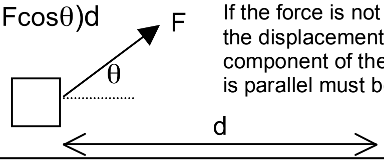
Work and Energy Summary Sheet

Chapter 6

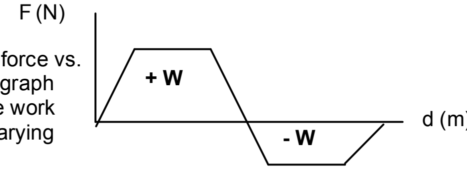
Work: work is done when a force is applied to a mass through a displacement or W=Fd. The force and the displacement must be parallel to one another in order for work to be done.

$W = (F\cos\theta)d$



If the force is not parallel to the displacement, then the component of the force that is parallel must be found.

The area of a force vs. displacement graph represents the work done by the varying force.



Signs and Units for Work

Work is a scalar but it can be positive or negative.

F ⟶ d ⟶ W = **+** (Ex: pitcher throwing ball)

F ⟵ d ⟶ W = **-** (Ex. catcher catching ball)

Units of Work

1 N•m = 1 J (Joule)

Note: $N = kg \bullet m/s^2$

Work – Energy Principle

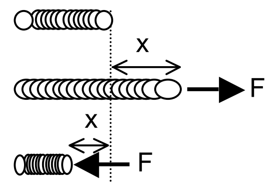
The work done on an object is equal to its change in kinetic energy.

$$W = \Delta E_k = ½ mv_f^2 – ½ mv_i^2$$

Hooke's Law

$F = kx$

F is the applied force.
x is the change in length.
k is the spring constant.



Energy Defined

Energy is the ability to do work.

Units

Same as work: 1 N•m = 1 J (Joule)

Kinetic Energy

Kinetic energy is the energy of motion. If a mass has velocity, then it has KE

$$E_k = ½ mv^2$$

To measure the change in KE use:

$$\Delta E_k = ½ mv_f^2 – ½ mv_i^2$$

Potential Energy

Potential energy is stored energy due to a system's shape, position, or state.

Gravitational PE

Mass with height

$$E_G = mgh$$

Change in E_G

$$\Delta E_G = mgh_f – mgh_i$$

Elastic (Spring) PE

Stretch/compress elastic material

$$E_E = ½ kx^2$$

Change in E_S

$$\Delta E_E = ½ kx_f^2 – ½ kx_i^2$$

Conservation of Energy

"The total energy is neither increased nor decreased in any process. Energy can be transferred from one object to another and transformed from one form to another, but the total energy remains constant."

$$W_D = \Delta E_k + \Delta E_G + \Delta E_E$$

W_D is the work done by dissipative forces (friction, air resistance; any force that transforms energy in such a way that it can not be given back). IF no dissipative forces are present, then $W_D = 0$.

Questions to ask when setting up the equation:

- Does the mass's velocity change?
- Does the mass's height change?
- Is an elastic material (spring) involved?
- Are any dissipative forces acting?

Other Problem Solving Tips

- Draw a picture and label it
- Label/list initial and final conditions
- List what you need to find

Power

Power is:

- the rate at which work is done
- the rate at which energy is transferred

Energy transferred?

Light bulb electrical energy to light energy

Car engine chemical energy to mechanical energy

Units of measure:

Watt (W) or horse power (hp)

1J/s = W (metric)

746 W = 1 hp (English)

The equation

P = Work/time = W/t

Variations:

P = W/t = Fd/t = Fv