A_x + B_x$

$\downarrow$

$C_x = 4 + 6\cos 60^\circ = 7$

$\boxed{C_x = 7}$

$C_y = A_y + B_y$

$\downarrow$

$C_y = 0 + 6\sin 60^\circ = \boxed{5.2}$

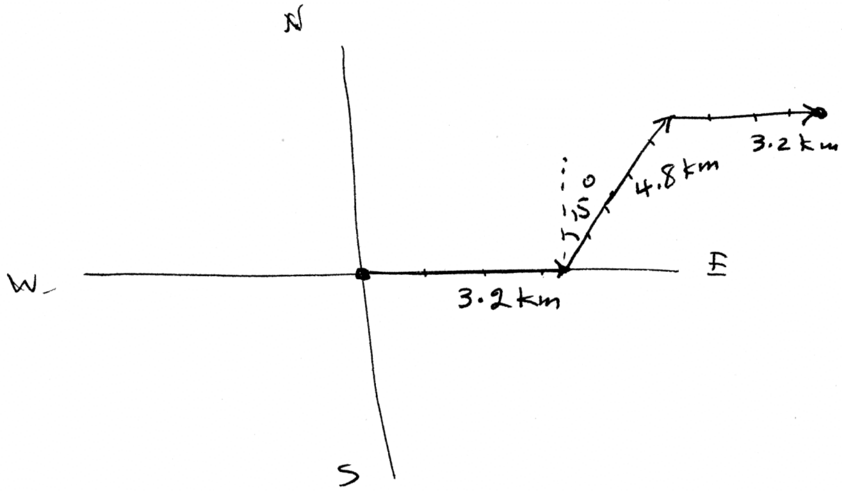
$\Leftarrow$

$C = \sqrt{C_x^2 + C_y^2} = 8.7$

$\tan\alpha = \frac{C_y}{C_x}$

$\boxed{\alpha = 36.6^\circ}$ $\rightarrow$ (not asked for!)

(25)



We need displacement.

$$\begin{cases} \Delta \vec{r}_1 = 3.2 \text{ km due East} \\ \Delta r_2 = 4.8 \text{ km due } 15^\circ \text{ east of north} \\ \Delta r_3 = 3.2 \text{ km due east} \end{cases}$$

$$\Delta \vec{r} = \Delta \vec{r}_1 + \Delta \vec{r}_2 + \Delta r_3$$

$$\begin{cases} \Delta r_x = 3.2 + 4.8 \sin 15^\circ + 3.2 = 7.6 \text{ km} \\ \Delta r_y = 0 + 4.8 \cos 15^\circ + 0 = 4.6 \text{ km} \end{cases}$$

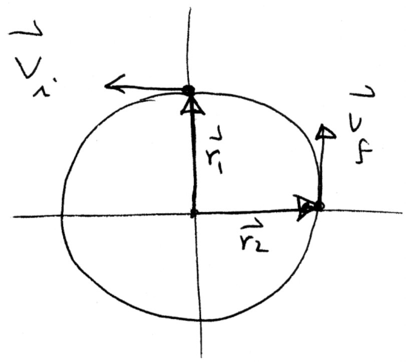
$$\Delta r = \sqrt{\Delta r_x^2 + \Delta r_y^2} = 8.9 \text{ km} \qquad \theta = \tan^{-1} \frac{\Delta r_y}{\Delta r_x} = 31.2^\circ$$

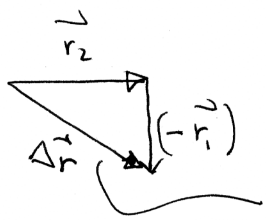
$$\vec{V}_{ave} = \frac{|\Delta \vec{r}|}{\Delta t} = \frac{8.9 \text{ km}}{\underbrace{0.1 + 0.15 + 0.1}_{0.35 h}} \simeq \boxed{26 \text{ km/h due } 31.2^\circ \text{ north of east}}$$

(31)

a)

$\Delta\vec{r} = \vec{r}_2 - \vec{r}_1$





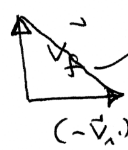
$|\Delta\vec{r}| = \sqrt{20^2 + 20^2} = 28.3\ m$

$\Rightarrow \vec{V}_{ave} = \frac{|\Delta\vec{r}|}{\Delta t} = \frac{28.3\ m}{3} = 9.4\ m/s$

b) $\vec{a}_{ave} = \frac{\Delta\vec{V}}{\Delta t}$; but $\Delta\vec{v} = \vec{V}_f - \vec{V}_i$

$\text{Speed} = \frac{\text{distance}}{\text{time}}$

$= \frac{3/4(2\pi r)}{\Delta t} = \frac{94.2}{3} = 31.4\ m/s$



$\Delta\vec{V} = \sqrt{31.4^2 + 31.4^2}$

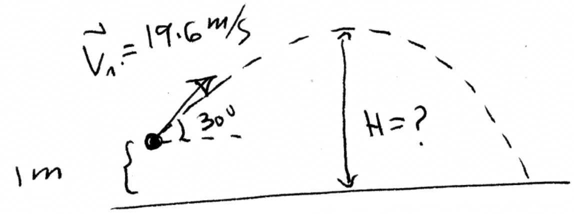
$= 44.4\ m/s$

$a_{ave} = \frac{44.4}{3}$

$\boxed{a_{ave} \simeq 15\ m/s^2}$

c) changing its direction

(37)



