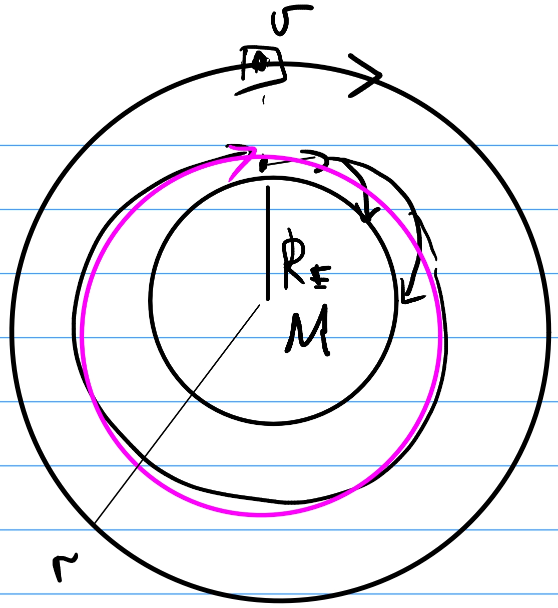


$$\sum \vec{F} = m\vec{a}$$

$$G\frac{\cancel{m}M_E}{r^2} = \cancel{m}\frac{v^2}{r}$$

$$v = \sqrt{\frac{GM_E}{r}} =$$

$$= \sqrt{\frac{6.67\cdot 10^{-11}\cdot 6\cdot 10^{24}}{6.4\cdot 10^{6}}} \simeq$$

$$= \sqrt{\frac{6.67\cdot 6}{6.4}\cdot 10^{7 = 6+1}}$$

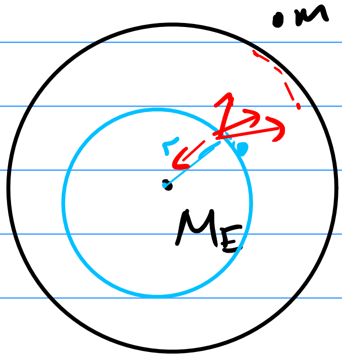
$$= \sqrt{\frac{66.7}{6.4}\cdot 10^{6}} =$$

$$= \sqrt{\frac{66.7}{6.4}}\cdot 10^{3}\ \frac{m}{s}$$

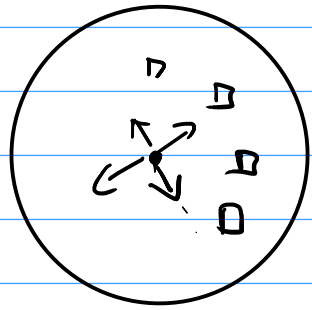
$$\simeq 8\cdot 10^{3}\ m/s$$

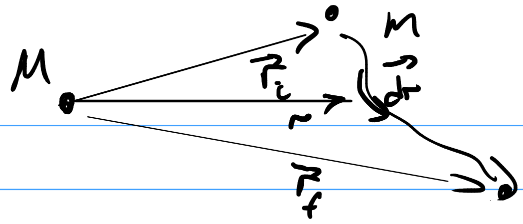
$R_E = 6.4\cdot 10^{6}\ m$

$h = 100\ km = 10^{5}$



$$F_g = G\frac{M \cdot m}{r^2}$$





$$W_g = \int_{\vec r_i}^{\vec r_f} \vec F_g \, d\vec r =$$

$$= \int_{\vec r_i}^{\vec r_f} \frac{GMm}{r^2} \cdot \hat r \cdot d\vec r = \int_{r_i}^{r_f} \frac{GMm}{r^2} (-1)\, dr$$

