

VARUN

ADVANCE 2026

PHYSICAL
CHEMISTRY

Lecture - 01

Chemical Equilibrium

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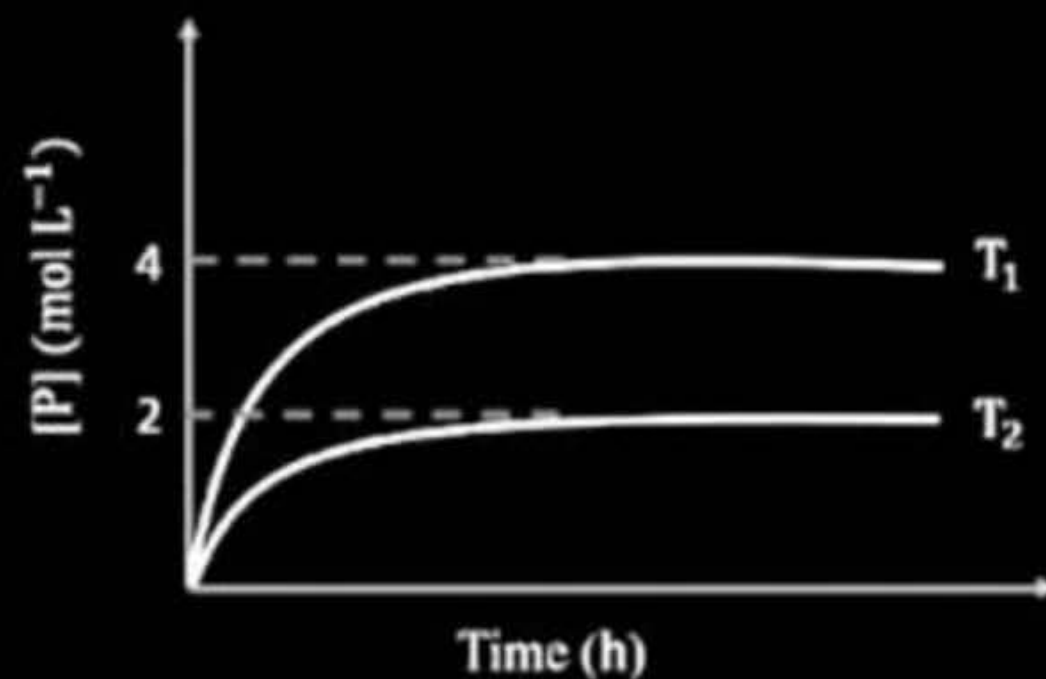
Topics to be covered

- 1 Revision

In a one-litre flask, 6 moles of A undergoes the reaction $A(g) \rightleftharpoons P(g)$. The progress of product formation at two temperature (in Kelvin). T_1 and T_2 , is shown in the figure.

If $T_1 = 2T_2$ and $(\Delta G_2^\circ - \Delta G_1^\circ) = RT_2 \ln x$, then the value of x is _____.

