Work and Energy

Work

Transference of Energy

Work = Force x distance

W=Fd

Work into system = work out of system

Work

- Lifting load against the force of the weight of the object
- Move an object twice as far results in twice the work
- Move two object (Twice the weight) the same distance as one is twice the work
- Nothing about time in definition
- Slow or fast
- Same force, same distance = same work

Work W=Fd

- Twice the weight
- Twice the distance

Work W=Fd

- Units of work are Newton-meters, same as Joules

$$F \cdot d = N \cdot m = \frac{kg \cdot m}{s^2} \cdot m = \frac{kg \cdot m^2}{s^2} = J$$

- SO Work is energy

Work is Energy

- Same units
- Work occurs with transfer of energy
- Work occurs when you store potential energy

Work is Energy

Mechanical energy

Moving things—has two forms

1. Potential mechanical energy
   Waiting to work
2. Kinetic mechanical energy
   Work being done

Work is Energy

- Energy stored in bow
- Work is done to create the potential energy

Potential Energy

http://www.howstuffworks.com/inside-clock.htm

- http://www.himalayan.pdx.edu/virtualjourney/slideshow/se_photos_web/pages/Boy%20with%20Slingshot%2C%20J.htm

Potential Energy

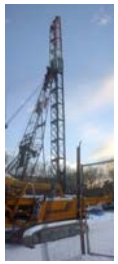
- Fuel is chemical potential energy

http://www.alternativefuels.com.au/Biodiesel/dragster.htm

http://www.lilligren.com/Redneck/redneck_lawnmower.htm

Work is Energy

- Lift heavy ram of pile driver
- Work transfers energy to lift into gravitational potential energy



Gravitational potential energy

- Due to object's position
- Relative to a surface

= weight x height = mgh

- Work done for object to gain potential energy

Gravitational potential energy

Gravitational potential energy

E_P = mass x (acceleration of gravity) x height

Height is above some reference level

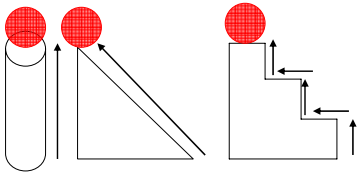
Potential energy is <u>always</u> referenced to a zero level defined in the system

Gravitational potential energy

- $E_P = mgh$
- mg = weight
- h = height

Gravitational potential energy

- $E_P = mgh$
- Path to the height is not factor in E_P
- Horizontal distance is not factor in E_P



Kinetic Energy of Motion

- $E_K = \frac{1}{2} mv^2$

- Work is a change in kinetic energy
- $W = \Delta E_K$
- Δ Delta 'change'

Kinetic Energy of Motion

- Heat
- Sound
- Electricity and light

Kinetic Energy of Motion

- $\mathbf{W = \Delta E_K}$ Work is change in kinetic energy
- Work-energy theorem
- Net work = force x distance $\mathbf{W = Fd}$
  - Due to net force

$$\mathbf{E_K} = \frac{\mathbf{mv^2}}{2} \qquad \mathbf{Fd} = \frac{\mathbf{mv^2}}{2}$$

Conservation of Energy

- Cannot be created or destroyed
- Can be converted from one form to another

Kinetic energy and momentum

- Properties of moving things
- Momentum is a vector quantity
  - can be cancelled with opposite momentum
- Kinetic Energy is a scalar quantity
  - Cannot ever be cancelled

- http://www.littletheatre.net/Firecracker_Miss/miss_firecracker_contest.htm

Conservation of Energy

- Transformation from one form to another
- Potential energy of stretched rubber of slingshot
- Transformed to kinetic energy of rock flying through air

Conservation of Energy

- Rock transfers its kinetic energy to the object it hits
- May be transformed to heat upon impact
- Energy cannot be created or destroyed

Conservation of Energy

- http://science.howstuffworks.com/roller-coaster.htm

Conservation of Energy

- E_P = 10000 J E_K = 0 J
- E_P = 7500 J E_K = 2500 J
- E_P = 5000 J E_K = 5000 J
- E_P = 2500 J E_K = 7500 J
- E_P = 0 J E_K = 10000 J

Conservation of Energy

- Does a car use more energy when its lights are on?
- What about when the air conditioner is on?
- How about using the radio when the engine is off?

Power

- Work done over time

$$\text{Power} = \frac{\text{Work done}}{\text{time interval}}$$

- Units: $\dfrac{kg \cdot m^2}{s^3} = watt$

Power

$$P = \frac{\textbf{energy}}{\textbf{time}}$$

- Half the time
  =Twice the power
- Twice the time
  =Half the power

Power: P = energy/time

- Fuel burn
- Biodiesel

http://www.alternativefuels.com.au/Biodiesel/dragster.htm

http://www.illigren.com/Redneck/redneck_lawnmower.htm

Work, Energy and Power

Water behind the dam

Potential energy

Convert it to electrical energy

Work and Energy

- E_P transformed to another form of energy
- Kinetic energy of motion