Kinetic and Potential Energy

Supplemental Text Material

Pages 326-333

Work

Transference of Energy

Work = Force x distance

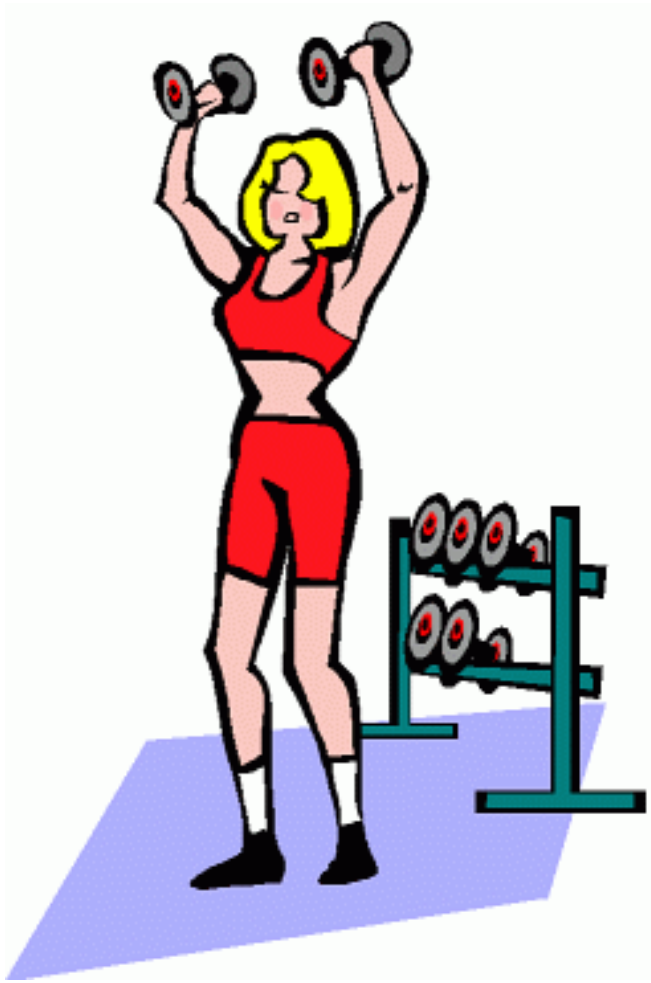
W=Fd

Work

- Lifting load against the force of the weight of the object
- Twice the distance results in twice the work
- Twice the weight is twice the work

Work W=Fd

- Twice the weight
- Twice the distance



Work W=Fd

- Weight lifter expends energy to keep the potential energy in the barbell
- But he does no work on the barbell after it is lifted

Work W=Fd

Work W=Fd

Units of force = Newtons = $\frac{kg \cdot m}{s^2}$

Force x distance = Newton meters

= $\frac{kg \cdot m}{s^2} \cdot m = \frac{kg \cdot m^2}{s^2}$

=Joules

Work W=Fd

- Units of work are Joules
- Work is energy

Work W=Fd

- Nothing about time in definition
- Slow or fast
- Same force, same distance = same work

Power

- Work W=Fd
- Power = work / time
- Units Joules/second

$$\frac{kg \cdot m^2 / s^2}{s} = \frac{kg \cdot m^2}{s^2} \div s$$

$$\frac{kg \cdot m^2}{s^2} \bullet \frac{1}{s} = \frac{kg \cdot m^2}{s^3} = watt$$

Power P = energy/time

$$\frac{kg \cdot m^2}{s^3} = watt$$

- 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.lilligren.com/Redneck/redneck_lawnmower.htm

