QB365

Important Questions - Equilibrium

11th Standard CBSE

Chemistry

Reg.No. : | | | | | | |

Time : 01:00:00 Hrs

Total Marks : 50

Section-A

1) A tank is full of water. Water is coming in as well as going out at same rate. What will happen to level of water in a tank? What is name given to such a state? **1**

2) Explain , why pure liquids and solids can be ignored while writing the equilibrium constant expression? **1**

3) What will be the pH of 1MNa_2so_4solution? **1**

4) What is the expression for $k_{sp} \quad of \quad Ag_2Cr0_4$? **1**

5) Is it possible to get a precipitate of $Fe(OH)_3$at pH=2? given reason. **1**

6) Will AgCl be more soluble in aqueous solution or NaCl solution and why? **1**

7) Why pH of our blood remains almost constant at 7.4 though we quite often eat spicy food? **1**

8) the ionization constant of formic acid is $1.8X10^{-4}$. Calculate the ratio of sodium formate and formic acid in a buffer of pH4.25 **1**

9) Identify the substance that get reduced in the following reaction. **1**

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

10) Write the conjugate acids for the following Bronsted bases NH_2^- , NH_3 and $HCOO^-$. **1**

Base + $H^+ \rightleftharpoons$ Conjugate acid

Section-B

11) Which of the following reactions involve homogeneous equilibrium and which involve heterogeneous equilibrium? **2**

$Ag_2O(s) + 2HNO_3(aq) \rightleftharpoons 2AgNO_3(aq) + H_2O(l)$

12) Which of the following reactions involve homogeneous equilibrium and which involve heterogeneous equilibrium? **2**

$CH_3COOC_2H_5(aq) + H_2O(l) \rightleftharpoons CH_3COOH(aq) + C_2H_5OH(aq)$

13) What will be the PH of 0.1 M ammonium acetate solution?$Pk_a = Pk_b = 4.74$ **2**

14) For the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g),$ the partial pressure of N_2 and H_2 are 0.80 and 0.40 atmosphere respectively at equilibrium. The total pressure of the system is 2.80 atmosphere. What is K_p for the above reaction? **2**

15) One mole of H_2O and one mole of CO are taken in 10 L vessel and heated to 725 K. At equilibrium, 40% of water (by mass) reacts with CO according to the equation, **2**

$H_2O(g) + CO(g) \rightleftharpoons H_2(g) + CO_2(g)$

Calculate the equilibrium constant for the reaction.

16) Urine has a pH of 6.0.If a patient eliminates 1300 mL of urine per day, how many gram equivalents of the acid the eliminates per day? **2**

17) Calculate the percentage hydrolysis of sodium acetate in 0.1 M solution at 25°C assuming the salt to be completely dissociated. $K_a = 1.8 \times 10^{-5}$. **2**

18) Blood has pH of 7.40. Calculate the ratio of hydrogen carbonate ion HCO_3^- to H_2CO_3 carbonic acid in blood to maintain its pH value. **2**

pK_a (H_2CO_3) = 6.37.

19) One of the reaction that takes place in producing steel from iron ore is the reduction of iron (II) oxide by carbon monoxide to give iron metal and CO_2 **2**

$Feo(s) + CO(g) \leftrightarrows Fe(s) + CO_2(g); \qquad K_p = 0.265 \quad atm \quad at \quad 1050 \quad K$

What are the equilibrium partial pressure of CO and CO_2 at 1050 K if the initial partial pressure are $P_{co} = 1.4 \quad atm$ and $PCO_2 = 0.80$ atm?

First Q_p by the given initial partial pressures of [CO] and [CO_2].

20) What is the minimum volume of water required to dissolved 1g of calcium sulphate at 298 K? (For calcium sulphate, K_{sp} is 9.1×10^{-6}) **2**

Section-C

21) Which of the following reactions involve homogeneous equilibrium and which ones involve heterogeneous equilibrium? **5**

$2NH_2(g) \rightleftharpoons N_2(g) + 3H_2(g)$

22) $K_{a_1}, K_{a_2}$and K_{a_3} are the respective ionisation constants for the following reactions. **5**

$H_2S \rightleftharpoons H^+ + HS^- HS^- \rightleftharpoons H^+ + S^{2-} H_2S \rightleftharpoons 2H^+ + S^{2-}$

Write the correct relationship $K_{a_1}, K_{a_2}, K_{a_3}$.

