SOLUTIONS TO PROBLEMS

P2.4 $x = 10t^2$: For

$t(\text{s})$	=	2.0	2.1	3.0
$x(\text{m})$	=	40	44.1	90

(a) $\bar{v} = \dfrac{\Delta x}{\Delta t} = \dfrac{50\text{ m}}{1.0\text{ s}} = \boxed{50.0\text{ m/s}}$

(b) $\bar{v} = \dfrac{\Delta x}{\Delta t} = \dfrac{4.1\text{ m}}{0.1\text{ s}} = \boxed{41.0\text{ m/s}}$

***P2.13** (a) The average speed during a time interval Δt is $\bar{v} = \dfrac{\text{distance traveled}}{\Delta t}$. During the first quarter mile segment, Secretariat's average speed was

$$\bar{v}_1 = \frac{0.250\text{ mi}}{25.2\text{ s}} = \frac{1\,320\text{ ft}}{25.2\text{ s}} = \boxed{52.4\text{ ft/s}} \quad (35.6\text{ mi/h}).$$

During the second quarter mile segment,

$$\bar{v}_2 = \frac{1\,320\text{ ft}}{24.0\text{ s}} = \boxed{55.0\text{ ft/s}} \quad (37.4\text{ mi/h}).$$

For the third quarter mile of the race,

$$\bar{v}_3 = \frac{1\,320\text{ ft}}{23.8\text{ s}} = \boxed{55.5\text{ ft/s}} \quad (37.7\text{ mi/h}),$$

and during the final quarter mile,

$$\bar{v}_4 = \frac{1\,320\text{ ft}}{23.0\text{ s}} = \boxed{57.4\text{ ft/s}} \quad (39.0\text{ mi/h}).$$

(b) Assuming that $v_f = \bar{v}_4$ and recognizing that $v_i = 0$, the average acceleration during the race was

$$\bar{a} = \frac{v_f - v_i}{\text{total elapsed time}} = \frac{57.4\text{ ft/s} - 0}{(25.2 + 24.0 + 23.8 + 23.0)\text{ s}} = \boxed{0.598\text{ ft/s}^2}.$$

P2.25 (a) Compare the position equation $x = 2.00 + 3.00t - 4.00t^2$ to the general form

$$x_f = x_i + v_i t + \frac{1}{2}at^2$$

to recognize that $x_i = 2.00\text{ m}$, $v_i = 3.00\text{ m/s}$, and $a = -8.00\text{ m/s}^2$. The velocity equation, $v_f = v_i + at$, is then

$$v_f = 3.00\text{ m/s} - (8.00\text{ m/s}^2)t.$$

The particle changes direction when $v_f = 0$, which occurs at $t = \dfrac{3}{8}$ s. The position at this time is:

$$x = 2.00\text{ m} + (3.00\text{ m/s})\left(\frac{3}{8}\text{ s}\right) - (4.00\text{ m/s}^2)\left(\frac{3}{8}\text{ s}\right)^2 = \boxed{2.56\text{ m}}.$$

(b) From $x_f = x_i + v_i t + \frac{1}{2}at^2$, observe that when $x_f = x_i$, the time is given by $t = -\frac{2v_i}{a}$. Thus, when the particle returns to its initial position, the time is

$$t = \frac{-2(3.00\text{ m/s})}{-8.00\text{ m/s}^2} = \frac{3}{4}\text{ s}$$

and the velocity is $v_f = 3.00\text{ m/s} - (8.00\text{ m/s}^2)\left(\frac{3}{4}\text{ s}\right) = \boxed{-3.00\text{ m/s}}$.

***P2.26** The time for the Ford to slow down we find from

$$x_f = x_i + \frac{1}{2}(v_{xi} + v_{xf})t$$
$$t = \frac{2\Delta x}{v_{xi} + v_{xf}} = \frac{2(250\text{ m})}{71.5\text{ m/s} + 0} = 6.99\text{ s}.$$

Its time to speed up is similarly

$$t = \frac{2(350\text{ m})}{0 + 71.5\text{ m/s}} = 9.79\text{ s}.$$

The whole time it is moving at less than maximum speed is $6.99\text{ s} + 5.00\text{ s} + 9.79\text{ s} = 21.8\text{ s}$. The Mercedes travels

$$x_f = x_i + \frac{1}{2}(v_{xi} + v_{xf})t = 0 + \frac{1}{2}(71.5 + 71.5)(\text{m/s})(21.8\text{ s})$$
$$= 1\,558\text{ m}$$

while the Ford travels $250 + 350\text{ m} = 600\text{ m}$, to fall behind by $1\,558\text{ m} - 600\text{ m} = \boxed{958\text{ m}}$.

