Class 11 Chemistry

Equilibrium

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Exercise 7.1

A liquid is in equilibrium with its vapour in a sealed container at a fixed temperature. The volume of the container is suddenly increased.

a. what is the initial effect of the change on vapour pressure?

b. How do rates of evaporation and condensation change initially?

c. What happens when equilibrium is restored finally and what will be the final vapour pressure?

CORRECT ANSWER: N//A

Exercise 7.2

What is K_c for the following equilibrium concentration of each substance is:

$\left[SO_2\right] = 0.60M$, $\left[O_2\right] = 0.82M$ and $\left[SO_3\right] = 1.90M$?

$2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g)$

CORRECT ANSWER: 12.229

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Exercise 7.3

At a certain temperature and a total pressure of $10^5 Pa$, iodine vapour contains 40 % by volume of Iatoms, Calculate K_p for the equilibrium.

$I_{2(g)} \Leftrightarrow 2I_{(g)}$

CORRECT ANSWER: $2.67XX10^{4}$

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Exercise 7.4

Write the expression for the equilibrium constant K_c for each of the following reactions:

a. $2NOCl(g) \Leftrightarrow 2NO(g) + Cl_2(g)$

b. $2Cu\left(NO_3\right)_2(s) \Leftrightarrow 2CuO(s) + 4NO_2(g) + O_2(g)$

c.

$CH_3COOC_2H_5(aq) + H_2O(1) \Leftrightarrow CH_3COOH(aq) + C_2H_5OH(aq)$

d. $Fe^{3+}(aq) + 3OH^{?}(aq) \Leftrightarrow Fe(OH)_3(s)$

e. $I_2(s) + 5F_2 \Leftrightarrow 2IF_5$

CORRECT ANSWER: N//A

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Exercise 7.5

Find out the value of K_c for each of the following equilibrium from the value of K_p:

a. $2NOCl(g) \Leftrightarrow 2NO(g) + Cl_2(g), K_p = 1.8 \times 10^{-2}$ at $500K$

b. $CaCO_3(s) \Leftrightarrow CaO(s) + CO_2(g), K_p = 167$ at $1073K$

CORRECT ANSWER: (I) $4.33XX10^{-4}$ (II) 1.90

Exercise 7.6

For the following equilibrium, $K_c = 6.3 \times 10^{14} at 1000K$

$NO(g) + O_3(g) \Leftrightarrow NO_2(g) + O_2(g)$

Both the forward and reverse reactions in the equilibrium are elementary bimolecular reactions. What is K_c, for the reverse reaction?

CORRECT ANSWER: $1.59XX10^{-15}$

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Exercise 7.7

Explain why pure liquids and solids can ignored while writing the equilibrium constant expression?

CORRECT ANSWER: N//A

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Exercise 7.8

Reaction between nitrogen and oxygen takes place as following:

$2N_{2(g)} + O_2 \Leftrightarrow 2N_2O_{(g)}$

If a mixture of 0.482moleN_2 and 0.933mole of O_2 is placed in a reaction vessel of volume $10 litre$ and allowed to form N_2O at a temperature for which $K_c = 2.0 \times 10^{-37} litremol^{-1}$. Determine the

composition of equilibrium mixture.

CORRECT ANSWER: $\left[N_2\right] = 0.0482\text{MOLL}^{-1}$,

$\left[O_2\right] = 0.0933\text{MOLL}^{-1}$. $\left[N_2O\right] = 6.6XX10^{-21}\text{MOLL}^{-1}$

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Exercise 7.9

Nitric oxide reacts with bromine and gives nitrosyl-bromide as per reaction given below:

$2NO_{(g)} + Br_{2(g)} \Leftrightarrow 2NOBr_{(g)}$.

When 0.087mole of NO and 0.0437mole of Br_2 are mixed in a closed container at constant temperature, 0.0518mole of $NOBr$ is obtained at equilibrium. Calculate equilibrium amount of nitric oxide and bromine.

CORRECT ANSWER: 0.0352MOL OF NO AND 0.0178MOL OF BR_2

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Exercise 7.10

At $450K$, $K_p = 2.0 \times 10^{10}/$ bar for the given reaction at equilibrium.

$2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g)$

What is K_c at this temperature?

CORRECT ANSWER: $7.47XX10^{11}M^{-1}$

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Exercise 7.11

A sample of $HI(g)$ is placed in flask at a pressure of $0.2atm$. At equilibrium. The partial pressure of $HI(g)$ is $0.04atm$. What is K_p for the given equilibrium?

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

CORRECT ANSWER: 4.0

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Exercise 7.12

A mixture of $1.57mol$ of N_2, $1.92mol$ of H_2 and $8.13mol$ of NH_3 is introduced into a $20L$ reaction vessel at $500K$. At this temperature, the equilibrium constant K_c for the reaction

$N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$ is 1.7×10^2. Is the reaction mixture at equilibrium? If not, what is the direction of the net reaction?

