-: THERMODYNAMIC : -

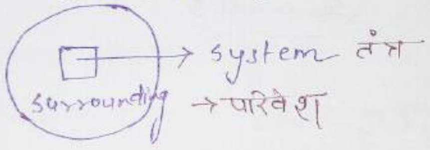
The Branch of chemistry in which we be deals the interconversion of heat, work and various kind of energy known as Thermodynamic's.

Thermodynamical Term ⇒

1- System ⇒ A system is difind as that part of universe which is under investigation.

2- SURROUNDING ⇒
The rest part of universe other then system is known as surounding.

3- UNIVERSE ⇒
Universe is an collection of system and surounding.



⇒ Type's of system ⇒
There are Three's of System

1- OPEN System ⇒
2. Closed System -
3. Isolated System -

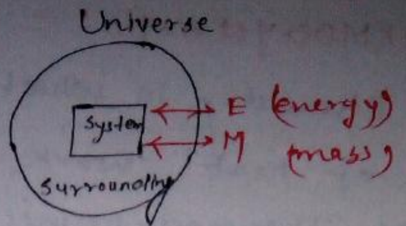
] = SYSTEM

- OPEN SYSTEM ⇒ Such type of system in which we can exchange both energy and mass with surrounding known as open System.

Ex - i) Making Tea in open Container

ii)

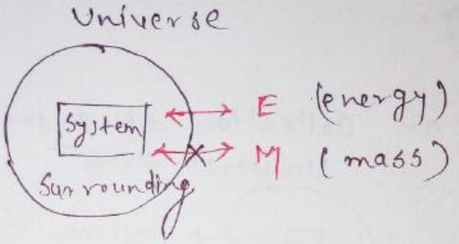
2) Open System



2) Close System (बन्द तंत्र)

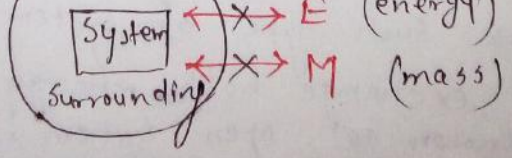
Such Type of System in which only energy can exchange between system and surrounding but mass Can't be exchange.

Ex- Cooking rise in presure Cooker.



3) ISOLATED SYSTEM

Such Type of system in which niether exchange of energy nor mass take place between system and surrounding. Known as Isolated system –



Ex- Boiling water: in thermoflask.

HOMOGENIOUS SYSTEM ⇒

Such Type of Thermodynimical system which is completelly Uniform through out the process Known as HOMOGINEOUS SYSTEM ⇒.

* HETEROGINEOUS SYSTEM ⇒

such type of Thermodynimical system which is not uniform through out the process is known as Heterogineous SYSTEM.

imp

*** INTENSIVE AND EXTENSIVE PROPERTY :→**

1) INTENSIVE PROPERTY —

Such Type of Physical Property which does not depentupon the quantity of the metter present into the system is Know as INTENSIVE property -

ex- Pressure, tempreture, Density, surface tension, viscousity PH, B.P., M.P., Freezing Point, Molerity, Normelity, mole frectio Percentage, refrective index —

2- EXTENSIVE Property - Such Type of Physical Property which depend on the quantity of matter present into the system is known as Extensive property

Ex- mass, volume, entropy, anthelpy, internal energy no. of mole,

*STATE FUNCTIONS ⇒

Such Type of Thermodynamical Property which depends only in final and initial value known as STATE function.

Ex- Tempreture, pressure, Volume, entropy, internal ENEGY.

* PATH FUNCTIONS ⇒

Such Type of Thermodynamical property whose value depends on the path of system by which the value proceed.

Ex- work, Molerheat Capacity, spacific Heat Capacity

THERMODYNAMICAL PROCESS ⇒

1- ISOTHERMAL Process ⇒

Such type of Thermodynamical process which proceed at Constant temp. is called isothermal process.

T is Constant.

ΔT = zero

NOTE in isothermal prosess the value of $\Delta E = 0$

is

ISO-BARIC PROCESS ⇒

Such type of Thermodynamical process which proceed and at Constant pressure is known as iso baric Process.

P- is constant

ΔP is ZERO.

* ISO- CORIC PROCESS ⇒

Such type of Thermodynamical process which proceed and at Const Volume Known as ISO-CORIC Process-

V is Constant

ΔV. is zero

* ADIABATIC PROCESS ⇒

such Type of Thermodynamical process in which No exchange of heat take place b/w system and Surrounding-

q is Zero.

* CYCLIC Process ⇒

When a system undergoes different process is and finally returned to its original Condition Know as Cyclic Process.