P2.42 We have $y_f = -\frac{1}{2}gt^2 + v_i t + y_i$

$$0 = -(4.90\text{ m/s}^2)t^2 - (8.00\text{ m/s})t + 30.0\text{ m}.$$

Solving for t,

$$t = \frac{8.00 \pm \sqrt{64.0 + 588}}{-9.80}.$$

Using only the positive value for t, we find that $t = \boxed{1.79\text{ s}}$.

SOLUTIONS TO PROBLEMS

P3.9 $-\mathbf{R} = \boxed{310 \text{ km at } 57° \text{ S of W}}$

(Scale: 1 unit = 20 km)

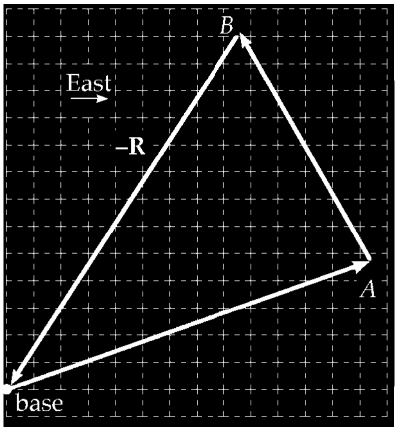

FIG. P3.9

P3.14 Your sketch should be drawn to scale, and should look somewhat like that pictured to the right. The angle from the westward direction, θ, can be measured to be $\boxed{4° \text{ N of W}}$, and the distance R from the sketch can be converted according to the scale to be $\boxed{7.9 \text{ m}}$.

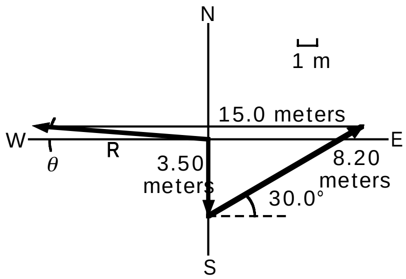

FIG. P3.14

P3.32 (a) $\mathbf{D} = \mathbf{A} + \mathbf{B} + \mathbf{C} = 2\hat{\mathbf{i}} + 4\hat{\mathbf{j}}$

$|\mathbf{D}| = \sqrt{2^2 + 4^2} = \boxed{4.47 \text{ m at } \theta = 63.4°}$

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

$|\mathbf{E}| = \sqrt{6^2 + 6^2} = \boxed{8.49 \text{ m at } \theta = 135°}$

P3.35 (a) $\mathbf{F} = \mathbf{F}_1 + \mathbf{F}_2$

$\mathbf{F} = 120\cos(60.0°)\hat{\mathbf{i}} + 120\sin(60.0°)\hat{\mathbf{j}} - 80.0\cos(75.0°)\hat{\mathbf{i}} + 80.0\sin(75.0°)\hat{\mathbf{j}}$

$\mathbf{F} = 60.0\hat{\mathbf{i}} + 104\hat{\mathbf{j}} - 20.7\hat{\mathbf{i}} + 77.3\hat{\mathbf{j}} = (39.3\hat{\mathbf{i}} + 181\hat{\mathbf{j}}) \text{ N}$

$|\mathbf{F}| = \sqrt{39.3^2 + 181^2} = \boxed{185 \text{ N}}$

$\theta = \tan^{-1}\left(\frac{181}{39.3}\right) = \boxed{77.8°}$

(b) $\mathbf{F}_3 = -\mathbf{F} = \boxed{(-39.3\hat{\mathbf{i}} - 181\hat{\mathbf{j}}) \text{ N}}$

P3.53 (a) $R_x = \boxed{2.00}$, $R_y = \boxed{1.00}$, $R_z = \boxed{3.00}$

(b) $$|\mathbf{R}| = \sqrt{R_x^2 + R_y^2 + R_z^2} = \sqrt{4.00 + 1.00 + 9.00} = \sqrt{14.0} = \boxed{3.74}$$

(c) $$\cos\theta_x = \frac{R_x}{|\mathbf{R}|} \Rightarrow \theta_x = \cos^{-1}\left(\frac{R_x}{|\mathbf{R}|}\right) = \boxed{57.7° \text{ from } +x}$$

$$\cos\theta_y = \frac{R_y}{|\mathbf{R}|} \Rightarrow \theta_y = \cos^{-1}\left(\frac{R_y}{|\mathbf{R}|}\right) = \boxed{74.5° \text{ from } +y}$$

$$\cos\theta_z = \frac{R_z}{|\mathbf{R}|} \Rightarrow \theta_z = \cos^{-1}\left(\frac{R_z}{|\mathbf{R}|}\right) = \boxed{36.7° \text{ from } +z}$$