Equilibrium

Question1

For the reaction $N_2O_4(g) \approx 2NO_2(g)$, Kp = 0.492 atm at 300K. K_c for the reaction at same temperature is $\times 10^{-2}$.

(Given : R = 0.082L atmmol⁻¹K⁻¹)

[29-Jan-2024 Shift 1]

Answer: 2

Solution:

$$K_{p} = K_{C} \cdot (RT)^{\Delta n_{g}}$$
$$\Delta n_{g} = 1$$
$$\Rightarrow K_{c} = \frac{K_{p}}{RT} = \frac{0.492}{0.082 \times 300} = 2 \times 10^{-2}$$

Question2

The following concentrations were observed at 500K for the formation of NH_3 from N_2 and $H_2.$ At equilibrium :

 $[N_2] = 2 \times 10^{-2}M$, $[H_2] = 3 \times 10^{-2}M$ and $[NH_3] = 1.5 \times 10^{-2}M$. Equilibrium constant for the reaction is____

[29-Jan-2024 Shift 2]

Answer: 417

Solution:

$$K_{\rm C} = \frac{[{\rm NH}_3]^2}{[{\rm N}_2][{\rm H}_2]^3}$$
$$K_{\rm C} = \frac{(1.5 \times 10^{-2})^2}{(2 \times 10^{-2}) \times (3 \times 10^{-2})^3}$$
$$K_{\rm C} = 417$$

Question3

For the given reaction, choose the correct expression of K_C from the following :-

 $\operatorname{Fe}_{(aq)}^{3+} + \operatorname{SCN}_{(aq)}^{-} \rightleftharpoons (\operatorname{FeSCN}_{(aq)}^{2+})$

[31-Jan-2024 Shift 1]

Options:

A.

 $K_{C} = \frac{[FeSCN^{2^{+}}]}{[Fe^{3^{+}}][SCN^{-}]}$

В.

 $K_{C} = \frac{[Fe^{3^{+}}][SCN^{-}]}{[FeSCN^{2^{+}}]}$

C.

$$K_{C} = \frac{[FeSCN^{2+}]}{[Fe^{3+}]^{2}[SCN^{-}]^{2}}$$

D.

 $K_{C} = \frac{[FeSCN^{2+}]^{2}}{[Fe^{3+}][SCN^{-}]}$

Answer: A

Solution:

 $K_c = \frac{Products ion conc.}{Reactants ion conc.}$

 $K_{C} = \frac{[FeSCN^{2+}]}{[Fe^{3+}][SCN^{-}]}$

.....

Question4

Given below are two statements :

Statement (I) : Aqueous solution of ammonium carbonate is basic. Statement (II) : Acidic/basic nature of salt solution of a salt of weak acid and weak base depends on Ka and Kb value of acid and the base forming it.

In the light of the above statements, choose the most appropriate answer from the options given below :

[27-Jan-2024 Shift 1]

Options:

A.

Both Statement I and Statement II are correct

B.

Statement I is correct but Statement II is incorrect

C.

Both Statement I and Statement II are incorrect

D.

Statement I is incorrect but Statement II is correct

Answer: A

Solution:

Aqueous solution of $(NH_4)_2CO_3$ is Basic

pH of salt of weak acid and weak base depends on Ka and Kb value of acid and the base forming it

Question5

Which of the following is strongest Bronsted base?

[27-Jan-2024 Shift 1]

Options:

A.



Β.











Answer: D

Solution:



Question6

The pH at which Mg(OH)₂[K sp = 1×10^{-11}] begins to precipitate from a solution containing 0.10M Mg²⁺ ions is____

[30-Jan-2024 Shift 1]

Answer: 9

Solution:

Precipitation when $Q_{sp} = K_{sp}$ $[Mg^{2^+}][OH^-]^2 = 10^{-11}$ $0.1 \times [OH^-]^2 = 10^{-11} \Rightarrow [OH^-] = 10^{-5}$ $\Rightarrow pOH = 5 \Rightarrow pH = 9$

Question7

The pH of an aqueous solution containing 1M benzoic acid (pKa = 4.20) and 1M sodium benzoate is 4.5. The volume of benzoic acid solution in 300 mL of this buffer solution is____ mL.

[30-Jan-2024 Shift 2]

Answer: 100

Solution:

1M Benzoic acid + 1M Sodium Benzoate $(V_a \text{ ml}) \qquad (V_s \text{ ml})$ Millimole $V_a \times 1 \qquad V_s \times 1$ pH = 4.5 $pH = pka + \log \frac{[\text{salt }]}{[\text{ acid }]}$ $4.5 = 4.2 + \log \left(\frac{V_s}{V_a}\right)$ $\frac{V_s}{V_a} = 2 \dots (1)$ $V_s + V_a = 300 \dots (2)$ $V_a = 100 \text{ ml}$

Question8

Ka for CH_3COOH is 1.8 × 10⁻⁵ and Kb for NH_4OH is 1.8 × 10⁻⁵. The pH of ammonium acetate solution will be

[1-Feb-2024 Shift 1]

Answer: 7

Solution:

$$pH = \frac{pK_w + pK_a - pK_b}{2}$$
$$pK_a = pK_b$$
$$\Rightarrow pH = \frac{pK_w}{2} = 7$$

Question9

Solubility of calcium phosphate (molecular mass, M) in water is W_g per 100mL at 25°C. Its solubility product at 25°C will be approximately.

[1-Feb-2024 Shift 2]

Options:

A. $10^7 \left(\frac{W}{M}\right)^3$ B. $10^7 \left(\frac{W}{M}\right)^5$ C. $10^3 \left(\ \frac{W}{M} \right)^5$ D. $10^5 \left(\frac{W}{M}\right)^5$ **Answer: B** Solution: $S = \frac{W \times 10}{M}$ $\operatorname{Ca}_{3}(\operatorname{PO}_{4})_{2}(s) \rightleftharpoons \operatorname{3Ca}^{2+}(\operatorname{aq.}) + 2\operatorname{PO}_{4}^{3-}(\operatorname{aq.})$ $S= \ \frac{W\times 1000}{M\times 100}= \ \frac{W\times 10}{M}$ $K_{sp} = (3 s)^3 (2 s)^2$ $= 108 s^5$ $= 108 \times 10^5 \times \left(\frac{W}{M} \right)^5$ $=1.08\times10^7\left(\frac{W}{M}\right)^5$

Question10

The dissociation constant of acetic is $x \times 10^{-5}$. When 25 mL of 0.2M CH₃COONa solution is mixed with 25 mL of 0.02 M CH₃COOH solution, the pH of the resultant solution is found to be equal to 5. The value of x is_____ [24-Jan-2023 Shift 1]

Answer: 10

Solution:

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Solution:
Buffer of HOAc and NaOAc
pH = pKa + \log \frac{0.1}{0.01}
5 = pKa + 1
pKa = 4
Ka = 10^{-4}
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If the pKa of lactic acid is 5 , then the pH of 0.005M calcium lactate solution at 25°C is $_$ ×10⁻¹ (Nearest integer) Lactic acid

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CH<sub>3</sub> - \frac{\overset{H}{}_{C}}{\overset{I}{}_{OH}} - COOH
[24-Jan-2023 Shift 2]
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Answer: 85

Solution:

Concentration of calcium lactate = 0.005 M,: concentration of lactate ion = (2×0.005) M. Calcium lactate is a salt of weak acid + strong base \therefore Salt hydrolysis will take place.

 $pH = 7 + \frac{1}{2}(pKa + \log C)$ = 7 + $\frac{1}{2}(5 + \log(2 \times 0.005))$ = 7 + $\frac{1}{2}[5 - 2\log 10] = 7 + \frac{1}{2} \times 3 = 8.5 = 85 \times 10^{-1}$

Question12

A litre of buffer solution contains 0.1 mole of each of NH_3 and NH_4 Cl. On the addition of 0.02 mole of HCl by dissolving gaseous HCl, the pH of the solution is found to be

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\frac{10^{-3}(\text{ Nearest integer})}{[. \text{ Given }: pK_b(\text{NH}_3) = 4.745]}
log 2 = 0.301
log 3 = 0.477
T = 298K]
[25-Jan-2023 Shift 1]
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Answer: 9079

Solution:

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In resultant solution

n_{NH_3} = 0.1 - 0.02 = 0.08

n_{NH_4Cl} = n_{NH_4^+} = 0.1 + 0.02 = 0.12

pOH = pKb_b + log \frac{[NH_4^+]}{[NH_3]}

= 4.745 + log \frac{0.12}{0.08}

= 4.745 + log \frac{3}{2}

= 4.745 + 0.477 - 0.301

pOH = 4.921

pH = 14 - pH

= 9.079
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Question13

When the hydrogen ion concentration $[H^+]$ changes by a factor of 1000, the value of pH of the solution _____. [25-Jan-2023 Shift 2]

Options:

A. increases by 1000 units

B. decreases by 3 units

- C. decreases by 2 units
- D. increases by 2 units

Answer: B

Solution:

 $\Delta [H^+] = 1000$ $\Delta pH = -\log \Delta [H^+] = -\log 10^3$ = -3

Question14

Match List I with List II

List I (Amines)	List II (pK _b)		
A. Aniline	l. 3.25		
B. Ethanamine	II. 3.00		
C. N-Ethylethanamine	III. 9.38		
D. N, N-Diethylethanamine	IV. 3.29		

Choose the correct answer from the options given below :-[25-Jan-2023 Shift 2]

Options:

A. A-I, B-IV, C-II, D-III

B. A-III, B-II, C-I, D-IV

C. A-III, B-II, C-IV, D-I

D. A-III, B-IV, C-II, D-I

Answer: D

Solution:



Millimoles of calcium hydroxyide required to produce 100 mL of the aqueous solution of pH 12 is $x \times 10^{-1}$. The value of x is _____(Nearest integer). Assume complete dissociation. [29-Jan-2023 Shift 1]

Answer: 5

Solution:

 $\therefore pH = 12$ $\therefore [H^+] = 10^{-12}M$ $\therefore [OH^-] = 10^{-2}M$ $\therefore [Ca(OH)_2] = 5 \times 10^{-3}M$ $5 \times 10^{-3} = \frac{\text{milli moles of Ca (OH)}_2}{100 \text{ mL}}$ milli moles of Ca(OH)_2 = 5 × 10^{-1}

Question16

 $600\,mL$ of $0.01M\,HCl$ is mixed with $400\,mL$ of $0.01MH_2SO_4.$ The pH of the mixture is

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\times 10^{-2}. (Nearest integer)
[Given log 2 = 0.30, log 3 = 0.48
log 5 = 0.69 log 7 = 0.84
log 11 = 1.04]
[30-Jan-2023 Shift 1]
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Answer: 186

Solution:

Total millimoles of $H^+ = (600 \times 0.01) + (400 \times 0.01 \times 2)$ = 14 $[H^+] = \frac{14}{1000} = 14 \times 10^{-3}$ pH = 3 - log 14 = 1.86 = 186 × 10^{-2}

Question17

The correct order of pK_a values for the following compounds is:



[30-Jan-2023 Shift 2]

Options:

A. c > a > d > b

B. b > d > a > c
C. b > a > d > c
D. a > b > c > d

Answer: B

Solution:

Solution:

Due to -M effect of $-NO_2$ group, it increases acidity +M effect of $N(CH_3)_2$ decreases acidity. Hyperconjugation of isopropyl decrease acidity \therefore order of acidic strength (c) > (a) > (b)

Question18

The logarithm of equilibrium constant for the reaction $Pd^{2+} + 4Cl^{-} \Rightarrow PdCl_{4}^{2-}$ is _____

(Nearest integer) Given : $\frac{2.303 \text{ RT}}{F} = 0.06V$ $Pd_{(aq)}^{2+} + 2e^{-} \Rightarrow Pd(s) E^{\circ} = 0.83V$ $PdCl_{4}^{2-}(aq) + 2e^{-} \Rightarrow Pd(s) + 4Cl^{-}(aq)$ $E^{\circ} = 0.65V$ [31-Jan-2023 Shift 1]

Answer: 6

Solution:

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Sol. \Delta G^{\circ} = -RT \ell n K

- nFE_{cell}^{0} = -RT \times 2.303(log_{10}K)

\frac{E_{Cell}^{0}}{0.06} \times n = log K \dots (1)

Pd<sup>+2</sup> (aq.) + not mathcal Le<sup>-</sup> \Rightarrow Pd(s), E_{cat,red}^{\circ} = 0.83

Pd(s) + 4Cl<sup>-</sup> (aq.) \Rightarrow PdCl<sub>4</sub><sup>2-</sup>, (aq) + 2e<sup>-</sup>, E_{mat.ouir}^{0} = 0.65

Net Reaction \rightarrow Pd<sup>2+</sup> (aq.) + 4Cl<sup>-</sup> (aq.) \Rightarrow PdCl<sub>4</sub><sup>2-</sup> (aq.)

E_{cell}^{\circ} = E_{cat,red}^{\circ} - E_{Alode, 0cd^{a}}

E_{cell}^{\circ} = 0.83 - 0.65

E_{cell}^{\circ} = 0.18 \dots (2)

Also n = 2 ... (3)

Using equation (1), (2) & (3)

log K = 6
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Question19

Incorrect statement for the use of indicators in acid-base titration is : [31-Jan-2023 Shift 2]

Options:

A. Methyl orange may be used for a weak acid vs weak base titration.

- B. Methyl orange is a suitable indicator for a strong acid vs weak base titration
- C. Phenolphthalein is a suitable indicator for a weak acid vs strong base titration
- D. Phenolphthalein may be used for a strong acid vs strong base titration.

Answer: A

Solution:

Methyl orange may be used for a strong acid vs strong base and strong acid vs weak base titration. Phenolpthalein may be used for a strong acid vs strong base and weak acid vs strong base titration.

Question20

At 298K, the solubility of silver chloride in water is 1.434×10^{-3} gL⁻¹. The value of $-\log K_{sp}$ for silver chloride is

(Given mass of Ag is 107.9gmol^{-1} and mass of Cl is _____ 35.5gmol^{-1}) [31-Jan-2023 Shift 2]

Answer: 10

Solution:

AgCl(s)
$$\rightarrow Ag_{s}^{+}(aq.) + Cl_{Cl}^{-}(aq.)$$

 $K_{sp} = S^{2} = \left(\frac{1.43}{143.4} \times 10^{-3}\right)^{2} = 10^{-10}$
 $-\log K_{sp} = 10$

Question21

Consider the following reaction approaching equilibrium at 27 °C and 1 atm pressure $A + B_{\underset{K_{c}=10^{2}}{\Rightarrow}}^{K_{c}=10^{3}}C + D$

The standard Gibb's energy change ($\Delta_r G^\circ$) at 27°C is (-) _____ kJ mol⁻¹

(Nearest integer). (Given : $R = 8.3 J K^{-1} mol^{-1}$ and ln 10 = 2.3) [29-Jan-2023 Shift 1]

Answer: 6

Solution:

Solution:

 $\begin{array}{l} \because \Delta G^{\circ} = -RT \ln K_{eq} \\ \text{and } K_{eq} = \frac{K_{f}}{K_{b}} \\ \therefore K_{eq} = \frac{10^{3}}{10^{2}} = 10 \\ \therefore \Delta G = -RT \ln 10 \\ \Rightarrow -(8.3 \times 300 \times 2.3) = -5.7 \text{ kJ mole} = 6 \text{ kJ} \\ \text{mole}^{-1}(\text{ nearest integer}) \\ \text{Ans} = 6 \end{array}$

Question22

At 298K $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g), K_1 = 4 \times 10^5$ $N_2(g) + O_2(g) \rightleftharpoons 2NO(g), K_2 = 1.6 \times 10^{12}$ $H_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons H_2O(g), K_3 = 1.0 \times 10^{-13}$ Based on above equilibria, the equilibrium constant of the reaction, $2NH_3(g) + \frac{5}{2}O_2(g) \neq 2NO(g) + 3H_2O(g)$ is _____ × 10⁻³³ (Nearest integer) [29-Jan-2023 Shift 2]

Answer: 4

Solution:

$$\begin{split} N_{2}(g) + 3H_{2}(g) &\rightleftharpoons 2NH_{3}(g), K_{1} = 4 \times 10^{5} \dots (i) \\ N_{2}(g) + O_{2}(g) &\rightleftharpoons 2NO(g), K_{2} = 1.6 \times 10^{12} \dots (ii) \\ H_{2}(g) + \frac{1}{2}O_{2}(g) &\rightleftharpoons H_{2}O(g), K_{3} = 1.0 \times 10^{-13} \dots (iii) \\ (ii) + 3 \times (iii) - (i) \\ 2NH_{3}(g) + \frac{5}{2}O_{2}(g) &\rightleftharpoons 2NO(g) + 3H_{2}O(g) \\ k_{eq} &= \frac{k_{2} \times k_{3}^{3}}{k_{1}} = \frac{1.6 \times 10^{12} \times (10^{-13})^{3}}{4 \times 10^{5}} \\ &= \frac{1.6}{4} \times 10^{-32} = 4 \times 10^{-33} \end{split}$$

Question23

Consider the following equation: $2SO_2(g) + O_2(g) \neq 2SO_3(g), \Delta H = -190 \text{ kJ}$ The number of factors which will increase the yield of SO₃ at equilibrium from the following is ______ A. Increasing temperature B. Increasing pressure C. Adding more SO₂ D. Adding more O₂ E. Addition of catalyst [30-Jan-2023 Shift 2]

Answer: 3

Solution:

The yield of SO_3 at equilibrium will be due to: B. Increasing pressure C. Adding more SO_2 D. Adding more O_2

Question24

For reaction: $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g) K_p = 2 \times 10^{12} \text{ at } 27^{\circ}\text{C} \text{ and } 1 \text{ atm pressure. The}$ K_c for the same reaction is ______ × 10^{13}. (Nearest integer) (Given R = 0.082L atm K⁻¹ mol⁻¹) [31-Jan-2023 Shift 1]

Solution:

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\begin{split} &\mathrm{SO}_{2(g)} + \; \frac{1}{2} \mathrm{O}_{2(g)} \rightleftharpoons \mathrm{SO}_{3(g)} \\ &\mathrm{K}_{\mathrm{p}} = 2 \times 10^{12} \; \mathrm{at} \; 300\mathrm{K} \\ &\mathrm{K}_{\mathrm{p}} = \mathrm{K}_{\mathrm{C}} \times \left(\mathrm{RT}\right)^{\Delta n_{\mathrm{g}}} \\ &2 \times 10^{12} = \mathrm{K}_{\mathrm{c}} \times \left(0.082 \times 300\right)^{-1/2} \\ &\mathrm{K}_{\mathrm{C}} = 9.92 \times 10^{12} \\ &\mathrm{K}_{\mathrm{C}} = 0.992 \times 10^{13} \\ &\mathrm{Ans.} \; 1 \end{split}
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Question25

For independent process at 300 K.

Process	$\Delta H/kJ mol^{-1}$	$\Delta S / JK^{-1}$
А	-25	-80
В	-22	40
С	25	-50
D	22	20

The number of non-spontaneous process from the following is_____ [24-Jan-2023 Shift 1]

Answer: 2

Solution:

 $\begin{array}{l} \Delta \, G = \Delta H - T \, \Delta \, S \\ A : \Delta G(Jmol^{-1}) = -25 \times 10^3 + 80 \times 300 : -ve \\ B : \Delta G(Jmol^{-1}) = -22 \times 10^3 - 40 \times 300 : -ve \\ C : \Delta G(Jmol^{-1}) = 25 \times 10^3 + 300 \times 50 : +ve \\ D : \Delta G(Jmol^{-1}) = 22 \times 10^3 - 20 \times 300 : +ve \\ \end{array}$

Question26

Water decomposes at 2300K $H_2O(g) \rightarrow H_2(g) + \frac{1}{2}O_2(g)$ The percent of water decomposing at 2300K and 1 bar is _____ (Nearest integer). Equilibrium constant for the reaction is 2 × 10⁻³ at 2300K [29-Jan-2023 Shift 1]

Answer: 2

Solution:

$$\begin{split} &H_2 O(g) \rightleftharpoons H_2(g) + \frac{1}{2} O_2(g) \\ &P_0[1-\alpha] \ P_0 \alpha \ \frac{P_0 \alpha}{2} \quad \text{partial pr. at eq.} \\ &P_0 \left[\ 1 + \frac{\alpha}{2} \ \right] = 1 \dots (i) \end{split}$$

$$\begin{split} K_{p} &= \frac{\left(P_{H_{2}}\right)\left(P_{O_{2}}\right)^{1/2}}{P_{H_{2}O}} \\ \frac{\left(P_{0}\alpha\right)\left(\frac{P_{0}\alpha}{2}\right)^{1/2}}{P_{0}[1-\alpha]} = 2 \times 10^{-3} \\ \text{since } \alpha \text{ is negligible w.r.t 1 so } P_{0} = 1 \text{ and } 1 - \alpha \approx 1 \\ \frac{\alpha\sqrt{\alpha}}{\sqrt{2}} &= 2 \times 10^{-3} \\ \alpha^{3/2} &= 2^{3/2} \times 10^{-3} \\ \alpha &= 2^{3/2 \times 2/3} \times 10^{-3 \times 2/3} \\ \alpha &= 2 \times 10^{-2} \ \%\alpha = 2\% \end{split}$$

Question27

At 25°C, the enthalpy of the following processes are given: $H_2(g) + O_2(g) \rightarrow 2 OH(g) \Delta H^0 = 78 \text{ kJ mol}^{-1}$ $H_2(g) + 1 / 2O_2(g) \rightarrow H_2O(g) \Delta H^0 = -242 \text{ kJ mol}^{-1}$ $H_2(g) \rightarrow 2H(g) \Delta H^0 = 436 \text{ kJ mol}^{-1}$ $1 / 2O_2(g) \rightarrow O(g) \Delta H^0 = 249 \text{ kJ mol}^{-1}$ What would be the value of X for the following reaction? _____ (Nearest integer) $H_2O(g) \rightarrow H(g) + OH(g) \Delta H^0 = X \text{ kJ mol}^{-1}$ [1-Feb-2023 Shift 1]

Answer: 499

Solution:

$$\begin{split} & 2H_2O(g) \to 2H_2(g) + O_2(g) + (242 \times 2) \, \text{kJ} \, \text{mol}^{-1} \\ & H_2(g) + O_2(g) \to 2 \, \text{OH} \, + 78 \, \text{kJ} \, \text{mol}^{-1} \\ & H_2(g) \to 2H \, + \, 436 \, \text{kJ} \, \text{mol}^{-1} \\ & 2H_2O \to 2H + 2 \, \text{OH} \, + \, 998 \, \text{kJ} \, \text{mol}^{-1} \end{split}$$

 $H_2O \rightarrow H + OH \ 998 \times \frac{1}{2} = +499 \,\text{kJ}\,\text{mol}^{-1}$

Question28

(i) $X(g) \neq Y(g) + Z(g)K_{p1} = 3$ (ii) $A(g) \neq 2B(g) K_{p2} = 1$ If the degree of dissociation and initial concentration of both the reactants X (g) and A(g) are equal, then the ratio of the total pressure at equilibrium $\left(\begin{array}{c} p_1 \\ p_2 \end{array}\right)$ is equal to

x : 1. The value of x is _____ (Nearest integer) [1-Feb-2023 Shift 1]

Answer: 12

Solution:

 $x(g) \rightleftharpoons y(g) + z(g) k_{p_1} = 3$ Initial moles n - at equilibrium $n - \alpha n \alpha n \alpha n$ $\begin{aligned} k_{p_1} &= \frac{\left(\frac{\alpha}{1+\alpha} \times p_1\right)^2}{\frac{1-\alpha}{1+\alpha} p_1} \\ 3 &= \frac{\alpha^2 \times p_1}{1-\alpha^2} \\ A(g) &\rightleftharpoons 2B(g) \ k_{p_2} = 1 \\ \text{Initial mole } n - \\ \text{at equilibrium } x - \alpha n 2\alpha n \ p_{\text{total}} = p_2 \\ k_{p_2} &= \frac{\left(\frac{2\alpha}{1+\alpha} \times p_2\right)^2}{\frac{1-\alpha}{1+\alpha} \times p_2} \\ 1 &= \frac{4\alpha^2 \times p_2}{1-\alpha^2} \\ \frac{k_{p_1}}{k_{p_2}} &= \frac{p_1}{4p_2} \\ \frac{3}{1} &= \frac{p_1}{4p_2} \ \therefore p_1 : p_2 = 12 : 1 \\ x = 12 \end{aligned}$

Question29

The effect of addition of helium gas to the following reaction in equilibrium state, is : $PCI_5(g) \neq PCl_3(g) + Cl_2(g)$ [1-Feb-2023 Shift 2]

Options:

A. the equilibrium will shift in the forward direction and more of Cl_2 and PCl_3 gases will be produced.

B. the equilibrium will go backward due to suppression of dissociation of PCl₅.

C. helium will deactivate PCl₅ and reaction will stop.

D. addition of helium will not affect the equilibrium.

Answer: 0

Solution:

Solution: $PCI_5(g) \Rightarrow PCI_3(g) + CI_2(g)$ (Case 1 : At constant P - volume will increase so reaction will shift in forward direction then answer will be A Case 2 : At constant volume no change in active mass so reaction will not shift in any direction then answer will be D.

