SAMPLE CONTENT

MHT-CET TRIUMPH

CHEMISTRY PART 2

BASED ON THE LATEST SYLLABUS OF MHT-CET

4507 MCQs

Std. XII

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Written in accordance with the latest MHT-CET Paper Pattern prescribed by State Common Entrance Test Cell, Maharashtra State

MHT-CET TRIUMPH

CHEMISTRY

4507 MCQs

Based on the latest Syllabus of MHT-CET

PART 2 Std. XII

Salient Features

- Includes all the chapters of Std. XII as per the latest MHT-CET Syllabus
- Includes '4507' MCQs
- Quick Review and exhaustive subtopic wise coverage of MCQs
- Compilation of all 'Important Formulae' in relevant chapters
- Solved Previous Years' MHT-CET questions till 2023
- Evaluation Test for each chapter
- Special Inclusion: Compilation of organic reaction based MCQs
- Two Model Question Papers with answer keys (Solutions provided through Q.R. codes)
- Two Question Papers & Answer Keys of MHT-CET 2023 (Solutions provided through Q.R. codes)
- Includes **Smart Keys** (Key Notes For Good Practice, Smart Code, Caution, Thinking Hatke, Shortcuts)
- 'Real-world applications' in each chapter
- Video/pdf links via QR codes for boosting conceptual retention
- Answer keys for all the chapters and Evaluation Tests at the end of book
- *Solutions to MCQs and Evaluation Test can be accessed through Q.R. code given at the end of each chapter*

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PREFACE

"Don't follow your dreams; chase them!" A quote by Richard Dumbrill is perhaps the most pertinent for one who is aiming to crack entrance examinations held after Std. XII. We are aware of the aggressive competition a student appearing for such career-defining examinations experiences and hence wanted to create books that develop the necessary knowledge, tools, and skills required to excel in these examinations.

For the syllabus of **MHT-CET**, 80% of the weightage is given to the syllabus for XIIth standard while only 20% is given to the syllabus for XIth standard (with inclusion of only selected topics).

We believe that although the syllabus for Std. XII and XI and MHT-CET is aligned, the outlook for studying the subject should be altered based on the nature of the examination. To score well in the MHT-CET, a student has to be not just good with the concepts but also quick to complete the test successfully. Such ingenuity can be developed through sincere learning and dedicated practice.

As a first step to MCQ solving, students should start with elementary questions. Once momentum is gained, complex MCQs with a higher level of difficulty should be practised. Such holistic preparation is the key to succeeding in the examination!

Target's **Triumph MHT-CET Chemistry Standard XII** book which covers all the chapters of Std. XII has been designed to achieve the above objectives. Beginning with basic MCQs, the book proceeds to develop competence to solve complex MCQs. It offers ample practice of recent questions from MHT-CET examinations. It also includes solutions (via QR codes) that provide explanations to help students learn how to solve the MCQs.

The sections of **Key Notes For Good Practice, Quick Review, Formulae,** and **MCQs (Classical, Critical, Concept Fusion, Previous Years' MHT-CET Questions, Evaluation Test)** form the backbone of every chapter and ensure adequate revision.

The exclusive addition of chapter **'Organic Reactions: Compilation of Organic Reaction Based MCQs'** leads students to an intuitive understanding of how different organic reactions can be used in specific sequences for the synthesis organic molecule.
The two **Model Question Papers** given at the end of the book are specially prepared to gauge the student's preparedness to appear for the MHT-CET examination. Two **MHT-CET 2023 Question Papers** have been provided to offer students a glimpse of the complexity of the questions asked in the examination.

All the features of this book pave the way for a student to excel in the examination. The features are designed keeping the following elements in mind: Time management, easy memorization or revision, and non-conventional yet simple methods for MCQ solving. The features of the book presented on the next page will explain more about them!

We hope the book benefits the learner as we have envisioned.

