Equilibrium

Question1

At a given temperature and pressure, the equilibrium constant values for the equilibria are given below:

$3A_2 + B_2 \rightleftharpoons 2A_3B, K_1$

$A_3B \rightleftharpoons \frac{3}{2}A_2 + \frac{1}{2}B_2, K_2$

The relation between K_1 and K_2 is :

[NEET 2024 Re]

Options:

A.

$K_1^2 = 2K_2$

B.

$K_2 = \frac{K_1}{2}$

C.

$K_1 = \frac{1}{\sqrt{K_2}}$

D.

$K_2 = \frac{1}{\sqrt{K_1}}$

Answer: D

Solution:

$3A_2 + B_2 \rightleftharpoons 2A_3B; K_1$

$2A_3B \rightleftharpoons 3A_2 + B_2; K' = \frac{1}{K_1}$

$\frac{1}{2}A_3B \rightleftharpoons \frac{3}{2}A_2 + \frac{1}{2}B_2; K_2 = \sqrt{K'}$

$K_2 = \sqrt{K'}$

$= \frac{1}{\sqrt{K_1}}$

Question2

For the reaction in equilibrium

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g), \Delta H = -Q$

Reaction is favoured in forward direction by:

[NEET 2024 Re]

Options:

A.

use of catalyst

B.

decreasing concentration of N_2

C.

low pressure, high temperature and high concentration of ammonia

D.

high pressure, low temperature and higher concentration of H_2

Answer: D

Solution:

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g), \Delta H = -Q$

According to Le Chatelier's principle.

- Exothermic reactions are favoured at low temperature.
- Increase in pressure shifts the reaction in direction having lesser number of moles. Hence, the given reaction shifts forward on increasing pressure.
- Increasing the concentration of reactants shifts the reaction in forward direction. So high concentration of H_2 shifts reaction in forward direction.

Question3

Which indicator is used in the titration of sodium hydroxide against oxalic acid and what is the colour change at the end point?

[NEET 2024 Re]

Options:

A.

Phenolphthalein, pink to yellow

B.

Alkaline KMnO4, colourless to pink

C.

Phenolphthalein, colourless to pink

D.

Methyl orange, yellow to pinkish red colour

Answer: C

Solution:

For weak acid and strong base titration, phenolphthalein is used as indicator. In acidic medium phenolphthalein is colourless while in alkaline medium it is pink in colour.

Question4

The ratio of solubility of AgCl in 0.1 M KCl solution to the solubility of AgCl in water is:

(Given : Solubility product of AgCl = 10^{-10})

[NEET 2024 Re]

Options:

A.

10^{-4}

B.

10^{-6}

C.

10^{-9}

D.

10^{-5}

Answer: A

Solution:

Solubility of AgCl (in 0.1 M KCl)

$$\mathrm{AgCl(aq)} \rightleftharpoons \underset{s}{\mathrm{Ag^{+}(aq)}} + \underset{(s+0.1)}{\mathrm{Cl(aq^{-})}}$$

$$K_{sp} = (s)(s+0.1)$$

$$s << 0.1 \therefore (s+0.1) \approx 0.1\mathrm{M}$$

$$\therefore 10^{-10} = s \times 0.1$$

$$\therefore s = \frac{10^{-10}}{0.1} = 10^{-9}\mathrm{M}$$

Solubility of AgCl (in water)

$$\mathrm{AgCl(aq)} \rightleftharpoons \underset{s}{\mathrm{Ag^{+}(aq)}} + \underset{s}{\mathrm{Cl^{-}(aq)}}$$

$$K_{sp} = s^2$$

$$\therefore 10^{-10} = s^2$$

$$\therefore s = \sqrt{10^{-10}} = 10^{-5}\mathrm{M}$$

Hence ratio of solubilities of $\mathrm{AgCl} = 10^{-9} : 10^{-5} = 10^{-4} : 1$

Question5

In which of the following equilibria, K_p and K_c are NOT equal?

[NEET 2024]

Options:

A.

$\mathrm{PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}}$

B.

$\mathrm{H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}}$

C.

$\mathrm{CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}}$

D.

$\mathrm{2BrCl_{(g)} \rightleftharpoons Br_{2(g)} + Cl_{2(g)}}$

Answer: A

Solution:

$K_p = K_c(RT)^{\Delta n_g}$

for $K_p \neq K_c$,

$\Delta n_g \neq 0$

$\Delta n_g = n_p - n_r$

(1) $\Delta n_g = 2 - 1 = 1$

(2) $\Delta n_g = 2 - 2 = 0$

(3) $\Delta n_g = 2 - 2 = 0$

(4) $\Delta ng_g = 2 - 2 = 0$

Question6

For the reaction 2A ⇌ B + C, KC = 4 × 10^{-3}. At a given time, the composition of reaction mixture is: [A] = [B] = [C] = 2 × 10^{-3}M.

Then, which of the following is correct?

[NEET 2024]

Options:

A.

Reaction is at equilibrium.

B.

Reaction has a tendency to go in forward direction.

C.

Reaction has a tendency to go in backward direction.

D.

Reaction has gone to completion in forward direction.

Answer: C

Solution:

$2A \rightleftharpoons B + C, K_C = 4 \times 10^{-3}$

At a given time t, Q_c is to be calculated and been compared with K_c.

$$Q_c = \frac{[B][C]}{[A]^2} = \frac{(2 \times 10^{-3})(2 \times 10^{-3})}{(2 \times 10^{-3})^2}$$

$Q_c = 1$

As $Q_C > K_C$, so reaction has a tendency to move backward.

Question7

Consider the following reaction in a sealed vessel at equilibrium with concentrations of

$N_2 = 3.0 \times 10^{-3}$M, $O_2 = 4.2 \times 10^{-3}$M and $NO = 2.8 \times 10^{-3}$M.

$2NO_{(g)} \rightleftharpoons N_{2(g)} + O_{2(g)}$

If 0.1 mol LL^{-1} of NO$_{(g)}$ is taken in a closed vessel, what will be degree of dissociation (α) of NO$_{(g)}$ at equilibrium?

[NEET 2024]

Options:

A.

0.00889

B.

0.0889

C.

0.8889

D.

0.717

Answer: D

Solution:

$2NO_{(g)} \rightleftharpoons N_{2(g)} + O_{2(g)}$

$$K_c = \frac{[N_2][O_2]}{[NO]^2}$$

$$= \frac{3 \times 10^{-3} \times 4.2 \times 10^{-3}}{2.8 \times 10^{-3} \times 2.8 \times 10^{-3}}$$

$= 1.607$

$$\begin{array}{lccccc} & 2NO_{(g)} & \rightleftharpoons & N_{2(g)} & + & O_{2(g)} \\ t=0 & 0.1 & & 0 & & 0 \\ & 0.1\text{–}0.1\alpha & & 0.05\alpha & & 0.05\alpha \end{array}$$

$$K_c = \frac{0.05\alpha \times 0.05\alpha}{(0.1-0.1\alpha)^2}$$

$$K_c = \frac{0.05\alpha \times 0.05\alpha}{0.01(1-\alpha)^2}$$

$$1.607 = \frac{(0.05)^2\alpha^2}{0.01(1-\alpha)^2}$$

$$\frac{\alpha^2}{(1-\alpha)^2} = \frac{1.607 \times (0.1)^2}{(0.05)^2}$$

$$\frac{\alpha}{1-\alpha} = \frac{1.27 \times 0.1}{0.05}$$

$$\frac{\alpha}{1-\alpha} = 2.54$$

$$\alpha = 2.54 - 2.54\alpha$$

$$3.54\alpha = 2.54$$

$$\alpha = \frac{2.54}{3.54} = 0.717$$

Question8

The equilibrium concentrations of the species in the reaction A + B ⇌ C + D are 2, 3, 10 and 6mol^{-1}, respectively at 300K.ΔG° for the reaction is (R = 2cal/molK)

[NEET 2023]

Options:

A.

−137.26cal

B.

−1381.80cal

C.

−13.73cal

D.

1372.60cal

Answer: B

Solution:

$A + B \rightleftharpoons C + D$

at equilibrium 2 3 10 6

$\text{keq}_{\text{eq}} = [C][D]/[A][B]$

$$k_{eq} = \frac{10 \times 6}{2 \times 3} = 10$$

$\Delta G^{\circ} = -RT \ln K$

$= -2.303\, RT \log K$

$= -2.303 \times 2 \times 300 \times \log 10$

$= -1381.8$ cal

Question9

For a weak acid HA, the percentage of dissociation is nearly 1% at equilibrium. If the concentration of acid is 0.1mol L^{-1}, then the correct option for its K_a at the same temperature is :

[NEET 2023 mpr]

Options:

A.

1×10^{-4}

B.

1×10^{-6}

C.

1×10^{-5}

D.

1×10^{-3}

Answer: C

Solution:

$K_a = C\alpha^2$

$K_a = (0.1) \times (0.01)^2$

$K_a = 1 \times 10^{-5}$

Question10

An acidic buffer is prepared by mixing :

[NEET 2023 mpr]

Options:

A.

weak acid and it's salt with strong base

B.

equal volumes of equimolar solutions of weak acid and weak base

C.

strong acid and it's salt with strong base

D.

strong acid and it's salt with weak base
(The pK_a of acid = pK_b of the base)

Answer: A

Solution:

Acidic buffer is prepared by mixing weak acid and its salt with strong base.

Question11

The pH of the solution containing 50mL each of 0.10M sodium acetate and 0.01M acetic acid is
[Given pK_a of $CH_3COOH = 4.57$]
[NEET-2022]

Options:

A. 5.57

B. 3.57

C. 4.57

D. 2.57

Answer: A

Solution:

$CH_3COONa + CH_3COOH, CH_3COOH(pK_a) = 4.57$

$0.1M$ $0.01M$

$50mL$ $50mL$

It is a mixture of weak acid and salt of its conjugate base. Hence it is acidic buffer.

$$pH = pK_a + \log \frac{[\text{ Salt }]}{[\text{ Acid }]}$$

$$= 4.57 + \log\left(\frac{0.1}{0.01}\right)$$

$$= 4.57 + 1$$

$$= 5.57$$

Question12

$3O_2(g) \rightleftharpoons 2O_3(g)$

for the above reaction at 298K, Kc is found to be 3.0×10^{-59}. If the concentration of O_2 at equilibrium is 0.040M then concentration of O_3 in M is
[NEET-2022]

Options:

A. 4.38×10^{-32}

B. 1.9×10^{-83}

C. 2.4×10^{31}

D. 1.2×10^{21}

Answer: A

Solution:

$3O_2(g) \rightleftharpoons 2O_3(g)$

$$K_C = \frac{[O_3]^2}{[O_2]^3}$$

$[O_3]^2 = K_C[O_2]^3 = 3 \times 10^{-59} \times (0.04)^3$

$[O_3]^2 = 1.9 \times 10^{-63} = 19 \times 10^{-64}$

$[O_3] = 4.38 \times 10^{-32}$

Concentration of O_3 at equilibrium $= 4.38 \times 10^{-32} M$

Question13

0.01M acetic acid solution is 1% ionised, then pH of this acetic acid solution is:
[NEET Re-2022]

Options:

A. 1

B. 3

C. 2

D. 4

Answer: D

Solution:

$$\begin{array}{llll} & CH_3COOH & \rightleftharpoons CH_3COO^- & + H^- \\ t = t_{eq} & C - c\alpha & C\alpha & C\alpha \end{array}$$

$$[H^+] = C \,.\, \alpha = 0.01 \times \frac{1}{100} = 10^{-4}$$

$$pH = -\log_{10}[H^+]$$

$$= 4$$

Question14

K_p for the following reaction is 3.0 at 1000K.
$CO_2(g) + C(s) \rightleftharpoons 2\,CO(g)$
What will be the value of K_c for the reaction at the same temperature?
(Given $-R = 0.083$L bar $K^{-1}mol^{-1}$)
[NEET Re-2022]

Options:

A. 3.6

B. 0.36

C. 3.6×10^{-2}

D. 3.6×10^{-3}

Answer: C

Solution:

