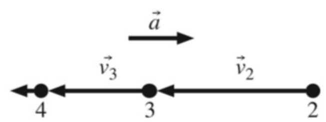
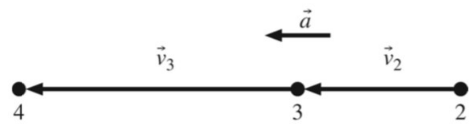
1.11. Solve:

(a)



(b)

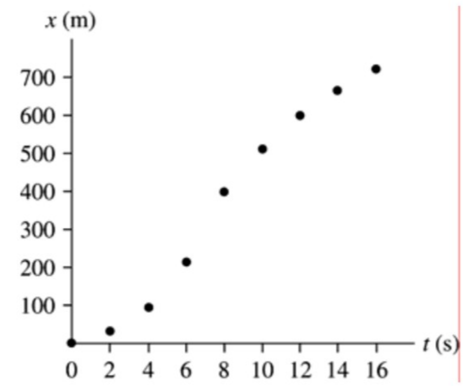


1.18. Solve:

(a)

Dot	Time (s)	*x* (m)
1	0	0
2	2	30
3	4	95
4	6	215
5	8	400
6	10	510
7	12	600
8	14	670
9	16	720

(b)



1.24. Solve: (a) $8.0\text{ inch} = (8.0\text{ inch})\left(\frac{2.54\text{ cm}}{1\text{ inch}}\right)\left(\frac{10^{-2}\text{ m}}{1\text{ cm}}\right) = 0.20\text{ m}$

(b) $66\text{ feet/s} = \left(66\frac{\text{feet}}{\text{s}}\right)\left(\frac{12\text{ inch}}{1\text{ foot}}\right)\left(\frac{1\text{ m}}{39.37\text{ inch}}\right) = 20\text{ m/s}$

(c) $60\text{ mph} = \left(60\frac{\text{miles}}{\text{hour}}\right)\left(\frac{1.609\text{ km}}{1\text{ mile}}\right)\left(\frac{10^3\text{ m}}{1\text{ km}}\right)\left(\frac{1\text{ hour}}{3600\text{ s}}\right) = 27\text{ m/s}$

(d) $14\text{ square inches} = (14\text{ inch}^2)\left(\frac{1\text{ m}}{39.37\text{ inches}}\right)^2 = 9.0\times10^{-3}\text{ m}^2 = 9.0\times10^{-3}\text{ square meters}$

Chapter 2

Conceptual Questions

2.4. (a) At $t = 1$ s, the slope of the line for object A is greater than that for object B. Therefore, object A's speed is greater. (Both are positive slopes.)
(b) No, the speeds are never the same. Each has a constant speed (constant slope) and A's speed is always greater.

2.7. (a) The slope of the position-versus-time graph is greatest at C, so the object is moving fastest at this point.
(b) The slope is negative at point F, meaning the object is moving to the left there.
(c) At point F the slope is increasing in magnitude (getting more negative), meaning that the object is speeding up to the left.
(d) At point E the object is not moving since the slope is zero. Before point E, the slope is positive, while after E it is negative, so the object is turning around at E.

2.14. (a) The vertical axis of the graph is velocity, not position. The object is speeding up where the velocity is increasing; this is the case at point C.
(b) The object is slowing down at point A because the velocity in the *x* direction is getting smaller.
(c) The graph of velocity is always above the *t* axis, so the velocity is always positive, or in the direction to the right. At none of the points A, B, or C is it moving to the left.
(d) The object is moving to the right at all three points because the velocity is positive at all three points.