In this process ΔE is ZERO

* RiVER SIBLE Process ⇒

Such type of Thermodynamical prosess in which all the Parameter (Presure, Volume, Tempreture) Come back to its original state. by appling sum ~~ori~~. external Condition Known as Rivle-sible process.

ERRIBLE SIBLE Process -

such type of thermodynamical process in which all the parameter (Presure, Volume, temp-) do't Come back to its original state. Know as iRRIBLE SIBLE Process.

INTERNAL ENERGY ⇒

The all posible types of energy present into the metter in a system is know as internal energy. it is represented By E.

$$E = E_{Rotational} + E_{vibrational} + E_{Branslational} + E_{Kinetic} + E_p + E_{et}$$

internal energy of system is extensive property

" " system " state function.

"

The SI unit of internal energy of Jule.

* HEAT

it is a form of energy exchange b/w system and Surrounding.

Heat always flows from higher temp to lowwer temp-

it is represented By Q OR q.

if, $\left[\begin{array}{l} Q \text{ is } -ve, \text{ system will be exothermic.} \\ Q \text{ is } +ve, \text{ system will be anothemic.} \end{array}\right]$

The value of depents of following two point ⇒

$$q \propto m \longrightarrow 1$$

$$q \propto \Delta T \longrightarrow 2$$

$$q \propto m \cdot \Delta T$$

$$\boxed{q = cm\Delta T}$$

if. c is specific heat constant.

$$\boxed{c = \frac{q}{m \cdot \Delta T}}$$

$$m = 1$$

$$\Delta T = 1$$

$$\boxed{c = q}$$

Hence the amount of heat absorb OR evolet when we change the temp. of unit mass object 1°.

unit of specific heat c is equal.

Jule kg^{-1} K^{-1}.

Question if a gold Ring with a mass of 5.5 gm changes it's temp from 25°c to 228°c how much heat is absorb by the Ring if spacific heat of gold is 0.129 Jule gm^{-1} K^{-1}. $\boxed{2.12}$

$$= \frac{0.129}{5.5 \times 276}$$

$$= 2.12$$

Question it has been found that 221.4 Jule heat is needed for 30 gm iron Rod to rays the temp 15°c to 18°c Calculate the spacific heat of iron.

$$q = cm\Delta T$$

$$221.4 = c \times 30 \times 3$$

$$c = \frac{221.4}{30 \times 3}$$

$$c = \frac{221.4}{90}$$

$$\boxed{c = 2.46}$$ Jule gm^{-1} K^{-1}

$T_1 = 273 + 15 = 288$

$T_2 = 273 + 18 = 291$

$T_2 - T_1 = T$

$291 - 288 = 03$

$$\boxed{T = 03}$$

next tuesday

~~for 1 mole~~

16 feb 2016

if we have n- mole gas

$$q = nC\Delta T$$

Here C is know as molar heat capacity.

$$C = \frac{q}{n\cdot\Delta T}$$

n = 1 mole , $\Delta T = 1^\circ$

$$\boxed{C = q}$$

hence moler heat capacity. it that heat for 1 mole which is use for changing the temp - 1°..

there are two types of molar heat capacity.

#1- malar heat capacity at constant volume. (C_v)

2- Molar heat capacity at constant presuree. (C_p).

1- Molar heat capacity at constant volume(C_v) ⇒

we know that $q = nC\Delta T$

at constant volume

$$\boxed{q_v = nC_v\cdot\Delta T}$$

$$C_v = \frac{q_v}{n\cdot\Delta T}$$

Let $n = 1$, for 1 mole -

$$\boxed{C_v = \frac{q_v}{\Delta T}}$$

Molar heat capacity at constant volume is that amount of heat which is requared for 1 mole. substance to the temp 1° at constant volume.

it is represented by C_v.

2 = Molar heat capacity at constant presurre ⇒
We know that $q = nC\Delta T$

at constant presure -

$$q_p = n\, C_p \cdot \Delta T$$

$$C_p = \frac{q_p}{n \cdot \Delta T}$$

$\therefore n = 1$

$$\boxed{C_p = \frac{q_p}{\Delta T}}$$ for 1 mole

Molar heat capacity at constant pressure is that amount of heat which is requared for 1 mole. Substance to the temp 1°. at Constant pressure it is represented by C_p.

first Low of thermodynamic ∀

Statement - I^st^

The energy af total universe is always conserved.

Statement II^nd^

energy con't created oR distroide but it Can we converted from 1 form to another form

Mathematical expilination of I^st^ Low of Theromodynamic →

let as Consider E_1 is the internal energy of the system. let q amount of heat a supplyed to the system, the new internal energy of the system is E_2.

Hence $E_2 = E_1 + q(\text{amount}) + w$

$$E_2 - E_1 = q + w$$

$$\boxed{\Delta E = q + w}$$

if we supplyed q amount of heat to the system the one part of heat is use for changing internal energy and the remaining part of heat is and use for doing work.

