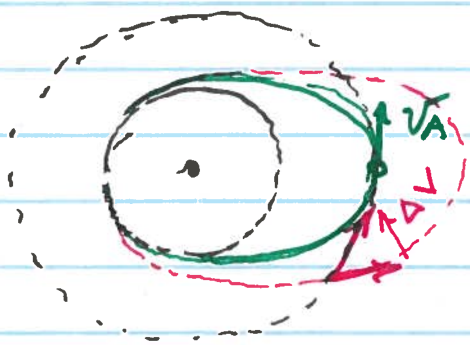
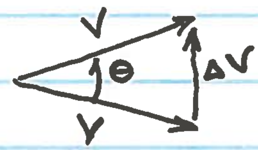
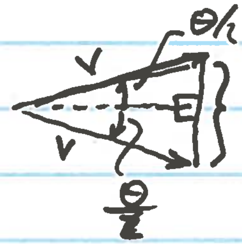
0) charlesNorto NASA

1) Project

2) Hohmann Transfers

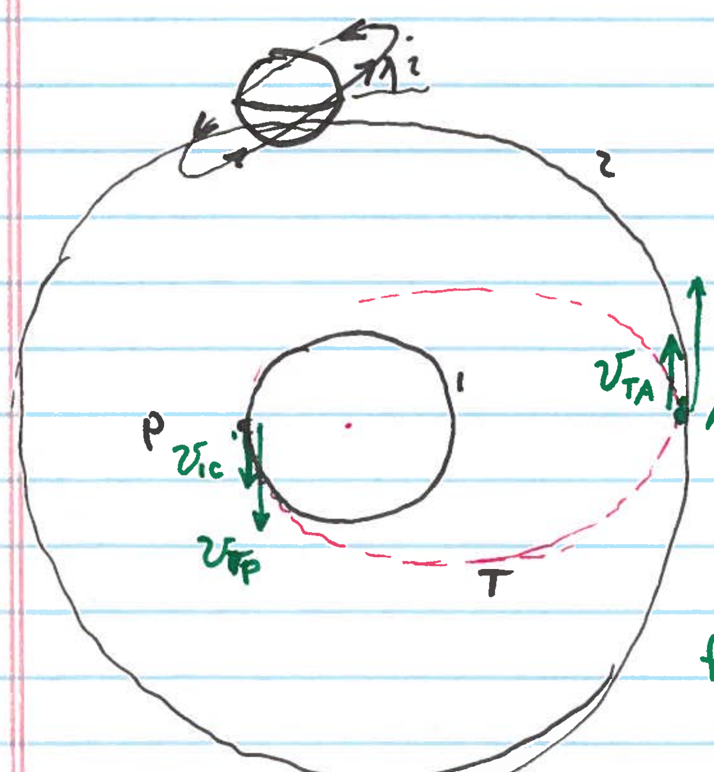






$\Delta V = 2V\sin\left(\frac{\theta}{2}\right)$

$\theta = 60 \Rightarrow \Delta V = 2V\underbrace{\sin(30)}_{0.5} = V$



$\Delta V_p = v_{Tp} - v_{Ep}$

$v_{2circ} = v_{CA}$

$\Delta V_A = v_{2circ} - v_{TA}$

Minimum ~~Enger~~ Energy for 2-Burn transfer

$$r(\theta) = \frac{h^2}{\mu(1+e\cos\theta)}$$

$$r_p = \frac{h^2}{\mu(1+e)} \qquad r_a = \frac{h^2}{\mu(1-e)}$$

$$\frac{r_a}{r_{ap}} = \frac{\left(\frac{h^2}{\mu(1-e)}\right)}{\left(\frac{h^2}{\mu(1+e)}\right)} = \frac{(1+e)}{(1-e)}$$