To find out the correct relationship between three ionisation constants ($K_{a_1}, K_{a_2}$and K_{a_3}) this must be keep in mind that when two reactions are added, their equilibrium constants are multiplied.

23) Calculate the pH of a buffer which is 0.1 M in acetic acid and 0.15 M in sodium acetate. Given that the ionisation costants of acetic acid is 1.75×10^{-5}. Also calculate the change in pH of the buffer if to 1L of the buffer **5**

1 cc of 1 M HCl are added. Assume that the charge in volume is negligible.

24) The first ionisation constant on H_2S is 9.1×10^{-8}.Calculate the concentration of HS^- ion in its 0.1 M solution. How will this concentration be affected if the solution is 0.1 M in HCl also? If the second dissociation constant of H_2S is 1.2×10^{-13}, calculate the concentration of S^{2-} under both conditions. **5**

H_2S being a weak acid, dissociates as

$$H_2S + H_2O \rightleftharpoons H_3O^+ + HS^- \therefore K_a = \frac{\left[H_3O^+\right]\left[HS^-\right]}{\left[H_2S\right]}$$

HCl being a strong acid dissociates completely, so calculate [HS-] in the presence of 0.1M HCl by taking [HS+] concentration as 0.1M.

Calculate [S2-] ion concentration by using the equation,

$$HS^- + H_2O \rightleftharpoons H_3O^+ + S^{2-}$$

Calculate the [S2-] ion concentration in the presence of 0.1M HCl.

****

Section-A

1) It will remain the same because rate of inflow is equal to rate of outflow. The state is called of 'equilibrium'. **1**

2) **1**

Molar concentration of pure solid or liquid (if in excess) is constant (i.e. independent of the amount present) . That's why pure liquids and solids can be ignored while the equilibrium constant expression.

3) Na_2so_4 is a salt of the strong acid and strong base, thus its aqueous solution will be neutral. Therefore,its pH wii be 7 **1**

4) $Ag_2Cr0_4(s) \rightleftharpoons 2Ag^+(aq) + Cro_4^{2-}(aq); K_{sp} = [Ag^+]^2[Cro_4^{2-}] = (2s)^2(s) = 4s^3$ **1**

5) No, because $Fe(OH)_3$will dissolve in the strongly acidic medium. **1**

6) **1**

In NaCl Solution, the Cl^- ions will increase.Since solubility product,$k_{sp} = [Ag]^+[cl^-]$remains constant. $[Ag]^+$ will decrease. therefore, the solubility of AgCl will be less in NaCl solution than in water

7) **1**

Blood is a buffer containing carbonic acid (H_2Co_3) and bicarbonate ions (H_2Co_3). Small amounts of the acid or base produced from the spicy food do not disturb its pH.

8) **1**

$$Pk_a = -log(1.8 \times 10^{-4}) = 3.74 \,|\, log\frac{[salt]}{[Acid]} = pH - pK_a = 4015 - 3.75 = 0.51 or \quad \frac{[salt]}{[Acid]} = Anrilog \quad 0.51 = 3.24$$

9) In the reaction, Fe_2O_3 loses oxygen and is reduced to Fe. **1**

10) The conjugate acid should have one extra proton in each case and therefore the corresponding conjugate acid are NH_3,NH_4^+ and HCOOH respectively **1**

Section-B

11) Heterogeneous equilibrium **2**

12) Homogeneous equilibrium **2**

13) **2**

$$pH = \frac{1}{2}pk_w + \frac{1}{2}pk_a - \frac{1}{2}pK_b = \frac{1}{2}(14) + \frac{1}{2}(4.75) - \frac{1}{2}(4.74) = 7$$

14) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, **2**

Given, at equilibrium, $PN_2 = 0.80$ atmosphere

$PH_2 = 0.40$ atmosphere

$P_{N_2} + P_{H_2} + P_{NH_3} = 2.80$ atmosphere

$\therefore P_{NH_3} = 2.80 - (0.80 + 0.40) = 1.60$ atmosphere

From, K

$$p = \frac{PNH_3^2}{P_{N_2} \times PH_2^3} = \frac{(1.60)^2}{0.80 \times (0.40)^3} = 50.0$$

15) $H_2O(g) + CO(g) \rightleftharpoons H_2(g) + CO_2(g)$ **2**

Initial conc.	1	1	0	0
Equili.conc.	(1-x)	(1-x)	x	x

H_2O reacted = 40% of 1 mole of H_2O=0.4 mol

$\therefore \quad x = 0.4mol$

$(1 - x) = 1 - 0.4 = 0.6mol$

$$K_c = \frac{\left[H_2\right][CO_2]}{[H_2O][CO]} = \frac{0.4 \times 0.4}{0.6 \times 0.6} = 0.444$$

16) pH=6.0 **2**

$[H_3O^+]=10^{-6}$M

[Acid]=10^{-6}M=10^{-6}N

Thus, 1000 mL of the urine contain acid = 10^{-6} g eq.

