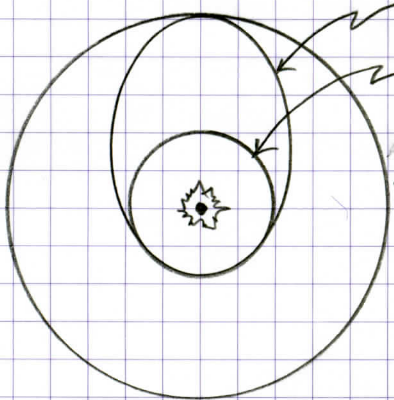
TM5 Pr 8.38

Calculate the minimum Δv needed to place an object in Earth's orbit into the orbit of Venus. How long would the trip take?



For a Hohmann transfer, the first burn must slow the object from v_E to $v_{aphelion}$

$$\Delta v_1 = v_⊕ - v_A$$

$$\Delta v_1 = \sqrt{\frac{GM_\odot}{r_⊕}} - \sqrt{\frac{2GM_\odot}{r_⊕}\left(\frac{r_♀}{r_♀ + r_⊕}\right)}$$

$$= \sqrt{\frac{GM_\odot}{r_⊕}}\left(1 - \sqrt{\frac{2r_♀}{r_♀ + r_⊕}}\right)$$

$$= \sqrt{\frac{(6.67\times10^{-11})(1.989\times10^{30})}{1.495\times10^{11}}}\left(1 - \sqrt{\frac{2(1.081)}{1.081 + 1.495}}\right)$$

$$\underline{\Delta v_1 = 2499 \frac{m}{s}}$$

The second burn slows the object to Venus' speed

$$\Delta v_2 = v_P - v_♀$$

$$= \sqrt{\frac{GM_\odot}{r_♀}}\left(\sqrt{\frac{2r_⊕}{r_♀ + r_⊕}} - 1\right)$$

$$= \sqrt{\frac{(6.67\times10^{-11})(1.989\times10^{30})}{1.081\times10^{11}}}\left(\sqrt{\frac{2(1.495)}{1.081+1.495}} - 1\right)$$

$$\underline{\Delta v_2 = 2701 \frac{m}{s}} \Rightarrow \boxed{\Delta v_{TOT} = \Delta v_1 + \Delta v_2 = 5200 \frac{m}{s}}$$

HOW LONG WOULD THE TRIP TAKE?

$$t_{TRANSFER} = \frac{1}{2} P_{TRANSFER} \qquad a_T = [(1.081 + 1.495) \times 10^{11}]\,0.5 =$$

$$= \frac{1}{2}\sqrt{\frac{\pi^2 a_T^3}{G M_\odot}} = \frac{1}{2}\sqrt{\frac{\pi^2 [(a_♀ + a_⊕)/2]^3}{G M_\odot}}$$

$$= \frac{1}{2}\sqrt{\frac{\pi^2 [(1.081 + 1.495) \times 10^{11}/2]^3}{(6.67 \times 10^{-11})(1.989 \times 10^{30})}}$$

$$= \frac{1}{2}(1.262 \times 10^7 \text{ sec}) = 6.31 \times 10^6 \text{ s}$$

$$= 1753.2 \text{ HR} = \boxed{73 \text{ DAYS} = t_{TRANSFER}}$$