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or exhaust velocity w.r.t rocket = V_e
Specific Impulse = I_{sp}

$$I_{sp} = \frac{F}{\frac{dm}{dt} \times g}$$

$$\Delta V = I_{sp}\, g_0 \ln\left[\frac{m_0}{m_f}\right]$$

$$V_f - V_i = I_{sp} \times g \times \ln \frac{m_0}{m_0 - mt}$$

$\therefore V_i = 0$

$$V_f = I_{sp} \times g_0 \times \ln \frac{m_0}{(m - m_0 t)}$$

for velocity with minimum thrust

$$(V_e)_f = \frac{3}{4}V - \frac{V_e}{4}$$

$$I_{sp} = \frac{F_{th}}{\frac{dm}{dt}}$$

$$\Rightarrow \frac{dm}{dt} = \frac{F_{th}}{I_{sp}}$$

$$F_{th} = \frac{m\Delta v}{\Delta t}$$

$$= \frac{m((v_e)_f - (v_e)_i)}{\Delta t}$$

$$= \frac{m\left(\frac{3}{4}v - \frac{5}{4}v_e\right)}{\Delta t}$$

$$\Rightarrow \frac{dm}{dt} = \frac{m\left(\frac{3}{4}v - \frac{5}{4}v_e\right)}{\Delta t \times I_{sp}}$$

$$= m$$

$v_f = v_i + (v_{rel})_i$

$\Rightarrow v_i = \frac{3}{4}v - \frac{v_e}{4}$

$\frac{3}{4}v$ $v_i \Rightarrow$

for collision not to take place

$v_i < (v_e)_f$

$= \frac{3}{4}v - \frac{1}{4}v_e < (v_e)_f$

$\Rightarrow \frac{2v}{5} < (v_e)_f$

minimum value of $v_e = \frac{2}{5}v$

$I_{sp} = \frac{F_{thrust}}{dm/dt}$

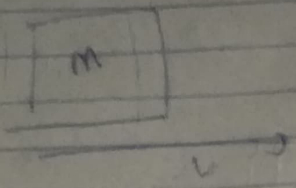
$\Rightarrow F_{thrust} = I_{sp} \frac{dm}{dt}$

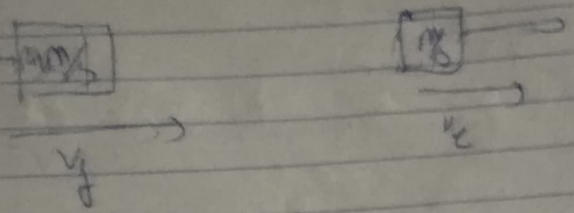
$F_{Th} = \frac{m\Delta v}{\Delta t}$

$\frac{m(v_{ef} - v_{ei})}{\Delta t}$

$= \frac{m_2(\frac{3}{5}v - v_e)}{\Delta t}$

$\Rightarrow \frac{dm}{dt} = \frac{m(\frac{3}{5}v - v_e)}{}$

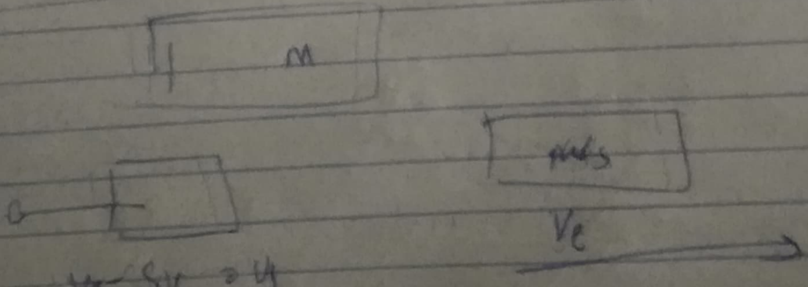




$$\frac{m}{5}v_e + \frac{4}{5}mv_g = mv$$

$$\Rightarrow \frac{mv_e - 5mv}{5} = -\frac{4}{5}mv_g$$

$$\Rightarrow \frac{v_e - 5v}{4} = v_g$$



$$\frac{v_e - 5v}{4} = v_g$$