A British navy ship is about 1 nautical mile from a fort defending Tortuga. (In 17th century Tortuga was one of the largest pirate strongholds). The fortress is located 50.0 meters above the sea level, with the walls as high as 60.0 meters. There is an armory house located 100.0 meters beyond the fort walls.

The captain of the navy ship knows that a direct hit of the armory house (stuffed with barrels of rum) may force pirates to surrender. The ship can fire cannons at the muzzle speed of v=200 m/s. Let's suppose that the captain can disregard air resistance in the problem (We will consider the effect of the air resistance later).

1 At what angle from the horizontal must the cannons be fired to hit the armory? (Use one of methods for solving non-linear equations)
2 Is it important to take into account that the ship is actually moving toward the fort with the speed about 2 knots? (1 knot = 1 nautical mile/hour = 1.852 km/h). The armory's dimensions are 8.0m*8.0m*3.2m.

Equations:

In the simplest case (with no air resistance) the 2D motion of a projectile is describe by a system of equations

$$x_f = x_i + (v_0 \cos\theta + v_{ship})t$$

$$y_f = y_i + (v_0 \sin\theta)t - \frac{gt^2}{2}$$

Eliminating the time from the equations gives

$$y_i - y_f + v_0 \sin\theta \frac{x_f - x_i}{v_0 \cos\theta + v_{ship}} - \frac{g}{2}\left(\frac{x_f - x_i}{v_0 \cos\theta + v_{ship}}\right)^2 = 0$$

Solving this non-linear equation for the angle θ would give the right shooting angle to hit a target.

In the case $y_i = y_f$ and $v_{ship} = 0$ a very simple analytic solution can be found in most textbook

$$\theta = \frac{1}{2}\arcsin\left(\frac{g(x_f - x_i)}{v_0^2}\right)$$

This simple case can be used to test numerical solutions when $y_i = y_f$ and $v_{ship} = 0$.