CORRECT ANSWER: $Q_C = 2.379XX10^3$, NO.

REACTION IS NOT AT EQUILIBRIUM.

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Exercise 7.13

The equilibrium constant expression for a gas reaction is :

$$K_c = \frac{\left[NH_3\right]^4\left[O_2\right]^5}{[NO]^4\left[H_2O\right]^6}$$

Write the balanced chemical equation corresponding to this expression.

CORRECT ANSWER: N//A

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Exercise 7.14

One mole of H_2O and one mole of CO are taken in a $10 litre$ vessel and heated to $725K$. At equilibrium, $40 percent$ of water (by mass) reacts with carbon monoxide according to the equation,

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

Calculate the equilibrium constant for the reaction.

CORRECT ANSWER: 0.44

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Exercise 7.15

At $700K$ equilibrium constant for the reaction,

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

is 54.8. If $0.5 mollitre^{-1}$ of $HI_{(g)}$ is present at equilibrium at $700K$, what are the concentrations of $H_{2(g)}$ and $I_{2(g)}$, assuming that we initially started with $HI_{(g)}$ and allowed it to reach equilibrium at $700K$.

CORRECT ANSWER: $0.068 MOLL^{-1}$ EACH OF H_2 AND I_2

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Exercise 7.16

What is the equilibrium concentration of each of the substance in

the equilibrium when the initial concentration of ICl was $0.78M$?

$2ICl(g) \Leftrightarrow I_2(g) + Cl_2(g), K_c = 0.14$

CORRECT ANSWER:

$\left[I_2\right] = \left[CL_2\right] = 0.167M.\ [ICL] = 0.0446M$

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Exercise 7.17

$K_p = 0.04atm$ at $899K$ for the equilibrium shown below. What is the equilibrium concentration of C_2H_6 when it is placed in a flask at $4.0atm$ pressure and allowed to come to equilibrium?

$C_2H_6(g) \Leftrightarrow C_2H_4(g) + H_2(g)$

CORRECT ANSWER: $\left[C_2H_6\right]_{EQ} = 3.62ATM$

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Exercise 7.18

The ester, ethyl acetate is formed by the reaction between ethanol and acetic acid and equilibrium is represented as:

$$CH_3COOH_{(l)} + C_2H_5OH_{(l)} \Leftrightarrow CH_3COOC_2H_{5_{(aq)}} + H_2O_{(l)}$$

(*a*) Write the concentration ratio (reaction quotient), Q_e, for this reaction. Note that water is not in excess and is not a solvent in this reaction.

(*b*) At $293K$, if one starts with 1.00mole of acetic acid and 0.180 of ethanol, there is 0.171mole of ehtyl acetate in the final equilibrium mixture. Calculate the equilibrium constant.

(*c*) Starting with 0.500mole of ethanol and 1.000mole of acetic acid and maintaining it at $293K$, 0.214mole of ethyl acetate is found after some time. Has equilibrium been reached?

CORRECT ANSWER: (I)

$$\left[CH_3COOC_2H_5\right]\left[H_2O\right] / \left[CH_2COOH\right]\left[C_2H_5OH\right]$$

(II) 3.92 , (III) VALUE OF Q_C IS LESS THAN K_C

THEREFORE EQUILIBRIUM IS NOT ATTAINED.

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Exercise 7.19

A sample of pure PCl_5 was introduced into an evacuted vessel at $473K$. After equilibrium was attained,concentration of PCl_5 was found to be $0.5 \times 10^{-1} mollitre^{-1}$. If value of K_c is $8.3 \times 10^{-3} mollitre^{-1}$. What are the concentrations of PCl_3 and Cl_2 at equilibrium ?

CORRECT ANSWER: $0.02 MOLL^{-1}$ FOR BOTH.

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Exercise 7.20

One of the reaction that takes plece in producing steel from iron ore is the reduction of iron(II) oxide by carbon monoxide to give iron

metal and CO_2.

$FeO(s) + CO(g) \Leftrightarrow Fe(s) + CO_2(g), K_p = 0.265$ atm at $1050K$

What are the equilibrium partial pressure of CO and CO_2 at $1050K$

if the partical pressure are: $p_{CO} = 1.4atm$ and $p_{CO_2} = 0.80atm$?

CORRECT ANSWER: $\left[P_{CO}\right] = 1.739$ATM,

$\left[P_{CO2}\right] = 0.461$ ATM.

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Exercise 7.21

Equilibrium constant, K_c for the reaction,

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

at $500K$ is $0.061 litre^2 \text{mole}^{-2}$. At a particular time, the analysis

shows that composition of the reaction mixture is $3.00 mol litre^{-1} N_2$,

$2.00 mol litre^{-1} H_2$, and $0.500 mol litre^{-1} NH_3$. Is the reaction at

equilibrium? If not, in which direction does the reaction tend to

proceed to reach equilibrium?

