1. Following two equilibrium is simultaneously established in a container

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$$
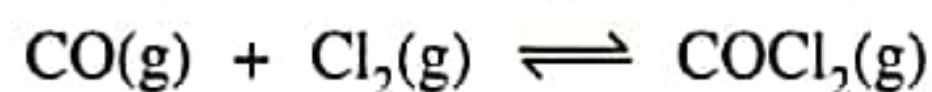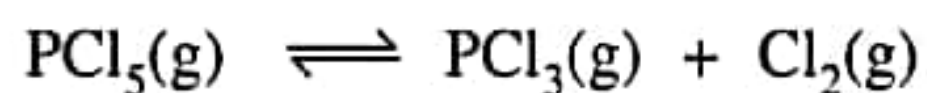
If some Ni(s) is introduced in the container forming $Ni(CO)_4$ (g) then at new equilibrium

(A) PCl_3 concentration will increase

(B) PCl_3 concentration will decrease

(C) Cl_2 concentration will remain same

(D) CO concentration will remain same

Ni reacts with CO ∴ reduces its amount

∴ the second reaction shifts backwards to increase CO so as to establish eqᵐ.

The increased amount of Cl_2, therefore, pushes the first reaction backwards; thereby reducing PCl_3. at new equilibrium

(2). When $NaNO_3$ is heated in a closed vessel, oxygen is liberated and $NaNO_2$ is left. At equilibrium

(A) addition of $NaNO_2$ favours reverse reaction

(B) addition of $NaNO_3$ favours forward reaction

(C) increasing temperature favours forward reaction

(D) increasing pressure favours reverse reaction

rx^n under consideration $\Rightarrow$

$$NaNO_{3(s)} \rightleftharpoons NaNO_{2(s)} + \frac{1}{2}O_{2(g)}$$
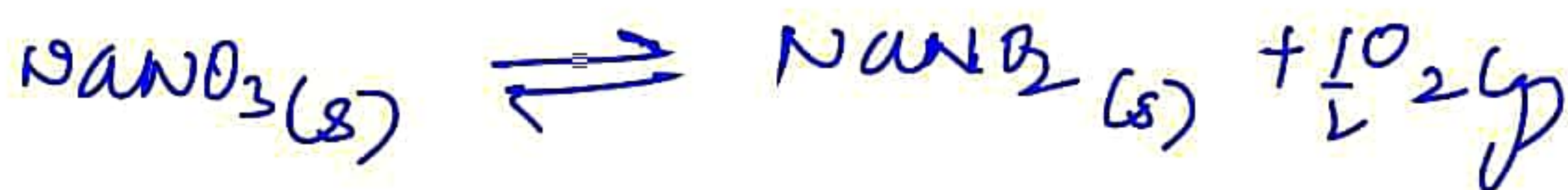
the reaction is an endothermic rx^n

& acc. to $\quad \frac{d}{dT}(\ln k_{eq}) = \frac{\Delta H}{RT^2} \quad; \quad \text{if}$

ΔH is positive (for endothermic rx^n;

$$\Delta H > 0)$$

the value of equilibrium constant increases with increase in temp. ∴ more product formation takes place with increasing temperature.

→ Increasing pressure would shift the reaction in direction of decreasing

gaseous moles. ∴ backward rx^n is favoured

(3). For the gas phase reaction, $C_2H_4 + H_2 \rightleftharpoons C_2H_6$ ($\Delta H = -32.7$ kcal), carried out in a closed vessel, the equilibrium moles of C_2H_4 can be increased by

