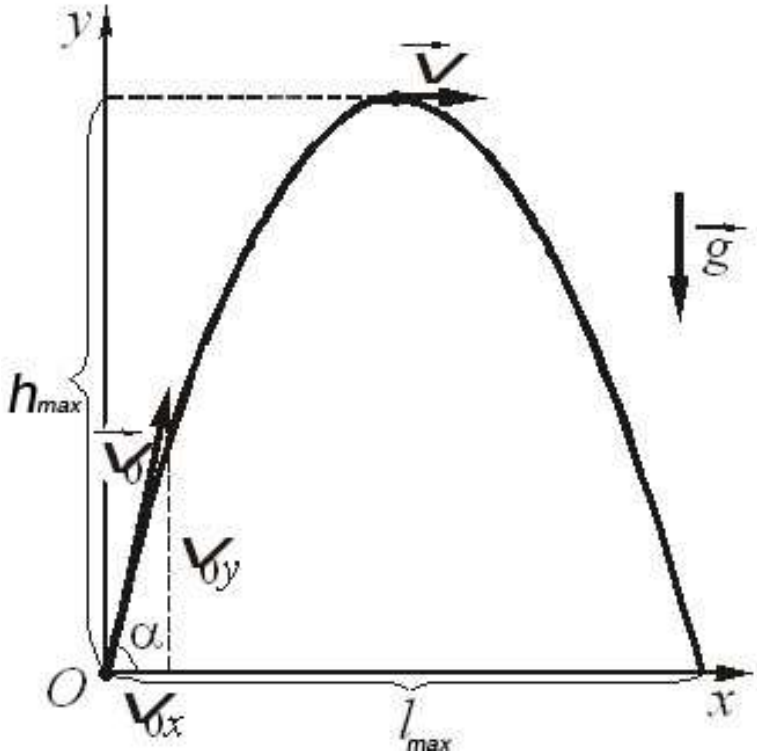
An archer fires an arrow with an initial velocity of 4m/sec at an elevation of 45 degrees. Calculate:
a) the max height attained;
b) the time of flight;
c) the max range of the arrow.

Solution.

$$\upsilon_0 = 4\frac{m}{s}, \alpha = 45°;$$

$$h_{max} - ?\ t - ?\ l_{max} - ?$$



$$\upsilon_x = \upsilon_0 cos\alpha;$$

$$\upsilon_y = \upsilon_0 sin\alpha.$$

a) the max height attained.

$$h_{max} = \frac{\upsilon_y^2 - \upsilon_{0y}^2}{-2g}.$$

At the max height $\upsilon_y = 0$:

$$h_{max} = \frac{-\upsilon_{0y}^2}{-2g};$$

$$h_{max} = \frac{\upsilon_{0y}^2}{2g};$$

$$h_{max} = \frac{\upsilon_0^2 sin^2\alpha}{2g}.$$

$$h_{max} = \frac{4^2 \cdot sin^2 45°}{2 \cdot 9.8} = 0.4(m).$$

b) the time of flight.

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

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

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

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

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

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

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

$$t = \frac{2 \cdot 4 \cdot sin45°}{9.8} = 0.58(s);$$

c) the max range of the arrow.

$$l_{max} = v_{0x}t;$$

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

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

$$l_{max} = \frac{2 \cdot 4^2 \cdot sin45° \cdot cos45°}{9.8} = 1.63(m).$$

Answer:

a) the max height attained: $h_{max} = 0.4m.$
b) the time of flight: $t = 0.58s.$
c) the max range of the arrow: $l_{max} = 1.63m.$