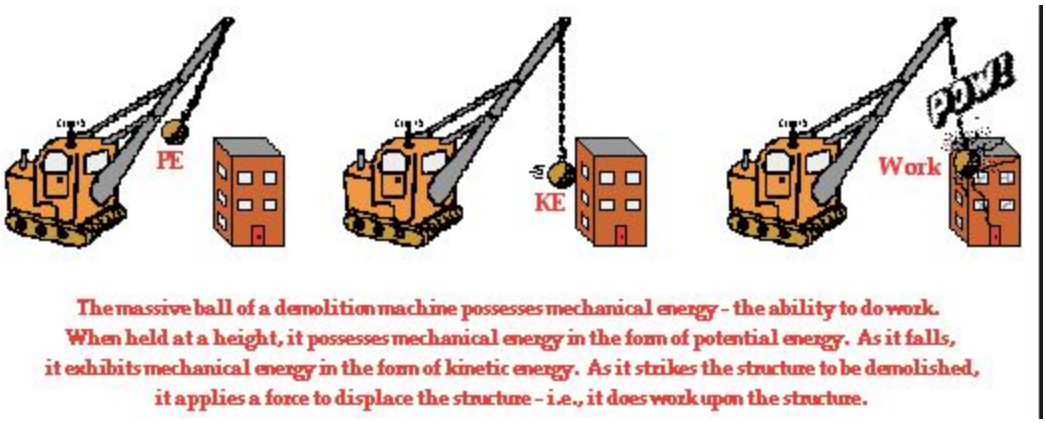
POTENTIAL ENERGY

"Position yourselves, stand still and see the salvation of the LORD, who is with you, O Judah and Jerusalem!" 2Chronicles 20:17

- to understand energy, must understand what it does; though energy cannot be seen, there is evidence of energy: movement, sound, heat, light
- work is involved if anything moves --> energy is defined as the ability to do work

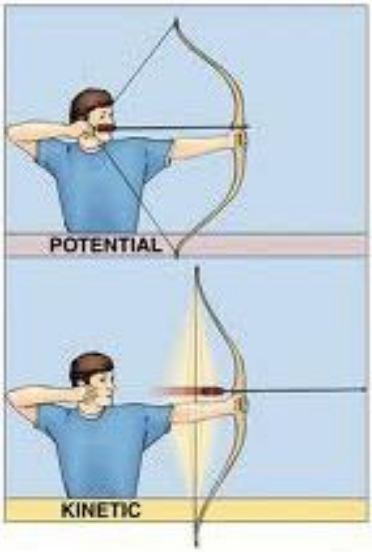
Potential energy

- potential energy appears in many different forms
- potential energy is defined as the energy in matter due to its position or the arrangement of its parts; an object can store energy as the result of its position
- *Examples:* 1) the heavy ball of a demolition machine stores energy when it is held at an elevated position



The massive ball of a demolition machine possesses mechanical energy - the ability to do work. When held at a height, it possesses mechanical energy in the form of potential energy. As it falls, it exhibits mechanical energy in the form of kinetic energy. As it strikes the structure to be demolished, it applies a force to displace the structure - i.e., it does work upon the structure.

- 2) a drawn bow stores energy when altered from its usual equilibrium position (not drawn)



- Elastic potential energy: energy stored as a result of applying a force to deform an elastic object
  The energy is stored until the force is removed and the object springs back to its original shape, doing work in the process.

  $$U = \frac{1}{2} \times k \times (\Delta x)^2$$

  Where U = elastic potential energy (in Joules)
  k = spring constant
  Δx = distance that the object is compressed or expanded (in meters)