CORRECT ANSWER: NO, THE REACTION

PROCEEDS TO FORM MORE PRODUCTS.

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Exercise 7.22

Bromine monochloride, ($BrCl$) decomposes into bromine and

chlorine and reaches the equilibrium.

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

For which $K_c = 32$ at $500K$. If initially pure $BrCl$ is present at a

concentration of $3.30 \times 10^{-3} mollitre^{-1}$, what is its molar

concentration in the mixture at equilibrium?

CORRECT ANSWER: $3XX10^{-4}$MOLL^{-1}

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Exercise 7.23

At $1127K$ and $1atm$ pressure, a gaseous mixture of CO and CO_2 in equilibrium with solid carbon has 90.55 % CO by mass:

$$C_{(s)} + CO_{2(g)} \Leftrightarrow 2CO_{(g)}$$

Calculate K_c for the reaction at the above temperature.

CORRECT ANSWER: 0.149

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Exercise 7.24

Calculate (a) $\Delta G^?$ and (b) the equilibrium constant for the formation of NO and O_2 at $298K$

$$NO(g) + 1/2O_2(g) \Leftrightarrow NO_2(g)$$

where

$$\Delta_f G^? \left(NO_2\right) = 52.0kJmol^{-1}$$

$\Delta_f G^?(NO) = 87.0 kJmol^{-1}$

$\Delta_f G^?\left(O_2\right) = 0 kJmol^{-1}$

CORRECT ANSWER: A) $-35.0 KJ$, B) $1.365 XX 10^6$

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Exercise 7.25

Does the number of moles of reaction products increase, decrease, or remain same when each of the following equilibrium is subjected to a decrease in pressure by increasing the volume?

a. $PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$

b. $CaO(s) + CO_2(g) \Leftrightarrow CaCO_3(s)$

c. $3Fe(s) + 4H_2O(g) \Leftrightarrow Fe_3O_4(s) + 4H_2(g)$

CORRECT ANSWER: N//A

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Exercise 7.26

Which of the following reactions will get affected by increasing the pressure? Also, mention whether change will cause the reaction the reaction to go into forward of backward direction.

a. $COCl_2(g) \Leftrightarrow CO(g) + Cl_2(g)$

b. $CH_4(g) + 2S_2(g) \Leftrightarrow CS_2(g) + 2H_2S(g)$

c. $CO_2(g) + C(s) \Leftrightarrow 2CO(g)$

d. $2H_2(g) + CO(g) \Leftrightarrow CH_3OH(g)$

e. $CaCO_3(s) \Leftrightarrow CaO(s) + CO_2(g)$

f. $4NH_3(g) + 5O_2(g) \Leftrightarrow 4NO(g) + 6H_2O(g)$

CORRECT ANSWER: N//A

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Exercise 7.27

The equilibrium constant for the following reaction is 1.6×10^5 at

$1024K$

$H_2(g) + Br_2(g) \Leftrightarrow 2HBr(g)$

find the equilibrium pressure of all gases if 10.0 bar of HBr is

introduced into a sealed container at $1024K$.

CORRECT ANSWER:

$\left[P_{H_2}\right]_{EQ} = \left[P_{BR_2}\right]_{EQ.} = 2.5XX10^{-2}\text{BAR}, \left[P_{HBR}\right] = 10.0$

BAR

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Exercise 7.28

Dihydrogen gas is obtained from natural gas by partial oxidation

with steam as per following endothermic reaction:

$CH_4(g) + H_2O(g) \Leftrightarrow CO(g) + 3H_2(g)$

a. Write an expression for K_(p) for the above reaction.

b. How will the value of $K_{(p)}$ and composition of equilibrium mixture be affected by

i. Increasing the pressure

ii. Increasing the temperature

iii. Using a catalyst?

CORRECT ANSWER: N//A

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Exercise 7.29

Decribe the effect of:

a. Addition of H_2

b. Addition of CH_3OH

c. Removal of CO

d. Removal of CH_3OH

on the equilibrium of the reaction:

$2H_2(g) + CO(g) \Leftrightarrow CH_3OH(g)$

CORRECT ANSWER: N//A

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Exercise 7.30

At $473K$, equilibrium constant K_c for decomposition of phosphorus pentachloride, PCl_5 is 8.3×10^{-3}. If decomposition is depicted as,

$PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g) \Delta_r H^? = 124.0 kJmol^{-1}$

a. Write an expression for K_c for the reaction.

b. What is the value of K_c for the reverse reaction at the same temperature?

c. What would be the effect on K_c if

i. More PCl_5 is added

ii. Pressure is increased

iii. The temperature is increased?

