Chapter 7 – Kinetic energy, potential energy, work

I. Kinetic energy.

II. Work.

III. Work - Kinetic energy theorem.

IV. Work done by a constant force: Gravitational force

V. Work done by a variable force.

- Spring force.
- General: 1D, 3D, Work-Kinetic Energy Theorem

VI. Power

VII. Potential energy → Energy of configuration

VIII. Work and potential energy

IX. Conservative / Non-conservative forces

X. Determining potential energy values: gravitational potential energy, elastic potential energy

Energy: scalar quantity associated with a state (or condition) of one or more objects.

I. Kinetic energy

Energy associated with the state of motion of an object.

$$K = \frac{1}{2}mv^2 \qquad (7.1)$$

Units: 1 Joule = 1J = 1 kgm^2/s^2 = N m

II. Work

Energy transferred "to" or "from" an object by means of a force acting on the object.

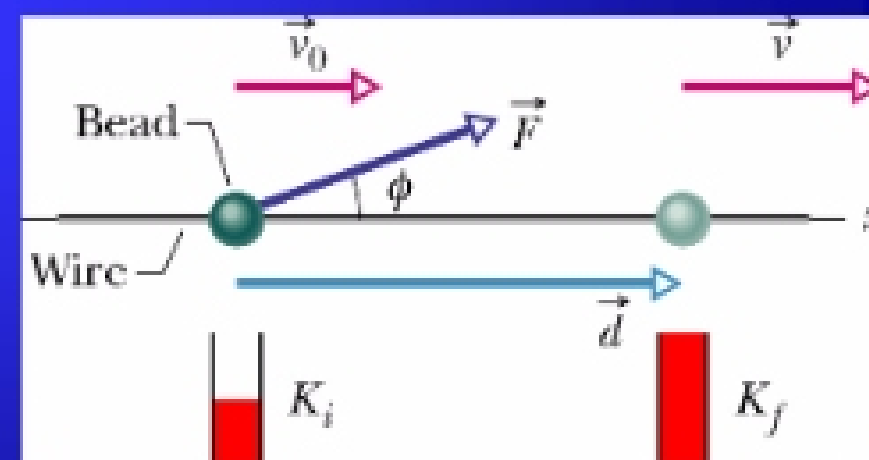
To → +W
From → -W

- **Constant force:** $F_x = ma_x$

$$v^2 = v_0^2 + 2a_x d \rightarrow a_x = \frac{v^2 - v_0^2}{2d}$$

$$F_x = ma_x = \frac{1}{2}m(v^2 - v_0^2)\frac{1}{d} \rightarrow ma_x d = \frac{1}{2}m(v^2 - v_0^2)$$

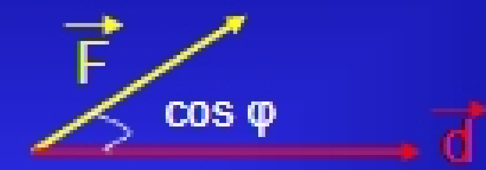
$$\rightarrow \frac{1}{2}m(v^2 - v_0^2) = K_f - K_i = F_x d \rightarrow \boxed{W = F_x d}$$



Work done by the force = Energy transfer due to the force.

- *To calculate the work done on an object by a force during a displacement, we use only the force component along the object's displacement. The force component perpendicular to the displacement does zero work.*

$$W = F_x d = F\cos\varphi \cdot d = \vec{F}\cdot\vec{d} \qquad (7.3)$$



- **Assumptions:** 1) F=cte, 2) Object particle-like.

$\varphi < 90^\circ \rightarrow +W$

$180^\circ > \varphi > 90^\circ \rightarrow -W$

$\varphi = 90^\circ \rightarrow 0$

Units: 1 Joule = 1J = 1 kgm^2/s^2

A force does +W when it has a vector component in the same direction as the displacement, and –W when it has a vector component in the opposite direction. W=0 when it has no such vector component.

Net work done by several forces = Sum of works done by individual forces.

Calculation: 1) $W_{net} = W_1 + W_2 + W_3 + \ldots$

2) $\vec{F}_{net} \rightarrow W_{net} = \vec{F}_{net} \cdot \vec{d}$