1. $r_1 = 36800 + 6400 = 42200 \text{ km}$

$= 4.22 \times 10^7 \text{ m}$

$r_2 = 6400 + r$

$a = \frac{(r_1 + r_2)}{2}$

For circular orbit

$$\frac{m v_0^2}{\cancel{r}} = \frac{G m m_e}{r^{\cancel{2}}}$$

$$v_0 = \sqrt{\frac{G m_e}{r}}$$

$$v_{initial} = \sqrt{\frac{G m_e}{r_1}}$$

Elliptical

$$\frac{1}{2}\cancel{m} v_f^2 - \frac{G \cancel{m} m_e}{r_2} = \frac{-G \cancel{m} m_e}{2a}$$

$$v_f = 2\sqrt{\left[\frac{1}{r_2} - \frac{1}{r_1 + r_2}\right] G m_e}$$

$$= 2\sqrt{\frac{r_1 (G m_e)}{(r_1 + r_2) r_2}}$$

change required $\Delta v = |v_f - v_i|$

Case-1: $r_2 = 6800 \text{ km} = 6.8 \times 10^6 \text{ m}$

$a = 24500 \text{ km} = 2.45 \times 10^7$

$v_0 = 3079.51 \text{ m/s}$

$v_f = 10068.32 \text{ m/s}$

$\Delta V = 6988.81 \text{ m/s}$

case-2: $r_2 = 42450\,km$
$= 4.245 \times 10^7\,m$
$a = 42325\,km = 4.2325 \times 10^7\,m$
$v_0 = 3079.51\,m/s$
$v_f = 3065.89\,m/s$
$\Delta v = 13.62\,m/s$

2nd transfer is preferable because the change required for 2nd transfer is less.

2

$$L_1 = \left(R\left[1-\left(\frac{m_2}{3m_1}\right)^{1/3}\right], 0\right)$$

$$= 1.5\times10^{11}\left[1-\left(\frac{5.972\times10^{24}}{\frac{1.989\times10^{30}}{3}}\right)\right]^{1/3}$$

$$= 1.485\times10^{11}$$

$$L_1 = \{1.485\times10^{11}, 0\}$$

$$L_2 = \left(R\left[1+\left(\frac{m_2/m_1}{3}\right)^{1/3}\right], 0\right)$$

$$= \left[1.5\times10^{11}\left[1+\left(\frac{5.972\times10^{24}}{3\times1.989\times10^{30}}\right)^{1/3}\right], 0\right]$$

$$= [1.515\times10^{11}, 0]$$

$$L_3 = \left(-R\left(1+\frac{5}{12}\frac{m_2}{m_1}\right), 0\right)$$

$$= \left[-1.5\times10^{11}\left(1+\frac{5}{12}\times3\times10^{-6}\right), 0\right]$$

$$\approx -1.5\times10^{11}$$

3. shows we can acheive large ΔV by using gravity of other planet. Without help of planet it may require high fuel for required change