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Solutions posted

Name: ____________
Date: ____________

Distant Objects Practice

1. Read and understand **Orbital Energetics** on pp.350-351. Skip the examples, but understand the reasoning and the diagrams.

a. What entirely determines the speed of a satellite around an object? the size of the orbit

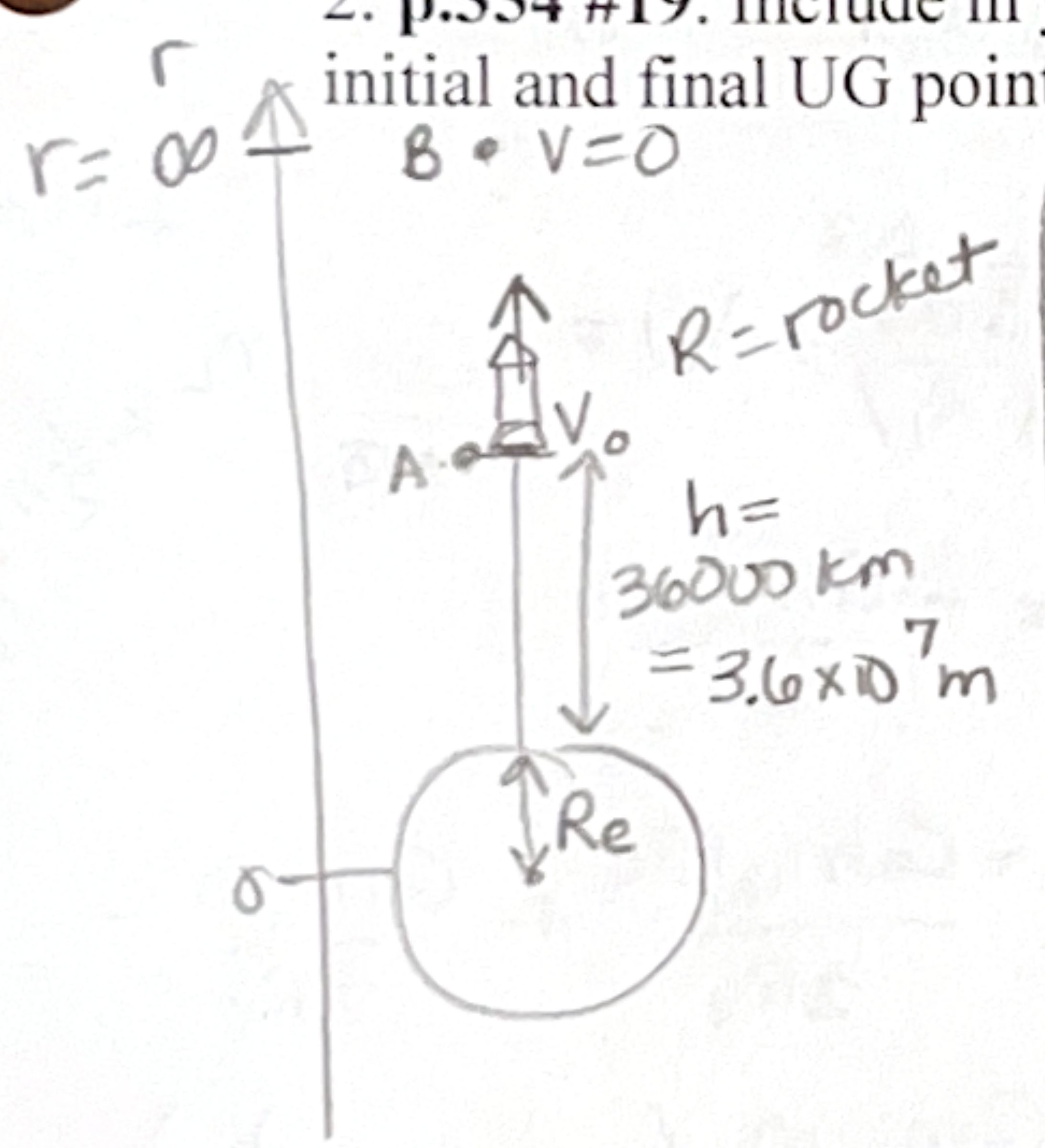
b. Is the speed of a satellite in a higher circular orbit around earth *greater than*, *equal to*, or *less than* the speed of a satellite in a lower circular orbit around earth? less than