$$h = h_p = \underbrace{v_p r_p} = v_a r_a$$

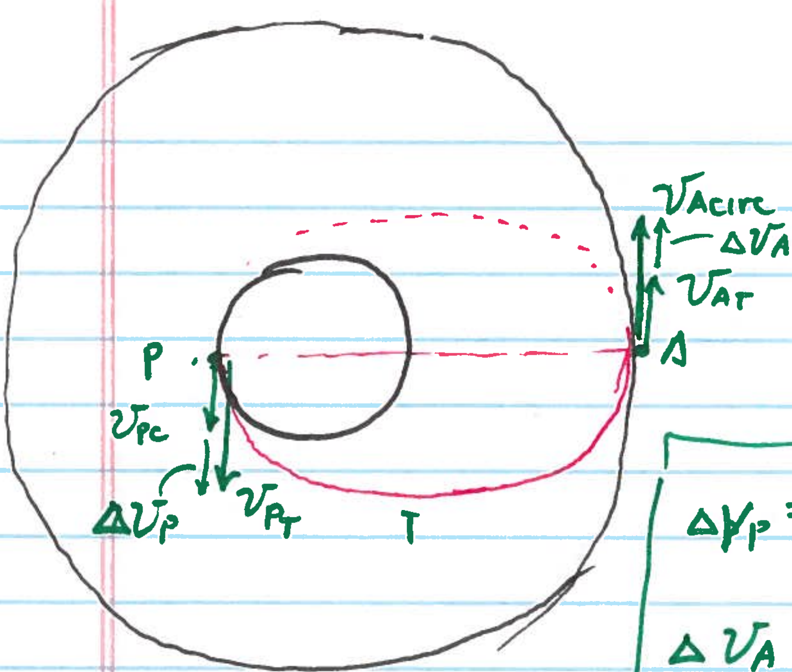
$$v_p = \frac{\mu}{h}(1+e)$$

$$v_p = \frac{\mu}{v_p r_p}(1+e)$$

$$r_p v_p^2 = \frac{\mu(1+e)}{} \Rightarrow e = \frac{r_p v_p^2}{\mu} - 1$$

$$\Rightarrow \boxed{v_p = \sqrt{\frac{2\mu r_a}{r_p(r_p+r_a)}}} \qquad r_a = r_p \quad v_{p\,circ} = \sqrt{\frac{\mu}{r_p}}$$

$$\boxed{v_a = \sqrt{\frac{2\mu r_p}{r_a(r_p+r_a)}}} \qquad v_{a\,circ} = \sqrt{\frac{\mu}{r_a}}$$

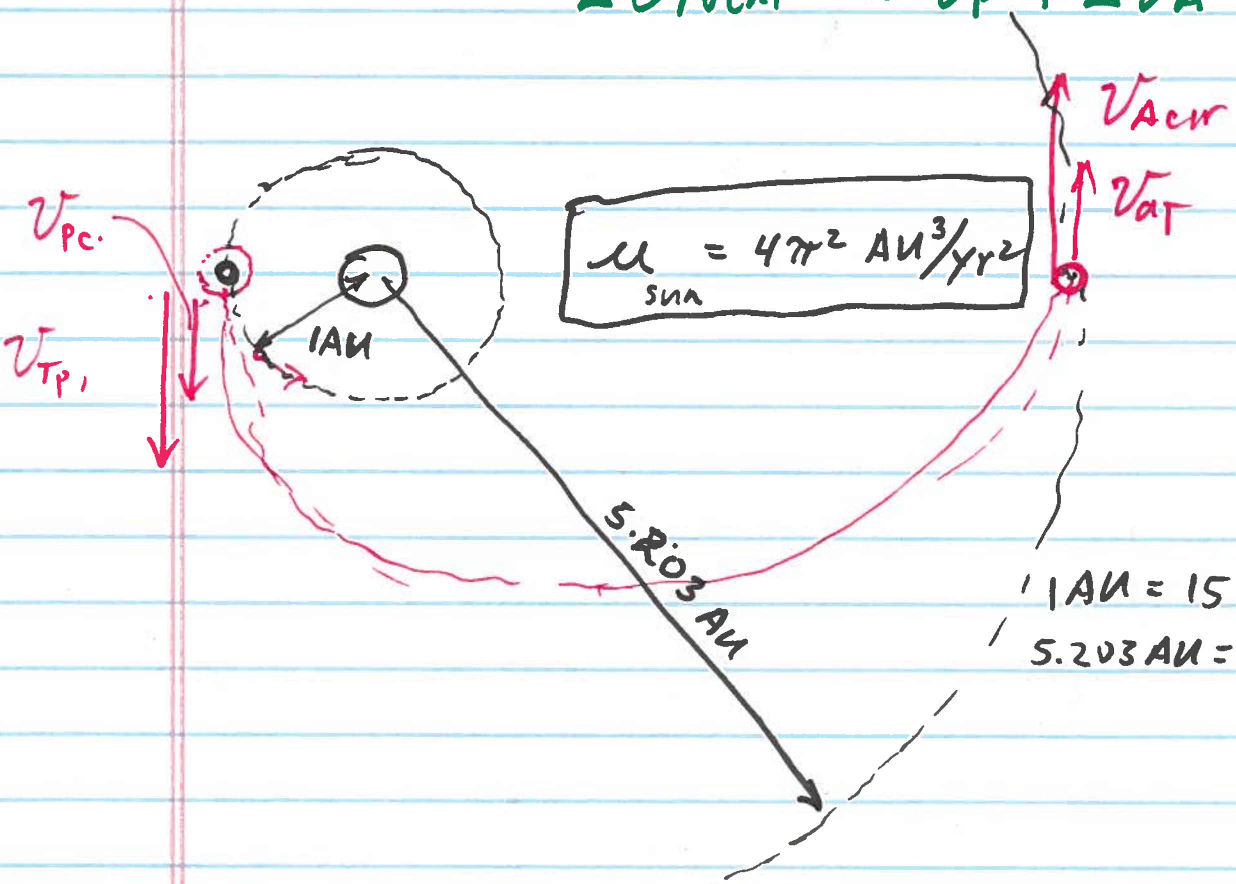


$$\Delta v_P = v_{P_T} - v_{Pcirc}$$

$$\Delta v_A = v_{Acirc} - v_{A_T}$$

$$\boxed{\begin{aligned} \Delta v_P &= \sqrt{\frac{2\mu r_a}{r_p(r_a+r_p)}} - \sqrt{\frac{\mu}{r_p}} \\ \Delta v_A &= \sqrt{\frac{\mu}{r_a}} - \sqrt{\frac{2\mu r_p}{r_a(r_p+r_a)}} \end{aligned}}$$

