

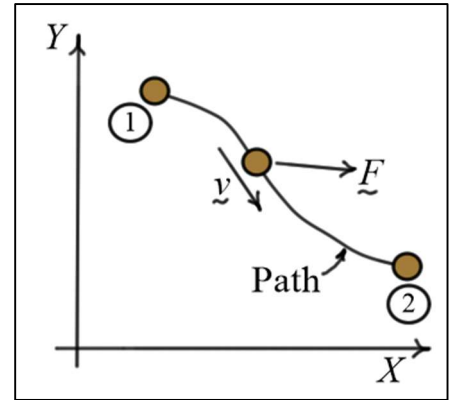
Elementary Dynamics

Power and Efficiency

The work done by a force \vec{F} as a particle moves along a path is defined to be

$$U_{1 \rightarrow 2} = \oint \vec{F} \cdot d\vec{r} = \int_{t_1}^{t_2} \left(\vec{F} \cdot \frac{d\vec{r}}{dt} \right) dt = \int_{t_1}^{t_2} (\vec{F} \cdot \vec{v}) dt$$

The **power** generated by \vec{F} at any **instant** of time is $P = \vec{F} \cdot \vec{v} = dU/dt$. The average power generated by \vec{F} over an interval of time Δt is $P_{avg} = \Delta U / \Delta t$.



Many mechanical or electro-mechanical systems are used to supply power to (or to do work on) other systems. One common example is the electric motor. These systems must always be supplied a higher level of power than they deliver. The ratio of the power they **deliver** to the power they **receive** is defined as the efficiency of the system.

$$\varepsilon = \frac{\text{power delivered}}{\text{power received}} \quad (\text{efficiency of the system})$$

Units:

Unit	Equivalent Unit
1 Joule (J)	1 (N-m)
1 Watt (W)	1 (J/s) = 1 (N-m/s)
1 Horsepower (HP)	550 (ft-lb/s)