

Parallels between energy and momentum (calculus-based physics)

Impulse and momentum	Work and energy
$\vec{p} := m\vec{v}$	$K := \frac{1}{2}mv^2$
$d\vec{J}_F := \vec{F}dt \quad \int_{t=t_i}^{t=t_f} d\vec{J}_F = \Delta\vec{J}_F$	$dW_F := \vec{F} \cdot d\vec{\ell} = F_{\parallel}d\ell = (F \cos \theta)d\ell$ $\int_{\vec{r}=\vec{r}_i}^{\vec{r}=\vec{r}_f} dW_F = \Delta W_F$ $[W] = \text{N} \cdot \text{m} = \text{J}$
$\vec{p}_i + \sum_F \overbrace{\Delta\vec{J}_F}^{\Delta\vec{J}_{\Sigma\vec{F}}} = \vec{p}_f$	$K_i + \sum_F \Delta W_F = K_f$ <p>If system has no internal degrees of freedom, $\sum_F \Delta W_F = \Delta W_{\Sigma\vec{F}}$.</p>
$\vec{F} = \frac{d\vec{J}_F}{dt} = \frac{d\vec{p}_F}{dt}$	$P_F := \frac{dW_F}{dt}$ $P_F = \vec{F} \cdot \vec{v} = (F \cos \theta)v$ $[P] = \frac{\text{J}}{\text{s}} = \text{W}$
	$-\Delta U_{F,1\dots N} := \Delta W_{F,2 \rightarrow 1} + \Delta W_{F,1 \rightarrow 2} + \dots + \Delta W_{F,N-1 \rightarrow N}$ $F_x = -\frac{dU_F}{dx} \quad \Delta U_G = mg\Delta h \quad \Delta U_S = \frac{1}{2}k(\Delta x)^2$
$\Sigma\vec{p}_i + \sum_{\text{EXT} \rightarrow \text{SYS}} \overbrace{\Delta\vec{J}_F}^{\Delta\vec{J}_{\Sigma\vec{F},\text{EXT} \rightarrow \text{SYS}}} = \Sigma\vec{p}_f$	$\overbrace{\Sigma K_i + \Sigma U_{G,i} + \Sigma U_{S,i}}^{\Sigma ME_{\text{SYS},i}} + \Sigma \Delta W_{\text{OUF}} = \overbrace{\Sigma K_f + \Sigma U_{G,f} + \Sigma U_{S,f}}^{\Sigma ME_{\text{SYS},f}} + \Sigma \Delta U_{\text{INT}}$