Equations

Total Impulse Thrust force integrated over the time of application.

$$I_t = \int_0^t F\,dt \tag{1}$$

Specific Impulse: Thrust per unit propellant 'weight' flow rate.

$$I_S = \frac{\int_0^t F\,dt}{g_0 \int_0^t \dot{m}\,dt} = \frac{I_t}{w} \tag{2}$$

Total Propellant Weight:

$$w = m_p g_0 \tag{3}$$

Weight Flow Rate:

$$\dot{w} = \dot{m}_p g_0 \tag{4}$$

Effectice Exhaust Velocity: An average or mass-equivalent velocity at which propellant is being ejected from the nozzle.

$$c = I_S g_0 = \frac{F}{\dot{m}} = v_2 + (p_2 - p_3)\frac{A_2}{\dot{m}} \tag{5}$$

Characteristic Velocity: Compares relative performance of different chemical rocket propulsion systems. Essentially independent of nozzle characteristics. Can be related to the efficiency of the combustion process.

$$c = I_S g_0 = \frac{F}{\dot{m}} = v_2 + (p_2 - p_3)\frac{A_2}{\dot{m}} \tag{6}$$

Mass Ratio: Ratio of the final mass over the initial mass.

$$\mathbf{MR} = \frac{m_f}{m_0} \tag{7}$$

Propellant Mass Fractio: Ratio of the usefull propellant mass to the intitial mass.

$$\zeta = \frac{m_p}{m_0} = \frac{(m_0 - m_f)}{m_0} = \frac{m_p}{(m_p + m_f)} \tag{8}$$

Impulse-to-Weight Ratio: The total impulse divided by the initial propellant-loaded vehicle sea-level weight.

$$\frac{I_t}{w_o} = \frac{I_t}{(m_f + m_p)g_0} = \frac{I_S}{\frac{m_f}{m_p} + 1} \tag{9}$$

Symbols

I_t	Total Impulse	N $\cdot$ s
I_S	Specific Impulse	s
m_p	Total Effective Propellant Mass	kg
w	Effectice Propellant Weight	N
$\dot{m}$	Total Mass Flow Rate	kg / s
$\dot{w}$	Weight Flow Rate	N / s
g_0	Earth's Average Gravity	kg / s^2
c	Effectice Exhaust Velocity	m / s
MR	Mass Ratio	Unitless
m_f	Final Mass	kg
m_0	Initial Mass	kg
ζ	Propellant Mass Fraction	Unitless
I_t / w_0	Impulse-to-Weight Ratio	s