CH_2

2.1 Forms of Energy

Total Energy

the sum of thermal, mechanical, kinetic, potential, electric, magnetic, chemical, and nuclear

$$e = \frac{E}{m}\ (\mathrm{kJ/kg})$$

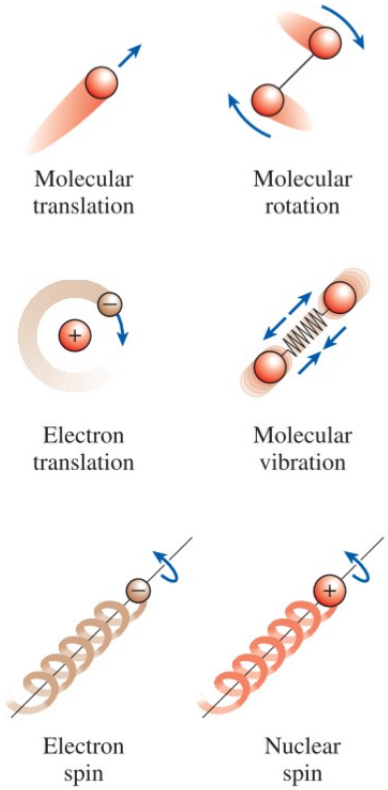
- the macroscopic forms of energy
  - kinetic energy

$$KE = \frac{1}{2}mV^2 \qquad KE = \frac{1}{2}I\omega^2$$

  - potential energy

$$PE = mgz$$

- the microscopic forms of energy
  - translational energy
  - rotational kinetic energy
  - vibrational kinetic energy
  - spin energy



the expression of E

$$E = U + KE + PE = U + \frac{1}{2}mV^2 + mgz$$

- for a closed system or a control mass

$$\Delta E = \Delta U$$

- for an open system or a control volume

  m ass flow rate

$$\dot{m} = \rho \dot{V} = \rho A_c V_{avg}$$

  energy flow rate

$$\dot{E} = \dot{m}e$$

the forms of energy of interactions

- a closed system: **Heat Transfer** and **work**
- a control system: **Heat Transfer**, **work** and **mass flow**

Mechanical energy

Definition: the form of energy that can be converted to mechanical work completely and directly by an ideal mechanical device

$$e_{mech} = \frac{P}{\rho} + \frac{V^2}{2} + gz$$

2.2 Energy Transfer by Heat

Heat

defined as the form of energy that is transferred between two systems by virtue of a temperature difference

Adiabatic Process

a process during which there is no heat transfer

- well insulated
- no temperature difference

Calculation of Heat

$$Q = \int_{t_1}^{t_2} \dot{Q} \mathrm{d}t \qquad Q = \dot{Q}\Delta t$$

Work

the energy transfer associated with a force acting through a distance

Directional Quantities

both heat and work are directional quantities

- heat transfer to a system and work done by a system(**+/positive**)
- heat transfer from a system and work done on a system(**-/negative**)

the Similarities between Heat and Work

- both heat and work are boundary phenomena
- systems possess energy, but not heat or work
- both are associated with a process, not a state
- both are path functions

2.3 the First Law of Thermodynamics

- **Energy can be neither created nor destroyed during a process; it can only change forms**
- **Energy Balance**

$$E_{in} - E_{out} = \Delta E_{System} = \Delta U + \Delta KE + \Delta PE$$

2.4 Energy Conversion Efficiencies

Efficiency

$$\text{Efficiency} = \frac{\text{Desired Output}}{\text{Required Input}}$$

$$\eta_{overall} = \prod^{n} \eta_i$$