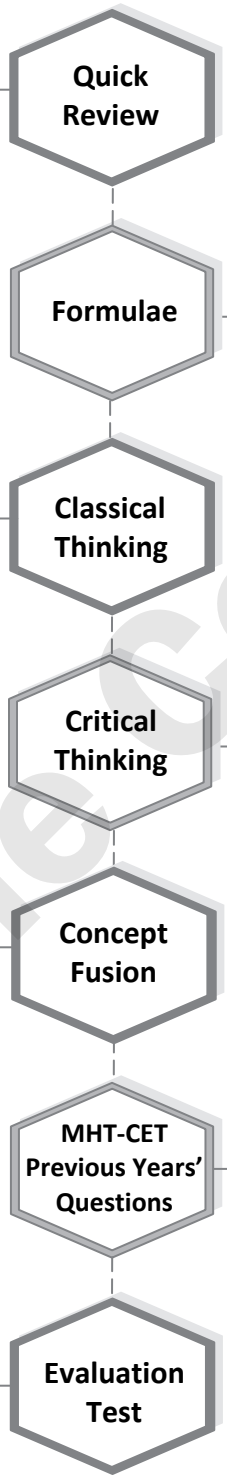
Publisher
Edition: Second

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

Please write to us on: mail@targetpublications.org

FEATURES

Quick Review includes tables/charts to summarize the key points/important chemical reactions in the chapter.
This is our attempt to help students to reinforce key concepts.



Formulae includes all of the key formulae in the chapter.
This is our attempt to make tools of formulae accessible for students while solving problems and revising at last minute at a glance.

Classical Thinking section encompasses straight forward questions including knowledge based questions.
This is our attempt to revise chapter in its basic form and warm up students to deal with complex MCQs.

Critical Thinking section encompasses challenging questions which test understanding, rational thinking and application skills of students.
This is our attempt to take students from beginner to proficient level in smooth steps.

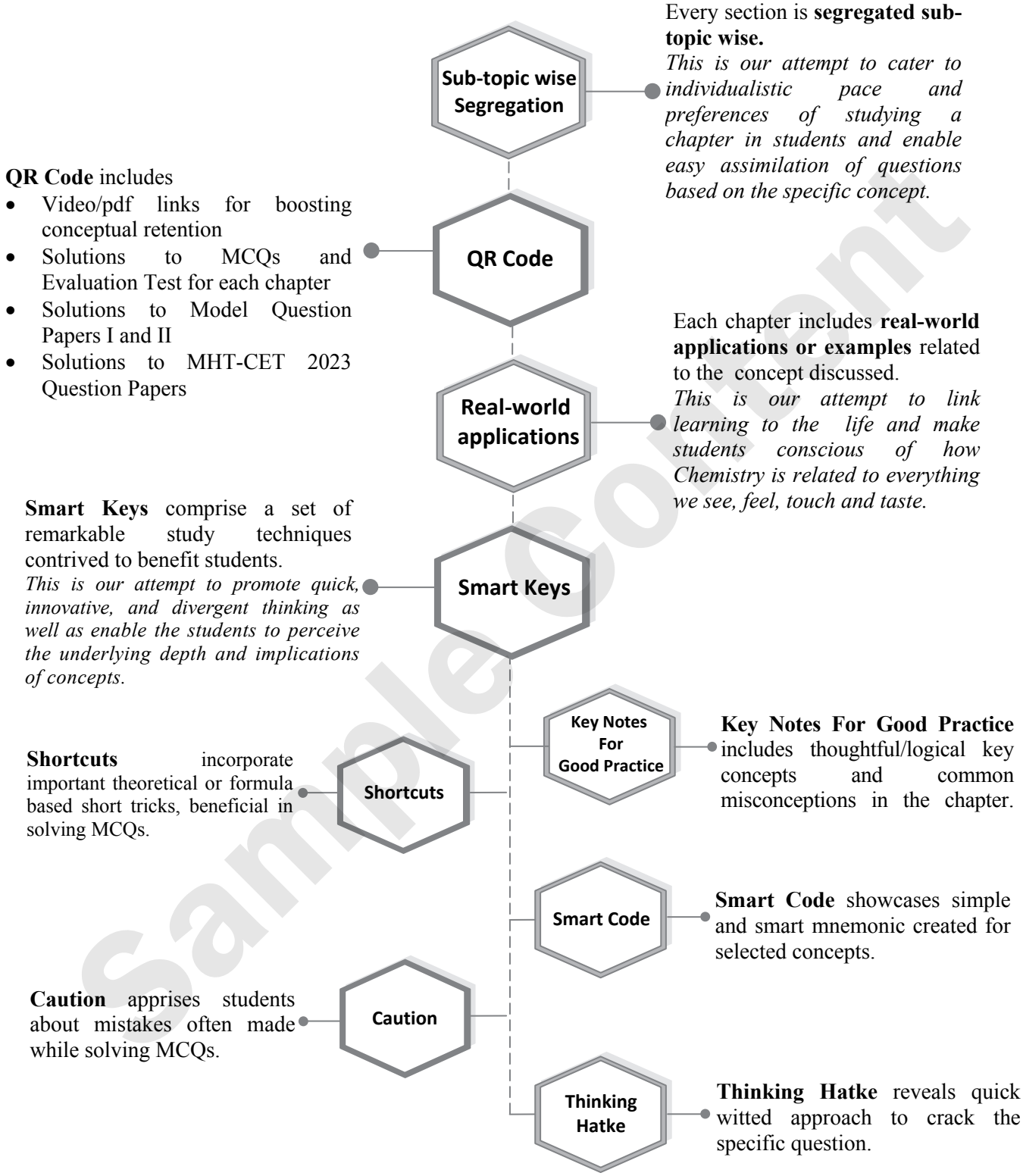
Concept Questions Fusion section encompasses questions whose solutions require knowledge of concepts covered in different sub-topics of same chapter or from different chapters.
This is our attempt to develop cognitive thinking in the students essential to solve questions involving fusion of multiple key concepts.

