Notes

*. Heat capacity :-

The amount of heat required to raise the temperature of the system through $1^{\circ}C$ or 1K.

If the mass of the system is 1 gram, the heat capacity is called the specific heat of the system.

If the mass of the system is 1 mol, then the heat capacity is termed as molar heat capacity.

It is denoted by C.

Thus, the molar heat capacity of a system between temperatures T_1 & T_2 will be expressed as –

$$C = \frac{q}{T_2 - T_1} = \frac{q}{\Delta T} \quad \text{—(1)}$$

The molar heat capacity of a gaseous system, determined at constant volume is different from that determined at constant pressure.

In former cases, no external work is done by the system or on the system.

Notes

Hence,

$$w = 0.$$

since, there is no change in volume.

Thus,

From 1st law —

$$\Delta U = q + w.$$

$$\therefore \Delta U = q$$

from eq^n — (1)

$$C_v = \left(\frac{\Delta U}{T_2 - T_1}\right)_v \quad \text{or } \Delta U = C_v \Delta T.$$

$$\text{or} \quad C_v = \left(\frac{\partial U}{\partial T}\right)_v \qquad \text{—— (2)}$$

At constant pressure, there is change of volume and some work is done.

then from 1st law —

$$\Delta U = q + w$$

$$\text{or} \quad q = \Delta U - w$$

Notes

Since,

$$w = -P\Delta V$$

$$\therefore q = \Delta U - (-P\Delta V)$$
$$= \Delta U + P\Delta V$$

Thus, from eqⁿ — (1)

$$C_p = \left(\frac{\Delta U + P\Delta V}{T_2 - T_1}\right)_P$$

$$C_p = \left(\frac{\Delta H}{T_2 - T_1}\right)_P \quad \text{or} \quad \Delta H = C_p \Delta T$$

or $$C_p = \left(\frac{\partial H}{\partial T}\right)_P \quad \text{—— (3)}$$

* Relationship between C_p & C_v.

We know that —

$$C = \frac{q}{\Delta T} \quad \text{—— (1)}$$

or $q = C\Delta T$

Notes

At Constant Volume -

$$q_v = C_v \Delta T = \Delta U \quad \text{—} (2)$$

and At Constant Pressure -

$$q_p = C_p \Delta T = \Delta H \quad \text{—} (3)$$

on substracting eqn - (2) from (3) -

$$C_p \Delta T - C_v \Delta T = \Delta H - \Delta U \quad \text{—} (4)$$

Since, Enthalpy

$$H = U + PV$$

change in enthalpy at constant P.

$$\Delta H = \Delta U + P \Delta V$$

or $\Delta H - \Delta U = P \Delta V$

~~[illegible]~~

from an ideal gas eqn -

$$PV = RT$$

Notes

or $P\Delta V = R\Delta T$

$\therefore \quad \Delta H - \Delta U = R\Delta T$

Now putting this value in eq^n — 4

$$C_p \Delta T - C_v \Delta T = R \Delta T$$

or $\boxed{C_p - C_v = R}$ for 1-mole.

& $\boxed{C_p - C_v = nR}$ for n-moles.