Question30

For a concentrated solution of a weak electrolyte (K_{eq} = equilibrium constant) A_2B_3 of concentration ' c ', the degree of dissociation " α ' is [6-Apr-2023 shift 1]

Options:

A.
$$\left(\frac{K_{eq}}{108c^4}\right)^{\frac{1}{5}}$$

B. $\left(\frac{K_{eq}}{6c^5}\right)^{\frac{1}{5}}$
C. $\left(\frac{K_{eq}}{5c^4}\right)^{\frac{1}{5}}$
D. $\left(\frac{K_{eq}}{25c^2}\right)^{\frac{1}{5}}$

Answer: A

Solution:

$$\begin{aligned} A_{2}B_{3} & (aq.) &\rightleftharpoons 2A_{(aq.)}^{3+} + 3B_{(aq)}^{2-} \\ c(1-\alpha) & 2c\alpha & 3c\alpha \\ K_{eq} &= \frac{[A^{3+}]^{2}[B^{2-}]^{3}}{[A_{2}B_{3}]} = \frac{4c^{2}\alpha^{2} \times 27c^{3}\alpha^{3}}{c(1-\alpha)} \\ K_{eq} &= = \frac{108c^{5}\alpha^{5}}{c}\alpha = \left(\frac{K_{eq}}{108c^{4}}\right)^{\frac{1}{5}} \end{aligned}$$

Question31

The number of correct statement/s involving equilibria in physical from the following is

[10-Apr-2023 shift 1]

Options:

A. Equilibrium is possible only in a closed system at a given temperature.

B. Both the opposing processes occur at the same rate.

C. When equilibrium is attained at a given temperature, the value of all its parameters

D. For dissolution of solids in liquids, the solubility is constant at a given temperature.

Answer: C

Solution:

Solution:

(A) is correct (B) for equilibrium $r_f = r_b \Rightarrow$ (B) is correct

(c) for equilibrium $\Gamma_f = \Gamma_b$ (c) is connect (c) at equilibrium the value of parameters become constant of a given temperature and not equal \Rightarrow (C) is incorrect (D) for a given could call the and a liquid column could be dependence to the temperature only \rightarrow (D) is correct

(D) for a given solid solute and a liquid solvent solubility depends upon temperature only \Rightarrow (D) is correct

Question32

The equilibrium composition for the reaction $PCl_3 + Cl_2 \approx PCl_5$ at 298K is given below. $[PCl_3]_{eq} = 0.2 \text{ mol } \text{L}^{-1} [Cl_2]_{eq} = 0.1 \text{ mol } \text{L}^{-1}$, $[PCl_5]_{eq} = 0.40 \text{ mol } \text{L}^{-1}$ If 0.2 mol of Cl_2 is added at the same temperature, the equilibrium concentrations of PCl_5 is _____ × 10⁻² mol L^{-1} . Given : K_c for the reaction at 298K is 20 [6-Apr-2023 shift 2]

Answer: 48

Solution:

```
PCl<sub>3</sub> + Cl<sub>2</sub> \Rightarrow PCl<sub>5</sub>
0.2M (0.1 + 0.2)M 0.4M
E q<sup>m</sup> · 0.2 - x 0.3 - x 0.4 + x
\frac{(0.4 + x)}{(0.2 - x)(0.3 - x)} = 20
⇒x ≈ 0.086
[PCl<sub>5</sub>]<sub>eq</sub> = 0.486M = 48.6 × 10<sup>-2</sup>M
```

A mixture of 1 mole of H_2O and 1 mole of CO is taken in a 10 litre container and heated to 725K. At equilibrium 40% of water by mass reacts with carbon monoxide according to the equation : $CO(g) + H_2O(g) \neq CO_2(g) + H_2(g)$. The equilibrium constant $K_e \times 10^2$ for the reaction is ______ (Nearest integer) [11-Apr-2023 shift 1]

Answer: 44

Solution:

 $CO(g) + H_2O(g) \approx CO_2(g) + H_2(g)$ $K_c = \frac{0.4 \times 0.4}{0.6 \times 0.6} = \frac{4}{9}$ $K_c \times 10^2 = \frac{4}{9} \times 100 = \frac{400}{9} = 44.44 \approx 44$

Question34

4.5 moles each of hydrogen and iodine is heated in a sealed ten litre vessel. At equilibrium, 3 moles of HI were found. The equilibrium constant for $H_2(g) + I_2(g) \rightleftharpoons 2 HI(g)$ is _____ [11-Apr-2023 shift 2]

Answer: 1

Solution:

$$\begin{array}{rcl} H_{2(g)} &+ I_{2(g)} &\rightleftharpoons 2HI_{(g)} \\ t = 0 & 4.5 & 4.5 & - \\ t_{eq} & 3 & 3 & 3 \\ K_c = \frac{[HI]^2}{[H_2][I_2]} = \frac{(3)^2}{3 \times 3} = \frac{9}{9} = 1 \end{array}$$

Question35

The titration curve of weak acid vs. strong base with phenolphthalein as indictor) is shown below. The $K_{phenolphthalein} = 4 \times 10^{-10}$ Given :log 2 = 0.3



The number of following statements/s which is/are correct about phenolphthalein is

[8-Apr-2023 shift 1]

Options:

A. It can be used as an indicator for the titration of weak acid with weak base.

- B. It begins to change colour at pH = 8.4
- C. It is a weak organic base
- D. It is colourless in acidic medium

Answer: B

Solution:

(B) $pk_n = -\log(4 \times 10^{-10}) = 9.4$ Indicator range $\Rightarrow pk_{In} \pm 1$ i.e. 8.4 to 10.4 (D) In acidic medium, phenolphthalein is in unionized form and is colourless.

Question36

Given below are two statements : Statement I : Methyl orange is a weak acid. Statement II : The benzenoid form of methyl orange is more intense/deeply coloured than the quinonoid form. In the light of the above statement, choose the most appropriate answer from the options given below: [8-Apr-2023 shift 2]

Options:

- A. Both statement I and statement II are incorrect
- B. Both statement I and Statement II are correct
- C. Statement I is correct but statement II is incorrect
- D. Statement I is incorrect but statement II is correct

Answer: A

Solution:



Question37

The solubility product of BaSO₄ is _____ 1×10^{-10} at 298K. The solubility of BaSO₄ in $0.1MK_2SO_4$ (aq) solut is $\times 10^{-9}gL^{-1}$ (Nearest integer) Given: Molar mass of BaSO₄ is 233gmol⁻¹ [8-Apr-2023 shift 2]

Solution:

 $K_{sp} = x(x + 0.1) = 10^{-10}$ 0.1x = 10⁻¹⁰ x = 10⁻⁹M x(in g/l) = 233 × 10⁻⁹

Question38

An analyst wants to convert 1LHCl of pH = 1 to a solution of HCl of pH 2. The volume of water needed to do this dilution is _____ mL. (Nearest integer) [12-Apr-2023 shift 1]

Answer: 9000

Solution:

```
(M_1 \times V_1) (M_2 \times V_2)

-1 = -2

10 \times 1 \ 10 \times V_2

V_2 = 10L

Water added = 10 - 1

= 9 Litre

= 9000 mL
```

Question39

25.0 mL of 0.050 MBa(NO₃)₂ is mixed with 25.0 mL of 0.020M NaF . K $_{sp}$ of BaF₂ is 0.5 × 10⁻⁶ at 298K. The ratio of [Ba²⁺][F⁻]² and K $_{sp}$ is ______. (Nearest integer) [13-Apr-2023 shift 1]

Answer: 5

Solution:

$$[Ba^{+2}] = \frac{25 \times 0.05}{50} = 0.025M$$
$$[F^{-}] = \frac{25 \times 0.02}{50} = 0.01M$$
$$[Ba^{+2}][F^{-}]^{2} = 25 \times 10^{-7}$$
$$K_{sp} = 5 \times 10^{-7} \text{ (given)}$$
$$Ratio = \frac{[Ba^{+2}][F^{-}]^{2}}{K_{sp}} = 5$$

Question40

20 mL of 0.1M NaOH is added to 50 mL of 0.1M acetic acid solution. The pH of the resulting solution is ______ ×10⁻² (Nearest integer) Given : pKa(CH₃COOH) = 4.76

```
\log 2 = 0.30
\log 3 = 0.48
[13-Apr-2023 shift 2]
```

Answer: 458

Solution:

	CH ₃ COOH	$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$					
Initially	5mmol	2mmol	0	0			
after Rxn	3mmol	0	2 mmole	2 mmole			

 $pH = pKa + \log_{10} \frac{[\text{ salt }]}{[\text{ acid }]}$ $pH = 4.76 + \log_{10} \frac{2}{3}$ $pH = 4.58 = 458 \times 10^{-2}$

Question41

Which of the following statement(s) is/are correct? (A) The pH of 1×10^{-8} M HCl solution is 8

(B) The conjugate hase of $H_2PH_4^-$ is HPO_4^{2-}

(C) K_w increases with increase in temperature.

(D) When a solution of a weak monoprotic acid is titrated against a strong base at half neutralisation point.

 $\mathbf{pH} = \frac{1}{2}\mathbf{pK}_{a}$

Choose the correct answer from the options given below [15-Apr-2023 shift 1]

Options:

A. (A), (B). (C)

B. (A), (D)

C. (B), (C)

D. (B), (C). (D)

Answer: D

Solution:

Solution:

(A) pH of 10^{-8} M HCl in acidic range (6.98). (B) Conjugate Base of $H_2PO_4^{-1}$ is HPO_4^{-2} (C) K_w increases with increasing Temperature, as the temperature increases, the dissociation of water increases. (D) At half neutralization point, half of the acid is present in the from salt. $pH = Pk_a + \log \frac{1}{1} = Pk_a$

Question42

For a reaction at equilibrium $A(g) \rightleftharpoons B(g) + \frac{1}{2}C(g)$ the relation between dissociation constant (K), degree of dissociation (α) and

equilibrium pressure (p) is given by: [24-Jun-2022-Shift-1]

Options:

A. K =
$$\frac{\frac{1}{\alpha^2 p^2}}{\left(1 + \frac{3}{2}\alpha\right)^{\frac{1}{2}}(1 - \alpha)}$$

B. K =
$$\frac{\frac{3}{\alpha^2 p^2}}{(2 + \alpha)^{\frac{1}{2}}(1 - \alpha)}$$

C. K =
$$\frac{\frac{(\alpha p)^2}{(1 + \frac{3}{2}\alpha)^{\frac{1}{2}}(1 - \alpha)}$$

D. K =
$$\frac{\frac{(\alpha p)^2}{(1 + \alpha)(1 - \alpha)^{\frac{1}{2}}}$$

Answer: B

Solution:

	A(g)	₽	B(g)	+	$\frac{1}{2}C(g)$	Total Moles
Att = 0:	1		0		0	1
$Att = t_{req}$:	1 – α		α		$\frac{\alpha}{2}$	1
Mole Fraction:	$\frac{\alpha}{1+\frac{\alpha}{2}}$		$\left(\begin{array}{c}\frac{1-a}{1+\frac{a}{2}}\right)$		$P\left(\frac{2}{2}\right)P$	
Now,	1					
$K_{\rm P}$ or $K = \frac{P_{\rm B} \times P_{\rm B}}{2}$	$(P_C)^{\frac{1}{2}}$		1			
$= \frac{\left(\frac{\alpha}{1+\frac{\alpha}{2}}\right) P}{2}$		$\frac{\frac{\alpha}{2}}{1+}$	$\frac{1}{\frac{\alpha}{2}} P $			
($\frac{1-\alpha}{1+\frac{\alpha}{2}}$) P				
$= \frac{\left(\frac{2\alpha}{2+\alpha}\right)P \times \left(\frac{2\alpha}{2+\alpha}\right)}{\left(\frac{2\alpha}{2+\alpha}\right)}$	$\left[\left(\frac{\alpha}{2+\alpha}\right) - \alpha\right] P$	π)Ρ	$]\frac{1}{2}$			
$= \frac{\alpha}{1-\alpha} \times \left(\begin{array}{c} \alpha \\ \frac{1}{2+\alpha} \\ 3 \end{array} \right)$	$\left(\frac{P}{\alpha}\right)^{\frac{1}{2}}$					
$= \frac{\alpha^{\overline{2}} \cdot P^{\overline{2}}}{\alpha^{\overline{2}}}$	1					
$(1-\alpha)(2+\alpha)$	$\frac{1}{2}$					

Question43

PCl₅ dissociates as $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ 5 moles of PCl_5 are placed in a 200 litre vessel which contains 2 moles of N_2 and is maintained at 600 K. The equilibrium prẽššưre is 2.46 atm. The equilibrium constant K_p for the dissociation of PCl₅ is ____×10⁻³. (nearest integer) (Given : $R = 0.082Latm^{-1}mol^{-1}$; Assume ideal gas behaviour) [24-Jun-2022-Shift-2]

Solution:

Total Moles $PCl_{5}(g) \longrightarrow PCl_{3}(g) + Cl_{2}(g)$ At t = 0: 5 0 0 At t = t_{eq}: 5 - x x x 5 + 2 (For N₂ gas) = 7 5-x+x+x+2 (For N2 gas) = 7 + x Mole Fraction : $\frac{5-x}{7+x}$ $\frac{5-x}{7+x}$ $\frac{5-x}{7+x}$ Partial pressure : $\left(\frac{5-x}{7+x}\right)P$ $\left(\frac{x}{7+x}\right)P$ $\left(\frac{x}{7+x}\right)P$ Here 2 moles of N_2 also present that is why 2 moles always have to add in total mole calculation. At equilibrium, Pressure (P) = 2.46 atmVolume (V) = 200LTemperature (T) = 600KApplying ideal gas equation, PV = nRT $\Rightarrow 2.46 \times 200 = (7 + x) \times 0.082 \times 600$ $\Rightarrow x = 3$ Now. $K_{P} = \frac{P_{PCl_{3}} \times P_{Cl_{2}}}{P_{PCl_{3}}}$ $=\frac{\left[\frac{3}{7+3}\times 2.46\right]\left[\frac{3}{7+3}\times 2.46\right]}{\left[\frac{5-3}{7+3}\times 2.46\right]}$

 $= \frac{\frac{3}{10} \times \frac{3}{10} \times (2.46)^2}{\frac{2}{10} \times 2.46}$ = $\frac{9}{20} \times 2.46$ = 1107×10^{-3} atm

Question44

The standard free energy change (ΔG°) for 50% dissociation of N_2O_4 into NO_2 at 27°C and 1 atm pressure is $-xJmol^{-1}$. The value of x is _____ (Nearest Integer) [Given : .R = 8.31JK⁻¹mol⁻¹, log 1.33 = 0.1239 ln 10 = 2.3] [25-Jun-2022-Shift-1]

Answer: 710

Solution:

 $N_2O_4 \iff 2NO_2$ t = 0 1 mol t = t (1-0.5) mol 0.5 × 2 mol = 0.5 mol 1 mol $k_p = \frac{\left(\frac{1}{1.5} \times 1\right)^2}{\left(\frac{0.5}{1.5} \times 1\right)} = \frac{1}{0.75} = \frac{100}{75}$ = 1.33 $\Delta G^0 = -RT \ell nk_p$ = -8.31 × 300 × ln(1.33) = -710.45J / mol = -710J / mol

```
2 \operatorname{NOCl}(g) \rightleftharpoons 2 \operatorname{NO}(g) + \operatorname{Cl}_2(g)
In an experiment, 2.0 moles of NOCl was placed in a one-litre flask and the concentration of NO after equilibrium established, was found to be 0.4 mol / L. The equilibrium constant at 30°C is_____ ×10^{-4}
[27-Jun-2022-Shift-1]
```

Answer: 125

Solution:

```
2 \operatorname{NOCl}(g) \rightleftharpoons 2 \operatorname{NO}(g) + \operatorname{Cl}_2(g)
At t = 0: 2 0 0

At t = t<sub>eq</sub>: 2-2x 2x 0

Given that at equilibrium, concentration of N O = 0.4 mol / L

\therefore 2x = 0.4

\Rightarrow x = 0.2

\therefore Concentration of NOCl at equilibrium,

[NOCl]<sub>eq</sub> = 2 - 2 × 0.2 = 1.6

and [NO]<sub>eq</sub> = 0.4

and [Cl<sub>2</sub>]<sub>eq</sub> = 0.2

We know,

K<sub>c</sub> = \frac{[N O]^2[Cl_2]}{[NOCl]^2}

= \frac{[0.4]^2[0.2]}{[1.6]^2}

\Rightarrow K_c = 12.5 \times 10^{-3}

\Rightarrow K_c = 125 \times 10^{-4}
```

Question46

4.0 moles of argon and 5.0 moles of PCl_5 are introduced into an evacuated flask of 100 litre capacity at 610K. The system is allowed to equilibrate. At equilibrium, the total pressure of mixture was found to be 6.0 atm. The K_p for the reaction is

```
[Given : .R = 0.082Latm K^{-1}mol^{-1}]
[29-Jun-2022-Shift-2]
Options:
A. 2.25
B. 6.24
C. 12.13
D. 15.24
Answer: A
Solution:
                                                                 Total Moles:
                   PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)
    At t = 0:
                                                   5 + 4(For Ne gas) = 9
                  5
                               0 0
                     5 - x x 5 - x + x + 4 (For Ne gas) = 9 + x
    At t = t_{eq}:
                     \frac{5-x}{9+x} \qquad \frac{x}{9+x} \qquad \frac{x}{9+x}
 Mole Fraction:
Partial Pressure: \left(\frac{5-x}{9+x}\right)P \left(\frac{x}{9+x}\right)^p \left(\frac{x}{9+x}\right)^p
```

Here 4 moles of inert gas argon also present.

```
.: Total moles of mixture present at equilibrium,
  n_{T} = 5 + x + 4
   = 9 + x
  At equilibrium, total pressure (p_T) = 6 atm
  Volume (v) = 100L
  Temperature = 610K
  : using ideal gas equation,
  P_T V = n_T RT
  \Rightarrow 6 \times 100 = (9 + x) \times 0.082 \times 610
  \Rightarrow x = 3
  Now,
  K_{P} = \frac{P_{PCl_{3}} \times P_{Cl_{2}}}{P_{PCl_{5}}}
= \frac{\left[\frac{3}{9+3} \times 6\right] \times \left[\frac{3}{9+3} \times 6\right]}{\left[\frac{5}{9+3} \times 6\right]}
= \frac{27}{12}
= \frac{9}{4}
= 2.25 c.
   = 2.25 atm
  Note :
  Inert gas always contribute to total mole and pressure calculation.
```

A box contains 0.90g of liquid water in equilibrium with water vapour at 27°C. The equilibrium vapour pressure of water at 27 °C is 32.0 Torr. When the volume of the box is increased, some of the liquid water evaporates to maintain the equilibrium pressure. If all the liquid water evaporates, then the volume of the box must be _____litre. [nearest integer]

(Given : $R = 0.082L atm K^{-1} mol^{-1}$)

(Ignore the volume of the liquid water and assume water vapours behave as an ideal gas.)

[29-Jun-2022-Shift-2]

Answer: 29

Solution:

We know, 760 Torr = 1 atm $\therefore 32 \text{ Torr} = \frac{32}{760} \text{ atm}$ As all the liquid water evaporates so entire water is in gaseous state. \therefore Weight of water vapour = 0.9g \therefore Moles of water vapour (n) = $\frac{0.9}{18}$ Pressure (P) = $\frac{32}{760} \text{ atm}$ Temperature (T) = (27 + 273)K = 300KR = 0.082L atm K⁻¹mol⁻¹ Given water vapour act as an ideal gas, so we can apply ideal gas equation. From ideal gas equation, PV = nRT $\Rightarrow \frac{32}{760} \times \text{v} = \frac{0.9}{18} \times 0.082 \times 300$ $\Rightarrow \text{v} = 29\text{L}$

Question48

Solute A associates in water. When 0.7g of solute A is dissolved in 42.0g of water, it depresses the freezing point by 0.2° C. The percentage association of solute A in water, is :

```
[Given : Molar mass of A = 93 \text{gmol}^{-1}. Molal depression constant of water is 1.86K kg mol<sup>-1</sup>.]
```

[25-Jun-2022-Shift-2]

Options:

- A. 50%
- B. 60%
- C. 70%
- D. 80%

Answer: D

Solution:

```
\begin{split} \Delta T &= ik_f \times m \\ 0.2 &= i \times 1.86 \times \frac{0.7}{93} \times \frac{1000}{42} \\ i &= \frac{0.2 \times 93 \times 6}{1.86 \times 100} \\ i &= 0.60 \\ 2A \rightleftharpoons A_2 \\ 1 - \alpha \quad \frac{\alpha}{2} \\ i &= 1 - \alpha + \frac{\alpha}{2} \\ i &= 1 - \frac{\alpha}{2} \\ 1 - \frac{\alpha}{2} = 0.60 \\ 1 - 0.60 &= \frac{\alpha}{2} \\ \alpha &= 0.80 \end{split}
```

Question49

Given below are two statements one is labelled as Assertion A and the other is labelled as Reason R :

Assertion A : The amphoteric nature of water is explained by using Lewis acid/base concept.

Reason R: Water acts as an acid with NH_3 and as a base with H_2S .

In the light of the above statements choose the correct answer from the options given below :

[25-Jun-2022-Shift-2]

Options:

A. Both A and R are true and R is the correct explanation of A.

B. Both A and R are true but R is NOT the correct explanation of A.

C. A is true but R is false.

D. A is false but R is true.

Answer: D

Solution:

The amphoteric nature of water is explained by using Bronsted-Lowry acid base concept

```
H_{2}O + NH_{3} - OH^{-} + NH_{4}^{+}
(acid)
H_{2}O + H_{2}S H_{3}O^{+} + HS^{-}
(base)
```

Hence, A is false but R is true

Question50

 $50 \text{ mL of } 0.1 \text{MCH}_3 \text{COOH}$ is being titrated against 0.1M NaOH. When 25 mL of NaOH has been added, the pH of the solution will be 2×10^{-2} . (Nearest integer) (Given : $pK_a(CH_3 \text{COOH}) = 4.76$) log 2 = 0.30 log 3 = 0.48 log 5 = 0.69 log 7 = 0.84 log 11 = 1.04

Answer: 476

[26-Jun-2022-Shift-1]

Solution:

 $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$ After adding 25 ml of NaOH volume of mixture = 50 + 25 = 75 mlInitially, Number of millimole of NaOH = $25 \times 0.1 = 2.5 \text{ mm}$ Number of millimole of $CH_3COOH = 50 \times 0.1 = 5 \text{ mm}$ After nutrilisation, Millimole of NaOH = 0Millimole of $CH_3COOH = 5 - 2.5 = 2.5 \text{ mm}$ Millimole of $CH_3COONa = 2.5$ After nutrilisation, Concentration of $CH_3COOH = [CH_3COOH] = \frac{5-2.5}{75} = \frac{1}{30}$ Concentration of CH₃COONa = [CH₃COONa] = $\frac{2.5}{75} = \frac{1}{30}$ $P^{H} = P^{Ka} + \log \frac{[CH_{3}COONa]}{[CH_{3}COOH]}$ $= 4.76 + \log \frac{\frac{1}{30}}{1}$ $= 4.76 + \log(1)$ = 4.76 + 0= 4.76 $= 4.76 \times 10^{-2}$

Question51

pH value of 0.001M NaOH solution is____ [27-Jun-2022-Shift-2]

Answer: 11

Solution:

 $[OH^{-}] = 0.001 = 10^{-3}M$ $[H^{+}][OH^{-}] = 10^{-14}$ $[H^{+}] = 10^{-11}$ $pH = -\log[H^{+}]$ $= -\log(10^{-11})$ pH = 11

Question52

A student needs to prepare a buffer solution of propanoic acid and its sodium salt with pH 4. The ratio of $\frac{[CH_3CH_2COO^-]}{[CH_3CH_2COOH]}$ required to make buffer is

Given : $K_a(CH_3CH_2COOH) = 1.3 \times 10^{-5}$ [28-Jun-2022-Shift-2]

Options:

- A. 0.03
- B. 0.13
- C. 0.23
- D. 0.33

Answer: B

Solution:

$$\begin{split} & \operatorname{CH_3CH_2COOH} \rightleftharpoons \operatorname{CH_3CH_2COO^-} + \operatorname{H^+} \\ & \operatorname{From Henderson equation} \\ & \operatorname{pH} = \operatorname{pK_a} + \log \frac{[\operatorname{CH_3CH_2COO^-}]}{[\operatorname{CH_3CH_2COOH}]} \\ & 4 = -\log 1.3 \times 10^{-5} + \log \frac{[\operatorname{CH_3CH_2COO^-}]}{[\operatorname{CH_3CH_2COOH^2}]} \\ & -\log 10^{-4} = -\log 1.3 \times 10^{-5} + \log \frac{[\operatorname{CH_3CH_2COO^-}]}{[\operatorname{CH_3CH_2COOH^-}]} \\ & -\log 10^{-4} = -\log 1.3 \times 10^{-5} \frac{[\operatorname{CH_3CH_2COOH^2}]}{[\operatorname{CH_3CH_2COOH^2}]} \\ & 10^{-4} = 1.3 \times 10^{-5} \frac{[\operatorname{CH_3CH_2COOH^3}]}{[\operatorname{CH_3CH_2COO^-}]} \\ & \frac{[\operatorname{CH_3CH_2COO^-}]}{[\operatorname{CH_3CH_2COO^-}]} \\ & \frac{[\operatorname{CH_3CH_2COO^-]}]}{[\operatorname{CH_3CH_2COOH^2]}} = 0.13 \end{split}$$

Question53

The solubility of AgCl will be maximum in which of the following? [29-Jun-2022-Shift-1]

Options:

A. 0.01M KCl

```
B. 0.01M HCl
```

C. 0.01MAgNO₃

D. Deionised water

Answer: D

Solution:

In deionized water no common ion effect will take place so maximum solubility.

Question54

K_{a1}, K_{a2} and K_{a3} are the respective ionization constants for the following reactions (a), (b) and (c). (a) $H_2C_2O_4 \rightleftharpoons H^+ + HC_2O_4^-$ (b) $HC_2O_4^- \rightleftharpoons H^+ + HC_2O_4^{-2-}$ (c) $H_2C_2O_4 \rightleftharpoons 2H^+ + C_2O_4^{-2-}$ The relationship between K_{a1}, K_{a2} and K_{a3} is given as

[25-Jul-2022-Shift-2]

Options:

A. $K_{a_3} = K_{a_1} + K_{a_2}$ B. $K_{a_3} = K_{a_1} - K_{a_2}$ C. $K_{a_3} = K_{a_1} / K_{a_2}$ D. $K_{a_3} = K_{a_1} \times K_{a_2}$ Answer: D

Solution:

$$\begin{split} &H_{2}C_{2}O_{4} \rightleftharpoons 2H^{+} + C_{2}O_{4}^{2-} K_{a3} \\ &H_{2}C_{2}O_{4} \rightleftharpoons H^{+} + HC_{2}O_{4}^{-} K_{a1} \\ &HC_{2}O_{4}^{-} \rightleftharpoons H^{+} + C_{2}O_{4}^{2-} K_{a2} \\ &K_{a3} = \frac{[H^{+}]^{2}[C_{2}O_{4}^{2-}]}{[H_{2}C_{2}O_{4}]} \\ &K_{a1} = \frac{[H^{+}][HC_{2}O_{4}^{-}]}{[H_{2}C_{2}O_{4}]}, K_{a2} = \frac{[H^{+}][C_{2}O_{4}^{-}]}{[HC_{2}O_{4}^{-}]} \\ &K_{a3} = K_{a1} \times K_{a2} \end{split}$$

Question55

At 298K, the equilibrium constant is 2×10^{15} for the reaction : $Cu(s) + 2Ag^{+}(aq) \neq Cu^{2+}(aq) + 2Ag(s)$ The equilibrium constant for the reaction $\frac{1}{2}Cu^{2+}(aq) + Ag(s) \neq \frac{1}{2}Cu(s) + Ag^{+}(aq)$ is $x \times 10^{-8}$. The value of x is _____. (Nearest Integer) [26-Jul-2022-Shift-1]

Answer: 2

Solution:

$$K_{eq} = \frac{1}{\sqrt{K_{eq}}} = \frac{1}{\sqrt{2 \times 10^{15}}} = X \times 10^{-8}$$

$$\Rightarrow \frac{1}{\sqrt{20}} \times \frac{1}{10^7} = X \times 10^{-8}$$

$$\Rightarrow \frac{1}{\sqrt{20}} \times 10^{-7} = X \times 10^{-8}$$

$$\Rightarrow x = \frac{\sqrt{10}}{\sqrt{2}} = \sqrt{5} = 2.236$$

$$\approx 2.24$$

Question56

At 600K, 2 mol of NO are mixed with 1 mol of O_2 .

