Dear all,

I am very sorry for my mistake. I should have posted these solutions with those have been posted.

Hope your homework is going well.

Thanks,

Zengming

3.17. **IDENTIFY:** The baseball moves in projectile motion. In part (c) first calculate the components of the velocity at this point and then get the resultant velocity from its components.

SET UP: First find the *x*- and *y*-components of the initial velocity. Use coordinates where the $+y$-direction is upward, the $+x$-direction is to the right and the origin is at the point where the baseball leaves the bat.

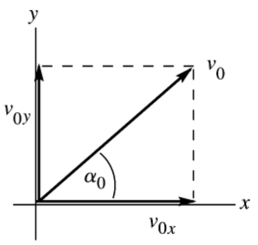


Figure 3.17a

$$v_{0x} = v_0 \cos\alpha_0 = (30.0\text{ m/s})\cos 36.9° = 24.0\text{ m/s}$$

$$v_{0y} = v_0 \sin\alpha_0 = (30.0\text{ m/s})\sin 36.9° = 18.0\text{ m/s}$$

Use constant acceleration equations for the *x* and *y* motions, with $a_x = 0$ and $a_y = -g$.

EXECUTE: **(a)** <u>*y*-component</u> (vertical motion):

$$y - y_0 = +10.0\text{ m/s},\quad v_{0y} = 18.0\text{ m/s},\quad a_y = -9.80\text{ m/s}^2,\quad t = ?$$

$$y - y_0 = v_{0y} + \tfrac{1}{2}a_y t^2$$

$$10.0\text{ m} = (18.0\text{ m/s})t - (4.90\text{ m/s}^2)t^2$$

$$(4.90\text{ m/s}^2)t^2 - (18.0\text{ m/s})t + 10.0\text{ m} = 0$$

Apply the quadratic formula: $t = \frac{1}{9.80}\left[18.0 \pm \sqrt{(-18.0)^2 - 4\,(4.90)(10.0)}\right]\text{ s} = (1.837 \pm 1.154)\text{ s}$

The ball is at a height of 10.0 above the point where it left the bat at $t_1 = 0.683\text{ s}$ and at $t_2 = 2.99\text{ s}.$ At the earlier time the ball passes through a height of 10.0 m as its way up and at the later time it passes through 10.0 m on its way down.

(b) $v_x = v_{0x} = +24.0\text{ m/s},$ at all times since $a_x = 0.$

$$v_y = v_{0y} + a_y t$$

<u>$t_1 = 0.683$ s:</u> $v_y = +18.0\text{ m/s} + (-9.80\text{ m/s}^2)(0.683\text{ s}) = +11.3\text{ m/s}.$ (v_y is positive means that the ball is traveling upward at this point.

<u>$t_2 = 2.99$ s:</u> $v_y = +18.0\text{ m/s} + (-9.80\text{ m/s}^2)(2.99\text{ s}) = -11.3\text{ m/s}.$ (v_y is negative means that the ball is traveling downward at this point.)

(c) $v_x = v_{0x} = 24.0$ m/s

Solve for v_y:

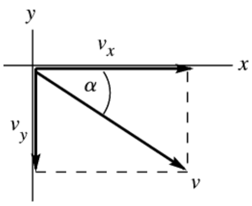
$v_y = ?$, $y - y_0 = 0$ (when ball returns to height where motion started),

$a_y = -9.80\text{ m/s}^2$, $v_{0y} = +18.0$ m/s

$v_y^2 = v_{0y}^2 + 2a_y(y - y_0)$

$v_y = -v_{0y} = -18.0$ m/s (negative, since the baseball must be traveling downward at this point)

Now solve for the magnitude and direction of $\vec{v}$.



$$v = \sqrt{v_x^2 + v_y^2}$$

$$v = \sqrt{(24.0\text{ m/s})^2 + (-18.0\text{ m/s})^2} = 30.0\text{ m/s}$$

$$\tan\alpha = \frac{v_y}{v_x} = \frac{-18.0\text{ m/s}}{24.0\text{ m/s}}$$

$\alpha = -36.9°$, $36.9°$ below the horizontal

Figure 3.17b

The velocity of the ball when it returns to the level where it left the bat has magnitude 30.0 m/s and is directed at an angle of $36.9°$ below the horizontal.