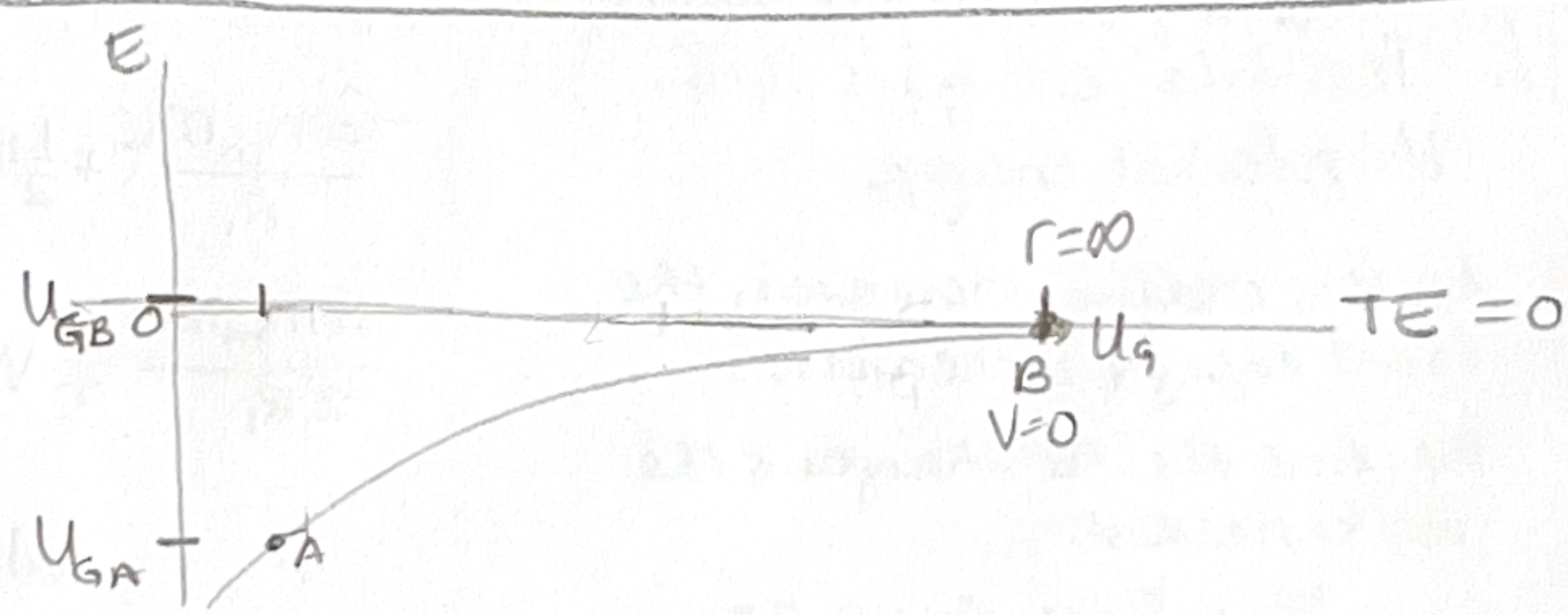
c. As a satellite is moved to a circular orbit with a larger radius, what happens to its kinetic energy? decreases What happens to the potential energy of the system? increases What happens to the total energy of the system? increases