 $2NO_{(g)} + O_2(g) \rightleftharpoons 2NO_2(g)$

The reaction occurring as above comes to equilibrium under a total pressure of 1 atm. Analysis of the system shows that 0.6 mol of oxygen are present at equilibrium. The equilibrium constant for the reaction is ____(Nearest integer) [28-Jul-2022-Shift-2]

Answer: 2

Solution:

```
\begin{split} 2\,NO(g) + O_2(g) &\rightleftharpoons 2NO_2(g) \\ \text{at intial} & 2 & 1 & 0 \\ \text{at equilibrium } 2 - 0.8 & 0.6 & 0.8 \\ \text{Partial pressure of NO}(g) &= 1.2 / 2.6 \times 1 \\ \text{Partial pressure of } O_2(g) &= 0.6 / 2.6 \\ \text{Partial pressure of NO}_2(g) &= 0.8 / 2.6 \\ K_p &= \left(P_{NO_2}\right)^2 / \left(P_{NO}\right)^2 \left(P_{O_2}\right) &= 0.8 \times 0.8 \times 2.6 / 1.2 \times 1.2 \times 0.6 \\ &= 1.925 \\ &\approx 2 \end{split}
```

Question57

20 mL of 0.1 MNH_4OH is mixed with 40 mL of 0.05 MHCl. The pH of the mixture is nearest to: (Given: $K_b(NH_4OH) = 1 \times 10^{-5}$, log 2 = 0.30, log 3 = 0.48, log 5 = 0.69, log 7 = 0.84, log 11 = 1.04)

[25-Jul-2022-Shift-1]

Options:

A. 3.2

B. 4.2

- C. 5.2
- D. 6.2

Answer: C

Solution:

NH₄OH + HCl → NH₄Cl + H₂O mmole 22 [NH₄⁺] = $\frac{2 \text{ mmole}}{60 \text{ ml}} = \frac{1}{30}$ M pH = $\frac{pK_w - pK_b - \log C}{2} = \frac{14 - 5 + 1.48}{2} = 5.24$

Question58

Class XII students were asked to prepare one litre of buffer solution of pH 8.26 by their Chemistry teacher: The amount of ammonium chloride to be dissolved by the student in 0.2M ammonia solution to make one litre of the buffer is (Given: $pK_b(NH_3) = 4.74$ Molar mass of $NH_3 = 17 gmol^{-1}$ Molar mass of $NH_4 Cl = 53.5 gmol^{-1}$) [26-Jul-2022-Shift-2] Options:

A. 53.5g

B. 72.3g

C. 107.0g

D. 126.0g

Answer: C

Solution:

For basic Buffer, $pOH = pK_b + log \frac{[salt]}{[Base]} pOH = 14 - 8.26 = 5.74$ $5.74 = 4.74 + log \frac{[NH_4 Cl]}{0.2}$ $[NH_4 Cl] = 2M$ Moles of $NH_4 Cl = 2 \times 1 = 2$ moles Weight of $NH_4 Cl = 2 \times 53.5 = 107g$

Question59

At 310K, the solubility of CaF_2 in water is 2.34×10^{-3} g / 100 mL. The solubility product of CaF_2 is _____ × 10^{-8} (mol / L)^3. (Give molar mass : $CaF_2 = 78$ gmol⁻¹) [27-Jul-2022-Shift-1]

Answer: 0

Solution:

```
CaF_{2} \stackrel{s}{\rightleftharpoons} Ca^{2+}_{s} + 2 F_{2s}^{-}
K_{sp} = s(2 s)^{2}
= 4 s^{3}
Solubility (s) = 2.34 × 10<sup>-3</sup> g / 100 mL
= \frac{2 \cdot 34 \times 10^{-3} \times 10}{78} \text{ mole / lit}
= 3 \times 10^{-4} \text{ mole / lit}
\therefore K_{sp} = 4 \times (3 \times 10^{-4})^{3}
= 108 \times 10^{-12}
= 0.0108 \times 10^{-8} (\text{mole / lit })^{3}
\therefore x \approx 0
```

Question60

The plot of pH-metric titration of weak base NH_4OH vs strong acid HCl looks like : [27-Jul-2022-Shift-2]

Options:











Answer: A

Solution:

 $\rm NH_4\,OH$ is a weak base and HCl is a strong acid. With the addition of HCl to $\rm NH_4\,OH,~pH$ of solution will decrease gradually. So, the correct graph should be



Question61

 K_a for butyric acid (C_3H_7COOH) is 2×10^{-5} . The pH of 0.2M solution of butyric acid is ______ $\times 10^{-1}$. (Nearest integer) [Given log 2 = 0.30] [28-Jul-2022-Shift-1]

Answer: 27

Solution:

```
K<sub>a</sub> of Butyric acid ⇒2 × 10<sup>-5</sup> PKa = 4.7

pH of 0.2M solution

pH = \frac{1}{2}pK<sub>a</sub> - \frac{1}{2}log C

= \frac{1}{2}(4 · 7) \frac{1}{2}log(0.2)

= 2.35 + 0.35 = 2.7

pH = 27 × 10<sup>-1</sup>
```

Question62

```
If the solubility product of PbS is 8 \times 10^{-28}, then the solubility of PbS in pure water at 298K is \times \times 10 - 16 \text{ mol L}^{-1}. The value of x is _____. (Nearest Integer) [Given : \sqrt{2} = 1.41 ] [29-Jul-2022-Shift-1]
```

Answer: 282

Solution:

```
K_{sp} = S^{2}
S = \sqrt{K_{sp}} = \sqrt{8 \times 10^{-28}} = 2\sqrt{2} \times 10^{-14}
= 2.82 × 10<sup>-14</sup>
= 282 × 10<sup>-16</sup>
∴ Ans. 282
```

Question63

200 mL of 0.01 MHCl is mixed with 400 mL of $0.01 MH_2 SO_4$. The pH of the mixture is

Given: $\log 2 = 0.30$, $\log 3 = 0.48$, $\log 5 = 0.70$, $\log 7 = 0.84$, $\log 11 = 1.04$ [29-Jul-2022-Shift-2]

Options:

A. 1.14

B. 1.78

C. 2.34

D. 3.02

Answer: B

Solution:

```
[H^{+}] = \frac{0.01 \times 200 + 2 \times 0.01 \times 400}{600}
= \frac{0.01 + 2 \times 0.01 \times 2}{3}
= \frac{0.01 + 0.04}{3}
= \frac{5}{3} \times 10^{-2}
pH = -\log[H^{+}]
= -\log\left(\frac{5}{3} \times 10^{-2}\right)
= -\left[\log\frac{5}{3} + \log 10^{-2}\right]
= -\left[\log 5 - \log 3 - 2\right]
= -0.7 + 0.48 + 2
= 2.48 - 0.7
= 1.78
```

Question64

The solubility of Ca(OH)₂ in water is [Given: The solubility product of Ca(OH)₂ in water = 5.5×10^{-6}] [25 Feb 2021 Shift 2]

Options:

A. 1.11×10^{-2}

B. 1.11×10^{-6}

C. 1.77×10^{-2}

D. 1.77×10^{-6}

Answer: A

Solution:

```
Let, solubility of Ca(OH)<sub>2</sub> in pure water = Smol / L

Ca(OH)<sub>2</sub> \rightleftharpoons Ca<sup>2+</sup> + 2OH<sup>-</sup>

Smol / L 2 × S(mol / L)

= [Ca^{2+}][OH^{-}]^2 = S \times (2S)^2 = 4S^3 (mol / L)

The expression of K<sub>sp</sub> can also be written as,

K<sub>sp</sub> = x^x \cdot y^y \cdot S^{x+y}

= 1^1 \cdot 2^2 \cdot S^{1+2}

= 4S^3

K<sub>sp</sub> = x^x \cdot y^y \cdot S^{x+y}

= 1^1 \cdot 2^2 \cdot S^{1+2}

= 4S^3 [\because For Ca(OH)<sub>2</sub> : x = 1, y = 2]

x and y are the coefficients of cations and anions respectively

S = \left(\frac{K_{sp}}{4}\right)^{1/3} = \left(\frac{5.5 \times 10^{-6}}{4}\right)^{1/3}

= 1.11 \times 10^{-2}mol / L
```

The solubility product of Pbl₂ is 8.0×10^{-9} . The solubility of lead iodide in 0.1 molar solution of lead nitrate is $x \times 10^{-6}$ mol / L. The value of x is (Rounded off to the nearest integer). [Given, : $\sqrt{2}$ = 1.41] [24 Feb 2021 Shift 2]

Answer: 141

Solution:

Given, $[K_{sp}]_{Pbl_{2}} = 8 \times 10^{-9}$ To calculate solubility of PbI ₂ in 0.1M solution of Pb(N O₃)₂. (I) Pb(N O₃)₂ $\rightarrow Pb^{2+}(aq) + 2N O_{3}^{-}(aq)$ $_{0.1M}^{-0.2M}$ $_{0.2M}^{-0.2M}$ (II) Pbl ₂(s) \Rightarrow Pb²⁺(aq) + 21⁻(aq) S 2S $\therefore [Pb^{2+}] = S + 0.1 \approx 0.1$ $\because S < < 0.1$ Now, $K_{sp} = 8 \times 10^{-9}$ $[Pb^{2}][I^{-}]^{2} = 8 \times 10^{-9}$ $0.1 \times (2S)^{2} = 8 \times 10^{-9}$ $4S^{2} = 8 \times 10^{-8} \Rightarrow S = 141 \times 10^{-6}M$ x = 141

Question66

Answer: 7

Solution:

Phosphoric acid is a weak tribasic acid (H $_{3}PO_{4}$) and N H $_{4}OH$ is a weak monoacidic base. So, hydrolysis of ammonium phosphate (N H $_{4}$) $_{3}PO_{4}$ can be shown as,

 $(N H_4)_3 PO_4 + 3H_2 O \rightleftharpoons H_3 PO_4 + 3N H_4 OH [3:1 type salt]$ So, $[H^+] - K_a \times \left(\frac{K_w}{K_a \times K_b}\right)^{12}$

```
pH = pK_{a} + \frac{1}{2}[pK_{w} - pK_{a} - pK_{b}]
= 5.23 + \frac{1}{2}(14 - 5.23 - 4.75)
[\because pK_{w} = 14H_{2}O
pK_{a} = 5.23(H_{3}PO_{4})
pK_{b} = 4.75(NH_{4}OH)]
= 7.24 \sim eq7
```

The solubility of AgCN in a buffer solution of pH = 3 is x. The value of x is..... . [Assume : No cyano complex is formed; $K_{sp}(AgCN) = 2.2 \times 10^{-16}$ and

 $K_{a}(H CN) = 6.2 \times 10^{-10}$] [25 Feb 2021 Shift 1]

Options:

- A. 0.625×10^{-6}
- B. 1.6×10^{-6}
- C. 2.2×10^{-16}

D. 1.9×10^{-5}

Answer: D

Solution:

pH of AgCN buffer solution = 3 [H⁺] = 10⁻³ $K_{sp}(AgCN) = 2.2 \times 10^{-16}$ $K_{a}[H CN] = 6.2 \times 10^{-10}$ AgCN $\Rightarrow Ag^{+} + CN^{-}....K_{sp}$ $CN^{-} + H^{+} \Rightarrow H CN \frac{1}{K_{a}}$ AgCN + H⁺ $\Rightarrow H CN + Ag^{+}$ $K_{sp} \times \frac{1}{K_{a}} = \frac{[Ag^{+}][CN^{-}][H CN]}{[H^{+}][CN^{-}]}$ [S] = $\sqrt{\frac{K_{sp}[H^{+}]}{K_{a}}} \Rightarrow \frac{2.2 \times 10^{-16}}{6.2 \times 10^{-10}} = \frac{[S][S]}{10^{-3}}$ [S]² = $\frac{2.2 \times 10^{-16}}{6.2 \times 10^{-10}} \times 10^{-3}$ S = 1.9 × 10⁻⁵

Question68

Answer: 73

Solution:

$$\begin{array}{l} (\Sigma \ \mbox{mole} \)_{t_{eq}} = 1 - x + x + 2x = (1 + 2x) \ \mbox{Partial pressure} \quad \frac{1 - x}{1 + 2x} p \\ (atm) \ \ \frac{x}{1 + 2x} p \ \ \frac{2x}{1 + 2x} p \\ [p = \ \mbox{Total pressure at equilibrium} = 1.9 atm] \end{array}$$

Now, at equilibrium pV = (1 + 2x)RT
⇒1 + 2x =
$$\frac{pV}{RT}$$
 = $\frac{1.9 \times 25}{0.082 \times 300}$ = 1.93 [V = 25L, R = 0.082L atm mol⁻¹K⁻¹T = 300K]
⇒ x = $\frac{1.93 - 1}{2}$ = 0.465
⇒ K_p = $\frac{p_A \times p_B^2}{p_{AB_2}}$ ⇒ $\frac{\left(\frac{x}{1 + 2x}p\right) \times \left(\frac{2x}{1 + 2x}p\right)^2}{\left(\frac{1 - x}{1 + 2x}p\right)}$
= $\frac{4x^3 \times p^3}{(1 + 2x)^3} \times \frac{(1 + 2x)}{(1 - x) \times p}$ = $\frac{4x^3 \times p^2}{(1 + 2x)^2 \times (1 - x)}$
= $\frac{4 \times (0.465)^3 \times (1.9)^2}{(1 + 2 \times 0.465)^2 \times (1 - 0.465)}$ = 0.7285atm
= 72.85 × 10⁻²atm ~ eq73 × 10⁻² = x × 10⁻²

At 1990K and 1atm pressure, there are equal number of Cl₂ molecules and Cl atoms in the reaction mixture. The value of K_p for the reaction Cl₂(g) \neq 2Cl (g) under the above conditions is x × 10⁻¹. The value of x is____ (Rounded off to the nearest integer) [24feb2021shift1]

Answer: 5

Solution:

```
Cl<sub>2</sub>(g) ≈ 2Cl (g)

Let mol of both of Cl<sub>2</sub> and Cl be x.

P<sub>Cl</sub> = \frac{x}{2x} \times 1 = \frac{1}{2}

P<sub>Cl<sub>2</sub></sub> = \frac{x}{2x} \times 1 = \frac{1}{2}

\therefore K_p = \frac{\left(\frac{1}{2}\right)^2}{\frac{1}{2}} = \frac{1}{2} = 0.5 = 5 \times 10^{-1}.
```

Question70

For the reaction $A(g) \rightarrow (B)(g)$, the value of the equilibrium constant at 300K and 1atm is equal to 100.0. The value of $\Delta_r G$ for the reaction at 300K and 1atm in J mol⁻¹ is -xR, where x is ______ (Rounded off to the nearest integer) (R = 8.31 J mol⁻¹ K⁻¹ and ln 10 = 2.3) [24feb2021shift1]

Answer: 1380

Solution:

 $\Delta G^{\circ} = RT \ln K_{p}$ = -R(300)(2) ln(10) = -R(300 × 2 × 2.3) $\Delta G^{\circ} = -1380R$

Question71

The solubility of Cd SO₄ in water is 8.0×10^{-4} mol L⁻¹. Its solubility in 0.01M H₂SO₄ solution is $\times 10^{-6}$ mol L⁻¹. (Round off to the nearest integer) (Assume that, solubility is much less than 0.01M) [18 Mar 2021 Shift 2]

Answer: 64

Solution:

Given, solubility in water (S) = 8.0×10^{-4} mol L⁻¹ In pure water K_{sp} = S² = $(8 \times 10^{-4})^2$ = 64×10^{-8} In 0.01 M H₂SO₄ H₂SO₄(aq) \rightarrow 2H⁺(aq) + SO₄²⁻(aq) ^{0.02} Cd SO₄(s) \Rightarrow Cd²⁺(aq) + SO₄²⁻(aq) ^x (x + 0.01) K_{sp} = x(x + 0.01) = 64×10^{-8} x + 0.01 \cong 0.01M So, x(0.01) = 64×10^{-8} x = 64×10^{-6} M

Question72

The oxygen dissolved in water exerts a partial pressure of 20kPa in the vapour above water. The molar solubility of oxygen in water is $\dots \times 10^{-5}$ mol d m⁻³. (Round off to the nearest integer).

```
[Given, Henry's law constant (K<sub>H</sub>) = 8.0 \times 10^4kPa for O<sub>2</sub>, density of water with dissolved oxygen = 1.0kgd m<sup>-3</sup>].
```

[17 Mar 2021 Shift 1]

Answer: 25

Solution:

Given, partial pressure of $O_2 = 20$ kPa K_H (Henry's constant) = 8×10^4 kPa From Henry's law, $p(g) = [K_H] \chi_{O_2}$ where, χ_{O_2} = solubility of oxygen $20 \times 10^3 = (8 \times 10^4 \times 10^3) \chi_{O_2}$ $\Rightarrow \chi_{O_2} = \frac{20}{8 \times 10^4}$ Solubility = $2.5 \times 10^{-4} = 25 \times 10^{-5}$

Question73

Two salts A_2X and MX have the same value of solubility product of 4.0×10^{-12} . The ratio of their molar solubilities i.e $\frac{S(A_2X)}{S(MX)} = \dots$. (Round off to the nearest integer) [16 Mar 2021 Shift 1] Answer: 50

Solution:

```
Let the solubility of A_2X be ' 'S'.

A_2X(s) \rightleftharpoons 2A^+(aq) + X_s^{2-}(aq); K_{sp1} = 4 \times 10^{-12}

K_{sp_1} = [A^+]^2[X^{2-}]

4 \times 10^{-12} = (2S)^2(S)

4 \times 10^{-12} = 4S^3

\Rightarrow S = 10^{-3}M

Let the solubility of MY be 'S<sub>1</sub>'.

MY(s) \rightleftharpoons M^+(aq) + Y^-(aq), K_{sp_2} = 4 \times 10^{-12}

K_{sp_2} = [M^+][Y^-]

K_{sp_2} = (S_1)^2

4 \times 10^{-12} = (S_1)^2

\Rightarrow S_1 = 2 \times 10^{-6}M

\frac{[A_2Y]}{[MY]} = \frac{S}{S_1} = \frac{10^{-4}}{2 \times 10^{-6}} = 50
```

Question74

0.01 moles of a weak acid HA(K_a = 2.0×10^{-6}) is dissolved in 1.0L of 0.1M HCl solution. The degree of dissociation of HA is $\times 10^{-5}$ (Round off to the nearest integer). [Neglect volume change on adding HA. Assume degree of dissociation $\ll < 1$] [17 Mar 2021 Shift 1]

Answer: 2

Solution:

Given, [HA] = 0.01[H Cl] = 0.1MWhen strong acid (H Cl) is completely dissociated, $\operatorname{H}_{0.1}^{\operatorname{Cl}} \longrightarrow \operatorname{H}_{0.1}^{+}(\operatorname{aq}) + \operatorname{Cl}_{0.1}^{-}(\operatorname{aq})$ 0.1 For weak acid, dissociation is very less, \Rightarrow H⁺(aq) + A⁻(aq) ΗA t = 00.01 0.1 0 $t = t_{ea} \quad 0.01 - 0.01 - \alpha \qquad 0.1 + 0.01\alpha$ 0.01α $K_{a} = \frac{[H^{+}][A^{-}]}{[HA]} = 2 \times 10^{-6} \Rightarrow \frac{(0.1 + 0.01\alpha)(0.01\alpha)}{(0.01 - 0.01\alpha)} = 2 \times 10^{-6}$ As $0.01\alpha < < 0.1$ [H⁺] = 0.1 and $0.01\alpha < < 0.01$ [H A] = 0.01 $\therefore 2 \times 10^{-6} = \frac{(0.1)(0.01\alpha)}{2.21} \Rightarrow \alpha = 2 \times 10^{-5}$ $\Rightarrow x = 2$

Question75

Given below are two statements: One is labelled as Assertion A and the other labelled as Reason R.

Assertion A During the boiling of water having temporary hardness, $Mg(HCO_3)_2$ is converted to $MgCO_3$.

Reason R The solubility product of $M g(OH)_2$ is greater than that of $M gCO_3$. In the light of the above statements, choose the most appropriate answer from the options given below [18 Mar 2021 Shift 1]

Options:
A. Both A and R are true but R is not the correct explanation of A.

B. A is true but R is fals

C. Both A and R are true and R is the correct explanation of A.

D. A is false but R is true.

Answer: D

Solution:

During boiling, soluble M g(H CO₃)₂ is converted into insoluble M g(OH)₂ and Ca(H CO₃)₂ is converted into insoluble CaCO₃. This is because of high solubility product of M g(OH)₂ as compared to M gCO₃ hence, M g(OH)₂ is precipitated. These precipitates can be removed by filtration. Thus, filtrate will be obtained in soft water. M g(H CO₃)₂ \rightarrow M g(OH)₂ \downarrow +2CO₂ Temporary hardness Ca(H CO₃)₂ \rightarrow CaCO₃ \downarrow +CO₂ +2H₂O K_{sp} of M g(OH)₂ > K_{sp} of M gCO₃ and hence, M g(OH)₂ precipitation first.

Question76

Answer: 1.66

Solution:

Given, $\Delta G = 25.2$ kJ mol⁻¹ $= 25200 \text{J} \text{ mol}^{-1}$ T = 400KAccording to standard free Gibb's equation, $\Delta G^0 = -RT \ln K_p$ $25200 = -2.3 \times 8.3 \times 400 \log(K_p)$ $\log K_{p} = \frac{-25200}{2.3 \times 8.3 \times 400} = -3.3$ K_p = 10^{-3.3} = 10⁻³ × 0.501 $K_{p} = 5.01 \times 10^{-4} bar^{-1}$ $K_{p} = 5.01 \times 10^{-5} Pa^{-1}$ We know that, $K_p = K_c (RT)^{\Delta r_k}$ $K_{p} = K_{c} (RT)^{-1} [::\Delta n_{q} = 1 - 2 = -1]$ $K_{p} = \frac{K_{C}}{8.3 \times 400}$ $K_c = 5.01 \times 10^{-5} \times 8.3 \times 400$ \Rightarrow K_c = 166 × 10⁻⁵m³/mol $= 1.66 \times 10^{-2}$ L/mol

Question77

Consider the reaction, N $_2O_4(g) \rightleftharpoons 2NO_2(g)$. The temperature at which K $_C = 20.4$ and K $_p = 600.1$, is K. (Round off to the nearest integer). [Assume all gases are ideal and R = 0.0831L bar, K $^{-1}$ mol $^{-1}$].

[17 Mar 2021 Shift 2]

Answer: 354

Solution:

The temperature at which $K_{\rm C} = 20.4$ and $K_{\rm p} = 600.1$, is $354 \rm K$. Given reaction is, $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ Given values are : $K_{\rm p} = 600.1$ $K_{\rm C} = 20.4$ $\Delta n_g =$ number of moles of product - number of moles of reactant Using relation between $K_{\rm p}$ and $K_{\rm C} = 2 - 1 = 1$ where R is the gas constant = 0.083Latm/K mol $\Delta n_g = 1$ (for given reaction) On putting given values, we will get $600.1 = 20.4 (\rm RT)^1 \Rightarrow T \approx 354 \rm K$

Question78

For the reaction, $A(g) \neq B(g)$ at 495K, Δ , $G^{\circ} = -9.478$ kJ mol⁻¹. If we start the reaction in a closed container at 495K with 22 millimoles of A, the amount of B is the equilibrium mixture is millimoles (Round off to the nearest integer). [R = 8.314J mol⁻¹K⁻¹, ln 10 = 2.303] [16 Mar 2021 Shift 1]

Answer: 20

Solution:

```
A(g) \rightleftharpoons B(g)
Given, T = 495K , \Delta_r C^\circ = -9.478 \text{kJ} / mol
We know,
\Delta G^{\circ} = -2.303 RT \log K
\therefore K = \frac{[B]}{[A]}
where, K = equilibrium constant
Now, \log K = \frac{-\Delta G^{\circ}}{2.303 RT}
                 9.478 \times 1000
\log K = \frac{9.476 \times 10^{10}}{2.303 \times 8.314 \times 495}
\therefore \log K = 1
\Rightarrow K = 10
\Rightarrow \frac{[B]}{[A]} = \frac{n_B}{n_A} = 10
                     A(g) \rightleftharpoons B(g)
Now, t = 0 22
                                      0
          t = t 22 - x
                                        х
K = \frac{[B]}{[A]} = \frac{x}{22 - x} = 10
So, x = 20 Milimoles of B = 20
```

Question79

In order to prepare a buffer solution of pH 5.74, sodium acetate is added to acetic acid. If the concentration of acetic acid in the buffer is 1.0M, the concentration of sodium acetate in the buffer is M. (Round off to the nearest integer). [Given : pK_a

(acetic acid =4.74] [18 Mar 2021 Shift 1]

Solution:

Given : pH = 5.74 Concentration of acetic acid in buffer = 1.0M Acetic acid and its conjugate base sodium acetate makes acidic buffer. CH $_3$ COOH + CH $_3$ COON a \rightarrow (Acidic buffer) Using formula, pH = pK $_a$ + log $\frac{[Salt]}{[Acid]}$ pH = pK + agg $\frac{[CH _3COON a]}{[CH _3COOH]}$ 5.74 = 4.74 + log $\frac{[CH _3COON a]}{[CH _3COOH]}$ 5.74 - 4.74 = log $\frac{[CH _3COON a]}{[CH _3COOH]}$ 1 = log $\frac{[CH _3COON a]}{[CH _3COOH]}$ $1 = \log \frac{[CH _3COON a]}{[CH _3COOH]} = 10 [::[CH _3COOH] = 1]$ [CH $_3COON a] = [10 \times 1] = 10$ Thus, the concentration of sodium acetate in buffer is 10M.