$CO_2(g) + C(s) \rightleftharpoons 2\,CO(g)$

$K_P = K_c(RT)^{\Delta n_g}(\Delta n_g = 2 - 1)$

$3 = K_c(0.083 \times 1000)$

$K_C = \dfrac{3}{0.083 \times 1000} = 3.6 \times 10^{-2}$

Question15

The pK_b of dimethylamine and pK_a of acetic acid are 3.27 and 4.77 respectively at T (K). The correct option for the pH of dimethylammonium acetate solution is:
[NEET 2021]

Options:

A. 8.50

B. 5.50

C. 7.75

D. 6.25

Answer: C

Solution:

Dimethylammonium acetate is a salt of weak acid and weak base whose pH can be calculated as

$$\begin{aligned} pH &= 7 + \frac{1}{2}(pK_a - pK_b) \\ &= 7 + \frac{1}{2}(4.77 - 3.27) \\ &= 7.75 \end{aligned}$$

Question16

Hydrolysis of sucrose is given by the following reaction.
Sucrose + $H_2O \rightleftharpoons$ Glucose + Fructose If the equilibrium constant (K_C) is 2×10^{13} at 300K, the value of $\Delta_r G^{\ominus}$ at the same temperature will be :
(2020)

Options:

A. $8.314\text{J mol}^{-1}\text{K}^{-1} \times 300\text{K} \times \ln(2 \times 10^{13})$

B. $8.314\text{J mol}^{-1}\text{K}^{-1} \times 300\text{K} \times \ln(3 \times 10^{13})$

C. $-8.314\text{J mol}^{-1}\text{K}^{-1} \times 300\text{K} \times \ln(4 \times 10^{13})$

D. $-8.314\text{J mol}^{-1}\text{K}^{-1} \times 300\text{K} \times \ln(2 \times 10^{13})$

Answer: D

Solution:

Solution:

(d) $\Delta G = \Delta G^\circ + RT \ln Q$

At equilibrium $\Delta G = 0, Q = K_{eq}$

So, $\Delta_r G^\circ = -RT \ln K_{eq}$

$\Delta_r G^\circ = -8.314\text{Jmol}^{-1}\text{K}^{-1} \times 300\text{K} \times \ln(2 \times 10^{13})$

Question17

Find out the solubility of $Ni(OH)_2$ in 0.1M NaOH. Given that the ionic product of $Ni(OH)_2$ is 2×10^{-15}

(2020)

Options:

A. $2 \times 10^{-8}\text{M}$

B. $1 \times 10^{-13}\text{M}$

C. $1 \times 10^{8}\text{M}$

D. $2 \times 10^{-13}\text{M}$

Answer: D

Solution:

(d) $Ni(OH)^2 \rightleftharpoons Ni^{2+} + 2OH^-$

2s

$NaOH \longrightarrow Na + OH^-$

Total $[OH^-] = 2s + 0.1 \approx 0.1$

Ionic product $= [Ni]^{2+}[OH]^2$

$2 \times 10^{-15} = s(0.1)^2$

$s = 2 \times 10^{-13}$

Solubility of $Ni(OH)_2 = 2 \times 10^{-13}\text{M}$

Question18

Which will make basic buffer?
(NEET 2019)

Options:

A. $100 mL$ of $0.1 M\ HCl + 100 mL$ of $0.1\ M\ NaOH$

B. $50 mL$ of $0.1 M\ NaOH + 25 mL$ of $0.1\ M\ CH_3COOH$

C. $100 mL$ of $0.1 M\ CH_3COOH + 100 mL$ of $0.1 M\ NaOH$

D. $100 mL$ of $0.1 M\ HCl + 200 mL$ of $0.1\ M\ NH_4OH$

Answer: D

Solution:

Solution:
Acid-base titration :
$HCl \quad + NH_4OH \longrightarrow NH_4Cl$
10 mmol 20 mmol
$\therefore$ HCl is the limiting reagent.
Solution contains NH_4OH (weak base) and NH_4Cl (salt of strong acid and weak base). Therefore, a basic buffer will be formed.

Question19

pH of a saturated solution of $Ca(OH)_2$ is 9. The solubility product (K_{sp}) of $Ca(OH)_2$ is
(NEET 2019)

Options:

A. 0.5×10^{-10}

B. 0.5×10^{-15}

C. 0.25×10^{-10}

D. 0.125×10^{-15}

Answer: B

Solution:

Solution:
pH of the saturated solution of $Ca(OH)_2 = 9$
$\therefore$ pOH of the saturated solution of $Ca(OH)_2 = 5$
$\Rightarrow [OH^-] = 10^{-5} \qquad (\because pH + pOH = 14)$
$Ca(OH)_2 \rightleftharpoons Ca^{2+} \quad + \quad 2OH^-$
s 2s

$$\frac{1}{2}\times 10^{-5} \quad 10^{-5}$$

$$K_{sp} = [Ca^{2+}][OH^-]^2 = \left[\frac{1}{2}\times 10^{-5}\right][10^{-5}]^2 = 0.5\times 10^{-15}$$

Question20

Conjugate base for Bronsted acids H_2O and HF are (NEET 2019)

Options:

A. H_3O^+ and H_2F^+, respectively

B. OH^- and H_2F^+, respectively

C. H_3O^+ and F^-, respectively

D. OH^- and F^-, respectively.

Answer: D

Solution:

Solution:

Bronsted acid	Conjugate base
H_2O	OH^-
HF	F^-

Question21

The pH of $0.01M\ NaOH_{(aq)}$ solution will be (Odisha NEET 2019)

Options:

A. 7.01

B. 2

C. 12

D. 9 d

Answer: C

Solution:

$NaOH \longrightarrow Na^+ + OH^-$
0.01 M   0.01 M
$\therefore\ [OH^-] = 0.01M$
$\therefore\ pOH = -\log[OH^-] = -\log(0.01) = 2$
$\therefore\ pH = 14 - pOH = 14 - 2 = 12$

Question22

Which of the following cannot act both as Bronsted acid and as Bronsted base?
(Odisha NEET 2019)

Options:

A. HCO_3^-

B. NH_3

C. HCl

D. HSO_4^-

Answer: C

Solution:

Solution:
HCl can donate protons but cannot accept any protons. Hence, HCl is a Bronsted acid

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Question23

The molar solubility of $CaF_2 (K_{sp} = 5.3 \times 10^{-11})$ in 0.1 M solution of NaF will be
(Odisha NEET 2019)

Options:

A. $5.3 \times 10^{-11} mol\ L^{-1}$

B. $5.3 \times 10^{-8} mol\ L^{-1}$

C. $5.3 \times 10^{-9} mol\ L^{-1}$

D. $5.3 \times 10^{-10} mol\ L^{-1}$

Answer: C

Solution:

$CaF_2 \longrightarrow Ca^{2+} + 2F^-$

$\quad\quad\quad s \quad\quad 2s$

$NaF \longrightarrow Na^+ + F^-$

$\quad\quad 0.1\text{ M} \quad 0.1\text{ M}$

$[Ca^{2+}] = s, [F^-] = (2s + 0.1) \approx 0.1M$

$K_{sp} = [Ca^{2+}][F^-]^2$

$5.3 \times 10^{-11} = (s)(0.1)^2$

$s = \dfrac{5.3 \times 10^{-11}}{(0.1)^2} = 5.3 \times 10^{-9} mol\,L^{-1}$

∴ Molar solubility is $5.3 \times 10^{-9} mol\,L^{-1}$

Question24

Following solutions were prepared by mixing different volumes of $NaOH$ and HCl of different concentrations:

A. $60mL\ \frac{M}{10} HCl + 40mL\ \frac{M}{10} NaOH$

B. $55mL\ \frac{M}{10} HCl + 45mL\ \frac{M}{10} NaOH$

C. $75mL\ \frac{M}{5} HCl + 25mL\ \frac{M}{5} NaOH$

D. $100mL\ \frac{M}{10} HCl + 100mL\ \frac{M}{10} NaOH$

pH of which one of them will be equal to 1?
(NEET 2018)

©

Options:

A. B

B. A

C. D

D. C

Answer: D

Solution:

Solution:
$pH = 1$, so $[H^+] = 10^{-1}$
For acid base mixture: $N_1V_1 - N_2V_2 = N_3V_3$
(For $NaOH$ and HCl, Normality = Molarity)

A. $M_1(H^+) = \dfrac{60 \times \frac{1}{10} - 40 \times \frac{1}{10}}{100} = 2 \times 10^{-3}M$ i.e. $pH = 2.7$

B. $M_2(H^+) = \dfrac{55 \times \frac{1}{10} - 45 \times \frac{1}{10}}{100} = \dfrac{1}{100} = 10^{-2}M$ i.e. $pH = 2$

C. $M_3(H^+) = \dfrac{75 \times \frac{1}{5} - 25 \times \frac{1}{5}}{100} = 10^{-1}M$ i.e. $pH = 1$

D. $M_4(H^+) = \dfrac{100 \times \frac{1}{10} - 100 \times \frac{1}{10}}{200} = 0$ i.e. $pH = 7$

Question25

The solubility of $BaSO_4$ in water is $2.42 \times 10^{-3} gL^{-1}$ at 298K . The value of its solubility product (K_{sp}) will be (Given molar mass of $BaSO_4 = 233 g mol^{-1}$)
(NEET 2018)

Options:

A. $1.08 \times 10^{-10} mol^2 L^{-2}$

B. $1.08 \times 10^{-12} mol^2 L^{-2}$

C. $1.08 \times 10^{-14} mol^2 L^{-2}$

D. $1.08 \times 10^{-8} mol^2 L^{-2}$

Answer: A

Solution:

Solubility of $BaSO_4$,

$$s = \frac{2.42 \times 10^{-3}}{233} mol\ L^{-1} = 1.04 \times 10^{-5} mol\ L^{-1}$$

$BaSO_4$ ionizes completely in the solution as:

$$BaSO_{4(s)} \rightleftharpoons \underset{s}{Ba_{(aq)}^{2+}} + \underset{s}{SO_{4(aq)}^{2-}}$$

$$K_{sp} = [Ba^{2+}][SO_4^{2-}] = s^2$$

$$= (1.04 \times 10^{-5})^2 = 1.08 \times 10^{-10} mol^2 L^{-2}$$

Question26

Which one of the following conditions will favour maximum formation of the product in the reaction
$A_{2(g)} + B_{2(g)} \rightleftharpoons X_{2(g)}, \Delta_r H = -X\ kJ$?
(NEE T 2018)

Options:

A. Low temperature and high pressure

B. Low temperature and low pressure

C. High temperature and high pressure

D. High temperature and low pressure

Answer: A

Solution:

Solution:
On increasing the pressure and decreasing the temperature, equilibrium will shift in forward direction.

