Task. Assuming zero friction, what is the initital velocity of a projectile that is fired straight up from the ground and takes 8 seconds to hit the ground.

Solution. We should find the initial velocity v_0 of the projectile.

Notcie that the projectile moved with constant acceleration $g = 9.8\ m/s^2$, and so the height of the projectile at time t is given by the formula

$$h(t) = v_0 t - \frac{gt^2}{2}.$$

By assumption the projectile hit the ground after 8 seconds, that is $h(8) = 0$. Hence we get the following equation

$$0 = h(8) = v_0 * 8 - \frac{g * 8^2}{2} \qquad \Rightarrow \qquad 8v_0 = \frac{64g}{2} = 32g,$$

and so

$$v_0 = 4g = 4 * 9.8 = 39.2\ m/s.$$

Answer. $39.2\ m/s$.