4. We use a coordinate system with $+x$ eastward and $+y$ upward. We note that 123° is the angle between the initial position and later position vectors, so that the angle from $+x$ to the later position vector is $40° + 123° = 163°$. In unit-vector notation, the position vectors are

$$\begin{aligned}\vec{r}_1 &= 360\cos(40°)\,\hat{\imath} + 360\sin(40°)\,\hat{\jmath} = 276\,\hat{\imath} + 231\,\hat{\jmath} \\ \vec{r}_2 &= 790\cos(163°)\,\hat{\imath} + 790\sin(163°)\,\hat{\jmath} = -755\,\hat{\imath} + 231\,\hat{\jmath}\end{aligned}$$

respectively (in meters). Consequently, we plug into Eq. 4-3

$$\Delta r = ((-755) - 276)\,\hat{\imath} + (231 - 231)\,\hat{\jmath}$$

and find the displacement vector is horizontal (westward) with a length of 1.03 km. If unit-vector notation is not a priority in this problem, then the computation can be approached in a variety of ways – particularly in view of the fact that a number of vector capable calculators are on the market which reduce this problem to a very few keystrokes (using magnitude-angle notation throughout).

9. We apply Eq. 4-10 and Eq. 4-16.

(a) Taking the derivative of the position vector with respect to time, we have

$$\vec{v} = \frac{d}{dt}\left(\hat{\text{i}} + 4t^2\,\hat{\text{j}} + t\,\hat{\text{k}}\right) = 8t\,\hat{\text{j}} + \hat{\text{k}}$$

in SI units (m/s).

(b) Taking another derivative with respect to time leads to

$$\vec{a} = \frac{d}{dt}\left(8t\,\hat{\text{j}} + \hat{\text{k}}\right) = 8\,\hat{\text{j}}$$

in SI units (m/s^2).

15. Since the x and y components of the acceleration are constants, then we can use Table 2-1 for the motion along both axes. This can be handled individually (for Δx and Δy) or together with the unit-vector notation (for Δr). Where units are not shown, SI units are to be understood.

(a) Since $\vec{r}_0 = 0$, the position vector of the particle is (adapting Eq. 2-15)

$$\begin{aligned} \vec{r} &= \vec{v}_0 t + \frac{1}{2}\vec{a}t^2 \\ &= (8.0\,\hat{\jmath})t + \frac{1}{2}(4.0\,\hat{\imath} + 2.0\,\hat{\jmath})t^2 \\ &= (2.0t^2)\,\hat{\imath} + (8.0t + 1.0t^2)\,\hat{\jmath}\ . \end{aligned}$$

Therefore, we find when $x = 29$ m, by solving $2.0t^2 = 29$, which leads to $t = 3.8$ s. The y coordinate at that time is $y = 8.0(3.8) + 1.0(3.8)^2 = 45$ m.

(b) Adapting Eq. 2-11, the velocity of the particle is given by

$$\vec{v} = \vec{v}_0 + \vec{a}t\ .$$

Thus, at $t = 3.8$ s, the velocity is

$$\vec{v} = 8.0\,\hat{\jmath} + (4.0\,\hat{\imath} + 2.0\,\hat{\jmath})(3.8) = 15.2\,\hat{\imath} + 15.6\,\hat{\jmath}$$

which has a magnitude of

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{15.2^2 + 15.6^2} = 22 \text{ m/s}\ .$$

37. We adopt the positive direction choices used in the textbook so that equations such as Eq. 4-22 are directly applicable. The coordinate origin is at ground level directly below the release point. We write $\theta_0 = -37°$ for the angle measured from $+x$, since the angle given in the problem is measured from the $-y$ direction. We note that the initial speed of the projectile is the plane's speed at the moment of release.

(a) We use Eq. 4-22 to find v_0 (SI units are understood).

$$\begin{aligned} y - y_0 &= (v_0 \sin\theta_0)\, t - \frac{1}{2} g t^2 \\ 0 - 730 &= v_0 \sin(-37°)\,(5.00) - \frac{1}{2}(9.8)(5.00)^2 \end{aligned}$$

which yields $v_0 = 202$ m/s.

(b) The horizontal distance traveled is $x = v_0 t \cos\theta_0 = (202)(5.00)\cos -37.0° = 806$ m.

(c) The x component of the velocity (just before impact) is $v_x = v_0\cos\theta_0 = (202)\cos -37.0° = 161$ m/s.

(d) The y component of the velocity (just before impact) is $v_y = v_0 \sin\theta_0 - gt = (202)\sin(-37°) - (9.80)(5.00) = -171$ m/s.

57. Relative to the car the velocity of the snowflakes has a vertical component of $8.0\,\mathrm{m/s}$ and a horizontal component of $50\,\mathrm{km/h} = 13.9\,\mathrm{m/s}$. The angle θ from the vertical is found from

$$\tan\theta = v_h/v_v = (13.9\,\mathrm{m/s})/(8.0\,\mathrm{m/s}) = 1.74$$

which yields $\theta = 60°$.

78. We choose a coordinate system with origin at the clock center and $+x$ rightward (towards the "3:00" position) and $+y$ upward (towards "12:00").

(a) In unit-vector notation, we have (in centimeters) $\vec{r}_1 = 10\,\hat{\text{i}}$ and $\vec{r}_2 = -10\,\hat{\text{j}}$. Thus, Eq. 4-2 gives

$$\Delta\vec{r} = \vec{r}_2 - \vec{r}_1 = -10\,\hat{\text{i}} - 10\,\hat{\text{j}} \;\longrightarrow\; (14\ \angle -135^\circ)$$

where we have switched to magnitude-angle notation in the last step.

(b) In this case, $\vec{r}_1 = -10\,\hat{\text{j}}$ and $\vec{r}_2 = 10\,\hat{\text{j}}$, and $\Delta\vec{r} = 20\,\hat{\text{j}}$ cm.

(c) In a full-hour sweep, the hand returns to its starting position, and the displacement is zero.