Answer

We will be using three main formulae

$$\Delta V = I_{sp} g_o \log \frac{M_i}{M_o} = I_{sp} g_o \log MR$$ --- B

$$\xi = \frac{M_p}{M_i} = \frac{MR - 1}{MR}$$ ------C

$$\frac{M_{pl}}{M_i} = 1 - \frac{\xi}{\lambda}$$----------D

where

$$\lambda = \frac{M_p}{M_s + M_p}$$

M_i = M_pl + M_s + M_p

Now

$\Delta V_T = \Delta V_1 + \Delta V_2$ and both are equal

so $\Delta V_1 = \Delta V_2 = \Delta V_T/2 = 5000 \quad ft/s$

Now using relation B

$$MR = e^{\frac{\Delta V}{I_{sp} g_0}}$$

using go = 32.152 ft/s^2

so

MR_1 = 1.77885

MR_2 = 1.55943

Now using relation C

$$\xi_1 = 0.437839$$

$$\xi_2 = 0.35874$$

Using relation D

$$\frac{M_{pl1}}{M_{i1}} = 0.513512$$

$$\frac{M_{pl2}}{M_{i2}} = 0.551575$$

Now we know Mpl2 = Mpl = 500 lb

so we get

Mi2 = 500 / 0.551575 -- > **M_i2= 906.495 lb**

Now

M_pl1 = Mi2 + M_inter_stage = 906.495 + 200 = 1106.495 lb

so

Mi1 = Mpli1 / 0.513512 -- > **Mi1 = 2154.76 lb**

Now using propellan tfraction we have

$$M_{p1} = \xi_1 M_{i1}$$

$$= 0.437839 \times 2154.76 = 943.438 \quad lb$$

$$M_{p2} = \xi_2 M_{i2}$$

$$= 0.35874 \times 906.495 = 325.196 \quad lb$$

using definition of lambda we have

$$\lambda = \frac{M_p}{M_s + M_p}$$

$$\frac{1}{\lambda} = \frac{M_s + M_p}{M_p}$$

$$\frac{1}{\lambda} = 1 + \frac{M_s}{M_p}$$

$$\frac{M_s}{M_p} = \frac{1}{\lambda} - 1$$

so we have

$$M_s = M_p(\frac{1}{\lambda} - 1)$$

Ms1 = 104.826 lb

Ms2 = 81.299 lb

Please note small difference in values is due to differene in value of g , kindly use your g in above methdo

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