MHT-CET Previous Years' Questions section encompasses questions from MHT-CET examinations.
This is our attempt to give students practice of MHT-CET questions and advance them to acquire knack essential to solve such questions.

Evaluation Test encompasses questions based on concepts covered in the entire chapter.
This is our attempt to allow self-assessment of the chapter

Continued…

FEATURES



MHT-CET PAPER PATTERN

- There will be three papers of Multiple Choice Questions (MCQs) in 'Mathematics', 'Physics and Chemistry' and 'Biology' of 100 marks each.
- Duration of each paper will be 90 minutes.
- Questions will be based on the syllabus prescribed by Maharashtra State Board of Secondary and Higher Secondary Education with approximately 20% weightage given to Std. XI and 80% weightage will be given to Std. XII curriculum.
- Difficulty level of questions will be at par with JEE (Main) for Mathematics, Physics, Chemistry and at par with NEET for Biology.
- There will be no negative marking.
- Questions will be mainly application based.
- Details of the papers are as given below:

Paper	Subject	Approximate No. of Multiple Choice Questions (MCQs) based on		Mark(s) Per Question	Total Marks
		Std. XI	Std. XII		
Paper I	Mathematics	10	40	2	100
Paper II	Physics	10	40	1	100
	Chemistry	10	40		
Paper III	Biology	20	80	1	100

- Questions will be set on
  i. the entire syllabus of Std. XII of Physics, Chemistry, Mathematics and Biology subjects prescribed by Maharashtra Bureau of Textbook Production and curriculum Research, Pune, and
  ii. chapters / units from Std. XI curriculum as mentioned below:

Sr. No.	Subject	Chapters / Units of Std. XI
1	Physics	Motion in a plane, Laws of motion, Gravitation, Thermal properties of matter, Sound, Optics, Electrostatics, Semiconductors
2	Chemistry	Some Basic Concepts of Chemistry, Structure of Atom, Chemical Bonding, Redox Reactions, Elements of Group 1 and Group 2, States of Matter: Gaseous and Liquid States, Basic Principles of Organic Chemistry, Adsorption and Colloids, Hydrocarbons
3	Mathematics	Trigonometry - II, Straight Line, Circle, Measures of Dispersion, Probability, Complex Numbers, Permutations and Combinations, Functions, Limits, Continuity
4	Biology	Biomolecules, Respiration and Energy Transfer, Human Nutrition, Excretion and osmoregulation

CONTENTS

Chapter

3

Ionic Equilibria

Coral reefs – Nature's chemistry Lab!

