Thermo chemistry

Thermochemistry: Thermochemistry is a branch of thermodynamics

وتعتبر من تطبيقات القانون الاول للثرموديناميك

The study the energy transferred as heat involved in physical and chemical process

The First Law of Thermodynamics

Energy cannot be created nor destroyed, only transferred

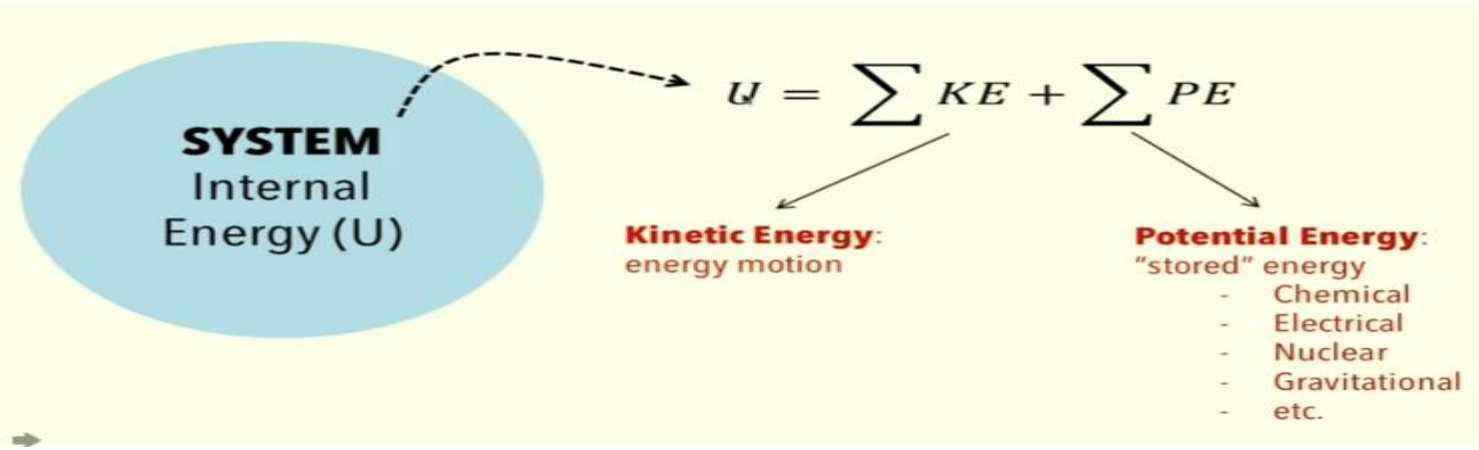
قانون حفظ الطاقة ينص على أن الطاقة لا تفنى ولا تستحدث، لكن تنتقل من حالة الى حالة اخرى