Exercises and Problems

2.4. Model: The jogger is a particle.
Solve: The slope of the position-versus-time graph at every point gives the velocity at that point. The slope at $t = 10\text{ s}$ is

$$v = \frac{\Delta s}{\Delta t} = \frac{50\text{ m} - 25\text{ m}}{20\text{ s}} = 1.25\text{ m/s}$$

The slope at $t = 25\text{ s}$ is

$$v = \frac{50\text{ m} - 50\text{ m}}{10\text{ s}} = 0.0\text{ m/s}$$

The slope at $t = 35\text{ s}$ is

$$v = \frac{0\text{ m} - 50\text{ m}}{10\text{ s}} = -5.0\text{ m/s}$$

2.6. Visualize: Please refer to Figure EX2.6 in the text. The particle starts at $x_0 = 10\text{ m}$ at $t_0 = 0$. Its velocity is initially in the –*x* direction. The speed decreases as time increases during the first second, is zero at $t = 1\text{ s}$, and then increases after the particle reverses direction.

Solve: (a) The particle reverses direction at $t = 1\text{ s}$, when v_x changes sign.

(b) Using the equation $x_f = x_0 +$ area of the velocity graph between t_1 and t_f,

$$x_{2s} = 10\text{ m} - (\text{area of triangle between 0 s and 1 s}) + (\text{area of triangle between 1 s and 2 s})$$

$$= 10\text{ m} - \frac{1}{2}(4\text{ m/s})(1\text{ s}) + \frac{1}{2}(4\text{ m/s})(1\text{ s}) = 10\text{ m}$$

$$x_{4s} = x_{2s} + \text{area between 2 s and 4 s}$$

$$= 10\text{ m} + \frac{1}{2}(4\text{ m/s} + 12\text{ m/s})(2\text{ s}) = 26\text{ m}$$

2.13. Model: Represent the car as a particle.
Solve: **(a)** First, we will convert units:

$$60\frac{\text{miles}}{\text{hour}}\times\frac{1\text{ hour}}{3600\text{ s}}\times\frac{1610\text{ m}}{1\text{ mile}}=27\text{ m/s}$$

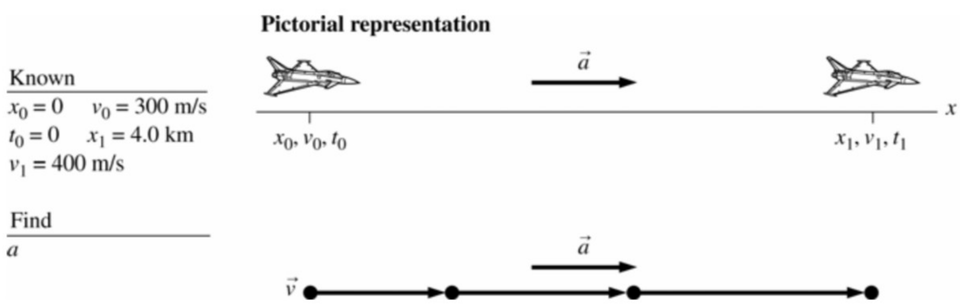
The motion is constant acceleration, so

$$v_1=v_0+a\Delta t\Rightarrow a=\frac{v_1-v_0}{\Delta t}=\frac{(27\text{ m/s}-0\text{ m/s})}{10\text{ s}}=2.7\text{ m/s}^2$$

(b) The distance is calculated as follows:

$$x_1=x_0+v_0\Delta t+\frac{1}{2}a(\Delta t)^2=\frac{1}{2}a(\Delta t)^2=1.3\times10^2\text{ m}=4.3\times10^2\text{ feet}$$

