Answers to even-numbered problems
Chapter 3

3.2.

(a) $x = -45.6\ \text{m}$ and $y = 58.8\ \text{m}$.

(b) $74.4\ \text{m}$.

3.4.

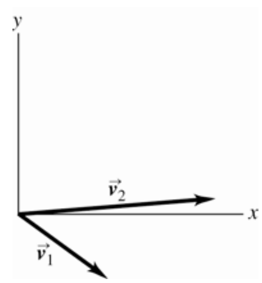
$t = 2b/3c$.

3.6.

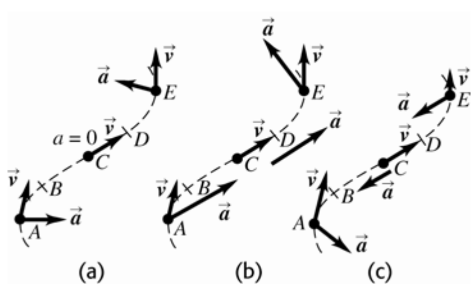
(a) $6.5\ \text{m/s}$. $0.52\ \text{m/s}$.

(b) $6.48\,\text{m/s}$, at an angle of $4.6°$ above the horizontal.

(c) The velocity vectors $\vec{v}_1$ and $\vec{v}_2$ are sketched in Figure 3.6. The two velocity vectors differ in magnitude and direction.



3.8.



(a) $7.82\ \text{s}$.
(b) $470\ \text{m}$.
(c) $v_x = 60.0\ \text{m/s}$. $v_y = 76.6\ \text{m/s}$.
(d) The graphs are given in Figure 3.10.
(e) Because the airplane and the bomb always have the same *x*-component of velocity and position, the plane will be 300 m directly above the bomb at impact.
NOTE: The initial horizontal velocity of the bomb doesn't affect its vertical motion.

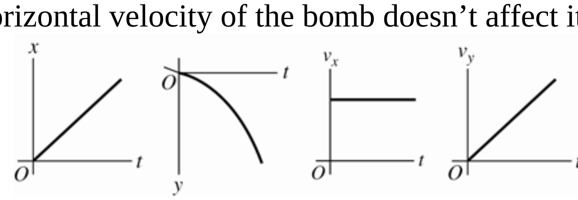


Figure 3.10

3.12.

Time to fall 9.00 m: $1.36\ \mathrm{s}$.

Speed needed to travel 1.75 m horizontally during this time: $1.29\ \mathrm{m/s}$.

3.14.

time it takes the marble to reach the height of the level ground;. $0.749\ \mathrm{s}$. The time does not depend on v_0.

Minimum v_0 : $2.67\ \mathrm{m/s}$.

Maximum v_0: $4.67\ \mathrm{m/s}$.

3.16. **(a)**. $1.63\ \mathrm{s}$.

(b) $13.1\ \mathrm{m}$.

(c) Regardless of how the algebra is done, the time will be twice that found in part (a), or 3.27 s

(d), $65.3\ \mathrm{m}$.

(e) The graphs are sketched in Figure 3.16.

When the football returns to its original level, $v_x = 20.0\ \mathrm{m/s}$ and $v_y = -16.0\ \mathrm{m/s}$.

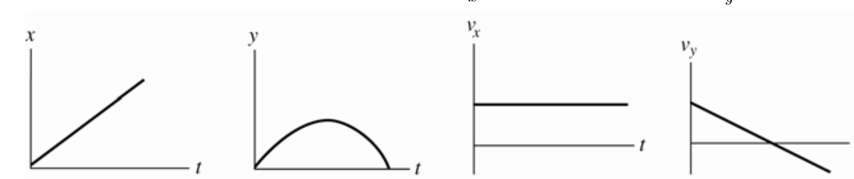


Figure 3.16

3.18.

(a) $h = 535\ \mathrm{m}$. $R = 1500\ \mathrm{m}$.

(b) $h = 3140\ \mathrm{m}$ and $R = 8800\ \mathrm{m}$.

3.20.

(a) If air resistance is to be ignored, the components of acceleration are 0 horizontally and $-9.80\ \mathrm{m/s^2}$ vertically downward.

(b) $v_x = 7.55\ \mathrm{m/s}$. $v_{0y} = 9.32\ \mathrm{m/s}$ at release and $v_y = -11.06\ \mathrm{m/s}$ when the shot hits.