(A) increasing the temperature

(B) decreasing the pressure

(C) removing some H_2

(D) adding some C_2H_6

increasing moles of C_2H_4 would mean shifting the reaction in backward dr^n;
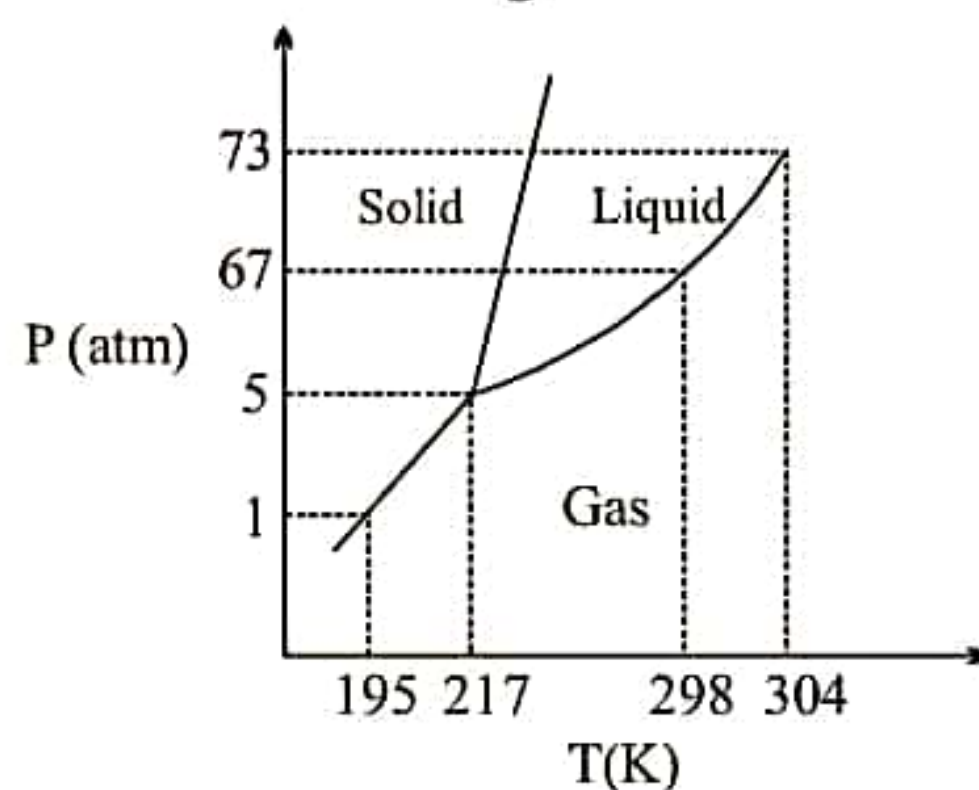
(A) acc. to van't Hoff eq^n: ʳ

the equilibrium constant of an exothermic rk^n would decrease with an increase in temperature. That would mean less product & more reactant at the higher temperature

(B) Decreasing the total pressure at equilibrium would shift reaction in the direction of increasing gaseous moles.
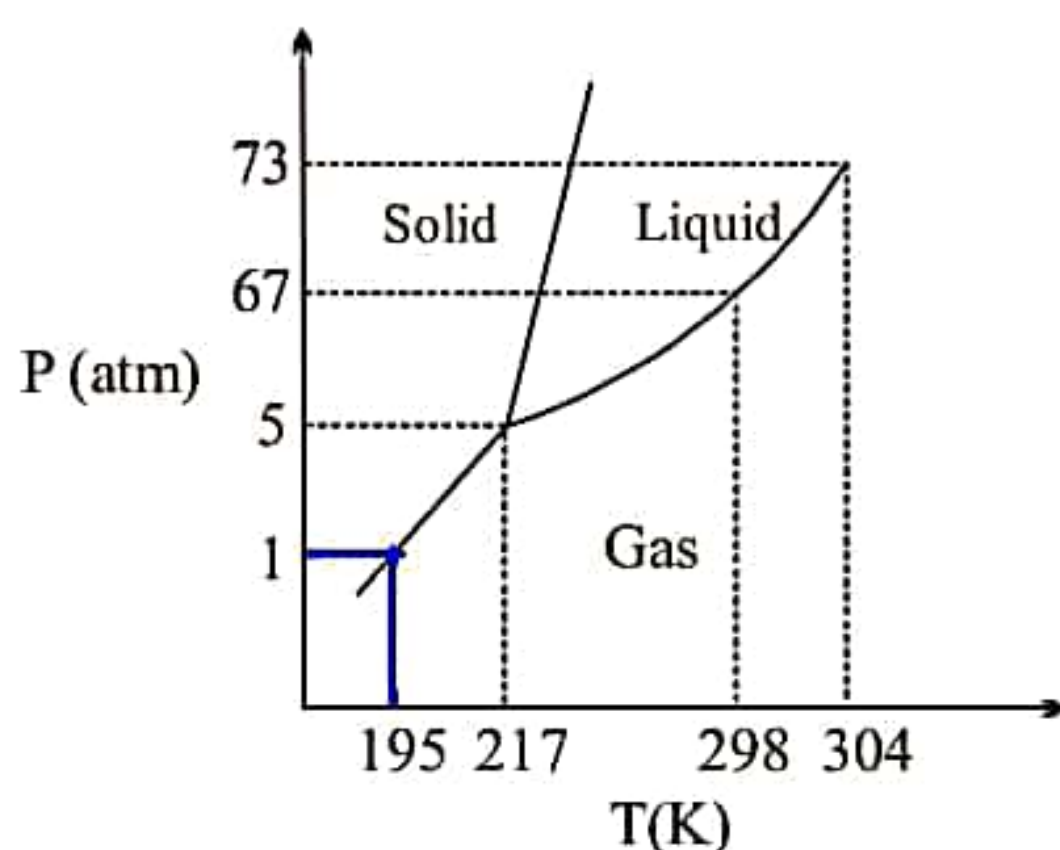
(4). Phase diagram of CO_2 is shown as following

