Chapter 3 Solutions

P3.2 (a) $x = r\cos\theta$ and $y = r\sin\theta$, therefore

$x_1 = (2.50\text{ m})\cos 30.0°$, $y_1 = (2.50\text{ m})\sin 30.0°$, and

$$(x_1, y_1) = \boxed{(2.17,\ 1.25)\text{ m}}$$

$x_2 = (3.80\text{ m})\cos 120°$, $y_2 = (3.80\text{ m})\sin 120°$, and

$$(x_2, y_2) = \boxed{(-1.90,\ 3.29)\text{ m}}$$

(b) $d = \sqrt{(\Delta x)^2 + (\Delta y)^2} = \sqrt{4.07^2 + 2.04^2}\text{ m} = \boxed{4.55\text{ m}}$

P3.4 We have $2.00 = r\cos 30.0°$

$$r = \frac{2.00}{\cos 30.0°} = \boxed{2.31}$$

and $y = r\sin 30.0° = 2.31\sin 30.0° = \boxed{1.15}$.

P3.8 Find the resultant $\vec{\mathbf{F}}_1 + \vec{\mathbf{F}}_2$ graphically by placing the tail of $\vec{\mathbf{F}}_2$ at the head of $\vec{\mathbf{F}}_1$. The resultant force vector $\vec{\mathbf{F}}_1 + \vec{\mathbf{F}}_2$ is of magnitude $\boxed{9.5\text{ N}}$ and at an angle of $\boxed{57°\text{ above the } x \text{ axis}}$.

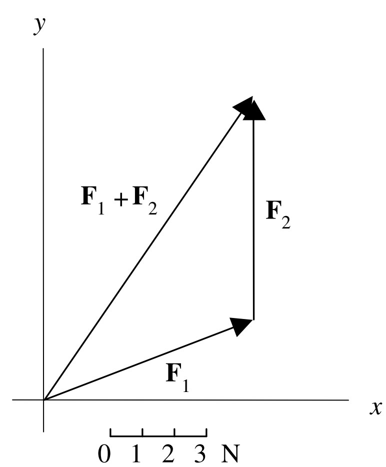
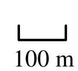


FIG. P3.8

P3.12 The three diagrams shown below represent the graphical solutions for the three vector sums: $\vec{\mathbf{R}}_1 = \vec{\mathbf{A}} + \vec{\mathbf{B}} + \vec{\mathbf{C}}$, $\vec{\mathbf{R}}_2 = \vec{\mathbf{B}} + \vec{\mathbf{C}} + \vec{\mathbf{A}}$, and $\vec{\mathbf{R}}_3 = \vec{\mathbf{C}} + \vec{\mathbf{B}} + \vec{\mathbf{A}}$. We observe that $\vec{\mathbf{R}}_1 = \vec{\mathbf{R}}_2 = \vec{\mathbf{R}}_3$, illustrating that $\boxed{\text{the sum of a set of vectors is not affected by the order in which the vectors are added}}$.



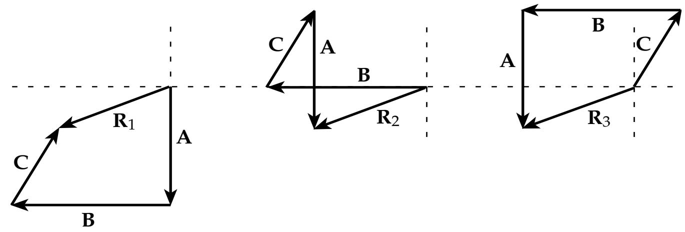


FIG. P3.12

P3.16 The person would have to walk $3.10\sin(25.0°) = \boxed{1.31 \text{ km north}}$, and

$$3.10\cos(25.0°) = \boxed{2.81 \text{ km east}}.$$

P3.18 (a) Her net x (east-west) displacement is $-3.00+0+6.00=+3.00$ blocks, while her net y (north-south) displacement is $0+4.00+0=+4.00$ blocks. The magnitude of the resultant displacement is

$$R=\sqrt{(x_{\text{net}})^2+(y_{\text{net}})^2}=\sqrt{(3.00)^2+(4.00)^2}=5.00 \text{ blocks}$$

and the angle the resultant makes with the x axis (eastward direction) is

$$\theta=\tan^{-1}\left(\frac{4.00}{3.00}\right)=\tan^{-1}(1.33)=53.1°.$$

The resultant displacement is then $\boxed{5.00 \text{ blocks at } 53.1° \text{ N of E}}$.

(b) The total distance traveled is $3.00+4.00+6.00=\boxed{13.0 \text{ blocks}}$.