Question27

The equilibrium constants of the following are
$N_2 + 3H_2 \rightleftharpoons 2NH_3; K_1$
$N_2 + O_2 \rightleftharpoons 2NO; K_2$
$H_2 + \frac{1}{2}O_2 \rightleftharpoons H_2O; K_3$
The equilibrium constant (K) of the reaction: $2NH_3 + \frac{5}{2}O_2 \overset{K}{\rightleftharpoons} 2NO + 3H_2O$ will be
(NEET 2017,2007,2003)

Options:

A. $K_2K_3^3/K_1$

B. K_2K_3/K_1

C. $K_2^3K_3^3/K_1$

D. $K_1K_3^3/K_2$

Answer: A

Solution:

Solution:
From the given equations,
$2NH_3 \rightleftharpoons N_2 + 3H_2; \frac{1}{K_1}$.....(i)
$N_2 + O_2 \rightleftharpoons 2NO; K_2$....(ii)
$3H_2 + \frac{3}{2}O_2 \rightarrow 3H_2O; K_3^3$......(iii)
By adding equations (i), (ii) and (iii), we get
$2NH_3 + \frac{5}{2}O_2 \overset{K}{\rightleftharpoons} 2NO + 2H_2O, K = \frac{K_2K_3^3}{K_1}$

Question28

Concentration of the Ag^+ ions in a saturated solution of $Ag_2C_2O_4$ is 2.2×10^{-4}mol L^{-1}. Solubility product of $Ag_2C_2O_4$ is
(NEET 2017)

Options:

A. 2.66×10^{-12}

B. 4.5×10^{-11}

C. 5.3×10^{-12}

D. 2.42×10^{-8}

Answer: C

Solution:

Let solubility of $Ag_2C_2O_4$ be s $\mathrm{mol\,L^{-1}}$

$$Ag_2C_2O_{4(s)} \rightleftharpoons \underset{2s}{2Ag_{(aq)}^{+}} + \underset{s}{C_2O_4{}^{2-}{}_{(aq)}}$$

s

$K_{sp} = (2s)^2(s) = 4s^3$

$K_{sp} = 4 \times (1.1 \times 10^{-4})^3 \qquad (\because [Ag^+] = 2s = 2.2 \times 10^{-4})$

$K_{sp} \approx 5.3 \times 10^{-12}$

Question29

A 20 litre container at 400K contains CO_2 at pressure 0.4atm and an excess of SrO (neglect the volume of solid SrO). The volume of the container is now decreased by moving the movable piston fitted in the container. The maximum volume of the container, when pressure of CO_2 attains its maximum value, will be
(Given that : $SrCO_{3(s)} \rightleftharpoons SrO_{(s)} + CO_{2(g)}$, $K_p = 1.6$ atm)
(NEET 2017)

Options:

A. 10 litre

B. 4 litre

C. 2 litre

D. 5 litre

Answer: D

Solution:

Solution:
$SrCO_{3(s)} \rightleftharpoons SrO_{(s)} + CO_{2(g)}$; $K_p = 1.6$atm

$K_p = \frac{p_{CO_2} \times p_{SrO}}{p_{SrCO_3}}$

$\Rightarrow 1.6 = p_{CO_2} \left(\because p_{SrO} = p_{SrCO_3} = 1\right)$

$\therefore$ Maximum pressure of $CO_2 = 1.6$ atm

Let the maximum volume of the container when pressure of CO_2 is 1.6 atm be V L

During the process, $PV =$ constant

$\therefore 0.4 \times 20 = 1.6 \times V$

$\Rightarrow V = \frac{0.4 \times 20}{1.6} = 5L$

Question30

The percentage of pyridine (C_5H_5N) that forms pyridinium ion (C_5H_5NH) in a 0.10M aqueous pyridine solution (K_b right. for $C_5H_5N = 1.7 \times 10^{-9}$) is
(NEET- II 2016)

Options:

A. 0.0060%

B. 0.013%

C. 0.77%

D. 1.6%

Answer: B

Solution:

Solution:

$C_5H_5N + H_2O \rightleftharpoons C_5H_5\overset{+}{N}H + OH^-$

0.10 M

$\alpha = \sqrt{\frac{K_b}{C}} = \sqrt{\frac{1.7 \times 10^{-9}}{0.10}} = 1.30 \times 10^{-4}$

$\therefore$ Percentage of pyridine that forms pyridinium ion $= 1.30 \times 10^{-4} \times 100 = 0.013\%$

Question31

The solubility of $AgCl_{(s)}$ with solubility product 1.6×10^{-10} in 0.1M NaCl solution would be
(NEET-II 2016)

Options:

A. $1.26 \times 10^{-5}M$

B. 1.6×10^{-9}M

C. 1.6×10^{-11}M

D. zero.

Answer: B

Solution:

Let s be the solubility of AgCl in moles per litre.

$AgCl_{(aq)} \rightleftharpoons Ag^{+}_{(aq)} + Cl^{-}_{(aq)}$

s s (s+0.1)

(∵0.1M NaCl solution also provides 0.1M Cl^{-} ion)

$K_{sp} = [Ag^{+}][Cl^{-}]$; $1.6 \times 10^{-10} = s(s + 0.1)$

$1.6 \times 10^{-10} = s(0.1)$ (∵s<<< < 0.1)

$$s = \frac{1.6 \times 10^{-10}}{0.1} = 1.6 \times 10^{-9}M$$

Question32

Which of the following fluoro-compounds is most likely to behave as a Lewis base?
(NEET-II 2016)

Options:

A. BF_3

B. PF_3

C. CF_4

D. SiF_4

Answer: B

Solution:

Solution:
$BF_3 \longrightarrow$ Lewis acid (incomplete octet)
$PF_3 \longrightarrow$ Lewis base (presence of lone pair on P atom)
$CF_4 \longrightarrow$ Complete octet
$SiF_4 \longrightarrow$ Lewis acid (empty d -orbital in Si-atom)

Question33

MY and NY_3, two nearly insoluble salts, have the same K_{sp} values of

6.2×10^{-13} at room temperature. Which statement would be true in regard to MY and NY_3?
(NEET- I 2016)

Options:

A. The salts MY and NY_3 are more soluble in $0.5M\ KY$ than in pure water.

B. The addition of the salt of KY to solution of MY and NY_3 will have no effect on their solubilities.

C. The molar solubilities of MY and NY_3 in water are identical.

D. The molar solubility of MY in water is less than that of NY_3

Answer: D

Solution:

Solution:
For $MY : K_{sp} = s_1^2$
$\Rightarrow\ s_1 = \sqrt{K_{sp}} = \sqrt{6.2 \times 10^{-13}} = 7.87 \times 10^{-7} \text{mol L}^{-1}$
For $NY_3 : K_{sp} = 27s_2^4$
$\Rightarrow\ s_2 = \sqrt[4]{\dfrac{6.2 \times 10^{-13}}{27}} = 3.89 \times 10^{-4} \text{mol L}^{-1}$
Hence, molar solubility of MY in water is less than that of NY_3.

Question34

Which one of the following pairs of solution is not an acidic buffer? (2015)

Options:

A. CH_3COOH and CH_3COONa

B. H_2CO_3 and Na_2CO_3

C. H_3PO_4 and Na_3PO_4

D. $HClO_4$ and $NaClO_4$

Answer: D

Solution:

Acidic buffer is a mixture of a weak acid and its a strong base.
$HClO_4$ is strong acid

Question35

Aqueous solution of which of the following compounds is this best conductor of electric current?
(2015)

Options:

A. Hydrochloric acid, HCl

B. Ammonia, NH_3

C. Fructose, $C_6H_{12}O_6$

D. Acetic acid,$C_2H_4O_2$

Answer: A

Solution:

Solution:
HCl is a strong acid and dissociates completely it in aqueous solution.

Question36

What is the pH of the resulting solution when equal volume of 0.1 M NaOH and 0.01 M HCL are mixed?
(2015)

Options:

A. 2.0

B. 7.0

C. 1.04

D. 12.65

Answer: D

Solution:

One mole of NaOH is completely neutralised by of HCl.
Hence, 0.01 mole of NaOH will be completely neutral 0.01 mole of HCl.
⇒NaOH left unneutralised =0.0 - 0.01 mol
=0.09 mol
As equal volumes of two solutions are mixed,

$[OH^-] = \frac{0.09}{2} = 0.045M$

$\Rightarrow pOH = -\log(0.045) = 1.35$

$\therefore pH = 14 - 1.35 = 12.65$

Question37

If the equilibrium constant for $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ is K,the equilibrium constant for

$\frac{1}{2}N_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons NO(g)$ will be

(2015)

Options:

A. $\frac{1}{2}K$

B. K

C. K^2

D. $K^{\frac{1}{2}}$

Answer: D

Solution:

Solution:

If the reaction is multiplied by $\frac{1}{2}$ then new equation constant, $K' = K^{\frac{1}{2}}$

Question38

If the value of equilibrium constant for a particular reaction is 1.6×10^{12},then at equilibrium the system will contain

(2015 Cancelled)

Options:

A. mostly products

B. similar amounts of reactants and products

C. all reactants

D. mostly reactants

Answer: A

Solution:

The value of K is high which means reaction proceeds almost to completion i.e., the system will contain mostly products.

Question39

Which of the following statements is correct for a reversible process in a state of equilibrium?
(2015 Cancelled)

Options:

A. ΔG° = - 2.30 RT log K

B. ΔG° = 2.30 RT log K

C. ΔG = - 2.30 RT log K

D. ΔG = 2.30 RT log K

Answer: A

Question40

The K_{sp} of Ag_2CrO_4,AgCl,AgBr and AgI are respectively
1.1×10^{-12}, 1.8×10^{-10}, 5.0×10^{-13}, 8.3×10^{-17}
Which or of the following salts will precipitate last if $AgNO_3$ solution added to the solution containing equal moles of NaCl,NaB NaI and Na_2CrO_4
(2015 Cancelled)

Options:

A. AgBr

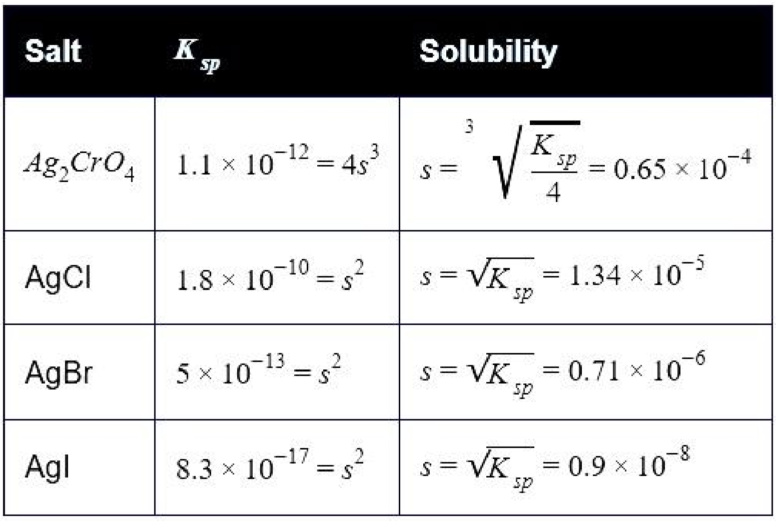
B. Ag_2CrO_4

C. AgI

D. AgCI

Answer: B

Solution:



Salt	K_{sp}	Solubility
Ag_2CrO_4	$1.1 \times 10^{-12} = 4s^3$	$s = \sqrt[3]{\frac{K_{sp}}{4}} = 0.65 \times 10^{-4}$
AgCl	$1.8 \times 10^{-10} = s^2$	$s = \sqrt{K_{sp}} = 1.34 \times 10^{-5}$
AgBr	$5 \times 10^{-13} = s^2$	$s = \sqrt{K_{sp}} = 0.71 \times 10^{-6}$
AgI	$8.3 \times 10^{-17} = s^2$	$s = \sqrt{K_{sp}} = 0.9 \times 10^{-8}$

∵ Solubility of Ag_2CrO_4 is highest thus, it will be precipitated at last.

Question41

For a given exothermic reaction,K_p and K'_p are the equilibrium constants at temperatures T_1 and T_2, respectively. Assuming that heat of reaction is constant in temperature range between T_1 and T_2,it is readily observed that
(2014)

Options:

A. $K_p > K'_p$

B. $K < K'_p$

C. $K_p = K'_p$

D. $K_p = \frac{1}{K'_p}$

Answer: A

Solution:

$$\log \frac{K'_p}{K_p} = -\frac{\Delta H}{2.303R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$$
For exothermic reaction, ΔH = -ve i,e. heat is evolved
The temperature T_2 is higher than T_1

Thus, $\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$ is negative
so $\log K'_p - \log K_p = -\text{ve}$ or $\log K_p > \log K'_p$
or $K_p > K'_p$

Question42

For the reversible reaction,
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + \text{heat}$
The equilibrium shifts in forward direction
(2014)

Options:

A. by increasing the concentration of $NH_3(g)$

B. by decreasing the pressure

C. by decreasing the concentrations of $N_2(g)$ and $H_2(g)$

D. by increasing pressure and decreasing temperature

Answer: D

Solution:

Solution:
As the forward reaction is exothermic and leads to lowering of pressure (produces lesser number of gaseous moles) hence, according to Le Chatelier's principle, at high pressure and low temperature, the given reversible reaction will shift in forward direction to form more product.

