7. A ball is thrown from the top of a building, straight up, at 15 m/s. It hits the ground 6.0 s later. How tall is the building?

\[ y - y_0 = v_{0y} t - \frac{1}{2} g t^2 = (15 \text{ m/s}) (6 \text{ s}) - \frac{1}{2} (9.8 \text{ m/s}^2) (6 \text{ s})^2 \]

\[ y - y_0 = -86.4 \text{ m} \]

8. A 22.0 kg mass initially moving at 12.0 m/s on a horizontal surface slows and stops due to friction. If it travels 45.0 m before stopping, what is the coefficient of static friction?

\[ \frac{v^2 - v_0^2}{2a} = \frac{(0)^2 - (12 \text{ m/s})^2}{2a} = 1.6 \text{ m/s}^2 \]

9. A cannon is aimed at an angle of 30 degrees above the horizontal and fires a shell at 550 m/s. How far away will the shell land if it lands at the same height it started at (neglect friction)?

\[ R = \frac{V_x t + V_y t}{g} = \frac{2V_x t}{g} = \frac{2 \cdot 550 \text{ m/s} \cdot \sin 30^\circ}{9.8 \text{ m/s}^2} = 28 \text{ s} \]

10. How long will the cannon shell from problem 9 be in the air before landing?

11. I want to throw a marker into a trash can which is 4.5 m away horizontally and 1.5 m below my hand. If I throw the marker at an angle of 30 degrees above the horizontal, what speed should I throw it at to hit the trash can?

\[ y - y_0 = -1.5 \text{ m} = v_{0y} t - \frac{1}{2} g t^2, \quad v_{0x} t = 4.5 \text{ m} \]

\[ 1.5 \text{ m} = \frac{4.5 \text{ m}}{30^\circ} - \frac{1}{2} (9.8 \text{ m/s}^2) \left( \frac{4.5 \text{ m}}{30^\circ} \right)^2 \quad \text{or} \quad 1.5 \text{ m} = \frac{132 \text{ m}^3/\text{s}^2}{41.1 \text{ m/s}} \]

\[ V_0 = \sqrt{\frac{132 \text{ m}^3/\text{s}^2}{41.1 \text{ m/s}}} = 5.7 \text{ m/s} \]

12. Sue travels 35 km west, then 25 km northwest (at a 45 degree angle to west). What is the magnitude of her displacement vector?

\[ \vec{A} = 35 \text{ km, \text{ west}} \]

\[ \vec{B}_w = (25 \text{ km}) \cos 45^\circ = 17.7 \text{ km, \text{ west component}} \]

\[ \vec{B}_n = (25 \text{ km}) \sin 45^\circ = 17.7 \text{ km, \text{ north component}} \]

\[ \vec{C} = \vec{A} + \vec{B} \]

\[ C_w = A_w + B_w = 35 \text{ km} + 17.7 \text{ km} = 52.7 \text{ km, \text{ west component}} \]

\[ C_n = A_n + B_n = 17.7 \text{ km} \]

\[ \vec{C} = \sqrt{(52.7 \text{ km})^2 + (17.7 \text{ km})^2} = 55.6 \text{ km} \]

13. Referring to problem 12, what angle does Sue's displacement vector make with respect to west?

\[ \theta = \tan^{-1} \left( \frac{17.7 \text{ km}}{52.7 \text{ km}} \right) = 18.6^\circ \]