A spectacular illustration of ionic (aqueous) equilibrium in action in nature may be seen in coral reefs.
Coral reefs are built by tiny animals, which make their exoskeleton from dissolved Ca^{2+} and CO_3^{2-} ions. The quantity of CO_2 dissolved in the ocean rises as atmospheric CO_2 levels rise. This causes the pH to fall and leads to decrease in CO_3^{2-} ions concentration. As a result, the aqueous equilibria existing in the ocean disrupts, thereby affecting the formation of coral reefs.

Chapter Outline

Key Notes For Good Practice

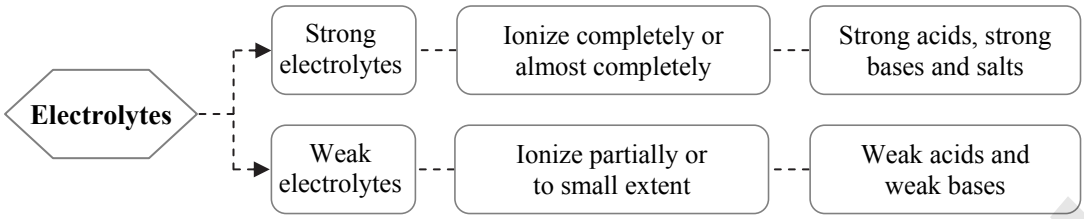
- *All Bronsted bases are also Lewis bases, but all Bronsted acids are not Lewis acids.*
- *Greater the value of K_a, higher is the strength of the acid. Greater the value of K_b, higher is the strength of the base.*
- *K_w is temperature dependent. The value of K_w increases with increase in temperature, i.e., the concentration of H^+ and OH^- ions increases with increase in temperature.*
- *A low pH indicates a high pOH for a substance and vice versa.*
- *The pH of a solution changes by one unit when $[H^+]$ changes by a factor 10, by two units when $[H^+]$ changes by a factor 100 and so on. Similarly, when $[H^+]$ decreases by a factor 10, pH increases by one unit.*
- *A dibasic acid gives twice the number of H^+ ions as compared to monobasic acid.*
- *On dilution of an acid by adding water, $[H^+]$ decreases. Hence, pH increases.*
- *A buffer solution has a definite pH value.*
- *Molar solubility is the number of moles of a compound that dissolve to form 1 L of saturated solution.*
- *Common ion effect follows Le-Chatelier's principle.*

Fundamental Constants in This Chapter

Ionic product of water (K_w) = 1.0×10^{-14} (at 298 K)

Quick Review

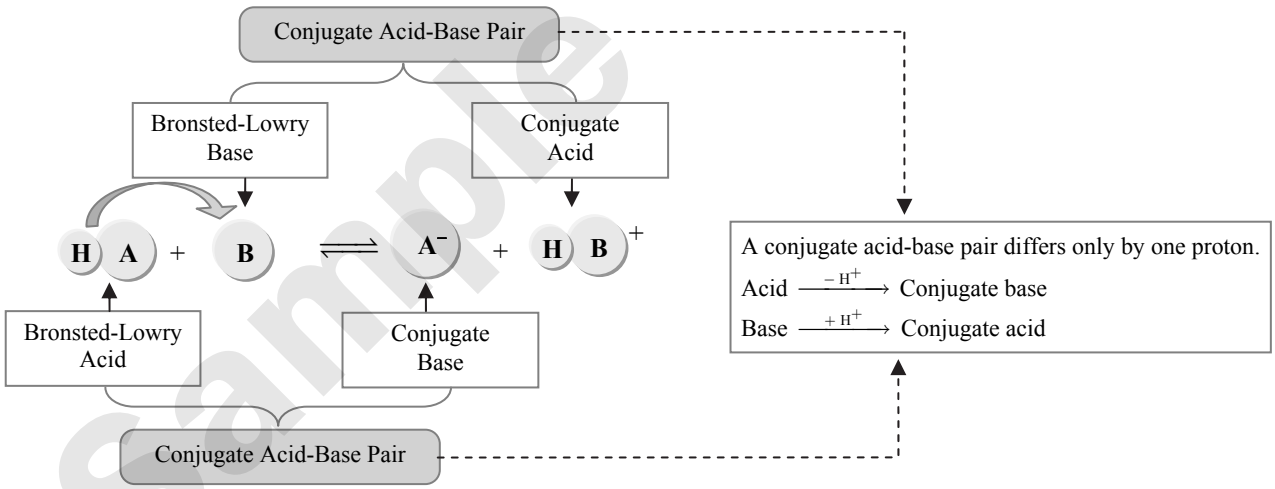
➢ **Classification of electrolytes (based on the extent of ionisation in dilute aqueous solution):**