Work vs. Energy

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

Work vs. Energy

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

Work vs. Energy

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

Work vs. Energy

Mechanical energy

Moving things—has two forms

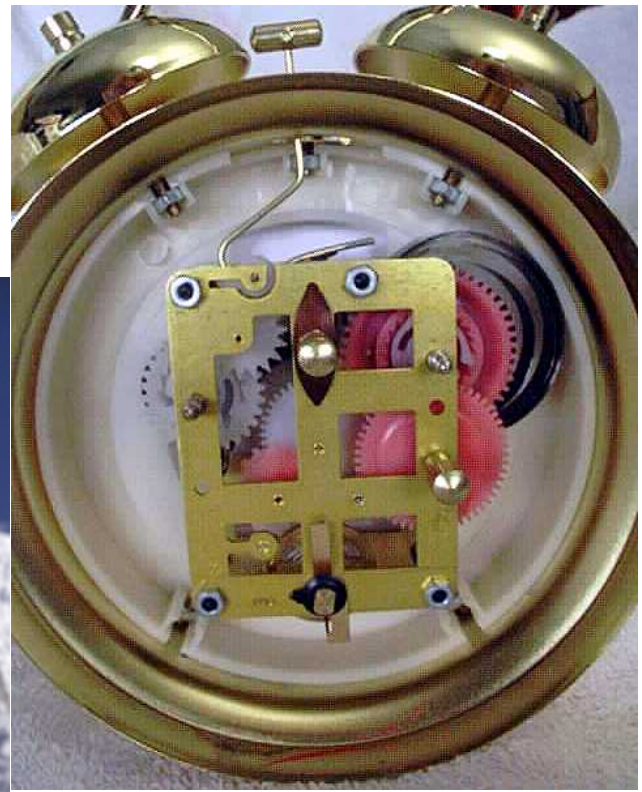
1. Potential mechanical energy

   Waiting to work

2. Kinetic mechanical energy

   Work being done

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

Gravitational potential energy

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

Gravitational potential energy

= 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

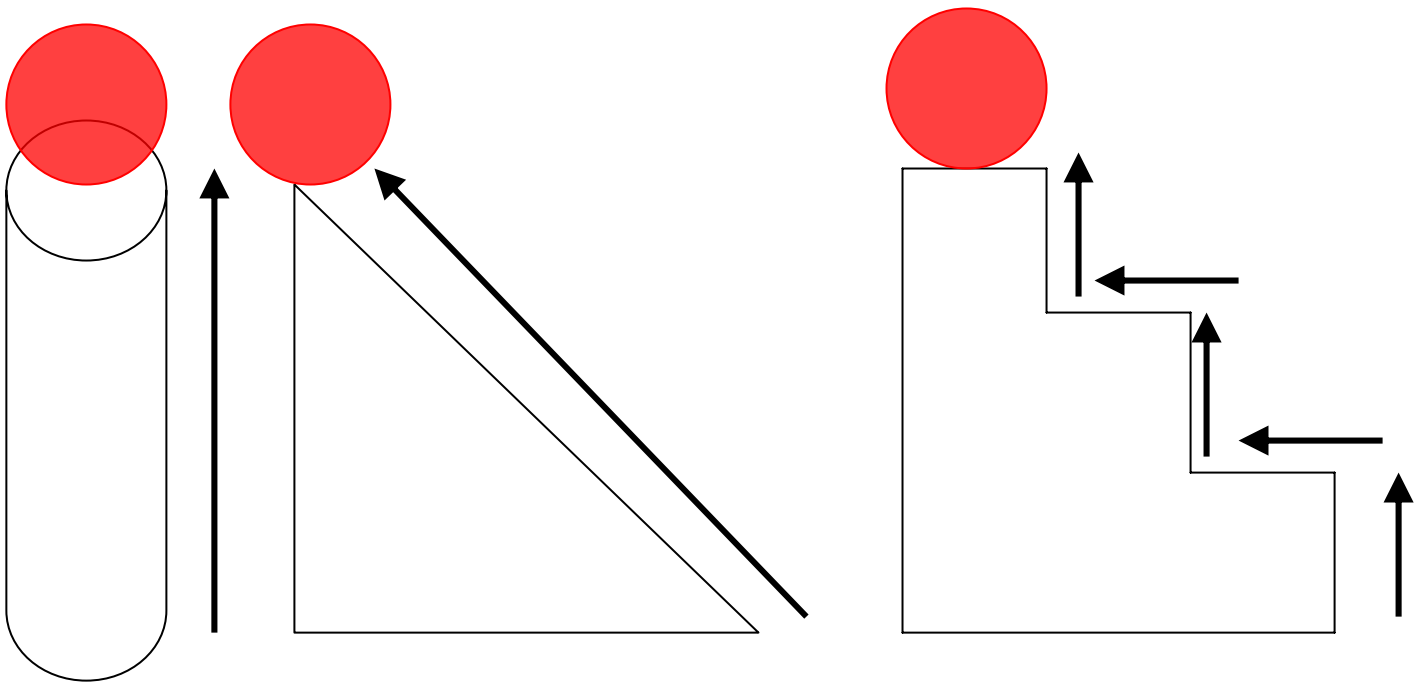
Potential energy is <u>always</u> referenced to a zero level defined in the system