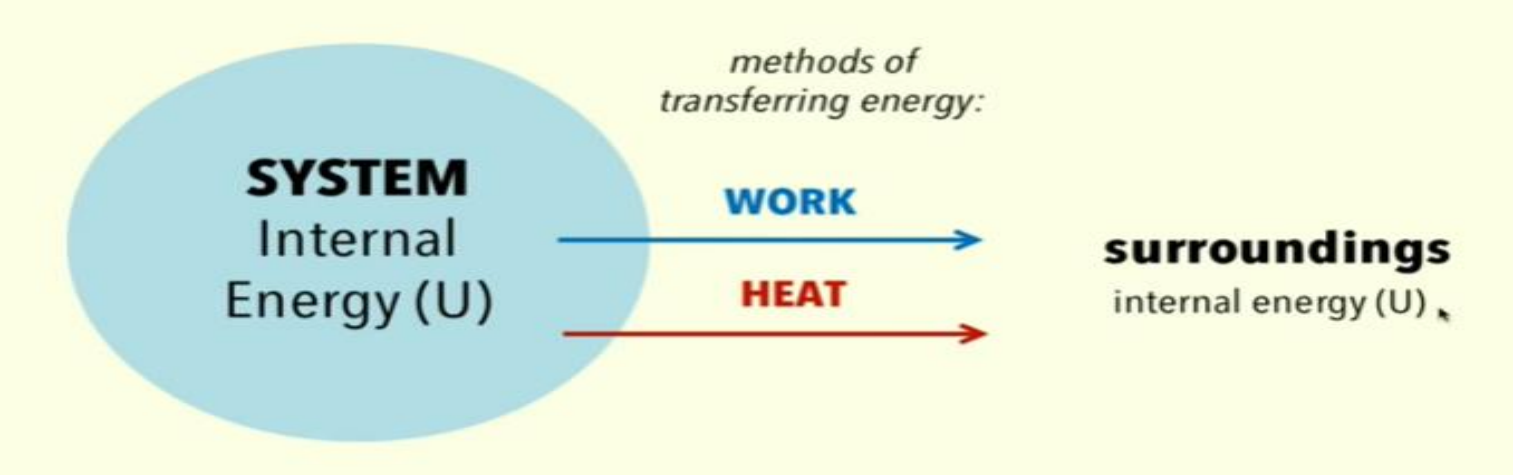
$\Delta U = q + w$

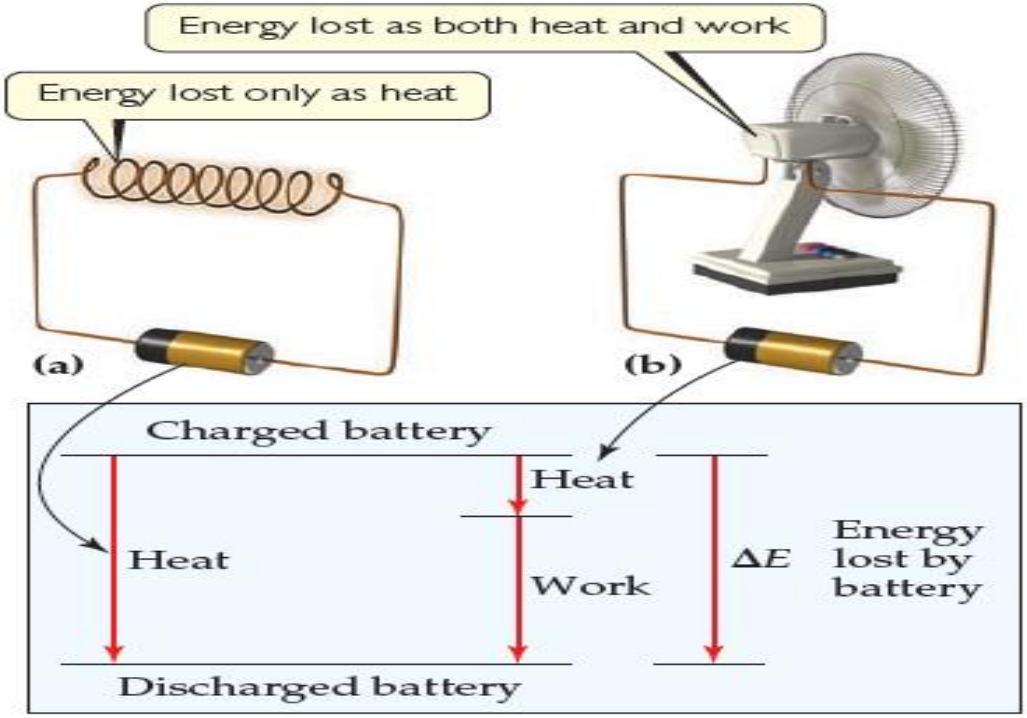
q = كمية الحرارة (J) , ΔE, or ΔU = الطاقة الداخلية (J)

W= الشغل (J)

internal energy, E or U, of a system is the sum of all the kinetic and potential energies,




methods of
transferring energy:
SYSTEM
Internal
Energy (U)
WORK
HEAT
surroundings
internal energy (U)


Energy lost as both heat and work
Energy lost only as heat
(a)
(b)
Charged battery
Heat
Heat
Work
ΔE
Energy
lost by
battery
Discharged battery

