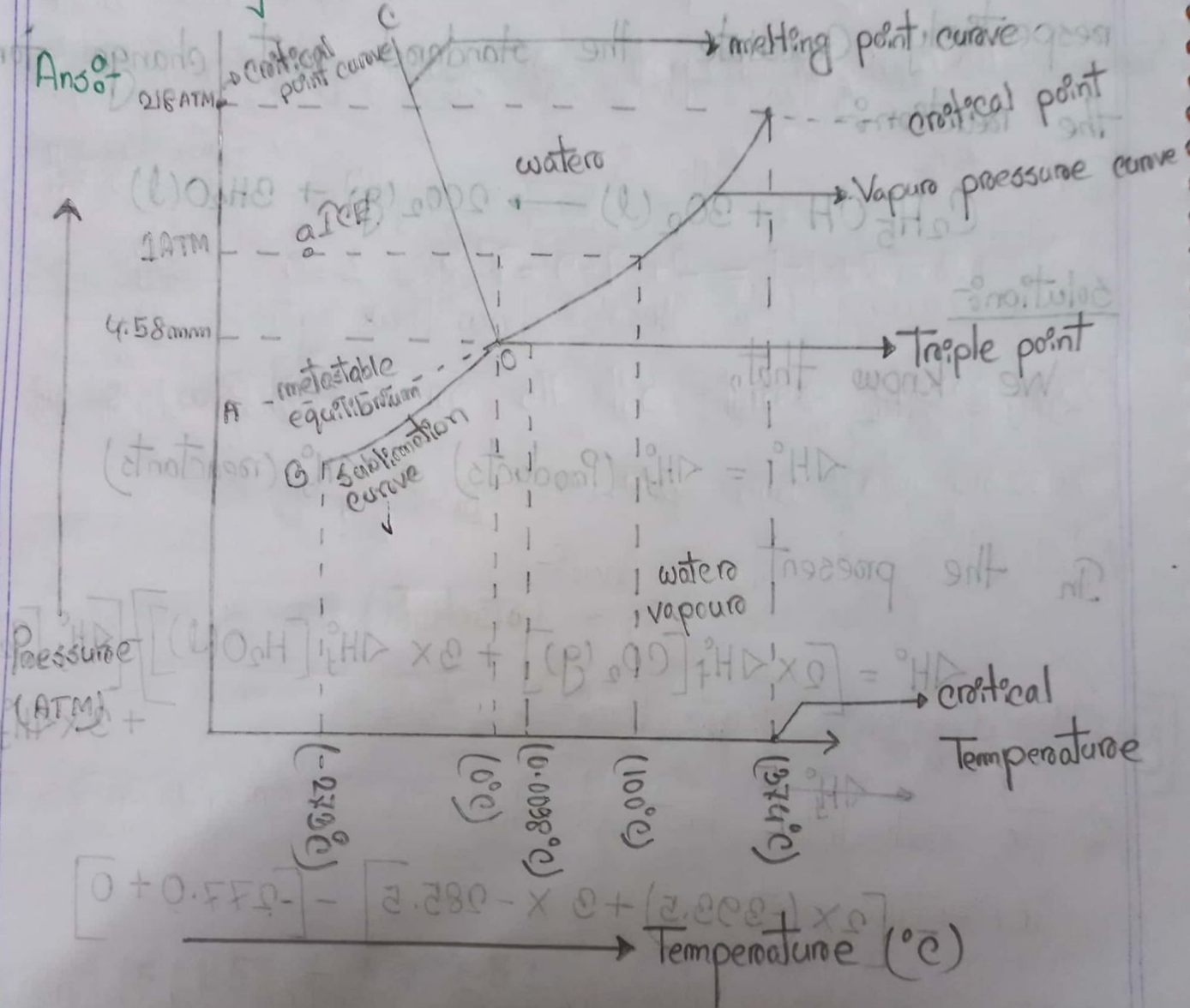1. Discuss main features of the phase diagram of water system.