Question80

Sulphurous acid (H $_2$ SO $_3$) has K $_{a_1} = 1.7 \times 10^{-2}$ and K $_{a_2} = 6.4 \times 10^{-8}$. The pH of 0.588M is (Round off to the nearest integer) [16 Mar 2021 Shift 2]

Answer: 1

Solution:

For H₂SO₃, K_{a1} > > K_{a2} So, we mainly consider 1st ionisation H₂SO₃ \rightleftharpoons H⁺ + H SO₃⁻; K_{a1} = 1.7 × 10⁻² t = 0 0.558 0 0 t = t_{eq} 0.558 - 0.558 α 0.558 α 0.558 α K_{a1} = $\frac{[H^+][H SO_3^-]}{[H_2SO_3]} = \frac{(0.558\alpha)(0.558\alpha)}{0.558(1 - \alpha)} = \frac{0.558\alpha^2}{1 - \alpha}$ $\alpha < < 1$ for weak acid (1 - α) ≈ 1 $\alpha = \sqrt{\frac{K_{a1}}{0.558}} = \sqrt{\frac{1.7 \times 10^{-2}}{0.558}}$ $\alpha = 1.7 \times 10^{-1} = 0.17$ [H]⁺ = 0.558 α = 9.9 × 10⁻² pH = -log[H⁺] = -log(9.9 × 10^{-2}) [::log 9.9 ≈ 1] = 2 - log 9.9 = 2 - 1 pH = 1

Question81

Assuming that Ba(OH)₂ is completely ionised in aqueous solution under the given conditions the concentration of H₃O⁺ions in 0.005M aqueous solution of Ba(OH)₂ at 298K is ______ × 10^{-12} mol L⁻¹. (Nearest integer) [25 Jul 2021 Shift 2]

Answer: 1

Solution:

```
Ba(OH)<sub>2</sub> → Ba<sup>+2</sup> + 2OH<sup>-</sup>

↓

2 × 0.005 = 0.01 = 10<sup>-2</sup>

At 298K : in aq. solution [H<sub>3</sub>O<sup>+</sup>][OH<sup>-</sup>] = 10<sup>-14</sup>

[H<sub>3</sub>O<sup>+</sup>] = \frac{10^{-14}}{10^{-2}} = 10^{-12}
```

Question82

A solution is 0.1M in Cl⁻and 0.001M in $\text{CrO}_4^{2^-}$. Solid AgN O₃ is gradually added to it Assuming that the addition does not change in volume and K_{sp} (AgCl) = 1.7×10^{-10} M² andK_{sp}(Ag₂CrO₄) = 1.9×10^{-12} M³ Select correct statement from the following: [20 Jul 2021 Shift 2]

Options:

A. AgCl precipitates first because its K_{sp} is high.

B. Ag_2CrO_4 precipitates first as its K_{sp} is low.

C. Ag_2CrO_4 precipitates first because the amount of Ag^+ needed is low.

D. AgCl will precipitate first as the amount of Ag^+ needed to precipitate is low.

Answer: D

Solution:

(i) $[Ag^{+}]$ required to ppt AgCl (s) K sp = I P = $[Ag^{+}][Cl^{-}] = 1.7 \times 10^{-10}$ $[Ag^{+}] = 1.7 \times 10^{-9}$ (ii) $[Ag^{+}]$ required to ppt Ag₂CrO₄(s) K sp = I P = $[Ag^{+}]^{2}[CrO_{4}^{-2}] = 1.9 \times 10^{-12}$ $[Ag^{+}] = 4.3 \times 10^{-5}$ $[Ag^{+}]$ required to ppt AgCl is low so AgCl will ppt 1st

Question83

The equilibrium constant for the reaction $A(s) \neq M(s) + \frac{1}{2}O_2(g)$ is $K_p = 4$. At equilibrium, the partial pressure of O_2 is _____ atm. (Round off to the nearest integer) [27 Jul 2021 Shift 2]

Answer: 16

Solution:

 $k_{p} = Po_{2}^{1/2} = 4$ $\therefore Po_{2} = 16bar = 16atm$

Question84

 $2\mathrm{SO}_2(\mathsf{g}) + \mathrm{O}_2(\mathsf{g}) \to 2\mathrm{SO}_3(\mathsf{g})$

The above reaction is carried out in a vessel starting with partial pressure $P_{SO_2} = 250m$ bar $P_{O_2} = 750m$ bar and $P_{SO_3} = 0$ bar. When the reaction is complete, the total pressure in the reaction vessel is _____ m bar. (Round off of the nearest integer). [27 Jul 2021 Shift 2]

Answer: 875

Solution:

	2SO ₂ (g)	+	O ₂ (g)	\rightarrow	2SO ₃ (g)
Initial	250mbar		750mbar		Ο
	(L.R.)				
Final	-250mbar		-125mbar		250mbar
	0		625mbar		250mba
∴ Final t	otal pressu	re	= 625 + 25	= 0	875mbar

Question85

PCl₅ ≈ PCl₃ + Cl₃ K_c = 1.844 3.0 moles of PCl₅ is introduced in a 1L closed reaction vessel at 380K. The number of moles of PCl₅ at equilibrium is _____ ×10⁻³ (Round off to the Nearest Integer) [27 Jul 2021 Shift 1]

Answer: 1400

Solution:

```
PCl <sub>5(g)</sub> ≈ PCl <sub>3(g)</sub> + Cl <sub>2(g)</sub> K<sub>c</sub> = 1.844

⇒ \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{x^2}{3-x} = 1.844

⇒ x^2 + 1.844 - 5.532 = 0

⇒ x = \frac{-1.844 + \sqrt{(1.844)^2 + 4 \times 5.532}}{2}

≈ 1.604

⇒ Moles of PCl<sub>5</sub> = 3 - 1.604 ≈ 1.396
```

Question86

Value of K_p for the equilibrium reaction $N_2O_4 \approx 2NO_{2(g)}$ at 288K is 47.9. The K_C for this reaction at same temperature is ______. (Nearest integer) (R = 0.083L. bar K⁻¹mol⁻¹) [22 Jul 2021 Shift 2] Answer: 2

Solution:

 $K_{\rm C} = \frac{K_{\rm P}}{RT} = \frac{47.9}{0.083 \times 288} = 2$

Question87

 $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ In an equilibrium mixture, the partial pressures are $P_{SO_3} = 43kPa; P_{O_2} = 530Pa \text{ and} P_{SO_2} = 45kPa$. The equilibrium constant K_P = $\underline{\qquad} \times 10^{-2}$. (Nearest integer) [20 Jul 2021 Shift 1]

Answer: 172

Solution:

```
2SO_{2}(g) + O_{2}(g) = 2SO_{3}(g)

K_{P} = \frac{(pSO_{3(g)})^{2}}{pSO2(g)} \times pO_{2(g)}

= \frac{43 \times 43}{45 \times 45} \times 530Pa^{-1}

= 172.28 \times 10^{-5}Pa^{-1}

= 172.28atm

= 17228 \times 10^{-2}atm
```

Question88

 $A_{3}B_{2}$ is a sparingly soluble salt of molar mass M(gmol⁻¹) and solubility xgL⁻¹. The solubility product satisfies $K_{sp} = a \left(\frac{x}{M}\right)^{5}$. The value of a is (Integer answer) [31 Aug 2021 Shift 1]

Answer: 108

Solution:

$$A_{3}B_{2} \rightleftharpoons 3A^{2+}(aq) + 2B^{3-}(aq)$$

$$K_{sp} = [A^{2+}]^{3}[B^{3-}]^{2}$$

$$K_{sp} = (3S)^{3}(2S)^{2} = 108S^{5}$$

$$AlsOS = \frac{x}{m}$$

$$K_{sp} = 108 \left(\frac{x}{m}\right)^{5}$$
Given that, $K_{sp} = a\left(\frac{x}{m}\right)^{5}$

$$\therefore a = 108$$

Question89

The pH of a solution obtained by mixing 50 mL of 1 M HCl and 30 mL of 1 M NaOH is $x \times 10^{-4}$. The value of x is (Nearest integer) [log 2.5 = 0.3979] [31 Aug 2021 Shift 2]

Answer: 6021

Solution:

$$\begin{split} \text{Milliequivalents of HCl}(N_a V_a) &= 50 \times 1 = 50 \\ \text{Milliequivalents of NaOH}(N_b V_b) &= 30 \times 1 = 30 \\ \text{Since, } N_a V_a > N_b N_b \\ \text{and they neutralise each other} \\ [H^+] &= \frac{N_a V_a - N_b V_b}{V_a + V_b} \\ &= \frac{50 - 30}{80} = 0.25 = 2.5 \times 10^{-1} \\ \text{pH} &= -\log[\text{H}^+] = -\log(2.5 \times 10^{-1}) \\ &= 1 - 0.3979 = 0.6021 \\ \text{pH} \times 10^4 = 0.6021 \times 10^4 = 6021 \\ \therefore x = 6021 \end{split}$$

Question90

The number of moles of NH₃, that must be added to 2L of 0.80MAgNO₃ in order to reduce the concentration of Ag⁺ ions to 5.0×10^{-8} M (K_{formation} for [Ag(NH₃)₂]⁺ = 1.0×10^{8}) is..... (Nearestinteger) [Assume no volume change on adding NH₃] [27 Aug 2021 Shift 1]

Answer: 4

Solution:

```
Let moles added = a

Ag<sup>+</sup> + 2NH<sub>3</sub> \Rightarrow Ag(NH<sub>3</sub>)<sub>2</sub><sup>+</sup>

t = 0

0.8 \left(\frac{a}{2}\right)

t = \infty

5 × 10<sup>-8</sup> \left[\frac{a}{2} - 1.6\right] 0.8

\frac{0.8}{5 \times 10^{-8} \left(\frac{a}{2} - 1.6\right)^2} = 10^8

\frac{a}{2} - 1.6 = 0.4

\Rightarrow a = 4.
```

Question91

The number of moles of NH₃, that must be added to 2L of 0.80MAgNO₃ in order to reduce the concentration of Ag⁺ ions to 5.0×10^{-8} M (K_{formation} for [Ag(NH₃)₂]⁺ = 1.0×10^{8}) is...... (Nearestinteger)

[Assume no volume change on adding NH₃] [27 Aug 2021 Shift 1]

Answer: 4

Solution:

```
Let moles added = a

Ag<sup>+</sup> + 2NH<sub>3</sub> \Rightarrow Ag(NH<sub>3</sub>)<sub>2</sub><sup>+</sup>

t = 0

0.8 \left(\frac{a}{2}\right)

t = \infty

5 × 10<sup>-8</sup> \left[\frac{a}{2} - 1.6\right] 0.8

\frac{0.8}{5 \times 10^{-8} \left(\frac{a}{2} - 1.6\right)^2} = 10^8

\frac{a}{2} - 1.6 = 0.4

\Rightarrow a = 4.
```

Question92

The equilibrium constant K_c at 298K for the reaction $A + B \rightleftharpoons C + D$ is 100. Starting with an equimolar solution with concentrations of A, B, C and D all equal to 1M, the equilibrium concentration of D is×10⁻²M. (Nearestinteger) [26 Aug 2021 Shift 2]

Answer: 182

Solution:

```
A + B ≠ C + D

Initially,

At equilibrium, 1- x, 1- x, 1+ x, 1+ x

∴K<sub>C</sub> = \left(\frac{1+x}{1-x}\right)^2

100 = \left(\frac{1+x}{1-x}\right)^2

\frac{1+x}{1-x} = 10

x = \frac{9}{11}

Moles of D = 1 + x

= 1 + \frac{9}{11} = \frac{20}{11}

= 1.818 = 181.8 × 10<sup>-2</sup> = 181.8 × 10<sup>-2</sup>

≡ 182 × 10<sup>-2</sup>M
```

Question93

When 5.1g of solid NH_4 HS is introduced into a two litre evacuated flask at 27°C, 20% of the solid decomposes into gaseous ammonia and hydrogen sulphide. The K_p for the reaction at 27°C is x × 10⁻². The value of x is (Integer answer) [Given, R = 0.082L atm K⁻¹ mol⁻¹] [27 Aug 2021 Shift 2]

Answer: 6

Solution:

 $51g \text{ of } NH_4 HS = 1 mol$ $5.1g \text{ of } NH_4 HS = \frac{1}{51} \times 5.1 = 0.1 \text{ mol}$ $\mathrm{NH}_4\mathrm{HS}(\mathrm{s}) \rightleftharpoons \mathrm{NH}_3(\mathrm{g}) + \mathrm{H}_2\mathrm{S}(\mathrm{g})$ Att = 0,0.1 At t = t, $0.1(1 - \alpha)$ 0.1α 0.1α It is given that dissociation is 20% from 100 moles. \therefore 20 moles get dissociated. 20% dissociation from $1 \mod \frac{20}{100} = 0.2$ moles get dissociated. $\alpha = 0.2$ $\therefore K_{\rm C} = \frac{[\rm NH_3][\rm H_2S]}{[\rm NH_4HS]} = \frac{[\rm NH_3][\rm H_2S]}{1} \text{ (Concentration of solid is assumed as 1)}$ $[NH_{3}] = \frac{\text{Number of moles of NH}_{3}(g)}{\text{Volume(in L)}} = \frac{0.1\alpha}{2}$ $[H_{2}S] = \frac{\text{Number of moles of H}_{2}S}{\text{Volume(in L)}} = \frac{0.1\alpha}{2}$ $K_{\rm C} = 0.1\alpha 2 \times \frac{0.1\alpha}{2} = \frac{0.1 \times 0.2}{2} \times \frac{0.1 \times 0.2}{2} = 10^{-4}$ $\therefore K_{\rm p} = K_{\rm C} (\rm RT)^{\Delta n}$ $[\Delta n = change in the number of gaseous moles = 2]$ $K_p = 10^{-4} \times (0.08 \times 300)^2$ $\dot{K_p} = 10^{-4} \times (24)^2 = 0.06$ $x \times 10^{-2} = 0.06$ $\Rightarrow x = \frac{0.06}{10^{-2}} = 0.06 \times 10^2 = 6$ x = 6 is the answer.

Question94

The molar solubility of $Zn(OH)_2$ in 0.1M NaOH solution is $x \times 10^{-18}$ M. The value of x is (Nearest integer) (Given; The solubility product of $Zn(OH)_2$ is 2×10^{-20}). [1 Sep 2021 Shift 2]

Answer: 2

Solution:

 $\begin{aligned} &\operatorname{Zn}(\operatorname{OH})_2 \rightleftharpoons \operatorname{Zn}^{2+}_S + 2\operatorname{OH}^-_{2S} \\ &\operatorname{Due} \text{ to common-ion effect (presence of NaOH) the concentration of OH^- will be (2S + 0.1) &\approx 0.1 \\ &(\because 0.1 > > 2 S) \\ &\therefore \text{ Solubility of product,} \\ &\operatorname{K}_{sp} = (0.1)^2 \times S \\ &2 \times 10^{-20} = 0.01 \times S \\ &\Rightarrow S = \frac{2 \times 10^{-20}}{0.01} = 2 \times 10^{-18} \\ &\therefore x = 2 \\ &\operatorname{Hence, answer is } 2. \end{aligned}$

Question95

In the figure shown below reactant A (represented by square) is in equilibrium with product B (represented by circle). The equilibrium constant is:



Options:

A. 4

- B. 8
- C. 1
- D. 2
- D. 2

Answer: D

Solution:

Equilibrium constant $K_c = \frac{[B]}{[A]} = \frac{11}{6} \approx 2$

Question96

For the following Assertion and Reason, the correct option is: Assertion: The pH of water increases with increase in temperature. Reason: The dissociation of water into H⁺ and OH⁻ is an exothermic reaction. [Jan.08,2020(II)]

Options:

A. Both assertion and reason are true, and the reason is the correct explanation for the assertion.

B. Both assertion and reason are false.

C. Both assertion and reason are true, but the reason is not the correct explanation for the assertion.

D. Assertion is not true, but reason is true.

Answer: B

Solution:

Temperature plays a significant role on pH measurements. As the temperature rises, molecular vibrations increase which results in greater ability of water to ionise and form more hydrogen ions.

As a result, the pH will drop. So assertion is incorrect. The dissociation of water molecules into ions is bond breaking and is therefore an endothermic process (energy must be absorbed to break the bonds). So reason is also incorrect.

Question97

Two solutions, A and B, each of 100L was made by dissolving 4g of N aOH and 9.8g of H_2SO_4 in water, respectively. The pH of the resultant solution obtained from mixing 40L of solution A and 10L of solution. B is _____. [NV, Jan. 07, 2020 (I)]

Answer: 10.60

Solution:

```
M_{H_2SO_4} = \frac{9.8}{98 \times 100} = 10^{-3}M
M_{NaOH} = \frac{4}{40 \times 100} = 10^{-3}M
After neutralisation [OH<sup>-</sup>] can be calculated as
[OH] = \frac{(40 \times 10^{-3}) - (2 \times 10^{-3} \times 10)}{50}
= \frac{20}{50} \times 10^{-3}
[OH<sup>-</sup>] = \frac{2}{5} \times 10^{-3}
POH = 3.397
PH = 14 - pOH
= 14 - 3.397 = 10.603
```

Question98

3g of acetic acid is added to 250mL of 0.1M H Cl and the solution made up to 500mL. To 20mL of this solution $\frac{1}{2}$ mL of 5M N aOH is added. The pH of the solution is

[Given: pKa of acetic acid = 4.75, molar mass of acetic acid = 60g / mol, log 3 = 0.4771] Neglect any changes in volume. [NV, Jan. 07, 2020 (II)]

Answer: 5.22

Solution:

No. of moles = $\frac{\text{Mass}}{\text{Molar mass}}$ 3gCH ₃COOH = $\frac{3}{60}$ 0.5mol = 50mmol No. of millimoles = Molarity \times Volume in mL $250mL \text{ of } 0.1M \text{ H Cl} = 250 \times 0.1 = 25mmol$ $500 \text{mL solution} = 50 \text{mmol CH}_{3} \text{COOH}$ $20\text{mL solution} = \frac{50}{500} \times 20 = 2\text{mmol CH}_{3}\text{COOH}$ 500mL solution contains = 25mmol H Cl 20mL solution contains = $\frac{25}{500} \times 20 = 1$ mmol H Cl $\frac{1}{2}$ mL of 5M N aOH = $\frac{1}{2} \times 5$ = 2.5mmol N aOH $H Cl + N aOH \rightarrow N aCl + H_2O$ ${\rm Remaining \ N \ aOH} = {\stackrel{1}{2.5}} - 1 = 1.5 {\rm mmol}$ $CH_3COOH + NaOH$ (remaining) $\rightarrow CH_3COONa + Water$ 2 0 0 0.5 1.5 $pH = pK_a + \log \frac{1.5}{0.5} = 4.74 + \log 3$ = 4.74 + 0.48 = 5.22

Question99

The K_{sp} for the following dissociation is 1.6×10^{-5} PbCl₂(s) \Rightarrow Pb²⁺(aq) + 2Cl⁻(aq) Which of the following choices is correct for a mixture of 300 mL 0.134 M Pb(NO₃)₂ and 100 mL 0.4 MNaCl? [Jan. 09, 2020 (I)]

Options:

A. Not enough data provided

```
B. Q < K .
```

C. Q > K_{sp}

D. Q = K_{sp}

Answer: C

Solution:

PbCl₂ ≈ Pb²⁺(aq) + 2Cl⁻(aq) Given; K_{sp} = 1.6 × 10⁻⁵ [Pb²⁺] = $\frac{300 \times 0.134}{400}$ = 0.1005 [Cl⁻] = $\frac{100 \times 0.4}{400}$ = 0.1 Q = [Pb²⁺][Cl⁻]² = 0.1005 × (0.1)² = 1.005 × 10⁻³ Q > K_{sp}

Question100

The solubility product of Cr(OH)₃ at 298K is 6.0×10^{-31} . The concentration of hydroxide ions in a saturated solution of Cr(OH)₃ will be: [Jan. 09,2020 (II)]

Options:

A. $(2.22 \times 10^{-31})^{1/4}$

- B. $(18 \times 10^{-31})^{1/4}$
- C. $(18 \times 10^{-31})^{1/2}$

```
D. (4.86 \times 10^{-29})^{1/4}
```

Answer: B

Solution:

```
Cr(OH)<sub>3</sub> → \underset{s^{3^{+}}}{\overset{s^{3^{+}}}{=}} 3OH<sup>-</sup>

K<sub>sp</sub> = s. (3s)<sup>3</sup>

⇒6 × 10<sup>-31</sup> = 27. s<sup>4</sup>; s = \left(\frac{6}{27} × 10^{-31}\right)^{1/4}

[OH<sup>-</sup>] = 3s = 3 × \left(\frac{6}{27} × 10^{-31}\right)^{1/4}

= (18 × 10<sup>-31</sup>)<sup>1/4</sup>M
```

Question101

The stoichiometry and solubility product of a salt with the solubility curve given below is, respectively:



Options:

A. X₂Y, 2 × 10⁻⁹M³ B. XY₂, 4 × 10⁻⁹M³ C. XY₂, 1 × 10⁻⁹M³ D. XY, 2 × 10⁻⁶M³

Answer: B

Solution:

From the given curve, if [X] = 1mM then [Y] = 2mM \therefore Salt is XY₂ $K_{sp} = [X][Y]^2 = (10^{-3})(2 \times 10^{-3})^2 = 4 \times 10^{-9} M^3$

Question102

For the reaction $Fe_2N(s) + \frac{3}{2}H_2(g) \Rightarrow 2Fe(s) + NH_3(g)$ [Sep. 06,2020(I)]

Options:

A. $K_{c} = K_{p}(RT)$ B. $K_{c} = K_{p}(RT)^{\frac{-1}{2}}$ C. $K_{c} = K_{p}(RT)^{\frac{1}{2}}$ D. $K_{c} = K_{p}(RT)^{\frac{3}{2}}$

Answer: C

Solution:

 $K_{p} = K_{c}(RT)^{\Delta n_{g}} = K_{c}(RT)^{1-3/2} = K_{c}(RT)^{-1/2}$ $\Rightarrow K_{c} = K_{p}(RT)^{1/2}$

Question103

The value of K c is 64 at 800K for the reaction N $_2(g) + 3H_2(g) \approx 2N H_3(g)$. The value of K $_c$ for the following reaction is:

N H₃(g) $\Rightarrow \frac{1}{2}$ **N**₂(g) + $\frac{3}{2}$ **H**₂(g) [Sep. 06, 2020 (II)] Options: A. 1 / 64 B. 8 C. 1 / 4 D. 1 / 8 Answer: D

Solution:

```
N<sub>2</sub>(g) + 3H<sub>2</sub>(g) ≈ 2N H<sub>3</sub>(g); K<sub>c</sub>

2N H<sub>3</sub>(g) ≈ N<sub>2</sub>(g) + 3H<sub>2</sub>(g); \frac{1}{K_c}

For

N H<sub>3</sub>(g) ≈ \frac{1}{2}N<sub>2</sub>(g) + \frac{3}{2}H<sub>2</sub>(g); \frac{1}{K_c^{1/2}}

\frac{1}{K_c^{1/2}} = \frac{1}{(64)^{1/2}} = \frac{1}{8}
```

Question104

For a reaction X + Y \Rightarrow 2Z, 1.0mol of X, 1.5mol of Y and 0.5 mol of Z were taken in a 1 L vessel and allowed to react. At equilibrium, the concentration of Z was 1.0mol L⁻¹. The equilibrium constant of the reaction is $\frac{x}{15}$. The value of x is _____. [NV, Sep. 05, 2020 (II)]

Answer: 16

Solution:

Solution:

Question105

For the equilibrium $A \rightleftharpoons B$, the variation of the rate of the forward (a) and reverse (b) reaction with time is given by: [Sep. 04,2020(I)]

For the equilibrium $A \rightleftharpoons B$, the variation of the rate of the forward (a) and reverse (b) reaction with time is given by: [Sep. 04,2020(I)]

Options:

A.





Answer: B

Solution:

Solution:

At equilibrium, rate of forward reaction = Rate of backward reaction.

Question106

If the equilibrium constant for $A \rightleftharpoons B + C$ is $K_{eq}^{(1)}$ and that of $B + C \rightleftharpoons P$ is $K_{eq}^{(2)}$, the equilibrium constant for $A \rightleftharpoons P$ is: [Sep. 04,2020(II)]

Options:

A. $K_{eq}^{(1)} / K_{eq}^{(2)}$ B. $K_{eq}^{(2)} - K_{eq}^{(t)}$ C. $K_{eq}^{(1)} + K_{eq}^{(2)}$ D. $K_{eq}^{(1)} K_{eq}^{(2)}$

Answer: D

Solution:

$$\begin{split} A &\rightleftharpoons B + C; K_{eq}^{(1)} \dots (i) \\ B + C &\rightleftharpoons P; K_{eq}^{(2)} \dots (ii) \\ \text{On adding equations (i) and (ii), we get} \\ A &\rightleftharpoons P \\ K_{eq}(\text{ overall }) = K_{eq}^{(1)} \cdot K_{eq}^{(2)} \end{split}$$

Question107

The variation of equilibrium constant with temperature is given below: Temperature Equilibrium Constant $T_1 = 25^{\circ}C K_1 = 10$ $T_2 = 100^{\circ}C K_2 = 100$ The values of ΔH° , ΔG° at T_1 and ΔG° at T_2 (in kj mol⁻¹) respectively, are close to [use R = 8.314J K⁻¹mol⁻¹] [Sep. 06, 2020 (I)]

Options:

A. 28.4, -7.14 and -5.71 B. 0.64, -7.14 and -5.71 C. 28.4, -5.71 and -14.29 D. 0.64, -5.71 and -14.29

Answer: C

Solution:

```
\begin{split} &\Delta G^{\circ} = -RT \ln K, T_{1} = 25^{\circ}C, K_{1} = 10 \\ &\Delta G^{\circ} \text{ at } T_{1} = -8.314 \times 298 \times 2.303 \times \log 10 = -5.71 \text{kJ} \ / \text{ mol} \\ &\Delta G^{\circ} \text{ at } T_{2} = -8.314 \times 298 \times 373 \times 2.303 \times \log(100) \\ &= -14.29 \text{kJ} \ / \text{ mol} \\ &\Delta G^{\circ} = \Delta H^{\circ} - T \ \Delta S^{\circ} \\ &\Rightarrow -5.71 = \Delta H^{\circ} - 298 (\Delta S^{\circ}) \\ &\Rightarrow -14.29 = \Delta H^{\circ} - 373 (\Delta S^{\circ}) \\ &\Delta H^{\circ} = 28.4 \text{kJ} \ / \text{ mol} \end{split}
```

Question108

Consider the following reaction:

N $_2O_4(g) \approx 2NO_2(g); \Delta H^0 = +58kJ$

For each of the following cases ((i), (ii)), the direction in which the equilibrium shifts is:

(i) Temperature is decreases

```
(ii) Pressure is increased by adding N _2 at constant T .
```

[Sep .05,2020(I)]

Options:

A. (i) towards product, (ii) towards product

B. (i) towards reactant, (ii) towards product

C. (i) towards reactant, (ii) no change

D. (i) towards product, (ii) no change

Answer: C

Solution:

Solution:

(i) As reaction is endothermic ($\Delta H z = + ve$) so on decrease in temperature equilibrium will shift towards reactant side. (ii) On increase in pressure by adding inert gas (N₂) at same temperature, no shifting will take place. The equilibrium changes only if the added gas is a reactant or product involved in the reaction.