System and Surroundings

Open system

is one in which **matter** and **energy** can be exchanged with the surroundings

Closed systems

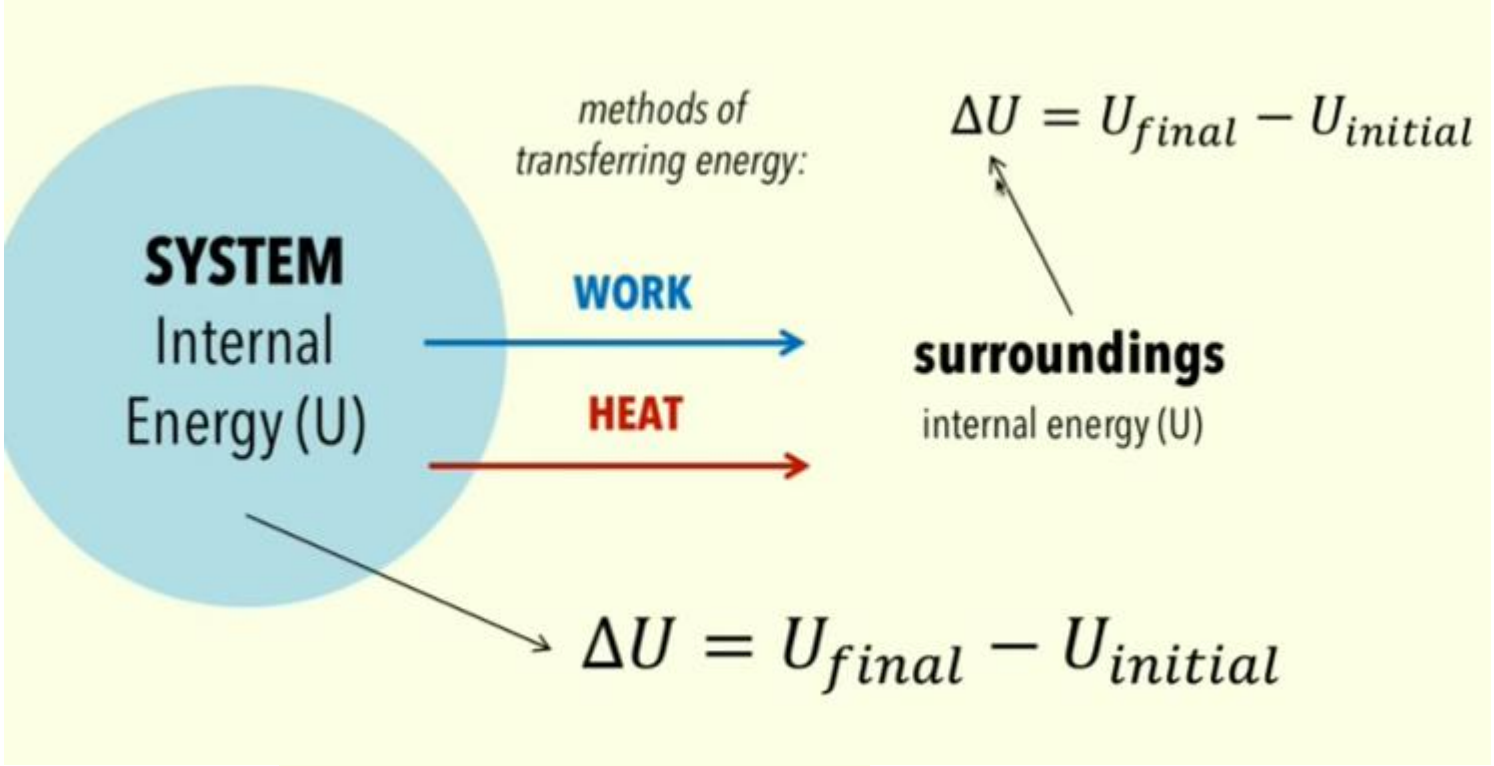
that can exchange energy but not matter with their surroundings

