Answer on Question #60022, Physics – Mechanics | Relativity

A model rocket fired from the ground ascends with constant upward acceleration.

After 1.0 s from firing a small bolt is dropped from the rocket and after 5.0 s from firing, its fuel is then finished. The bolt strikes the ground after 2.0 s from the instant it was dropped. Acceleration due to gravity is g = 10 m/s^2.

(a) acceleration of the rocket while running on its fuel is 8.0 m/s^2

(b) rocket was at height 100 m above the ground when its fuel was finished.

(c) maximum speed of the rocket during its flight is 40 m/s

(d) total airtime of the rocket is 15 s

THE QUESTION IS HOW MANY STATEMENTS ARE TRUE?

CAN U PLEASE EXPLAIN IN DETAIL

Solution:

Equations for rocket:

$$h_1 = \frac{at_1^2}{2}$$

$$a = \frac{v_1}{t_1}$$

where initial velocity v_0 =0, t_1=1.0 s and a is acceleration.

Substituting we have

$$h_1 = \frac{v_1 t_1}{2}$$

Equations for bolt:

$$h = h_1 + v_1 t_2 - \frac{gt_2^2}{2}$$

where initial velocity v_1 , t_2=2.0 s and final h = 0.

We obtain system of equations:

$$\begin{cases} h_1 = \frac{v_1}{2} \\ h_1 + 2v_1 - 20 = 0 \end{cases}$$

$$\frac{v_1}{2} = 20 - 2v_1$$

$$v_1 = 8\frac{\text{m}}{\text{s}}$$

Thus,

$$a = \frac{v_1}{t_1} = \frac{8}{1} = 8\ \text{m/s}^2$$

(a) acceleration of the rocket while running on its fuel is 8.0 m/s^2 is **TRUE**

$$h_5 = \frac{at_5^2}{2} = 8 \cdot \frac{5^2}{2} = 100\ \text{m}$$

(b) rocket was at height 100 m above the ground when its fuel was finished is **TRUE**.

The maximum speed

$$v = at_5 = 8 \cdot 5 = 40 \text{ m/s}$$

(c) maximum speed of the rocket during its flight is 40 m/s is **TRUE**.

The airtime of the rocket after the fuel was finished

$$h = h_5 + v_5 t - \frac{gt^2}{2}$$

$$h_5 = 100 \text{ m}$$

$$v_5 = 40 \frac{\text{m}}{\text{s}}$$

$$h = 0$$

$$5t^2 - 40t - 100 = 0$$

$$t = 10 \text{ s}$$

Thus, the total time is

$$total\ time = t_5 + t = 5 + 10 = 15 \text{ s}$$

(d) total airtime of the rocket is 15 s is **TRUE**.

Output: **a, b, c, d are TRUE.**