2.14. Model: Represent the jet plane as a particle.
Visualize:

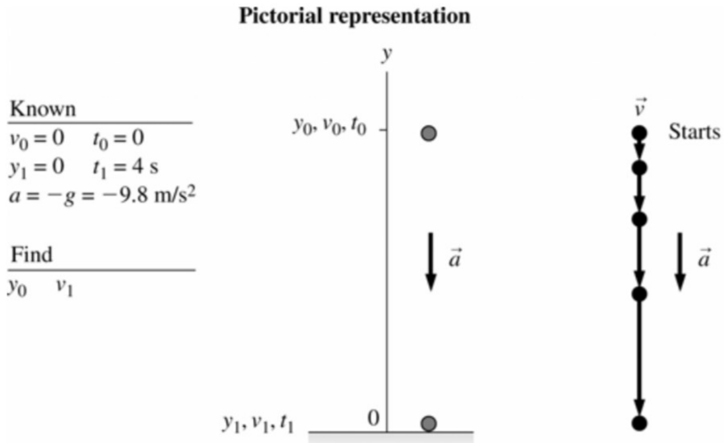


Solve: Since we don't know the time of acceleration, we will use

$$v_1^2=v_0^2+2a(x_1-x_0)$$
$$\Rightarrow a=\frac{v_1^2-v_0^2}{2x_1}=\frac{(400\text{ m/s})^2-(300\text{ m/s})^2}{2(4000\text{ m})}=8.75\text{ m/s}^2\approx8.8\text{ m/s}^2$$

Assess: The acceleration of the jet is not quite equal to g, the acceleration due to gravity; this seems reasonable for a jet.

2.20. Model: Represent the spherical drop of molten metal as a particle.
Visualize:



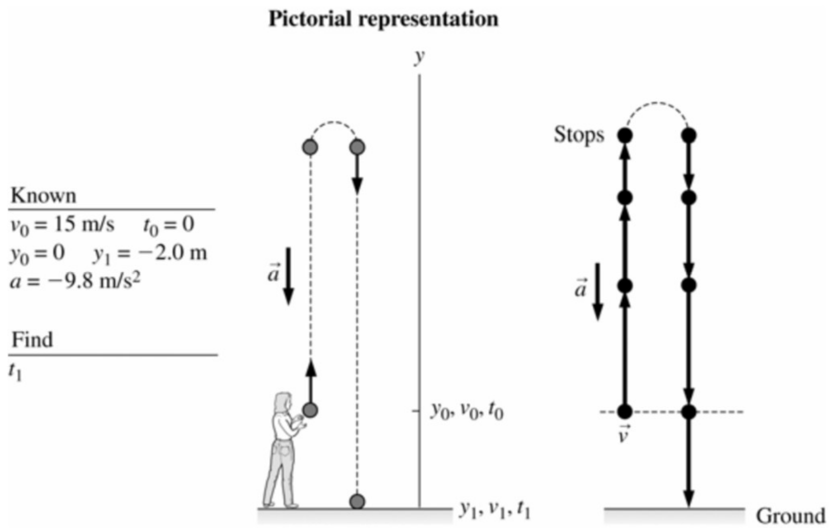
Solve: **(a)** The shot is in free fall, so we can use free fall kinematics with $a = -g$. The height must be such that the shot takes 4 s to fall, so we choose $t_1 = 4$ s. Then,

$$y_1 = y_0 + v_0(t_1 - t_0) - \frac{1}{2}g(t_1 - t_0)^2 \Rightarrow y_0 = \frac{1}{2}gt_1^2 = \frac{1}{2}(9.8 \text{ m/s}^2)(4 \text{ s})^2 = 78.4 \text{ m}$$

(b) The impact velocity is $v_1 = v_0 - g(t_1 - t_0) = -gt_1 = -39.2$ m/s.

Assess: Note the minus sign. The question asked for *velocity*, not speed, and the *y*-component of $\vec{v}$ is negative because the vector points downward.

2.21. Model: We model the ball as a particle.
Visualize:



Solve: Once the ball leaves the student's hand, the ball is in free fall and its acceleration is equal to the free-fall acceleration g that always acts vertically downward toward the center of the earth. According to the constant-acceleration kinematic equations of motion

$$y_1 = y_0 + v_0 \Delta t + \frac{1}{2} a \Delta t^2$$

Substituting the known values

$$-2 \text{ m} = 0 \text{ m} + (15 \text{ m/s})t_1 + (1/2)(-9.8 \text{ m/s}^2)t_1^2$$

One solution of this quadratic equation is $t_1 = 3.2$ s. The other root of this equation yields a negative value for t_1, which is not valid for this problem.
Assess: A time of 3.2 s is reasonable.