

$dW = \vec{F} \cdot d\vec{s} = m \frac{d\vec{v}}{dt} \cdot d\vec{s} = m \vec{v} \cdot d\vec{v}$

$L_{gravitazionale}: L = \int_A^B \vec{m}\vec{g} \cdot d\vec{s} = m\vec{g} \cdot \int_A^B d\vec{s} = m\vec{g} \cdot \vec{AB} = -m\vec{g} \cdot (\vec{z}_B - \vec{z}_A)$   
 $L = mg(z_A - z_B) = E_{PA} - E_{PB} = -\Delta E_P$

$L_{springa elastica}: L = \int_A^B -Kx \cdot dx = -\frac{Kx^2}{2} \Big|_A^B = -\Delta E_P, E_P = \frac{1}{2} Kx^2$

$L_{forza attrito}: L = \int_A^B \vec{f} \cdot d\vec{s} = \int_A^B \mu_d N \hat{u}_v \cdot d\vec{s} = \mu_d N \int_A^B ds = \mu_d N \Delta s$

$dW = \vec{F} \cdot d\vec{s} = F_x dx + F_y dy + F_z dz = -dE_P$  se  $\vec{F} = -\vec{\nabla} E_P$

$\oint dW = 0 \Rightarrow \exists f(x, y, z) \text{ t.c. } F_x = -\frac{\partial f}{\partial x}, F_y = -\frac{\partial f}{\partial y}, F_z = -\frac{\partial f}{\partial z} \quad f = E_P$   
 $\vec{F} = -\vec{\nabla} E_P \rightarrow \vec{F} = m\vec{g} \Rightarrow \frac{dE_P}{dz} = F = mg \quad E_P = \int mg \cdot dz = mgz$   
 $\vec{F} = -Kx \Rightarrow \frac{dE_P}{dx} = -Kx \quad E_P = \int -Kx \cdot dx = -\frac{Kx^2}{2}$

$\vec{L} = \vec{r}_0 \times \vec{p} = \vec{r}_0 \times m\vec{v}$   
 $\vec{r}_0 = \vec{OO'} + \vec{r}$   
 $\vec{L}_{O'} = \vec{OO'} \times \vec{p} + \vec{L}_O$   
 $\vec{L} = \vec{r} \times m(\vec{v}_r + \vec{v}_0) = \vec{r} \times m\vec{v}_0$   
 $\vec{M}_0 = \vec{r}_0 \times \vec{F}$   
 $\vec{M}_{O'} = \vec{M}_0 + \vec{OO'} \times \vec{F}$   
 $\vec{M} = \sum \vec{r}_i \times \vec{F}_i = \vec{r} \times \sum \vec{F}_i = \vec{r} \times \vec{R}$

$\frac{d\vec{L}}{dt} = \frac{d\vec{r}}{dt} \times \vec{p} + \vec{r} \times \frac{d\vec{p}}{dt} = \vec{v} \times m\vec{v} + \vec{r} \times \vec{F} = \vec{M}$

$\vec{v} = \frac{d\vec{r}}{dt} = \frac{dr}{dt} \hat{u}_r + r \frac{d\hat{u}_r}{dt} = v \hat{u}_r + r \frac{d\theta}{dt} \hat{u}_\theta$   
 $\vec{L} = \vec{r} \times m r \frac{d\theta}{dt} \hat{u}_\theta$

Se  $\vec{r} \perp \hat{u}_\theta \Rightarrow L = mrv^2 \frac{d\theta}{dt}$

$F \text{ centrale} \Rightarrow \vec{L} = \text{cost.} \Rightarrow \frac{1}{2} r^2 \frac{d\theta}{dt} = \text{cost.}$   
 $\frac{dA}{dt} = \frac{1}{2} r^2 \frac{d\theta}{dt}$   
 $A = \frac{L}{2m}$  periodo:  $T = \frac{2\pi A}{L}$

$L_{\text{ovoro forze centrali}}: L = \int_A^B \vec{F} \cdot d\vec{s} = \int_A^B F(r) \hat{u}_r \cdot d\vec{s}$   
 $ds \cos \theta = dr \Rightarrow \hat{u}_r \cdot d\vec{s} = dr$   
 $d\vec{r} = r d\theta \hat{u}_\theta \quad |d\vec{r}| = r d\theta = dr$   
 $L = \int_A^B F(r) dr = f(r_f) - f(r_i)$

$\vec{r} = \vec{r}_0 + \vec{r}'$   
 $\vec{v} = \frac{d\vec{r}}{dt} = \frac{d\vec{r}_0}{dt} + \frac{d\vec{r}'}{dt} = \vec{v}_0 + \vec{v}' + \vec{\omega} \times (\vec{x}' \hat{x}' + \vec{y}' \hat{y}' + \vec{z}' \hat{z}') = \vec{v}_0 + \vec{v}' + \vec{\omega} \times \vec{r}'$