

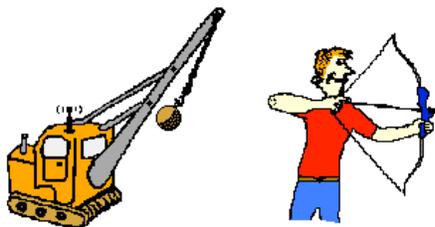
## Potential and Kinetic Energy

“Position yourselves, stand still, and see the salvation of the LORD, who is with you,  
O Judah and Jerusalem!” 2Chron 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 2)a drawn bow stores energy when altered from its usual equilibrium position (not drawn)



The massive ball of a demolition machine and the stretched bow possesses stored energy of position - potential energy.

- **Gravitational potential energy** is 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 equation:

$$\text{PE}_{\text{gravity}} = \text{mass} \times \text{acceleration of gravity} \times \text{height}$$
$$\text{PE}_{\text{grav}} = m \times g \times h$$

where **m** represents the mass of the object, **h** represents the height of the object and **g** represents the gravitational field strength (9.8 m/s<sup>2</sup> on Earth) - sometimes referred to as the acceleration of gravity

### Kinetic energy

- **kinetic energy is defined as the energy of a moving object or the energy of motion**
- Examples: 1)a thrown football 2)a speeding automobile 3)a waterfall 4)a rock falling from a cliff
- an object that has motion - whether it is vertical or horizontal motion - has kinetic energy
- there are many forms of kinetic energy - vibrational (the energy due to vibrational motion), rotational (the energy due to rotational motion), and translational (the energy due to motion from one location to another)
- the amount of kinetic energy that an object has depends upon two variables:
  - 1)the mass (m) of the object and 2)the speed (v) of the object
- the following equation is used to represent the kinetic energy (KE) of an object.

$$KE = 1/2 \times m \times v^2$$

where **m** = mass of object and **v** = speed of object

- kinetic energy is a scalar quantity and does not have a direction
- the unit of measurement of potential and kinetic energy is the Joule (J): 1 Joule = 1 kg x m<sup>2</sup>/s<sup>2</sup>

Let's practice!

1. What is the potential energy of a 625kg roller-coaster car sitting at the top of a coaster that is 30m high?

$$\begin{aligned} \text{potential energy (PE)} &= \text{mass of object} \times \text{acceleration of gravity} \times \text{height} \\ &= 625\text{kg} \times 9.8\text{m/s}^2 \times 30\text{m} = 183,750 \text{ Joules} \end{aligned}$$

2. Determine the kinetic energy of that roller-coaster car that is moving 20m/s.

$$\text{kinetic energy (KE)} = 1/2 \times 625\text{kg} \times (20\text{m/s})^2 = 1/2 \times 625\text{kg} \times 400\text{m}^2/\text{s}^2 = 125,000 \text{ Joules}$$