GRAVITATIONAL POTENTIAL ENERGY

Gravitational Potential Energy

- Energy that is "stored" in an object's gravitational field.
- Work must be done in order to change the position of a second mass from an infinitely far away point in space to a position relatively near the first mass.
- Remember: **Work-Energy Theorem**
  - The amount of work done on an object is equal to the change in energy of that object.
  - In this case, the energy change is all potential.

Gravitational Potential Energy

- Work is done when moving the mass from a distance infinitely far from the source of a gravitational field to some distance ***R*** from the source
- This work is stored in the gravitational field between the two masses: **Gravitational Potential Energy**

$$W = E_p = -\frac{GMm}{R}$$

Gravitational Potential (*V*)

- A field, defined at every point in space, but a ***scalar quantity***
- Defined as:
  - The work done **per unit mass** to bring a small point mass (m) from infinity to a point P.

$$V = \frac{W}{m} = \frac{E_p}{m}$$

$$V = \frac{-\frac{GMm}{r}}{m}$$

$$V = -\frac{GM}{r}$$

Total Energy of an Object in Orbit

- Total energy, as usual, is the sum of the orbiting object's gravitational potential and kinetic energies:

$$E = \tfrac{1}{2}mv^2 - \frac{GMm}{r}$$

- Howeve

Total Energy… simplified!

- Solve for v^2 using Newton's laws:

$$G\frac{Mm}{r^2} = \frac{mv^2}{r}$$

$$\frac{GMmr}{r^2 m} = v^2$$

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

- Substitute into energy equation:

$$E = \tfrac{1}{2}m\left(\frac{GM}{r}\right) - \frac{GMm}{r}$$

$$E = -\frac{GMm}{2r} = -\tfrac{1}{2}mv^2$$

Graphing Mechanical Energy:

- Graph of gravitational potential energy as a function of distance from a planet's surface