Ans:-

Fig:- Phase diagram of water system

Some important features of water system:-

① Possible phase:- Ice (s), water (l), Vapour (g)

(II) Curves:- There are are three stable curves. They are:-

(a) OA curve (vaporization curve, Liquid $\rightleftharpoons$ Gas)

Here,

no of Phase, $P = 2$, no of components, $C = 1$

$\therefore$ Degree of freedom, $F = C - P + 2 = 1 - 2 + 2 = 1$

(b) OB curve (sublimation curve, solid $\rightleftharpoons$ Gas)

Here,

no of phase, $P = 2$, no of complonents, $C = 1$

$\therefore F = C - P + 2$

$= 1 - 2 + 2$

$= 1$

(C) OC curve (melting curve, solid $\rightleftharpoons$ liquid)

Here, $P = 2$, $C = 1$ $\therefore F = C - P + 2$

$= 1 - 2 + 2$

$= 1$

(III) One metastable Curve:- OA' (Vapour pressure curve of super cooled water, super cooled liquid $\rightleftharpoons$ ice)

Here,

$P = 2$

$C = 1$

$\therefore F = C - P + 2 = 1 - 2 + 2 = 1$

(IV) **Areas:-** There are three areas in water system. They are:-

    (a) BOC → ice $P=1$, $C=1$, $F = C - P + 2 = 1 - 1 + 2 = 2$

    (b) AOC → water, $P=1$, $C=1$, $F = C - P + 2 = 1 - 1 + 2 = 2$

    (c) BOA → Vapour, $P=1$, $C=1$, $F = C - P + 2 = 1 - 1 + 2 = 2$

(V) **Triple Point (0):-**

Triple point is that point where all the three phases are in equilibrium (0.0098°c and 4.58mm pressure).

The melting point curve OC slopes towards pressure axis has negative slope, showing that the melting point of ice decreases with increase of pressure.

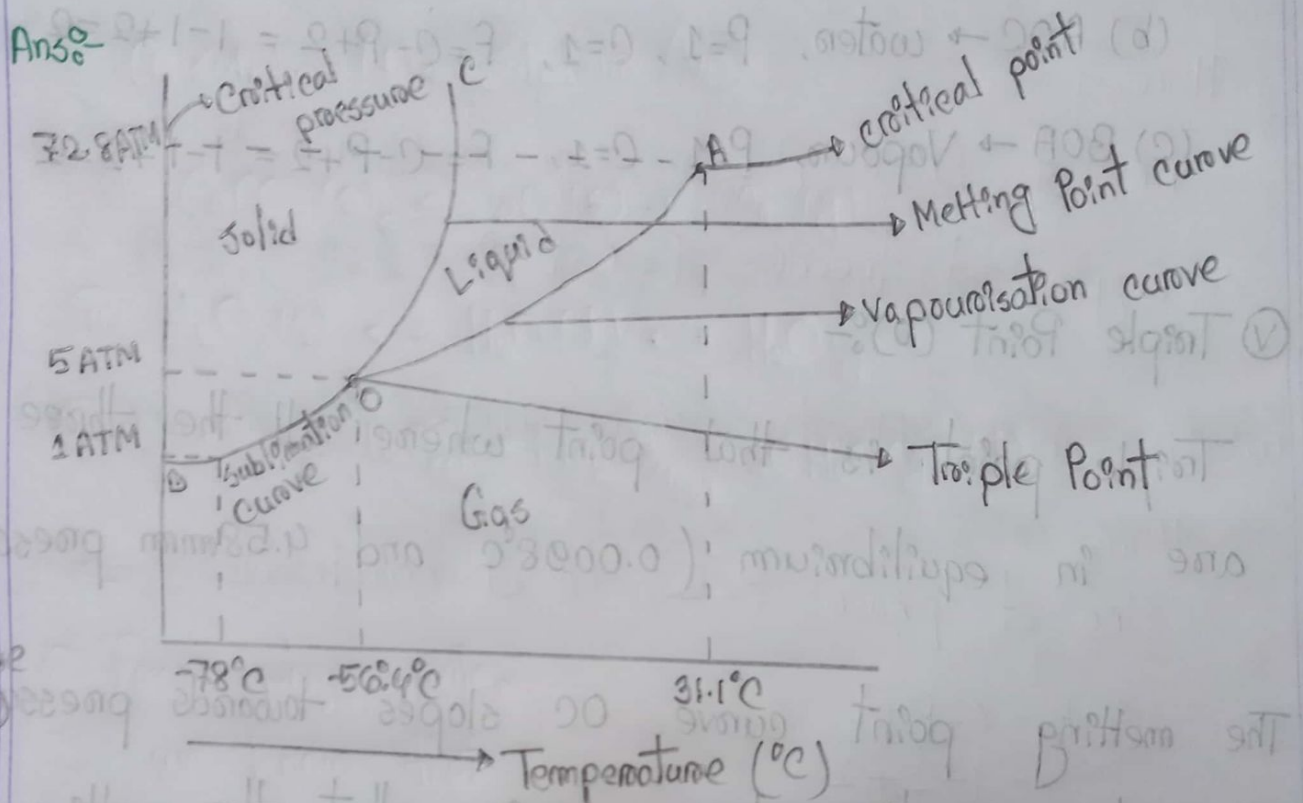## 2. Discuss the salient features of phase diagram of carbon dioxide system