Question43

Using the Gibb's energy change ΔG° = +63.3 kJ for the following reaction
$Ag_2CO_{3(s)} \rightleftharpoons 2Ag^{+}_{(aq)} + CO_{3(aq)}^{2-}$
the K_{sp} of $Ag_2CO_{3(s)}$ in water at 25°C is ($R = 8.314\ J\ K^{-1} mol^{-1}$)
(2014)

Options:

A. 3.2×10^{-26}

B. 8.0×10^{-12}

C. 2.9×10^{-3}

D. 7.9×10^{-2}

Answer: B

Solution:

$\Delta G° = -2.303RT\log K_{sp}$
$63.3 \times 10^3 J = -2.303 \times 8.314 \times 298\log K_{sp}$
$63.3 \times 10^3 J = -5705.84\log K_{sp}$
$\log K_{sp} = -\frac{63.3 \times 10^3}{5705.84} = -11.09$
K_{sp} = antilog $(-11.09) = 8.128 \times 10^{-12}$

Question44

Which of the following salts will give highest pH in water? (2014)

Options:

A. KCl

B. NaCl

C. Na_2CO_3

D. $CuSO_4$

Answer: C

Solution:

Solution:
Na_2CO_3 which is a salt of NaOH (strong base) and H_2CO_3 (weak acid) will produce a basic solution with pH greater than 7.

Question45

Which of these is least likely to act as a Lewis base? (2013 NEET)

Options:

A. BF_3

B. PF_3

C. CO

D. F^-

Answer: A

Solution:

BF_3 is Lewis acid (e^- pair acceptor).

Question46

$KMnO_4$ can be prepared from K_2MnO_4 as per the reaction,
$3MnO_4^{2-} + 2H_2O \rightleftharpoons 2MnO_4^- + MnO_2 + 4OH^-$
The reaction can go to completion by removing OH^- ions by adding
(2013 NEET)

Options:

A. CO_2

B. SO_2

C. HCl

D. KOH

Answer: A

Solution:

Solution:
HCl and SO_2 arc reducing agents. So they can reduce MnO_4^-.
CO_2 is neither oxidising nor reducing agent, it will provide only acidic medium. It can shift the reaction in forward direction and the reaction can go to completion.

Question47

Accumulation of lactic acid ($HC_3H_5O_3$), a monobasic acid in tissues leads to pain and a feeling of fatigue. In a 0.10M aqueous solution, lactic acid is 3.7% dissociates. The value of dissociation constant, K_a, for this acid will be
(Karnataka NEET 2013)

Options:

A. 1.4×10^{-5}

B. 1.4×10^{-4}

C. 3.7×10^{-4}

D. 2.8×10^{-4}

Answer: B

Solution:

Solution:

Degree of dissociation, $\alpha = \frac{3.7}{100} = 0.037$

According to Ostwald's formula,

$K_a = \alpha^2 C = (0.037)^2 \times 0.10 = 1.369 \times 10^{-4} \approx 1.4 \times 10^{-4}$

Question48

At 100°C the K_w of water is 55 times its value at 25°C. What will be the pH of neutral solution? ($\log 55 = 1.74$)
(Karnataka NEET 2013)

Options:

A. 7.00

B. 7.87

C. 5.13

D. 6.13

Answer: D

Solution:

We know that, at 25°C, $K_w = 1 \times 10^{-14}$

At 100°C, $K_w = 55 \times 10^{-14}$

$H^+ = \sqrt{55 \times 10^{-14}}$

$pH = -\log[H^+]$

$pH = -\log\left[\sqrt{55 \times 10^{-14}}\right]$

$= \frac{1}{2}[-\log(55 \times 10^{-14})] = \frac{1}{2}[-\log 55 + 14 \log 10]$

$= \frac{1}{2}[-1.74 + 14] = \frac{1}{2}[12.26] = 6.13$

Question49

The values of K_{sp} of $CaCO_3$ and CaC_2O_4 are 4.7×10^{-9} and 1.3×10^{-9} respectively at 25°C. If the mixture of these two is washed with water, what is the concentration of Ca^{2+} ions in water?
(Karnataka NEET 2013)

Options:

A. 5.831×10^{-5}M

B. 6.856×10^{-5}M

C. 3.606×10^{-5}M

D. 7.746×10^{-5}M

Answer: D

Solution:

$$\mathrm{CaCO_3} \rightarrow \underset{x}{\mathrm{Ca^{2+}}} + \underset{x}{\mathrm{CO_3^{2-}}}$$
$$\mathrm{CaC_2O_4} \rightarrow \underset{y}{\mathrm{Ca^{2+}}} + \underset{y}{\mathrm{C_2O_4^{2-}}}$$

Now, $[\mathrm{Ca^{2+}}] = x + y$
and $x(x + y) = 4.7 \times 10^{-9}$.....(i)
$y(x + y) = 1.3 \times 10^{-9}$....(ii)
Dividing equation (i) and (ii) we get
$\frac{x}{y} = 3.6$
$\therefore\ x = 3.6y$
Putting this value in equation (ii), we get
$y(3.6y + y) = 1.3 \times 10^{-9}$
On solving, we get $y = 1.68 \times 10^{-5}$
and $x = 3.6 \times 1.68 \times 10^{-5} = 6.048 \times 10^{-5}$
$\therefore [\mathrm{Ca^{2+}}] = (x + y) = (1.68 \times 10^{-5}) + (6.048 \times 10^{-5})$
$\therefore\ [\mathrm{Ca^{2+}}] = 7.728 \times 10^{-5}$M

Question50

The dissociation constant of a weak acid is 1×10^{-4}. In order to prepare a buffer solution with a pH $= 5$, the [Salt]/[Acid] ratio should be (Karnataka NEET 2013)

Options:

A. 4: 5

B. 10: 1

C. 5: 4

D. 1: 10

Answer: B

Solution:

$$pH = pK_a + \log\frac{[\text{ Salt }]}{[\text{Acid }]}$$

$$5 = -\log K_a + \log\frac{[\text{ Salt }]}{[\text{ Acid }]} \quad [\because pK_a = -\log K_a]$$

$$5 = -\log[1 \times 10^{-4}] + \log\frac{[\text{ Salt }]}{[\text{ Acid }]}$$

$$5 = 4 + \log\frac{[\text{ Salt }]}{[\text{ Acid }]}, 5 - 4 = \log\frac{[\text{ Salt }]}{[\text{ Acid }]}$$

$$1 = \log\frac{[\text{ Salt }]}{[\text{ Acid }]}, \frac{[\text{ Salt }]}{[\text{ Acid }]} = 10 \text{ i.e. } 10:1$$

Question51

Given the reaction between 2 gases represented by A_2 and B_2 to give the compound AB(g).
$A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$
At equilibrium the concentration of $A_2 = 3.0 \times 10^{-3}$ M of
$B_2 = 4.2 \times 10^{-3}$M ,of AB = 2.8×10^{-3}M
If the reaction takes place in a sealed vessel at 527°C, thenthe value of K_C will be
(2012 Mains)

Options:

A. 2.0

B. 1.9

C. 0.62

D. 4.5

Answer: C

Solution:

$$A_{2(g)} + B_{2(g)} \rightleftharpoons 2AB_{(g)}$$

$$K_c = \frac{[AB]^2}{[A_2][B_2]}$$

$$= \frac{(2.8 \times 10^{-3})^2}{(3.0 \times 10^{-3})(4.2 \times 10^{-3})} = \frac{2.8 \times 2.8}{3.0 \times 4.2} = 0.62$$

Question52

Given that the equilibrium constant for the reaction,
$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$
has a value of 278 at a particular temperature. What is the value of the equilibrium constant for the following reaction at the same

temperature?
$SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$
(2012 Mains)

Options:

A. 1.8×10^{-3}

B. 3.6×10^{-3}

C. 6.0×10^{-2}

D. 1.3×10^{-5}

Answer: C

Solution:

Solution:
$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$.....(i)
K = 278
By revrsing the equation (i),we get
$2SO_{3(g)} \rightleftharpoons 2SO_{2(g)} + O_{2(g)}$....(ii)
Equilibrium constant for this reaction is
$K' = \frac{1}{K} = \frac{1}{278}$
By dividing the equation (ii) by 2, we get desired equation
$SO_{3(g)} \rightleftharpoons SO_{2(g)} + \frac{1}{2}O_{2(g)}$.....(iii)
Equilibrium constant for this reaction
$K'' = \sqrt{K'} = \sqrt{\frac{1}{K}} = \sqrt{\frac{1}{278}}$
$= 0.0599 \approx 0.06 \text{ or } 6 \times 10^{-2}$

Question53

Buffer solutions have constant acidity and alkalinity because (2012)

Options:

A. these give unionised acid or base on reaction with added acid or alkali

B. acids and alkalies in these solutions are shielded from attack by other ions

C. they have large excess of H^+ or OH^- ions

D. they have fixed value of pH

Answer: A

Question54

Equimolar solutions of the following substances were prepared separately. Which one of these will record the highest pH value? (2012)

Options:

A. $BaCl_2$

B. $Al\,Cl_3$

C. LiCl

D. $BeCl_2$

Answer: A

Solution:

Solution:
$BaCl_2$ is made up of $Ba(OH_2) + HCl$.
$Al\,C_3$ is made up $Al\,(OH)_3$ and HCl
LiCl is made up of LiOH and HCl.
$BeCl_2$ is made up of $Be(OH_2)$ and HCl
$Ba(OH)_2$ is strongest base among the given options thus have maximum pH

Question55

In qualitative analysis, the metals of group I can be separated from other ions by precipitating them as chloride salts. A solution initially contains Ag^+ and Pb^{2+} at a concentration of 0.10 M. Aqueous HCI is added to this solution until the Cl^- concentration is 0.10 M. What will the concentrations of Ag^+ and Pb^{2+} be at equilibrium ? (K_{sp} for $AgCl = 1.8 \times 10^{-10}$, K_{sp} for $PbCl_2 = 1.7 \times 10^{-5}$) (2011 Mains)

Options:

A.

$[Ag^+] = 1.8 \times 10^{-7}M$, $[Pb^{2+}] = 1.7 \times 10^{-6}M$

B.

$[Ag^+] = 1.8 \times 10^{-11}M$, $[Pb^{2+}] = 8.5 \times 10^{-5}M$

C.

$[Ag^+] = 1.8 \times 10^{-9}M$, $[Pb^{2+}] = 1.7 \times 10^{-3}M$

D.

$[Ag^+] = 1.8 \times 10^{-11}M$, $[Pb^{2+}] = 1.7 \times 10^{-4}M$

Answer: C

Solution:

Solution:

$$K_{sp}[AgCl] = [Ag^+][Cl^-]$$

$$[Ag^+] = \frac{1.8 \times 10^{-10}}{10^{-1}} = 1.8 \times 10^{-9}M$$

$$K_{sp}[PbCl_2] = [Pb^{2+}][Cl^{-2}]$$

$$[Pb^{2+}] = \frac{1.7 \times 10^{-5}}{10^{-1} \times 10^{-1}} = 1.7 \times 10^{-3}M$$

Question56

For the reaction ,$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$ the equilibrium constant is K_1.
The equilibrium constant is K_2 for the reaction,
$2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$.
What is K for the reaction. $NO_{2(g)} \rightleftharpoons \frac{1}{2}N_2(g) + O_{2(g)}$
(2011)

Options:

A. $\frac{1}{2K_1K_2}$

B. $\frac{1}{4K_1K_2}$

C. $\left[\frac{1}{K_1K_2}\right]^{\frac{1}{2}}$

D. $\frac{1}{K_1K_2}$

Answer: C

Solution:

$$N_2 + O_2 \rightleftharpoons 2NO \quad ; \quad K_1$$

$2NO + O_2 \rightleftharpoons 2NO_2\ ;\ K_2$

$NO_2 \rightleftharpoons \frac{1}{2}N_2 + O_2\ \ ;\ K$

$$K_1 = \frac{[NO]^2}{[N_2][O_2]};\ K_2 = \frac{[NO_2]^2}{[NO]^2 \times [O_2]}$$

$$K = \frac{[N_2]^{\frac{1}{2}}[O_2]}{[NO_2]} = \sqrt{\frac{[N_2][O_2] \times [NO]^2[O_2]}{[NO]^2 \times [NO_2]^2}}$$

$$K = \sqrt{\frac{1}{K_1K_2}}$$

Question57

Which of the following is least likely to behave as Lewis base?
(2011)

Options:

A. H_2O

B. NH_3

C. BF_3

D. OH^-

Answer: C

Solution:

Solution:
BF_3 is an electron deficient species and acts as Lewis base.