Based on above find the correct statement(s)

(A) 298K is the normal boiling point of liquid CO_2

(B) At 1 atm & 190 K CO_2 will exist as gas.

(C) $CO_2(s)$ will sublime above 195K under normal atmospheric pressure

(D) Melting point & boiling point of CO_2 will increase on increasing pressure

(A)

The normal boiling point of CO_2 is 195 k.

(B) Below 195k at 1 atm; CO_2 will exist as solid & not gas as visible from the phase diagram.

(C) Above 195k at 1 atm; CO_2 will exist in gas phase as visible from the phase diagram. The process of converting a solid to gas is sublimation.

(D)

P₂

73

P_1

Solid   Liquid

67

P (atm)

5

1   Gas

195 217   298 304

T(K)
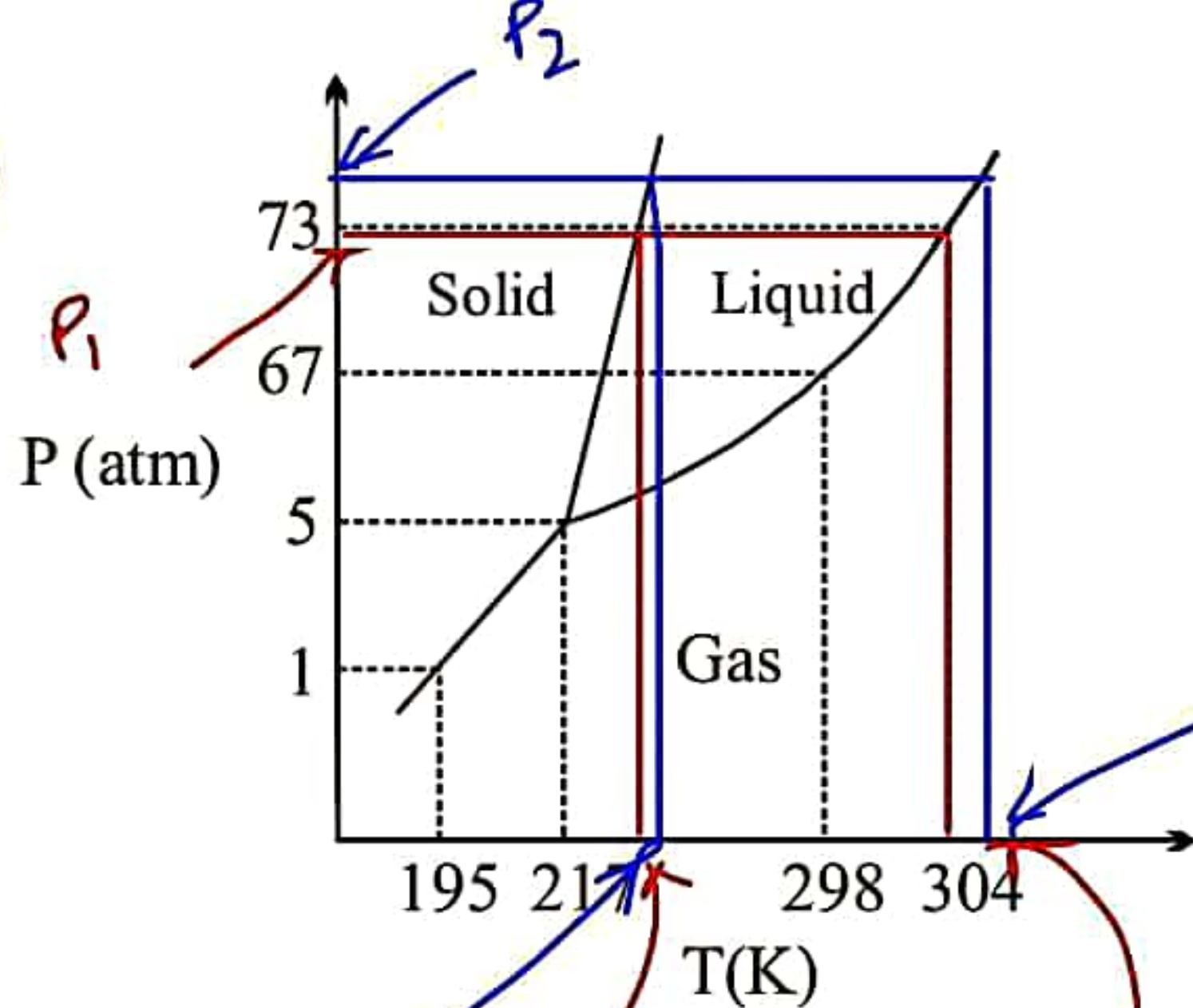
melting point at pressure δ_2

melting point at pressure P_1

Boiling point at pressure P_1

Boiling point at pressure P_2

(5). For the gas phase exothermic reaction, $A_2 + B_2 \rightleftharpoons C_2$, carried out in a closed vessel, the equilibrium moles of A_2 can be increased by
(A) increasing the temperature
(B) decreasing the pressure
(C) adding inert gas at constant pressure
