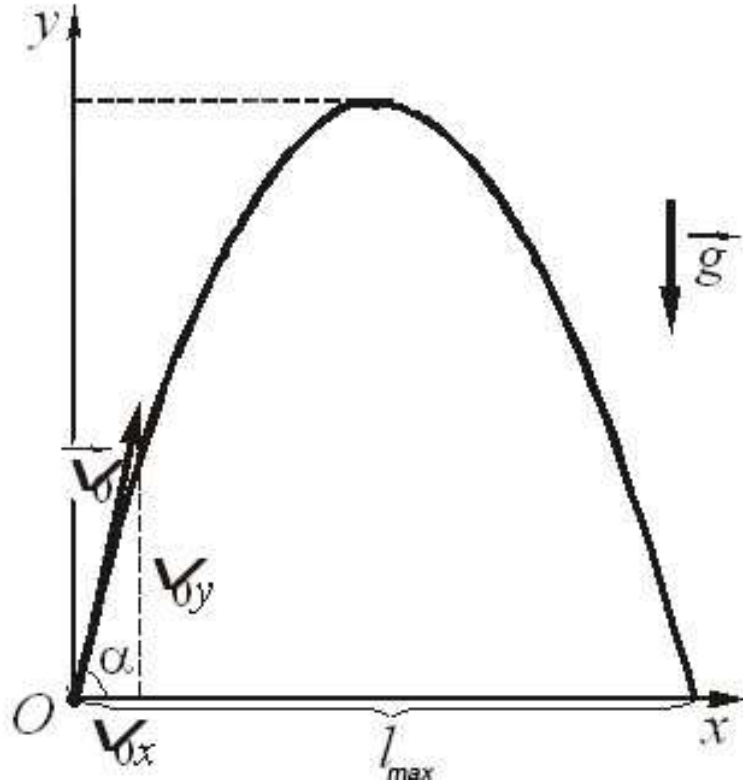A cannon ball fires a shell with a speed of 84 m/s. When the canon is inclining at 45 degree, the horizontal distance covered is observed as 630 m. What is the percentage decrease in horizontal distance observed due to air resistance?

Solution.

$$v_0 = 84\frac{m}{s}, \alpha = 45°, l = 630m, g = 9.8\frac{m}{m^2};$$

$$k-?$$

$$v_x = v_0 cos\alpha;$$
$$v_y = v_0 sin\alpha.$$

The max distance.

$$l_{max} = v_{0x}t;$$
$$l_{max} = v_0 cos\alpha t;$$

The time of flight.

$$y = v_{0y}t - \frac{gt^2}{2};$$

$$y = v_0 sin\alpha t - \frac{gt^2}{2}.$$

At the end of the flight $y = 0$:

$$0 = v_0 sin\alpha t - \frac{gt^2}{2};$$

$$v_0 sin\alpha t = \frac{gt^2}{2};$$

$$v_0 sin\alpha = \frac{gt}{2};$$

$$t = \frac{2v_0 sin\alpha}{g}.$$

The max distance.

$$l_{max} = v_0 cos\alpha \frac{2v_0 sin\alpha}{g};$$

$$l_{max} = \frac{2v_0^2 sin\alpha cos\alpha}{g}.$$

$$l_{max} = \frac{2 \cdot 84^2 \cdot sin45° \cdot cos45°}{9.8} = 720(m).$$

The percentage decrease in horizontal distance observed due to air resistance:

$$k = \frac{l_{max} - l}{l_{max}} \cdot 100\% = \left(1 - \frac{l}{l_{max}}\right) \cdot 100\%;$$

$$k = \left(1 - \frac{l}{l_{max}}\right) \cdot 100\%.$$

$$k = \left(1 - \frac{630}{720}\right) \cdot 100\% = 12.5(\%).$$

Answer:

The percentage decrease in horizontal distance observed due to air resistance is $k = 12.5\%$.