EVALUATE: The discussion in parts (a) and (b) explains the significance of two values of t for which $y - y_0 = +10.0$ m. When the ball returns to its initial height, our results give that its speed is the same as its initial speed and the angle of its velocity below the horizontal is equal to the angle of its initial velocity above the horizontal; both of these are general results.

3.28. IDENTIFY: Each planet moves in a circular orbit and therefore has acceleration $a_{\text{rad}} = v^2/R$.

SET UP: The radius of the earth's orbit is $r = 1.50\times10^{11}$ m and its orbital period is $T = 365\text{ days} = 3.16\times10^7$ s. For Mercury, $r = 5.79\times10^{10}$ m and $T = 88.0\text{ days} = 7.60\times10^6$ s.

EXECUTE: **(a)** $v = \dfrac{2\pi r}{T} = 2.98\times10^4$ m/s

(b) $a_{\text{rad}} = \dfrac{v^2}{r} = 5.91\times10^{-3}\text{ m/s}^2$.

(c) $v = 4.79\times10^4$ m/s, and $a_{\text{rad}} = 3.96\times10^{-2}\text{ m/s}^2$.

EVALUATE: Mercury has a larger orbital velocity and a larger radial acceleration than earth.

3.29. IDENTIFY: Uniform circular motion.

SET UP: Since the magnitude of $\vec{v}$ is constant, $v_{\tan} = \frac{d|\vec{v}|}{dt} = 0$ and the resultant acceleration is equal to the radial component. At each point in the motion the radial component of the acceleration is directed in toward the center of the circular path and its magnitude is given by v^2/R.

EXECUTE: **(a)** $a_{\text{rad}} = \frac{v^2}{R} = \frac{(7.00\text{ m/s})^2}{14.0\text{ m}} = 3.50\text{ m/s}^2$, upward.

(b) The radial acceleration has the same magnitude as in part (a), but now the direction toward the center of the circle is downward. The acceleration at this point in the motion is 3.50 m/s^2, downward.

(c) SET UP: The time to make one rotation is the period *T*, and the speed *v* is the distance for one revolution divided by *T*.

EXECUTE: $v = \frac{2\pi R}{T}$ so $T = \frac{2\pi R}{v} = \frac{2\pi\,(14.0\text{ m})}{7.00\text{ m/s}} = 12.6\text{ s}$

EVALUATE: The radial acceleration is constant in magnitude since *v* is constant and is at every point in the motion directed toward the center of the circular path. The acceleration is perpendicular to $\vec{v}$ and is nonzero because the direction of $\vec{v}$ changes.

3.38. IDENTIFY: Use the relation that relates the relative velocities.

SET UP: The relative velocities are the velocity of the plane relative to the ground, $\vec{v}_{\text{P/G}}$, the velocity of the plane relative to the air, $\vec{v}_{\text{P/A}}$, and the velocity of the air relative to the ground, $\vec{v}_{\text{A/G}}$. $\vec{v}_{\text{P/G}}$ must due west and $\vec{v}_{\text{A/G}}$ must be south. $v_{\text{A/G}} = 80\text{ km/h}$ and $v_{\text{P/A}} = 320\text{ km/h}$. $\vec{v}_{\text{P/G}} = \vec{v}_{\text{P/A}} + \vec{v}_{\text{A/G}}$. The relative velocity addition diagram is given in Figure 3.38.

EXECUTE: **(a)** $\sin\theta = \frac{v_{\text{A/G}}}{v_{\text{P/A}}} = \frac{80\text{ km/h}}{320\text{ km/h}}$ and $\theta = 14°$, north of west.

(b) $v_{\text{P/G}} = \sqrt{v_{\text{P/A}}^2 - v_{\text{A/G}}^2} = \sqrt{(320\text{ km/h})^2 - (80.0\text{ km/h})^2} = 310\text{ km/h}$.

EVALUATE: To travel due west the velocity of the plane relative to the air must have a westward component and also a component that is northward, opposite to the wind direction.

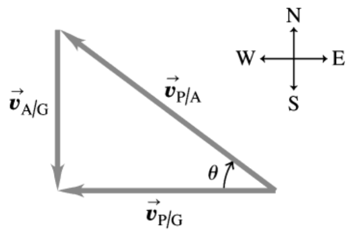
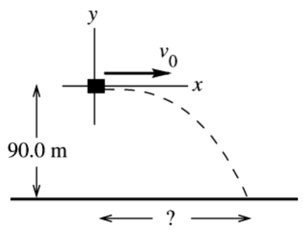


Figure 3.38

3.53. **IDENTIFY:** The cannister moves in projectile motion. Its initial velocity is horizontal. Apply constant acceleration equations for the x and y components of motion.