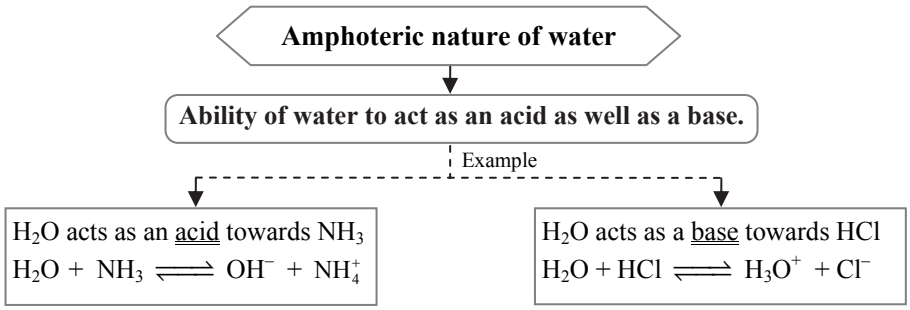
➢ **Various theories of acids and bases:**

Arrhenius theory	**Acid:** A substance that contains hydrogen and produces H^+ ions in aqueous solution. **Base:** A substance that contains OH group and produces OH^- ions in aqueous solution.
Bronsted-Lowry theory	**Acid:** Any substance that can donate a proton (H^+) i.e., proton donor. **Base:** Any substance that can accept a proton i.e., proton acceptor.
Lewis theory	**Acid:** Any species that can accept a share in an electron pair. **Base:** Any species that can donate a share in an electron pair.

➢ **Conjugate acid-base pair:**



➢ **Amphoteric nature of water:**



➢ Classification of acids and bases:

Acids and Bases

Based on extent of dissociation

- **Strong acids** **e.g.** HNO_3
- **Weak acids** **e.g.** HF
- **Strong bases** **e.g.** KOH
- **Weak bases** **e.g.** $Cu(OH)_2$

➢ Ostwald's dilution law:

Weak acid

$HA \rightleftharpoons H^+ + A^-$

Acid dissociation constant:

$K_a = \frac{[H^+][A^-]}{[HA]}$

Ostwald's dilution law

$\alpha = \sqrt{\frac{K_a}{c}}$ or $\alpha = \sqrt{K_a \cdot V}$

Weak base

$BOH \rightleftharpoons B^+ + OH^-$

Base dissociation constant:

$K_b = \frac{[B^+][OH^-]}{[BOH]}$

Ostwald's dilution law

$\alpha = \sqrt{\frac{K_b}{c}}$ or $\alpha = \sqrt{K_b \cdot V}$

➢ Autoionization of water:

Ionization equilibrium of water

$H_2O_{(l)}^+ + H_2O_{(l)} \rightleftharpoons H_3O_{(aq)}^+ + OH_{(aq)}^-$

Ionic product of water

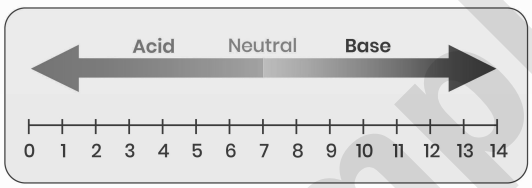
$K_w = [H_3O^+]\,[OH^-]$

For pure water at 298 K,

$[H_3O^+] = [OH^-] = 1.0 \times 10^{-7}$ mol/L

$\therefore \quad K_w = 1.0 \times 10^{-4}$

➢ pH Scale:



Acidic solutions	$[H^+] > [OH^-]$	$[H^+] > 1.0 \times 10^{-7}$ M	pH < 7.00
Basic solutions	$[H^+] < [OH^-]$	$[H^+] < 1.0 \times 10^{-7}$ M	pH > 7.00
Neutral solutions	$[H^+] = [OH^-]$	$[H^+] = 1.0 \times 10^{-7}$ M	pH = 7.00

➢ Types of salts:

Acidity and basicity of salts

- **Salts of strong acid and strong base**
  - Solution will be neutral. **e.g.** NaCl, KNO_3, Na_2SO_4
- **Salts of strong acid and weak base**
  - Solution will be acidic. **e.g.** NH_4Cl, NH_4NO_3 $(NH_4)_2SO_4$
- **Salts of weak acid and strong base**
  - Solution will be basic. **e.g.** CH_3COONa, KCN, Na_2CO_3
- **Salts of weak acid and weak base**
  - Solution may be acidic, basic or neutral depending on K_a and K_b values of weak acid and weak base respectively. **e.g.** CH_3COONH_4, NH_4CN, $(NH_4)_2CO_3$
    - If $K_a > K_b$, solution is acidic. **e.g.** NH_4F
    - If $K_a < K_b$, solution is basic. **e.g.** NH_4CN
    - If $K_a = K_b$, solution is neutral. **e.g.** CH_3COONH_4

➢ **Buffer solutions:**

Buffer solutions

A buffer solution resists drastic changes in pH upon the addition of a small amount of either an acid or a base.

Types

Acidic buffer solution

- A solution containing a weak acid and its salt with a strong base.
  e.g.
  CH_3COOH and CH_3COONa in water.
- Henderson-Hasselbalch equation is:

$$pH = pK_a + \log_{10}\frac{[salt]}{[acid]}$$

Basic buffer solution

- A solution containing a weak base and its salt with a strong acid.
  e.g.
  NH_4OH and NH_4Cl in water.
- Henderson-Hasselbalch equation is:

$$pOH = pK_b + \log_{10}\frac{[salt]}{[base]}$$

Properties

- When a small amount of strong acid (or strong base) is added to a buffer solution, there is no significant change in the value of pH.
- The dilution of a buffer solution will not change its pH.
- The pH of a buffer solution does not change with time.

➢ **Applications of buffer solution:**

Applications of buffer solution

Biochemical system | Agriculture | Industry | Medicine | Analytical chemistry

➢ **Different expressions for solubility product (K_{sp}):**

Type of electrolyte	Example	Equation	K_{sp} expression	Molar solubility
AB (1 : 1 type salt)	AgCl	$AgCl \rightleftharpoons Ag^+ + Cl^-$	$K_{sp} = [Ag^+]\,[Cl^-]$ $\mathbf{K_{sp} = S^2}$	$S = \sqrt{K_{sp}}$
AB_2 (1 : 2 type salt)	$PbCl_2$	$PbCl_2 \rightleftharpoons Pb^{2+} + 2Cl^-$	$K_{sp} = [Pb^{2+}]\,[Cl^-]^2$ $K_{sp} = [S]\,[2S]^2$ $\mathbf{K_{sp} = 4S^3}$	$S = \sqrt[3]{\frac{K_{sp}}{4}}$
A_2B (2 : 1 type salt)	Ag_2CrO_4	$Ag_2CrO_4 \rightleftharpoons 2Ag^+ + CrO_4^{2-}$	$K_{sp} = [Ag^+]^2\,[CrO_4^{2-}]$ $K_{sp} = [2S]^2\,[S]$ $\mathbf{K_{sp} = 4S^3}$	$S = \sqrt[3]{\frac{K_{sp}}{4}}$
AB_3 (1 : 3 type salt)	$AlCl_3$	$AlCl_3 \rightleftharpoons Al^{3+} + 3Cl^-$	$K_{sp} = [Al^{3+}]\,[3Cl^-]$ $K_{sp} = [S]\,[3S]^3$ $\mathbf{K_{sp} = 27S^4}$	$S = \sqrt[4]{\frac{K_{sp}}{27}}$
A_2B_3 (2 : 3 type salt)	As_2S_3	$As_2S_3 \rightleftharpoons 2As^{3+} + 3S^{2-}$	$K_{sp} = [As^{3+}]^2\,[S^{2-}]^3$ $K_{sp} = [2S]^2\,[3S]^3$ $K_{sp} = 4S^2 \times 27S^3$ $\mathbf{K_{sp} = 108S^5}$	$S = \sqrt[5]{\frac{K_{sp}}{108}}$

➢ **Condition for the formation of a precipitate:**

Condition	Type of solution	Result
Ionic product = K_{sp}	Saturated solution	No precipitation
Ionic product > K_{sp}	Supersaturated solution	Precipitation
Ionic product < K_{sp}	Unsaturated solution	No precipitation

Caution

The ionic product (IP) expression contains concentration of ions under any condition whereas expression of K_{sp} contains only equilibrium concentrations in a saturated solution.