(D) removing some C_2

(A) acc. to van't Hoff eq^n; $\frac{d}{dT}\left(\ln k_{eq}\right) = \frac{\Delta H}{RT^2}$

the equilibrium constant of an exothermic rx^n would decrease with an increase in temperature. That would mean less product & more reactant at the higher temperature

(B) Decreasing the total pressure at equilibrium would shift reaction in the direction of increasing gaseous moles

(C.) Introducing an inert gas at constant pressure would shift the reaction in the direction of increasing gaseous moles.

(6). onsider the equilibrium $HgO(s) + 4I^- (aq) + H_2O (l) \rightleftharpoons HgI_4^{2-} (aq) + 2OH^- (aq)$, which changes ill decrease the equilibrium concentration of HgI_4^{2-}

(A) Addition of 0.1 M HI (aq)

(B) Addition of HgO (s)

(C) Addition of H_2O (l)

(D) Addition of KOH (aq)

$\rightarrow$ Addition of KOH would shift the reaction in backward dr^n to reestablish equilibrium $\{ \therefore$ the conc. of $HgI_4^{2\ominus}$ would decrease at the new equilibrium.

$\dashv$ $K_c = \dfrac{[HgI_4^{2-}][OH^-]^2}{[I^-]^4} = \dfrac{n_{HgI_4^{2-}} \cdot n_{OH^-}^2}{n_{I^-}^4} \times V$

