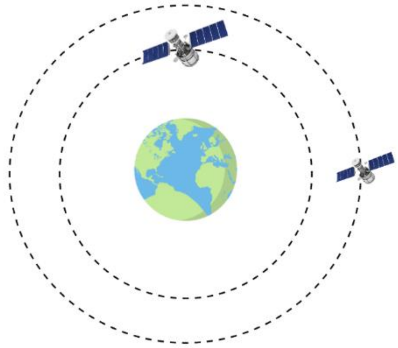
CONCEPT: Energy of Circular Orbits

- You'll see problems where an object changes from one orbit to another

- To solve changing orbit problems, use **Energy Conservation:**



ORBIT
$v_{sat} = \sqrt{\frac{GM}{r}}$
$K = \frac{1}{2}mv^2$ $U = -\frac{GMm}{r}$

$$K_i + U_i + W_{NC} = K_f + U_F$$

- To change orbits, there must be some _________ done.

Changing orbital distance

EXAMPLE 1: How much work is needed for a 200-kg spacecraft to travel from a circular orbit 300km above Earth to a higher circular orbit 35,900 km high?

Changing orbital velocity

EXAMPLE 2: How much work is needed for a 200-kg spacecraft travelling around Earth to change from a circular orbit in which it travels at 6000m/s to a different circular orbit in which it travels at 9000m/s?

$E_{circ} =$ $K + U =$ ________ = _________

- The Kinetic and Potential energies in an orbit are CONSTANT.

- To increase/enlarge an orbit, the work done must be **[POSITIVE | NEGATIVE]**

  - r ___, v ___

- To decrease/shrink an orbit, the work done must be **[POSITIVE | NEGATIVE]**

  - r ___, v ___

PRACTICE: The 12,000-kg Lunar Command Module is in a circular orbit above the Moon's surface. If it spends ¼ of its fuel energy (-1.74×10⁹ J) bringing it to a circular orbit just above the surface, how high was its original orbit?

EQUATIONS	CONSTANTS
$v_{sat} = \sqrt{\frac{GM}{r}}$ $v_{sat} = \frac{2\pi r}{T}$ $T_{sat}^2 = \frac{4\pi^2 r^3}{GM}$	G = 6.67×10^{-11} $\frac{m^3}{kg\cdot s^2}$ M_E = 5.97×10^{24} kg R_E = 6.37×10^{6} m M_{Moon} = 7.35×10^{22} kg R_{Moon} = 1.74×10^{6} m
$U_G = -\frac{GMm}{r}$ $K_i + U_i + W_{NC} = K_f + U_f$	
$E_{circ} = -\frac{GMm}{2r} = -\frac{1}{2}mv^2$	

PRACTICE**:** a) How much work do you have to do on a 100-kg payload to move it from Earth's surface to a height of 1000km? b) How much additional work must you do to put this payload into orbit at this altitude?

EQUATIONS	CONSTANTS
$v_{sat} = \sqrt{\frac{GM}{r}}$ $v_{sat} = \frac{2\pi r}{T}$ $T_{sat}^2 = \frac{4\pi^2 r^3}{GM}$	G = 6.67×10^{-11} $\frac{m^3}{kg \cdot s^2}$ M_E = 5.97×10^{24} kg R_E = 6.37×10^6 m M_{Moon} = 7.35×10^{22} kg R_{Moon} = 1.74×10^6 m
$U_G = -\frac{GMm}{r}$ $K_i + U_i + W_{NC} = K_f + U_f$	
$E_{circ} = -\frac{GMm}{2r}$	