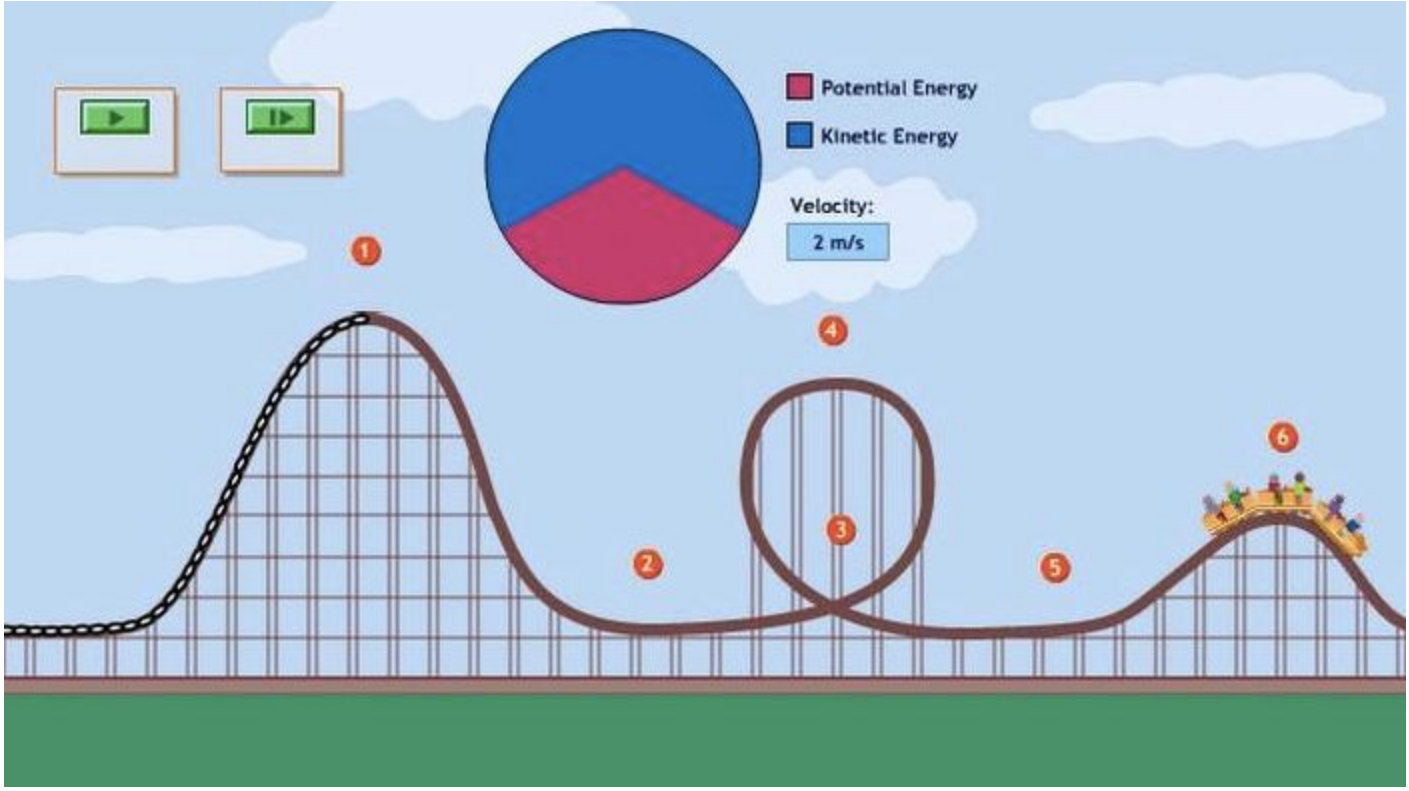
  Ex: k=500 N/m for a bow & arrow

<u>Gravitational potential energy</u>

- the energy stored in an object as the result of its vertical position or height
- the energy is stored as the result of the gravitational attraction of the Earth for the object
- There is a direct relation between gravitational potential energy and the mass of an object: more massive objects have greater gravitational potential energy.
- There is also a direct relation between gravitational potential energy and the height of an object. The higher that an object is elevated, the greater the gravitational potential energy. These relationships are expressed by the following expression:

  $PE_{gravity}$ = mass x acceleration of gravity x height
  $PE_{gravity} = m \times g \times h$

  where m represents the mass of the object, h represents the height of the object and g represents the gravitational field strength (9.81 m/s^2 on Earth) - sometimes referred to as the *acceleration of gravity*
- Only attracts and does not repel



<u>Weak Nuclear Force</u>

- affects certain subatomic (smaller than atoms) particles
- Short-ranged; over distances less than $2x10^{-18}$ m
- Difficult to study
- Potential energy caused by weak nuclear force is usually insignificant compared to the potential energy caused by other fundamental forces

<u>Electromagnetic Force</u>

- 717 times stronger than weak nuclear force and more than 10^{36} times stronger than gravitational force
- Only affects objects with an electric charge
- Can either attract or repel
- Responsible for all known forces in the universe except for gravitational and some subatomic forces; most forces in daily life caused by repulsive force between electrons which are negatively charged
- Electric potential energy: caused by two stationary charged objects affecting each other based on amount and location of the charges maintained by each object
  Ex: static electricity between balloon and hair
- Magnetic potential energy: interacting magnetic fields of a charged particle in motion
  Ex: compass

- Chemical energy: energy resulting from chemical combination of atoms to molecules; like electric potential energy between subatomic particles
- Elastic potential energy: potential energy caused by a restorative elastic force that tries to return an object to its original shape; contributes to an object's mechanical energy

Strong Nuclear Force

- Strongest fundamental force
- Acts only within nuclei of atoms; binds subatomic particles together in an atom
- Extremely short range of about 1.6×10^{-15} m
- Nuclear potential energy: potential energy caused by strong nuclear force
- Not observed in everyday life but very important in chemical reactions

FUNDAMENTAL FORCES IN ORDER OF STRONGEST TO WEAKEST

Strong nuclear force > electromagnetic force > weak nuclear force > gravitational force