addition of water would increase volume of the rx^n mixture $\{$ hence the first term of K_c would reduce $\therefore$ $n_{HgI_4^{2\ominus}}$ would decrease $\{$ the concentrat -ion
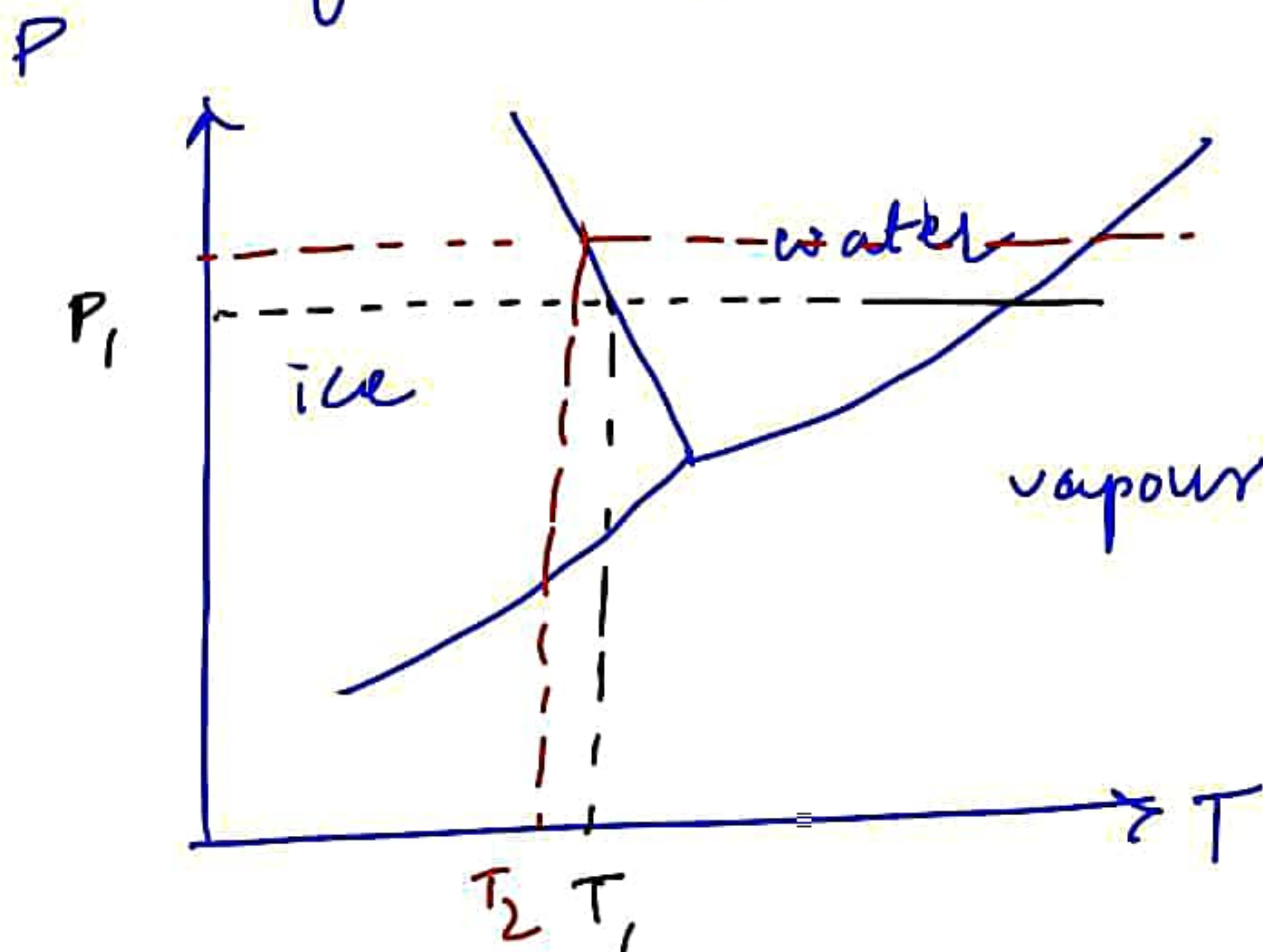
$\therefore$ decreases

(7). Decrease in the pressure for the following equilibria : H_2O (s) $\rightleftharpoons$ $H_2O(l)$ result in the :

(A) formation of more H_2O (s) (B) formation of more $H_2O(l)$

(C) increase in melting point of H_2O(s) (D) decrease in melting point of H_2O(s)

निम्न साम्य H_2O (s) $\rightleftharpoons$ $H_2O(l)$ के लिए दाब को कम करने के परिणामस्वरूप :

(A) H_2O (s) का आधिक्य में निर्माण होगा। (B) $H_2O(l)$ का आधिक्य में निर्माण होगा।

(C) H_2O(s) के गलनांक में वृद्धि होगी। (D) H_2O(s) के गलनांक में कमी होगी।

phase diagram of water :-

at pressure P_1 ; T_1 is the melting point of water

at an increased pressure P_2 ; T_2 is the melting point of H_2O

∴ as pressure was increased, the melting point of H_2O decreased.

(8).