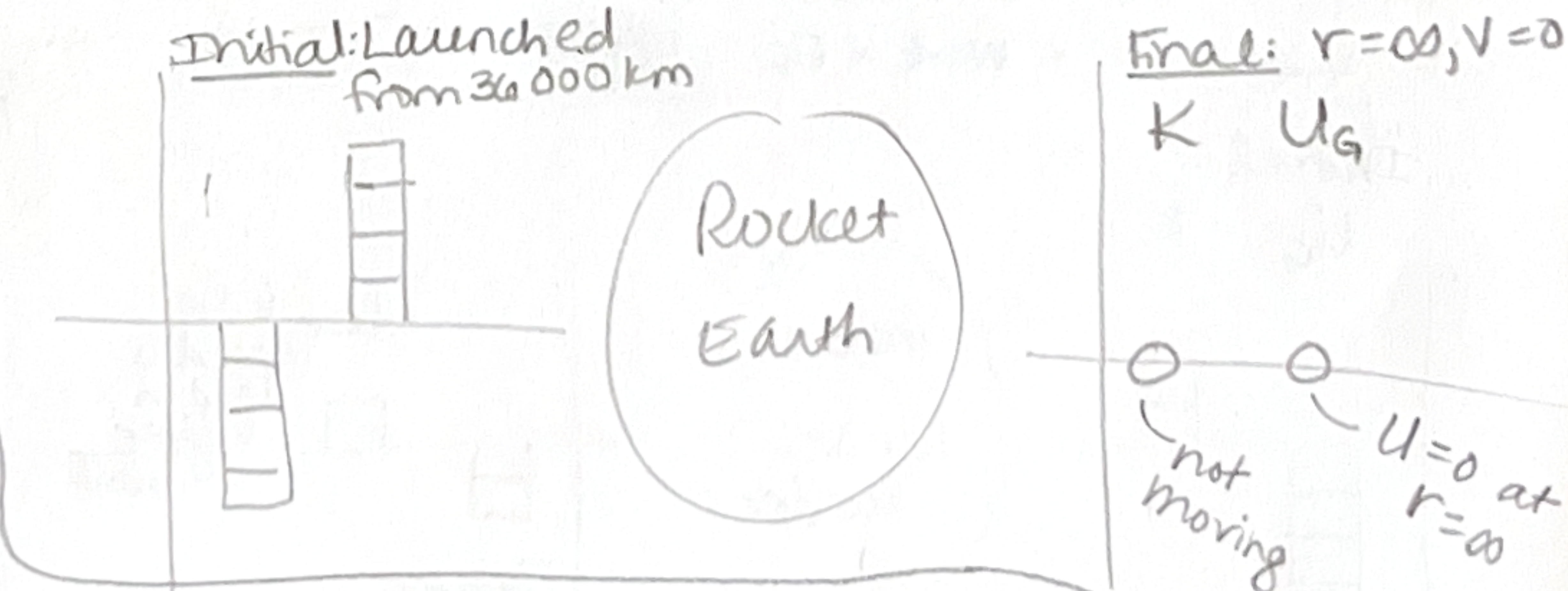
d. What is the total mechanical energy of a satellite in a circular orbit in terms of U_G? $\frac{1}{2} U_G$

e. What is characteristic of the total energy of a bound system? Total energy is negative.

2. **p.354 #19.** Include in your solution an Energy Diagram (with UG curve, a TE line, and the initial and final UG points marked) and an Energy Bar Chart







