Физика 1
предавање (3.4.2020.)

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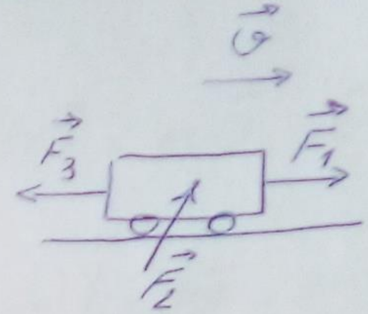
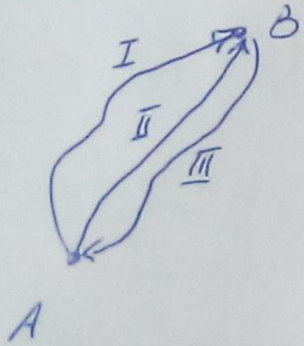
Закони одржања



Механички рад силе:

$$A = \vec{F} \cdot \vec{s}$$

Конзервативне силе:



$$A_{AB(I)} = A_{AB(II)} = -A_{BA(III)}$$

$$A_{ABA} = A_{AB(I)} + A_{BA(III)} = 0$$

$$\oint \vec{F} \cdot d\vec{s} = 0$$

Снага или ефекат рада:

$$P = \frac{\delta A}{dt} \Rightarrow P = \vec{F} \cdot \frac{d\vec{s}}{dt} = \vec{F} \cdot \vec{v}.$$

$$\Rightarrow A = \int_{t_1}^{t_2} P(t)\, dt.$$

$$[A] = N \cdot m = J, \quad [P] = N \cdot \frac{m}{s} = \frac{J}{s} = W.$$

Кинетичка енергија

$$\delta A = \vec{F}\cdot d\vec{s} = \left(m\cdot\frac{d\vec{\vartheta}}{dt}\right)\cdot d\vec{s} = m\vec{\vartheta}\cdot d\vec{\vartheta} = d\left(\frac{m\vartheta^2}{2}\right)$$

$$A = \int_{s_1}^{s_2}\vec{F}\cdot d\vec{s} = m\int_{s_1}^{s_2}\frac{d\vec{\vartheta}}{dt}\cdot d\vec{s} = m\int_{\vartheta_1}^{\vartheta_2}\vec{\vartheta}\cdot d\vec{\vartheta} = \frac{m\vartheta_2^2}{2} - \frac{m\vartheta_1^2}{2}$$

$$\Rightarrow \quad A = E_{k2} - E_{k1} = \Delta E_k$$

$$\underline{E_k = \frac{1}{2}m\vartheta^2}$$

за систем од n честице:

$$E_k = \sum_{i=1}^{n} E_{k_i} = \sum_{i=1}^{n}\frac{m_i\vartheta_i^2}{2} \qquad [E_k] = J.$$

Потенцијалне енергије

$$A = \int_1^2 \delta A = \int_1^2 \vec{F}\cdot d\vec{r} = \int_1^2 dA = -\int_1^2 dU = U_1 - U_2$$

За конзервативне силе рад не зависи од облика путање

U – потенцијална енергија

$$\vec{F}\cdot d\vec{r} = -dU \Rightarrow \vec{F} = -\frac{dU}{dr}\cdot\vec{e}_r$$

$$\vec{F} = -\operatorname{grad} U = -\nabla U$$

$$\operatorname{grad} = \left\{ \frac{\partial}{\partial x}\vec{e}_x + \frac{\partial}{\partial y}\vec{e}_y + \frac{\partial}{\partial z}\vec{e}_z \right\}$$

Закон одржања механичке енергије

Случај 1 реакције:

$$\frac{d(m\vec{v})}{dt} = \vec{F}^{(c)} + \vec{F}^{(nc)} \quad /\cdot d\vec{r}$$

$$\Rightarrow \quad m\, d\vec{v} \cdot \overbrace{\frac{d\vec{r}}{dt}}^{=\vec{v}} = \underbrace{\vec{F}^{(c)} \cdot d\vec{r}} + \vec{F}^{(nc)} \cdot d\vec{r}$$

$$\Rightarrow \quad \underbrace{m\,\vec{v}\,d\vec{v}} = -dU + \vec{F}^{(nc)} \cdot d\vec{r}$$

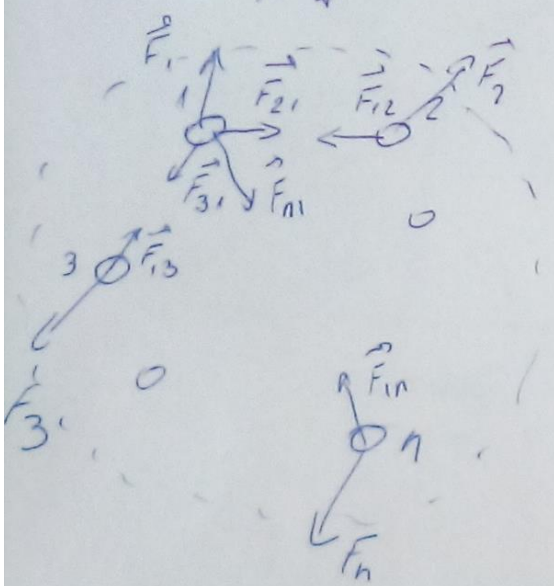
$$\Rightarrow \quad d\left(\frac{mv^2}{2}\right) + dU = \vec{F}^{(nc)} \cdot d\vec{r}$$

$$\Rightarrow \quad \boxed{d\left(\frac{mv^2}{2} + U\right) = \delta A^{(nc)}}$$

За $\delta A^{(nc)} = 0 \Rightarrow d\left(\frac{mv^2}{2} + U\right) = 0 \Rightarrow \boxed{\frac{mv^2}{2} + U = const}$