The presence of a catalyst doesn't affect the value of equilibrium constant since it equally lowers the forward & backward activation energy and therefore the value of enthalpy change for the reaction stays constant.

$$\Delta H_{rxn} = Ea_{forward} - Ea_{backward}$$

(9) Acc- to van't Hoff equations

$\Rightarrow$ If $\Delta^{\circ}H_{rxn} < 0$; the value of equilibrium constant decreases with increase in temp. and vice-versa, however,

if $\Delta^{\circ}H_{rxn} > 0$; the value of equilibrium constant decreases with decrease in temp. and vice-versa
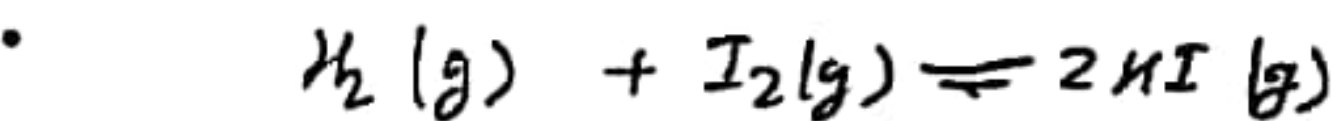
(10). for reaction $\Delta n_g = 0$ for $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

$$\therefore \quad K_p = K_c \, (RT)^0$$

$$\Rightarrow \quad K_p = K_c = 49$$

(11).

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

| $t=0$ | 0.5 mole | 0.5 mole | — |
| Eq. | $(0.5-x)$ | $(0.5-x)$ | $2x$ |

Total moles $= (0.5-x) + (0.5-x) + 2x$
$$= 1$$

By $PV = nRT$

$$P \times 7 = 1 \times 0.0821 \times 700$$

$$P = 8.21 \, atm$$

(12).

$$K_c = \frac{[HI]^2}{[H_2][I_2]}$$

$$49 = \frac{(2x)^2}{(0.5-x)(0.5-x)} \qquad \Rightarrow \qquad 7 = \frac{2x}{0.5-x}$$

$$x = \frac{3.5}{9}$$

moles $(I_2) = 0.5 - \frac{3.5}{9} = \frac{1}{9}$

(13). for $HI \longrightarrow P_{HI} \times V = n_{HI} \cdot RT$

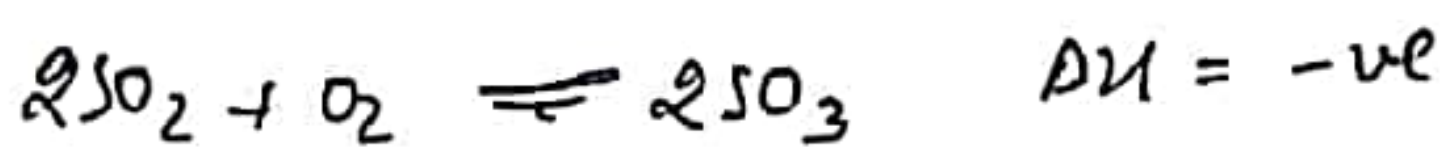$$P_{HI} \times 7 = \left(2 \times \frac{3.5}{9}\right) \times 0.0821 \times 700$$

$$P_{HI} = \frac{7}{9} \times 8.21 = 6.385 \, atm$$

(14). As pressure increases, reaction moves backward hence degree of dissociation decreases but K_c remains constant as all equilibrium constant depends only and only on temperature.

(15).

$$2SO_2 + O_2 \rightleftharpoons 2SO_3 \qquad \Delta H = -ve$$

As temperature increases, for exothermic reaction, reaction moves backward, hence dissociation of SO_3 increases.

for Exothermic reaction as Temperature increases K_c (equilibrium constant) decreases.

(16).
As Fe^{+3} is added in solution, reaction moves forward as per Le-chatelier's principle. and red colour of solution deepens due to formation of $[Fe(NCS)]^{2+}_{(aq.)}$

(17).

for option (A)

$K_p < K_c$ if for reaction $(\Delta n_g) < 0$, Hence Reaction in (P), (R) and (S) have $K_p < K_c$.

for option (B)