Question58

A buffer solution is prepared in which the concentration of NH_3 is 0.30 M and the concentration of NH_4^+ is 0.20 M.If the equilibrium constant,K_b for NH_3 equals 1.8×10^{-5},what is the pH of this solution ? (log 2.7=0.43)
(2011)

Options:

A. 9.08

B. 9.43

C. 11.72

D. 8.73

Answer: B

Solution:

Solution:
$[NH_3] = 0.30M$, $K_b = 1.8 \times 10^{-5}$, $[NH_4^+] = 0.20M$
$pOH = pK_b + \log\frac{[salt]}{[base]} = 4.74 + \log\frac{0.2}{0.3} = 4.56$
$pH = (14 - 4.56) = 9.43$

Question59

The value of ΔH for the reaction,
$X_2(g) + 4Y_2(g) \rightleftharpoons 2XY_4(g)$ is less than zero,Formation of $XY_4(g)$ will be favoured at
(2011)

©

Options:

A. high temperature and high pressure

B. low pressure and low temperature

C. high temperature and low pressure

D. high pressure and low temperature

Answer: D

Solution:

Solution:
$X_2(g) + 4Y_2(g) \rightleftharpoons 2XY_4(g)$
$\Delta_{n_g} = -ve$ and $\Delta H = -ve$
The reaction is favoured in forward direction at low temperature and high pressure.

Question60

The reaction, $2A(g) + B(g) \rightleftharpoons 3C(g) + D(g)$ is begun with the concentrations of A and B both at an initial value of 1.00 M. When equilibrium is reached, the concentration of D is measured and found to be 0.25 M. The value for the equilibrium constant for this reaction is given by the expression
(2010 Mains)

Options:

A. $[(0.75)^3(0.25)] \div [(1.00)^2(1.00)]$

B. $[(0.75)^3(0.25)] \div [(0.50)^2(0.75)]$

C. $[(0.75)^3(0.25)] \div [(0.50)^2(0.25)]$

D. $[(0.75)^3(0.25)] \div [(0.75)^2(0.25)]$

Answer: B

Solution:

Solution:

	$2A(g)$	+	$B(g)$	$\rightleftharpoons 3C(g)$	+	$D(g)$
Initial moles:	1		1	0		0
Mole at eq :	1-(2×0.25)		1-0.25	3×0.25		0.25
	= 0.5		= 0.75	= 0.75		= 0.25

Equilibrium constant, $K = \frac{[C]^3[D]}{[A]^2[B]}$

$\Rightarrow K = \frac{(0.75)^3(0.25)}{(0.5)^2(0.75)}$

Question61

In a buffer solution containing equal concentration of B^- and HB, the K_b for B^- is 10^{-10}. The pH of buffer solution is (2010)

Options:

A. 10

B. 7

C. 6

D. 4

Answer: D

Solution:

Solution:

We know, $pOH = pk_b + \log\frac{[B^-]}{[HB]}$

Since $[B^-] = [HB]$ (given)

$\therefore pOH = pK_b \Rightarrow pOH = 10$

$\therefore pH = 14 - 10 = 4$

Question62

In which of the following equilibrium K_c and K_p are not equal ?
(2010)

Options:

A. $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$

B.

$SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g)$

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

D. $2C(s) + O_2(g) \rightleftharpoons 2CO_2(g)$

Answer: D

Solution:

We have
$K_P = K_C(RT)^{\Delta n}$
$\triangle n =$ no. of moles of gaseous (products - reactants)
$\Rightarrow$ if $\Delta n = 0 \Rightarrow K_P = K_C(RT)^0$
$\Rightarrow K_P = K_C$
For, $2C(s) + O_2(g) \rightleftharpoons 2CO_2(g)$
$\triangle n = 2 - 1 = 1$
$\Rightarrow K_P = K_C(RT)$

Question63

What is $[H^+]$ is mol/L of a solution that is 0.20 M in CH_3COONa and 0.10M in CH_3COOH ? K_a for $CH_3COOH = 1.8 \times 10^{-5}$
(2010)

Options:

A. 3.5×10^{-4}

B. 1.1×10^{-5}

C. 1.8×10^{-5}

D. 9.0×10^{-6}

Answer: D

Solution:

$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$
C - x x x

$CH_3COONa \rightarrow CH_3COO^- + Na^+$
0.2 M 0.2 M 0.2M

$[CH_3COOH] = C - x \approx 0.1M$ {acetic acid is a weal acid so, dissociation is minimum.

$[CH_3COO^-] = 0.2 + x \approx 0.2M$ {acetic acid is a weal acid so, dissociation is minimum.

$$\therefore [H^+] = \frac{K_a[CH_3COOH]}{[CH_3COO^-]}$$

$$= \frac{1.8 \times 10^{-5} \times 10^{-1}}{2 \times 10^{-1}} = 9 \times 10^{-6}M$$

Question64

If pH of a saturated solution of $Ba(OH)_2$ is 12,the value of its K_{sp} is (2010,2012)

Options:

A. 4.00×10^{-6}

B. 4.00×10^{-7}

C. 5.00×10^{-6}

D. 5.00×10^{-7}

Answer: D

Solution:

pH of solution $= 12$

$[H^+] = 10^{-12}$

$$[OH^-] = \frac{10^{-14}}{10^{-12}} = 10^{-2}$$

$Ba(OH)_2 \rightleftharpoons Ba^{2+} + 2OH^-$
s 2s

$$2s = 10^{-2} \Rightarrow s = \frac{10^{-2}}{2s}$$

$K_{sp} = (s)(2s)^2 = 4s^3$

$$= 4 \times \left(\frac{10^{-2}}{2}\right)^3 = \frac{4}{8} \times 10^{-6} = 5 \times 10^{-7}$$

Question65

What is the $[OH^-]$ in the final solution prepared by mixing 20.0 mL of 0.050 M HCl with 30.0 mL of 0.01 M $Ba(OH)_2$ (2009)

Options:

A. 0.40M

B. 0.0050 M

C. 0.12 M

D. 0.10 M

Answer: D

Solution:

Millimoles of H^+ produced $= 20 \times 0.05 = 1$
Millimoles of OH^- produced $= 30 \times 0.1 \times 2 = 6$
($\because$Each $Ba(OH)_2$ gives $2OH^-$)
$\therefore$ Millimoles of OH^- remaining in solution $= 6 - 1 = 5$
Total volume of solution $= 20 + 30 = 50mL$
$\therefore [OH^-] = \frac{5}{50} = 0.1M$

Question66

The ionization constant of ammonium hydroxide is 1.77×10^{-5} at 298 K. Hydrolysis constant of ammonium chloride is (2009)

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Options:

A. 6.50×10^{-12}

B. 5.65×10^{-13}

C. 5.65×10^{-12}

D. 5.65×10^{-10}

Answer: D

Solution:

Solution:
NH_4Cl is a salt of strong acid and weak base, so hydrolysis constant is
$K_h = \frac{K_w}{K_b}$
Given $K_b(NH_4OH) = 1.77 \times 10^{-5}$
$K_w = 10^{-14}$
$\therefore K_h = \frac{10^{-14}}{1.77 \times 10^{-5}} = 0.56 \times 10^{-9}$
or $K_h = 5.6 \times 10^{-10}$

Question67

Which of the following molecules acts as a Lewis acid? (2009)

Options:

A. $(CH_3)_2O$

B. $(CH_3)_3P$

C. $(CH_3)_3N$

D. $(CH_3)_3B$

Answer: D

Solution:

Solution:
Lewis acids are electron deficient compounds, since $(CH_3)_3B$ is electron deficient (due to incomplete octect of B), it acts as a Lewis acid.

Question68

The dissociation constants for acetic acid and HCN at 25 are 1.5×10^{-5} and 4.5×10^{-10} respectively.The equilibrium constant for the equilibrium,

$$CN^- + CH_3COOH \rightleftharpoons HCN + CH_3COO^-$$

would be
(2009)

Options:

A. 3.0×10^{-5}

B. 3.0×10^{-4}

C. 3.0×10^{4}

D. 3.0×10^{5}

Answer: C

Solution:

Given:

$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

$K_1 = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]} = 1.5 \times 10^{-5}$

$HCN \rightleftharpoons H^+ + CN^-$

$K_2 = \frac{[CN^-][H^+]}{[HCN]} = 4.5 \times 10^{-10}$

$CN^- + CH_3COOH \rightleftharpoons HCN + CH_3COO^-$

$K = \frac{[HCN][CH_3COO^-]}{[CN^-][CH_3COOH]}$

$K = \frac{K_1}{K_2} = \frac{1.5 \times 10^{-5}}{4.5 \times 10^{-10}} \approx 0.3 \times 10^5$

or $K = 3 \times 10^4$

Question69

The values of K_{p_1} and K_{p_2} for the reactions

$X \rightleftharpoons Y + Z$ ....(1)

$A \rightleftharpoons 2B$..............(2)

are in the ratio 9 : 1. If degree of dissociation of X and be equal, then total pressure at equilibrium (1) and (2) in the ratio

(2008)

Options:

A. 36 : 1

B. 1 : 1

C. 3 : 1

D. 1 : 9

Answer: A

Solution:

Solution:

$X \rightleftharpoons Y + Z$ ....(1)

$A \rightleftharpoons 2B$..............(2)

$X \rightleftharpoons Y + Z$

1 0 0 Initially

1-α α α at equilibrium

Total no.of moles at equilibrium $= 1 - \alpha + 2\alpha$

$= 1 + \alpha$

Similarly

$A \rightleftharpoons 2B$

1, 0 Initially when t=0

1-α 2α at equilibrium

Total no.of moles at equilibrium $= 1 - \alpha + 2\alpha$

$1 = 1 + \alpha$

$$\therefore K_{P_1} = \frac{P_Y \times p_Z}{P_X} = \frac{\frac{\alpha}{1+\alpha} \times P_1 \times \frac{\alpha}{1+\alpha} \times P_1}{\frac{1-\alpha}{1+\alpha}} \times P_1$$

$$K_{P_2} = \frac{(p_B)^2}{P_A} = \frac{\left(\frac{2\alpha}{1+\alpha} \times P_2\right)^2}{\frac{1-\alpha}{1+\alpha} \times P_2}$$

$$\text{Now, } \frac{K_{P_1}}{K_{P_2}} = \frac{P_1}{4P_2} \Rightarrow \frac{P_1}{P_2} = \frac{36}{1} = 36 : 1$$

Question70

The value of equilibrium constant of the reaction:
$HI(g) \rightleftharpoons \frac{1}{2}H_2(g) + \frac{1}{2}I_2(g)$ is 8.0.The equilibrium constant of the reaction $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ will be
(2008)

Options:

A. 16

B. 1/8

C. 1/16

D. 1/64

Answer: D

Solution:

$$HI(g) \rightleftharpoons \frac{1}{2}H_2(g) + \frac{1}{2I_2(g)}$$

$$\text{i.e } K = \frac{[H_2]^{1/2}[I_2]^{1/2}}{[HI]} = 8$$

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

$$K' = \frac{[HI]^2}{[H_2][I_2]} = \left(\frac{1}{8}\right)^2$$

$$K' = \frac{1}{64}$$

Question71

Equal volumes of three acid solutions of pH 3, 4 and 5 mixed in a vessel. What will be the H^+ ion concentration the mixture?
(2008)

Options:

A. $3.7 \times 10^{-3}M$

B. 1.11×10^{-3}M

C. 1.11×10^{-4}M

D. 3.7×10^{-4}M

Answer: D

Solution:

$pH = -\log[H^+]$
or $[H^+] = 10^{-pH}$; $[H^+]$ of soln.1 $= 10^{-3}$
$[H^+]$ of soln.2 $= 10^{-4}$; $[H^+]$ of soln.3 $= 10^{-5}$
Total concentration of
$[H^+] = 10^{-3}(1 + 1 \times 10^{-1} + 1 \times 10^{-2})$
$10^{-3}\left(\frac{1}{1} + \frac{1}{10} + \frac{1}{100}\right) \Rightarrow 10^{-3}\left(\frac{100 + 10 + 1}{100}\right)$
$\Rightarrow 10^{-3}\left(\frac{111}{100}\right) = 1.11 \times 10^{-3}$
So, H^+ ion concentration in mixture of equal volume of these acid solution $= \frac{1.11 \times 10^{-3}}{3} = 3.7 \times 10^{-4}$M

Question72

If the concentration of OH^- ions in the reaction $Fe(OH)_3(g) \rightleftharpoons Fe^{3+}(aq) + 3OH^-(aq)$ is decreased by 1/4 times, then equilibrium concentration of will increase by (2008)

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Options:

A. 64 times

B. 4 times

C. 8 times

D. 16 times

Answer: A

Solution:

Solution:
$Fe(OH)_3(g) \rightleftharpoons Fe_{aq}^{3+} + 3OH_{aq}^{-}$
$K = \frac{[Fe^{3+}][OH^-]^3}{[Fe(OH_3)]}$
$K = [Fe^{3+}][OH^-]^3$(activity of solid is taken unity)
Concentration of OH- ion in the reaction is decreased by 1/4times then equilibrium concentration of Fe^{3+} will be increased by 64 times in order to keep the value of K constant.

