

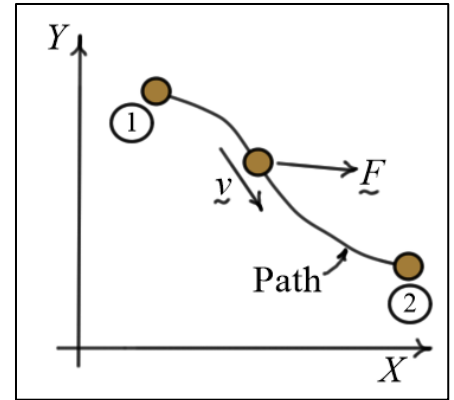
## Elementary Dynamics

### Power and Efficiency

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

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

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  $\Delta t$  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)