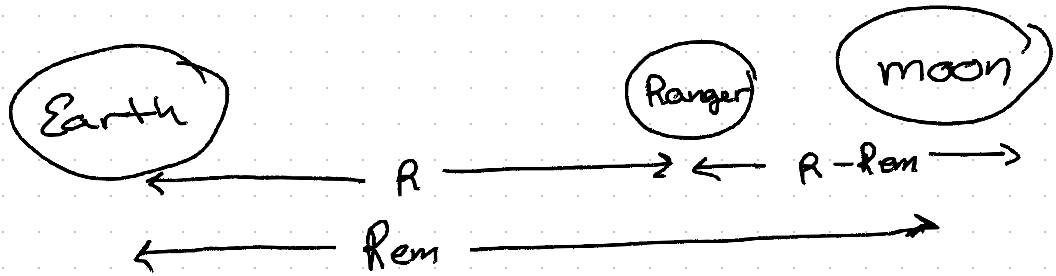
Nathan's Notes on first Python assignment specifically the Ranger 7 mission plots.



Point of No Return:

$$\frac{G\, M_E \cdot M_R}{R^2} = \frac{G \cdot M_m \cdot M_R}{(R - R_{em})^2}$$

Solve for R

Something like $R^2 = (R - R_{em})^2 \cdot \frac{G\, M_E\, M_R}{G\, M_m\, M_R}$

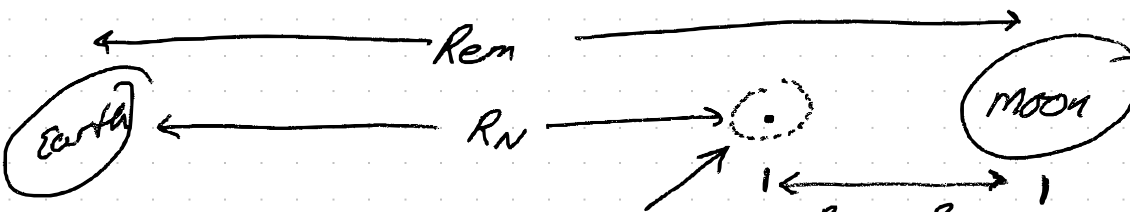
math problem of form

$$x^2 = (x - a)^2\, b$$

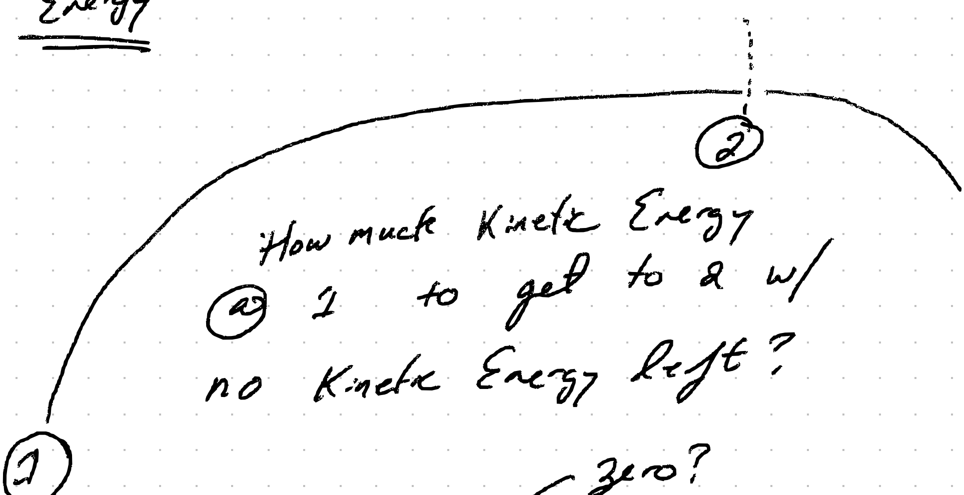
Then, Assuming you've found point of no Return, call it R_N

how fast @ $R_1 = R_{Earth} + 50e3\,m$ to make it to R_N w/ no velocity left?

$$U_{moon} = \frac{-G\,M_m \cdot M_R}{(R_{em} - R_N)} \qquad U_{Earth} = \frac{-G\,M_E \cdot M_R}{R_N}$$



Energy



How much Kinetic Energy @ 1 to get to 2 w/ no Kinetic Energy left?

$$KE_1 + U_1 = \overset{\text{zero?}}{KE_2} + U_2$$

Forces balance at:

$$R^2 = (R - R_{em})^2 \cdot \frac{\cancel{G} M_E \cancel{M_R}}{\cancel{G} M_m \cancel{M_R}}$$

$$R^2 \left(\frac{M_m}{M_E}\right) = R^2 - 2R \cdot R_{em} + R_{em}^2$$

$$0 = \left(1 - \frac{M_m}{M_E}\right) R^2 - 2 R_{em} \cdot R + R_{em}^2$$

$$R = \frac{-(-2R_{em}) \pm \sqrt{(-2R_{em})^2 - 4 \cdot \left(1 - \frac{M_m}{M_e}\right) \cdot R_{em}^2}}{2 \cdot \left(1 - \frac{M_m}{M_e}\right)}$$

$m_m = 7{,}3 \times 10^{22}$
$m_e = 6 \times 10^{24}$
$R_{em} = 3{,}8 \times 10^8$

$R = (4.3 \text{ or } 3.4) \times 10^8$ meters

this is the real one

$F_E \leftarrow \bullet \rightarrow F_M$

about 90% of the way to the moon

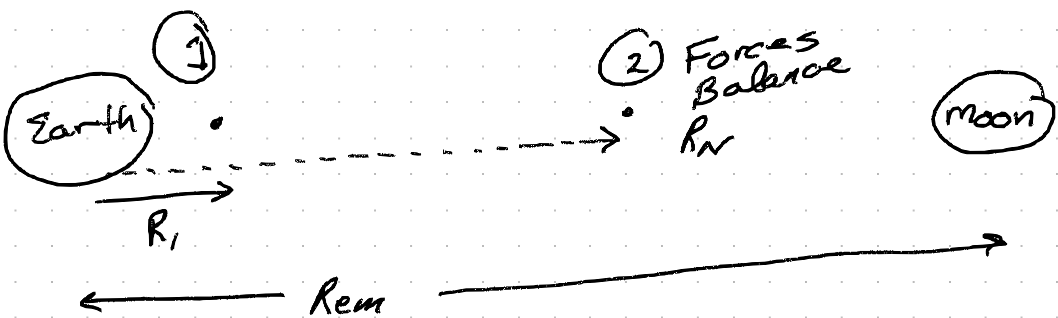
$\leftarrow F_e$
$\leftarrow F_m$
on the far side

What Energy/Velocity @ 50 km from Earth's Surface if you make it to the pt of NO Return (where forces balance)?

1

$$KE = \frac{1}{2} M_R \cdot V_1^2$$

$$U_G = -\frac{G M_E M_R}{R_1} - \frac{G M_m M_R}{R_{em} - R_1}$$



2 $KE = 0$ (because you stop when you get there?

$$U_G = \frac{-G M_E M_R}{R_N} - \frac{G M_m M_R}{R_{em} - R_N}$$

Equate $E_1 = E_2$ and solve for V_1

Python says $V_1 \approx 11$ km/s minimum