1300 mL of the urine will contain acid = 1.3 x 10^{-6} g eq.

17) **Ans.** 0.00075% **2**

18) **Ans.** 10 mL **2**

19) **2**

$Feo(s) + co(g) \leftrightharpoons Fe(s) + CO_2 \quad (g);$

Initial pressure 1.4atm 0.80 atm

(K_p=.265 at 1050 K)

$Q_p = \frac{PCO_2}{PCO} = \frac{0.80}{1.4} = 0.571[\because Fe \quad and \quad Feo \quad are \quad solids]$

$\because Q_p > K_p$, the reaction will go in reverse direction. Due to this, pressure of CO_2 will decrease and that of CO will increase to attain equilibrium.

Suppose p is the decrease in pressure of CO_2 and p is the increase in pressure of CO. Hence,

$pco_2 = (0.80 - p) \quad and \quad pco = (1.4 + p) Now, \quad from \quad K_p = \frac{pco_2}{pco} \Rightarrow \qquad 0.265 = \frac{(0.80-p)}{(1.4+p)} \qquad p = \frac{0.429}{1.265} = 0.339 \quad atmHence, \quad at \quad equilibrium, pco_2 = 0.80 - 0.3$

20) $CaSO_4 \rightleftharpoons Ca^{2+} + SO_4^{2-}; K_{sp} = 9.1 \times 10^{-6}$ **2**

S S S

Where s is the solubility of $CaSO_4$

$K_{sp} = \left[Ca^{2+}\right]\left[SO_4^{2-}\right] = S.S = S^2S = \sqrt{K_{sp}} = \sqrt{9.1 \times 10^{-6}} \Rightarrow S = 3.017 \times 10^{-3} M$

Solubility of $CaSO_4$ = 3.017x10^{-3} mol^{-1}

=3.017x10^{-3} x136 gL^{-1}

(Molar mass of $CaSO_4$ =136 g mol^{-1})

=410.3 x 10^{-3} gL^{-1}

410.3x10^{-3} g $CaSO_4$ is dissolved in = 1L

1g $CaSO_4$ is dissolved in = $\frac{1 \times 1}{410.3 \times 10^{-3}}$=2.437 L

Section-C

21) Homogeneous equilibrium **5**

22) For the reaction **5**

$H_2S \rightleftharpoons H^+ + HS^- K_{a_1} = \frac{\left[H^+\right]\left[HS^-\right]}{\left[H_2s\right]} For \quad the \quad reaction, \quad HS^- \rightleftharpoons H^+ + S^{2-} K_{a_2} = \frac{\left[H^+\right]\left[S^{2-}\right]}{\left[HS^-\right]}$

When the above two reactions are added, their equilibrium constants are multiplied, thus

$K_{a_3} = \frac{\left[H^+\right]^2\left[S^{2-}\right]}{\left[H_2s\right]} = K_{a_1} \times K_{a_2} Hence, K_{a_3} = K_{a_1} \times K_{a_2} x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

23) 1 cc of 1 M HCl contains HCl = 10^{-3} mol. This will convert 10^{-3} mol CH_3COONa into CH_3COOH. **5**

Now, [Acid] =0.10 +0.001 =0.101 M

[Salt] =0.15 - 0.001 =0.149 M

pH =4.757 +$\log\frac{0.149}{0.101}$

= 4.757 +0.169

= 4.925

Decrease in pH =4.933 = 0.007 which is again negligible.

24) In the presence of 0.1M HCl, **5**

$K_{a_2} = \frac{\left[H_3O^+\right]\left[S^{2-}\right]}{\left[HS^-\right]} = \frac{[0.1]\left[S^{2-}\right]}{\left[9.1 \times 10^{-8}\right]} \left[S^{2-}\right] = 1.092 \times 10^{-19} M$