Work, Energy, Power

* Work: \( W = \int_{a}^{b} F \cdot ds \) [in some definition, \( ds \) should be infinitesimal small].

When \( W \) is +ve, the work is done by the force. When \( W \) is -ve, the work is done against the force.

* No-work force: \( W = \int F \cdot ds \cos 90^\circ = 0 \)

* Work done by a couple: \( W = \int \tau \cdot d\theta \)

* \( E_k = \frac{1}{2} mv^2 \); \( P = \sqrt{2mE_k} \)

* Work-Energy Theorem: The change in kinetic energy of a body is equal to the work done on it by the resultant force acting on it.

* Power, \( P = \frac{dW}{dt} \).

* \( P = (F \cdot ds)/dt = F \cdot \vec{v} \)

* Principle of Minimum Potential Energy: In all spontaneous motion, potential energy of a body always decreases.

* When force is applied on a body, which is placed above another body, the work done by the resultant force on the lower body is positive.

* Work done, changes with frame of reference.

* 1 amu = \( 1.67 \times 10^{-27} \) kg = 931 MeV

* \( F(x) = -\frac{dU(x)}{dx} \)

1 kg = \( 9 \times 10^{-16} J \) = \( 1.6 \times 10^{-10} \) (by \( E = mc^2 \)).

In thermo-couple heat to electrical energy transformation occurs.

Types of Equilibrium:
1) Stable: \( f = -\frac{dU}{dx} = 0 \) \& \( \frac{d^2U}{dx^2} = +ve \).
2) Unstable: \( f = -\frac{dU}{dx} = 0 \) \& \( \frac{d^2U}{dx^2} = -ve \).
3) Neutral: \( f = -\frac{dU}{dx} = 0 \) \& \( \frac{d^2U}{dx^2} = 0 \).

If a chain of length \( L \) & mass \( M \) is held on a frictionless table with \( (\frac{1}{n})^{th} \) of length hanging over the edge, work done on pulling the chain against gravity = \( \frac{MgL}{2n^2} \).

Velocity of chain while leaving the table = \( \sqrt{gL(1-\frac{1}{n^2})} \).

1 watt = 1 J/s = 10^7 erg/s.
1 hp = 746 watt. 1 kw hr = \( 3.6 \times 10^6 \) J.

Position \& velocity of an automobile with time, while the engine supplies constant power \( P \).
\( v = \left( 2P/t/m \right)^{1/2} \)
\( s = \left( \frac{8p}{9m} \right)^{1/2} + \frac{3}{2} \)