(c) $15.7\ \mathrm{m}$.

(d) The initial and final heights are not the same.

(e) $y_0 = 1.81\,\mathrm{m}$.

(f) The graphs are sketched in Figure 3.20.

When the shot returns to its initial height, $v_y = -9.32\ \text{m/s}$. The shot continues to accelerate downward as it travels downward 1.81 m to the ground and the magnitude of v_y at the ground is larger than 9.32 m/s.

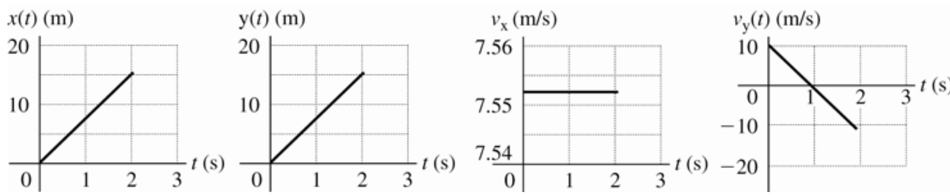


Figure 3.20

$a_x = 0$

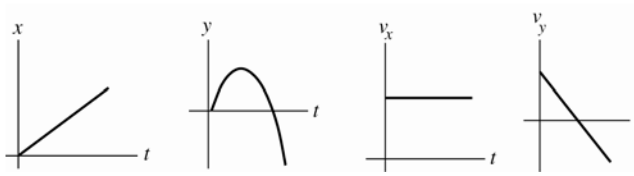
$x - x_0 = v_{0x}t + \frac{1}{2}a_x t^2 = v_{0x}t$, since $a_x = 0$

3.22. **IDENTIFY:**

(a) $y = 2.14\ \text{m}$.

(b) $y = 1.45\ \text{m}$.

(c) $y = -2.29\ \text{m}$. In this case, the dart was fired with so slow a speed that it hit the ground before traveling the 3-meter horizontal distance.



3.24. **(a** $\theta_0 = 53.1°$

(b) At the highest point $v_x = 15.0\ \text{m/s}$, $v_y = 0$ and $v = \sqrt{v_x^2 + v_y^2} = 15.0\ \text{m/s}$. At all points in the motion, $a = 9.80\ \text{m/s}^2$ downward.

(c) $15.9\ \text{m}$

$v_x = 15.0\ \text{m/s}$, $v_y = -9.41\ \text{m/s}$, and $v = 17.7\ \text{m/s}$

3.26. (a) $v_0 = 3.26\ \text{m/s}$ and $t = 2.51\ \text{s}$.

(b) v_y when shell reaches cliff: $v_y = -2.4\ \text{m/s}$

The shell is traveling downward when it reaches the cliff, so it lands right at the edge of the cliff.

3.28. $T' = T / \sqrt{3}$.

3.30. **(a)** $196\ \text{m/s}$.

(b) $1.13 \times 10^4\ \text{m/s}^2 = 1.15 \times 10^3 g$.

3.32. **:**

(a) $2.98 \times 10^4 \text{ m/s}$

(b) $5.91 \times 10^{-3} \text{ m/s}^2$.

(c) $v = 4.79 \times 10^4 \text{ m/s}$, and $a_{\text{rad}} = 3.96 \times 10^{-2} \text{ m/s}^2$.

3.34.

(a) $a_{\text{rad}} = 0.643 \text{ m/s}^2$. $a = 0.814 \text{ m/s}^2$, $37.9°$ to the right of vertical.

(b) The sketch is given in Figure 3.34.

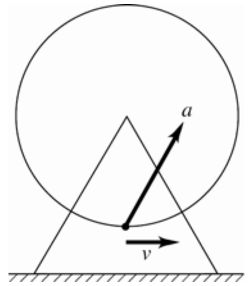


Figure 3.34

3.36.

(a) 5.0 m/s to the right

(b) 16.0 m/s to the left

(c) 13.0 m/s to the left.

3.38. The walker moves a total distance of 3.0 km at a speed of 4.0 km/h, and takes a time of three fourths of an hour (45.0 min).

The total time the rower takes is 88.2 min.

3.40.

(a) $\theta = 14°$, north of west.

(b) 310 km/h.