Question73

The dissociation equilibrium of a gas AB_2 can be represented as:
$2AB_2(g) \rightleftharpoons 2AB(g) + B_2(g)$
The degree of dissociation is x and is small compared The expression relating the degree of dissociation (x) equilibrium constant K_p and total pressure P is
(2008)

Options:

A. $\left(\frac{2K_p}{P}\right)^{1/2}$

B. $\left(\frac{K_p}{P}\right)$

C. $\left(\frac{2K_p}{P}\right)$

D. $\left(\frac{2K_p}{P}\right)^{1/3}$

Answer: D

Solution:

Solution:

$2AB_2(g) \rightleftharpoons 2AB(g) + B_2(g)$

2 0 0 (initially)

2(1-x) 2x x (at equilibrium)

Amount of moles at equilibrium

$= 2(1-x) + 2x + x = 2 + x$

$$K_p = \frac{[P_{AB}]^2[P_{B_2}]}{[P_{AB_2}]}$$

$$K_p = \frac{\left(\frac{2x}{2+x} \times P\right)^2 \times \left(\frac{x}{2+x} \times p\right)}{\left(\frac{2(1-x)}{2+x} \times P\right)^2} = \frac{\frac{4x^3}{2+x} \times P}{4(1-x)^2}$$

$$K_p = \frac{4x^3 \times P}{2} \times \frac{1}{4} \quad (\because 1 - x \approx 1 \& 2 + x \approx 2)$$

$$x = \left(\frac{8K_p}{4P}\right)^{\frac{1}{3}} \Rightarrow x = \left(\frac{2K_p}{P}\right)^{\frac{1}{3}}$$

Question74

Calculate the pOH of a solution at 25°C that contains $1 \times 10^{-10}M$ of hydronium ions i.e. H_3O^+
(2007)

Options:

A. 4.000

B. 9.000

C. 1.000

D. 7.000

Answer: A

Solution:

Given $[H_3O^+] = 1 \times 10^{-10}$ or,pH=10
Now at 25°C,$\mathrm{pH} + \mathrm{pOH} = \mathrm{pK}_w = 14$
or,$\mathrm{pOH} = 14 - \mathrm{pH} = 14 - 10 = 4$

Question75

The following equilibrium constants are given:
$N_2 + 3H_2 \rightleftharpoons 2NH_3; K_1$
$N_2 + O_2 \rightleftharpoons 2NO; K_2$
$H_2 + \frac{1}{2}O_2 \rightleftharpoons H_2O; K_3$
The equilibrium constant for the oxidation of NH_3 by oxygen to give NO is
(2007)

Options:

A. $\frac{K_2 K_3^2}{K_1}$

B. $\frac{K_2^2 K_3}{K_1}$

C. $\frac{K_1 K_2}{K_3}$

D. $\frac{K_2 K_3^3}{K_1}$

Answer: D

Solution:

$N_2 + 3H_2 \rightleftharpoons 2NH_3; \quad K_1 = \dfrac{[NH_3]^2}{[N_2][H_2]^3}$ ......(1)

$N_2 + O_2 \rightleftharpoons 2NO; \quad K_2 = \dfrac{[NO]^2}{[N_2][O_2]}$ ......(2)

$H_2 + \frac{1}{2}O_2 \rightleftharpoons H_2O; \quad K_3 = \dfrac{[H_2O]}{[H_2][O_2]^{1/2}}$ ......(3)

For the reaction $2NH_3 + \frac{5}{2}O_2 \rightleftharpoons 2NO + 3H_2O$

$$K = \frac{[NO]^2[H_2O]^3}{[NH_3]^2[O_2]^{5/2}}$$

$$= \frac{[NO]^2}{[N_2][O_2]} \times \frac{[H_2O]^3}{[H_2]^3[O_2]^{3/2}} \times \frac{[N_2][H_2]^3}{[NH_3]^2}$$

$$= \frac{K_2 \times K_3{}^3}{K_1}$$

Question76

A weak acid, HA, has a K_a of 1.00×10^{-5}. If 0.100 mol of this acid is dissolved in one litre of water, the percentage of acid dissociated at equilibrium is closest to
(2007)

Options:

A. 1.00%

B. 99.9%

C. 0.100%

D. 99.0%

Answer: A

Solution:

For a weak acid, degree of dissociation,

$\alpha = \sqrt{\dfrac{K_a}{C}} = \sqrt{\dfrac{1 \times 10^{-5}}{0.1}} = 10^{-2}$i . e1.00%

Question77

The hydrogen ion concentration of a 10^{-8}M HCl aqueous solution at 298K ($K_w = 10^{-14}$)
(2006)

Options:

A. $1.0 \times 10^{-8} M$

B. $1.0 \times 10^{-6} M$

C. $1.0525 \times 10^{-7} M$

D. $9.525 \times 10^{-8} M$

Answer: C

Solution:

10^{-8}MHCl = $10^{-8} M\, H^{+}$
Aslo from water,$[H^{+}] = 10^{-7}$.
Total
$[H^{+}] = 10^{-7} + 0.10 \times 10^{-7} = 1.1 \times 10^{-7}$

Question78

Which of the following pairs constitutes a buffer? (2006)

Options:

A. HCl and KCl

B. HNO_2 and $NaNO_2$

C. NaOH and NaCl

D. HNO_3 and NH_4NO_3

Answer: B

Solution:

Solution:
HNO_2 and $NaNO_2$ are examples of acidic buffer.

Question79

For the reaction: $CH_4(g) + 2O_2(g) \rightleftharpoons CO_2(g) + 2H_2O(l)$, $\Delta H_r = -170.8 kJ\ mol^{-1}$. Which of the following statements is not true? (2006)

Options:

A. The reaction is exothermic.

B. At equilibrium, the concentrations of $CO_2(g)$ and $H_2O(l)$ are not equal.

C. The equilibrium constant for the reaction is given by $K_p = \frac{[CO_2]}{[CH_4][O_2]}$

D. Addition of $CH_4(g)$ or $O_2(g)$ at equilibrium will cause a shift to the right.

Answer: C

Solution:

Solution:

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

$$K_p = \frac{P_{CO_2}}{P_{CH_4} \cdot P_{O_2}{}^2}$$

Question80

At 25°C, the dissociation constant of a base, BOH, is 1.0×10^{-12}. The concentration of hydroxyl ions in 0.01M aqueous solution of the base would be
(2005)

Options:

A. $1.0 \times 10^{-5} \text{mol L}^{-1}$

B. $1.0 \times 10^{-6} \text{mol L}^{-1}$

C. $2.0 \times 10^{-6} \text{mol L}^{-1}$

D. $1.0 \times 10^{-7} \text{mol L}^{-1}$

Answer: D

Solution:

$C = 0.01M$

$K_b = 1 \times 10^{-12}$ at 25°C

	BOH	$\rightleftharpoons$	B^+	$+ OH^-$
Intially	C		0	0
At eq.	$C - C\alpha$		$C\alpha$	$C\alpha$

$[OH^-] = C\alpha$

$[OH^-] = \sqrt{K_b C} = \sqrt{1 \times 10^{-12} \times 10^{-2}}$

$[OH^-] = 10^{-7} \text{ mol L}^{-1}$

Question81

H_2S gas when passed through a solution of cations containing HCl precipitates the cations of second group of qualitative analysis but not those belonging to the fourth group. It is because
(2005)

Options:

A. presence of HCl decreases the sulphide ion concentration

B. solubility product of group II sulphides is more than that of group IV sulphides

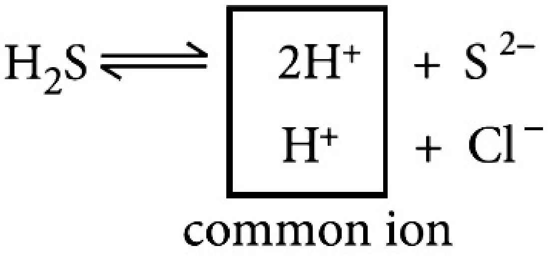
C. presence of H Cl increases the sulphide ion concentration

D. sulphides of group IV cations are unstable in HCl.

Answer: A

Solution:

The cation of group II are precipitated as their sulphides.
Solubility product of sulphide of group II radicals are very low. Therefore, even with low conc. of S^{2-} ions, the ionic product exceeds the value of their solubility product and the radical of group II gets precipitated. The low conc. of S^{2-} ions is obtained by passing H_2S gas through the solution of the salt in the presence of dil. HCl which suppresses degree of ionisation of H_2S by common ion effect.



common 10n
Note : Solubility product of group IV radicals are quite high.
It is necessary to suppress the conc. of S^{2-} ions, otherwise radical of group IV will also get precipitated along with group II radicals.

Question82

Equilibrium constants K_1 and K_2 for the following equilibria:

$NO_{(g)} + \frac{1}{2}O_{2(g)} \overset{K_1}{\rightleftharpoons} NO_{2(g)}$ and

$2NO_{(g)} \overset{K_2}{\rightleftharpoons} 2NO_{2(g)} + O_{2(g)}$ are related as

(2005)

Options:

A. $K_2 = 1/K_1^2$

B. $K_2 = K_1^2$

C. $K_2 = 1/K_1$

D. $K_2 = K_1/2$

Answer: A

Solution:

$$K_1 = \frac{p_{NO_2}}{p_{NO} \cdot (p_{O_2})^{1/2}} \text{.....(1)}$$

$$K_2 = \frac{(p_{NO})^2 \cdot p_{O_2}}{(p_{NO_2})^2} \text{.....(2)}$$

taking square root on both sides in eq. 2 .

$$\Rightarrow \sqrt{K_2} = \frac{p_{NO} \cdot (p_{O_2})^{1/2}}{p_{NO_2}}$$

$$\Rightarrow \sqrt{K_2} = \frac{1}{K_1} \Rightarrow K_2 = \frac{1}{K_1^2}$$

Question83

The solubility product of a sparingly soluble salt AX_2 is 3.2×10^{-11}. Its solubility (in moles/L) is
(2004)

Options:

A. 5.6×10^{-6}

B. 3.1×10^{-4}

C. 2×10^{-4}

D. 4×10^{-4}

Answer: C

Solution:

$$K_{sp} = 3.2 \times 10^{-11}$$

$$\underset{}{AX_2} \rightleftharpoons \underset{s}{A^{2+}} + \underset{2s}{2X^-}$$

$$K_{sp} = s \times (2s)^2 = 4s^3; \text{ i.e., } 3.2 \times 10^{-11} = 4s^3$$

$$\text{or, } \quad s^3 = 0.8 \times 10^{-11} = 8 \times 10^{-12}$$

$$\therefore \; s = 2 \times 10^{-4}$$

Question84

The rapid change of pH near the stoichiometric point of an acid-base titration is the basis of indicator detection. pH of the solution is related to ratio of the concentrations of the conjugate acid (HIn) and base (In^-) forms of the indicator by the expression

(2004)

Options:

A. $\log \frac{[In^-]}{[HIn]} = pK_{In} - pH$

B. $\log \frac{[HIn]}{[In^-]} = pK_{In} - pH$

C. $\log \frac{[HIn]}{[In^-]} = pH - pK_{In}$

D. $\log \frac{[In^-]}{[HIn]} = pH - pK_{In}$

Answer: D

Solution:

Solution:

Let us consider the formation of a salt of a weak acid and a strong base.