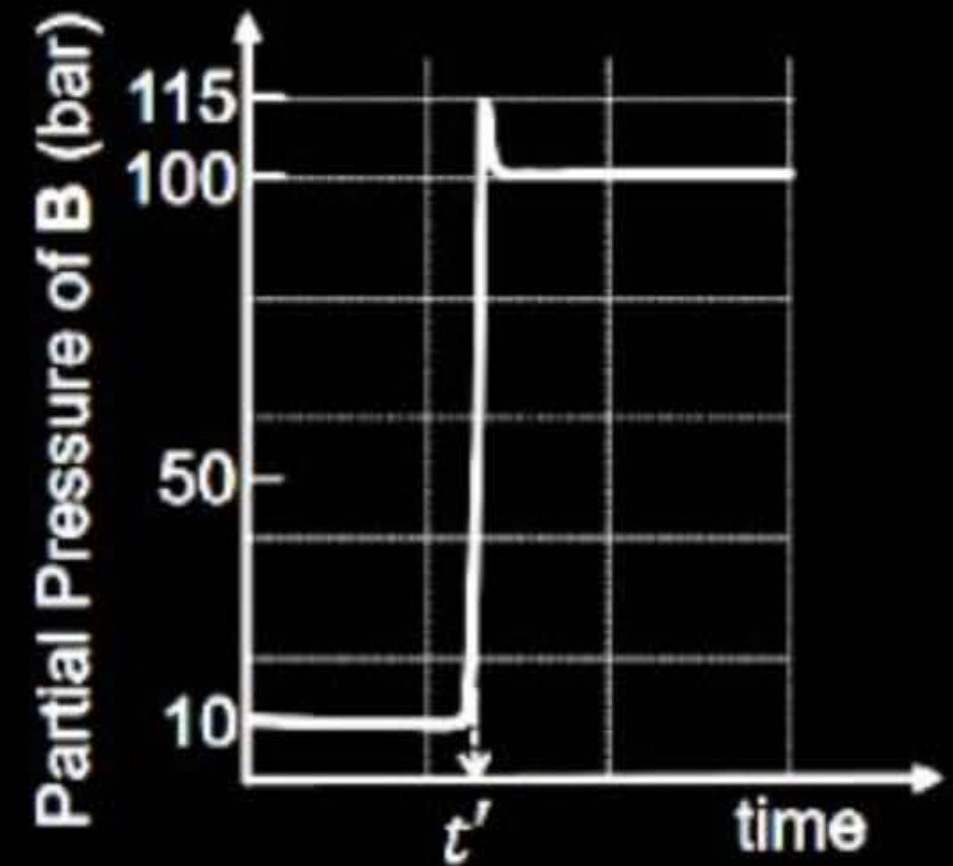
(ΔG_1° and ΔG_2° are standard Gibbs free energy change for the reaction at temperature T_1 and T_2 respectively.)



[Ans : 8]

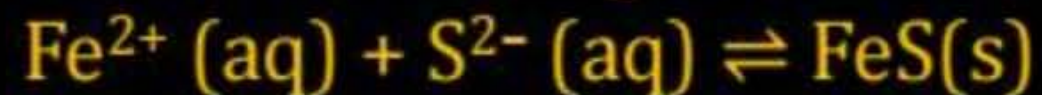
QUESTION

Consider the reaction $A \rightleftharpoons B$ at 1000 K. At time t' , the temperature of the system was increased to 2000 K and the system was allowed to reach equilibrium. Throughout this experiment, the partial pressure of A was maintained at 1 bar. Given below is the plot of the partial pressure of B with time. What is the ratio of the standard Gibbs energy of the reaction at 1000 K to that at 2000 K?



[Ans : 0.25]

For the following reaction, the equilibrium constant K_c at 298 K is 1.6×10^{17} .



When equal volumes of 0.06 M $\text{Fe}^{2+}(\text{aq})$ and 0.2 M $\text{S}^{2-}(\text{aq})$ solutions are mixed, the equilibrium concentration of $\text{Fe}^{2+}(\text{aq})$ is found to be $Y \times 10^{-17}$ M. The value of Y is

_____.

[Ans : 8.93]

QUESTION

For the equilibrium $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}(\text{s}) \rightleftharpoons \text{SrCl}_2 \cdot 2\text{H}_2\text{O}(\text{s}) + 4\text{H}_2\text{O}(\text{g})$, $K_p = 8.1 \times 10^{-7} \text{ atm}^4$ at 27°C . If 1.642 L of air saturated with water vapour at 27°C is exposed to a large quantity of $\text{SrCl}_2 \cdot 2\text{H}_2\text{O}(\text{s})$, then what mass of water vapour will be absorbed? Saturated vapour pressure of water at $27^\circ\text{C} = 30.4 \text{ torr}$.

