13 − 117

~~for circular orbit $e = 1$~~

~~$$e = \frac{Ch^2}{GM_e}$$~~

~~in this case we have Mars.~~

~~$$M_e \rightarrow M_{mars} = 0.1074 M_e$$~~

~~$$1 = \frac{Ch^2}{66.73 \times 10^{-12}, 0.1074(5.976 \times 10^{24})}$$~~

For parabolic orbit

$$V_e = \sqrt{\frac{2GM_{mars}}{r_0}}$$

$$\frac{10 \times 10^6}{3600} = \sqrt{\frac{2(66.73 \times 10^{-12})(0.1074 \times 5.976 \times 10^{24})}{r_0}}$$

$$\Rightarrow r_0 =$$

now at r_0, spacecraft is injected into circular orbit

$$V_c = \sqrt{\frac{GM_{mars}}{r_0}}$$

$$= \sqrt{\frac{(66.73 \times 10^{-12})(0.1074 \times 5.976 \times 10^{24})}{\square}}$$

$$V_c =$$

This is the velocity that must be implemented at r_0 from Mars and maintained to have a circular orbit. In practise how would you do this.

13-122

$r_0 = r_p = 4000\ mi = (4000)(5280)\ ft.$

So we need free flight speed at perigee (or periapsis)

$$r_a = \frac{r_0}{\frac{2GM_e}{r_0 V_0^2} - 1} = \frac{r_p}{\frac{2G(0.6M_e)}{r_p V_p^2} - 1}$$

$$V_p = \left\{ \left(\frac{r_p}{r_a} + 1 \right) \left[\frac{r_p}{2G(0.6M_e)} \right] \right\}^{-1/2}$$

$$V_p = \left(\frac{4000}{10000} + 1\right)\left[\frac{4000(5280)}{2(34.4\times10^{-9})(0.6)(409\times10^{21})}\right]^{-1/2}$$

$=$

ft/s.

13-123

To find free-flight speed at apoapsis, same process as above, but $r_0 = r_p = 2000$ mi

- Next V_p
- Next: from eccentricity formula

$$h = r_0 V_0 = r_p V_p = r_a V_a$$

so we get V_a or speed at A'

Time elapsed from A' to B ?

we have constant acceleration because we are in free flight.

Students see how you can use Equations of motion to figure this out.

Alternately we can use the Period T formula. T is the time for 1 orbit. ~~From~~

$$T = \frac{\pi}{h}(r_p + r_a)\left(\sqrt{r_p r_a}\right)$$

from A' to B is half of an orbit

$$\frac{T}{2} = \frac{\pi}{2h}(r_p + r_a)\sqrt{r_p r_a}$$

In general to find time to some point of an ellipse, find the corresponding area and its proportion with regard to total ellipse area, the adjust the period T formula accordingly

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$v_p = 25 \ Mm/h$ $\quad V_a = 15 \ Mm/h$

$r_p = ?$ $\quad r_a = 6378 \ Km + 18 \ Mm$

$= 24.378 \ Mm$

$h = r_p V_p = r_a V_a$

$25 \, r_p = 24.378 (15) =$

$r_p = \quad Mm$

Period, $T = \frac{\pi}{h}(r_p + r_a)\sqrt{r_p r_a}$

from our data, answer will be in hours.