Answer on Question #42193, Physics, Mechanics | Kinematics | Dynamics

1. Water drips from the nozzle of a shower onto the floor 200 cm below. The drops fall at regular (equal) intervals of time, the first drop striking the floor at the instant the fourth drop begins to fall. Find the locations of the second and third drops when the first strikes the floor.

2. A parachutist bails out and freely falls 50 m. Then the parachute opens and thereafter she decelerates at 2.0 m/s². She reaches the ground with a speed of 3.0 m/s. How long is the parachutist in the air? At what height does the fall begin?

Solution:

1.

Given:

$h = 200$ cm $= 2$ m,

$S_2 = ?,$

$S_3 = ?$

Time taken for the first drop to reach the floor is

$$t_1 = \sqrt{\frac{2h}{g}}$$

As the time interval between the first and second drop is equal to that of the second and the third drop (drops dripping at regular intervals), time taken by the second drop is

$$t_2 = \frac{2t_1}{3}$$

and time taken by the third drop is

$$t_3 = \frac{t_1}{3}$$

therefore, distance travelled by the second drop is

$$S_2 = \frac{1}{2}gt_2{}^2 = \frac{1}{2}g\frac{4}{9}\frac{2h}{g} = \frac{4h}{9} = \frac{4 \cdot 200}{9} = 88.89 \text{ cm}$$

distance travelled by the third drop is

$$S_3 = \frac{1}{2}gt_3{}^2 = \frac{1}{2}g\frac{1}{9}\frac{2h}{g} = \frac{h}{9} = \frac{200}{9} = 22.22 \text{ cm}$$

Answer. 1. 2nd drop is 88.89 cm below the nozzle and 3rd drop is 22.22 cm below the nozzle.

2.

Solution:

Given:

$S = 50$ m,

$a_1 = -2$ m/s^2,

$v_2 = 3$ m/s,

$t = ?$,

$h = ?$

Time when she opens the chute is

$$t_1 = \sqrt{\frac{2S}{g}} = \sqrt{\frac{2 \cdot 50}{9.81}} = 3.193 \text{ s}$$

Speed at this distance:

$$v_1 = v_0 + gt = 0 + 9.81 \cdot 3.193 = 31.323 \text{ m/s}$$

Time to decelerate to 3m/s:

$$t_2 = \frac{v_2 - v_1}{a_1} = \frac{3 - 31.323}{-2} = 14.1615 \text{ s}$$

Total time is

$$t = t_1 + t_2 = 3.193 + 14.1615 \approx 17.35 \text{ s}$$

Distance fallen is

$$D = v_1 t_2 + \frac{1}{2} a_1 t_2^2 = 31.323 \cdot 14.1615 - \frac{1}{2} \cdot 2 \cdot 14.1615^2 \approx 243 \text{ m}$$

Total height is

$$h = S + D = 50 + 243 = 293 \text{ m}$$

Answer. 2. $t = 17.35$ s, $h = 293$ m.