* WORK *

axchangeof energy b/w system and surrounding can occure in the form of work.

for gaseous system we will use pressure volume work (PV-work).

Work done in Isothermal & revel sible prosess –

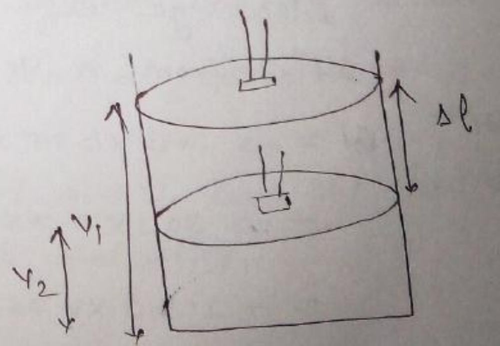
Such type of thermodynamical process in which all the thermodynamical parameter. nor comes to its original state.

Let us consider a gas inclosed in a cylinder

$$\text{Pressure} = F/A$$

$$\text{Work} = F \times \Delta l$$

$$= PA\Delta l$$



$$\boxed{W = P \times \Delta V}$$

if work done on the system W will we positive.

if work by the system w will we negative.

Work done for Isothermal Rivle-sible ⇒

Rivle-sible process a such type of Process in which all the thermodynamic parameter come to it's original state.

this process carryedout in no. of steps.

$$dw = -P \cdot dv$$

Total work

$$\int dw = -\int P dv$$

$$= -\int \frac{nRT}{V} dv$$

$$W = -nRT \int \frac{dv}{V}$$

$$W = -nRT \ln \frac{V_2}{V_1}$$

$$\boxed{W = -2.303\, nRT \log_{10} \frac{V_2}{V_1}}$$

Question⇒ Calculate the work done when 0.75 mol of an ideal gas expand isothermally Reversibably at 27°C from a voloume of 15 L to 25 L.

Sol^n

$$W = -2.303 \times 0.75 \times 8.314 \times 27 \log_{10} \frac{\cancel{25}}{\cancel{15}} \frac{5}{3}$$

$$= -2.303 \times 0.75 \times 8.314 \times 27 \log 5 + \log 3$$

$$= -2.303 \times 0.75 \times 8.314 \times 27 \times 0.6990 + 0.4771$$

$$= 387.7 \times 3.2761$$

$$\boxed{W = 955 \text{ Joule}}$$

Question 2 mol of an ideal gas at 27°c at 1 atm pressure expand isothermally Reversibdy till its pressure become 0-25 atm. Calculate the work done -

$$W = -2.303 \times nRT \log_{10} \frac{V_2}{V_1}$$

by baijle's Law

$$\frac{P_1}{P_2} = \frac{V_2}{V_1}$$

$$W = -2.303\, nRT \log_{10} \frac{P_1}{P_2}$$

$$W = -2.303 \times 2 \times 8.314 \times 27 \log_{10} \frac{\cancel{100}^{\,4}}{\cancel{25}},$$

$$W = -2.303 \times 2 \times 8.314 \times 27 \times 0.602$$

$$W = -6915 \text{ Joule.}$$

Centhalpy :-

The total that heat contein of a system at constant Pressure is equal to the sum of internal energy and PV work known as enthelpy it is Represented by - H.

$$H = E + PV$$

Since anternal energy of the system Con not Calcuted there for enthelpy of the system also on not be Calculated -

let us consider E_1 P_1 and V_1 are the initial state of the system therefor enthelpy.

$$H_1 = E_1 + P_1V_1 \longrightarrow ①$$

if the system go in state 2. the new enthdpy of the system is -

$$H_2 = E_2 + P_2V_2 \longrightarrow ②$$

by eqn. ① and ②

$$H_2 - H_1 = E_2 - E_1 + P_2V_2 - P_1V_2$$

Since enthelpy is calculated at constant pressure

$\therefore \quad P_1 = P_2 = P$

$$\boxed{\Delta H = \Delta E + P\Delta V} \longrightarrow ①$$

let us consider a system has n_1 mol, at system go in state. to. The new mol will be n_2.

by. ideal gas equation.

$$PV_1 = n_1 RT$$

$$PV_2 = n_2 RT$$

$$P(V_2 - V_1) = (n_2 - n_1) RT$$

$$P\Delta V = \Delta n RT$$

Putting there value in eq^n ①

$$\boxed{\Delta H = \Delta E + \Delta n RT}$$

Here $\Delta n = n_p - n_r$ $\left\{ \begin{array}{l} n_p = \text{number of mol of Product} \\ n_r = \text{number of mol of Reactant} \end{array} \right\}$

