Answer on Question 71526, Physics, Mechanics, Relativity

Question:

A cannon fires a cannonball with a muzzle velocity of $50\ m/s$ at an angle of 40°.

a) What is the flight time?

b) What is the cannonball maximum altitude?

c) What is the cannon's range at this angle?

Solution:

a) Let's first find the projections of the initial velocity of the cannonball on axis x and y:

$$v_{0x} = v_0 cos\alpha = 50\ \frac{m}{s} \cdot cos40^{\circ} = 38.3\ \frac{m}{s},$$

$$v_{0y} = v_0 sin\alpha = 50\ \frac{m}{s} \cdot sin40^{\circ} = 32.14\ \frac{m}{s}.$$

Let's consider the motion of the cannonball in the vertical direction. We can find the time t_{rise} that the cannonball need to reach the maximum altitude from the kinematic equation:

$$v = v_{0y} - gt_{rise},$$

here, v_{0y} is the projection of the initial velocity of the cannonball on axis y, $v = 0$ is the velocity of the cannonball at maximum altitude, $g = -9.8\ \frac{m}{s^2}$ is the acceleration due to gravity.

Then, we get:

$$t_{rise} = \frac{v_{0y}}{g} = \frac{32.14\ \frac{m}{s}}{9.8\ \frac{m}{s^2}} = 3.28\ s.$$

Finally, we can find the flight time multiply t_{rise} by 2:

$$t_{flight} = 2 \cdot t_{rise} = 2 \cdot 3.28\ s = 6.56\ s.$$

b) We can find cannonball maximum altitude from the equation:

$$h = \frac{1}{2} g t_{rise}^2 = \frac{1}{2} \cdot 9.8 \frac{m}{s^2} \cdot (3.28\ s)^2 = 52.7\ m.$$

c) Let's consider the motion of the cannonball in the horizontal direction. We can find the cannon's range at this angle from the formula:

$$x = v_{0x} \cdot t_{flight} = 38.3 \frac{m}{s} \cdot 6.56\ s = 251.25\ m.$$

Answer:

a) $t_{flight} = 6.56\ s.$

b) $h = 52.7\ m.$

c) $x = 251.25\ m.$