Chapter 8

Conservation of Energy

Isolated Systems

- Ways to transfer energy to a system: work; waves; heat; matter transfer; electric currents; E/M radiation; etc.
  - mechanical energy in a non-isolated system does not have to be conserved
- Isolated system: no energy crosses the system boundary by any method
  - mechanical energy in an isolated system may or may not be conserved

Conservation of Mechanical Energy

- For a system which only includes conservative forces, the total mechanical energy is conserved

$$W = -\Delta U = \Delta K \qquad K_i + U_i = K_f + U_f$$

  - Gravitation: $\frac{mv_f^2}{2} + mgy_f = \frac{mv_i^2}{2} + mgy_i$
  - Spring: $\frac{mv_f^2}{2} + \frac{mx_f^2}{2} = \frac{mv_i^2}{2} + \frac{mx_i^2}{2}$

Conservative Forces + Friction

- Mechanical energy is no longer conserved – part of it is wasted on friction

$$\Delta K = W = \int F\,dx = \int (F_c + F_k)\,dx = -\Delta U + \int F_k\,dx$$

$$K_f + U_f = K_i + U_i - F_k d$$

Power

- Power = work/time
- Instantaneous power: rate (work per unit time)

$$P = \frac{dW}{dt} = \vec{F}\frac{d\vec{r}}{dt} = \vec{F}\vec{v}$$

- More generally, power = rate of energy transfer