$R = 8.314$ Joule/K/mole

uestion The enthelpy change ΔH for the Reaction n_2 (gas) + $3H_2$ (gas) $\longrightarrow$ $2NH_3$ (gas) is -92.38 KJ at 298 K Temp - Calculate the value of ΔE.

$$\Delta H = \Delta E + \Delta n RT$$

$$-92.98 \times 10^{-3} = \Delta E - 2 \times 8.314 \times 298$$

Question ⇒ $2A + 5B \longrightarrow 2AB$ for this Reaction if the Value of $\Delta E = -37.609$ KJ at 27°C find out ΔH.

$$\Delta H = -37.609 - 5 \times 0.314 \times 300$$

$$= -37.609 - 7402.6$$

$$= -45171 \times 2$$

$$\Delta H = -52653 \text{ Joule.}$$

NOTE [इन प्रश्नो में हमेशा गैस के मोल ही गिने जाते है। Solid OR Liquid के नहीं –]

Relationship b/w C_p and C_v ⇒

We know that

$$H = E + PV$$

for 1 mole ideal gas $PV = RT$

$$H = E + RT$$

differentiate this w.r.to to T.

$$\frac{d}{dt} H = \frac{d}{dt}(E) + R\frac{d}{dt}(T)$$

$$\frac{dH}{dt} = \frac{dE}{dt} + R$$

$$C_p = C_v + R$$

$$\boxed{C_p - C_v = R}$$

* Atomicity of A gas ⇒

The Ratio of Cp and Cv Called Atomicity of the gas Represented By γ. (gamma)

$\gamma = C_p = C_v$

$\gamma = 1.6$

gas will monoatomic.

If $\gamma = 1.40$

gas will be diatomic.

$\gamma = 1.33$

gas will be poly atomic.

* Heat of Combension ⇒

When 1 mole of the Substance is complitity bornt the heat revold this Known as Heat of Combension.

ex - $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$.

$\Delta H = -890 \text{ KJ mole}^{-1}$

Cailorific value ⇒

When 1 gm of Substance is Complity borned the amount of heat produced Called Cailorific value.

* Heat of Neutrilization ⇒ enthelpy of neutrilization

when 1 gm equivelent of an acid is neutrilize by 1 gm equivelent of as base in dil-Soln. the heat evoldt in Known as enthelpy of neutrilization.

Ex— $\underset{(aq)}{HCl} + \underset{(aq)}{NaOH} \longrightarrow \underset{(aq)}{NaCl} + H_2O$

$\Delta H = -57.1$ KJ OR -13.7 K cal

NOTE

When strong acid strong base are teke part in neutrallization. the enthalpy of neutrallization alway 57.1 KJ OR 13.7 KCOL.

Howere when a strong acid and weak base, weak acid and strong base and weak acid and weak base. take part in neutrilization, The heat of neutrilization alway smaller then 57.1 KJ OR 13.7 K cal.

* Heat of Solution ⇒

The heat of solution of a substance in a particular solvent is difined as the heat change when 1 mole of the substance. is disolved in such a large volume of the solvent. that further addition of the solvent does not producess any more heat.

Ex— $\underset{(Solid)}{CuSO_4} (+ H_2O \longrightarrow \underset{(aq)}{Cu^{+2}} + \underset{(aq)}{SO_4^{-2}}$.

$\Delta H = -56$ KJ.

* enthelpy of fusion OR Heat of fussion ⇒

When 1 mole of a Solid Substance converted into its liquid state at its melting point. Known as heat of fuesion.

$$\underset{(ice)}{H_2O} \longrightarrow \underset{(liq)}{H_2O}$$

$\Delta H = +6$ KJ.

* Heat of vepourization ⇒

When 1 mole of a liquid directily convert into its gaseous state at its B.P. the requared is Known as Heat of vaporization.

$$\underset{(liq)}{H_2O} \longrightarrow \underset{(gas)}{H_2O}$$

$\Delta H = 40$ KJ.

Heat of Sublimation ⇒ (उर्ध्वपातन)

When 1 mole of a Solid Substance is directitily Converted into a vapour state below its melting point. The heat requared is Known as Heat of Sublimation.

$$\underset{(Solid)}{I_2} \longrightarrow \underset{(gas)}{I_2}$$

$\Delta H = 62$ KJ.

$\Delta H = +14.92$ KcaL

$\Delta H = 62.425$ KJ

1 KcaL = 4.184

14.92 Kcal = 14.92 × 4.184

$\Delta H = 62.425$ KJ

→ **Hess Law** हेस का नियम

According to this law the total amount of heat evolved or absorb in any thermodynamical chemical Rxn. alway same, wether the rxn will take place in one step or in more then one step.