P3.30 $\vec{\mathbf{A}}=-8.70\hat{\mathbf{i}}+15.0\hat{\mathbf{j}}$ and $\vec{\mathbf{B}}=13.2\hat{\mathbf{i}}-6.60\hat{\mathbf{j}}$

$\vec{\mathbf{A}}-\vec{\mathbf{B}}+3\vec{\mathbf{C}}=0$:

$$3\vec{\mathbf{C}}=\vec{\mathbf{B}}-\vec{\mathbf{A}}=21.9\hat{\mathbf{i}}-21.6\hat{\mathbf{j}}$$
$$\vec{\mathbf{C}}=7.30\hat{\mathbf{i}}-7.20\hat{\mathbf{j}}$$

or $$C_x=\boxed{7.30 \text{ cm}};\ C_y=\boxed{-7.20 \text{ cm}}$$

P3.34 (a) $\vec{\mathbf{D}}=\vec{\mathbf{A}}+\vec{\mathbf{B}}+\vec{\mathbf{C}}=2\hat{\mathbf{i}}-2\hat{\mathbf{j}}$

$\left|\vec{\mathbf{D}}\right|=\sqrt{2^2+2^2}=\boxed{2.83 \text{ m at } \theta=315°}$

(b) $\vec{\mathbf{E}}=-\vec{\mathbf{A}}-\vec{\mathbf{B}}+\vec{\mathbf{C}}=-6\hat{\mathbf{i}}+12\hat{\mathbf{j}}$

$\left|\vec{\mathbf{E}}\right|=\sqrt{6^2+12^2}=\boxed{13.4 \text{ m at } \theta=117°}$

P3.36 Let the positive x-direction be eastward, the positive y-direction be vertically upward, and the positive z-direction be southward. The total displacement is then

$$\vec{\mathbf{d}} = \left(4.80\hat{\mathbf{i}} + 4.80\hat{\mathbf{j}}\right) \text{ cm} + \left(3.70\hat{\mathbf{j}} - 3.70\hat{\mathbf{k}}\right) \text{ cm} = \left(4.80\hat{\mathbf{i}} + 8.50\hat{\mathbf{j}} - 3.70\hat{\mathbf{k}}\right) \text{ cm}.$$

(a) The magnitude is $d = \sqrt{(4.80)^2 + (8.50)^2 + (-3.70)^2} \text{ cm} = \boxed{10.4 \text{ cm}}$.

(b) Its angle with the y-axis follows from $\cos\theta = \dfrac{8.50}{10.4}$, giving $\boxed{\theta = 35.5°}$.

P3.38 The y coordinate of the airplane is constant and equal to 7.60×10^3 m whereas the x coordinate is given by $x = v_i t$ where v_i is the constant speed in the horizontal direction.

At $t = 30.0$ s we have $x = 8.04 \times 10^3$, so $v_i = 8\,040 \text{ m}/30 \text{ s} = 268 \text{ m/s}$. The position vector as a function of time is

$$\vec{\mathbf{P}} = (268 \text{ m/s})t\hat{\mathbf{i}} + \left(7.60 \times 10^3 \text{ m}\right)\hat{\mathbf{j}}.$$

At $t = 45.0$ s, $\vec{\mathbf{P}} = \left[1.21 \times 10^4\,\hat{\mathbf{i}} + 7.60 \times 10^3\,\hat{\mathbf{j}}\right]$ m. The magnitude is

$$\vec{\mathbf{P}} = \sqrt{\left(1.21 \times 10^4\right)^2 + \left(7.60 \times 10^3\right)^2} \text{ m} = \boxed{1.43 \times 10^4 \text{ m}}$$

and the direction is

$$\theta = \arctan\left(\frac{7.60 \times 10^3}{1.21 \times 10^4}\right) = \boxed{32.2° \text{ above the horizontal}}.$$

P3.40 (a) $\vec{\mathbf{E}} = (17.0 \text{ cm})\cos 27.0°\hat{\mathbf{i}} + (17.0 \text{ cm})\sin 27.0°\hat{\mathbf{j}}$

$\vec{\mathbf{E}} = \boxed{\left(15.1\hat{\mathbf{i}} + 7.72\hat{\mathbf{j}}\right) \text{ cm}}$

(b) $\vec{\mathbf{F}} = -(17.0 \text{ cm})\sin 27.0°\hat{\mathbf{i}} + (17.0 \text{ cm})\cos 27.0°\hat{\mathbf{j}}$

$\vec{\mathbf{F}} = \boxed{\left(-7.72\hat{\mathbf{i}} + 15.1\hat{\mathbf{j}}\right) \text{ cm}}$ Note that we do not need to explicitly identify the angle with the positive x axis.

(c) $\vec{\mathbf{G}} = +(17.0 \text{ cm})\sin 27.0°\hat{\mathbf{i}} + (17.0 \text{ cm})\cos 27.0°\hat{\mathbf{j}}$

$\vec{\mathbf{G}} = \boxed{\left(+7.72\hat{\mathbf{i}} + 15.1\hat{\mathbf{j}}\right) \text{ cm}}$

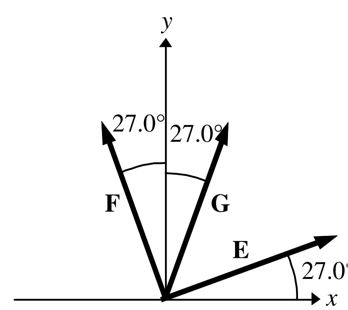


FIG. P3.40