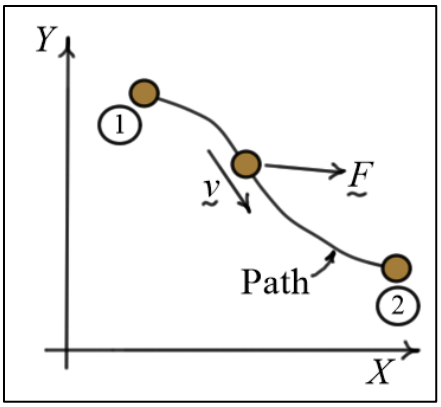
Elementary Dynamics
Power and Efficiency

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



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

The ***power*** generated by $\underset{\sim}{F}$ at any ***instant*** of time is $P = \underset{\sim}{F} \cdot \underset{\sim}{v} = dU/dt$. The average power generated by $\underset{\sim}{F}$ 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.

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

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)