Homework Solutions
9/4/2007

Conceptual

12. The racing car rounds the turn at a constant speed of 90 mi/hr.

13. An acceleration perpendicular to a velocity will result in a parabolic path.

14. The balls will be closest to each other right as the second ball is leaving the table. The first ball will always be traveling faster than the first ball because it has been accelerating longer. The second ball will land one second after the first ball. Changing the horizontal velocity of either ball will have no affect on the time the balls spend in the air because horizontal velocity remains constant and does affect anything vertically.

17. Yes, the projectile is a freely falling body. Its acceleration in the vertical plane is 9.81 meters per second squared. Its acceleration in the horizontal plane is 0.

19. To have zero speed at the top of its trajectory a projectile must be thrown vertically. To have a non-zero speed at the top of its trajectory a projectile must be thrown at an angle (other than vertical).

Problems

24.

$$v_x = 18.0\frac{m}{s}$$

$$v_y = 0\frac{m}{s}$$

$$y = 50.0m$$

$$x = x_0 + v_0 t + \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2x}{a}} = \sqrt{\frac{2(-50.0m)}{-9.81\frac{m}{s^2}}} = 3.193s = 3.19s$$

$$v = v_o + at$$

$$v_y = 0 - 9.81\frac{m}{s^2}(3.193s) = 31.32\frac{m}{s} = 31.3\frac{m}{s}$$

$$v_{actual} = \sqrt{v_x^2 + v_y^2} = \sqrt{\left(18.0\frac{m}{s}\right)^2 + \left(31.32\frac{m}{s}\right)^2} = 36.1\frac{m}{s}$$

$$\theta = \tan^{-1}\left(\frac{31.3}{18.0}\right) = 60.1°$$

The stone is traveling 36.1 m/s and strikes the ground at an angle of 60.1 degrees below the ground.

26.

$$y = 1.5m$$

$$v_x = 5.0\frac{m}{s}$$

$$v_{0,y} = 0\frac{m}{s}$$

$$x = x_0 + v_0 t + \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2x}{a}} = \sqrt{\frac{2(-1.5m)}{-9.81\frac{m}{s}}} = 0.5530s$$

$$x = vt$$

$$x = 5.0\frac{m}{s}(0.5530s) = 2.8m$$

$$v_y = v_0 + at$$

$$v_y = 0 - 9.81\frac{m}{s^2}(0.5530s)$$

$$v_y = -5.425\frac{m}{s}$$

$$v_{actual} = \sqrt{v_x^2 + v_y^2} = \sqrt{\left(5.0\frac{m}{s}\right)^2 + \left(-5.425\frac{m}{s}\right)^2} = 7.4\frac{m}{s}$$

30. a.

$$v = 20.0\frac{m}{s}$$

$$\theta = 53.0°$$

$$y = 3.05m$$

$$x = 36.0m$$

$$v_x = 20.0\cos(53.0°) = 12.04\frac{m}{s}$$

$$v_y = 20.0\sin(53.0°) = 15.97\frac{m}{s}$$

$$v = \frac{x}{t}$$

$$t = \frac{x}{v} = \frac{36.0m}{12.04\frac{m}{s}} = 2.99s$$

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$$x = 15.97\frac{m}{s}(2.99s) + \frac{1}{2}\left(-9.81\frac{m}{s^2}\right)(2.99s)^2 = 3.899m$$

Yes the ball clears the goal post by almost 0.85m.

b. Let's find the time the ball takes to get to the top of its path.

$$v = v_0 + at$$

$$t = \frac{v - v_0}{a} = \frac{0 - 15.97\frac{m}{s}}{9.81\frac{m}{s^2}} = 1.63s$$

Because the ball will spend a little more than 1.6s on its way up and the ball crosses the goal post at 2.99s, the ball must be on its way down.