➢ **Common ion effect:**

Common ion effect

Ionisation of a weak electrolyte is supressed in presence of a strong electrolyte containing an ion common to the weak electrolyte.
E.g. Dissociation of CH_3COOH decreases by addition of CH_3COONa in solution.

Common ion effect and Solubility

The solubility of a sparingly soluble compound ($PbCl_2$) decreases with the presence of a common ion (Cl^-) in solution.

Added Cl^-

$$PbCl_{2(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2Cl^-_{(aq)}$$

the equilibrium shifts to form more $PbCl_2$

Formulae

1. Degree of dissociation (α):

$$\alpha = \frac{\text{Number of moles dissociated}}{\text{Total number of moles}}$$

2. Ostwald's dilution law:

$$\alpha \propto \frac{1}{\sqrt{c}} \quad \textbf{OR} \quad \alpha \propto \sqrt{V}$$

c = concentration in mol dm^{-3},
V = volume in dm^3

3. Acid dissociation constant (K_a):

For weak acid HA, $K_a = \frac{[H^+][A^-]}{[HA]}$

$K_a = \alpha^2/V$ and $K_a = \alpha^2 c$

4. Base dissociation constant (K_b):

For weak base BOH, $K_b = \frac{[B^+][OH^-]}{[BOH]}$

$K_b = \alpha^2/V$ and $K_b = \alpha^2 c$

5. Ionic product of water (K_w) at 298 K:

$K_w = [H_3O^+]\,[OH^-] = 1.0 \times 10^{-14}$

6. pH of solution:

$pH = -\log_{10}[H_3O^+]$

7. pOH of solution:

$pOH = -\log_{10}[OH^-]$

8. Relation between pH and pOH:

$pH + pOH = 14$

9. Henderson-Hasselbalch equation:

Acidic buffer:

$$pH = pK_a + \log_{10}\frac{[salt]}{[acid]}$$

$pK_a = -\log_{10} K_a$

Basic buffer:

$$pOH = pK_b + \log_{10}\frac{[salt]}{[base]}$$

$pK_b = -\log_{10} K_b$

10. Solubility product (K_{sp}):

For salt B_xA_y: $B_xA_y \rightleftharpoons x B^{y+} + y A^{x-}$

$K_{sp} = [B^{y+}]^x\,[A^{x-}]^y$

11. Molar solubility, S (mol/L):

$$S = \frac{\text{Solubility in g/L}}{\text{Molar mass in g/mol}}$$

12. Relation between K_{sp} and S:

$K_{sp} = x^x\, y^y\, S^{x+y}$

Classical Thinking

3.1 Introduction

1. Identify the CORRECT statement.
(A) The equilibrium between ions and unionized molecules in solution is called ionic equilibrium.
(B) The equilibrium between solid salt and its ions in water is an example of physical equilibrium.
(C) The reaction between ions of salt and ions of water is an example of physical equilibrium.
(D) The principles of chemical equilibrium cannot be applied to ionic equilibrium.

3.2 Types of electrolyte

1. Identify the INCORRECT statement from the following.
(A) Substances which completely ionize into ions in their aqueous solution are called strong electrolytes.
(B) Substances which give rise to ions when dissolved in water are called nonelectrolytes.
(C) Substances which ionize to a smaller extent in their aqueous solutions are known as weak electrolytes.
(D) Ionization equilibrium is represented as double arrow $(\rightleftharpoons)$ between the ions and nonionized molecules.

