Rocket has initial velocity of 35ms^{-1}. Acceleration is 5.0ms^{-2}. Engine break at high 20km. What the maximum height achieved by the rocket?

Solution.

$$v_i = 35\frac{m}{s}; a = 5.0\frac{m}{s^2};\ h_1 = 20km = 20 \cdot 10^3 m, g = 9.8\frac{m}{s^2};$$

$$h_{max} - ?$$

The height h_1 achieved by the rocket with the engine running:

$$h_1 = \frac{v_1^2 - v_i^2}{2a};$$

v_i - the initial velocity of the rocket;
v_1 – the final velocity of the rocket when it moved with the engine running;
a – the acceleration of the rocket.

$$v_1^2 = 2ah_1 + v_i^2.$$

The height h_2 achieved by the rocket without the engine running:

$$h_2 = \frac{v_2^2 - v_1^2}{-2g};$$

v_1 - the initial velocity of the rocket when the engine break;
$v_2 = 0$ – the final velocity of the rocket when it achieved the maximum high;
g – the gravity acceleration.

$$h_2 = \frac{0 - v_1^2}{-2g} = \frac{-v_1^2}{-2g} = \frac{v_1^2}{2g};$$

$$h_2 = \frac{2ah_1 + v_i^2}{2g}.$$

The maximum height achieved by the rocket:

$$h_{max} = h_1 + h_2;$$

$$h_{max} = h_1 + \frac{2ah_1 + v_i^2}{2g}.$$

$$h_{max} = 20 \cdot 10^3 m + \frac{2 \cdot 5.0\frac{m}{s^2} \cdot 20 \cdot 10^3 m + \left(35\frac{m}{s}\right)^2}{2 \cdot 9.8\frac{m}{s^2}} = 30267m.$$

Answer: The maximum height achieved by the rocket is $h_{max} = 30267m$.