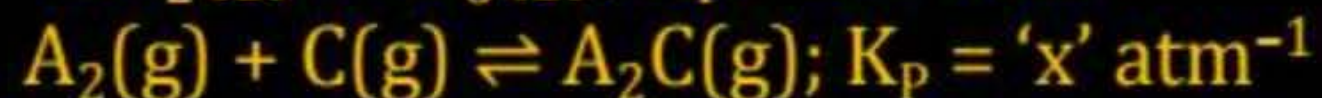
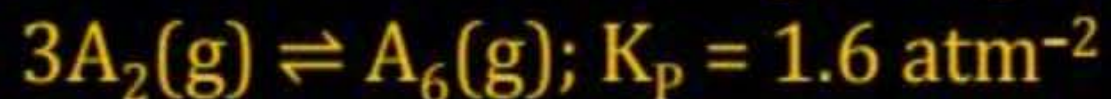
- A** 12 mg
- B** 6.67 mg
- C** 9 mg
- D** 48 mg

[Ans :A]

QUESTION



The following equilibria are established on mixing two gases A_2 and C.

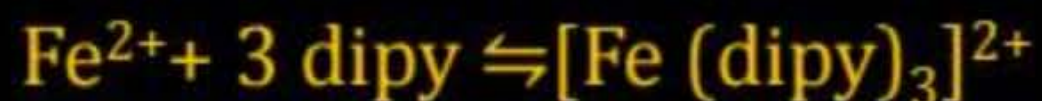


When $A_2(g)$ and $C(g)$ are mixed in 2 : 1 molar ratio, the total pressure of gases at equilibrium is found to be 1.4 atm and partial pressure of $A_6(g)$, 0.2 atm. The value of '4x' is

[Ans : 6]

QUESTION

The complexation of Fe^{2+} with the chelating agent dipyrityl has been studied kinetically in both the forward and reverse directions.



For this reaction, the rates of forward and reverse reactions are $(1.45 \times 10^{13} \text{ M}^{-3} \text{ s}^{-1}) [\text{Fe}^{2+}][\text{dipy}]^3$ and $(1.22 \times 10^{-4} \text{ s}^{-1}) [\text{Fe} (\text{dipy})_3]^{2+}$, at What is the stability constant of the complex?

- A** 1.77×10^9
- B** 8.4×10^{-18}
- C** 1.18×10^{17}
- D** 5.65×10^{-10}

Ans: (C)



QUESTION

In the system, $\text{LaCl}_3(\text{s}) + \text{H}_2\text{O}(\text{g}) + \text{heat} \rightleftharpoons \text{LaClO}(\text{s}) + 2\text{HCl}(\text{g})$, equilibrium is established. More water vapour is added to disturb the equilibrium. If the pressure of water vapour at new equilibrium is double that of at initial equilibrium, the factor by which pressure of HCl is changed is

- A** 2 times
- B** $\sqrt{2}$ times
- C** $\frac{1}{\sqrt{2}}$ times
- D** 4 times

Ans : (B)



QUESTION

For dissociation of a gas N_2O_5 as $\text{N}_2\text{O}_5(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g})$. The reaction is performed at constant temperature and volume. If D is the vapour density of equilibrium mixture, P_0 is initial pressure of $\text{N}_2\text{O}_5(\text{g})$ and M is molecular mass of N_2O_5 , then the correct information(s) at the equilibrium is /are

- A** The total pressure of gases at equilibrium is $\frac{P_0 \cdot M}{2D}$.
- B** The degree of dissociation of $\text{N}_2\text{O}_5(\text{g})$ is $\frac{M-2D}{3D}$.
- C** The partial pressure of $\text{N}_2\text{O}_5(\text{g})$ at equilibrium is $\frac{(5D-M) \cdot P_0}{3D}$.
- D** The partial pressure of $\text{O}_2(\text{g})$ at equilibrium is $\frac{(M-2D) \cdot P_0}{3D}$.