Gravitational potential energy

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

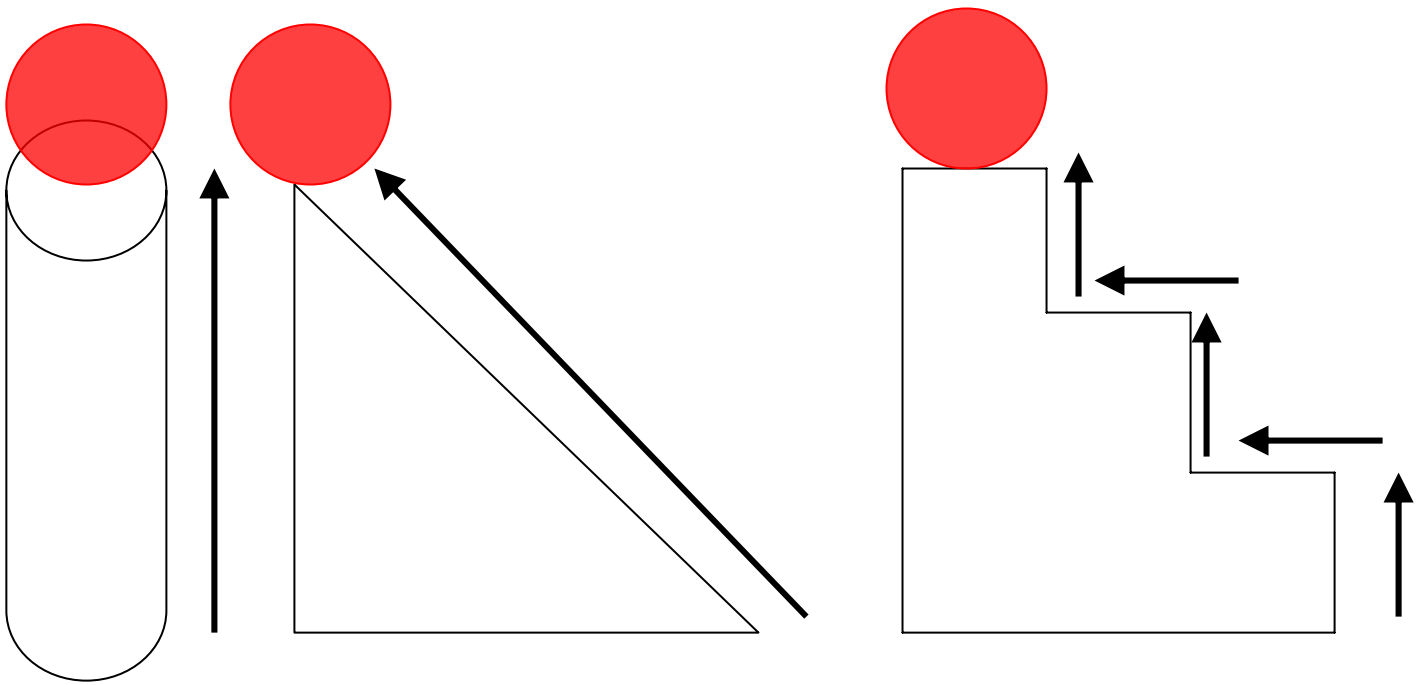
Gravitational potential energy

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



Gravitational potential energy

- $E_P = mgh$
- Horizontal distance is not factor in E_P



Work, Power and Energy

- How much work is done when you carry a 75 N bowling ball across the room?

- Not any, no change in height, so no change in potential energy

Work, Power and Energy

- Potential energy only important when it changes
- Change of E_P does **work**
- W=Fd
- E_P transformed to another form of energy

Work, Power and Energy

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

Work, Power and Energy

Water behind the dam

Potential energy

Kinetic Energy of Motion

- $E_K = ½ mv^2$
- Work is a change in kinetic energy
- $W = \Delta E_K$
- Δ Delta ‘change’

Kinetic Energy of Motion

- $W = \Delta E_K$
- Work energy theorem
- Net work
- Due to net force

