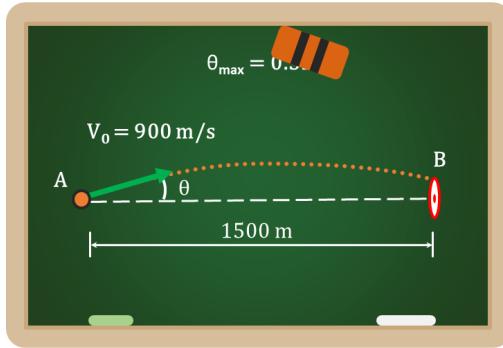


# Bullet on Target



A person fires a round from A toward a target B. Find an expression for the time  $t$  it takes for the bullet to reach the target, in terms of  $d$ ,  $v_0$  and  $\theta$ . The target diameter is 2 m and the target centre is at the same altitude as the end of the rifle barrel. The bullet velocity at the end of the barrel 900 m/s, the distance between A and B is  $d = 1500$  m. Neglect air resistances and assume that the round is directed along the vertical centreline of the target. Take  $g = 10$  m/s<sup>2</sup>.

$$t = \dots$$

*Using known expressions:*

$$a = \frac{dv}{dt} \Rightarrow dv = adt \quad (1)$$

$$\int_{v_0}^v dv = a \int_0^t dt \quad (2)$$

$$v(t) = a \cdot t + v_0 \quad (3)$$

$$v = \frac{ds}{dt} \Rightarrow ds = vdt = (v_0 + at)dt \quad (4)$$

$$\int_{s_0}^s ds = \int_0^t (v_0 + at) dt \quad (5)$$

$$s(t) = \frac{1}{2}a \cdot t^2 + v_0 \cdot t + s_0 \quad (6)$$

*Given:*

Distance A-B:  $d = 1500m$

Gravitational acceleration:  $g = 10m/s^2$

Initial velocity:  $v_0 = 900m/s$

Diameter target:  $D = 2m$

Filling in Equation 6 gives an relation for the x-position with respect to time. Where  $a = x_0 = 0$ , since there is no acceleration in the x-direction and the coordinate system is chosen at the end of the rifle barrel.

$$x(t) = v_{0,x} \cdot t \Rightarrow x(t) = \cos \theta \cdot v_0 \cdot t = d \quad (7)$$

Rewriting gives a relation for the time  $t$  with respect to  $\theta$  and  $v_0$ .

$$\cos \theta \cdot v_0 \cdot t = d \Rightarrow t = \frac{d}{\cos(\theta) \cdot v_0} \quad (8)$$