POTENTIAL ENERGY

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- We often say potential energy is "stored energy," but we need to be careful with what that means.
- The object doesn't just have energy sitting in it, waiting to do something.
- The object has potential energy due to being a part of a system where a force may/will/can do work on the object.

- Con't on next slide ….

- Gravitational potential energy
  - An object itself doesn't have gravitational potential energy; it has gravitational potential energy because it is part of the Earth-object system.
  - Earth has potential to do work on the object through the force of gravity.
  - The object's location relative to the surface of the Earth determines how much energy the work done by the gravitational force can transfer to the object.

GRAVITATIONAL POTENTIAL ENERGY

- Energy an object possesses due to its position
- The height of an object relative to a reference point determines its position.
- Reference point is chosen by you, but it's generally easiest to make it the lowest point in the problem/scenario.
- $U_g = m\ g\ \Delta y$

GRAVITATIONAL POTENTIAL ENERGY

- As the object moves closer to the Earth there is less potential to transfer energy to the object.
- $\Delta U_g = mg\Delta y$

- Notice how the change in potential energy is what matters. That determines how much energy can/will/has been transferred to the object.

- For example: If we look at a ball at the top of the ramp we often say it's potential energy is mgh, and then look at it's potential at the bottom of the ramp as mgh. The same Earth was part of the system the entire time so it has the same effect in both locations. We've really only accounted for it's change of position relative to the Earth, and this gets us to how much work Earth (gravitational force) did to move the ball down the ramp.

WORK DONE BY GRAVITY

- An object in free fall experiences a change in motion due to the force of gravity doing work on the object and changing its potential energy
  - An object rising in free fall would experience an increase in potential energy while the work done by gravity would be removing kinetic energy from the object. (force and displacement oppose)
  - An object falling in free fall would experience a decrease in potential energy while the work done by gravity would be transferring kinetic energy to the object. (force and displacement agree)

  - $W_g = - \Delta U_G$

ELASTIC POTENTIAL ENERGY

- When an elastic material is stretched or compressed it has the potential to transfer energy to an object.
- The more we stretch or compress, the more energy it can transfer to the object.
- Again, the object has potential energy because it is part of a system. In this case, the object and the spring/elastic material.

- Elastic materials have a spring constant, k, that describes how easy/difficult they are to stretch/compress.

ELASTIC POTENTIAL ENERGY

- The amount of energy stored in a stretched of compressed object depends on the material's spring constant and how far it has been stretch or compressed.
  - $U_E = \frac{1}{2} kx^2$

RESTORING FORCE

- From Earlier
  - Stretching or compressing a spring results in a restoring force
  - The restoring force (Fsp) is directed back to the original resting position of the spring
  - The restoring force increases linearly as you move away from equilibrium position

  - $F = k x$

WORK DONE ON OR BY A SPRING

- The work done on or by a spring is easily found be looking at the spring's change in potential energy.
  - $W_{sp} = \Delta PE$

- Misconception ALERT: Work by a spring cannot be found using $W = F\,d$ because the force changes as the spring moves towards/away from equilibrium.