Kinetic Energy of Motion

- Heat
- Sound
- Electricity and light

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

- Kinetic energy of rock flying through air = Potential energy of stretched rubber of slingshot
- Transformed from potential to kinetic

Conservation of Energy

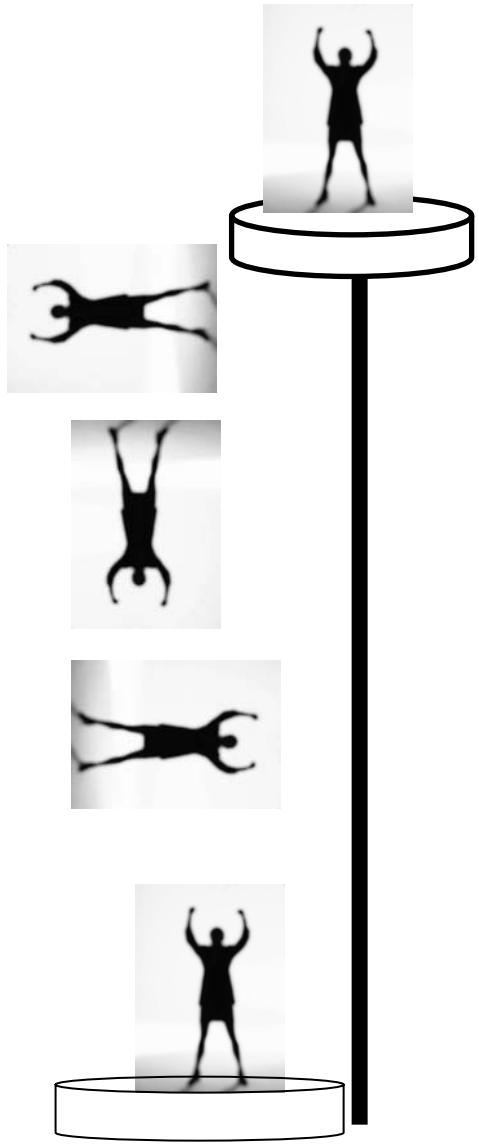
- Rock transfers its kinetic energy to the object it hits
- May be transformed to heat upon impact

Conservation of Energy

- Energy cannot be created or destroyed; it may be transformed form one form into another, but the total amount never changes.

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

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

Conservation of Energy

- Sun's energy from fusion of hydrogen to helium

$$4\,{}_{1}^{1}H \rightarrow {}_{2}^{4}He + energy$$

- Sun's energy converted to chemical energy by plants
- Sun's heat converted to potential energy when it evaporates water

Conservation of Energy

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