Prepared by Dr. A. Mekki

Summary of chapter 7

- We defined the kinetic energy K of a particle of mass m having a velocity v as $K = \frac{1}{2}mv^2$. This is a scalar quantity, which can never be negative. The units of K is Joule (J).

- ***The work energy theorem*** is stated as follows:

$$\Delta K = K_f - K\, i = W$$

where ΔK is the change in kinetic energy and W is the work done by a force on the object.

- The work done by a ***constant force*** $\vec{F}$ during a displacement $\vec{d}$ of the particle is defined as:

$$W = Fd\cos q = \vec{F} \cdot \vec{d}$$

where θ is the angle between $\vec{F}$ and $\vec{d}$.

If more than one force act on the object, then the net work is

$$W_{net} = \vec{F}_1 \cdot \vec{d} + \vec{F}_2 \cdot \vec{d} + \vec{F}_3 \cdot \vec{d} + ...$$

- To calculate the work done by the weight is given by:

$$W_g = mgd\cos q$$

where θ is the angle between $m\vec{g}$ and $\vec{d}$.

We can see that we have two situations:

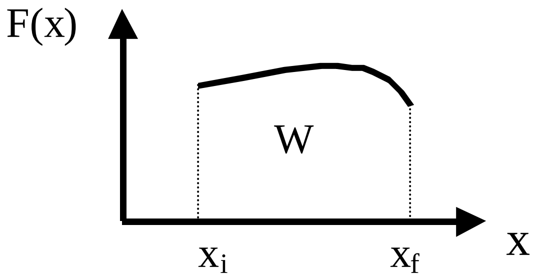
- If the object is **moving up**, the work is **negative** and energy is transferred from the object (its kinetic energy will decrease).
- If the object is **moving down** the work is **positive and energy** is transferred to the object (its kinetic energy will increase).

- Work done by a ***variable force***:

In One dimension: $$W = \int_{xi}^{xf} F(x)dx$$

In three dimension: $$W = \int_{xi}^{xf} F(x)dx + \int_{yf}^{yi} F(y)dy + \int_{zf}^{zi} F(z)dz$$

If you are given a graph of F(x) versus x, then **the work is just the area under the curve.**



- A special case of a variable force is the force of a spring. This force is given by:

$$\vec{F} = -k\vec{x} \qquad \text{(Hooke's law)}$$

where $\vec{x}$ is the displacement of the free end from its relaxed state and k is the spring constant.
We see from the equation that **the force is always opposite the displacement**.

- **The work done by a spring**

$$W_s = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$$

If $x_i = 0$ and $x_f = x$ then $$W_s = -\frac{1}{2}kx$$

- **The power** due to a force is defined **<u>as the rate at which the force does work</u>** on an object.

  - The average power is defined as:

    $$\overline{P} = \frac{W}{\Delta t}$$

  - The instantaneous power is defined as:

    $$P = \frac{dw}{dt} = \vec{F} \cdot \vec{v}$$

The units of power is Joule/sec or Watt (W).