Question109

Arrange the following solutions in the decreasing order of pOH: (A) 0.01M H Cl(B) 0.01M N aOH(C) $0.01M CH_3 COON a$ (D) 0.01M N aCl[Sep. 06, 2020 (I)]

Options:

A. (A) > (C) > (D) > (B)

B. (A) > (D) > (C) > (B)

C. (B) > (C) > (D) > (A)

D. (B) > (D) > (C) > (A)

Answer: B

Solution:

```
0.01M H Cl

[H^{+}] = 10^{-2}, pH = -\log 10^{-2} = 2
pOH = 14 - 2 = 12
(B) 0.01M N aOH

[OH^{-}] = 10^{-2}, pOH = -\log[OH] = 2
(C) 0.01M CH <sub>3</sub>COON a

pH = 7 + \frac{1}{2}[pK_{a} + \log 0.01]
pH > 7 \Rightarrow pOH < 7
(D) 0.01M N aCl, pH = 7, pOH = 7

Decreasing order of pOH value is,

(A) > (D) > (C) > (B)
```

Question110

A soft drink was bottled with a partial pressure of CO_2 of 3 bar over the liquid at room temperature. The partial pressure of CO_2 over the solution approaches a value of 30 bar when 44g of CO_2 is dissolved in 1kg of water at room temperature. The approximate pH of the soft drink is _____ ×10⁻¹.

(First dissociation constant of H $_2CO_3 = 4.0 \times 10^{-7}$; log 2 = 0.3; density of the soft drink = 1gmL⁻¹)

```
[NV, Sep. 05, 2020(I)]
```

Answer: 7

Solution:

```
CO_{2} + H_{2}O \longrightarrow H_{2}CO_{3}
30 bar ..... 1 mol/L

3 bar ..... 0.1 mol/L

H_{2}CO_{3} \overleftrightarrow{\longrightarrow} H^{+} + HCO_{3}^{-}
t = 0 \quad 0.1 \qquad 0.1 \qquad
```

Question111

100mL of 0.1M H Cl is taken in a beaker and to it 100mL of 0.1M N aOH is added in steps of 2mL and the pH is continuously measured. Which of the following graphs correctly depicts the change in pH? [Sep. 03, 2020 (II)]

Options:

A.





Solution:

Solution: At equivalence point pH is 7 and pH increases with addition of N aOH so correct graph is (c).

Question112

If the solubility product of AB_2 is $3.20 \times 10^{-11} M^3$, then the solubility of AB_2 in pure water is ______ $\times 10^{-4} mol L^{-1}$. [Assuming that neither kind of ion reacts with water]

[NV, Sep.06, 2020 (II)]

Answer: 2

Solution:

 $AB_{2} \rightleftharpoons A^{2+}(aq) + 2B_{2s^{-}(aq)}$ $K_{sp} = 4s^{3} = 3.2 \times 10^{-11}$ $\Rightarrow s^{3} = 8 \times 10^{-12}$ \Rightarrow s = 2 × 10⁻⁴

Question113

An acidic buffer is obtained on mixing : [Sep. 03,2020 (I)]

Options:

A. 100mL of 0.1M CH $_{\rm 3}{\rm COOH}\,$ and 100mL of 0.1M N aOH

- B. 100mL of $0.1M\,H\,Cl\,$ and 200mL of $0.1M\,N\,aCl\,$
- C. 100mL of 0.1M CH $_3$ COOH and 200mL of 0.1M N aOH
- D. 100mL of 0.1M H Cl and 200mL of 0.1M CH $_3 \rm COON$ a

Answer: D

Solution:

	HCl+Cl	$H_3COONa \longrightarrow$	CH ₃ COOH+1	VaC1		
Millimoles	10	20	0	0		
at start						
Millimoles	0	10	10	10		
after						
reaction						
Buffer solu	ition conta	ains CH ₃ COON a	10 millimole) a	nd CH ₃ COO)H (10 millimole) which is a

Question114

For the following Assertion and Reason, the correct option is Assertion (A): When Cu (II) and sulphide ions are mixed, they react together extremely quickly to give a solid. Reason (R): The equilibrium constant of $Cu^{2+}(aq) + S^{2-}(aq) \Rightarrow CuS(s)$ is high because the solubility product is low. [Sep. 02,2020(I)]

acidic buffer.

Options:

- A. (A) is false and (R) is true
- B. Both (A) and (R) are false
- C. Both (A) and (R) are true but (R) is not the explanation for (A) $\label{eq:constraint}$
- D. Both (A) and (R) are true and (R) is the explanation for (A)

Answer: C

Solution:

 $\begin{array}{l} Cu^{2^+} \text{ ions get precipitated every quickely due to low K}_{sp} \text{ value even at very low concentration of S}^{2^-} \text{ ion.} \\ CuS(s) &\rightleftharpoons Cu^{2^+} + S^{2^-} \\ K_{sp} &= [Cu^{2^+}][S^{2^-}] \\ Cu^{2^+} + S^{2^-} &\rightleftharpoons CuS(s) \\ K_{eq} &= \frac{1}{[Cu^{2^+}][S^{2^-}]} = \frac{1}{K_{sp}} \\ \text{Due to high value of K}_{eq} \text{, CuS precipitated easily.} \end{array}$

Question115

For the equilibrium 2H $_2O \rightleftharpoons$ H $_3O^+$ + OH $^-$; the value of ΔG° at 298K is approximately: [Jan. 11, 2019 (II)]

Options:

- A. 100kJ mol⁻¹
- B. -80kJ mol⁻¹
- C. 80kJ mol⁻¹
- D. -100kJ mol⁻¹

Answer: C

Solution:

 $\Delta G = \Delta G^{\circ} + RT \ln Q$ At equilibrium; $\Delta G = 0$ and $Q = K_{eq}$ $\Rightarrow \Delta G^{\circ} = -2.303RT \log K_{w}$ $= -2.303 \times 8.314 \times 298 \times \log 10^{-14}$ $= 79.9 kJ / mol \approx 80 kJ / mol$

Question116

Which amongst the following is the strongest acid? [Jan. 9,2019 (I)]

Options:

A. CH Br₃

B. CH I₃

C. CH (CN) $_3$

D. CH Cl₃

Answer: C

Solution:



Due to the resonance stabilisation of the conjugate base, CH (CN)₃ is the strongest acid amongst the given compounds. CH (CN)₃ \Rightarrow H⁺ + \overline{C} (CN)₃

The conjugate bases of CH Br_3 and CH I_3 are stabilised by inductive effect of halogens. This is why, they are less stable. Also, the conjugate base of CH Cl_3 involves backbonding between 2p and 3p orbitals.

Question117

If K $_{50}$ of Ag $_2$ CO $_3$ is 8 × 10⁻¹², the molar solubility of Ag $_2$ CO $_3$ in 0.1M AgN O $_3$ is: [Jan. 12,2019(II)]

Options:

A. 8×10^{-12} M

B. 8 × 10^{-11} M

C. 8×10^{-10} M

D. 8×10^{-13} M

Answer: C

Solution:

```
Solution:
As AgN O<sub>3</sub> dissociates completely,
therefore in 0.1M AgN O<sub>3</sub> solution, [Ag^+] = 0.1M
AgN O<sub>3</sub> \rightarrow Ag + N O_{0.1}^{-}
Ag<sub>2</sub>CO<sub>3</sub> \approx 0.1 + 2ss^{-1} Ag^{+} + CO_{3}^{-2}
K_{sp} = [Ag^{+}]^{2}[CO_{3}^{-2}]
8 \times 10^{-12} = (0.1 + 2s)^{2} \times s
0.01s = 8 \times 10^{-12}; (0.1 + 2s \times 0.1)
s = 8 \times 10^{-10} M
```

Question118

20mL of 0.1M H $_2$ SO₄ solution is added to 30mL of 0.2 M N H $_4$ OH solution. The pH of the resultant mixture is: [pK $_b$ of N H $_4$ OH = 4.7] [Jan. 9,2019 (I)]

Options:

A. 5.2

B. 9.0

C. 5.0

D. 9.4

Answer: B

Solution:

 $m \cdot mol of H_2SO_4 = 20 \times 0.1 = 2$ m. mol of N H₄OH = 30 × 0.2 = 6

```
H_2SO_4 + 2NH_4OH \rightarrow (NH_4)_2SO_4 + 2H_2O
```

```
0
 Initial
         2 m mol
                     6 m mol
                      (6 - 2 \times 2)
 Final (2-2)
                                        2 m mol
[N H_4 OH]_{left} = 2m mol
[(N H_4)_2 SO_4] = 2m mol
[N H_4] = 2 \times 2 = 4 m mol
Total Volume = 30 + 20 = 50 \text{ mL}
pOH = pK_b + log \left[ \frac{Salt}{Base} \right]
= 4.7 + \log \frac{4/50}{2/50}
= 4.7 + \log 2 = 5
pH = 14 - pOH
pH = 14 - 5 = 9
    _____
```

Question119

A mixture of 100m mol of Ca(OH)₂ and 2g of sodium sulphate was dissolved in water and the volume was made up to 100mL. The mass of calcium sulphate formed and the concentration of OH⁻ in resulting solution, respectively, are: (Molar mass of Ca(OH)₂, N a₂SO₄ and CaSO₄ are 74,143 and 136gmol⁻¹, respectively; K_{sp} of Ca(OH)₂ is 5.5×10^{-6})

[Jan. 10,2019(I)]

Options:

- A. 1.9g, 0.28mol L⁻¹
- B. 13.6g, 0.28mol L⁻¹
- C. 1.9g, 0.14 mol L⁻¹
- D. 13.6g, $0.14 \text{mol } \text{L}^{-1}$

Answer: A

Solution:

N $a_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2N aOH$ m mol of N $a_2SO_4 = \frac{2 \times 1000}{143} = 13.98 m mol$ m mol of CaSO₄ formed = 13.98 m mol Mass of CaSO₄ formed = 13.98 × 10⁻³ × 136 = 1.90g m mol of N aOH = 28m mol ≈ 0.028 mol Ca(OH)₂ $\approx Ca^{2+} + 2OH^{-2}_{2S+0.028}$ Value of 'S' will be negligible so [OH] = $\frac{0.028 mol}{0.1L} = 0.28 mol L^{-1}$

Question120

Two solids dissociate as follows $A(s) \rightarrow B(g) + C(g); K_{P_1} = xatm^2$ $D(s) \rightarrow C(g) + E(g); K_{P_2} = yatm^2$

The total pressure when both the solids dissociate simultaneously is: [Jan. 12, 2019 (I)]

Options:

A. $\sqrt{x + y}$ atm

B. $2(\sqrt{x+y})$ atm

```
C. (x + y)atm
```

D. $x^2 + y^2$ atm

Answer: B

Solution:

 $\begin{array}{l} A(s) \longrightarrow B(g) + C(g) \\ P_1 \ P_1 + P_2 \\ K_{P_1} = P_B \times P_C \\ P_1(P_1 + P_2) = x \\ K_{P_2} = P_C \times P_E \\ (P_1 + P_2)P_2 = y \ \dots(ii) \\ Adding (i) and (ii) \\ \therefore P_1(P_1 + P_2) + P_2(P_1 + P_2) = x + y \\ P_1^{\ 2} + P_1P_2 + P_2P_1 + P_2^{\ 2} = x + y \\ P_1^{\ 2} + P_2^{\ 2} + 2P_1P_2 = x + y \\ \Rightarrow \& (P_1 + P_2)^2 = x + y \\ \Rightarrow \& (P_1 + P_2)^2 = x + y \\ \Rightarrow P_1 + P_2 = \sqrt{x + y} \\ \therefore \text{ Total pressure } (P_T) = P_C + P_B + P_E \\ (P_1 + P_2) + P_1 + P_2 = 2(P_1 + P_2) \\ P_T = 2(\sqrt{x + y}) \end{array}$

Question121

In a chemical reaction, $A + 2B^{E} + D$, the initial concentration of B was 1.5 times of the concentration of A, but the equilibrium concentrations of A and B were found to be equal. The equilibrium constant (K) for the aforesaid chemical reaction is: [Jan. 12, 2019 (I)]

Options:

- A. 4
- B. 16
- C. $\frac{1}{4}$
- D. 1

Answer: A

Solution:

```
A + 2B = 2C + D
i = 0 2 3 0 0
i_{eq} 2 - x 3 - 2x 2x x
Given, 3 - 2x = 2 - x
\Rightarrow x = 1
\therefore [C] = 2, [D] = 1, [A] = 1, [B] = 1
K_{c} = \left\{ \frac{2^{2} \times 1}{1^{2} \times 1} \right\} = 4
```

Question122

Consider the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ The equilibrium constant of the above reaction is K_p . If pure ammonia is left to dissociate, the partial pressure of ammonia at equilibrium is given by (Assume that $P_{NH_3} < P_{total}$ at equilibrium) [Jan. 11, 2019 (I)]

Options:

A. $\frac{3^{3/2} K_{p}^{-1/2} P^{2}}{16}$ B. $\frac{K_{p}^{-1/2} P^{2}}{16}$ C. $\frac{K_{p}^{-1/2} P^{2}}{4}$ D. $\frac{3^{3/2} K_{p}^{-1/2} P^{2}}{4}$

Answer: A

Solution:

 $2N H_{3}(g) \rightleftharpoons N_{2}(g) + 3H_{2}(g), K = \frac{1}{K_{p}}$ $K = \frac{1}{K_{p}} = \frac{P_{N_{2}}(P_{H_{2}})^{3}}{(P_{NH_{3}})^{2}} \dots (i)$ $\Rightarrow P_{Total} (P) = P_{N_{2}} + P_{H_{2}} + P_{NH_{3}}$ $= P_{N_{2}} + P_{H_{2}} (\because P_{NH_{3}} < P_{T})$ Now, Partial $f_{2} = \frac{1}{4}P$; Partial pressure of $H_{2} = \frac{3}{4}P$

From eq (i),
$$\frac{1}{K_{P}} = \frac{\left(\frac{1}{4}P\right)\left(\frac{3}{4}P\right)^{3}}{\left(P_{NH_{3}}\right)^{2}}$$

 $\frac{\left(P_{NH_{3}}\right)^{2}}{K_{P}} = \frac{P}{4} \cdot \frac{P^{3}}{4^{3}} \cdot 3^{3}; \frac{\left(P_{NH_{3}}\right)^{2}}{K_{P}} = \frac{P^{4}}{4^{4}} \cdot 3^{3}$
 $\left(P_{NH_{3}}\right)^{2} = K_{P} \cdot \frac{P^{4}}{4^{4}} \cdot 3^{3}; P_{NH_{3}} = \left[K_{P} \cdot \frac{P^{4}}{4^{4}} \cdot 3^{3}\right]^{1/2}$
 $P_{NH_{3}} = \frac{3^{3/2} \cdot P^{2} \cdot K_{P}^{1/2}}{16}$

Question123

The values of K_p / K_c for the following reactions at 300K are, respectively: (At 300K, RT = 24.62dm³ atm mol⁻¹) N₂(g) + O₂(g) \neq 2N O(g) N₂O₄(g) \neq 2N O₂(g) N₂(g) + 3H₂(g) \neq 2N H₃(g) [Jan. 10, 2019 (I)]

Options:

A. 1, 24.62dm³ atm mol⁻¹, 606.0dm⁶ atm²mol⁻²

B. 1, 24.62d $m^3 atm mol^{-1}$, 1.65 × 10⁻³ dm⁻⁶ atm⁻² mol²

C. 1, $4.1 \times 10^{-2} \text{dm}^{-3} \text{atm}^{-1} \text{ mol}$, 606dm⁶atm²mol²

D. $24.62 dm^3 atm mol^{-1}$, 606.0dm⁶atm²mol⁻² 1.65 × 10⁻³ dm⁻⁶atm⁻²mol²

Answer: B

Solution:

Solution: $K_p = K_c (RT)^{\Delta^n g}$ $\Delta n_g = No. of gaseous moles of products - No. of gaseous moles of reactants <math>\frac{K_p}{K_c} = (RT)^{\Delta^n g}$ $N_2(g) + O_2(g) \rightleftharpoons 2N O(g), \Delta n_g = 0$ $\frac{K_p}{K_c} = (24.62d \text{ m}^3 \text{ atmmol}^{-1})^0 = 1$ $N_2O_4(g) \rightleftharpoons 2N O_2(g), \Delta n_g = 1$ $\frac{K_p}{K_c} = 24.62d \text{ m}^3 \text{ atmmol}^{-1}$ $N_2(g) + 3H_2(g) \rightleftharpoons 2N H_3(g), \Delta n_g = -2$ $\frac{K_p}{K_c} = (24.62d \text{ m}^3 \text{ atmmol}^{-1})^{-2}$ $= \frac{1}{(24.62d \text{ m}^3 \text{ atmmol}^{-1})^2}$ $= 1.65 \times 10^{-3} \text{ d} \text{ m}^{-6} \text{ atm}^{-2} \text{ mol}^2$

Question124

5.1 gN H ₄SH is introduced in 3.0L evacuated flask at 327°C, 30% of the solid N H ₄SH decomposed to N H ₃ and H ₂S as gases. The K _p of the reaction at 327°C is (R = 0.082L atm mol⁻¹K⁻¹, molar mass of S = 32gmol⁻¹, molar mass of N = 14gmol⁻¹) [Jan. 10, 2019 (II)]

Options:

A. $0.242 \times 10^{-4} \text{atm}^2$ B. $1 \times 10^{-4} \text{atm}^2$ C. $4.9 \times 10^{-3} \text{atm}^2$

D. $0.242atm^2$

Answer: D

Solution:

Concerned reaction: N H₄SH \rightarrow N H₃(g) + H₂S(g) Initial moles = $\frac{5.1}{51}$ = 0.1mol Moles at equillibrium N H₄SH \rightarrow N H₃(g) + H₂S(g) 0.1(1 - 0.3) 0.1 × 0.3 0.1 × 0.3 \therefore K_c = [N H₃][H₂S] = $\left(\frac{0.03}{3}\right)^2$ = 10⁻⁴ K_p = K_c(RT)^{Δn}g = 10⁻⁴ × (0.082 × 600)² = 0.242atm²

Question125

Consider the following reversible chemical reactions: $A_2(g) + B_2(g) \stackrel{K_1}{\leftarrow} 2AB(g) \dots (1)$ $6AB(g) \stackrel{K_2}{\neq} 3A_2(g) + 3B_2(g) \dots (2)$ The relation between K_1 and K_2 is: [Jan. 9,2019(II)]

Options:

A. $K_1 K_2 = \frac{1}{3}$ B. $K_2 = K_1^3$ C. $K_2 = K_1^{-3}$

D. $K_1 K_2 = 3$

Answer: C

Solution:

Given: $A_2 + B_2 \rightleftharpoons 2AB$ $\Rightarrow 2AB \rightleftharpoons A_2 + B_2; K = \frac{1}{K_1}$ $6AB \xleftarrow{K_1} 3A_2 + 3B_2; K_2 = \left(\frac{1}{K_1}\right)^3$ The relation between K_1 and K_2 is $K_2 = {K_1}^{-3}$

Question126

The INCORRECT match in the following is: [April 12, 2019 (II)]

Options:

A. $\Delta G^0 < 0$, K > 1

B. $\Delta G^0 = 0, K = 1$ C. $\Delta G^0 > 0, K < 1$ D. $\Delta G^0 < 0, K < 1$

Answer: D

Solution:

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

\therefore \text{ If } K > 1 \text{ then } \Delta G^{\circ} < 0

\text{ If } K < 1 \text{ then } \Delta G^{\circ} > 0

\text{ If } K = 1 \text{ then } \Delta G^{\circ} = 0
```

Question127

In which one of the following equilibria, $K_p \neq K_c$? [April 12, 2019 (II)]

Options:

A. $2C(s) + O_2(g) \rightleftharpoons 2CO(g)$

B. 2H I (g) \rightleftharpoons H ₂(g) + I ₂(g)

C. N O₂(g) + SO₂(g) \rightleftharpoons N O(g) + SO₃(g)

D. 2N O(g) \rightleftharpoons N ₂(g) + O₂(g)

Answer: A

Solution:

We know that, $K_p = K_c \cdot (RT)^{\Delta n_g}$ \therefore If $\Delta n_g \neq 0$ then $K_p \neq K_c$ Now, 2C(s) + O₂(g) \rightleftharpoons 2CO(g) $\Delta n_g = +1$ $\Rightarrow K_p = K_c (RT)^1$ Hence, $K_p \neq K_c$

Question128

For the following reactions, equilibrium constants are given: $S(s) + O_2(g) \neq SO_2(g); K_1 = 10^{52}$ $2S(s) + 3O_2(g) \neq 2SO_3(g); K_2 = 10^{129}$ The equilibrium constant for the reaction, $2SO_2(g) + O_2(g) \neq 2SO_3(g)$ is: [April 8, 2019 (II)]

Options:

A. 10¹⁵⁴

B. 10¹⁸¹

C. 10²⁵

D. 10⁷⁷

Answer: C

Solution:

Given, $S + O_2 \rightleftharpoons SO_2...$ (i); $K_1 = 10^{52}$ $2S + 3O_2 \rightleftharpoons 2SO_3 ...$ (ii); $K_2 = 10^{129}$ $2SO_2 + O_2 \rightleftharpoons 2SO_3 ...$ (iii); K = ?To get equation (iii) follow (ii) -2 (i), $2S + 3O_2 \rightarrow 2SO_3 K = 10^{129}$ $-(2S + 2O_2 \rightarrow 2SO_2 K = 10^{104})$ $O_2 \rightarrow 2SO_3 - 2SO_2 K = 10^{25}$ or $2SO_2 + O_2 \rightarrow 2SO_3 K = 10^{25}$

Question129

For the reaction, $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $\Delta H = -57.2 \text{kJ mol}^{-1}$ and $\text{K}_c = 1.7 \times 10^{16}$ Which of the following statement is INCORRECT? [April 10, 2019 (II)]

Options:

A. The equilibrium constant is large suggestive of reaction going to completion and so no catalyst is required.

B. The equilibrium will shift in forward direction as the pressure increases.

C. The equilibrium constant decreases as the temperature increases.

D. The addition of inert gas at constant volume will not affect the equilibrium constant.

Answer: A

Solution:

Equilibrium constant has no relation with catalyst. Catalyst only affects the rate of the reaction. Catalyst, V_2O_5 in the given reaction, is used to speed up the reaction.

Question130

Consider the following statements (a) The pH of a mixture containing 400mL of $0.1M H_2SO_4$ and 400mL of 0.1M N aOH will be approximately 1.3. (b) Ionic product of water is temperature dependent. (c) A monobasic acid with $K_a - 10^{-5}$ has a pH = 5. The degree of dissociation of this acid is 50%. (d) The Le Chatelier's principle is not applicable to common-ion effect. The correct statements are : [April 10, 2019 (I)]

Options:

- A. (a), (b), and (d)
- B. (a), (b) and (c)
- C. (b) and (c)
- D. (a) and (b)

Answer: B

Solution:

 $H_{2}SO_{4} + NaOH \rightarrow NaHSO_{4} + H_{2}O$

Initial mol 0.04 0.04 mol at eam. 0 0.04 0.04 0 $N aH SO_4 \rightarrow N a^+ + H^+ + SO_4^{2-}$ $[H^+] = \frac{0.04}{0.80} = 0.05M$; pH = 1.3 (b) Ionic product of water increases with increase in temperature because ionisation of water is endothermic. $HA \implies H^+ + A$ (c) 0 Initial С 0 At eqm. C $(1 - \alpha)$ Cα Ca Given pH = $5 \Rightarrow -\log(H^+) = 5$ $\therefore [H^+] = 10^{-5}$ As we know, $K_a = \frac{C\alpha^2}{1-\alpha}; \quad 10^{-5} = \frac{C\alpha^2}{1-\alpha} = \frac{C\alpha \cdot \alpha}{(1-\alpha)}$ $10^{-5} = 10^{-5} \frac{\alpha}{1-\alpha}$; $\alpha = \frac{1}{2}$ i.e., 50%

Question131

In an acid base titration, 0.1M H Cl solution was added to the N aOH solution of unknown strength. Which of the following correctly shows the change of pH of the titration mixture in this experiment?



[April 9,2019 (II)]

Options:

A. (B)

- B. (A)
- C. (C)
- D. (D)

Answer: B

Solution:

Solution:

Graph A and B, both represents the titration curve between strong acid and strong base, i.e., H Cl and N aOH but, the pH of N aOH is more than 7 and during the titration it decreases, so graph (A) is correct.

Question132

What is the molar solubility of Al (OH)₃ in 0.2M N aOH solution ? Given that, solubility product of Al (OH)₃ = 2.4×10^{-24} : [April 12, 2019 (I)]

Options:

```
A. 3 \times 10^{-19}
B. 12 \times 10^{-21}
C. 3 \times 10^{-22}
```

D. 12×10^{-23}

Answer: C

Solution:

```
Solution:

Let the solubility of Al (OH)<sub>3</sub> in 0.2M N aOH solution be s.

