Problem 2.53

A rocket is given 50 m/s of initial velocity with 2 m/s/s acceleration until it reaches 150 meters.

a.) What happens after the propulsion cuts out?

b.) What is the rocket's maximum height?

c.) How long does it take to maximum height?

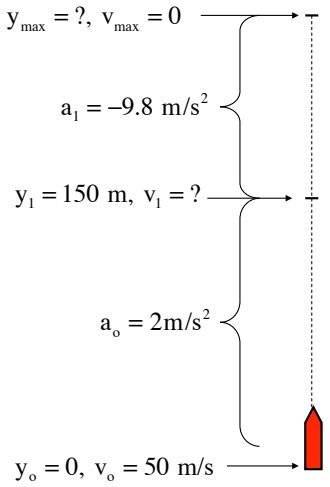
d.) How long is the rocket in the air?

A rocket is given 50 m/s of initial velocity with 2 m/s/s acceleration until it reaches 150 meters.

a.) What happens after the propulsion cuts out?

Gravity takes over do it continues upward slowing as it goes until it gets to its maximum height.

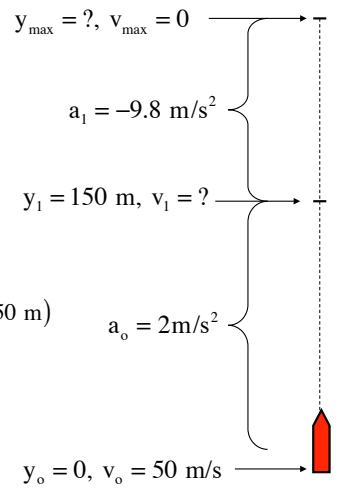
b.) What is the rocket's maximum height?



b.) What is the rocket's maximum height?

$$v_1^2 = v_o^2 + 2a_o\Delta y$$
$$\Rightarrow\ v_1^2 = (50\ m/s)^2 + 2(2\ m/s^2)(150\ m)$$
$$\Rightarrow\ v_1 = 55.7\ m/s$$

$$v_{max}^2 = v_1^2 + 2a_1\Delta y$$
$$\Rightarrow\ 0 = (55.7\ m/s)^2 + 2(-9.8\ m/s^2)(y_{max} - 150\ m)$$
$$\Rightarrow\ y_{max} = 308\ m$$

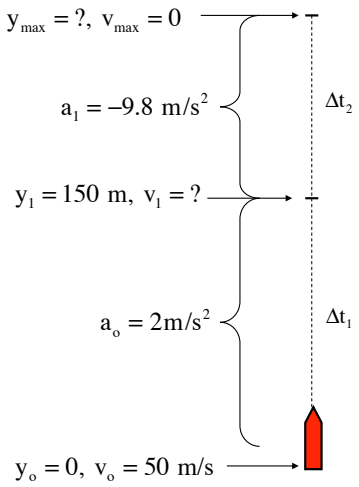


c.) How long does it take to maximum height?

$$a_o = \frac{v_1 - v_o}{\Delta t_1}$$
$$\Rightarrow\ (2\ m/s^2) = \frac{(55.6\ m/s) - (50\ m/s)}{\Delta t_1}$$
$$\Rightarrow\ \Delta t_1 = 2.8\ seconds$$

$$a_1 = \frac{v_{max} - v_1}{\Delta t_2}$$
$$\Rightarrow\ (-9.8\ m/s^2) = \frac{(0\ m/s) - (55.6\ m/s)}{\Delta t_2}$$
$$\Rightarrow\ \Delta t_2 = 5.7\ seconds$$

$$t_{total} = t_1 + t_2$$
$$= (2.8\ sec) + (5.7\ sec)$$
$$= 8.5\ seconds$$



d.) How long is the rocket in the air?

To freefall 308 meters under the influence of gravity:

$$y_o = y_{max} + v_{max}\Delta t_{down} + \frac{1}{2}a_1 \Delta t_{down}^{\ 2}$$

$$(0) = (308\ \text{m}) + (0)\Delta t_{down} + \frac{1}{2}(-9.8\ \text{m/s}^2)\Delta t_{down}^{\ 2}$$

$$\Rightarrow \quad \Delta t_{down} = 7.9 \text{ seconds}$$

$$t_{in\ air} = t_{up} + t_{down}$$

$$= (8.5 \text{ sec}) + (7.9 \text{ sec})$$

$$= 16.4 \text{ seconds}$$