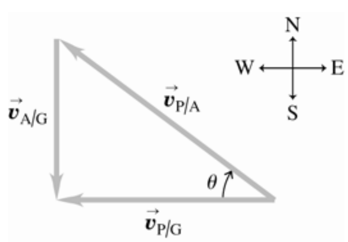


Figure 3.40

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3.42. The velocity addition diagram is given in Figure 3.42.

(a) $\theta = 28.4°$, north of east.

(b) 3.7 m/s

(c) 216 s.

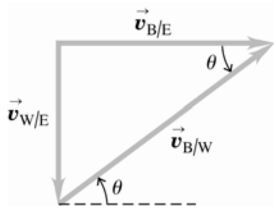


Figure 3.42

Figure 3.43a

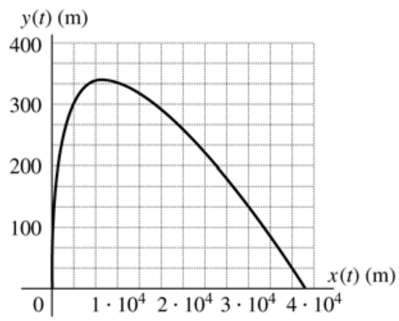
3.44.

(a) $v_x = v_{0x} + \frac{\alpha}{3}t^3,\ v_y = v_{0y} + \beta t - \frac{\gamma}{2}t^2$, and $x = v_{0x}t + \frac{\alpha}{12}t^4,\ y = v_{0y}t + \frac{\beta}{2}t^2 - \frac{\gamma}{6}t^3$.

(b) $13.59\ \text{s}$. maximum height is 341 m.

(c) The path of the rocket is sketched in Figure 3.44.

(d) $3.85 \times 10^4\ \text{m}$.



3.46.

(a) $\vec{r} = (\alpha t - \frac{\beta}{3}t^3)\hat{i} + (\frac{\gamma}{2}t^2)\hat{j}$. $\vec{a} = (-2\beta t)\hat{i} + \gamma\,\hat{j}$.

(b) $9.0\ \text{m}$.

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

3.48.

. $D_M = 2.64 D_E$.

3.50.

(a) $10.05\ \text{m/s}$

The speed relative to the ground is $10.5\ \text{m/s}$.

(b) $12.6\ \text{m/s}^2$.

(c) Using the vertical and horizontal velocity components $\theta = \tan^{-1}\frac{3.00\ \text{m/s}}{10.05\ \text{m/s}} = 16.6°$.

3.52. **(a)** She will land 55.5 m south of the point where she drops from the helicopter and this is where the mats should have been placed.

(b) The *x-t*, *y-t*, v_x *-t* and v_y *-t* graphs are sketched in Figure 3.52.

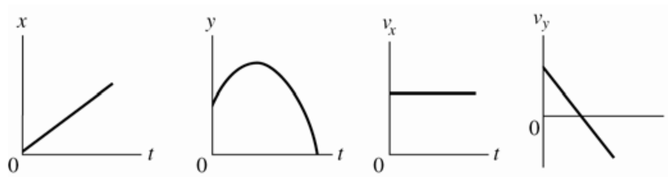


Figure 3.52

3.54. 25.5 m.

3.56. $v_0 = 3\sqrt{gD}$; $v_0 = \sqrt{49gD / 5} = 3.13\sqrt{gD}$

3.58. **(a)** The ball cannot be aimed lower than directly at the bar. $\alpha_0 = 15.5°$.

(b) 12.2 m/s

3.60.

(a) 6.91 m.

(b) The *x-t*, *y-t*, v_x *-t* and v_y *-t* graphs are sketched in Figure 3.60.

(c) 0.746 s. In this time the snowball travels downward a distance 6.08 m and is therefore 7.9 m above the ground.

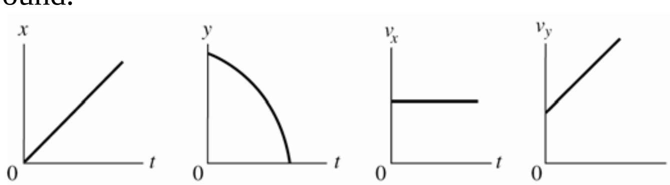


Figure 3.60

3.62. **(a** 13.8 m/s.

(b) $v = 8.4 \text{ m/s}$, at an angle of $9.16°$.