$$\Delta v_{Total} = \Delta v_P + \Delta v_A$$



$$\boxed{\mu_{sun} = 4\pi^2\ AU^3/yr^2}$$

1AU = 152.1×10^6 Km

5.203 AU = 815.7×10^6 Km

$$\Delta V_{TOTAL} = \Delta V_p + \Delta V_A$$

$$\Delta V_p = \sqrt{\frac{2\mu r_a}{r_p(r_p + r_a)}} - \sqrt{\frac{\mu}{r_p}}$$

$$r_p = 152.1 \times 10^6 \text{ Km} = 1 \text{ AU}$$

$$\mu_{sun} = 4\pi^2 \, (\text{AU})^3/\text{yrs} = 1.327 \times 10^{11} \text{ Km}^3/\text{s}^2$$

$$r_a = 5.203 \text{ AU} = 815.7 \times 10^6 \text{ Km}$$

$$\Delta V_p = \sqrt{\frac{2\mu_{sun}(815.7 \times 10^6)}{(152.1 \times 10^6)[152.1 + 815.7] \times 10^6}} - \sqrt{\frac{\mu_s}{152.1 \times 10^6}} = \underline{\underline{8.8121}} \text{ Km/s}$$

$$\Delta V_A = \sqrt{\frac{\mu}{r_a}} - \sqrt{\frac{2\mu_{sun} r_p}{r_A(r_p + r_A)}}$$

$$= 5.604 \text{ Km/s}$$

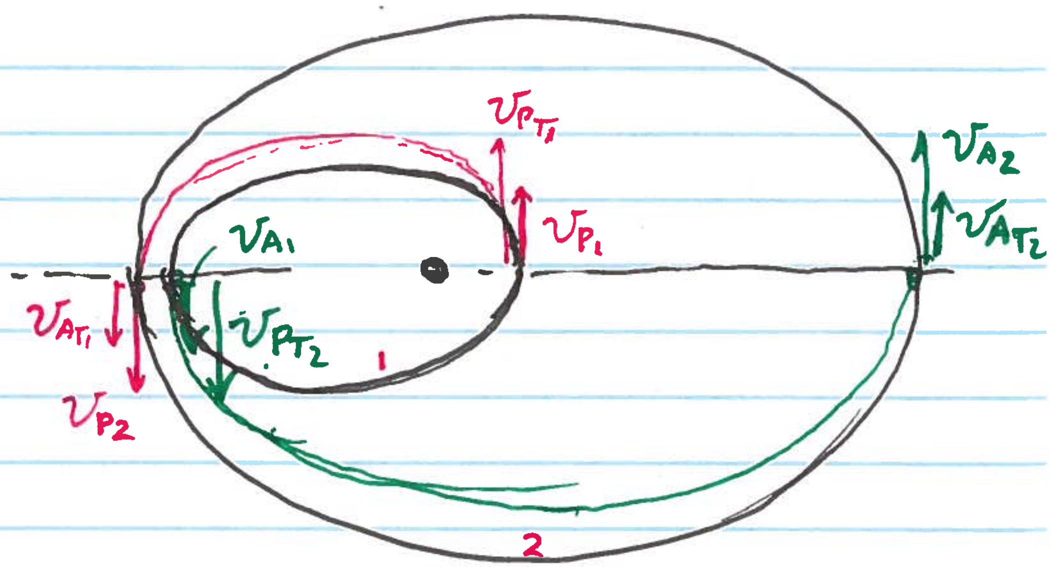
$$\Delta V_{Total} = 8.812 + 5.604 = ?$$

$$a = \frac{r_p + r_a}{2}$$

$$\tau_{Ellipse} = 2\pi \sqrt{\frac{a^3}{\mu}}$$

$$\tau_{Trans} = \pi \sqrt{\frac{a^3}{\mu}} = \pi \sqrt{\frac{(r_p + r_a)^3}{8\mu}} = 9.18 \times 10^7 \text{ SEC}$$

$$= 2.909 \text{ Year}$$



CASE #1

$$\Delta V_{TOTAL} = \Delta V_{P_{T_1}} + \Delta V_{A_{T_1}}$$
$$= [v_{P_{T_1}} - v_{P_1}] + [v_{P_2} - v_{AT_1}]$$

CASE #2

$$\Delta V_{TOTA} = \Delta V_{P_{T_2}} + \Delta V_{A_{T_2}}$$
$$= [v_{PT_2} - v_{A_1}] + [v_{A_2} - v_{AT_2}]$$