Ex-

$$C_{(s)} + O_{2}(g) \longrightarrow CO_{2}\ (g)$$

$$\Delta H = -\ 393.5\ KJ.$$

if this rxn carryed out in more then one step-

$$C_{(s)} + \tfrac{1}{2}O_{2}\ (g) \longrightarrow CO\ (g)$$

$$\Delta H = -\ 110.5\ KJ.$$

$$CO(g) + \tfrac{1}{2}O_{2}\ (g) \longrightarrow CO_{2}\ (g)$$

$$\Delta H = -\ 283.0\ KJ.$$

Total heat = −110.5 − 283.0

T.H. = − 393.5 KJ   this is Hess Law.

Neumerical ③

Type number. 1

Calculate the heat of Combusion for the following

Rxn. $H_{2}C = CH_{2} + H_{2} \longrightarrow H_{3}C - CH_{3}$

if the bond energy data are

$C-H = 414\ KJ.mol^{-1}$

$C=C = 619\ KJ\ mol^{-1}$

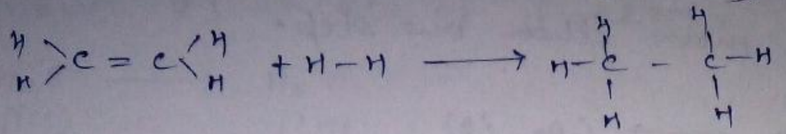
$H-H = 120\ KJ\ mol^{-1}$

$C-C = 184\ KJ\ mol^{-1}$

The heat of combunsion = bond energy of the reactant

— bond energy of the Product

$H_2C = CH_2 + H_2 \longrightarrow H_3C - CH_3$



$[4(C-H) + (C=C) + (H-H)] - [6(C-H) + (C-C)]$

$[4 \times 414 + 619 + 120] - [6 \times 414 + 184]$

$[1656 + 619 + 120] - [2484 + 184]$

$[1656 + 739] - [2668]$

$[1695] - [2668]$

$$\begin{array}{r} 2668 \\ -1695 \\ \hline 973 \end{array}$$

Heat of combunstion = − 973 KJ.

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1 Joule = 0.2390 calories

1 calorie = 4.184 J

1 Kcal = 4.184 KJ

1 Joule = 10^7 ergs

1 erg = 10^7 J

1 KJ = 1000 J

Bond	Bond energy
Cl−Cl	243 KJ mol⁻¹
O=O	499.0 KJ mol⁻¹
C−H	414.0 KJ mol⁻¹
O−H	460.0 KJ mol⁻¹
C=C	619 KJ mol⁻¹
H−H	120 KJ mol⁻¹

ΔE = internal energy

ΔH = heat content

Topic

* Heat of Transition

ΔH = +3.3 Kcal

$C_{diamand} \rightarrow C_{amorphous}$

ΔH = 0.016 Kcal

$S_{monoclinic} \rightarrow S_{rhombic}$

$P_{white} \longrightarrow P_{red}$

ΔH = −1.020 Kcal

Bond	B.E
C−C	184 KJ mol⁻¹

Example→ Three moles of ideal gas ($C = 5$ cal deg^{-1} mol^{-1}) at 10.0 atm and 0° are converted to 2.0 atm at 50° find ΔE and ΔH for the change.

$R = 2$ cal mol^{-1} deg^{-1}

Soln

$$\Delta E = n C_v dT$$
$$= 3 \times 5 \times (50 - 0)$$
$$= 750 \text{ cals}$$

$$\Delta H = n C_p dT = n(C_p + R) dT$$
$$= 3 \times (5 + 2) \times 50$$
$$= 1050 \text{ cals.}$$

Ex- Calculate ΔH° for the reaction -

$$CO_2(g) + H_2(g) \longrightarrow CO(g) + H_2O(g)$$

given that ΔH°_f for $CO_2(g)$, $CO(g)$ and $H_2O(g)$ are -393.5 -111.31 and -241.80 kJ mol^{-1} respectively -

Soln

$$CO_2(g) + H_2(g) \longrightarrow CO(g) + H_2O(g)$$

$$\Delta H^\circ = \Delta H^\circ_f \text{ (Product)} - \Delta H^\circ_f \text{ (reactant)}$$

$$= [\Delta H^\circ_f [CO(g)] + \Delta H^\circ_f [H_2O(g)]] - [\Delta H^\circ_f [CO_2(g)] - \Delta H^\circ_f H_2(g)]$$

$$= [-111.3 + (-241.8)] - [-393.5 + 0]$$

$$= -353.1 + 393.5$$

$$\boxed{\Delta H^\circ = 40.4 \text{ KJ}}$$

Ex- Given that energies for H-H ; O=O and O-H bonds are 104, 118 and 111 Kcal mol^{-1} example -