For inert gas added at constant pressure, Volume increases by $(PV = nRT)$, as addition of inert gas increases moles and hence Volume. Due to increase in volume, concentration decrease for each and every substance in all reaction.
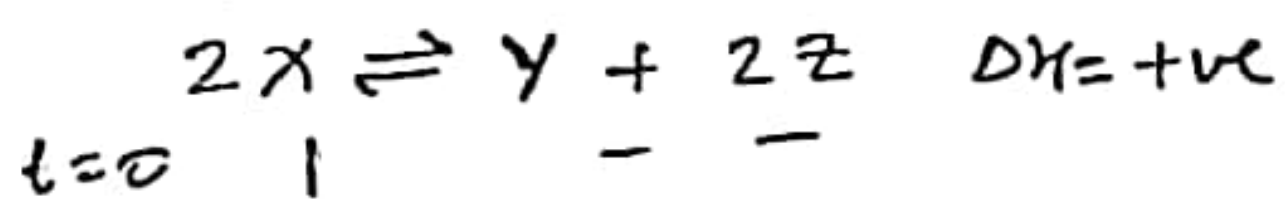
for option (C)

We know (K_p°) and (K_c°) are dimensionless equilibrium constant, hence this holds true for all reactions in options (P), (Q), (R), (S)

for option (D) :- [As T↑es, endothermic reaction moves forward] We know decomposition reactions are endothermic. Reaction in option (Q) is decomposition hence endothermic whereas reverse reactions in option (P), (R) (S) are decompo-sition, hence forward reaction are exothermic.

(18). For option (D)

$$2X \rightleftharpoons Y + 2Z \qquad \Delta H = +ve$$

$t=0 \qquad 1 \qquad - \qquad -$

Eq. $\qquad 1-\alpha \qquad \dfrac{\alpha}{2} \qquad \alpha$

$$Kp = \dfrac{(\alpha/2) \cdot \alpha^2}{(1-\alpha)^2} \cdot \left(\dfrac{P}{1-\alpha+\frac{\alpha}{2}+\alpha}\right)^1$$

$$Kp = \dfrac{\alpha^3/2}{1} \left(\dfrac{P}{1+\frac{\alpha}{2}}\right)^1$$

$$Kp = \dfrac{\alpha^3}{2} \times P$$
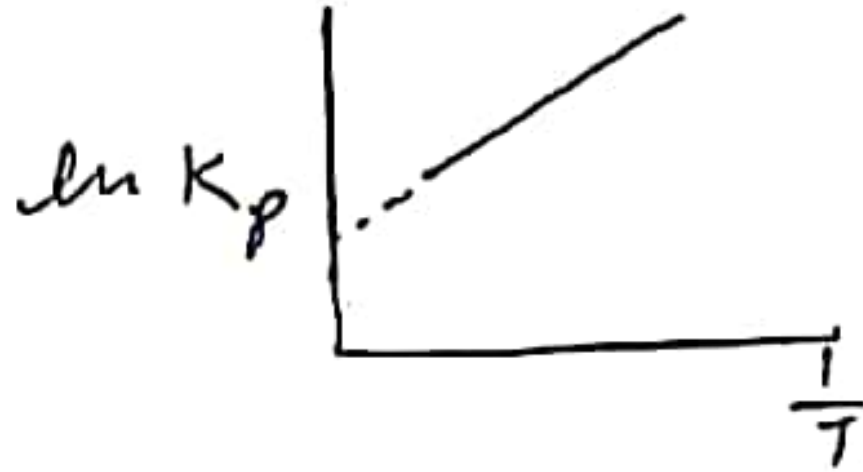
$$\alpha = \left(\dfrac{2\,Kp}{P}\right)^{1/3}$$

As inert gas added at constant pressure reaction moves forward as gaseous moles increases.

(19): _for ophion (A)_ $\Rightarrow$ for exothermic reaction

$$\ln k_p = \ln\left(\frac{\Delta E}{A_b}\right) - \frac{\Delta H}{R}\left(\frac{1}{T}\right)$$

$$y = c + m x$$

$$m = \left(-\frac{\Delta H}{R}\right) \quad \text{As} \quad \Delta H \text{ is } (-ve) \Rightarrow \text{slope} = (+ve)$$

(20). _for ophion (B)_

Given $\quad \text{`}\alpha\text{'} \propto \frac{1}{\sqrt{P}}$

$\Rightarrow$ of V becomes 16 times at constant temperature
Pressure reduced to $\left(\frac{1}{16}\right)$ times of it's initial.

$\Rightarrow \qquad \frac{\alpha_2}{\alpha_1} = \sqrt{\frac{P_1}{P_2}}$

$$\frac{\alpha_2}{\alpha_1} = \sqrt{\frac{P_1}{P_1/16}} = \sqrt{16} \qquad \Rightarrow \boxed{\alpha_2 = 4\alpha_1}$$