$In^- + H_2O \rightleftharpoons HIn + OH^-$

$K_h = \frac{[HIn][OH^-]}{[In^-]}$ ....(1)

Other equations present in the solution are

$HIn \rightleftharpoons H^+ + In^-$

$H_2O \rightleftharpoons H^+ + OH^-$

$K_{In} = \frac{[H^+][In^-]}{[HIn]}$ ....(ii)

$K_w = [H^+][OH^-]$......(iii)

From (ii) and (iii),

$\frac{K_w}{K_{In}} = \frac{[HIn][OH^-]}{[In^-]} = K_h$.....(iv)

$[OH^-] = \frac{K_w}{K_{In}} \frac{[In^-]}{[HIn]}$

$\log[OH^-] = \log K_w - \log K_{In} + \log \frac{[In^-]}{[HIn]}$

$-pOH = -pK_w + pK_{In} + \log \frac{[In^-]}{[HIn]}$

$pK_w - pOH = pK_{In} + \log \frac{[In^-]}{[HIn]}$

or, $pH = pK_{In} + \log \frac{[In^-]}{[HIn]}$

i.e. $\log \frac{[In^-]}{[HIn]} = pH - pK_{In}$

Question85

In Haber process 30 litres of dihydrogen and 30 litres of dinitrogen

were taken for reaction which yielded only 50% of the expected product. What will be the composition of gaseous mixture under the aforesaid condition in the end?
(2003)

Options:

A. 20 litres ammonia, 20 litres nitrogen, 20 litres hydrogen

B. 10 litres ammonia, 25 litres nitrogen, 15 litres hydrogen

C. 20 litres ammonia, 10 litres nitrogen, 30 litres hydrogen

D. 20 litres ammonia, 25 litres nitrogen, 15 litres hydrogen

Answer: B

Solution:

Solution:

$3H_2$	+	N_2	$\rightarrow$	$2NH_3$
3		1		2
3/2		1/2		1
$10 \times \frac{3}{2}$		$10 \times \frac{1}{2}$		10×1
15		5		10

Composition of gaseous mixture under the aforesaid condition in the end
$H_2 = 30 - 15 = 15$ litres
$N_2 = 30 - 5 = 25$ litres
$NH_3 = 10$ litres

Question86

The reaction quotient (Q) for the reaction $N_2 + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ is given by $Q = \frac{[NH_3]^2}{[N_2][H_2]^3}$. The reaction will proceed from right to left if where K_c is the equilibrium constant.
(2003)

Options:

A. $Q = K_c$

B. $Q < K_c$

C. $Q > K_c$

D. $Q = 0$

Answer: C

Solution:

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}; \Delta n = 2 - 4 = -2$

Thus, the reaction will shift in forward direction when $Q > K_c$

Question87

Which one of the following statements is not true? (2003)

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Options:

A. Among halide ions, iodide is the most powerful reducing agent

B. Fluorine is the only halogen that does not show a variable oxidation state.

C. HOCl is a stronger acid than HOBr.

D. HF is a stronger acid than HCl.

Answer: D

Solution:

Solution:
Due to strong hydrogen-fluorine bond, proton is not given off easily and hence, HF is weakest acid.

Question88

The solubility product of AgI at $25^{\circ}C$ is $1.0 \times 10^{-16} mol^2 L^{-2}$. The solubility of AgI in $10^{-4} N$ solution of KI at $25^{\circ}C$ is approximately (in $mol\ L^{-1}$) (2003)

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Options:

A. 1.0×10^{-16}

B. 1.0×10^{-12}

C. 1.0×10^{-10}

D. 1.0×10^{-8}

Answer: B

Solution:

$AgI \rightleftharpoons Ag^{+} + I^{-}$
$1.0 \times 10^{-16} = s \times s$
Solubility of $Ag^{+} = 1.0 \times 10^{-8} mol\,L^{-1}$
Solubility of AgI in KI solution $= 1.0 \times 10^{-8} \times 10^{-4} = 1.0 \times 10^{-12} mol\,L^{-1}$

Question89

Reaction
$BaO_{2(s)} \rightleftharpoons BaO_{(s)} + O_{2(g)}$; $\Delta H = +ve$
In equilibrium condition, pressure of O_2 depends on
(2002)

Options:

A. increase mass of BaO_2

B. increase mass of BaO

C. increase temperature on equilibrium

D. increase mass of BaO_2 and BaO both.

Answer: C

Solution:

Solution:
Pressure of O_2 does not depend on concentration terms of other reactants (because both are in solid state), since this is an endothermic reaction. If the temperature be raised dissociation of BaO_2 would occur, more O_2 is produced at equilibrium, pressure of O_2 increases.

Question90

Solubility of MX_2 type electrolytes is 0.5×10^{-4} mole/lit., then find out K_{sp} of electrolytes.
(2002)

Options:

A. 5×10^{-12}

B. 25×10^{-10}

C. 1×10^{-13}

D. 5×10^{-13}

Answer: D

Solution:

If s is the solubility of the electrolyte MX_2
$C_{M^{2+}} = s$, $C_{X^-} = 2s$
Solubility product, $K_{sp} = s \times (2s)^2 = 4s^3$
$s = 0.5 \times 10^{-4}$ mole/litre
$\therefore\ K_{sp} = 4 \times (0.5 \times 10^{-4})^3$; $K_{sp} = 5 \times 10^{-13}$

Question91

Which has highest pH?
(2002)

Options:

A. CH_3COOK

B. Na_2CO_3

C. NH_4Cl

D. $NaNO_3$

Answer: B

Solution:

Solution:
NH_4OH is a weak base but HCl is a strong acid in solution, so pH of NH_4Cl solution is comparatively low.
$NaNO_3$ is a salt of strong base and strong acid, so pH of the solution will be 7 .
Hydrolysis of potassium acetate (a salt of a weak acid and a strong alkali) gives a weakly alkaline solution, since the acetate ion acts as a weak base.
$CH_3COOK + H_2O \rightarrow CH_3COOH + K^+ + OH^-$
The pH of this solution ≈ 8.8.
Hydrolysis of sodium carbonate (a salt of strong alkali and a weak acid) gives an alkaline solution
$Na_2CO_3 + 2H_2O \rightarrow 2(Na^+ + OH^-) + H_2CO_3$
The pH of this solution is > 10.

Question92

Solution of 0.1N NH_4OH and 0.1N NH_4Cl has pH 9.25. Then find out pK_b of NH_4OH .
(2002)

Options:

A. 9.25

B. 4.75

C. 3.75

D. 8.25

Answer: B

Solution:

Solution:
Solution of $0.1N\ NH_4OH$ and $0.1N\ NH_4Cl$ is a buffer solution. According to Henderson equation, the pH of a basic buffer, $pH = 14 - pK_b - \log\frac{C_{salt}}{C_{base}}$

$\Rightarrow pK_b = 14 - pH - \log\frac{C_{salt}}{C_{base}}$

$\Rightarrow\ pK_b = 14 - 9.25 - \log\frac{0.1}{0.1}$

$\Rightarrow\ pK_b = 14 - 9.25 = 4.75$

$\therefore\ pK_b$ of $NH_4OH = 4.75$

Question93

In HS^-, I^-, $R-NH_2$, NH_3 order of proton accepting tendency will be (2001)

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Options:

A.

$I^- > NH_3 > R-NH_2 > HS^-$

B.

$NH_3 > R-NH_2 > HS^- > I^-$

C.

$R-NH_2 > NH_3 > HS^- > I^-$

D.

$HS^- > R-NH_2 > NH_3 > I^-$

Answer: C

Solution:

Proton accepting tendency is known as the strength of basicity.

In $R-\ddot{N}H_2$, N has lone pair of electron which intensify due to electron releasing R -group and increase the tendency to donate lone pair of electrons to H^+
Secondly as the size of the ion increases there is less attraction for H^+ to form weaker bonds with H - atom and are less basic. The order of the given series: $RNH_2 > NH_3 > HS^- > I^-$

Question94

Ionisation constant of CH_3COOH is 1.7×10^{-5} and concentration of H^+ ions is 3.4×10^{-4}. Then find out initial concentration of CH_3COOH molecules.
(2001)

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Options:

A. 3.4×10^{-4}

B. 3.4×10^{-3}

C. 6.8×10^{-4}

D. 6.8×10^{-3}

Answer: D

Solution:

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

$$K_{ion} = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$$

$$[CH_3COOH] = \frac{3.4 \times 10^{-4} \times 3.4 \times 10^{-4}}{1.7 \times 10^{-5}} = 6.8 \times 10^{-3}$$

Question95

Solubility of M_2S salt is 3.5×10^{-6} then find out solubility product.
(2001)

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Options:

A. 1.7×10^{-6}

B. 1.7×10^{-16}

C. 1.7×10^{-18}

D. 1.7×10^{-12}

Answer: B

Solution:

For reaction, $M_2S \rightleftharpoons 2M^+ + S^{2-}$
Solubility $= 3.5 \times 10^{-6}$
Solubility product, $K_{sp} = [M^+]^2[S^{2-}]$
$= (2s)^2 s = 4s^3 = 4 \times (3.5 \times 10^{-6})^3 = 1.7 \times 10^{-16}$

Question96

Correct relation between dissociation constants of a dibasic acid is (2000)

Options:

A. $K_{a_1} = K_{a_2}$

B. $K_{a_1} > K_{a_2}$

C. $K_{a_1} < K_{a_2}$

D. $K_{a_1} = \frac{1}{K_{a_2}}$

Answer: B

Solution:

Solution:

(i) $H_2A \overset{K_{a_1}}{\rightleftharpoons} HA^- + H^+$

(ii) $HA^- \overset{K_{a_2}}{\rightleftharpoons} A^{2-} + H^+$

In the 1^{st} step H^+ ion comes from neutral molecule, while in the 2^{nd} step the H^+ ion comes from negatively charged ions. The presence of -ve charge makes the removal of H^+ ion difficult.
Thus, $K_{a_1} > K_{a_2}$

Question97

For any reversible reaction, if we increase concentration of the reactants, then effect on equilibrium constant (2000)

Options:

A. depends on amount of concentration

B. unchange

C. decrease

D. increase. (2000)

Answer: B

Solution:

Solution:
For a reaction, A + B ⇌ C + D.
$K_{eq} = \frac{[C][D]}{[A][B]}$
Increase in conc. of reactants will proceed the equilibrium in the forward direction giving more products. So that the equilibrium constant value remains constant and independent of concentration.

Question98

Conjugate acid of NH_2^- is (2000)

Options:

A. NH_4OH

B. NH_4^+

C. NH_2^-

D. NH_3

Answer: D

Solution:

Solution:
$NH_2^- + H^+ \rightarrow NH_3$ (conjugate acid)
Substance $+H^+ \rightarrow$ conjugate acid
Substance $-H^+ \rightarrow$ conjugate base

Question99

Which statement is wrong about pH and H^+? (2000)

Options:

A. pH of neutral water is not zero.

B. Adding 1N solution of CH_3COOH and 1N solution of $NaOH$, pH will be seven.

C. $[H^+]$ of dilute and hot H_2SO_4 is more than concentrated and cold H_2SO_4.

D. Mixing solution of CH_3COOH and HCl, pH will be less than 7

Answer: B

Solution:

Solution:
After mixing 1N solution of CH_3COOH (weak acid) and $1N$ $NaOH$ (strong base), the resulting solution will have free OH^- ions. Thus pH will be higher than 7.

Question100

Equilibrium constant K_p for following reaction $MgCO_{3(s)} \rightleftharpoons MgO_{(s)} + CO_{2(s)}$ (2000)

Options:

A. $K_p = P_{CO_2}$

B. $K_p = P_{CO_2} \times \frac{P_{CO_2} \times P_{MgO}}{P_{MgCO_3}}$

C. $K_p = \frac{P_{CO_2} + P_{MgO}}{P_{MgCO_3}}$

D. $K_p = \frac{P_{MgCO_3}}{P_{CO_2} \times P_{MgO}}$

Answer: A

Solution:

Solution:
$K_p = P_{CO_2}$
Solids do not exert pressure, so their partial pressure is taken as unity.

Question101

The strongest conjugate base is (1999)

Options:

A. SO_4^{2-}

B. Cl^-

C. NO_3^-

D. CH_3COO^-

Answer: D

Solution:

Solution:
$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$
Weak acid Conjugate base
As CH_3COOH is the weakest acid, so its conjugate base (CH_3COO^-) is the strongest base. H_2SO_4, HCl, HNO_3 are strong acids, so their conjugate bases are weak.