Isolated system

is one in which neither energy nor matter can be exchanged with the surroundings

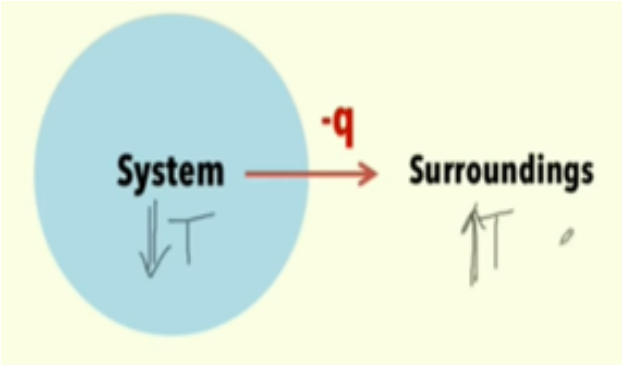
The system then undergoes a change, which might involve work being done or heat being transferred.

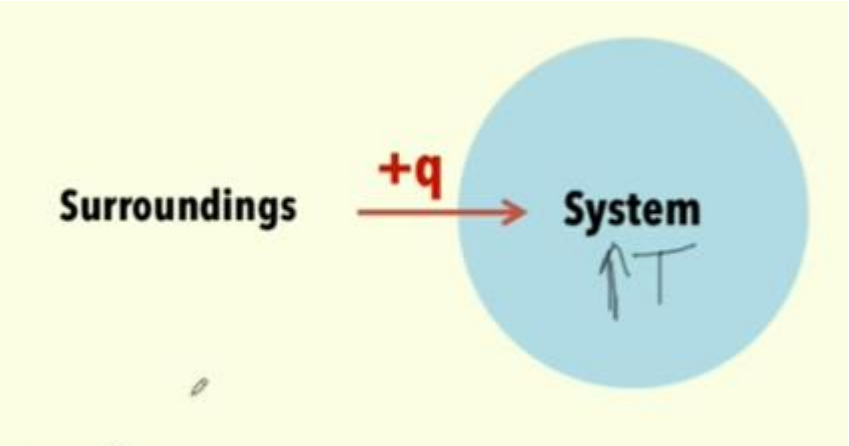
After the change $\Delta U = U_{final} - U_{initial}$



$$\Delta U_{sys} = -\Delta U_{surr}$$

Heat(q): measure of thermal energy transfer that can be determined by the change in temperature of an object





- Factors that determine amount of heat transfer:
  - Temperature change
  - Amount of substance
  - Nature of the substance

$$\Delta Q = mcdt$$

$$\Delta Q = nCdt$$

ΔQ the heat change can be sensed by a variation in the temperature (dt) of system

(m) mass of substance

(n) number of moles of substance

<u>Heat capacity :</u>amount of heat required to raise the temperature of amount of substance by 1K or 1°C.

- Specific heat capacity (c): 1 gram of substance (J/g-K)
- Molar heat capacity (C): 1 mol of substance (J/mol-K)

Material	c (J/g·K)
Al	0.900
Al_2O_3	1.275
C_2H_5OH, ethanol	2.42
C_6H_6, benzene (vapors)	1.05
C_6H_{14}, n-hexane	1.65
Cu	0.385
Fe	0.452
Fe_2O_3	0.651
H_2 (g)	14.304
H_2O (s)	2.06
H_2O (ℓ), 25°C	4.184
H_2O (g), 25°C	1.864
H_2O, steam, 100°C	2.04
He	5.193
Hg	0.138
N_2	1.040
NaCl	0.864
O_2 (g)	0.918

If C is temperature dependent

$C = C(T) = a + bT + cT^2$

$\int dq = n \int_{T1}^{T2} (a + bT + cT2)dT$

$q = n[a(T) + b/2(T^2) + c/3(T^3)]$

$q = n[a(T_2 - T_1) + b/2(T_2^2 - T_1^2) + c/3(T_2^3 - T_1^3)]$

$_{Tf}$

$_{Tin}$

ΔQ depend on the route chosen, either at constant volume or constant pressure.