$E_i + E_{trans} = E_f$

$U_{GA} + K_A = 0$

$$\frac{-Gm_e \cancel{m}/R}{(R_e+h)} = -\frac{1}{2}\cancel{m}v^2/R$$

$$\sqrt{\frac{2Gm_e}{(R_e+h)}} = v$$

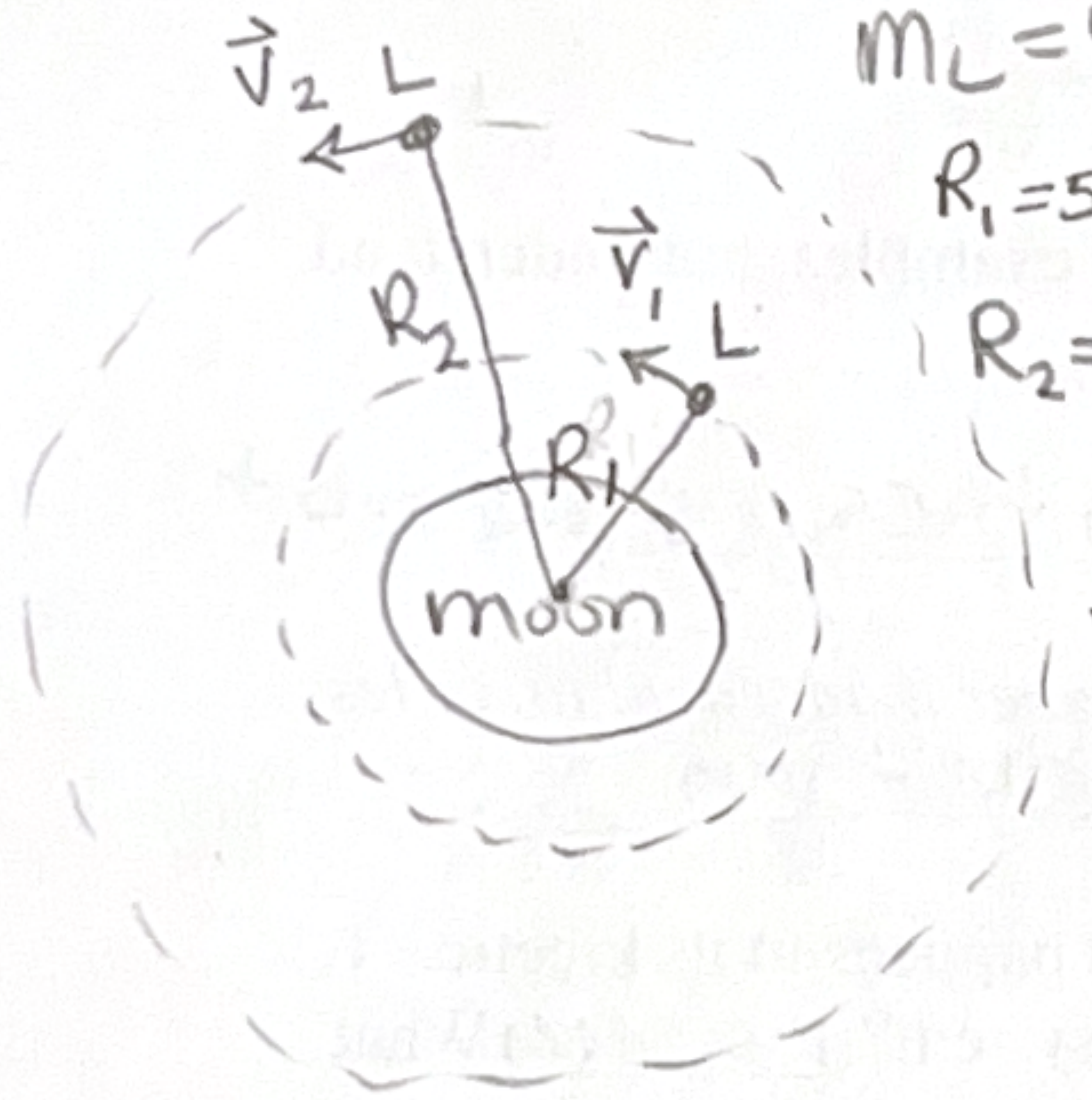
$$v = \sqrt{\frac{2(6.67\times10^{-11}\,Nm^2/kg^2)(5.98\times10^{24}\,kg)}{6.37\times10^6 + 3.6\times10^7\,m}}$$

$$\boxed{v = 4340\ m/s}$$

3. **p.355 #51**. Include in your solution an Energy Diagram (with UG curve, a TE line, and the initial and final UG points marked) and an Energy Bar Chart

From book: $R_{moon} = 1.74 \times 10^{6}\,m$

$m_L = 4000\,kg$



$R_1 = 50\,km + R_{moon} = 5.0 \times 10^4\,m + 1.74 \times 10^6\,m = 1.79 \times 10^6\,m$

$R_2 = 300\,km + R_{moon} = 3 \times 10^5\,m + 1.74 \times 10^6\,m = 2.04 \times 10^6\,m$

Work = ?