$$H_2(g) + \tfrac{1}{2} O_2(g) \longrightarrow H_2O(g)$$

Soln In this reaction, two O-H bond are formed and one H-H bon ~~are to~~ is brokem. Therefore we can write for ΔH

$$\Delta H = -2\Delta H(O-H) + \Delta H(H-H) + \tfrac{1}{2}\Delta H(O=O)$$

$$= (-2 \times 111) + 104 + (\tfrac{1}{2} \times \overset{59}{\cancel{118}})$$

$$= -222 + 163$$

$$\Delta H = -59 \text{ Kcal mol}^{-1}$$

Ques Determine of · ΔH of the reaction -

$$C(s) + 2H(g) \longrightarrow CH_4(g)$$

from the following data -

i) $C(s) + 2H_2(g) \longrightarrow CH_4(g)$

i) $C(s) + O_2(g) \longrightarrow CO_2(g)$ $\Delta H = -393.7 KJ$

ii) $H_2(g) + \frac{1}{2} O_2(g) \longrightarrow H_2O(l)$ $\Delta H = -285.7 KJ$

iii) $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$ $\Delta H = -890.3 KJ$

Soln

i) $C + 2H_2 \longrightarrow CH_4$

$\Delta H = 1 \times (2 \times 120) = 240$

$-393.7 - 240 = 0$

multiplying eqn ⓘⓘ by 2 and adding to eqn ⓘ we get

(iv) $C(s) + O_2(g) + 2H_2(g) + O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$

$\Delta H = (2 \times -285.7) + (-393.7)$

$= -471.4 \mp 393.7$

$= -965.1 KJ$

On subtracting equation (iii) from equation (iv) we get.

$C(s) + 2H_2(g) = CH_4$ $\Delta H = -965.1 - (-890.3)$

$\Delta H = -74.8 KJ.$

Thus the heat of formation of methane is $-74.8 KJ$.

TYPE - 2

Calculate the standard enthelpy of formation of ~~$CH_3(OH)$~~ $CH_3(OH)(l)$ a following data are given →

i) $CH_3OH(l) + 3/2\,O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$, $\Delta H = -726\ KJ\ mol^{-1}$

ii) $C(s) + O_2(g) \longrightarrow CO_2(g)$ $\Delta H = -393\ KJ\ MoL^{-1}$

iii) $H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$ $\Delta H = -286\ KJ\ moL^{-1}$

Soln

$\cancel{CO_2} + \cancel{2H_2O} \longrightarrow CH_3OH + 3/2\,O_2$ $\Delta H = +726$

$C + O_2 \longrightarrow \cancel{CO_2}$ $\Delta H = -393$

$2H_2 + O_2 \longrightarrow \cancel{2H_2O}$ $\Delta H = -286 \times 2$

$C + 2H_2 + \frac{1}{2}O_2 \longrightarrow CH_3OH$ $+726 - 393 - 572$

$\Delta H = -239$

Question calculate the enthelpy of combunsion of CH_4 if the following data are given

I) $CH_4 + O_2 \longrightarrow CO_2 + 2H_2O$ $\Delta H = -890.3$

II) $C + O_2 \longrightarrow CO_2$ $\Delta H = -393.5$

III) $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$ $\Delta H = -285.8$.

Soln

$\cancel{CO_2} + \cancel{2H_2O} \longrightarrow CH_4 + \cancel{O_2}$ $\Delta H = +890.3$

$C + \cancel{O_2} \longrightarrow \cancel{CO_2}$ $\Delta H = -393.5$

$2H_2 + O_2 \longrightarrow \cancel{2H_2O}$ $\Delta H = -285.8 \times 2$

$C + 2H_2 + O_2 \longrightarrow CH_4$ $\Delta H = +890.3 - 393.5 - 285.8$

Type-3

Calculate the heat of the following rxn :

$F_2O\,(g) + H_2O\,(g) \longrightarrow 2HF\,(g) + O_2$

If heat of formation of $F_2O\,(g)$, $H_2O\,(g)$, $HF\,(g)$ are $22\ KJ\ mol^{-1}$, $-285\ KJ\ mol^{-1}$, $-276\ KJ\ mol^{-1}$ respectivily -

$$\underset{(g)}{F_2O} + \underset{(g)}{H_2O} \longrightarrow \underset{(g)}{2HF} + \underset{(g)}{O_2}$$

$$\Delta H_R = \Delta H_{Product} - \Delta H_{Reactent}$$

$$= [2 \times \Delta H_{HF} + \Delta H_{O_2}] - [\Delta H_{F_2O} + \Delta H_{H_2O}]$$

$$= [2\times -276] - [22 - 285]$$

$$= -552 + 263$$

$$\Delta H_R = -289$$

Quest

Calculate the enthelpy change for the following rxn -

$CH_4\,(g) + 2O_2\,(g) \longrightarrow CO_2\,(g) + 2H_2O\,(l)$

if the heat of formation of CH_4, CO_2, H_2O are $-74.8\ KJ\ mol^{-1}$, $-393.5\ KJ\ mol^{-1}$, $-286.2\ KJ\ mol^{-1}$ respectivily -