Ans: (A), (B), (C)



Comprehension

In a vessel, the equilibrium $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ and $\text{N}_2(\text{g}) + 2\text{H}_2(\text{g}) \rightleftharpoons \text{N}_2\text{H}_4(\text{g})$ are achieved simultaneously. Initially, the vessel contains N_2 and H_2 molar ratio of 9 : 13. The equilibrium pressure is $7P_0$ in which due to ammonia, the pressure is P_0 and due to hydrogen, the pressure is $2P_0$.

QUESTION

The value of K_p for the reaction $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ is

A $20 P_0^2$

B $\frac{20 P_0^2}{3}$

C $\frac{1}{20 P_0^2}$

D $\frac{3}{20 P_0^2}$

Ans: (A)



Comprehension

In a vessel, the equilibrium $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ and $\text{N}_2(\text{g}) + 2\text{H}_2(\text{g}) \rightleftharpoons \text{N}_2\text{H}_4(\text{g})$ are achieved simultaneously. Initially, the vessel contains N_2 and H_2 molar ratio of 9 : 13. The equilibrium pressure is $7P_0$ in which due to ammonia, the pressure is P_0 and due to hydrogen, the pressure is $2P_0$.

QUESTION

The value of K_P for the reaction $\text{N}_2(\text{g}) + 2\text{H}_2(\text{g}) \rightleftharpoons \text{N}_2\text{H}_4(\text{g})$ is

A $20 P_0^2$

B $\frac{20 P_0^2}{3}$

C $\frac{1}{20 P_0^2}$

D $\frac{3}{20 P_0^2}$

Ans: (D)



QUESTION

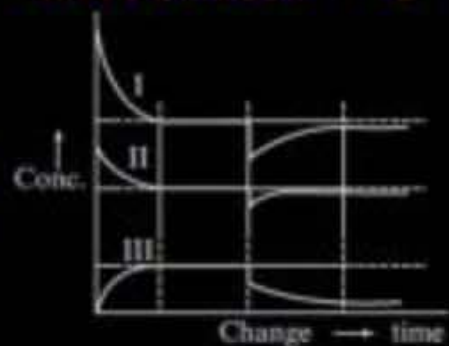


For an endothermic reaction : $4A(g) + B_2(g) \rightleftharpoons 2A_2B(g)$

Column - I

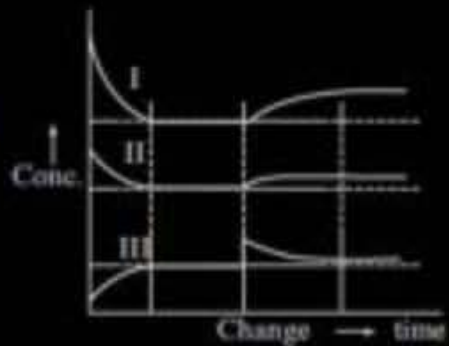
Column - II

(A)



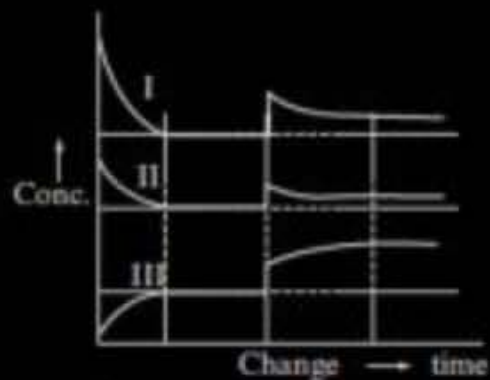
(P) Increase in temperature

(B)



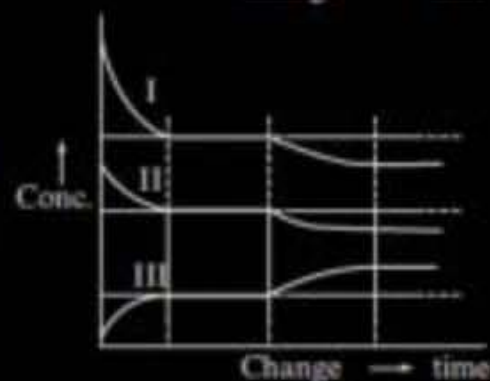
(Q) Increase in pressure

(C)



(R) Addition of A_2B at equilibrium

(D)



(S) Addition of inert gas at const press.

