9/19/05

CHM 123 - Lecture (Monday 10:50 am)

Nature of Energy:

Energy units:

SI unit: Joule (J) - Amount of energy needed to move kg of mass at speed of 1 m/s.

First Law of Thermodynamics:

Energy is conserved. So energy that is lost by the system must be gained by the surrounding and vice versa.

Internal Energy:

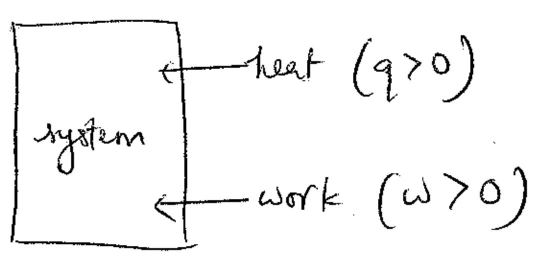
- Sum of all kinetic and potential energy components of the system.
- $E_{initial} \rightarrow E_{final}$
- $\Delta E = E_{final} - E_{initial}$
- Not possible to know the energy of a system but possible to measure the change in internal energy.

ΔE and heat and work:

Internal energy changes if system loses or gains heat or if it does work or work is done on it.

$$\Delta E = q + w$$

Sign convention to keep track of:



Both heat added to system and work done on system increase internal energy of system.

Divide the universe into 2 parts;

- System: what we're studying
- surroundings: everything else.

$\Delta E > 0$ (system gained energy from surroundings)
$\Delta E < 0$ (system lost energy to surroundings)

$$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(g)} + \text{energy}.$$

Work and Heat

Energy can be transferred in the form of heat, work or combination of both.

Work is done against a force over a certain distance.

$$W = F \times d$$

Heat is energy transferred from hotter ~~to~~ object to colder one.

Energy: capacity to do work or to transfer heat.

Example 1:

Calculate change in internal energy of the system for a process in which system absorbs 140 J of heat from the surroundings and does 85 J of work on the surroundings.

$q = +140\text{ J}$
$w = -85\text{ J}$

$\Delta E = q + w$
$= 140\text{ J} - 85\text{ J} = \underline{\underline{+55\text{ J}}}$

Heat capacity:

- Determines the temperature change experienced by an object when it absorbs energy.
- Amount of heat required to raise temperature by 1 degree.
- Larger the heat capacity, the greater the amount of heat needed to raise the temperature.

- **Molar heat capacity:**
  Heat capacity of 1 mole of a substance.

- **Specific heat capacity:**
  Heat capacity of 1 gram of a substance.

$$c = \frac{\text{qty. of heat transferred}}{(\text{grams of substance}) \times (\text{temp. change})} = \frac{q}{m \Delta T}.$$

Example 2
How much heat is needed to warm 300g of water from 20°C to 95°C? The specific heat of water is 4.18 J/g°C,

$$q = (4.18\ J/g°C)(300g)(95°C - 20°C) = 94050\ J$$
$$= \underline{\underline{94\ kJ}}$$

Calorimetry:

- Assume no heat loss or gained through calorimeter.
- Any heat lost by reaction (or substance) is gained by solution.
- Any heat gained by reaction lost by solution.

$$q_{soln} = -q_{rxn} \quad \text{OR} \quad q_{soln} = -q_{metal}.$$