Then,

Al (OH)<sub>3</sub> \rightleftharpoons Al<sup>3+</sup> + 3OH<sup>-</sup>

s and N aOH \rightleftharpoons N a<sup>+</sup> + OH<sup>-</sup>

0.2M 0.2M 0.2M 0.2M

[Al<sup>3+</sup>] = s and [OH<sup>-</sup>] = 3s + 0.2 \approx 0.2

K<sub>sp</sub> = 2.4 × 10<sup>-24</sup> = [Al<sup>3+</sup>][OH]<sup>3</sup>

2.4 × 10<sup>-24</sup> = s(0.2)<sup>3</sup>

s = \frac{2.4 \times 10^{-24}}{8 \times 10^3} = 3 × 10<sup>-22</sup>mol / L
```

Question133

The molar solubility of Cd (OH)₂ is 1.84×10^{-5} M in water. The expected solubility of Cd (OH)₂ in a buffer solution pH = 12 is: [April 12, 2019 (II)]

Options:

A. 1.84×10^{-9} M

B. $\frac{2.49}{1.84} \times 10^{-9}$ M

C. 6.23×10^{-11} M

D. 2.49×10^{-10} M

Answer: D

Solution:

```
Solution:

Cd (OH)<sub>2</sub> ≓ Cd<sup>2+</sup> + 2OH<sup>-</sup>

s <sup>2s</sup>

At equilibrium, K <sub>sp</sub> = s(2s)<sup>2</sup> = 4s<sup>3</sup>

⇒K <sub>sp</sub> = 4 × (1.84 × 10<sup>-5</sup>)<sup>-3</sup>

Solubility in buffer solution having pH = 12

[OH<sup>-</sup>] = 10<sup>-2</sup>

Cd (OH)<sub>2</sub> ≓ Cd<sup>2+</sup> + 2OH<sup>-</sup>

2s' + 10<sup>-2</sup> ≈ 10<sup>-2</sup>

∴K <sub>sp</sub> = 4 × (1.84 × 10<sup>-5</sup>)<sup>3</sup> = s'(10<sup>-2</sup>)<sup>2</sup>

⇒s' = \frac{24.9 × 10^{-15}}{10^{-4}} = 2.49 × 10^{-10}M
```

Question134

The pH of a 0.02M N H $_4$ Cl solution will be [given K $_b$ (N H $_4$ OH) = 10⁻⁵ and log 2 = 0.301] [April 10, 2019 (II)]

Options:

A. 2.65

B. 4.35

C. 4.65

D. 5.35

Answer: D

Solution:

 $pH = 7 - \frac{1}{2}pK_{b} - \frac{1}{2}\log C$ $= 7 - \frac{5}{2} - \frac{1}{2}(\log 2 \times 10^{-2}) = 5.35$ pH = 5.35

Question135

If solubility product of $Zr_3(PO_4)_4$ is denoted by K_{sp} and its molar solubility is denoted by S, then which of the following relation between S and K _{sn} is correct? [April 8, 2019 (I)]

Options:

A. S = $\left(\frac{K_{gp}}{144}\right)^{1/6}$ B. S = $\left(\frac{K_{sp}}{6912}\right)^{1/7}$ C. S = $\left(\frac{K_{\phi}}{929}\right)^{1/9}$ D. S = $\left(\frac{K_{sp}}{216}\right)^{1/7}$ **Answer: B**

Solution:

 $Z r_3(PO_4)_4 \rightleftharpoons 3Z r^{4+} + 3SO_4^{3-}$ $K_{sp} = [Z r^{4+}]^3 [PO_4^{3-}]^4 = (3S)^3 (4S)^4$ $K_{sp} = 6912S^7$ $S = \left(\frac{K_{sp}}{6912}\right)^{1/7}$

Question136

At a certain temperature in a 5L vessel, 2 moles of carbon monoxide and 3 moles of chlorine were allowed to reach equilibrium according to the reaction, CO + Cl₂ \neq COCl₂ At equilibrium, if one mole of CO is present then equilibrium constant (K_c) for the reaction is:

[Online April 15, 2018 (II)]

Options:

- A. 2.5
- B. 4
- C. 2
- D. 3

Answer: A

Solution:

Initially 2 moles of CO are present. At equilibrium, 1 mole of CO is present Hence, 2 - 1 = 1 moles of CO has reacted. I. mole of CO will react with 1 mole of Cl 2 to form 1 mole of COCl 2 $3 - 1 = 2 \text{ moles of Cl}_2 \text{ remains at equilibrium The equilibrium constant}$ $K_c = \frac{[COCl_2]}{[CO][Cl_2]} = \frac{\frac{1 \text{mol}}{5L}}{\frac{1 \text{mol}}{5L} \times \frac{2 \text{mol}}{5L}} = 2.5$

Question137

In which of the following reactions, an increase in the volume of the container will favour the formation of products? [Online April 15,2018(I)]

Options:

A. $4N H_3(g) + 5O_2(g) \rightleftharpoons 4N O(g) + 6H_2O(l)$

B. $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$

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

D. H₂(g) + I₂(g) \rightleftharpoons 2H I (g)

Answer: B

Solution:

Solution: Volume $\uparrow P \downarrow$, reaction proceeds in which direction where the number of moles of gases increases. $2N O_2(g) \rightleftharpoons 2N O(g) + O_2(g) \quad \Delta n_g = (2 + 1) - 2 = 1$

Question138

The gas phase reaction $2NO_2(g) \rightarrow N_2O_4(g)$ is an exothermic reaction. The decomposition of N_2O_4 , in equilibrium mixutre of $NO_2(g)$ and $N_2O_4(g)$, can be increased by: [Online April 16, 2018]

Options:

- A. addition of an inert gas at constant pressure
- B. lowering the temperature
- C. increasing the pressure
- D. addition of an inert gas at constant volume

Answer: C

Solution:

Solution:

Reaction at equilibrium $N \cap \rightarrow 2N \cap$

 $N_2O_4 \rightleftharpoons 2NO_2$ According to Le chatelier's principle-

(a) addition of an inert gas at constant pressure will increase volume and equilibirium shifts towards more number of molecules.

(b) Decomposition of N_2O_4 will be endothermic, so reaction will move in forward reaction when temperature is increased. So, It is incorrect. It will not effect reaction (volume is constant)

(c) Increasing the pressure on a gas reaction shifts the position of equilibirium towards the side with fewer molecules. So, it will move in backward direction which leads to formation of N $_2O_4$ from N O_2 .

Question139

Following four solutions are prepared by mixing different volumes of N aOH and H Cl of different concentrations, pH of which one of them will be equal to 1 ? [Online April 15, 2018 (II)]

Options:

A. $55mL \frac{M}{10}H Cl + 45mL \frac{M}{10}N aOH$ B. $75mL \frac{M}{5}H Cl + 25mL \frac{M}{5}N aOH$ C. $100mL \frac{M}{10}H Cl + 100mL \frac{M}{10}N aOH$

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

Answer: B

Solution:

Solution:

 $\begin{array}{l} 75 \mathrm{mL}\,\frac{\mathrm{M}}{5}\mathrm{H}\,\mathrm{Cl}\,+25 \mathrm{mL}\,\frac{\mathrm{M}}{5}\mathrm{N}\,\mathrm{aOH} \\ 25 \mathrm{mL}\,\frac{\mathrm{M}}{5}\mathrm{N}\,\mathrm{aOH} \,\,\mathrm{will}\,\,\mathrm{neutralise}\,\,25 \mathrm{mL}\,\frac{\mathrm{M}}{5}\mathrm{H}\,\mathrm{Cl} \\ 75-25=50 \mathrm{mL}\,\frac{\mathrm{M}}{5}\mathrm{H}\,\mathrm{Cl}\,\,\mathrm{will}\,\,\mathrm{remain}. \\ \mathrm{Total}\,\,\mathrm{volume}\,\,\mathrm{will}\,\,\mathrm{be}\,\,75+25=100 \mathrm{mL} \\ 50 \mathrm{mL}\,\frac{\mathrm{M}}{5}\mathrm{H}\,\mathrm{Cl}\,\,\mathrm{is}\,\,\mathrm{diluted}\,\,\mathrm{to}\,\,100 \mathrm{mL} \\ \mathrm{[H^{+}]}=[\mathrm{H}\,\mathrm{Cl}\,]=\,\frac{\mathrm{M}}{5}\times\frac{50}{100}=\,\frac{\mathrm{M}}{10} \\ \mathrm{pH}\,=-\mathrm{log}_{10}[\mathrm{H^{+}}]=-\mathrm{log}_{10}\,\frac{\mathrm{M}}{10}=1 \end{array}$

Question140

Which of the following is a Lewis acid? [Online April 15, 2018 (I)]

Options:

A. PH₃

B. N F $_3$

C. N aH

D. B(CH ₃)₃

Answer: D

Solution:



Question141

Which of the following salts is the most basic in aqueous solution? [2018]

Options:

A. Al (CN) $_{\rm 3}$

B. CH ₃COOK

C. F eCl $_3$

D. Pb(CH ₃COO)₂

Solution:

 $\begin{array}{l} {\rm CH}_{3}{\rm COOK} \mbox{ is a salt of weak acid (CH}_{3}{\rm COOH}\mbox{) and strong base (KOH).} \\ {\rm F}\mbox{ eCl}_{3}\mbox{ is a salt of weak base [Fe(OH)_{3}] and strong acid (HCl).} \\ {\rm Pb}({\rm CH}_{3}{\rm COO})_{2},\mbox{ is a salt of weak base Pb(OH)}_{2}\mbox{ and weak acid (CH}_{3}{\rm COOH}\mbox{) } \\ {\rm Al}\mbox{ (CN)}_{3}\mbox{ is a salt of weak base [Al (OH)_{3}] and weak acid (HCN).} \end{array}$

Question142

An aqueous solution contains 0.10M H $_2$ S and 0.20M HCl. If the equilibrium constants for the formation of HS from H $_2$ S is 1.0×10^{-7} and that of S²⁻ from H S -ions is 1.2 $\times 10^{-13}$ then the concentration of S²⁻ ions in aqueous solution is : [2018]

Options:

- A. 5×10^8 B. 3×10^{-20}
- C. 6×10^{-21}
- D. 5×10^{-19}

```
Answer: B
```

Solution:

```
H_{2}S \rightleftharpoons 2H^{+} + S_{?}^{2-}, K_{a_{1}} \cdot K_{a_{2}} = K_{eq}
\therefore \frac{[H^{+}]^{2}[s^{2-}]}{[H_{2}S]} = 1 \times 10^{-7} \times 1.2 \times 10^{-13}
\frac{[0.2]^{2}[s^{2-}]}{[0.1]} = 1.2 \times 10^{-20}
[S^{2}] = 3 \times 10^{-20}
```

Question143

An aqueous solution contains an unknown concentration of Ba^{2+} . When 50mL of a 1M solution of N a_2SO_4 is added, $BaSO_4$ just begins to precipitate. The final volume is 500 mL. The solubility product of $BaSO_4$ is 1×10^{-10} . What is the original concentration of Ba^{2+} ? [2018]

Options:

A. 5×10^{-9} M

B. 2×10^{-9} M

C. 1.1×10^{-9} M

D. 1.0×10^{-10} M

Answer: C

Solution:

Concentration of SO₄²⁻ in BaSO₄ solution M $_1V_1 = M_2V_2$ 1 × 50 = M $_2 \times 500$

```
\begin{split} M_{2} &= \frac{1}{10} \\ \text{For just precipitation} \\ \text{Ionic product} &= K_{\text{sp}} \\ [\text{Ba}^{2+}][\text{SO}_{4}^{2}] &= K_{\text{sp}}(\text{BaSO}_{4}) \\ [\text{Ba}^{2+}] &\times \frac{1}{10} = 10^{-10} \\ [\text{Ba}^{2+}] &= 10^{-9}\text{M} \text{ in 500mL solution} \\ \text{Thus [Ba}^{2+}] &= 10^{-9}\text{M in 500mL solution} \\ (500 - 50 = 450\text{mL}) \\ &\Rightarrow M_{1} \times 450 = 10^{-9} \times 500 \\ [\text{ where } M_{1} &= \text{ Molarity of original solution]} \\ M_{1} &= \frac{500}{450} \times 10^{-9} = 1.11 \times 10^{-9}\text{M} \end{split}
```

Question144

The minimum volume of water required to dissolve 0.1g lead (II) chloride to get a saturated solution (K_{sP} of PbCl₂ = 3.2×10^{-8} ; atomic mass of Pb = 207u) is: [Online April 15, 2018 (I)]

Options:

A. 1.798L

B. 0.36L

C. 17.95L

D. 0.18L

Answer: D

Solution:

```
(K_{sp})_{PbCl_{2}} = 3.2 \times 10^{-8} = 32 \times 10^{-9}
PbCl_{2} \rightleftharpoons Pb^{2+} + 2Cl
K_{sp} = [Pb^{2+}][Cl^{-}]^{s^{-}}
K_{sp} = 4s^{3} = 32 \times 10^{-9}
s^{3} = 8 \times 10^{-9}
s = 2 \times 10^{-3}M
\frac{W}{M \cdot W} \times \frac{1}{V_{L}} = 2 \times 10^{-3}
\frac{0.1}{278} \times \frac{1}{V_{L}} = 2 \times 10^{-3}
V_{L} = \frac{0.1 \times 1000}{278 \times 2} = 0.18L
```

Question145

The following reaction occurs in the Blast Furnace where iron ore is reduced to iron metal :

 $Fe_2O_3(s) + 3CO(g) \neq 2Fe(l) + 3CO_2(g)$

Using the Le Chatelier's principle, predict which one of the following will not disturb the equilibrium? [Online April 9, 2017]

Options:

A. Removal of CO

B. Removal of CO_2

C. Addition of CO_2

D. Addition of Fe_2O_3

Solution:

Perturbation	Shifts reaction towards
Removal of CO	Left
Removal of CO2	Right
Addition of CO ₂	Left
Addition of Fe_2O_3	No change (This is a solid compound. Its concentration has noeffect on the equilibrium.)

Question146

50mL of 0.2M ammonia solution is treated with 25mL of 0.2M H Cl . If pK_b of ammonia solution is 4.75, the pH of the mixture will be: [Online April 9, 2017]

Options:

A. 3.75

B. 4.75

C. 8.25

D. 9.25

Answer: D

Solution:

N H₃ + H Cl → N H₄Cl moles of H Cl = 0.2M × 25 × 10⁻³L = 0.005 moles HCl (total consumed) moles of N H₃ = 0.2M × 50 × 10⁻³L = 0.01mol esH Cl excess N H₃ = 0.01 - 0.005 = 0.005mol es 1 mole ammonia = 1mol eN H₄Cl 0.005N H₃ = 0.005N H₄Cl Total volume = V_{HCl} + V_{NH₃} = 25 + 50 = 75mL [N H₃] = [N H₄Cl] = $\frac{0.005mol e}{75 × 10^{-3}L}$ = 0.066M pOH = pK_b + log $\frac{[N H_4 Cl]}{[N H_3]}$ pOH = 4.75 + log $\frac{[0.066]}{[0.066]}$ pOH = 4.75 pH = 14 - pOH ⇒ pH = 9.25

Question147

 pK_a of a weak acid (HA) and pK_b of a weak base (BOH) are 3.2 and 3.4, respectively. The pH of their salt (AB) solution is $\cite{2017}\c$

Options:

A. 7.2

- B. 6.9
- C. 7.0
- D. 1.0

Answer: B

Solution:

The salt (AB) given is a salt of weak acid and weak base. Hence the pH can be calculated by the following formula $\therefore pH = 7 + \frac{1}{2}pK_{a} - \frac{1}{2}pK_{b}$ $= 7 + \frac{1}{2}(3.2) - \frac{1}{2}(3.4) = 6.9$

Question148

Addition of sodium hydroxide solution to a weak acid (HA) results in a buffer of pH.. If ionisation constant of HA is 10^{-5} , the ratio of salt to acid concentration in the buffer solution will be: [Online April 8, 2017]

Options:

A. 4 : 5

B. 1 : 10

C. 10 : 1

D. 5 : 4

Answer: C

Solution:

$$\begin{split} HA &\rightleftharpoons H^{+} + A^{-} \\ (Unionized, weak acid and common ion effect) \\ HA + N aOH &\longrightarrow N aA + H_{2}O \\ N aA &\longrightarrow N a^{+} + A^{-} (ionized) \\ K_{a} &= \frac{[H^{+}][A^{-}]}{[HA]} \\ \text{Given, pH} &= 6, [H^{+}] = 1 \times 10^{-6} \\ [H^{+}] &= \frac{K_{a}[\text{ Acid }]}{[\text{ Salt }]} \\ \frac{[\text{ Salt }]}{[\text{ Acid }]} &= \frac{K_{a}}{[H^{+}]} = \frac{10^{-5}}{10^{-6}} = 10:1 \end{split}$$

Question149

The equilibrium constant at 298K for a reaction $A + B \rightleftharpoons C + D$ is 100. If the initial concentration of all the four species were 1 M each, then equilibrium concentration of D (in mol L⁻¹) will be:

[2016]

Options:

A. 1.818

B. 1.182

C. 0.182

D. 0.818

Answer: A
Solution:

```
Given, A + B \rightleftharpoons C + D

No of moles initially 1 \qquad 1 \qquad 1 \qquad 1

At eqm. 1 - x \qquad 1 - x \qquad 1 + x \qquad 1 + x

Given, A + B \rightleftharpoons C + D

K_c = \left(\frac{1+a}{1-a}\right)^2 = 100; \quad \frac{1+a}{1-a} = 10

On solving; a = 0.81

[D]_{At_{og}} = 1 + a = 1 + 0.81 = 1.81
```

Question150

A solid XY kept in an evacuated sealed container undergoes decomposition to form a mixture of gases X and Y at temperature T. The equilibrium pressure is 10 bar in the vessel. K_p for this reaction is:

[Online April 10,2016]

Options:

A. 25

B. 100

C. 10

D. 5

Answer: A

Solution:

 $\begin{array}{l} X \: Y \: (s) \rightleftharpoons X \: (g) + Y \: (g) \\ & p \\ \text{At eqm.} \\ \text{Total pressure } = 2p = 10 \text{ bar } \because p = 5; \\ \text{Now } \: K_p = (p_x)(p_y) = p^2 = 25. \end{array}$

Question151

The plot shows the variation of $-\ln K_p$ versus temperature for the two reactions. M(s) + $\frac{1}{2}O_2(g) \rightarrow MO(s)$ and



Identify the correct statement: [Online April 9,2016]

Options:

A. At T $\,$ < 1200K , oxidation of carbon is unfavourable.

B. Oxidation of carbon is favourable at all temperatures.

C. At T $\,<\,1200K$, the reaction M O(s) + C(s) \rightarrow M (s) + CO(g) is spontaneous.

D. At T > 1200K, carbon will reduce MO(s) to M(s).

Answer: C

Solution:



At T<1200K , carbon will reduce M O(s) to M (s) hence, chemical reaction M $O(s)+C(s)\longrightarrow M$ (s)+CO(g) is spontaneous.

Question152

For the reaction,

A(g) + B(g) → C(g) + D(g), ΔH° and ΔS° are, respectively, -29.8kJ mol⁻¹ and -0.100kJ K⁻¹mol⁻¹ at 298K. The equilibrium constant for the reaction at 298K is : [Online April 9, 2016]

Options:

```
A. 1.0 \times 10^{-10}
```

B. 10

C. 1

D. 1.0×10^{10}

Answer: C

Solution:

```
Given \Delta H^{\circ} = -29.8 \text{kJ mol}^{-1}

\Delta S^{\circ} = -1.00 \text{kJ K}^{-1}

From the equation

\Delta G^{\circ} = \Delta H^{\circ} - T \Delta S^{\circ} = -29.8 - (298 \times -0.100)

= -29.8 + 29.8 = 0

Now, \Delta G^{\circ} = -2.303 \text{RT} \log K_{eq}

0 = -2.303 \text{RT} \log K_{eq}

\therefore K_{eq} = 1.
```

Question153

Gaseous N $_2O_4$ dissociates into gaseous N O_2 according to the reaction [N $_2O_4(g) \neq 2N O_2(g)$]

At 300K and 1 atm pressure, the degree of dissociation of N $_2O_4$ is 0.2. If one mole of N $_2O_4$ gas is contained in a vessel, then the density of the equilibrium mixture is : [Online April 10, 2015]

Options:

A. 1.56g / L

B. 6.22g / L

C. 3.11gL

D. 4.56g / L

Answer: C

Solution:

 $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ 1 t = 00 t = eqm $1 - \alpha$ 20 $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ Where α = degree of dissociation. : Mol. wt. of mixture $(1 - \alpha) \times M_{N_2O_4} + 2\alpha \times M_{NO_2}$ $= \frac{1}{(1-\alpha+2\alpha)}$ $= \frac{(1-0.2)92 + 2 \times 0.2 \times 46}{76.66} = 76.66$ (1 + 0.2)Now, as per ideal gas equation, PV = nRT $PM_{mix} = d RT$ $\therefore d = \frac{PM_{mix}}{RT} = \frac{1 \times 76.66}{0.0821 \times 300} = 3.11g / L$

Question154

The standard Gibbs energy change at 300K for the reaction $2A \Rightarrow B + C$ is 2494.2J. At a given time, the composition of the reaction mixture is $[A] = \frac{1}{2}$, [B] = 2 and $[C] = \frac{1}{2}$. The reaction proceeds in the : [R = 8.314J / K / mol, e = 2.718] [2015]

Options:

A. forward direction because $Q < K_{c}$

B. reverse direction because $Q < K_c$

C. forward direction because $Q > K_c$

D. reverse direction because $Q > K_c$

Answer: D

Solution:

$$\begin{split} &\Delta G^{\circ} = 2494.2J \\ &2A \rightleftharpoons B + C. \\ &[A] = \frac{1}{2}, [B] = 2, [C] = \frac{1}{2} \\ &Q = \frac{[B][C]}{[A]^2} = \frac{2 \times 1/2}{\left(\frac{1}{2}\right)^2} = 4 \\ &\Delta G^{\circ} = -2.303 \text{RT} \log \text{K}_c \\ &2494.2J = -2.303 \times (8.314\text{J} / \text{K} / \text{mol}) \times (300\text{K}) \log \text{K}_c \\ &\Rightarrow \log \text{K}_c = -\frac{2494.2\text{J}}{2.303 \times 8.314\text{J} / \text{K} / \text{mol} \times 300\text{K}} \\ &\Rightarrow \log \text{K}_c = -0.4341; \text{K}_c = 0.37; \text{Q} > \text{K}_c \end{split}$$

Question155

The following reaction is performed at 298K . 2N O(g) + O₂(g) \rightleftharpoons 2N O₂(g)

The standard free energy of formation of N O(g) is 86.6 KJ / mol at 298K. What is the standard free energy of formation of N O₂(g) at 298K?(K $_p = 1.6 \times 10^{12}$) [2015]

Options:

A. $86600 - \frac{\ln(1.6 \times 10^{12})}{R(298)}$ B. $0.5[2 \times 86, 600 - R(298)\ln(1.6 \times 10^{12})]$ C. $R(298)\ln(1.6 \times 10^{12}) - 86600$ D. $86600 + R(298)\ln(1.6 \times 10^{12})$ Answer: B

Solution:

 $\Delta G_{rex^{n}}^{\circ} = 2 \Delta G_{f}^{\circ}(N O_{2}) - 2 \Delta G_{f}^{\circ}(N O) - \Delta G_{f}^{\circ}(O_{2})$ $2 \Delta G_{f}^{\circ}(N O_{2}) = \Delta G_{rex^{n}}^{\circ} + 2 \Delta G_{f}^{\circ}(N O) + \Delta G_{f}^{\circ}(O_{2})$ $\therefore \Delta G = \Delta G^{\circ} + RT \ln K_{p}$ At equilibrium, $\Delta G = 0, Q = K_{p}; \Delta G^{\circ} = -R \ln K_{p}$ $\Delta G_{j}^{\circ}(O_{2}) = 0$ $\therefore \Delta G_{f}^{\circ}(N O_{2}) = \frac{1}{2} [2 \times 86600 - R(298) \ln(1.6 \times 10^{12})]$

Question156

The increase of pressure on ice ≠ water system at constant temperature will lead to [Online April 11, 2015]

Options:

A. a decrease in the entropy of the system

- B. an increase in the Gibb's energy of the system
- C. no effect on the equilibrium
- D. a shift of the equilibrium in the forward direction

Answer: D

Solution:

Solution:

Volume of ice is greater than that of water. The direction in which the reaction will proceed can be predicted by applying Le-Chatelier's principle Pressure $\propto \frac{1}{\text{Volume}}$

So equilibrium, will shift forward.

Question157

For the reaction $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$, if $K_p = K_c(RT)^x$ where the symbols have usual meaning then the value of x is (assuming ideality): [2014]

Options:

A. -1B. $-\frac{1}{2}$ C. $\frac{1}{2}$ D. 1

Answer: B

```
\begin{split} &\mathrm{SO}_2(g) + \frac{1}{2}\mathrm{O}_2(g) \rightleftharpoons \mathrm{SO}_3(g) \\ &\mathrm{K}_\mathrm{p} = \mathrm{K}_\mathrm{c}(\mathrm{RT})^{\mathrm{X}} \\ &\mathrm{where} \ \mathrm{x} = \Delta \mathrm{n}_\mathrm{g} = \ \mathrm{number} \ \mathrm{of} \ \mathrm{gaseous} \ \mathrm{moles} \ \mathrm{in} \ \mathrm{product} - \ \mathrm{number} \ \mathrm{of} \ \mathrm{gaseous} \ \mathrm{moles} \ \mathrm{in} \ \mathrm{reactants} \\ &= 1 - \left(1 + \frac{1}{2}\right) = 1 - \frac{3}{2} = -\frac{1}{2} \end{split}
```

At a certain temperature, only 50%H I is dissociated into H $_2$ and I $_2$ at equilibrium. The equilibrium constant is: [Online April 9, 2014]

Options:

A. 1.0

B. 3.0

C. 0.5

D. 0.25

Answer: D

Solution:

 $2HI \rightleftharpoons H_2 + I_2$ At t = 0 c 0 0At eqm. $c - c\alpha$ $\frac{c\alpha}{2}$ $\frac{c\alpha}{2}$ $2H I \rightleftharpoons H_2 + I_2$ At eqm. $c - c\alpha$ $\frac{c\alpha}{2} \frac{c\alpha}{2}$ Now, $K_c = \frac{\left(\frac{c\alpha}{2}\right) \left(\frac{c\alpha}{2}\right)}{(c - c\alpha)^2}$ $K_c = \frac{\alpha}{4(1 - \alpha)^2}; K_c = \frac{0.5}{4(1 - 0.5)^2}$ $K_0 = 0.25$

Question159

For the decomposition of the compound, represented as $N H_2COON H_4(s) \rightleftharpoons 2N H_3(g) + CO_2(g)$ the $K_p = 2.9 \times 10^{-5} atm^3$. If the reaction is started with 1mol of the compound, the total pressure at equilibrium would be: [Online April 19, 2014]

Options:

A. 1.94×10^{-2} atm

B. 5.82×10^{-2} atm

C. 7.66 × 10^{-2} atm

D. 38.8×10^{-2} atm

Answer: B

Solution:

 $\text{NH}_{2}\text{COONH}_{4}(s) \rightleftharpoons 2\text{NH}_{3}(g) + \text{CO}_{2}(g)$

$$\begin{split} & K_{p} = \frac{\left(P_{NH_{3}}\right)^{2} \times \left(P_{Co_{2}}\right)}{P_{NH_{2}COONH_{4}}(s)} = \left(P_{NH_{3}}\right)^{2} \times \left(P_{CO_{2}}\right) \\ & \text{As evident by the reaction, N H}_{3} \text{ and CO}_{2} \text{ are formed in molar ratio of } 2:1. \\ & \text{Thus if P is the total pressure of the system at equilibrium, then} \\ & p_{NH_{3}} = \frac{2}{3} \times p \ p_{CO_{2}} = \frac{1}{3} \times P \\ & K_{p} = \left(\frac{2P}{3}\right)^{2} \times \frac{P}{3} = \frac{4P^{3}}{27} \\ & \text{Given, } K_{p} = 2.9 \times 10^{-5} \\ & \therefore 2.9 \times 10^{-5} = \frac{4P^{3}}{27} \\ & P^{3} = \frac{2.9 \times 10^{-5} \times 27}{4} \\ & P = \left(\frac{2.9 \times 10^{-5} \times 27}{4}\right)^{1/3} = 5.82 \times 10^{-2} \text{atm} \end{split}$$

Question160

What happens when an inert gas is added to an equilibrium keeping volume unchanged? [Online April 12, 2014]

Options:

A. More product will form

B. Less product will form

C. More reactant will form

D. Equilibrium will remain unchanged

Answer: D

Solution:

Solution:

On adding inert gas at constant volume the total pressure of the system is increased, but the partial pressure of each reactant and product remains the same. Hence no effect on the state of equilibrium.

Question161

The conjugate base of hydrazoic acid is: [Online April 12, 2014]

Options:

A. N $^{-3}$

B. N₃⁻

C. N $_2$

D. HN_3^{-}

Answer: B

Solution:

 $\begin{array}{ll} N_{3}H & \rightleftharpoons N_{3}^{-} + H^{+} \\ & & \\ & & \\ \text{Hydrazoic acid} \end{array} \\ \text{i.e, conjugate base of hydrazoic acid is N}_{3}. \end{array}$

Question162

Assuming that the degree of hydrolysis is small, the pH of 0.1M solution of sodium

acetate (K_a = 1.0×10^{-5}) will be: [Online April 11, 2014]

Options:

- A. 5.0
- B. 6.0
- C. 8.0
- D. 9.0

Answer: D

Solution:

Sodium acetate is a salt of strong base and weak acid. $\therefore pH = 7 + \frac{1}{2}pK_a + \frac{1}{2}\log c \text{ where } pK_a = -\log K_a$ $= 7 + \frac{5}{2} - \frac{1}{2}$ = 9.0 $= -\log 10^{-5} = 5$ $\log c = \log 10^{-1} = -1$

Question163

In some solutions, the concentration of H_3O^+ remains constant even when small amounts of strong acid or strong base are added to them. These solutions are known as:

[Online April 11, 2014]

Options:

A. Ideal solutions

B. Colloidal solutions

C. True solutions

D. Buffer solutions

Answer: D

Solution:

Solution:

Solutions which resist the change in the value of pH when small amount of acid or base is added to them are known as buffers.

Question164

Consider the following equilibrium AgCl $\downarrow +2NH_3 \rightleftharpoons [Ag(NH_3)_2]^+ + Cl^-$ White precipitate of AgCl appears on adding which of the following? [Online April 11,2014]

Options:

A. N H $_{\rm 3}$

B. aqueous N aCl

C. aqueous H N O₃

D. aqueous N H $_4$ Cl

Solution:

 $2H N O_3(aq) + [Ag(N H_3)_2]^+ + Cl^- \rightarrow AgCl(s) \downarrow + 2N H_4 + 2N O_3^-$ When nitric acid is added to amine solution, solution is made acidic and the complex ion dissociates and liberate silver ion to recombine with chloride ion. This is the conformatory test for silver in group 1.

Question165

Zirconium phosphate $[Zr_3(PO_4)_4]$ dissociates into three zirconium cations of charge +4 and four phosphate anions of charge -3. If molar solubility of zirconium phosphate is denoted by S and its solubility product by K_{sp} then which of the following relationship between S and K_{sp} is correct? [Online April 19,2014]

Options:

```
A. S = {K_{sp} / (6912)^{1/7}}
B. S = {K_{sp} / 144}<sup>1/7</sup>
C. S = {K_{sp} / 6912}<sup>1/7</sup>
D. S = {K_{sp} / 6912}<sup>7</sup>
Answer: C
```

Solution:

```
[Z r_{3}(PO_{4})_{4}] \rightleftharpoons 3Z r^{4+} + 4PO_{4}^{3-}

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

= 27s^{3} \times 256s^{4}

= 6912s^{7}

\therefore s = \left(\frac{K_{sp}}{6912}\right)^{1/7}
```

Question166

In reaction $A + 2B \rightleftharpoons 2C + D$, initial concentration of B was 1.5 times of [A], but at equilibrium the concentrations of A and B became equal. The equilibrium constant for the reaction is : [Online April 9, 2013]

- .

Options:

- A. 8
- B. 4

C. 12

D. 6

Answer: B

Solution:

 $A + 2B \rightleftharpoons 2C + D$ $At t = 0 \quad a \quad 1.5a \quad 0 \quad 0$ $At eqns. \quad (a-x) \quad (1.5a-2x) \quad 2x \quad x$

```
Hence, K_c = \frac{(2x)^2 \times x}{(a-x)(1.5a-2x)^2}

Given, at equilibrium

\therefore (a-x) = (1.5a-2x)

\therefore a = 2x

On solving K_c = 4
```

Question167

(1) $N_2(g) + 3H_2(g) \neq 2NH_3(g), K_1$ (2) $N_2(g) + O_2(g) \neq 2NO(g), K_2$ (3) $H_2(g) + \frac{1}{2}O_2(g) \neq H_2O(g), K_3$ The equation for the equilibrium constant of the reaction $2NH_3(g) + \frac{5}{2}O_2(g) \neq 2NO(g) + 3H_2O(g), (K_4)$ in ter of K_1, K_2 and K_3 is : [Online April 23, 2013]

Options:

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

C. $K_1 K_2 K_3$

D.
$$\frac{K_2 \cdot K_3}{K_1}$$

Answer: D

Solution:

Solution: To calculate the value of K₄ in the given equation we should apply: eqn. (2) +cqn. (3) × 3 -eqn. (1) hence $K_4 = \frac{K_2 K_3^{-3}}{K_1}$

Question168

The ratio $\frac{K_p}{K_c}$ for the reaction is: [Online April 25, 2013]

Options:

A. $\frac{1}{\sqrt{\text{RT}}}$

B. (RT)^{1 / 2}

C. RT

D. 1

Answer: A

Solution:

$$\begin{split} & \mathrm{K}_{\mathrm{p}} = \mathrm{K}_{\mathrm{c}} (\mathrm{RT})^{\Delta \mathrm{n}_{\mathrm{g}}} \\ & \text{For the reaction} \\ & \mathrm{CO}(\mathrm{g}) + \frac{1}{2} \mathrm{O}_{2}(\mathrm{g}) \rightleftharpoons \mathrm{CO}_{2}(\mathrm{g}) \\ & \Delta \mathrm{n}_{\mathrm{g}} = 1 - \left(1 + \frac{1}{2}\right) = -\frac{1}{2} \end{split}$$

 $\therefore K_{p} = \frac{K_{c}}{\sqrt{RT}}; \quad \frac{K_{p}}{K_{c}} = \frac{I}{\sqrt{RT}}$

How many litres of water must be added to 1 litre an aqueous solution of H Cl with a pH of 1 to create an aqueous solution with pH of 2 ? [2013]

Options:

A. 0.1L

B. 0.9L

C. 2.0L

D. 9.0L

Answer: D

Solution:

```
\begin{array}{l} \because pH = 1; H^{+} = 10^{-1} = 0.1M \\ pH = 2; H^{+} = 10^{-2} = 0.01M \\ \therefore M_{1} = 0.1 \ V_{1} = 1 \\ M_{2} = 0.01, V_{2} = ? \\ From \\ M_{1}V_{1} = M_{2}V_{2} \\ 0.1 \times 1 = 0.01 \times V_{2} \\ V_{2} = 10L \\ \therefore \text{ Volume of water added } = 10 - 1 = 9L \end{array}
```

Question170

N aOH is a strong base. What will be pH of 5.0×10^{-2} M N aOH solution ? (log 2 = 0.3) [Online April 22, 2013]

Options:

A. 14.00

B. 13.70

C. 13.00

D. 12.70

Answer: D

Solution:

Given $[OH^{-}] = 5 \times 10^{-2}$ $\therefore pOH = -\log 5 \times 10^{-2}$ $= -\log 5 + 2\log 10 = 1.30$ $\therefore pH + pOH = 14$ $\therefore pH = 14 - pOH$ = 14 - 1.30 = 12.70

Question171

Equimolar solutions of the following compounds are prepared separately in water. Which will have the lowest pH value? [Online April 23, 2013]

Options:

- A. BeCl₂
- B. SrCl₂
- C. CaCl $_{\rm 2}$
- D. M gCl₂

Answer: A

Solution:

Metal halide on hydrolysis with water form corresponding hydroxides. The basic strength of hydroxide increases as we move down in a group. This is because of the increase in size which results in decrease of ionization energy which weakens the strength of M - O bonds in M OH and thus increases the basic strength. Be(OH)₂ $M g(OH)_2$ Amphoteric Weakbase Ca(OH)₂ Sr(OH)₂Ba(OH)₂ Strong base Hence, Be(OH)₂ will have lowest pH.

Question172

What is the pH of a $10^{-4} M \, OH^-$ solution at 330K , if K_w at 330K is $10^{-13.6} ?$ [Online April 23, 2013]

Options:

A. 4

- B. 9.0
- C. 10
- D. 9.6

Answer: D

Solution:

```
Given at 330K

K_w = 10^{-13.6}

i.e. pK_w = pH + pOH

\because pOH = -log[OH^{-}]

13.6 = pH + pOH

pOH = -log 10^{-4}

pOH = 4

\therefore pH = 13.6 - 4

= 9.6
```

Question173

Which one of the following arrangements represents the correct order of the proton affinity of the given species: [Online April 25, 2013]

```
Options:
```

```
A. I^{-} < F^{-} < H S^{-} < N H_{2}^{-}
B. H S^{-} < N H_{2}^{-} < F^{-} < I^{-}
C. F^{-} < I^{-} < N H_{2}^{-} < H S
D. N H_{2}^{-} < H S^{-} < I^{-} < F^{-}
```

Solution:

The species with the greatest proton affinity will be the strongest base, and its conjugate acid will be the weakest acid. The weakest acid will have the smallest value of K $_{a^*}$ Since H I is a stronger acid than H F which is a stronger acid than H $_2$ S, a partial order of proton affinity is I⁻ < F⁻ < H S⁻

Since N H $_3$ is a very weak acid, N H $_2^-$ must be a very strong base. Therefore the correct order of proton affinity is I $^-$ < F $^-$ < H S $^-$ < N H $_2^-$

Question174

Values of dissociation constant, K₀ are given as follows:

Acid	K _a
HCN	6.2×10^{-10}
HF	$7.2 imes 10^{-4}$
HNO ₂	4.0×10^{-4}

Correct order of increasing base strength of the base CN - F and NO_2 will be: [Online April 22, 2013]

Options:

- A. F < CN⁻ < NO₂⁻
- B. $NO_2^- < CN^- < F^-$
- C. F < N O_2^- < CN $^-$

D. $NO_{2}^{-} < F^{-} < CN^{-}$

Answer: C

Solution:

Higher the value of K_a lower will be the value of pK_a i.e. higher will be the acidic nature. Further since CN^- , F^- and NO_2^- are conjugate base of the acids HCN, HF and HNO_2 respectively hence the correct order of base strength will be

 $F^- < NO_2^- < CN$

(\because stronger the acid weaker will be its conjugate base)

Question175

What would be the pH of a solution obtained by mixing 5g of acetic acid and 7.5g of sodium acetate and making the volume equal to 500mL? ($K_a = 1.75 \times 10^{-5}$, p $K_a = 4.76$)

[Online April 25, 2013]

Options:

A. pH = 4.70

B. pH < 4.70

C. pH of solution will be equal to pH of acetic acid

D. 4.76 < pH < 5.0

Answer: D

```
Concentration of CH <sub>3</sub>COOH is computed as under.

conc. = 5g in 500mL

= 10g / L [ Mol. wt. of CH <sub>3</sub>COOH = 60

[CH <sub>3</sub>COOH] = \frac{10}{60}M; \frac{1}{6}M

concentration of CH <sub>3</sub>COON a is computed as under.

conc. = 7.5g in 500mL

= 15g / L

[CH <sub>3</sub>COOH] = \frac{15}{18}M

pK <sub>a</sub> = -\log K_a

= \log(1.8 \times 10 - 5) = 4.7447

pH = pK <sub>a</sub> + \log \frac{[sal t]}{[acid]}

= 4.744 \log \frac{15/82}{1/6}

= 4.7447 + \log 1.097

= 4.7447 + 0.0402

= 4.78
```

Question176

Solid Ba(N O₃)₂ is gradually dissolved in a 1.0×10^{-4} M N a₂CO₃ solution. At which concentration of Ba²⁺, precipitate of BaCO₃ begins to form ?(K_{sp} for BaCO₃ = 5.1×10^{-9}) [Online April 9, 2013]

Options:

A. 5.1×10^{-5} M B. 7.1×10^{-8} M C. 4.1×10^{-5} M

D. 8.1 × 10^{-7} M

Answer: A

Solution:

Conc. of N $a_2CO_3 = 1.0 \times 10^{-4}M$ $\therefore [CO_3^2] = 1.0 \times 10^{-4}M$ i.e. $s = 1.0 \times 10^{-4}M$ At equilibrium $[Ba^{2^+}][CO_3^{2^-}] = K_{sp} \text{ of } BaCO_3$ $[Ba^{2^+}] = \frac{K_{sp}}{[CO_3^{2^-}]} = \frac{5.1 \times 10^{-9}}{1.0 \times 10^{-4}}$ $= 5.1 \times 10^{-5}M$

Question177

Which one of the following arrangements represents the correct order of solubilities of sparingly soluble salts H g_2 Cl $_2$, Cr $_2$ (SO $_4$) $_3$, BaSO $_4$ and CrCl $_3$ respectively? [Online April 22, 2013]

Options:

A. $BaSO_4 > Hg_2Cl_2 > Cr_2(SO_4)_3 > CrCl_3$

B. $BaSO_4 > Hg_2Cl_2 > CrCl_3 > Cr_2(SO_4)_3$

C. BaSO₄ > CrCl ₃ > H g₂Cl ₂ > Cr₂(SO₄)₃

D. H g_2 Cl $_2$ > BaSO $_4$ > CrCl $_3$ > Cr $_2$ (SO $_4$) $_3$

Answer: B

Solution:

```
\begin{array}{l} {\rm Cr}_2({\rm SO}_4)_3 \Longrightarrow 2{\rm Cr}^{3+} + 3{\rm SO}_4^{\ 2-} \\ {\rm K}_{\rm sp} = (2{\rm s})^2(3{\rm s})^3 = 4{\rm s}^2 \times 27{\rm s}^3 = 108{\rm s}^5 \\ {\rm s} = \left( {\begin{array}{*{20}c} {{\rm K}_{\rm sp}} \\ 108 \end{array}} \right)^{1/5} \\ {\rm H} \, {\rm g}_2{\rm Cl}_2 \rightleftharpoons 2{\rm H} \, {\rm g}^{2+} + 2{\rm Cl} \\ {\rm Zs}^- \\ {\rm K}_{\rm sp} = (2{\rm s})^2 \times (2{\rm s})^2 = 16{\rm s}^4 \\ {\rm s} = \left( {\begin{array}{*{20}c} {{\rm K}_{\rm sp}} \\ 108 \end{array}} \right)^{1/4} \\ {\rm BaSO}_4 \rightleftharpoons {\rm Ba}^{2+} + {\rm SO}_4^{\ 2-} \\ {\rm s}^- {\rm s}^- {\rm s}^- {\rm s}^- \\ {\rm s}^- {\rm s}^- {\rm s}^- {\rm s}^- \\ {\rm S} = \sqrt{{\rm K}_{\rm sp}} \\ {\rm CrCl}_3 \Longrightarrow {\rm Cr}^{3+} + 3{\rm CI}^- \\ {\rm K}_{\rm sp} = {\rm s} \times (3{\rm s})^3 = 27{\rm s}^4 \\ {\rm s} = \left( {\begin{array}{*{20}c} {{\rm K}_{\rm sp}} \\ 27 \end{array}} \right)^{1/4} \\ {\rm Hence the correct order of solubilities of salts is} \\ \sqrt{{\rm K}_{\rm sp}} > \left( {\begin{array}{*{20}c} {{\rm K}_{\rm sp}} \\ 108 \end{array}} \right)^{1/4} > \left( {\begin{array}{*{20}c} {{\rm K}_{\rm sp}} \\ 27 \end{array}} \right)^{1/4} > \left( {\begin{array}{*{20}c} {{\rm K}_{\rm sp}} \\ 108 \end{array}} \right)^{1/5} \end{array} \right)^{1/5} \end{array}
```

Question178

K₁, K₂ and K₃ are the equilibrium constants of the following reactions (I), (II) and (III) respectively: (I) N₂ + 2O₂ \rightleftharpoons 2N O₂ (II) 2N O₂ \rightleftharpoons N₂ + 2O₂ (III) N O₂ \rightleftharpoons $\frac{1}{2}$ N₂ + O₂ The correct relation from the following is

[Online May 7, 2012]

Options:

A.
$$K_1 = \frac{1}{K_2} = \frac{1}{K_3}$$

B. $K_1 = \frac{1}{K_2} = \frac{1}{(K_3)^2}$
C. $K_1 = \sqrt{K_2} = K_3$
D. $K_1 = \frac{1}{K_2} = K_3$

Answer: B

(I)
$$N_{2} + 2O_{2} \rightleftharpoons 2N O_{2}$$

 $K_{1} = \frac{[N O_{2}]^{2}}{[N_{2}][O_{2}]^{2}} \dots$ (i)
(II) $2N O_{2} \rightleftharpoons N_{2} + 2O_{2}$
 $K_{2} = \frac{[N_{2}][O_{2}]^{2}}{[N O_{2}]^{2}} \dots$ (ii)
(III) $N O_{2}$ eftarrows $\frac{1}{2}N_{2} + O_{2}$
 $K_{3} = \frac{[N_{2}]^{1/2}[O_{2}]}{[N O_{2}]}$
 $\therefore (K_{3})^{2} = \frac{[N_{2}][O_{2}]^{2}}{[N O_{2}]^{2}} \dots$ (iii)
 \therefore From equation (i), (ii) and (iii)
 $K_{1} = \frac{1}{K_{2}} = \frac{1}{(K_{3})^{2}}$

8 mol of $AB_3(g)$ are introduced into a 1.0d m³ vessel. If it dissociates as 2AB₃(g) \Rightarrow A₂(g) + 3B₂(g). At equilibrium, 2 mol of A₂ are found to be present. The equilibrium constant of this reaction is [Online May 12, 2012]

Options:

A. 2

B. 3

C. 27

D. 36

Answer: C

Solution:

 $2AB_{3}(g) \xrightarrow{} A_{2}(g) + 3B_{2}(g)$ at t = 0 8 0 0 at eqm. $(8 - 2 \times 2)$ 2 3×2 -4 2 6 molar cones. 4/V 2/V 6/V $2AB_{3}(g) \Rightarrow A_{2}(g) + 3B_{2}(g)$ now $K_{c} = \frac{[A_{2}][B_{2}]^{3}}{[AB_{3}]^{2}} = \frac{2/1 \times [6/1]^{3}}{[4/1]^{2}} = 27$

Question180

The value of K $_p$ for the equilibrium reaction N $_2O_4(g) \rightleftharpoons 2NO_2(g)$ is 2 . The percentage dissociation of N $_2O_4(g)$ at a pressure of 0.5 atm is [Online May 19, 2012]

Options:

A. 25

B. 88

C. 50

D. 71

Answer: D

Solution:

 $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ Initial moles 1 0 Moles at eqm. (1 - α) 2 α (α = degree of dissociation)

Total number of moles at eqm. = $(1 - \alpha) + 2\alpha$ = $(1 + \alpha)$ $p_{N_2O_4} = \frac{(1 - \alpha)}{a(1 + \alpha)} \times P$ $p_{NO_2} = \frac{2\alpha}{a(1 + \alpha)} \times P$

```
\begin{split} K_{p} &= \frac{\left(P_{N O_{2}}\right)^{2}}{P_{N_{2} O_{4}}} = \frac{\left(\frac{2\alpha}{(1+\alpha)} \times P\right)^{2}}{\left(\frac{1-\alpha}{1+\alpha}\right) \times P} \\ K_{p} &= \frac{4\alpha^{2}P}{\frac{(1+\alpha)^{2}(1-\alpha)}{1+\alpha}}; K_{p} = \frac{4\alpha^{2}P}{(1+\alpha)(1-\alpha)}; = \frac{4\alpha^{2}P}{1-\alpha^{2}} \\ \text{Given, } K_{p} &= 2, P = 0.5 \text{atm} \\ \therefore K_{p} &= \frac{4\alpha^{2}P}{1-\alpha^{2}}; 2 = \frac{4\alpha^{2} \times 0.5}{1-\alpha^{2}} \\ \alpha &= 0.707 \approx 0.71 \\ \therefore \text{ Percentage dissociation} \\ &= 0.71 \times 100 = 71 \end{split}
```

One mole of O₂(g) and two moles of SO₂(g) were heated in a closed vessel of one-litre capacity at 1098K. At equilibrium 1.6 moles of SO₃(g) were found. The equilibrium constant K_c of the reaction would be

[Online May 26, 2012]

Options:

A. 30

B. 40

C. 80

D. 60

Answer: C

Solution:

 $O_{2} + 2SO_{2} \implies 2SO_{3}$ At t = 0At eqm. $(1 - \alpha)$ $2(1 - \alpha)$ 2α Given at equilibrium, $2\alpha = 1.6$ $\alpha = 0.8$ $K_{c} = \frac{(2\alpha)^{2}}{(1 - \alpha)(2 - 2\alpha)^{2}} = \frac{(0.8)^{2}}{(1 - 0.8)(1 - 0.8)^{2}} = \frac{0.64}{0.002}$ $K_{c} = 80$

Question182

The pH of a 0.1 molar solution of the acid H Q is 3. The value of the ionization constant, $\rm K_a$ of the acid is :

[2012] Options:

A. 3×10^{-1} B. 1×10^{-3}

C. 1×10^{-5}

D. 1×10^{-7}

Answer: C

H⁺ = C
$$\alpha$$
; $\alpha = \frac{[H^+]}{C}$
or $\alpha = \frac{10^{-3}}{0.1} = 10^{-2}$
K_a = C α^2 = 0.1 × 10⁻² × 10⁻² = 10⁻⁵

Question183

Given

(i) H CN (aq) + H₂O(I) \Rightarrow H₃O⁺(aq) + CN⁻(aq) K_a = 6.2 × 10⁻¹⁰ (ii) CN⁻(aq) + H₂O(I) \Rightarrow H CN (aq) + OH⁻(aq)

 $K_{\rm h} = 1.6 \times 10^{-5}$

These equilibria show the following order of the relative base strength, [Online May 12, 2012]

```
Options:
```

A. OH $^-$ > H $_2$ O > CN $^-$

B. $OH^- > CN^- > H_2O$

 $C. H_{2}O > CN^{-} > OH^{-}$

D. CN $^{->}$ H $_2$ O > OH $^{-}$

Answer: B

Solution:

Solution:

The more is the value of equilibrium constant, the more is the completion of reaction or more is the concentration of products i.e. the order of relative strength would be $OH^- > CN^- > H_2O$

Question184

The solubility (in mol L^{-1}) of AgCl (K $_{\rm sp}$ = 1.0 \times 10 $^{-10}$) in a 0.1 M KCl solution will be [Online May 7, 2012]

Options:

A. 1.0×10^{-9}

B. 1.0×10^{-10}

C. 1.0×10^{-5}

D. 1.0×10^{-11}

Answer: A

```
Let solubility of AgCl = smol / L

AgCl \Rightarrow Ag<sup>+</sup> + Cl<sup>-</sup>

i.e., K_{sp(AgCl)} = s \times s

K Cl \rightarrow K^+ + Cl^-

[Cl<sup>-</sup>] from K Cl = 0.1M

Total [Cl<sup>-</sup>] in solution = s + 0.1

K<sub>cp</sub>(AgCl) = [Ag<sup>+</sup>][Cl<sup>-</sup>] = s(s + 0.1)

1.0 × 10<sup>-10</sup> = s(s + 0.1)

1.0 × 10<sup>-10</sup> = s<sup>2</sup> + 0.1s

1.0 × 10<sup>-10</sup> = 0.1s (as s<sup>2</sup> < 1)

s = 1.0 × 10<sup>-9</sup>mol / L
```

If K $_{\rm sp}$ of CaF $_2$ at 25°C is 1.7 × 10⁻¹⁰, the combination amongst the following which gives a precipitate of CaF $_2$ is [Online May 19, 2012]

Options:

A. 1×10^{-2} M Ca²⁺ and 1×10^{-3} M F⁻ B. 1×10^{-4} M Ca²⁺ and 1×10^{-4} M F⁻ C. 1×10^{-2} M Ca²⁺ and 1×10^{-5} M F D. 1×10^{-3} M Ca²⁺ and 1×10^{-5} M F⁻

Answer: A

Solution:

When ionic product i.e. the product of the concentration of ions in the solution exceeds the value of solubility product, formation of precitipate occurs. $CaF_{2} \neq Ca^{2+} + 2F^{-}$ Ionic product = $[Ca^{2+}][F^{-}]^{2}$ when, $[Ca^{2+}] = 1 \times 10^{-2}M$ $[F^{-}]^{2} = (1 \times 10^{-3})^{2}M$ = $1 \times 10^{-6}M$ $\therefore [Ca^{2+}][F^{-}]^{2} = (1 \times 10^{-2})(1 \times 10^{-6}) = 1 \times 10^{-8}$ In this case, Ionic product $(1 \times 10^{-8}) >$

solubility product (1.7 \times 10⁻¹⁰)

Question186

The solubility of PbI $_2$ at 25°C is 0.7gL⁻¹. The solubility product of PbI $_2$ at this temperature is (molar mass of PbI $_2$ = 461.2gmol⁻¹) [Online May 26, 2012]

Options:

- A. 1.40×10^{-9}
- B. 0.14×10^{-9}
- C. 140×10^{-9}
- D. 14.0×10^{-9}

Answer: D

Solution:

PbI₂ ≠ Pb²⁺ + 2I⁻ s K_{cp} = s × (2s)² = 4s³ = 4 × $\left(\frac{0.7}{461.2}\right)^3$ = 14.0 × 10⁻⁹

Question187

An acid HA ionises as HA \rightleftharpoons H⁺ + A⁻ The pH of 1.0M solution is 5. Its dissociation constant would be :

[2011RS]

Options:

A. 5 B. 5×10^{-8} C. 1×10^{-5}

D. 1×10^{-10}

Answer: D

Solution: pH = 5 means [H⁺] = 10⁻⁵ HA \implies H⁺ + A⁻ *i*=0 c 0 0 *i*_{eq} c(1-\alpha) c\alpha c\alpha K_a = $\frac{[H^+][A^-]}{[HA]} = \frac{(c\alpha)^2}{c(1-\alpha)} = \frac{[H^+]^2}{c-[H^+]}$ But, [H⁺] < c \therefore K_a = [H⁺]² = (10⁻⁵)² = 10⁻¹⁰

Question188

The K $_{\rm sp}$ for Cr(OH) $_3$ is 1.6 × 10⁻³⁰. The solubility of this compound in water is : [2011 RS]

Options:

A. $4\sqrt{1.6 \times 10^{-30}}$

B. $4\sqrt{1.6 \times 10^{-30} / 27}$

C. $1.6 \times 10^{-30/27}$

D. $2\sqrt{1.6 \times 10^{-30}}$

Answer: B

Solution:

 $Cr(OH)_{3}(s) \implies Cr^{3+}(aq) + 3OH^{-}(aq.)$ $27s^{4} = K_{sp}$ $s = \left(\frac{K_{sp}}{27}\right)^{1/4} = \left(\frac{1.6 \times 10^{-30}}{27}\right)^{1/4}$

Question189

In aqueous solution the ionization constants for carbonic acid are $K_L = 4.2 \times 10^{-7}$ and $K_2 = 4.8 \times 10^{-11}$ Select the correct statement for a saturated 0.034M solution of the carbonic acid. [2010]

Options:

A. The concentration of CO_3^{2-} is 0.034M .

B. The concentration of CO_3^{2-} is greater than that of H CO_3^{--}

C. The concentrations of H $^+$ and H CO $_3^-$ are approximately equal.

D. The concentration of H ⁺ is double that of CO_3^{2-} .

Answer: C

Solution:

$$\begin{split} &H_{2}CO_{3} \rightleftharpoons H^{+} + HCO_{3}^{-}K_{1} = 4.2 \times 10^{-7} \\ &HCO_{3}^{-} \rightleftharpoons H^{+} + CO_{3}^{2-}K_{2} = 4.8 \times 10^{-11} \\ &Second dissociation constant (K_{2}) is much smaller than the first one (K_{1}). Just a small fraction of total <math>HCO_{3}^{-}$$
 formed will undergo second stage of ionization. Hence in saturated solution $[H^{+}] \gg > [CO_{3}^{2-}]; [CO_{3}^{2-}] \neq 0.034M \\ [HCO_{3}^{2-}] > [CO_{3}^{2-}] and [H^{+}] \approx [HCO_{3}^{-}] \end{split}$

Question190

Solubility product of silver bromide is 5.0×10^{-13} . The quantity of potassium bromide (molar mass taken as 120g mol⁻¹) to be added to 1 litre of 0.05M solution of silver nitrate to start the precipitation of AgBr is [2010]

Options:

A. 1.2×10^{-10} g

B. 1.2×10^{-9} g

C. 6.2×10^{-5} g

D. 5.0×10^8 g

Answer: B

Solution:

AgBr \Rightarrow Ag⁺ + Br⁻ K_{sp} = [Ag⁺][Br⁻] For precipitation to occur lonic product > Solubility product [Br⁻] = $\frac{K_{sp}}{[Ag^+]} = \frac{5 \times 10^{-13}}{0.05} = 10^{-11}$ i.e., precipitation just starts when 10^{-11} moles of K Br is added to I LAgN O₃ solution ∴ Number of moles of Br⁻ needed from K Br = 10^{-11} ∴ Mass of K Br = $10^{-11} \times 120 = 1.2 \times 10^{-9}$ g

Question191

At 25°C, the solubility product of M g(OH)₂ is 1.0×10^{-11} . At which pH , will M g²⁺ ions start precipitating in the form of M g(OH)₂ from a solution of 0.001M M g²⁺ ions? [2010]

Options:

- A. 9
- B. 10
- C. 11

D. 8

Answer: B