Question102

The concentration of $[H^+]$ and concentration of $[OH^-]$ of a 0.1 aqueous solution of 2% ionised weak acid is [ionic product of water $= 1 \times 10^{-14}$] (1999)

Options:

A. $2 \times 10^{-3}M$ and $5 \times 10^{-12}M$

B. $1 \times 10^{-3}M$ and $3 \times 10^{-11}M$

C. $0.02 \times 10^{-3}M$ and $5 \times 10^{-11}M$

D. $3 \times 10^{-2}M$ and $4 \times 10^{-13}M$

Answer: A

Solution:

$[H^+] = Ca = 0.1 \times 0.02 = 2 \times 10^{-3}M$
(As degree of dissociation $= 2\% = 0.02$)
Hence, $[OH^-] = \dfrac{10^{-14}}{2 \times 10^{-3}} = 5 \times 10^{-12}M$

Question103

The solubility of a saturated solution of calcium fluoride is 2×10^{-4}

moles per litre. Its solubility product is
(1999)

Options:

A. 22×10^{-11}

B. 14×10^{-4}

C. 2×10^{-2}

D. 32×10^{-12}

Answer: D

Solution:

For mathrm CaF_2, decomposition is as follows:
$CaF_2 \rightarrow Ca^{2+} + 2F^-$
s s 2s
$\Rightarrow K_{sp} = [Ca^{2+}][F^-]^2 = s \times (2s)^2$
or,
$K_{sp} = 4s^3 \Rightarrow K_{sp} = 4s^3 = 4 \times (2 \times 10^{-4})^3$
$\Rightarrow K_{sp} = 32 \times 10^{-12}$

Question104

If K_1 and K_2 are the respective equilibrium constants for the two reactions,
$XeF_6 + H_2O_{(g)} \rightarrow XeOF_{4(g)} + 2HF_{(g)}$
$XeO_{4(g)} + XeF_{6(g)} \rightarrow XeOF_{4(g)} + XeO_3F_{2(g)}$
the equilibrium constant of the reaction,
$XeO_{4(g)} + 2HF_{(g)} \rightarrow XeO_3F_{2(g)} + H_2O_{(g)}$
will be
(1998)

Options:

A. $\frac{K_1}{K_2}$

B. $K_1 \cdot K_2$

C. $K_1/(K_2)^2$

D. $\frac{K_2}{K_1}$

Answer: D

Solution:

Given
$XeF_6 + H_2O \rightleftharpoons XeOF_4 + 2HF$, $K_{eq} = K_1$ $XeOF_4 + 2HF \rightleftharpoons XeF_6 + H_2O$, $K_{eq} = 1/K_1$.....(1)
and
$XeO_4 + XeF_6 \rightleftharpoons XeOF_4 + XeO_3F_2$, $K_{eq} = K_2 \ldots (2)$
The reaction, $XeO_4 + 2HF \rightleftharpoons XeO_3F_2 + H_2O$ can be obtained by adding eq. (1) and eq.(2). So, the equilibrium constant for the above reaction can be obtained by multiplying the equilibrium constants of eq. (1) and eq. (2).
Hence, the value is $= \frac{K_2}{K_1}$

Question105

A physician wishes to prepare a buffer solution at pH $= 3.85$ that efficiently resists changes in pH yet contains only small concentration of the buffering agents. Which of the following weak acids together with its sodium salt would be best to use?
(1997)

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Options:

A. 2,5 -Dihydroxy benzoic acid ($pK_a = 2.97$)

B. Acetoacetic acid ($pK_a = 3.58$)

C. m -Chlorobenzoic acid ($pK_a = 3.98$)

D. p -Chlorocinnamic acid ($pK_a = 4.41$)

Answer: A

Question106

The hydride ion H^- is stronger base than its hydroxide ion OH^-. Which of the following reaction will occur if sodium hydride (NaH) is dissolved in water?
(1997)

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Options:

A. $H^- + H_2O \rightarrow$ no reaction

B. $H_{(aq)}^{-} + H_2O \rightarrow H_2O$

C.

$H_{(aq)}^{-} + H_2O_{(l)} \rightarrow OH^{-} + H_2$

D. None of these.

Answer: C

Solution:

Solution:
$NaH + H_2O \rightarrow NaOH + H_2$
or, $H_{(aq)}^{-} + H_2O_{(l)} \rightarrow OH^{-} + H_2\uparrow$

Question107

The solubility product of CuS, Ag_2S and HgS are 10^{-31}, 10^{-44} and 10^{-54} respectively. The solubilities of these sulphides are in the order (1997)

Options:

A. $HgS > Ag_2S > CuS$

B. $CuS > Ag_2S > HgS$

C. $Ag_2S > CuS > HgS$

D. $AgS > HgS > CuS$

Answer: B

Solution:

Solution:
The greater the solubility product, the greater is the solubility.

Question108

The equilibrium constant for the reaction $N_2 + 3H_2 \rightleftharpoons 2NH_3$ is K, then the equilibrium constant for the equilibrium $2NH_3 \rightleftharpoons N_2 + 3H_2$ is (1996)

Options:

A. $\sqrt{K}$

B. $\sqrt{\frac{1}{K}}$

C. $\frac{1}{K}$

D. $\frac{1}{K^2}$

Answer: C

Solution:

Solution:
The equilibrium constant for the reverse reaction will be $\frac{1}{K}$.

Question109

The ionic product of water at $25^\circ C$ is 10^{-14} Its ionic product at $90^\circ C$ will be,
(1996)

Options:

A. 1×10^{-14}

B. 1×10^{-16}

C. 1×10^{-20}

D. 1×10^{-12}

Answer: D

Solution:

Solution:
At high temperature, the value of ionic product increases.

Question110

If α is dissociation constant, then the total number of moles for the reaction, $2HI \rightarrow H_2 + I_2$ will be
(1996)

Options:

A. 1

B. $1-\alpha$

C. 2

D. $2-\alpha$

Answer: C

Solution:

Solution:
Total number of moles $= 2(1-\alpha) + 2\alpha = 2$

Question111

The pH value of $N/10NaOH$ solution is (1996)

Options:

A. 12

B. 13

C. 10

D. 11

Answer: B

Solution:

Solution:
since $NaOH$ is a strong base, therefore it completely ionises. Thus, the hydroxyl ion concentration is equal to that of the base itself. We know that concentration of OH^- in $N/10$ NaOH
$= 0.1 = 10^{-1}$
Therefore value of

$$[H_3O^+] = \frac{K_w}{[OH^-]} = \frac{1\times10^{-14}}{10^{-1}} = 1\times10^{-13}$$

$$pH = -\log[H_3O^+] = -\log[1\times10^{-13}] = 13$$

Question112

Which of the following is not a Lewis acid? (1996)

Options:

A. SiF_4

B. C_2H_4

C. BF_3

D. $FeCl_3$

Answer: B

Solution:

Solution:
In BF_3 and $FeCl_3$ molecules, the central atoms have incomplete octet and in SiF_4,the central atom has empty d -orbitals. Hence, according to Lewis concept, these are Lewis acids.

Question113

The pH value of blood does not appreciably change by a small addition of an acid or a base, because the blood
(1995)

Options:

A. can be easily coagulated

B. contains iron as a part of the molecule

C. is a body fluid

D. contains serum protein which acts as buffer.

Answer: D

Solution:

Solution:
The pH value of the blood is maintained constant by buffer solution present in the blood itself. Buffer solutions resist the change in pH values.

Question114

The pH value of a $10M$ solution of HCl is
(1995)

Options:

A. equal to 1

B. equal to 2

C. less than 0

D. equal to 0

Answer: C

Solution:

Solution:
since HCl is a strong acid and it completely ionises, therefore H_3O^+ ions concentration is equal that of the acid itself i.e., $[H_3O^+] = [HCl] = 10M$
Therefore,
$pH = -\log[H_3O^+] = -\log[10] = -1$

Question115

The solubility of AgCl will be minimum in (1995)

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Options:

A. $0.01M\ CaCl_2$

B. pure water

C. $0.001M\ AgNO_3$

D. $0.01M\ NaCl$

Answer: A

Solution:

Solution:
There are greater number of particles (i.e. ions) compared to others. Hence, solubility will be minimum.

Question116

In liquid-gas equilibrium, the pressure of vapours above the liquid is constant at (1995)

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Options:

A. constant temperature

B. low temperature

C. high temperature

D. none of these.

Answer: A

Solution:

Solution:
Vapour pressure is directly related to temperature. Greater is the temperature, greater will be the vapour pressure. So to keep it constant, temperature should be constant.

Question117

Which one of the following is most soluble? (1994)

Options:

A. $Bi_2S_3(K_{sp} = 1 \times 10^{-70})$

B. $Lt_2S(K_{sp} = 6 \times 10^{-51})$

C. $CuS(K_{sp} = 8 \times 10^{-37})$

D. $MnS(K_{sp} = 7 \times 10^{-16})$

Answer: D

Solution:

Solution:
Higher the value of solubility product, greater is the solubility.

Question118

At 80°C, distilled water has $[H_3O^+]$ concentration equal to 1×10^{-6} mole/litre. The value of K_w at this temperature will be (1994)

Options:

A. 1×10^{-12}

B. 1×10^{-15}

C. 1×10^{-6}

D. 1×10^{-9}

Answer: A

Solution:

Solution:
$[H_3O^+] = [OH^-] = 1 \times 10^{-6}$ mole/litre
$K_w = [H_3O^+][OH^-] = [1 \times 10^{-6}] \times [1 \times 10^{-6}] = 1 \times 10^{-12}$

Question119

According to Le Chatelier's principle, adding heat to a solid and liquid in equilibrium will cause the
(1993)

Options:

A. temperature to increase

B. temperature to decrease

C. amount of liquid to decrease

D. amount of solid to decrease.

Answer: D

Solution:

Solution:
When solid and liquid are in equilibrium, the increase in temperature results in increase in volume of liquid or decrease in the amount of solid.
Solid ⇌ Liquid
With increase in temperature equilibrium shifts in forward direction.

Question120

0.1 M solution of which one of these substances will act basic?
(1992)

Options:

A. Sodium borate

B. Ammonium chloride

C. Calcium nitrate

D. Sodium sulphate

Answer: A

Solution:

Solution:
Sodium borate is a salt formed from strong base ($NaOH$) and weak acid (H_3BO_3).
Hence, sodium borate will act basic.

Question121

Which one of the following information can be obtained on the basis of Le Chatelier principle?
(1992)

Options:

A. Dissociation constant of a weak acid

B. Entropy change in a reaction

C. Equilibrium constant of a chemical reaction

D. Shift in equilibrium position on changing value of a constraint

Answer: D

Solution:

Solution:
According to Le Chatelier's principle, if an equilibrium is subjected to a change in concentration, pressure or temperature, etc. equilibrium shift in such a way so as to undo the effect of a change imposed.

Question122

Aqueous solution of acetic acid contains
(1991)

Options:

A. CH_3COO^- and H^+

B. CH_3COO^-, H_3O^+ and CH_3COOH

C. CH_3COO^-, H_3O^+ and H^+

D. CH_3COOH , CH_3COO^- and H^+

Answer: B

Solution:

Solution:
$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

Question123

K_1 and K_2 are equilibrium constant for reactions (i) and (ii)
$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$....(i)
$NO_{(g)} \rightleftharpoons \frac{1}{2}N_{2(g)} + \frac{1}{2}O_{2(g)}$....(ii)
(1989)

Options:

A. $K_1 = \left(\frac{1}{K_2}\right)^2$

B. $K_1 = K_2^{\,2}$

C. $K_1 = \frac{1}{K_2}$

D. $K_1 = (K_2)^0$

Answer: A

Solution:

Solution:
Reaction (ii) is the reversible reaction of (i) and is half of the reaction (i). Thus, rate constant can be given as:
$K_2 = \sqrt{\frac{1}{K_1}}$ or $K_1 = \left[\frac{1}{K_2}\right]^2$

Question124

The compound whose water solution has the highest pH is (1988)

Options:

A. $NaCl$

B. $NaHCO_3$

C. Na_2CO_3

D. NH_4Cl

Answer: C

Solution:

NH_4Cl and $NaHCO_3$ are acidic in nature and $NaCl$ is neutral. Only Na_2CO_3 is basic and thus have highest pH.