Ans:-

Fig:- Phase diagram of Carbon dioxide system

Salient features of phase diagram of carbon dioxide system:-

① Possible phases:-

   (a) solid CO_2

   (b) liquid CO_2

   (c) Gases CO_2

(II) **Curves:-** There are three stable curves. They are:-

(a) OA curve (vaporization curve, Liquid $\rightleftharpoons$ Gas)

Here,

$$P = 2, \quad C = 1 \quad \therefore F = C - P + 2 = 1 - 2 + 2 = 1$$

(b) OB curve (Sublimation curve; solid $\rightleftharpoons$ Gas)

Here,

$$P = 2, \quad C = 1 \quad \therefore f = C - P + 2 = 1 - 2 + 2 = 1$$

(c) OC curve (melting curve, solid $\rightleftharpoons$ liquid)

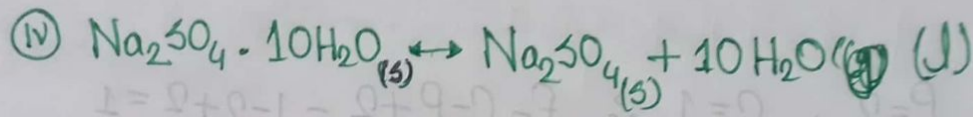Here, $P = 2, \quad C = 1 \quad \therefore f = C - P + 2 = 1 - 2 + 2 = 1$

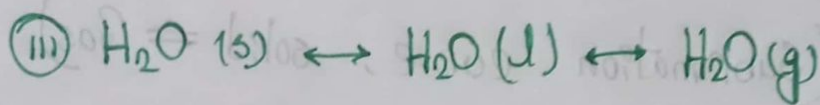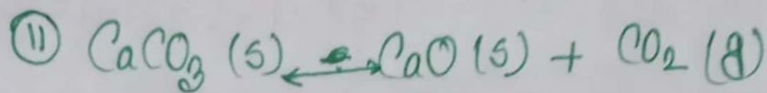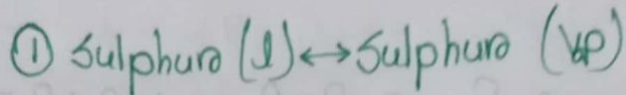(III) **Areas:-** There are three areas respectively solid CO_2, liquid CO_2 and gases CO_2 respectively.

For all of these three areas,

$$P = 1, \quad C = 1, \quad F = C - P + 2 = 1 - 1 + 2 = 2$$

(IV) **Triple Point:-** Where all the three phases exist together
($-56.4°c$ and $5 atm$ pressure)

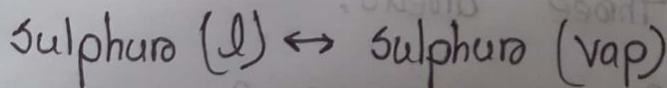3. Find out number of degrees of freedom in the following system:-

  (i) Sulphur $(l) \leftrightarrow$ Sulphur (vp)

  (ii) $CaCO_3 (s) \leftrightarrow CaO (s) + CO_2 (g)$

  (iii) $H_2O (s) \leftrightarrow H_2O (l) \leftrightarrow H_2O (g)$

  (iv) $Na_2SO_4 \cdot 10H_2O_{(s)} \leftrightarrow Na_2SO_{4(s)} + 10 H_2O (l)$

Ans:-

(i) From phase rule,

  we know that,

  No. of freedom, $F = $ no of component $(c) - $ no. of phase $(P) + 2$

Now, for

  Sulphur $(l) \leftrightarrow$ Sulphur (vap)

no of phase , $P = 2$

no of component, $C = 1$

∴ Degree of freedom, $F = C - P + 2$
        $= 1 - 2 + 2$
        $= 1$

(II) no of component, $C = 2$

no of phase, $P = 3$

$\therefore$ $F = C - P + 2$

$= 2 - 3 + 2$

$= 1$

(III) no of component, $C = 1$

no of phase, $P = 3$

$\therefore$ $F = C - P + 2$

$= 1 - 3 + 2$

$= 0$

(IV) no of component, $C = 2$

no of phase, $P = 3$

$\therefore$ $F = C - P + 2$

$= 2 - 3 + 2$

$= 1$