5. (30 pts.) A satellite of mass $220kg$ is initially in a circular orbit of radius 7.31×10^6m (measured from the **center** of the earth).

a. (10 pts.) Find the speed of the satellite.

b. (10 pts.) Find the total mechanical energy of the satellite.

c. (10 pts.) Due to friction with the earth's atmosphere, the satellite slowly spirals in towards the earth. Suppose that at some later time, the satellite is in a circular orbit of radius 6.90×10^6m (measured from the **center** of the earth). Assume that the orbit is circular.

   Is the new total mechanical energy greater than, less than, or equal to the initial total mechanical energy? Justify your answer.

$M_E = 5.98 \times 10^{24}\text{kg}$

$R_E = 6.37 \times 10^6\text{m}$

4. (30 pts.) A satellite of mass 220 kg is initially in a circular orbit of radius 7.31×10^6 m (measured from the **center** of the earth).

a. (10 pts.) Find the speed of the satellite.

b. (10 pts.) Find the total mechanical energy of the satellite.

c. (5 pts.) Due to friction with the earth's atmosphere, the satellite slowly spirals in towards the earth. Suppose that at some later time, the satellite is in a circular orbit of radius 6.90×10^6 m (measured from the **center** of the earth). Find the new speed of the satellite. (Assume that the orbit is circular.)

d. (5 pts.) Is the new total mechanical energy greater than, less than, or equal to the initial total mechanical energy? Justify your answer.

a. $F = ma \Rightarrow \frac{GmM}{r^2} = \frac{mv^2}{r} \Rightarrow v = \sqrt{\frac{GM_E}{r}} = \boxed{7387\ m/s}$

b. $K = \frac{1}{2}mv^2 = \frac{1}{2}(220\,kg)(7387\,m/s)^2 = 6.00 \times 10^9\,J$

$U = -\frac{GMm}{r} = \frac{-(6.67\times10^{-11})(5.98\times10^{24})(220)}{7.31\times10^6} = -1.200\times10^{10}\,J$

$E = K + U = \boxed{-6.00\times10^9\,J}$

c. $v = \sqrt{\frac{GM_E}{r}} = \sqrt{\frac{(6.67\times10^{-11})(5.98\times10^{24})}{6.90\times10^6}} = \boxed{7603\ m/s}$

speed goes up!

d. $K = \frac{1}{2}mv^2 = 6.36\times10^9\,J$

$U = -\frac{GMm}{r} = -1.27\times10^{10}\,J$

$\boxed{E = -6.36\times10^9\,J}$

Note: Speed goes up, but total energy goes down.