Constant volume the entire energy supplied goes to alter the internal energy as no work is done on the gas.

$$dq_v = n\, C_v\, dT$$

$$C_v = n\left(\frac{dq}{dT}\right)_v$$

Where C_v is heat capacity of the system under constant volume.

Constant pressure the energy supplied goes to increase internal energy and also supplies energy required to do work on the gas

$$dq_p = n\, C_p\, dT$$

$$C_p = n\left(\frac{dq}{dT}\right)_p$$

<u>In liquid and solid</u>

$C_v = C_p$

<u>In Gas</u>

$Cp > Cv$

<u>In ideal gas</u>

$C_p - C_v = R$

<u>Enthalpy(H)</u>: a state function define as the heat involved in a process at constant pressure

$\Delta H = q_p$

$\Delta U = q + w$

$\Delta U = q - p\,\Delta V$

At constant pressure($\Delta H = q_p$)

$\Delta U = \Delta H - p\,\Delta V$

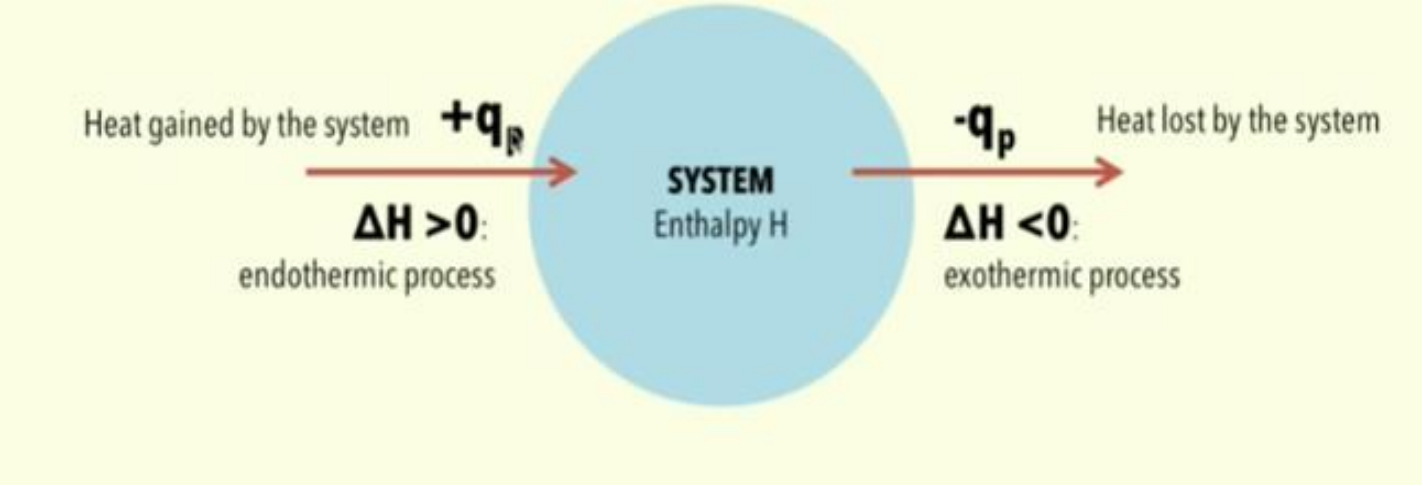
$\Delta H = \Delta U + p\,\Delta V$

$\Delta H = \Delta q_p = n\,Cp\,dT$

$C_p = \frac{1}{n}\left(\frac{dH}{dT}\right)_P$

$\Delta U = \Delta q_V = nC_V\, dT$

$C_V = \frac{1}{n}\left(\frac{dU}{dT}\right)_V$



<u>For mono atomic</u>

$C_V = \frac{3}{2}R$

$C_P = \frac{5}{2}R$

<u>For diatomic</u>

$C_v = \frac{5}{2}R$

$C_p = \frac{3}{2}R$