

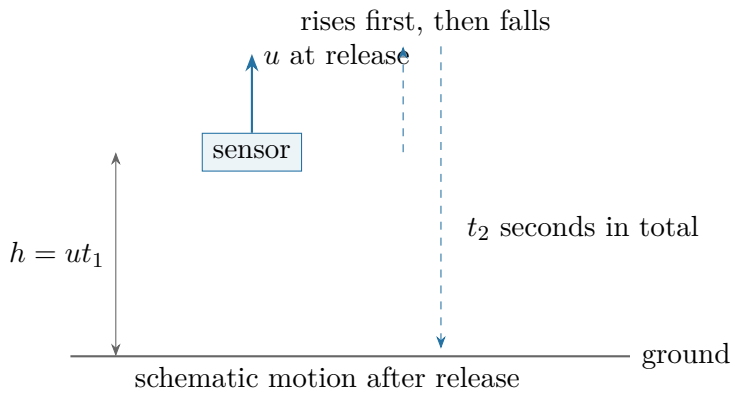
Part (b)

Game plan: We find how high the balloon has risen before the sensor is released. Then we use the sensor’s motion back to the ground to connect the two times.

Step 1: Find the height at release

The balloon travels upwards at constant speed u for t_1 seconds. Its height when the sensor is released is therefore

$$h = ut_1.$$



The sensor is already moving upwards with the balloon. Releasing it does not make its velocity suddenly zero: its initial velocity is still u upwards.

Step 2: Write the sensor’s displacement equation

Take upwards as positive, and measure the sensor’s displacement from the release point. When it reaches the ground its displacement is $-h$. Its acceleration is $-g$, and the time since release is t_2 .

Constant acceleration	Logbook Page 50
$s = ut + \frac{1}{2}at^2.$	

$$\begin{aligned} -h &= ut_2 - \frac{1}{2}gt_2^2, \\ -ut_1 &= ut_2 - \frac{1}{2}gt_2^2. \end{aligned}$$

Step 3: Rearrange to find the release time

$$\begin{aligned} ut_1 &= \frac{1}{2}gt_2^2 - ut_2, \\ t_1 &= \frac{gt_2^2}{2u} - t_2 \\ &= \frac{t_2}{2} \left(\frac{gt_2}{u} - 2 \right). \end{aligned}$$

Final Answer
$t_1 = \frac{t_2}{2} \left(\frac{gt_2}{u} - 2 \right).$