(c) The graph of $v_x(t)$ is a horizontal line. The other graphs are sketched in Figure 3.62.

(d) 23.8 m

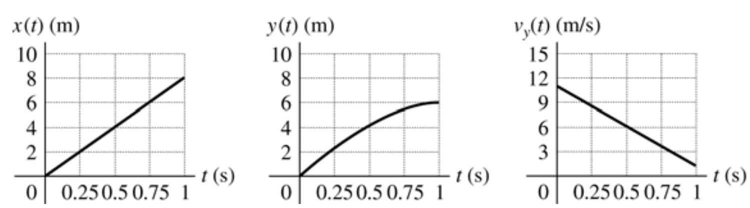


Figure 3.62

3.64. $v = \sqrt{v_0^2 + 2gh}$, which is independent of α_0.

3.66.

(a). $72.5°$.

(b) Relative to the ground the ball moves in a parabola. The ball and the runner have the same horizontal component of velocity, so relative to the runner the ball has only vertical motion. The trajectories as seen by each observer are sketched in Figure 3.66.

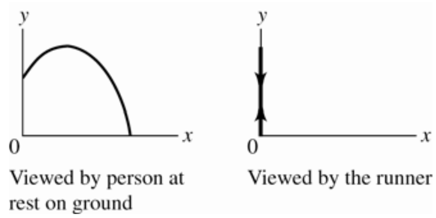


Figure 3.66

3.68. **(a)** $12.2\ \mathrm{m/s}$.

(b) 36.6 m from the building.

3.70. $h = \dfrac{2v^2 g}{a^2}$.

3.72. **(a)** (i) $7.22\ \mathrm{m/s}$ and $9.58\ \mathrm{m/s}$. (ii) 0 and $8.50\ \mathrm{m/s}$. $7.22\ \mathrm{m/s}$ and $18.1\ \mathrm{m/s}$.

(b) $19.5\ \mathrm{m/s}$. and $68.3°$.

(c. $162\ \mathrm{m}$.

3.74. **IDENTIFY:**

The grenade has velocity of magnitude 61.2 km/h relative to the hero.

The magnitude of the velocity relative to the earth is $v_\mathrm{E} = \sqrt{v_{\mathrm{E}x}^2 + v_{\mathrm{E}y}^2} = 140\ \mathrm{km/h}$.

3.76. **(a)** You will land 120.0 m east of point *B*, which is 45.0 m east of point *C*. The distance you will have traveled is $418\ \mathrm{m}$.

(b) 197 m downstream from *B*, so 122 m downstream from *C*.

(c) (i) The boat will head $83.5°$ north of west, so $6.5°$ west of north.

(ii) The time to cross the river is $4.02\ \mathrm{min}$.

(iii) You travel from *A* to *C*, a distance of $407\ \mathrm{m}$.

(iv) $101\ \mathrm{m/min}$.

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3.78. This fragment lands a horizontal distance 3*D* from the point of explosion and hence 4*D* from *A*.

3.80.

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

(b) $v_{\mathrm{R/E}} = 20.8\ \mathrm{m/s}$. $v_{\mathrm{R/T}} = 24.0\ \mathrm{m/s}$.

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.

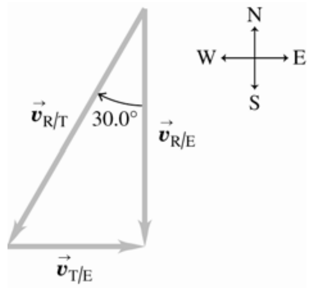

Figure 3.80

$$(v_{P/E})_x = -240 \text{ km/h (west)}$$

$$(v_{P/E})_y = -40 \text{ km/h (south)}$$

3.82. (a) $t = 0.782$ s.

(b) -7.67 m/s.

(c) the speed relative to Earth is 5.17 m/s.
(d) Relative to Earth, the distance the bolt traveled is -1.04 m.

3.84. The total time for the round trip will be 7.11 h.

3.86. **(a)** 9.80 m/s.

(b) 1.00 s.

(c) 13.6 m in front of the hoop at release.
(d) Relative to the flat car, $\theta = 65°$. Relative to the ground the angle is $\theta = 35.7°$.

3.88. $70.5°$.

3.90.

(a) $\phi = 17.5°$.
(b) $-17.0°$.

3.92. 5.15 s.