```
\begin{split} M & g(OH)_2 \rightleftharpoons M g^{2+} + 2OH^{-1} \\ K_{sp} &= [M g^{2+}][OH^{-1}]^2 \\ 1.0 \times 10^{-11} &= 10^{-3} \times [OH^{-1}]^2 \\ [OH^{-1}] &= \sqrt{\frac{10^{-11}}{10^{-3}}} = 10^{-4} \\ \therefore & pOH = 4 \\ \therefore & pH + pOH = 14 \\ \therefore & pH = 10 \end{split}
```

Three reactions involving $H_2PO_4^-$ are given below: (i) $H_3PO_4 + H_2O \rightarrow H_3O^+ + H_2PO_4^-$ [2010] (ii) $H_2PO_4^- + H_2O \rightarrow HPO_4^{2-} + H_3O^+$ (iii) $H_2^{-2}PO_4^- + OH^- \rightarrow H_3PO_4 + O^2$ In which of the above does $H_2PO_4^-$ act as an acid ? [2010]

Options:

A. (ii) only

B. (i) and (ii)

C. (iii) only

D. (i) only

Answer: A

Solution:

(i) $H_{3}PO_{4} + H_{2}O \rightarrow H_{3}O^{+} + H_{2}PO_{4}^{-}$ $acid_{1} \qquad base_{2} \qquad acid_{2} \qquad base_{1}$ (ii) $H_{2}PO_{4}^{-} + H_{2}O \rightarrow HPO_{4}^{2-} + H_{3}O^{+}$ $acid_{1} \qquad base_{2} \qquad base_{1} \qquad acid_{2}$ (iii) $H_{2}PO_{4}^{-} + OH^{-} \rightarrow H_{3}PO_{4} + O^{2-}$ $base_{1} \qquad acid_{2} \rightarrow H_{3}PO_{4} + O^{2-}$ $base_{2} \qquad base_{2}$ Hence only in (ii) reaction, $H_{2}PO_{4}^{-}$ is acting as an acid.

Question193

Solid Ba(NO₃)₂ is gradually dissolved in a 1.0×10^{-4} M Na₂CO₃ solution. At what concentration of Ba²⁺ will a precipitate begin to form? (K_{xp} for for BaCO₃ = 5.1×10^{-9}) [2009]

Options:

A. 5.1×10^{-5} M

B. 8.1 × 10^{-8} M

C. 8.1 × 10^{-7} M

D. 4.1×10^{-5} M

Answer: A

Solution:

$$\begin{split} & \operatorname{Na_2CO_3} \longrightarrow \operatorname{2Na^+}_{1 \times 10^{-4}M} + \operatorname{CO_3^{2-}}_{1 \times 10^{-4}M} \\ & \operatorname{K_{sp(BaCO_3)}} = [\operatorname{Ba^{2+}}][\operatorname{CO_3^{2-}}] \end{split}$$

 $[\mathrm{Ba}^{2+}] = \frac{5.1 \times 10^{-9}}{1 \times 10^{-4}} = 5.1 \times 10^{-5} \mathrm{M}$

Question194

The equilibrium constants K_{p_1} and K_{p_2} for the reactions $X \neq 2Y$ and $Z \neq P + Q$,

respectively are in the ratio of 1:9. If the degree of dissociation of X and Z be equal, then the ratio of total pressures at these equilibria is [2008]

Options:

A. 1 : 36

B. 1 : 1

C. 1 : 3

D. 1 : 9

Answer: A

Solution:

Let the initial moles of $X\,$ be 'a' and that of $Z\,$ be ' b ' then for the given reactions.



Question195

For the following three reactions (i), (ii) and (iii), equilibrium constants are given: (i) $CO(g) + H_2O(g) \neq CO_2(g) + H_2(g)$; K_1 (ii) $CH_4(g) + H_2O(g) \neq CO(g) + 3H_2(g)$; K_2 (iii) $CH_4(g) + 2H_2O(g) \neq CO_2(g) + 4H_2(g)$; K_3 Which of the following is correct? [2008]

Options:

A. $K_{1}\sqrt{K_{2}} = K_{3}$ B. $K_{2}K_{3} = K_{1}$

C.
$$K_{3} = K_{1}K_{2}$$

D. $K_3 \cdot K_2^3 = K_1^2$

Answer: C

Solution:

Reaction (iii) can be obtained by adding reactions (i) and (ii) therefore K $_3$ = K $_1$. K $_2$

Question196

Four species are listed below: i. H CO₃⁻ ii. H ₃O⁺ iii. H SO₄⁻ iv. H SO₃F Which one of the following is the correct sequence of their acid strength? [2008]

Options:

A. iv < ii < iii < i

B. ii < iii < i < iv

C. i < iii < ii < iv

D. iii < 1 < iv < ii

Answer: C

Solution:

The correct order of acidic strength of the given species is $H SO_3F > H_3O^+ > H SO_4^- > H CO_3^-$ (iv) (ii) (iii) (iii) (i) or (i) < (iii) < (ii) < (iv)

Question197

The pK $_{\rm a}$ of a weak acid, H A, is 4.80. The pK $_{\rm b}$ of a weak base, BOH , is 4.78. The pH of an aqueous solution of the corresponding salt, BA, will be [2008]

Options:

A. 9.58

B. 4.79

C. 7.01

D. 9.22

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Answer: C
```

Solution:

In aqueous solution, BA(salt) hydrolyses to give BA + H $_2O \rightleftharpoons BOH + HA_{acid}$ Now pH is given by pH = $\frac{1}{2}pK_W + \frac{1}{2}pK_a - \frac{1}{2}pK_b$ Substituting given values, we get pH = $\frac{1}{2}(14 + 4.80 - 4.78) = 7.01$

The first and second dissociation constants of an acid H $_2$ A are 1.0×10^{-5} and 5.0×10^{-10} respectively. The overall dissociation constant of the acid will be [2007]

Options:

A. 0.2×10^{5} B. 5.0×10^{-5} C. 5.0×10^{15} D. 5.0×10^{-15} . Answer: D Solution: $H_{2}A \rightleftharpoons H^{+} + HA^{-}$ $\therefore K_{1} = 1.0 \times 10^{-5} = \frac{[H^{+}][HA^{-}]}{[H_{2}A]}$ $HA^{-} \rightleftharpoons H^{+} + A^{-}$ $\therefore K_{2} = 5.0 \times 10^{-10} = \frac{[H^{+}][A^{-}]}{[HA^{-}]}$ For the reaction, $H_{2}A \rightleftharpoons 2H^{+} + A^{2-}$ $K = \frac{[H^{+}]^{2}[A^{2-}]}{[H_{2}A]} = K_{1} \times K_{2}$ $= (1.0 \times 10^{-5}) \times (5 \times 10^{-10}) = 5 \times 10^{-15}$

Question199

The pK $_{\rm a}$ of a weak acid (HA) is 4.5. The pOH of an aqueous buffer solution of H A in which 50% of the acid is ionized is [2007]

Options:

- A. 7.0
- B. 4.5
- C. 2.5
- D. 9.5

Answer: D

Solution:

```
For acidic buffer, pH = pK_a + log\left[\frac{salt}{acid}\right] pH = 4.5 + log \frac{[salt]}{[acid]}
As HA is 50% ionized so [salt] = [ acid ]
\therefore pH = 4.5
\because pH + pOH = 14
pOH = 14 - pH = 14 - 4.5 = 9.5
```

Question200

In a saturated solution of the sparingly soluble strong electrolyte AgI O_3 (molecular mass = 283) the equilibrium which sets in is AgI $O_3(s) \Rightarrow$ Ag⁺(aq) + I $O_3^-(aq)$. If the

```
solubility product constant K _{\rm sp} of AgI O _3 at a given temperature is 1.0 × 10<sup>-8</sup>, what is
the mass of AgI O<sub>3</sub> contained in 100mL of its saturated solution?
[2007]
```

Options:

A. 1.0×10^{-4} g B. 28.3×10^{-2} g C. 2.83 $\times 10^{-3}$ g D. 1.0×10^{-7} g. **Answer: C** Solution: Let s = solubility $AgI O_3 \rightleftharpoons Ag^+ + I O_3^ K_{sp} = [Ag^+][IO_3^{s}] = s \times s = s^2$ Given K $_{5p} = 1 \times 10^{-8}$ $\therefore s = \sqrt{K_{sp}} = \sqrt{1 \times 10^{-8}}$

= 1.0×10^{-4} mol / L = $1.0 \times 10^{-4} \times 283$ g / L (\because Molecular mass of AgI O₃ = 283) $= \frac{1.0 \times 10^{-4} \times 283 \times 100}{1000} \text{g} / 100 \text{mL}$ $= 2.83 \times 10^{-3}$ g / 100mL

Question201

Phosphorus pentachloride dissociates as follows, in a closed reaction vessel $PCl_{5}(g) \neq PCl_{3}(g) + Cl_{2}(g)$

If total pressure at equilibrium of the reaction mixture is P and degree of dissociation of PCl₅ is x, the partial pressure of PCl₃ will be [2006]

Options:

- A. $\left(\frac{x}{x-1}\right)P$
- B. $\left(\frac{x}{1-x}\right)P$
- C. $\left(\frac{x}{x+1}\right)P$
- D. $\left(\frac{2x}{1-x}\right)P$

Answer: C

Solution:

 $\operatorname{PCl}_{5}(g) \rightleftharpoons \operatorname{PCl}_{3}(g) + \operatorname{Cl}_{2}(g)$ Total moles after dissociation 1 - x + x + x = 1 + x $p_{PCl_{3}}$ = Mole fraction of PCl₃× Total pressure $=\left(\frac{x}{1+x}\right)P$

Question202

The equilibrium constant for the reaction $SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$

```
is K_c = 4.9 \times 10^{-2}.
The value of K_c for the reaction 2SO_2(g) + O_2(g) \neq 2SO_3(g)
will be
[2006]
```

Options:

A. 9.8×10^{-2} B. 4.9×10^{-2} C. 416 D. 2.40×10^{-3}

Answer: C

Solution:

 $SO_{3}(g) \rightleftharpoons SO_{2}(g) + \frac{1}{2}O_{2}(g)$ $K_{c} = \frac{[SO_{2}][O_{2}]^{1/2}}{[SO_{3}]} = 4.9 \times 10^{-2}$ On taking the square of the above reaction $\frac{[SO_{2}]^{2}[O_{2}]}{[SO_{3}]^{2}} = 24.01 \times 10^{-4}$ Now for 2SO₂(g) + O₂(g) \nothermolecep 2SO₃ $K_{c} = \frac{[SO_{3}]^{2}}{[SO_{2}]^{2}[O_{2}]} = \frac{1}{24.01 \times 10^{-4}} = 416$

Question203

For the reaction : $2NO_2(g) \Rightarrow 2NO(g) + O_2(g)$ ($K_c = 1.8 \times 10^{-6}$ at $184^{\circ}C$)(R = 0.0831kJ / (mol . K)) When K_p and K_c are compared at $184^{\circ}C$, it is found that [2005]

Options:

A. Whether K $_{\rm p}$ is greater than, less than or equal to K $_{\rm c}$ depends upon the total gas pressure

B. $K_p = K_c$

C. K $_{\rm p}$ is less than K $_{\rm c}$

D. K_p is greater than K_c

Answer: D

Solution:

For the reaction:- $2N O_2(g) \rightleftharpoons 2N O(g) + O_2(g)$ Given $K_c = 1.8 \times 10^{-6}$ at $184^{\circ}C$ $R = 0.0831 \text{kJ} / \text{mol} \cdot \text{K}$ $K_p = K_c (\text{RT})^{\Delta n}$ $K_p = 1.8 \times 10^{-6} \times 0.0831 \times 457$ $= 6.836 \times 10^{-6}$ Hence it is clear that $K_p > K_c$

Question204

An amount of solid N H $_4$ H S is placed in a flask already containing ammonia gas at a certain temperature and 0.50 atm pressure. Ammonium hydrogen sulphide decomposes to yield N H $_3$ and N $_2$ S gases in the flask. When the decomposition reaction reaches equilibrium, the total pressure in the flask rises to 0.84 atm? The equilibrium constant for N H $_4$ H S decomposition at this temperature is

[2005]

- **Options:**
- A. 0.11
- B. 0.17
- C. 0.18
- D. 0.30

Answer: A

Solution:

 $\begin{array}{rrrr} NH_4HS(s) & \longleftrightarrow NH_3(s) + H_2S(g) \\ At & t=0 & 0.5 \ atm & 0 \ atm \\ At \ eqm. & 0.5 + x \ atm & x \ atm. \\ Then & 0.5 + x + x = 2x + 0.5 = 0.84 \ (given) \\ x = 0.17 \ atm. \\ p_{NH_3} = 0.5 + 0.17 = 0.67 \ atm \\ p_{H_2S} = 0.17 \ atm \\ K = p_{NH_3} \times p_{H_2S} = 0.67 \times 0.17 \ atm^2 \\ = 0.1139 = 0.11 \end{array}$

Question205

The exothermic formation of CIF $_3$ is represented by the equation:

 $\operatorname{Cl}_2(\mathbf{g}) + 3F_2(\mathbf{g}) \rightleftharpoons 2\operatorname{Cl} F_3(\mathbf{g}); \quad \Delta H = -329 \text{kJ}$

Which of the following will increase the quantity of CI F $_3$ in an equilibrium mixture of Cl $_2$, F $_2$ and Cl F $_3$?

[2005]

Options:

A. Adding F $_{\rm 2}$

B. Increasing the volume of the container

C. Removing Cl $_{\rm 2}$

D. Increasing the temperature

Answer: A

Solution:

The reaction given is an exothermic reaction thus accordingly to Le-Chatalier's principle lowering of temperature, addition of F $_2$ and or Cl $_2$ favour the forward direction and in hence the production of CI F $_3$.

Question206

Hydrogen ion concentration in mol / L in a solution of pH = 5.4 will be: [2005]

Options:

A. 3.98×10^{-6}

B. 3.68×10^{-6}

C. 3.88×10^{6}

D. 3.98×10^{8}

Answer: A

Solution:

 $pH = -\log[H^{+}] = \log \frac{1}{[H^{+}]}$ 5.4 = log $\frac{1}{[H^{+}]}$ On solving, [H^{+}] = 3.98 × 10⁻⁶

Question207

What is the conjugate base of OH⁻? [2005]

Options:

A. O^{2–}

B. O⁻

C. H $_2O$

 $D. \ O_2$

Answer: A

Solution:

Conjugate acid-base pair differ by only one proton. OH $^- \rightarrow$ H $^+$ + O²⁻ Conjugate base of OH is O²

Question208

The solubility product of a salt having general formula M X $_2$, in water, is :4 × 10⁻¹². The concentration of M $^{2+}$ ions in the aqueous solution of the salt is [2005]

Options:

A. 4.0×10^{-10} M

B. 1.6×10^{-4} M

C. 1.0×10^{-4} M

D. 2.0×10^{-6} M

Answer: C

Solution:

 $MX_{2} \rightleftharpoons M_{s}^{2+} + 2s_{2s}^{2+}$ Where s is the solubility of MX₂ then K_{sp} = 4s³ $4 \times 10^{-12} = 4s^{3}$

The equilibrium constant (K_c) for the reaction N₂(g) + O₂(g) \rightarrow 2N O(g) at temperature T is 4 × 10⁻⁴. The value of K_c for the reaction N O(g) $\rightarrow \frac{1}{2}$ N₂(g) + $\frac{1}{2}$ O₂(g) at the same temperature is: [2004, 2012]

Options:

A. 0.02

B. 2.5×10^2

C. 4×10^{-4}

D. 50.0

Answer: D

Solution:

For the reaction N₂ + O₂ \rightarrow 2N O K c = 4 × 10⁻⁴ Hence for the reaction N O $\rightarrow \frac{1}{2}$ N₂ + $\frac{1}{2}$ O₂ K_c' = $\frac{1}{\sqrt{K_c}} = \frac{1}{\sqrt{4 \times 10^{-4}}} = 50$

Question210

What is the equilibrium expression for the reaction $P_4(s) + 5O_2(g) \rightleftharpoons P_4O_{10}(s)$? [2004]

Options:

A. $K_c = [O_2]^5$ B. $K_c = [P_4O_{10}] / 5[P_4][O_2]$ C. $K_c = [P_4O_{10}] / [P_4][O_2]^5$

D. $K_c = 1 / [O_2]^5$

Answer: D

Solution: For $P_4(s) + 5O_2(g) \rightleftharpoons P_4O_{10}(s)$ $K_c = \frac{1}{(O_2)^5}$ Solids have concentration unity.

Question211

For the reaction, CO(g) + Cl₂(g) \Rightarrow COCl₂(g) the K_{p/}K_c is equal to [2004]

Options:

A. \sqrt{RT}

B. RT

C. 1 / RT

D. 1.0

Answer: C

Solution:

 $K_{p} = K_{c} (RT)^{\Delta n};$ Here $\Delta n = 1 - 2 = -1$ $\therefore \frac{K_{p}}{K_{c}} = \frac{1}{RT}$

Question212

The conjugate base of $H_2PO_4^-$ is [2004]

Options:

A. H₃PO₄

B. P_2O_5

C. PO₄³⁻

D. HPO_4^{2-}

Answer: D

Solution:

H $_{2}PO_{4}^{-} \xrightarrow{-H^{+}} H PO_{4}^{2-}$ Acid Conjugate acid-base differs by H⁺.

Question213

The molar solubility (in mol L⁻¹) of a sparingly soluble salt M X₄ is 's'. The corresponding solubility product is $K_{sp}^{}$'s' is given in term of $K_{sp}^{}$ by the relation: [2004]

Options:

A. s = $(256K_{sp})^{1/5}$ B. s = $(128K_{sp})^{1/4}$ C. s = $(K_{sp} / 128)^{1/4}$ D. s = $(K_{sp} / 256)^{1/5}$

Answer: D

Solution:

 $MX_{4} \rightleftharpoons M_{s}^{4+} + 4X_{4s^{-}}$ $K_{sp} = [s][4s]^{4} = 256s^{5}$ $\therefore s = \left(\frac{K_{sp}}{256}\right)^{1/5}$

For the reaction equilibrium $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ the concentrations of N_2O_4 and NO_2 at equilibrium are 4.8×10^{-2} and 1.2×10^{-2} mol L⁻¹ respectively. The value of K_c for the reaction is [2003]

Options:

A. 3×10^{-1} mol L⁻¹ B. 3×10^{-3} mol L⁻¹ C. 3×10^{3} mol L⁻¹

D. $3.3 \times 10^2 \text{mol L}^{-1}$

Answer: B

Solution:

$$K_{c} = \frac{[N O_{2}]^{2}}{[N_{2}O_{4}]} = \frac{[1.2 \times 10^{-2}]^{2}}{[4.8 \times 10^{-2}]}$$
$$= 3 \times 10^{-3} \text{mol} / \text{L}$$

Question215

Consider the reaction equilibrium $2SO_2(g) + O_2(g) \Rightarrow 2SO_3(g); \Delta H^\circ = -198kJ$ On the basis of Le Chatelier's principle, the condition favourable for the forward reaction is [2003]

Options:

A. increasing temperature as well as pressure

B. lowering the temperature and increasing the pressure

- C. any value of temperature and pressure
- D. lowering of temperature as well as pressure

Answer: B

Solution:

Due to exothermic nature of reaction low or optimum temperature will be required. Since 3 moles are changing to 2 moles, therefore high pressure will be required.

Question216

Which one of the following statements is not true? [2003]

Options:

A. pH + pOH = 14 for all aqueous solutions

B. The pH of 1×10^8 M H Cl is 8

C. 96,500 coulombs of electricity when passed through a ${\rm CuSO}_4$ solution deposits 1 gram equivalent of copper at the cathode

D. The conjugate base of H $_2PO_4^{-1}$ is H PO $_4^{2-1}$

Answer: B

Solution:

pH of an acidic solution should be less than 7. The reason is that from H $_2$ O, [H $^+$] = 10^{-7} M which cannot be neglected in comparison to 10^{-8} M. The pH can be calculated as.

From acid, $[H^+] = 10^{-8}M$ From H_2O , $[H^+] = 10^{-7}M$ \therefore Total $[H^+] = 10^{-8} + 10^{-7}$ $= 10^{-8}(1+10) = 11 \times 10^{-8}$ $\therefore pH = -\log[H^+] = -\log 11 \times 10^{-8}$ $= -[\log 11 + 8\log 10]$ = -[1.0414 - 8] = 6.9586

Question217

When rain is accompanied by a thunderstorm, the collected rain water will have a pH value [2003]

Options:

A. slightly higher than that when the thunderstorm is not there

B. uninfluenced by occurrence of thunderstorm

C. that depends on the amount of dust in air

D. slightly lower than that of rain water without thunderstorm.

Answer: D

Solution:

Solution:

The rain water after thunderstorm contains dissolved acid and therefore the pH is less than rain water without thunderstorm.

Question218

The solubility in water of a sparingly soluble salt AB_2 is 1.0×10^{-5} mol L⁻¹. Its solubility product will be [2003]

Options:

A. 4×10^{-10}

B. 1×10^{-15}

C. 1×10^{-10}

D. 4×10^{-15}

Answer: D

Solution:

 $AB_{2} \rightleftharpoons A^{2+} + 2B^{-}$ [A] = 1.0 × 10⁻⁵, [B] = [2.0 × 10⁻⁵] K_{qp} = [B][A] = [2 × 10⁻⁵]²[1.0 × 10⁻⁵] = 4 × 10⁻¹⁵

For the reaction CO(g) + $(1 / 2)O_2(g) \rightleftharpoons CO_2(g)$, K_p / K_c is [2002]

Options:

- A. RT
- B. $(RT)^{-1}$
- C. $(RT)^{-1/2}$
- D. (RT)^{1/2}

Answer: C

Solution:

 $K_p = K_c (RT)^{\Delta n};$ $\Delta n = 1 - \left(1 + \frac{1}{2}\right) = 1 - \frac{3}{2} = -\frac{1}{2}$ $\therefore \frac{K_p}{K_c} = (RT)^{-1/2}$

Question220

Change in volume of the system does not alter which of the following equilibria? [2002]

Options:

A. N₂(g) + O₂(g) \rightleftharpoons 2N O(g)

B. PCl $_{5}(g) \rightleftharpoons$ PCl $_{3}(g) + Cl _{2}(g)$

- C. N₂(g) + 3H₂(g) \rightleftharpoons 2N H₃(g)
- D. $SO_2Cl_2(g) \rightleftharpoons SO_2(g) + Cl_2(g)$

Answer: A

Solution:

In reaction (a) the ratio of number of moles of reactants to products is same i.e. 2 : 2, hence change in volume will not alter the number of moles.

Question221

Species acting as both Bronsted acid and base is [2002]

Options:

A. H SO_4^-

B. N a_2CO_3

C. N H $_3$

D. OH

Answer: A

 $(H SO_4)^-$ can accept and donate a proton $(H SO_4)^- + H^+ \rightarrow H_2SO_4$ (acting as base) $(H SO_4) - H^+ \rightarrow SO_4^{-2-}$. (acting as acid)

Question222

Let the solubility of an aqueous solution of M g(OH) $_2$, be x, then its K $_{\rm sp}$ is [2002]

Options:

A. $4x^3$

B. $108x^5$

C. $27x^4$

D. 9x.

Answer: A

Solution:

M g(OH)₂ → [M g²⁺] + 2[OH⁻] K_{sp} = [M g][OH]² = [x][2x]² = x.4x² = 4x³

Question223

1M NaCl and 1M HCl are present in an aqueous solution. The solution is [2002]

Options:

A. not a buffer solution with pH $\,<7$

B. not a buffer solution with pH > 7

C. a buffer solution with pH < 7

D. a buffer solution with pH > 7.

Answer: A

Solution:

A buffer is a solution of weak acid and its salt with strong base and vice versa. H Cl is strong acid and N aCl is its salt with strong base. pH is less than 7 due to H Cl.