Soln

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

$$\Delta H_R = \Delta H_{product} - \Delta H_{Reactent}$$

$$= \left[\cancel{2\times} - \underset{-393.5}{\cancel{74.8}} + 0\right] - \left[-74.8 + 2\cdot\right.$$

$= [-393.5 + 2(-206.2] - [-74.8 + 0]$

$= [-393.5 - 572.4] + 74.8$

$= -965.9 + 74.8$

$= -891.1$ KJ mol^{-1}

Question

the standard heat of formation at 298 K for $CCl(g)$, $H_2O(g)$, $CO_2(g)$ and $HCl(g)$ are -25.5, -57.8, $-$~~100~~ 94.1 and -22.1 Kcal mol^{-1} respectivily Calculate the enthelpy of formation for the following Reaction -

$$CCl_4(g) + 2H_2O(g) \longrightarrow CO_2(g) + 4HCl(g) -$$

Soln

$\Delta H_R = \Delta H_{Product} - \Delta H_{Reactant}$

$= [94.1 + 4 \times -22.1] - [-25.5 + 2 \times -57.8]$

$= -182.5 + [-141.1]$

$\Delta H_R = -41.4$ KcaL.

* Kirchhoff's equactions:-

The equaction Representing the variosion of heat of the rxn. with temp. Know as kirchoff equations.

at constent volume, the heat of rxn

$$\Delta E = E_2 - E_1$$

differentiate w.r. to temp at Constant Volume-

$$\left\{\frac{d}{dt}(\Delta E)\right\} = \left\{\frac{d}{dt}(E_2)\right\} - \left\{\frac{d}{dt}(E_1)\right\}$$

$$\left\{\frac{d(\Delta E)}{dT}\right\}_V = (C_V)_2 - (C_V)_1$$

$$\frac{d(\Delta E)}{dT} = \Delta C_V$$

$$d(\Delta E) = \Delta C_V \cdot dT$$

$$\int d(\Delta E) = \int_{T_1}^{T_2} \Delta C_V \cdot dT$$

$$\Delta E = \Delta C_V [T_2 - T_1]$$

$$\boxed{\Delta E_2 - \Delta E_1 = \Delta C_V [T_2 - T_1]}$$

This eqn is known as kirchofs eqn at constant volume

at constant pressure

$$\Delta H = H_2 - H_1$$

$$\left\{\frac{d}{dT}(\Delta H)\right\}_P = \left\{\frac{d}{dT}(H_2)\right\}_P - \left\{\frac{d}{dT}(H_1)\right\}_P$$

$$\left\{\frac{d(\Delta H)}{dT}\right\}_p = (C_p)_2 - (C_p)_1$$

$$\frac{d(\Delta H)}{dT} = \Delta C_p$$

$$d(\Delta H) = \Delta C_p \cdot dT$$

$$\int d(\Delta H) = \int_{T_1}^{T_2} \Delta C_p \cdot dT$$

$$\Delta H = \Delta C_p \cdot [T_2 - T_1]$$

$$\boxed{\Delta H_2 - \Delta H_1 = \Delta C_p \cdot [T_2 - T_1]}$$

Que

The heat of rxn $\frac{1}{2} H_2$ ~~+~~

$\frac{1}{2} H_2 + \frac{1}{2} Cl_2 \longrightarrow HCl$ at 27°C is −22·1 Kcal

Calculate the heat of the rxn is 77°C. the molar heat capacity at constant pressure at 27°C for Hydrogen, Chlorine, HCl. are 6.82, 7.7, 6.8 cal/mol.

Soln $\frac{1}{2} H_2 + \frac{1}{2} Cl_2 \longrightarrow HCl$

at 27°C = 300K $\Delta H_1 = -22100$ cal

$\Delta H_2 = ?$

77°C = 350K

$T_1 = 300K$

$T_2 = 350K$

$\Delta H_2 - \Delta H_1 = \Delta C_p (T_2 - T_1)$

$\Delta H_2 + 22100 = -0.46 \times 50$

$\Delta H_2 = \frac{.23}{22100} = .0010$

$\Delta C_p = C_p(\text{Product}) - C_p(\text{Reactor})$

$= 6.80 - [\frac{1}{2} \times 6.82 + \frac{1}{2} 7.7]$

$= 6.80 - [3.41 + 3.85]$

$= 6.80 - 7.26$

$= -.46$

$\Delta H_2 + 22100 = -0.46 \times 50$

$\Delta H_2 + 22100 = -23$

$\Delta H_2 = 23 - 22100$

$\boxed{\Delta H_2 = -22133 \text{ cal}}$

Question

The heat of the rxn

$N_2 + 3H_2 \longrightarrow 2NH_3$ at 27°C was found to be −21.976 Kcal. What will we the heat of rxn at 50°C if the molar heat capacities at Constant Pressure - for N, H, NH_3 are 6.8, 6.77, 8.86 Cal mol^{-1} respectivity -