CORRECT ANSWER: B) 120.48

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Exercise 7.31

Dihydrogen gas used in Haber's process is produced by reacting methane from natural gas with high temperature steam. The first stage of the two 2 stage reaction involves the formation of CO and H_2. In second stage, CO formed in first stage is reacted with more steam in water gas shift reaction,

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

If a reaction vessel at $400\,C$ is charged with an equimolar mixture of CO and steam such that $p_{CO} = p_{H_2O} = 4.0$ bar, what will be the partial pressure of H_2 at equilibrium? $K_p = 0.1$ at $400\,C$.

CORRECT ANSWER: $\left[H_2\right]_{EQ} = 0.96$ BAR

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Exercise 7.32

Predict which of the following reactions will have appreciable concentration of rectants and products:

a. $Cl_2(g) \Leftrightarrow 2Cl(g), K_c = 5 \times 10^{-39}$

b. $Cl_2(g) + 2NO(g) \Leftrightarrow 2NOCl(g), K_c = 3.7 \times 10^{8}$

c. $Cl_2(g) + 2NO_2(g) \Leftrightarrow 2NO_2Cl(g), K_c = 1.8$

CORRECT ANSWER: N//A

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Exercise 7.33

The value of K_c for the reaction $3O_2(g) \Leftrightarrow 2O_3(g)$ is 2.0×10^{-50} at $25C$. If the equilibrium concentration of O_2 in air at $25C$ is 1.6×10^{-2}, what is the concentration of O_3?

CORRECT ANSWER: $2.86XX10^{-28}M$

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Exercise 7.34

The reaction, $CO(g) + 3H_2(g) \Leftrightarrow CH_4(g) + H_2O(g)$ is at equilibrium at $1300K$ in a $1L$ flask. It also contains $0.30mol$ of CO, $0.10mol$ of H_2 and 0.02 mol of H_2O and an unknown amount of CH_4 in the flask. Determine the concentration of CH_4 in the mixture. The equilibrium constant K_c for the reaction at the given temperature us 3.90.

CORRECT ANSWER: $5.85XX10^{-3}$

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Exercise 7.35

What is meant by the conjugate acid-base pair? Find the conjugate acid/base for the following species:

$HNO_2, CN^{?}, HClO_4, F^{?}, \overset{?}{OH}, CO_3^{2-}$, and S^{2-}

CORRECT ANSWER:

$NO_2^-, HCN, CLO_4, HF, H_2O, HCO_3^-, HS^-$

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Exercise 7.36

Which of the followings are Lewis acids: $H_2O, BF_3, H^{\oplus}$ and NH_4?

CORRECT ANSWER: BF_3, H^+, NH_4^+

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Exercise 7.37

Write the conjugate bases for the following Brddotonsted acids

(a) HF (b) H_2SO_4 (c) $HCO_3^{?}$

CORRECT ANSWER: F^-, HSO_4^-, CO_3^{2-}

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Exercise 7.38

Wirte the conjugate acids for the following Brdddotosted bases:

?

a. NH_2 b. NH_3 c. $HCOO^?$

CORRECT ANSWER: $NH_3, NH_4^+, HCOOH$

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Exercise 7.39

The species: $H_2O, HCO_3^?, HSO_4^?$ and NH_3 can act both as Bronsted acids and bases. For each case give the corresponding conjugate acid and base.

CORRECT ANSWER: N//A

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Exercise 7.40

Classify the following species into Lewis acids and Lewis bases and show how these act as Lewis acid/base:

?

a. OH, $b.\ F^{?}$, $c.\ H^{\oplus}$, $d.\ BCl_3$

CORRECT ANSWER: N//A

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Exercise 7.41

The concentration of hydrogen ion in a sample of soft drink is $3.8 \times 10^{-3} M$. What is its pH?

CORRECT ANSWER: 2.42

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Exercise 7.42

The pH of a sample of vinegar is 3.76, Calculate the concentration of hydrogen ion in it.

CORRECT ANSWER: $1.7XX10^{-4}M$

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Exercise 7.43

The ionization constant of HF, $HCOOH$ and HCN at $298K$ are 6.8×10^{-4}, 1.8×10^{-4} and 4.8×10^{-9} respectively. Calculate the ionization constant of the corresponding conjugate base.

CORRECT ANSWER:

$F^- = 1.5XX10^{-11}, HCOO^- = 5.6XX10^{-11}, CN^- = 2.08XX10^{-6}$

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Exercise 7.44

The ionization constant of phenol is 1.0×10^{-10}. What is the concentration of phenolate ion in $0.05M$ solution of phenol? What will be its degree of ionization if the solution is also $0.01M$ in sodium phenolate?