(T) Increase in volume

Ans: (A) S, T

(B) R

(C) Q

(D) P



QUESTION

When $\text{N}_2\text{O}_5(\text{g})$ is heated to 600 K, it dissociates as $\text{N}_2\text{O}_5(\text{g}) \rightleftharpoons \text{N}_2\text{O}_3(\text{g}) + \text{O}_2(\text{g})$; $K_c = 2.5$ M. Simultaneously, $\text{N}_2\text{O}_3(\text{g})$ decomposes as $\text{N}_2\text{O}_3(\text{g}) \rightleftharpoons \text{N}_2\text{O}(\text{g}) + \text{O}_2(\text{g})$. When initially 4.0 moles of $\text{N}_2\text{O}_5(\text{g})$ is taken in a 2.0 L flask and allowed to attain equilibrium, the equilibrium concentration of $\text{O}_2(\text{g})$ is found to be 2.5 M. The equilibrium concentration of $\text{N}_2\text{O}(\text{g})$ (in M) is

Ans: (1)



QUESTION



$\text{NH}_4\text{HS(s)}, \text{NH}_3(\text{g}),$ $\text{H}_2\text{S(g)}, \text{He(g)}$ at equilibrium		He(g)
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Fixed SPM, which allows only He(g) to cross it.

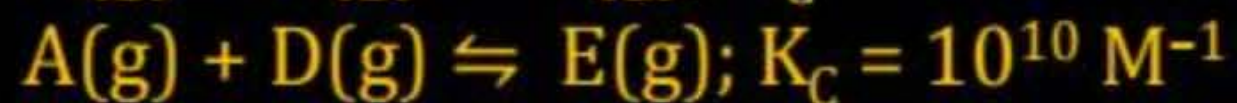
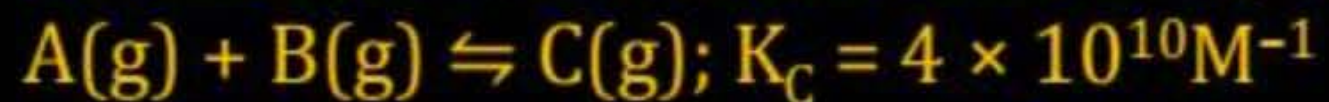
The entire system is at equilibrium at 300 K. The volume of each chamber is 82.1 L. The total pressure in left chamber is 4 atm and in right chamber, 2 atm. $\text{NH}_3(\text{g})$ and $\text{H}_2\text{S(g)}$ are obtained only from the dissociation of $\text{NH}_4\text{HS(s)}$. The value of K_p (in atm^2) for the reaction $\text{NH}_4\text{HS(s)} \rightleftharpoons \text{NH}_3(\text{g}) + \text{H}_2\text{S(g)}$ is

Ans: (1)



QUESTION

An amount of 5.0 moles each of 'A', 'B' and 'D' is added to a 1.0 L container.



If at equilibrium, the moles of 'B' is 'x', then the value of '150x' is

Ans: (250)



QUESTION

In a 10.0 L container, an equilibrium was established between SO_3 , SO_2 and O_2 gases, by starting with SO_3 only. The density of equilibrium mixture was found to be 16 g/litre at a temperature of $\frac{900}{0.0821}$ K.

If the degree of dissociation of SO_3 is 40%, then the value of K_p (in atm) for the reaction $2\text{SO}_3(\text{g}) \rightleftharpoons 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g})$ is

Ans: (16)



QUESTION

The minimum mass (in g) of CaCO_3 required to establish the equilibrium:

$\text{CaCO}_3(\text{s}) \rightleftharpoons \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$, $K_c = 0.05 \text{ M}$ at a certain temperature in a 1.0 L container is

Ans: (5)



QUESTION

The dissociation constant of PCl_5 is 8 atm at 273°C . What pressure (in atm) will be developed when 62.55 g of this substance is vaporized at 273°C in 4480 ml vessel originally full of chlorine gas at 0°C and 1 atm pressure?