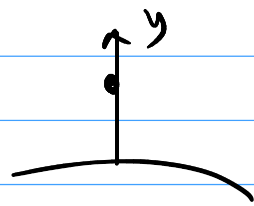
element of path

distance change

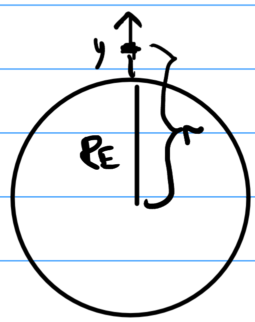
$$= -\frac{GMm}{1} \int_{r_i}^{r_f} \frac{dr}{r^2} = -\frac{GMm}{1}\left(-\frac{1}{r}\Big|_{r_i}^{r_f}\right)$$

$$= -\left(\frac{GMm}{r_f} - \left(-\frac{GMm}{r_i}\right)\right)$$

$$= -(U_f - U_i)$$



$$\boxed{U(r) = -\frac{GMm}{r}} \iff mgy$$



$$U(r) = U(R_E + y) =$$

$$= -\frac{GMm}{r} = -\frac{GMm}{R_E + y}$$

$$= -\frac{GMm}{R_E} \frac{1}{\left(1 + \frac{y}{R_E}\right)} = \left| \frac{y}{R_E} = x \ll 1 \right|$$

$$= -\frac{GMm}{R_E}\left(\frac{1}{1+x}\right) \approx -\frac{GMm}{R_E}(1 - x)$$

$$= -\frac{GMmR_E}{R_E \cdot R_E}\left(1 - \frac{y}{R_E}\right) = -mg\left(R_E - \frac{yR_E}{R_E}\right)$$

$mg =$

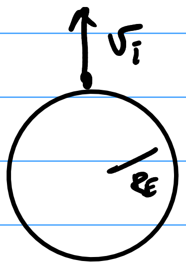
familiar

$$U(y) = -mg + mg \cdot y \qquad \text{iff} \quad y \ll R_E$$

constant

$$\Delta E = 0 = \Delta K + \Delta U$$

$\uparrow v_f = 0$



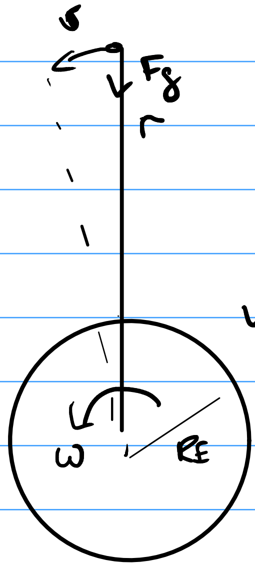
$$E_i = E_f$$

$$\underbrace{\frac{m v_i^2}{2}}_{K} - \underbrace{\frac{GMm}{r_i}}_{U} = K + U = \frac{m \cancel{v_f}^2}{2} - \cancel{\frac{GMm}{r_f}}$$

$v_f \to 0$, $r_f = \infty$, $\to 0$

$$\frac{\cancel{m} v_i^2}{2} - \frac{GM\cancel{m}}{r_i} = 0, \quad r_i = R_E$$

$$v_i = v_{\text{escape velocity}} = \sqrt{\frac{2GM_E}{R_E}} \simeq 12 \frac{km}{s}$$



$$\frac{\cancel{m} v^2}{r} = G\frac{M\cancel{m}}{r^2}$$

$$v = \frac{2\pi r}{T} = \omega r, \quad \frac{2\pi}{T} = \omega$$

$$\frac{\omega^2 r^2}{r} = \frac{GM}{r^2}$$

$$\omega^2 = \frac{GM}{r^3}$$

$$\omega^2 = \left(\frac{2\pi}{24 \cdot 3600}\right)^2 = \frac{GM}{r^3} \Rightarrow r_{geostat.}$$

$$\omega^2 = \frac{G \cdot M}{r^3} = \left(\frac{2\pi}{T}\right)^2 =$$

$$\frac{G \cdot M}{(2\pi)^2} \cdot T^2 = r^3 \Rightarrow \boxed{r^3 \sim T^2}$$

3rd Kepler's law