CORRECT ANSWER: [PHENOLATE ION]

$= 2.2XX10^{-6}, ALPHA = 4.47XX10^{-5}, ALPHA$ IN SODIUM

PHENOLATE $= 10^{-8}$

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Exercise 7.45

The first ionization constant of H_2S is 9.1×10^{-8}. Calculate the concentration of $HS^{?}$ ion in its $0.1M$ solution. How will this concentration be affected if the solution is $0.1M$ in HCl also? If the

second dissociation constant if H_2S is 1.2×10^{-13}, calculate the concentration of S^{2-} under both conditions.

CORRECT ANSWER: $\left[HS^{-}\right] = 9.54XX10^{-5}$, IN

$0.1MHCL\left[HS^{-}\right] = 9.1XX10^{-8}M$, $\left[S^{2-}\right] = 1.2XX10^{-13}M$, IN

$0.1MHCL\left[S^{2-}\right] = 1.09XX10^{-19}M$

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Exercise 7.46

The ionization constant of acetic acid 1.74×10^{-5}. Calculate the degree of dissociation of acetic acid in its $0.05M$ solution. Calculate the concentration of acetate ion in the solution and its pH.

CORRECT ANSWER: $\left[AC^{-}\right] = 0.00093, PH = 3.03$

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Exercise 7.47

It has been found that the pH of a $0.01M$ solution of an organic acid is 4.15. Calculate the concentration of the anion, the ionization constant of the acid and its pK_a.

CORRECT ANSWER:

$$\left[A^-\right] = 7.08XX10^{-5}M, K_A = 5.08XX10^{-7}, PK_A = 6.29$$

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Exercise 7.48

Assuming complete dissociation, calculate the pH of the following solutions,

a. $0.003MHCl$, *b*. $0.005MNaOH$,

c. $0.002MHBr$, *d*. $0.002MKOH$

CORRECT ANSWER: A) 2.52 , B) 11.70 , C) 2.70 , D) 11.30

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Exercise 7.49

Calculate the pH of the following solutions:

a. $2g$ of $TlOH$ dissolved in water to give 2 litre of solution.

b. $0.3g$ of $Ca(OH)_2$ dissolved in water to give $500mL$ of solution.

c. $0.3g$ of $NaOH$ dissolved in water to give $200mL$ of solution.

d. $1mL$ of $13.6MHCl$ is duluted with water to give 1 litre of solution.

CORRECT ANSWER: A) 11.65 , B) 12.21, C) 12.57 , D) 1.87

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Exercise 7.50

The degree of ionization of a 0.1M bromoacetic acid solution is 0.132. Calculate the pH of the solution and the $pK_(a)$ of bromoacetic acid.

CORRECT ANSWER: PH = 1.88, $PK_(A)$ = 2.70

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Exercise 7.51

The pH of 0.005 M codenine ($C_(18)H_(21)NO_(3)$) solution is 9.95. Calculate its ionisation constant and $pK_(b)$.

CORRECT ANSWER: $K_(B) = 1.6 XX 10^(-6)$, $PK_(B)$ = 5.8

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Exercise 7.52

What is the pH of 0.001 M aniline solution? The ionization constant of aniline 4.27xx10^(-10). Calculate the degree of ionization of aniline in the solution. Also calculate the ionization constant of the conjugate acid of aniline.

CORRECT ANSWER: ALPHA = 6.53 XX 10^(-4), K_(A) = 2.35 XX 10^(-5)

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Exercise 7.53

Calculate the degree of ionisation of 0.05 M acetic acid if its pK_(a) value is 4.74. How is the degree of dissociation affected when its solution also contains

a. 0.01 M, b. 0.1 M in HCl?

CORRECT ANSWER: A) 0.0018 , B) 0.00018

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Exercise 7.54

The ionisation constant of dimethylamine is $5.4xx10^{(-4)}$. Calculate its degree of ionization in its $0.02M$ solution. What percentage of dimethylamine is ionized if the solution is also 0.1 M in NaOH?

CORRECT ANSWER: ALPHA = 0.0054

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Exercise 7.55

Calculate the hydrogen ion concentration in the following biological fluids whose pH are given below:

a. Human muscle-fluid, 6.83

b. Human stomach fluid, 1.2

c. Human blood, 7.38

d. Human saliva, 6.4.

CORRECT ANSWER: A) 1.48 XX 10^(-7) M , B) 0.063 , C) 4.17 XX 10^(-8) M , D) 3.98 XX 10^(-7)

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Exercise 7.56

The pH of milk, black coffee, tomato juice, lemon juice and egg white are 6.8, 5.0, 4.2, 2.2 and 7.8 respectively. Calculate corresponding hydrogen ion concentration in each.

CORRECT ANSWER: A) 1.5 XX 10^(-7) M , B) 10^(-5) M , C) 6.31 XX 10^(-5) M , D) 6.31 XX 10^(-3) M

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Exercise 7.57

If $0.561\ g$ of (KOH) is dissolved in water to give. $200\ mL$ of solution at $298\ K$. Calculate the concentration of potassium, hydrogen and hydroxyl ions. What is its pH?