Ans: (7)



QUESTION

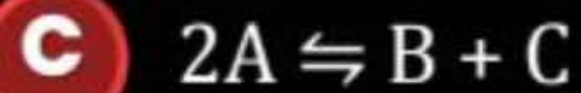
The percent dissociation of $\text{H}_2\text{S}(\text{g})$ if 0.1 mole of H_2S is kept in 0.4 L vessel at 1000 K for the reaction $2\text{H}_2\text{S} \rightleftharpoons 2\text{H}_2(\text{g}) + \text{S}_2(\text{g})$; $K_c = 1.0 \times 10^{-6}$.

Ans: (2)



QUESTION

A reaction at 300 K with $\Delta G^\circ = -1743$ J consists of 3 moles of A(g), 6 moles of B(g) and 3 moles of C(g). If A, B and C are in equilibrium in 1 L container, then the reaction may be ($\ln 2 = 0.7$, $R = 8.3$ J/K-mol)



Ans: (C)



QUESTION

The equilibrium $\text{NH}_4\text{HS(s)} \rightleftharpoons \text{NH}_3\text{(g)} + \text{H}_2\text{S(g)}$ is achieved at the equilibrium pressure of 'X' bar at TK. The value of $\Delta_r G^\circ$ for the reaction is

- A** $-RT \ln X$
- B** $-2RT \ln X$
- C** $-2RT (\ln X - \ln 2)$
- D** $-2RT \ln (2X)$

Ans: (C)



QUESTION

The equilibrium constant for the reaction $\text{CO(g)} + \text{H}_2\text{O(g)} \rightleftharpoons \text{CO}_2\text{(g)} + \text{H}_2\text{(g)}$ is 3.0 at 500 K. In a 2.0 L vessel, 60 g of water gas [equimolar mixture of CO(g) and $\text{H}_2\text{(g)}$] and 90 g steam is initially taken. What is the equilibrium concentration of $\text{H}_2\text{(g)}$?

- A** 1.75 M
- B** 3.5 M
- C** 1.5 M
- D** 0.75 M

QUESTION

Solid ammonium carbamate dissociates as:

$\text{NH}_2\text{COONH}_4(\text{s}) \rightleftharpoons 2\text{NH}_3(\text{g}) + \text{CO}_2(\text{g})$. In a closed vessel, solid ammonium carbamate is in equilibrium with its dissociation products. At equilibrium ammonia is added such that the partial pressure of NH_3 at new equilibrium now equals the original total pressure. The ratio of total pressure at new equilibrium to that of original total pressure is

A 1 : 1

B 27 : 31

C 31 : 27

D 3 : 4

Ans: (C)



QUESTION

If for the equilibria $\text{NH}_2\text{COONH}_4(\text{s}) \rightleftharpoons \text{N}_2 + \text{H}_2 + \text{CO} + \text{O}_2$, the value of K_p at 800 K is $27 \times 2^{\lambda/2}$ and the equilibrium pressure is 22 atm. The value of λ is

A 21

B 22

C 11

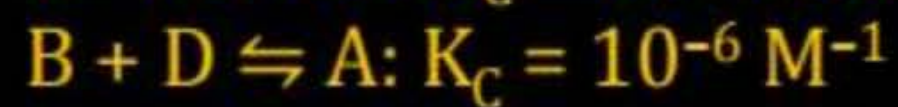
D 12

Ans: (A)



QUESTION

An amount of 1 mole each of A and D is introduced in 1 L container. Simultaneously the following two equilibria are established.



The equilibrium concentration of A will be

A 10^{-6} M

B 10^{-3} M

C 10^{-12} M

D 10^{-4} M

THANK
YOU