Answer on Question #73875, Physics / Mechanics | Relativity

Question. An inquisitive physics student and mountain climber climbs a $S = 50\ m$ cliff that overhangs a calm pool of water. He throws two stones vertically downwards $t_0 = 1\ s$ apart and observes that they cause a single splash. The first stone has an initial velocity of $v_{01} = 2\ m/s$.

(a) At what time Δt after release of the first stone will the two stones hit the water?

(b) What is the initial velocity v_{02} that the second stone should have if they are to hit simultaneously?

(c) What will the velocity v_1, v_2 of each stone be at the instant they hit the water?

Solution.

For the first stone

$$S = v_{01}\Delta t + \frac{g\Delta t^2}{2}.$$

For the second stone

$$S = v_{02}(\Delta t - t_0) + \frac{g(\Delta t - t_0)^2}{2}.$$

(a) At what time Δt after release of the first stone will the two stones hit the water?

$$S = v_{01}\Delta t + \frac{g\Delta t^2}{2} \rightarrow 50 = 2\Delta t + 9.8 \cdot \frac{\Delta t^2}{2} \rightarrow 9.8\Delta t^2 + 4\Delta t - 100 = 0 \rightarrow \Delta t \approx 3\ s.$$

(b) What is the initial velocity v_{02} that the second stone should have if they are to hit simultaneously?

$$S = v_{02}(\Delta t - t_0) + \frac{g(\Delta t - t_0)^2}{2} \rightarrow 50 = v_{02}(3-1) + \frac{9.8 \cdot (3-1)^2}{2} \rightarrow v_{02} = 15.2\ \frac{m}{s}.$$

(c) What will the velocity v_1, v_2 of each stone be at the instant they hit the water?

$$v_1 = v_{01} + g\Delta t = 2 + 9.8 \cdot 3 = 31.4\ \frac{m}{s}.$$

$$v_2 = 15.2 + 9.8 \cdot (3-1) = 34.8\ \frac{m}{s}.$$

Answer. $\Delta t \approx 3\ s$; $v_{02} = 15.2 m/s$; $v_1 = 31.4\ \frac{m}{s}$; $v_2 = 34.8\ \frac{m}{s}$.