Answer on Question #47614-Physics-Computational Physics

A spacecraft orbiting a planet goes out of control and starts falling towards a planet. The spacecraft falls $h_1 = 1200\ meters$ in the first $t_1 = 10\ seconds$ after which the retro-rocket fires and the craft starts to accelerate upwards at $a_2 = 0.5\ g$ 9(1 g = 9.81 m/s²)

a. How long after the rocket fires does the craft stop falling?

b. How much further does the craft fall before stopping?

c. How many seconds after the rocket fires does the craft reach its original point?

Solution

a. The spacecraft falls $h_1 = 1200\ meters$ in the first $t_1 = 10\ seconds$:

$$h_1 = \frac{a_1 t_1^2}{2} \rightarrow a_1 = \frac{2h_1}{t_1^2}.$$

The speed of spacecraft when the retro-rocket fires and the craft starts to accelerate upwards is

$$v_1 = a_1 t_1 = \frac{2h_1}{t_1^2} t_1 = \frac{2h_1}{t_1}.$$

The speed of spacecraft when it stoped

$$v_2 = 0 = v_1 - a_2 t_2 = \frac{2h_1}{t_1} - a_2 t_2 \rightarrow t_2 = \frac{2h_1}{t_1 a_2} = \frac{2 \cdot 1200}{10 \cdot 0.5 \cdot\ 9.81} = 48.9\ s.$$

b.

$$h_2 = v_1 t_2 - \frac{a_2 t_2^2}{2} = \frac{2h_1}{t_1} t_2 - \frac{a_2 t_2^2}{2} = \frac{2 \cdot 1200}{10} 48.9 - \frac{0.5 \cdot\ 9.81 \cdot 48.9^2}{2} = 5872\ m.$$

c.

$$h_1 + h_2 = \frac{a_2 t_3^2}{2} \rightarrow t_3 = \sqrt{\frac{2(h_1 + h_2)}{a_2}}.$$

The time when the craft reach its original point after the rocket fires is

$$t_2 + t_3 = t_2 + \sqrt{\frac{2(h_1 + h_2)}{a_2}} = 48.9\ + \sqrt{\frac{2(1200 + 5872)}{0.5 \cdot\ 9.81}} = 102.6\ s.$$

Answer: a. $\mathbf{8.9\ s}$; b. $\mathbf{5872\ m}$; c. $\mathbf{102.6\ s}$.