CORRECT ANSWER: $[K^{(+)}] = [OH^{(-)}] = 0.05M$, $[H^{(+)}] = 2.0 XX 10^{(-13)}\ M$

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Exercise 7.58

The solubility of $Sr(OH)_{(2)}$ at $298\ K$ is $19.23\ g\ L^{(-1)}$ of solution.

Calculate the concentrations cf strontium and hydroxyl ions and the pH of the solution.

CORRECT ANSWER: $[SR^{(2+)}] = 0.1581M$, $[OH^{(-)}] = 0.3162M$, $PH = 13.50$

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Exercise 7.59

The ionization constant of propionic acid is 1.32xx10^(-5).

Calculate the degree of ionization of the acid in its 0.05M solution and also its pH. What will be its degree of ionization in the solution of 0.01N HCI ?

CORRECT ANSWER: ALPHA = 1.63 XX 10^(-2), PH = 3.09, IN PRESENCE OF 0.01 M HCL, ALPHA = 1.32 XX 10^(-3)

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Exercise 7.60

The pH of 0.1 M solution of cyanic acid (HCNO) is 2.34. Calculate the ionization constant of the acid and its degree of ionisation in the solution.

CORRECT ANSWER: $K_{(A)} = 2.09 \times 10^{(-4)}$ AND

DEGREE OF IONIZATION = 0.0457

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Exercise 7.61

The ionization constant of nitrous acid is $4.5 \times 10^{(-4)}$. Calculate the pH of 0.04 M sodium nitrite solution and also its degree of hydrolysis.

CORRECT ANSWER: PH = 7.97. DEGREE OF HYDROLYSIS = $2.36 \times 10^{(-5)}$

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Exercise 7.62

A 0.02 M solution of pyridinium hydrochloride has pH=3.44.

Calculate the ionization constant of pyridine.

CORRECT ANSWER: $K_{(B)} = 1.5 \times 10^{(-9)}$

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Exercise 7.63

Predict if the solutions of the following salts are neutral, acidic or basic: $NaCl$, KBr, $NaCN$, $NH_{(4)}NO_{(3)}$, $NaNO_{(2)}$ and KF

CORRECT ANSWER: NACL, KBR SOLUTIONS ARE NEUTRAL, NACN, $NANO_{(2)}$ AND KF SOLUTION ARE BASIC AND $NH_{(4)}NO_{(3)}$ SOLUTION IS ACIDIC.

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Exercise 7.64

The ionization constant of chloroacetic acid is $1.35 \times 10^{(-3)}$. What will be the pH of 0.1 M acid and its 0.1M sodium salt solution?

CORRECT ANSWER: (A) PH OF ACID SOLUTION = 1.9 , (B) PH OF ITS SALT SOLUTION = 7.9

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Exercise 7.65

Ionic product of water at 310 K is 2.7xx10^(-14). What is the pH of netural water at this temperature?

CORRECT ANSWER: PH = 6.78

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Exercise 7.66

Calculate the pH of the resultant mixture:

a. 10 mL of 0.2M Ca(OH)_(2)+25 mL of 0.1 M HCl

b. 10 mL of 0.01 M H_(2)SO_(4) + 10 mL of 0.01 M Ca(OH)_(2).

c. 10 mL of 0.1 M H_(2)SO_(4)+ 10 mL of 0.1 M KOH.

CORRECT ANSWER: A) 12.6 , B) 7.00 , C) 1.3

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Exercise 7.67

Determine the solubilities of silver chromate, barium chromate, ferric hydroxide, lead chloride and mercurous iodide at 298K from their solubility product constants given in Table 7.9. Determine also the molarities of individual ions.

CORRECT ANSWER: SILVER CHROMATE S = 0.65 XX 10^(-4) M; MOLARITY OF AG^(+) = 1.30 XX 10^(-4) M

MOLARITY OF CRO_(4^(2-)) = 0.65 XX 10^(-4) M;

BARIUM CHROMATE S = 1.1 XX 10^(-5) M; MOLARITY OF

BA^(2+) AND CRO_(4^(2-)) EACH IS 1.1 XX 10^(-5) M;

FERRIC HYDROXIDE $S = 1.39 XX 10^{(-10)} M$;

MOLARITY OF $FE^{(3+)} = 1.39 XX 10^{(-10)} M$;

MOLARITY OF $[OH^{(-)}] = 4.17 XX 10^{(-10)}M$

LEAD CHLORIDE $S = 1.59 XX 10^{(-2)} M$; MOLARITY

OF $PB^{(2+)} = 1.59 XX 10^{(-2)} M$

MOLARITY OF $CL^{(-)} = 3.18 XX 10^{(-2)} M$;

MERCUROUS IODIDE $S = 2.24 XX 10^{(-10)} M$;

MOLARITY OF $HG_{(2^{(2+)})} = 2.24 XX 10^{(-10)}M$ AND

MOLARITY OF $I^{(-)} = 4.48 XX 10^{(-10)} M$

Exercise 7.68

The solubility product constant of $Ag_{(2)}CrO_{(4)}$ and $AgBr$ are $1.1xx10^{(-12)}$ and $5.0xx10^{(-13)}$ respectively. Calculate the ratio of the molarities of their saturated solutions.

