Summary of chapter 8

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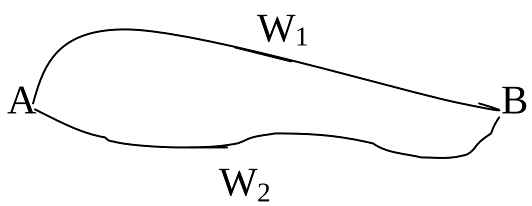
- There are two types of potential energies: One is ***gravitational*** and the other is ***elastic*** (spring).

- The work done by a conservative force is related to the change in potential energy by the relation: $\Delta U = -W$

- The **weight** and the **spring force** are both **conservative forces**.

- The **force of friction** and any applied force such as the **tension** are **non-conservative forces**.

- The work done by a conservative force on a particle moving between two points, A and B, does not depend on the path taken by the particle.



If the Force is conservative, then $W_1 = W_2$.

- For a conservative force we have a relation between the force and the change in potential energy: $\Delta U = -\int_{x_i}^{x_f} F(x)dx$ (in One dimension).

- The **change in gravitational potential energy** of the Earth-object system is therefore:

$$\Delta U = mg\Delta y$$

Δy is the **vertical distance** traveled by the object.

- ? If the object is moving up, ?y is positive and ?U is positive.
- ? If the object is moving down, ?y is negative and ?U is negative.

✍ The **potential energy** at any location y is given by: $U \; ? \; mgy$

✍ The **change in elastic potential energy** of the block-spring system is:

$$?U \; ? \; \frac{1}{2}kx_f^2 \; ? \; \frac{1}{2}kx_i^2$$

✍ The **potential energy** of the spring is given by: $U \; ? \; \frac{1}{2}kx^2$

✍ If ***only conservative forces act on a particle***, then the **mechanical energy is conserved**, **E = K + U = Constant**, and the change in mechanical energy is zero**:** **?E = ?K + ?U = 0**

✍ If ***only a conservative force act on a particle***, and U(x) is given, then the force acting on the particle can be found by:

$$F(x) \; ? \; ? \frac{dU(x)}{dx}$$

You can check this relation for yourself in the case of the weight and the spring force:

In the case of the spring force $U \; ? \; \frac{1}{2}kx^2$, then

$? \frac{dU}{dx} \; ? \; ?kx \; ? \; F(x)$ and this is the force of the spring (Hooke's law)

✍ Work done by non-conservative forces:

There are two types of non-conservative forces: (i) Applied force and (ii) Force of friction.

? Applied force:

The work energy theorem of chapter 7 says: $? K \ ? \ W_c \ ? \ W_a$

Where W_c is the work of conservative forces (focrce of gravity or spring force) and W_a is the work of the applied force. But W_c = ? ? U, so:

$$? K \ ? \ ? U \ ? \ W_a$$

or

$$? E \ ? \ W_a$$

? Friction force:

If only a single friction force exist in the problem, then the change in mechanical energy is:

$$? \boldsymbol{E} \ ? \ ? \ \boldsymbol{f_k d} \ ? \ ? ? \ \boldsymbol{E_{int}}$$

(this is the mechanical energy **<u>dissipated</u>** by the force of friction f_k).

✍ If we chose our system such as the friction force becomes an internal force, and therefore transfers energy within the system (internally) then:

$$? \boldsymbol{K} \ ? \ ? \boldsymbol{U} \ ? \ ? \ \boldsymbol{f_k d}$$

so: $$? K \ ? \ ? U \ ? \ ? E_{\text{int}} \ ? \ ? E_{tot} \ ? \ 0$$