Закон одржања механичке енергије

2. случај – систем n - честице



$$m_i \frac{d\vec{v}_i}{dt} = \sum_{j\neq i}^{n} \vec{F}_{ji}^{(c)} + \vec{F}_i^{s(nc)} \quad \Big/ \cdot d\vec{r}_i$$

$$m_i \frac{d\vec{v}_i}{dt}\cdot d\vec{r}_i = \sum_{j\neq i}^{n} \vec{F}_{ji}^{(c)}\cdot d\vec{r}_i + \vec{F}_i^{s(nc)}\cdot d\vec{r}_i \qquad \frac{d\vec{r}_i}{dt} = \vec{v}_i$$

$$d\left(\frac{m_i v_i^2}{2}\right) = \sum_{j\neq i}^{n} \left(-dU_{ji}\right) + \vec{F}_i^{s(nc)}\cdot d\vec{r}_i$$

$$\sum_i \Rightarrow \underbrace{\sum_i d\left(\frac{m_i v_i^2}{2}\right)}_{dE_k} + \underbrace{\sum_i \sum_{j\neq i}^{n} \left(dU_{ji}\right)}_{dU} = \underbrace{\sum_i \vec{F}_i^{s(nc)}\cdot d\vec{r}_i}_{\delta A^{s(nc)}}$$

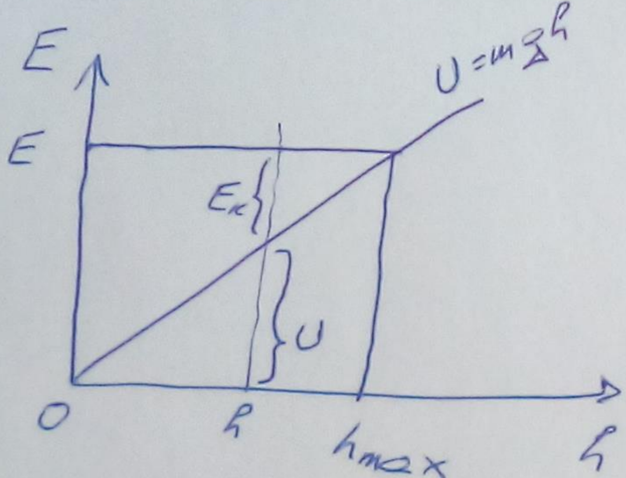
$$dE_k + dU = \delta A^{s(nc)}$$

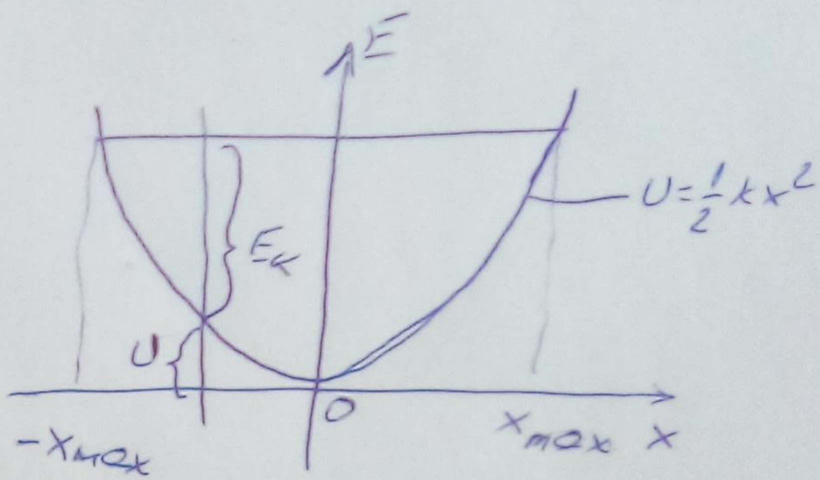
$$\Rightarrow \boxed{d(E_k + U) = \delta A^{s(nc)}}$$

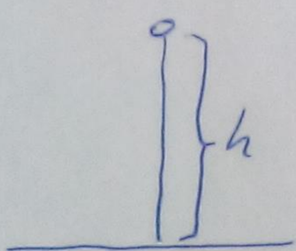
$$\delta A^{s(nc)} = 0 \Rightarrow d(E_k + U) = 0$$

$$\boxed{\Rightarrow E_k + U = const}$$

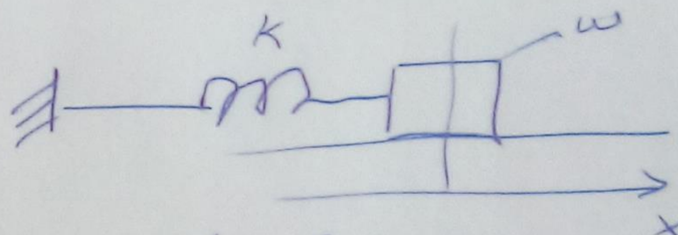
Енергијски дијаграми







$U = mgh$



$U = \frac{1}{2} k x^2$