SET UP:



Take the origin of coordinates at the point where the canister is released. Take $+y$ to be upward. The initial velocity of the canister is the velocity of the plane, 64.0 m/s in the $+x$-direction.

Figure 3.53

Use the vertical motion to find the time of fall:

$t = ?,\quad v_{0y} = 0,\quad a_y = -9.80\text{ m/s}^2,\quad y - y_0 = -90.0\text{ m}$ (When the canister reaches the ground it is 90.0 m <u>below</u> the origin.)

$$y - y_0 = v_{0y}t + \tfrac{1}{2}a_y t^2$$

EXECUTE: Since $v_{0y} = 0$, $t = \sqrt{\dfrac{2(y - y_0)}{a_y}} = \sqrt{\dfrac{2(-90.0\text{ m})}{-9.80\text{ m/s}^2}} = 4.286\text{ s.}$

SET UP: Then use the horizontal component of the motion to calculate how far the canister falls in this time:

$x - x_0 = ?,\quad a_x - 0,\quad v_{0x} = 64.0\text{ m/s}$

EXECUTE: $x - x_0 = v_0 t + \tfrac{1}{2}at^2 = (64.0\text{ m/s})(4.286\text{ s}) + 0 = 274\text{ m.}$

EVALUATE: The time it takes the cannister to fall 90.0 m, starting from rest, is the time it travels horizontally at constant speed.

3.74. **IDENTIFY:** The object moves with constant acceleration in both the horizontal and vertical directions.

SET UP: Let $+y$ be downward and let $+x$ be the direction in which the firecracker is thrown.

EXECUTE: The firecracker's falling time can be found from the vertical motion: $t = \sqrt{\dfrac{2h}{g}}$.

The firecracker's horizontal position at any time t (taking the student's position as $x = 0$) is $x = vt - \tfrac{1}{2}at^2$. $x = 0$ when cracker hits the ground, so $t = 2v/a$. Combining this with the expression for the falling time gives $\dfrac{2v}{a} = \sqrt{\dfrac{2h}{g}}$ and $h = \dfrac{2v^2 g}{a^2}$.

EVALUATE: When h is smaller, the time in the air is smaller and either v must be smaller or a must be larger.

3.82. IDENTIFY: Use the relation that relates the relative velocities.

SET UP: The relative velocities are the raindrop relative to the earth, $\vec{v}_{R/E}$, the raindrop relative to the train, $\vec{v}_{R/T}$, and the train relative to the earth, $\vec{v}_{T/E}$. $\vec{v}_{R/E} = \vec{v}_{R/T} + \vec{v}_{T/E}$. $\vec{v}_{T/E}$ is due east and has magnitude 12.0 m/s. $\vec{v}_{R/T}$ is $30.0°$ west of vertical. $\vec{v}_{R/E}$ is vertical. The relative velocity addition diagram is given in Figure 3.82.

EXECUTE: **(a)** $\vec{v}_{R/E}$ is vertical and has zero horizontal component. The horizontal component of $\vec{v}_{R/T}$ is $-\vec{v}_{T/E}$, so is 12.0 m/s westward.

(b) $v_{R/E} = \dfrac{v_{T/E}}{\tan 30.0°} = \dfrac{12.0\text{ m/s}}{\tan 30.0°} = 20.8\text{ m/s}$. $v_{R/T} = \dfrac{v_{T/E}}{\sin 30.0°} = \dfrac{12.0\text{ m/s}}{\sin 30.0°} = 24.0\text{ m/s}$.

EVALUATE: The speed of the raindrop relative to the train is greater than its speed relative to the earth, because of the motion of the train.

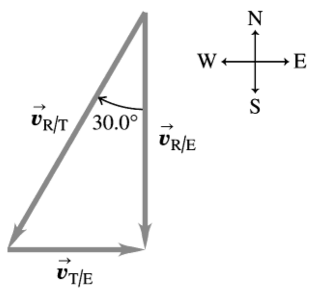


Figure 3.82