11. The values used in the problem statement make it easy to see that the first part of the trip (at 100 km/h) takes 1 hour, and the second part (at 40 km/h) also takes 1 hour. Expressed in decimal form, the time left is 1.25 hour, and the distance that remains is 160 km. Thus, a speed v = (160 km)/(1.25 h) = 128 km/h is needed.

15. We use Eq. 2-4 to solve the problem.

(a) The velocity of the particle is

$$v = \frac{dx}{dt} = \frac{d}{dt}\left(4 - 12t + 3t^2\right) = -12 + 6t.$$

Thus, at t = 1 s, the velocity is v = (–12 + (6)(1)) = –6 m/s.

(b) Since $v < 0$, it is moving in the $-x$ direction at t = 1 s.

(c) At t = 1 s, the *speed* is $|v|$ = 6 m/s.

(d) For $0 < t < 2$ s, $|v|$ decreases until it vanishes. For $2 < t < 3$ s, $|v|$ increases from zero to the value it had in part (c). Then, $|v|$ is larger than that value for $t > 3$ s.

(e) Yes, since v smoothly changes from negative values (consider the t = 1 result) to positive (note that as $t \to +\infty$, we have $v \to +\infty$). One can check that $v = 0$ when $t = 2$ s.

(f) No. In fact, from $v = -12 + 6t$, we know that $v > 0$ for $t > 2$ s.

34. Let d be the 220 m distance between the cars at t = 0, and v_1 be the 20 km/h = 50/9 m/s speed (corresponding to a passing point of x_1 = 44.5 m) and v_2 be the 40 km/h =100/9 m/s speed (corresponding to a passing point of x_2 = 76.6 m) of the red car. We have two equations (based on Eq. 2-17):

$$d - x_1 = v_o t_1 + \frac{1}{2} a t_1^2 \qquad \text{where } t_1 = x_1 / v_1$$

$$d - x_2 = v_o t_2 + \frac{1}{2} a t_2^2 \qquad \text{where } t_2 = x_2 / v_2$$

We simultaneously solve these equations and obtain the following results:

(a) The initial velocity of the green car is v_o = – 13.9 m/s. or roughly – 50 km/h (the negative sign means that it's along the $-x$ direction).

(b) The corresponding acceleration of the car is a = – 2.0 m/s^2 (the negative sign means that it's along the $-x$ direction).

59. We neglect air resistance, which justifies setting $a = -g = -9.8$ m/s^2 (taking *down* as the $-y$ direction) for the duration of the motion. We are allowed to use Table 2-1 (with Δy replacing Δx) because this is constant acceleration motion. The ground level is taken to correspond to the origin of the y-axis.

(a) The time drop 1 leaves the nozzle is taken as $t = 0$ and its time of landing on the floor t_1 can be computed from Eq. 2-15, with $v_0 = 0$ and $y_1 = -2.00$ m.

$$y_1 = -\frac{1}{2} g t_1^2 \quad \Rightarrow \quad t_1 = \sqrt{\frac{-2y}{g}} = \sqrt{\frac{-2(-2.00 \text{ m})}{9.8 \text{ m/s}^2}} = 0.639 \text{ s} .$$

At that moment, the fourth drop begins to fall, and from the regularity of the dripping we conclude that drop 2 leaves the nozzle at $t = 0.639/3 = 0.213$ s and drop 3 leaves the nozzle at $t = 2(0.213 \text{ s}) = 0.426$ s. Therefore, the time in free fall (up to the moment drop 1 lands) for drop 2 is $t_2 = t_1 - 0.213 \text{ s} = 0.426$ s. Its position at the moment drop 1 strikes the floor is

$$y_2 = -\frac{1}{2} g t_2^2 = -\frac{1}{2}(9.8 \text{ m/s}^2)(0.426 \text{ s})^2 = -0.889 \text{ m},$$

or about 89 cm below the nozzle.

(b) The time in free fall (up to the moment drop 1 lands) for drop 3 is $t_3 = t_1 - 0.426$ s $= 0.213$ s. Its position at the moment drop 1 strikes the floor is

$$y_3 = -\frac{1}{2} g t_3^2 = -\frac{1}{2}(9.8 \text{ m/s}^2)(0.213 \text{ s})^2 = -0.222 \text{ m},$$

or about 22 cm below the nozzle.

93. We neglect air resistance, which justifies setting $a = -g = -9.8$ m/s^2 (taking *down* as the $-y$ direction) for the duration of the stone's motion. We are allowed to use Table 2-1 (with Δx replaced by y) because the ball has constant acceleration motion (and we choose $y_0 = 0$).

(a) We apply Eq. 2-16 to both measurements, with SI units understood.

$$v_B^2 = v_0^2 - 2gy_B \quad \Rightarrow \quad \left(\frac{1}{2}v\right)^2 + 2g\left(y_A + 3\right) = v_0^2$$
$$v_A^2 = v_0^2 - 2gy_A \quad \Rightarrow \quad v^2 + 2gy_A = v_0^2$$

We equate the two expressions that each equal v_0^2 and obtain

$$\frac{1}{4}v^2 + 2gy_A + 2g(3) = v^2 + 2gy_A \quad \Rightarrow \quad 2g(3) = \frac{3}{4}v^2$$

which yields $v = \sqrt{2g(4)} = 8.85\ \text{m/s}.$

(b) An object moving upward at *A* with speed v = 8.85 m/s will reach a maximum height $y - y_A = v^2/2g$ = 4.00 m above point *A* (this is again a consequence of Eq. 2-16, now with the "final" velocity set to zero to indicate the highest point). Thus, the top of its motion is 1.00 m above point *B*.