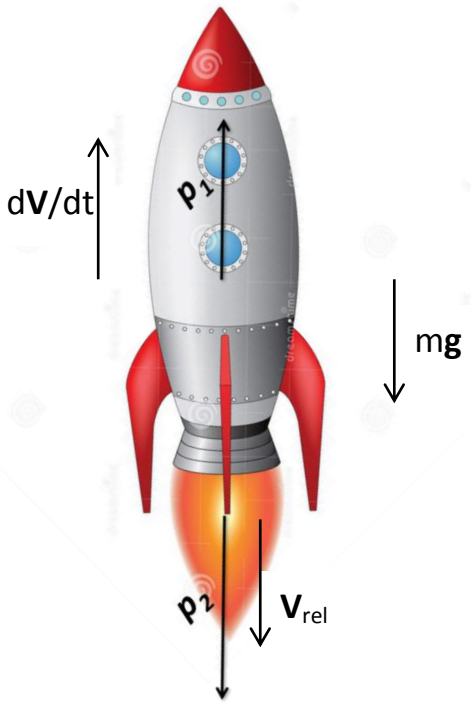
Answer on Question #44912, Physics, Mechanics | Kinematics | Dynamics

For a rocket propulsion velocity of exhaust gases relative to rocket is 2km/s.If mass of rocket system is 1000kg,then what is the rate of fuel consumption for a rocket to rise up with acceleration 4.9m/s^2?

Solution.



According to the general equation of variable-mass motion

$$\vec{F}_{ext} + \vec{V}_{rel}\frac{dm}{dt} = m\frac{d\vec{V}}{dt}$$

where F_{ext} is the net external force on the body, V_{rel} is the relative velocity of the escaping or incoming mass with respect to the center of mass of the body, and v is the velocity of the body (copypaste from Wikipedia)

In projection on the vertical axis:

$$-mg - V_{rel}\left(-\frac{dm}{dt}\right) = m\frac{dV}{dt}$$

The mass of the rocket is decreasing so $\frac{dm}{dt}$ term has negative sign.

$$\frac{dV}{dt} = a$$

So:

$$_{rel}\frac{dm}{dt} = m(a+g)$$

$$\frac{dm}{dt} = \frac{m(a+g)}{_{rel}}$$

Numerically:

$$\frac{dm}{dt} = \frac{1000kg \cdot (4.9\frac{m}{s^2} + 9.8\frac{m}{s^2})}{2000\frac{m}{s}} = 7.35\frac{kg}{s}$$

Answer:

$$\frac{dm}{dt} = 7.35\frac{kg}{s}$$