CORRECT ANSWER: SILVER CHROMATE IS MORE SOLUBLE AND THE RATIO OF THEIR MOLARITIES = 91.9

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Exercise 7.69

Equal volumes of 0.002 M solution of sodium iodate and cupric chlorate are mixed togather. Will it lead to precipitation of copper iodate?

("for cupric iodate" K =7.4xx10^(-8)).

CORRECT ANSWER: NO PRECIPITATE

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Exercise 7.70

The ionisation constant of benzoic acid (PhCOOH) is 6.46 xx

10^{-5} and K_{sp} for silver benzoate is 2.5×10^{-3}. How many times is silver benzoate more soluble in a buffer of pH 3.19 compared to its solubility is pure water?

CORRECT ANSWER: SILVER BENOZATE IS 3.317

TIMES MORE SOLUBLE AT LOWER PH

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Exercise 7.71

What is the maximum concentration of equimolar solutions of ferrous sulphate and sodium sulphide so that when mixed in equal volumes, there is no precipitation of iron sulphide? (For iron sulphide, $K_{sp}=6.3 \times 10^{-18}$).

CORRECT ANSWER: THE HIGHEST MOLARITY FOR THE SOLUTION IS 2.5×10^{-9} M

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Exercise 7.72

What is the minimum volume of water required to dissolve 1.0 g of calcium sulphate at 298 K? (For calcium sulphate , K_(sp) is 9.1xx10^(-6)).

CORRECT ANSWER: 2.43 LITRE OF WATER

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Exercise 7.73

The concentration of suphide ion in 0.1 M HCl solution saturated with hydrogen sulphide is 1.0xx10^(-19)M. If 10 mL of this is added to 5 mL of 0.04 M solution of the following: FeSO_(4), MnCl_(2), ZnCl_(z) and CdCl_(2). In which of these solutions precipitation will take place?

CORRECT ANSWER: PRECIPITATION WILL TAKE PLACE IN CADMIUM CHLORIDE SOLUTION.

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Solved Example 1

The following concentrations were obtained for the formation of $NH_{(3)}$ from $N_{(2)}$ and $H_{(2)}$ at equilibrium at $500\ K$. $[N_{(2)}]=1.5xx10^{(-2)}\ M$, $[H_{(2)}]=3.0xx10^{(-2)}M$, and $[NH_{(3)}]=1.2xx10^{(-2)}M$. Calculate the equilibrium constant.

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Solved Example 2

At equilibrium, the concentrations of $N_{(2)}=3.0xx10^{(-3)}M$, $O_{(2)}=4.2xx10^{(-3)}\ M$, and $NO=2.8xx10^{(-3)}\ M$ in a sealed vessel at $800K$. What will be $K_{(c)}$ for the reaction

$N_{(2)(g)}+O_{(2)(g)}N_{(2)(g)}+O_{(2)(g)}hArr2NO(g)2NO(g)$

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Solved Example 3

$PCl_{(5)}, PCl_{(3)}$ and $Cl_{(2)}$ are at equilibrium at $500\ K$ and having concentration $1.59\ M\ PCl_{(3)}$, $1.59\ M\ Cl_{(2)}$ and $1.41\ M\ PCl_{(5)}$.

Calculate $K_{(c)}$ for the reaction,

$PCl_{(5)}\ hArr\ PCl_{(3)} + Cl_{(2)}$

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Solved Example 4

The value of $K_{(c)} = 4.24$ at $800\ K$ for the reaction.

$CO(g) + H_{(2)}O(g)\ hArr\ CO_{(2)(g)}+H_{(2)(g)}$

Calculate equilibrium concentration of $CO_{(2)}, H_{(2)}, CO$ and $H_{(2)}O$ at $800K$. If only CO and $H_{(2)}O$ are present initially at

concentrations of $0.10\ M$ each.

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Solved Example 5

For the equilibrium

$2NOCl(g)\ hArr\ 2NO(g)+Cl_(2)(g)$

the value of the equilibrium constant, $K_(c)$ is $3.75\ xx\ 10^(-6)$ at $1069\ K$. Calcualate the $K_(p)$ for the reaction at this temperature?

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Solved Example 6

The value of $K_(p)$ for the reaction

$CO_(2)(g)+C(s)hArr2CO(g)$

is 3.0 bar at $1000\ K$. If initially $P_(CO_(2)) = 0.48$ bar, $P_(CO) = 0$ bar and pure graphite is present then determine equilibrium partial

pressue of CO and CO_(2) .