m = moon

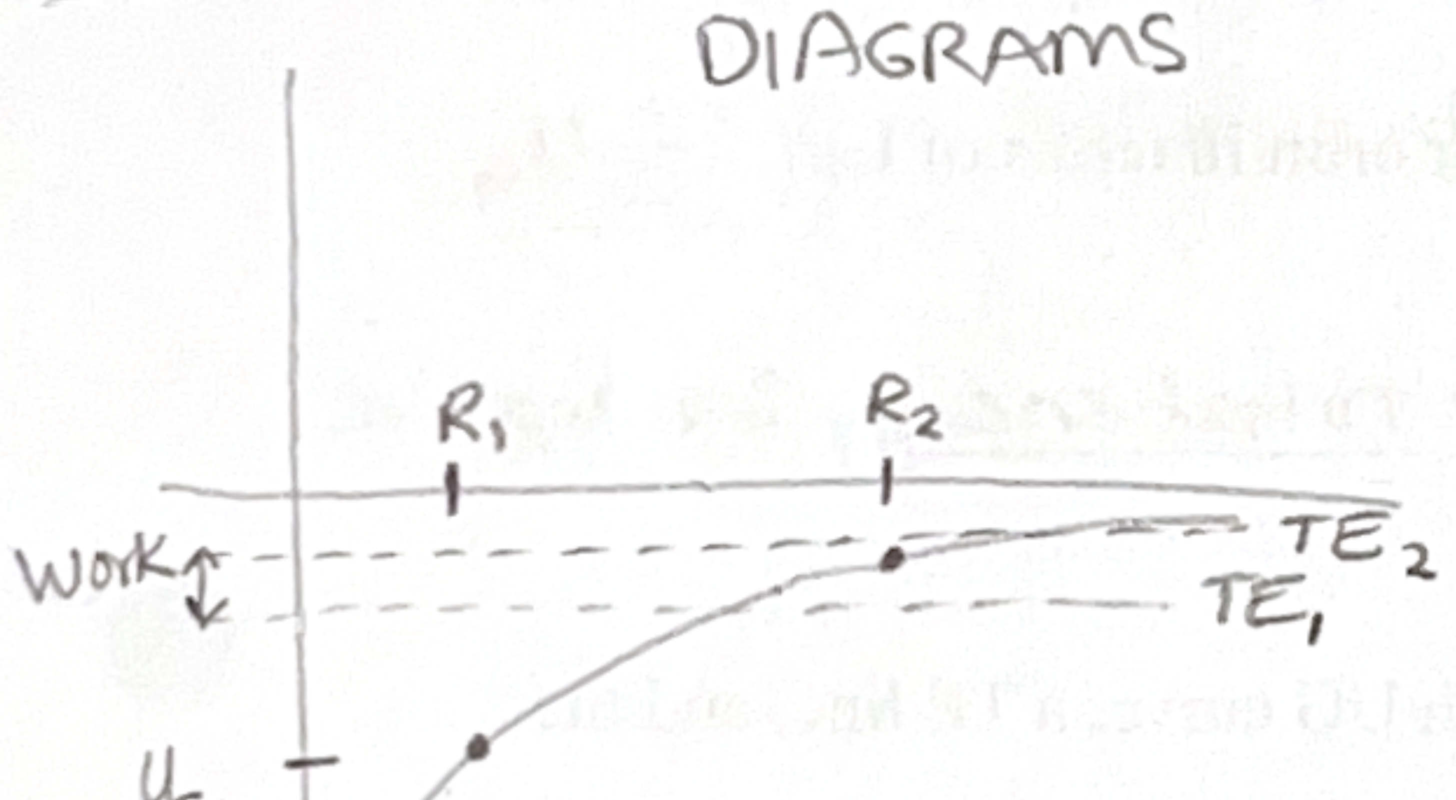
L = Lunar Lander

Need v_1 and v_2 for each orbit, so find v eqn:

$a_r = \frac{\Sigma F_r}{m}$

$\frac{v^2}{r} = \frac{\left(\frac{G m_m m_L}{r^2}\right)}{m_L} \Rightarrow v = \sqrt{\frac{G m_m}{r}}$

DIAGRAMS



For a given orbital radius, The total energy is half the potential energy.

As the radius increases, the total energy increases.

The amt the TE changes is the work needed.

$E_i + \Sigma transfers = E_f$

$E_i + Work = E_f$

REPRESENT MATHEMATICALLY + SOLVE:

$E_i + \Sigma transfers = E_f$

$U_{G1} + K_1 + W_{thrusters} = U_{G2} + K_2$

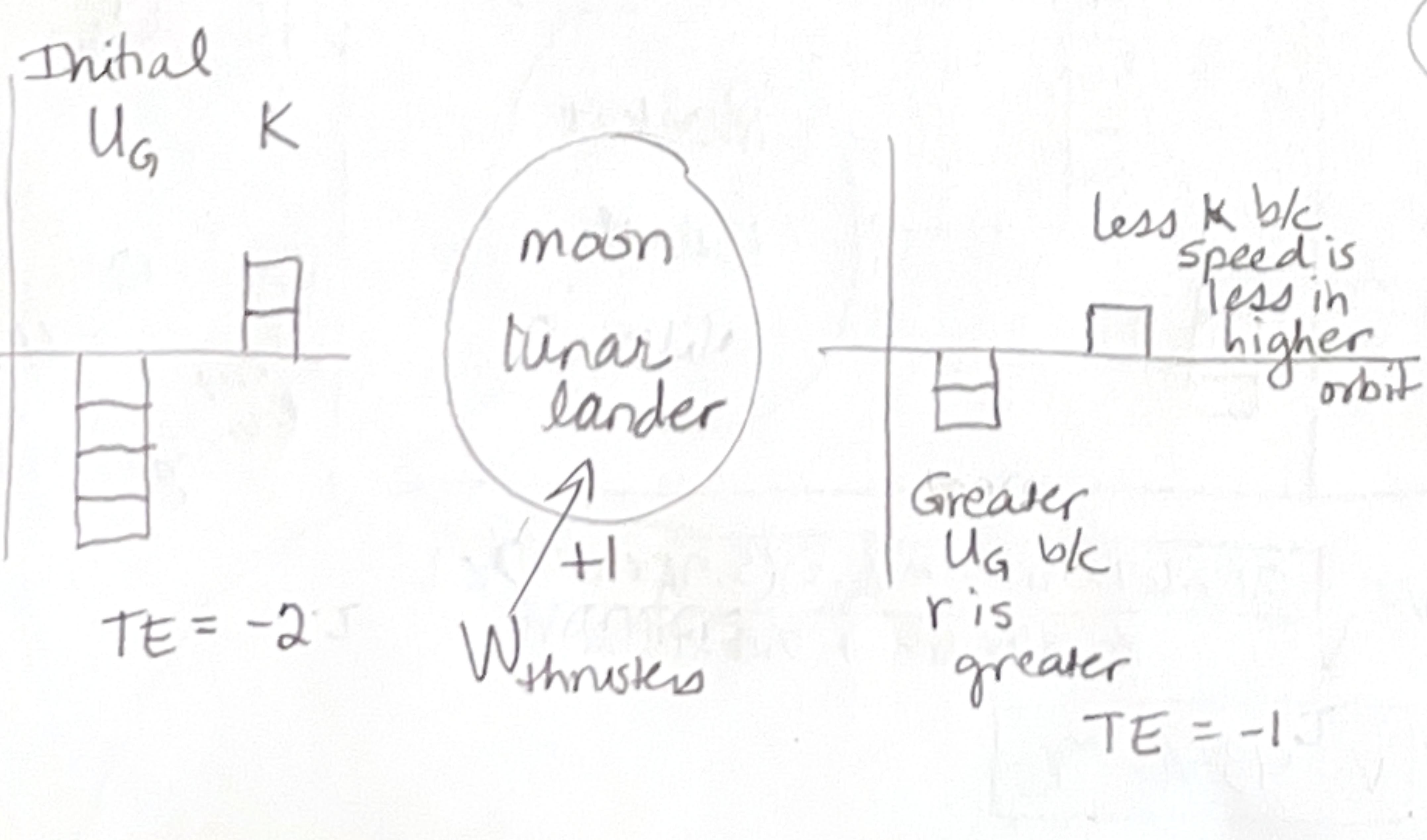
$-\frac{G m_m m_L}{R_1} + \frac{1}{2} m_L v_1^2 + W_{thrusters} = -\frac{G m_m m_L}{R_2} + \frac{1}{2} m_L v_2^2$

$-\frac{G m_m m_L}{R_1} + \frac{1}{2} m_L \left(\sqrt{\frac{G m_m}{R_1}}\right)^2 + W = -\frac{G m_m m_L}{R_2} + \frac{1}{2} m_L \left(\sqrt{\frac{G m_m}{r}}\right)^2$

$-\frac{G m_m m_L}{2R_1} + W = -\frac{G m_m m_L}{2R_2}$

$W = -\frac{G m_m m_L}{2R_2} + \frac{G m_m m_L}{2R_1}$

$W = \frac{G m_m m_L}{2}\left(-\frac{1}{R_2} + \frac{1}{R_1}\right)$



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$$W = \frac{\left(6.67\times10^{-11}\,\frac{Nm^2}{kg^2}\right)\left(7.36\times10^{22}\,kg\right)\left(4000\,kg\right)}{2}\underbrace{\left(\frac{-1}{2.04\times10^{6}\,m} + \frac{1}{1.79\times10^{6}\,m}\right)}$$

$$W = \frac{(\quad)(\quad)(\quad)}{2}\left(6.85\times10^{-8}\right)$$

$$W = \boxed{6.7\times10^{8}\ J}$$

This is positive, which matches the diagrams which show energy transfering into the system.