a) $V_{ix} = 19.6 \cos 30^\circ = 17\ m/s$

$V_{iy} = 19.6 \sin 30^\circ = 9.8\ m/s$

using $V_{f,y}^2 - V_{i,y}^2 = 2 a_y \Delta Y$

$$0 - (9.8)^2 = 2(-9.8)\,\Delta Y$$

$$\Rightarrow \boxed{\Delta Y = 4.9\ m}$$ above the starting point

$$H = 4.9 + 1 = 5.9\ m$$

b) At the highest point, $V_Y \to 0$ and

$$V_{highest} = V_x = V_{ix} = 17\ m/s$$

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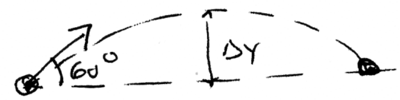

a) $V_{ix} = 22 \cos 60^\circ = 11 \, m/s$

$V_{iy} = 22 \sin 60^\circ = 19.1 \, m/s$

$V_{f,y}^2 - V_{i,y}^2 = 2a_y \Delta Y$

(at highest point) $0 - 19.1^2 = 2(-9.8)\Delta Y \rightarrow \boxed{\Delta Y = 18.6 \, m}$

b) $t =$ 2 x time to reach the highest

$V_{f,y} = V_{iy} + a_y \Delta t$

$0 = 19.1 - 9.8 \Delta t \rightarrow \boxed{\Delta t = 1.9 s}$

$t = 2(1.9) = \boxed{3.8 \, s}$

c) $\Delta x = ?$ $\quad \Delta x = V_{ix} \underbrace{\Delta t}_{\text{total time}}$

$\Delta x = (11)(3.8) = \boxed{42.8 \, m}$

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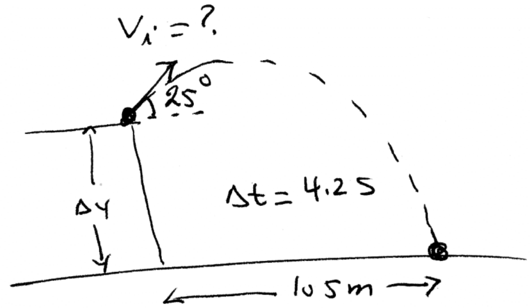
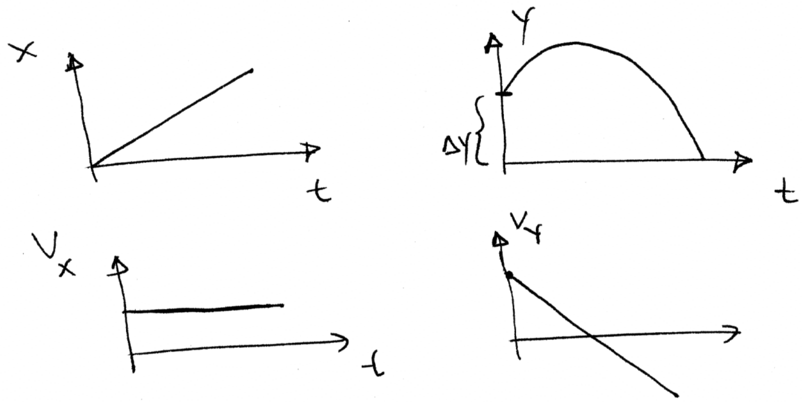


a)



b) $\Delta x = V_{ix}\,\Delta t \rightarrow 105 = (V_i \cos 25^\circ)(4.2)$

$$\Rightarrow \boxed{V_i = 27.6\ m/s}$$

c) $\Delta y = V_{iy}\,\Delta t + \frac{1}{2} a_y \Delta t^2$

$$\Delta y = (27.6 \sin 25^\circ)(4.2) + \frac{1}{2}(-9.8)(4.2)^2$$

$$= \boxed{-37.5\ m}$$

height $= |\Delta y| = 37.5\ m$

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$V_i = 36.2\ m/s$

a) $R = \dfrac{V_i^2 \sin 2\theta}{a_y} = \dfrac{(36.2)^2 \sin(72^\circ)}{9.8} = 127.2\ m$

$R = \dfrac{V_i^2 \sin 2\theta}{a_y} = \dfrac{(36.2)^2 \sin 108}{9.8} = 127.2\ m$

b) . . .

c) . . .

d) At 45° the range is maximum

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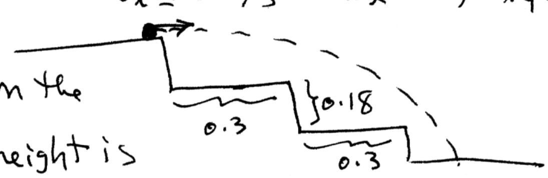
$V_i = 3\ m/s = V_{ix}$, $V_{iy} = 0$



Suppose it lands on the nth step. The height is

$\Delta y = n(0.18)$

and the x-distance is Δx

$\Delta y = \cancel{V_{iy} \Delta t} + \frac{1}{2} a_y \Delta t^2 \Rightarrow -n(0.18) = \frac{1}{2}(-9.8)\Delta t^2$

0

$\Delta t = \sqrt{\dfrac{2 \times 0.18}{9.8} \times n} = 0.19\sqrt{n}$

$\left.\begin{array}{l} \Delta x = V_{ix} \Delta t = 3(0.19)\sqrt{n} \\ \text{but } \Delta x \simeq (0.3)n \end{array}\right\} \rightarrow \begin{array}{l} 3(0.19)\sqrt{n} = 0.3n \\ n = 3.6 \text{ or } \boxed{n = 4} \end{array}$