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Solved Example 7

The value of K_(c) for the reaction 2A hArr B+C is 2.0xx10^(-3).

At a given time, the composition of reaction mixture is [A]=[B]=

[C]=3xx10^(-4)M. In which direction the reaction will proceed?

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Solved Example 8

13.8 g of N_(2)O_(4) was placed in a 1L reaction vessel at 400 K

and allowed to attain equilibrium

N_(2)O_(4) (g) hArr 2NO_(2)(g)

The total pressuers at equilibrium was found to be 9.15 bar.

Calculate K_(c), K_(p) and partial pressure at equilibrium.

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Solved Example 9

3.00 mol of PCl_(5) kept in 1L closed reaction vessel was allowed to attain equilibrium at 3.80 K. Calculate composition of the mixture at equilibrium K_(c) = 1.80

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Solved Example 10

The value of DeltaG^(?) for the phosphorylation of glycose in glycolysis is 13.8 kJ mol^(-1). Find the value of K_(c) at 298 K

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Solved Example 11

Hydrolysis of sucrose gives

"Sucrose" +H_(2)OhArr"Glucose + Fructose"

Equilibrium constant K_(c) for the reaction is 2xx10^(13) at 300 K.

Calculate DeltaG^(?) at 300 K.

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Solved Example 12

Write the conjugate bases for the following Brddotonsted acids

(a) HF (b) H_(2)SO_(4) (c) HCO_(3)^(?)

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Solved Example 13

Wirte the conjugate acids for the following Brdddotosted bases:

a. overset(?)NH_(2) b. NH_(3) c. HCOO^(?)

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Solved Example 14

The species: $H_{(2)}O, HCO_{(3)}^{(?)}, HSO_{(4)}^{(?)}$ and $NH_{(3)}$ can act both as Bronsted acids and bases. For each case give the corresponding conjugate acid and base.

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Solved Example 15

Classify the following species into Lewis acids and Lewis bases and show how these act as Lewis acid//base:

a. $\overset{(?)}{(O)}H$, b. $F^{(?)}$, c. $H^{(o+)}$, d. $BCl_{(3)}$

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Solved Example 16

The concentration of hydrogen ion in a sample of soft drink is $3.8 \times 10^{-3} M$. What is its pH?

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Solved Example 17

The pH of $10^{-8} M$ solution of HCl in water is

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Solved Example 18

The ionization constant of HF is 3.2×10^{-4}. Calculate the degree of ionization of HF in its $0.02 M$ solution. Calculate the concentration of all species present in the solution and its pH.

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Solved Example 19

The pH of 0.1M monobasic acid is 4.50. Calculate the concentration of species, H^(o+), A^(?), and HA at equilibrium. Also determine the value of K_(a) and pK_(a) of the monobasic acid.

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Solved Example 20

Calculate the pH of 0.08 solution of HOCI (hydrochlorous acid). The ionisation constant of the acid is 2.5 xx 10^(-5). Determine the percent dissociation of HOCI.

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Solved Example 21

The pH of 0.004M hydrazine (NH_(2).NH_(2)) solution is 9.7.

Calculate its ionisation constant $K_{(b)}$ and $pK_{(b)}$.

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Solved Example 22

Calculate the pH of the solution in which 0.2 M $NH_{(4)}Cl$ and 0.1 M $NH_{(3)}$ are present. The $pK_{(b)}$ of ammonia solution is 4.75.

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Solved Example 23

Determine the degree if ionization and pH of 0.05 M of ammonia solution. The ionization constant of ammonia can be taken from Table 7.7. Also calculate the ionization constant of the conjugate acid of ammonia.

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Solved Example 24

50.0 mL of 0.10 M ammonia solution is treated with 25.0 mL of 0.10M HCl. If $K_{b}(NH_{3})=1.77 \times 10^{-5}$, the pH of the resulting solution will be

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Solved Example 25

The pK_{a} of acetic acid and pK_{b} of ammonium hydroxide are 4.76 and 4.75 respectively. Calculate the pH of ammonium acetate solution.

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Solved Example 26

Calcualte the solubility of $M_{2}X_{3}$ in pure water, assuming that

neither kind of ion reacts with $H_(2)O$. The solubility product of $M_(2)X_(3), K_(sp) = 1.1 xx 10^(-23)$.

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Solved Example 27

The values of $K_(sp)$ of two sparingly solubles salts, $Ni(OH)_(2)$ and $AgCN$ are $2.0 xx 10^(-15)$ and $6 xx 10^(-7)$ respectively, which salt is more soluble? Explain

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Solved Example 28

The solubility product of $Ni(OH)_(2)$ is $2.0xx10^(-15)$. The molar solubility of $Ni(OH)_(2)$ in $0.1 M NaOH$ solution is

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