

**2.44:** a) Using  $a_y = -g$ ,  $v_{0y} = 5.00 \text{ m/s}$  and  $y_0 = 40.0 \text{ m}$  in Eqs. (2.8) and (2.12) gives  
 i) at  $t = 0.250 \text{ s}$ ,

$$y = (40.0 \text{ m}) + (5.00 \text{ m/s})(0.250 \text{ s}) - (1/2)(9.80 \text{ m/s}^2)(0.250 \text{ s})^2 = 40.9 \text{ m},$$

$$v_y = (5.00 \text{ m/s}) - (9.80 \text{ m/s}^2)(0.250 \text{ s}) = 2.55 \text{ m/s}$$

and ii) at  $t = 1.00 \text{ s}$ ,

$$y = (40.0 \text{ m}) + (5.00 \text{ m/s})(1.00 \text{ s}) - (1/2)(9.80 \text{ m/s}^2)(1.00 \text{ s})^2 = 40.1 \text{ m},$$

$$v_y = (5.00 \text{ m/s}) - (9.80 \text{ m/s}^2)(1.00 \text{ s}) = -4.80 \text{ m/s}.$$

b) Using the result derived in Example 2.8, the time is

$$t = \frac{(5.00 \text{ m/s}) + \sqrt{(5.00 \text{ m/s})^2 - 2(9.80 \text{ m/s}^2)(0 - 40.0 \text{ m})}}{(9.80 \text{ m/s}^2)} = 3.41 \text{ s}.$$

c) Either using the above time in Eq. (2.8) or avoiding the intermediate calculation by using Eq. (2.13),

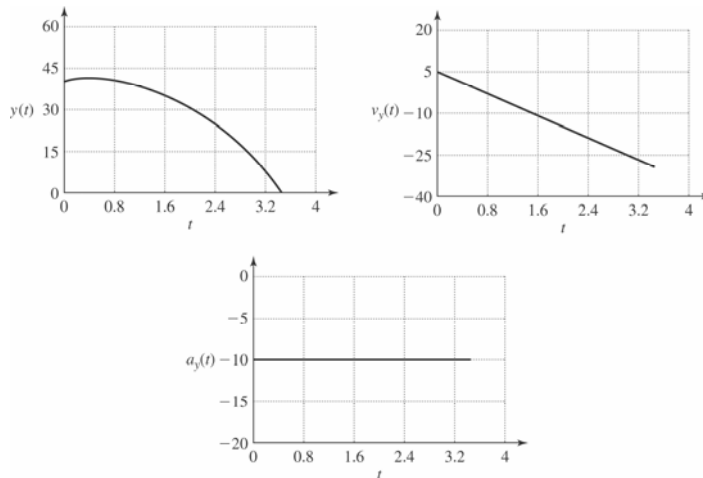
$$v_y^2 = v_{0y}^2 - 2g(y - y_0) = (5.00 \text{ m/s})^2 - 2(9.80 \text{ m/s}^2)(-40.0 \text{ m}) = 809 \text{ m}^2/\text{s}^2,$$

$$v_y = -28.4 \text{ m/s}.$$

d) Using  $v_y = 0$  in Eq. (2.13) gives

$$y = \frac{v_0^2}{2g} + y_0 = \frac{(5.00 \text{ m/s})^2}{2(9.80 \text{ m/s}^2)} + 40.0 \text{ m} = 41.2 \text{ m}.$$

e)



**2.67:** The total distance you cover is  $1.20 \text{ m} + 0.90 \text{ m} = 2.10 \text{ m}$  and the time available is  $\frac{1.20 \text{ m}}{1.50 \text{ m/s}} = 0.80 \text{ s}$ . Solving Eq. (2.12) for  $a_x$ ,

$$a_x = 2 \frac{(x - x_0) - v_{0x}t}{t^2} = 2 \frac{(2.10 \text{ m}) - (0.80 \text{ m/s})(0.80 \text{ s})}{(0.80 \text{ s})^2} = 4.56 \text{ m/s}^2.$$

**2.93:** The velocities are  $v_A = \alpha + 2\beta t$  and  $v_B = 2\gamma t - 3\delta t^2$ . a) Since  $v_B$  is zero at  $t = 0$ , car A takes the early lead. b) The cars are both at the origin at  $t = 0$ . The non-trivial solution is found by setting  $x_A = x_B$ , cancelling the common factor of  $t$ , and solving the quadratic for

$$t = -\frac{1}{2\delta} \left[ (\beta - \gamma) \pm \sqrt{(\beta - \gamma)^2 - 4\alpha\delta} \right]$$

Substitution of numerical values gives 2.27 s, 5.73 s. The use of the term “starting point” can be taken to mean that negative times are to be neglected. c) Setting  $v_A = v_B$  leads to a different quadratic, the positive solution to which is

$$t = -\frac{1}{6\delta} \left[ (2\beta - 2\gamma) - \sqrt{(2\beta - 2\gamma)^2 - 12\alpha\delta} \right]$$

Substitution of numerical results gives 1.00 s and 4.33 s.

d) Taking the second derivative of  $x_A$  and  $x_B$  and setting them equal, yields,  $2\beta = 2\gamma - 6\delta t$ . Solving,  $t = 2.67 \text{ s}$ .