$N_2 + 3H_2 \longrightarrow 2NH_3$

at 27°C → 300 K $\Delta H_1 = -$

50°C → 323 K $\Delta H_2 =$

$T_1 = 300$

$T_2 = 323$

$T_2 - T_1 = 323 - 300$

$T = 23$ K

$\Delta C_p = C_p(\text{Product}) - C_p(\text{reactant})$

$= 2 \times 8.86 - [6.8 + 3[6.77]]$

$= 17.72 - [6.8 + 20.31]$

$= 17.72 - 27.11$

$\boxed{\Delta C_p = -9.39}$

-22.192

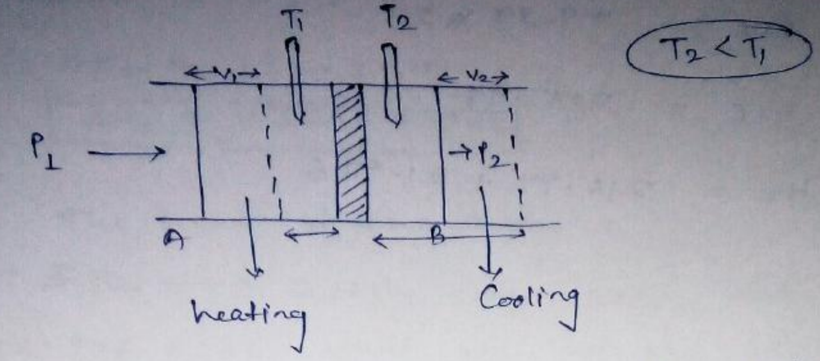
$\Delta H_2 - \Delta H_1 = \Delta C_p (23)$

$\Delta H_2 - 21.976 = -9.39 \times 23$

$\Delta H_2 - 21.976 = 215.97$

$\Delta H_2 = 215.97 + 21.976$

Joule Thomson effect :-



The phenominon of producing lowwering of temp- when a gas is ~~ex~~ made to expend Adiabetically from a high pressure to low pressure region. Know as Joule Thomson effect.

Let us consider the work done by piston A, $W_1 = p_1 V_1$

Let the work done by the piston $W_2 = P_2 V_2$

hence the net work done by the gas

$$W = W_2 - W_1$$

$$W = p_2 V_2 - p_1 V_1$$

According to the first low of thermodynamic

$\Delta E = Q - W$, if the system is adiabatic

$$QV = 0$$

$$\Delta E = -W$$

$$\Delta E = -(P_2 V_2 - P_1 V_1)$$

$$E_2 - E_1 = -(P_2 V_2 - P_1 V_1)$$

$$E_2 + P_2V_2 = E_1 + P_1V_1$$

$$H_2 = H_1$$

$$\boxed{\Delta H = 0}$$

The Ratio of change in temp with change in pressure is Known as Joule Thomson Coefficiant.

~~dep~~ represented by μ.

$$\mu = \frac{dt}{dp}$$

if μ is +ve, gas expends, cooling effect.

μ is −ve = gas compress heating effect.

NOTE

The value of μ depends on the aplly~~ed~~ temperature.

Calculate the heat of combunsion of ethene

$CH_2=CH_2 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$

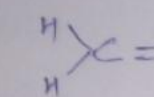
If the bond energy data's are

$C-C = 619$ KJ mol^{-1}, $C=O = 724$ KJ mol^{-1}

$C-H = 414$ KJ mol^{-1}, $O-H = 460$ KJ mol^{-1}

$O=O = 419$ KJ mol^{-1}

<u>Sol</u>

Sol^n  $+ 3(O=O) \longrightarrow 2(O=C=O) + 2(H-O-H)$

$\Delta H = [4(C-H) + \overset{(C=C)+}{\wedge} 3(O=O)] - [4(C=O) + 4(O-H)]$

$[4(414 + 619 + 3(419] - [4(724 + 4(460)]$

$= 1656 + 619 + 1257 - 2896 + 1840$

$= 3532 - 4736$

$\boxed{\Delta H = -964 \text{ KJ}}$