Task. A bullet is fired horizontally at a velocity 10 m/s from a watch tower 100 m high. How long does it take to reach the ground? $(g = 9.8m/s^2)$

Solution. First compute the time t when the bullet will reach the ground. Let $v = (v_x, v_y)$ be the velocity of the bullet, where v_x is the horizontal component of v and v_y is the vertical one. Since it is thrown horizontally, we see that

$$v_x(0) = 10m/s, \qquad v_y(0) = 0$$

Furhtermore, there is a gravitation force $F = mg$ acting on the bullet and it is directed along y-axis, whence the bullet moves with constant velocity along x-axis, i.e. v_x does not depend on t:

$$v_x(t) = 10,$$

and with constant acceleration g along y-axis, so

$$v_y(t) = -gt,$$

and the height of the bullet is equal to

$$h = 100 - \frac{gt^2}{2}.$$

Hence the time t when the bullet reach to the ground is satisfies the equation

$$0 = 100 - \frac{gt^2}{2},$$

$$t = \sqrt{200/g} = \sqrt{200/9.8} \approx 4.5175\,s.$$

During this time the bullet will fly the distance

$$d = v_x t = 10 \cdot 4.5175 = 45.175\,m.$$

So the bullet will reach the ground at the distance 45.175 m from the tower.