Chapter 5 problems:

To further your understanding of this material, I have done more problems than I have assigned.

6. A ball rolls across the diagonal of a 3 m by 4 m table with a velocity of 0.25 m/s. First picture the situation.

The angle can be found using the equation:

\[ \tan \theta = \frac{3}{4} \]

\[ \theta = \tan^{-1}(0.75) = 37^\circ \]

This velocity has a horizontal component of 0.25 \( \cos \theta = 0.2 \) m/s and

A vertical velocity of 0.25 \( \sin \theta = 0.15 \) m/s

So, \( x = V_x t = 0.2 \times 6 \) sec = 1.2 m

And

\( Y = V_y t = 0.15 \times 6 \) sec = 0.8 m

12. An arrow is shot vertically upward with a speed of 25 m/s. The arrow will slow down as it goes upward (negative acceleration) until it stops going upward at its maximum height. So, its velocity at its maximum height is zero. !!

\[ V_o = 0 \text{ m/s} \]

\[ Y_0 = 0 \text{ m} \]

\[ V_0 = 25 \text{ m/s} \]

\[ V_1 = 0 \text{ m/s} \]

\[ A = -9.8 \text{ m/s}^2 \]

\[ T = ? \]

\[ V_1^2 = V_o^2 + 2a(y_1 - y_0) \]

\[ 0 = 25^2 + 2(-9.8)(y_1 - 0) \]

\[ 0 = 625 - 19.6y_1 \]

\[ y_1 = \frac{-625}{-19.6} = 31.9 \text{ m} \]

At a time, \( t = 4.0 \) sec.

\[ Y - 0 = 25(4) + \frac{1}{2}(-9.8)(4)^2 \]

\[ Y = 100 + (-4.9)(16) \]

\[ Y = 100 - 78.4 = 21.6 \text{ m} \]
20. A golf ball goes up and down while going horizontally. It is a combination of vertical and horizontal motion. To solve a problem involving both, one solves one form of motion separately then goes back and solves the other. The ball was hit giving it a velocity of 120 ft/s (british system) at an angle of 45° to the horizontal. The amount of the velocity directed vertically, \( v_y = 120 \sin 45 = 84.9 \text{ ft/s} \) and the amount of the velocity directed horizontally is \( v_x = 120 \cos 45 = 84.9 \text{ ft/s} \) (notice that \( \sin 45 = \cos 45 \)).

\[ V_{y1} = 0 \text{ but } V_{x1} = 84.9 \text{ ft/s} \]

\[ 120 \quad 45° \]

Solve the vertical motion for the time it takes to get to the maximum height, then solve for the maximum height.

\[ V_{y1} = V_{y0} + a \cdot t \]
\[ 0 = 84.9 + (-32) \cdot t \]
\[ t = \frac{84.9}{32} = +2.65 \text{ sec} \]
then
\[ Y_1 - Y_0 = V_{y0} \cdot t + \frac{1}{2} a \cdot t^2 \]
\[ Y_1 = 84.9 \cdot (2.65) + \frac{1}{2} (-32) \cdot (2.65)^2 \]
\[ Y_1 = 225 + (-16) \cdot (7.02) = 112.7 \text{ ft} \]
This is the half way point in the trajectory!!!

The horizontal distance to the mid-point is \( X_1 = V_x \cdot t \)
\[ X_1 = 84.9 \cdot (2.65) = 225 \text{ ft} \]
Which is half the total horizontal distance. So the total distance would be 450 ft.

Likewise the total time in the air would be twice the time to get to the half way mark, so total time = 5.3 seconds.

29. An object in circular motion has a centripetal acceleration given by \( a = \frac{v^2}{R} \).
So given that \( a = 0.090 \text{ m/s}^2 \) and \( R = 1.5 \text{ m} \), \( v \) equals the square root of \( a \times R \)

\[ V = \sqrt{(0.090 \times 1.5)} = 0.37 \text{ m/s} \]