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Q2

exhaust velocity wrt rocket = V_e

specific impulse $\Rightarrow I_{sp}$

fuel burnout time $\Rightarrow t_b$

$$I_{sp} = F_{thrust} / \left[\left(\frac{dm}{dt}\right) g_0\right]$$

$$\Delta V = I_{sp} \times g_0 \ln\left[\frac{M_0}{M_f}\right]$$

$$V_f - V_i = I_{sp} \times g_0 \times \ln\left[\frac{M_0}{M_0 - M_t}\right] \quad -①$$

~~$V_f - V_i = V_e \ln \frac{M_f}{M_0}$~~

$$V_e \ln\left[\frac{M_f}{M_0}\right] = I_{sp} \times g_0 \times \ln\left[\frac{M_0}{M_f}\right]$$

~~$[V_e = (I_{sp} g_0)] \ln M_f = (I_{sp} g_0 - M_0)$~~

$$V_e = -I_{sp} g_0$$

Since $V_i = 0$

$$V_f = I_{sp} \times g_0 \times \ln\left[\frac{M_0}{M_0 - M_{at}}\right]$$

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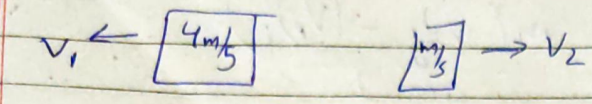
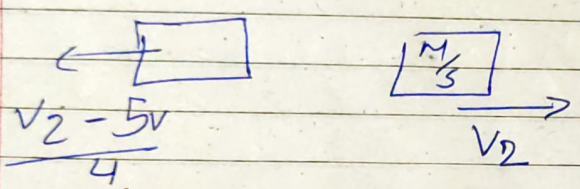
Q3



$$\frac{M}{5}V_2 - \frac{4}{5}MV_1 = MV$$

$$\frac{MV_2 - 5MV}{5} = \frac{4}{5}MV_1$$

$$V_1 = \frac{V_2 - 5V}{4}$$



$$V_d + V_2 = \text{Konstant}$$

$$V_d = \frac{7}{4}V - \frac{V_2}{4}$$

~~For collision m,~~

For not collision, $V_d \leq (V_2)_f$

$$\Rightarrow \frac{7}{4}V - \frac{V_2}{4} \leq (V_2)_f$$

$I_{sp} = F_{thrust} / \left(\frac{dm_g}{dt}\right)$

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

$$\frac{dm}{dt} = \frac{m\,dv}{I_{sp}\,dt}$$

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$$F_{thrust} = \frac{m\left((V_2)_f - (V_2)_i\right)}{\Delta t}$$

$$\boxed{\frac{dm}{dt} = \frac{m\left(\frac{7}{4}V - \frac{5}{4}V_2\right)}{\Delta T \; I_{sp}}}$$