



$$\frac{dP}{dt} = \sum_i F_i$$

Foguete:  $p(t) = m(t) \cdot v(t)$

$$\frac{dp}{dt} = m \frac{dv}{dt} + v \frac{dm}{dt}$$

combustível:  $\frac{dp}{dt} = - \frac{dm}{dt} (v(t) - v_g)$

$v_g$  = velocidade que o combustível sai

$$\frac{dp}{dt} = \left( m \frac{dv}{dt} + v \frac{dm}{dt} \right) + \left( - \frac{dm}{dt} (v(t) - v_g) \right)$$

$$m \frac{dv}{dt} + \cancel{v \frac{dm}{dt}} - \cancel{v \frac{dm}{dt}} + v_g \frac{dm}{dt}$$

$$\frac{dP}{dt} = m \frac{dv}{dt} + v_g \frac{dm}{dt}$$

$$\sum F = -m(t)g - b v(t)^2$$

$$\frac{dP}{dt} = \sum_i F_i$$

$$-m(t)g - b v(t)^2 = m \frac{dv}{dt} + v_g \frac{dm}{dt}$$

$$m(t) \frac{dv}{dt} = - v_g \frac{dm}{dt} - b v(t)^2 - m(t)g$$

$$\frac{dv}{dt} = \frac{-V_g}{m(t)} \frac{dm}{dt} - \frac{b}{m(t)} v(t)^2 - g$$

MASSA DE COMBUSTÍVEL

$$m_c(t) = m_c(0) - Z(t)$$

$$Z(t) = 0,9 t^n$$

ou

MASSA DE COMBUSTÍVEL

$$m_c(t) = m_c(0) e^{-\frac{t}{n}}$$

MASSA total:  $m(t) = m_{\text{Foguete}} + m_c(t)$

$$\lim_{t \rightarrow \infty} m(t) = m_{\text{Foguete}}$$

$$m(t) = m_F + m_c(0) e^{-\frac{t}{n}}$$

$$\frac{dv}{dt} = \frac{-V_g}{m(t)} \frac{d}{dt} m(t) - \frac{b}{m(t)} v(t)^2 - g$$