2. $CuSO_4$ and CH_3COONH_4 are _____.
(A) Strong electrolytes
(B) Weak electrolytes
(C) Weak and strong electrolyte respectively
(D) Strong and weak electrolyte respectively

3. Which of the following dissociates only partially in dilute aqueous solution?
(A) $CuSO_4$ (B) H_2SO_4
(C) HF (D) KOH

4. The degree of dissociation of an electrolyte is given by the expression _____.
(A) $\alpha = \frac{\text{number of moles dissociated}}{\text{Percent dissociation}}$
(B) $\alpha = \frac{\text{number of moles dissociated}}{\text{total number of moles}}$
(C) $\alpha = \frac{\text{total number of moles}}{\text{number of moles dissociated}}$
(D) $\alpha = \frac{\text{number of moles of cations}}{\text{number of moles of anions}}$

3.3 Acids and bases

1. Which of the following is used in household cleaning products?
(A) Citric acid
(B) Ammonia
(C) Tartaric acid
(D) Magnesium hydroxide

2. Select the CORRECT statement.
(A) According to the Arrhenius theory, an acid is a substance that gives H^+ ions in aqueous solution.
(B) According to the Arrhenius theory, an acid is a substance that gives OH^- ions in aqueous solution.
(C) According to the Arrhenius theory, a base is a substance that gives H^+ ions in aqueous solution.
(D) According to the Arrhenius theory, a base is a substance that accepts an electron pair.

3. The H^+ ions in the aqueous solution exists in the form of _____.
(A) hydroxide ions (B) hydronium ions
(C) oxide ions (D) hydride ions

4. _____ present in the gastric juice is secreted by our stomach and is essential for digestion of food.
(A) H_2CO_3 (B) HNO_3
(C) CH_3COOH (D) HCl

5. Which of the following is NOT a base according to Arrhenius theory?
(A) NaOH (B) NH_3
(C) NH_4OH (D) $Mg(OH)_2$

6. According to the Bronsted-Lowry theory, a base is a substance that _____.
(A) donates a proton to another substance
(B) accepts an electron pair
(C) contains OH group
(D) accepts a proton from another substance

7. The conjugate acid of NH_3 is _____.
(A) NH_4^+ (B) NH_2^-
(C) H_3O^+ (D) NH_4OH

8. Conjugate base for Bronsted acids H_2O and HF are _____.
(A) H_3O^+ and F^-, respectively
(B) OH^- and F^-, respectively
(C) H_3O^+ and H_2F^+, respectively
(D) OH^- and H_2F^+, respectively

9. According to _____ theory, a base is any species which _____.
(A) Bronsted-Lowry; donates a share in an electron pair
(B) Lewis ; accepts a share in an electron pair
(C) Lewis ; accepts a proton
(D) Bronsted-Lowry ; donates a proton

10. Acidity of BF_3 can be explained on which of the following concepts?
(A) Arrhenius concept
(B) Bronsted-Lowry concept
(C) Lewis concept
(D) Bronsted-Lowry as well as Lewis concept

11. Water acts as a/an _____ towards NH_3 and as a/an _____ towards HCl.
(A) acid; base (B) base; acid
(C) acid; acid (D) base; base

3.4 Ionization of acids and bases

1. Which of the following is NOT a weak acid?
(A) H_2SO_4 (B) CH_3COOH
(C) H_2S (D) HF

2. Identify the CORRECT relation between dissociation constant and degree of dissociation of a weak acid.
(A) $K_a = \frac{\alpha^2 c}{1-\alpha^2}$ (B) $K_a = \frac{\alpha^2 c}{1-\alpha}$
(C) $K_a = \frac{1-\alpha}{\alpha^2 c}$ (D) $K_a = \frac{(1-\alpha)c}{\alpha^2}$

3. The degree of dissociation of a weak base BOH is α. If one mole of BOH is present in V dm^3 of the solution, the equilibrium concentration of BOH is _____ mol/dm^3.
(A) α/V (B) $\frac{1-\alpha}{V}$
(C) $\frac{\alpha^2}{V}$ (D) $1 - \alpha$

4. The dissociation constant of a weak base (BOH) is 1.8×10^{-5}. Its degree of dissociation in 0.01 M solution is _____.
(A) $\sqrt{1.8\times10^{-1}}$ (B) $\sqrt{1.8\times10^{-2}}$
(C) $\sqrt{1.8\times10^{-3}}$ (D) $\sqrt{1.8\times10^{-4}}$

3.5 Autoionization of water

1. The value of K_w for pure water at 298 K is _____.
(A) 7 (B) 1×10^{-7}
(C) 14 (D) 1×10^{-14}

3.6 pH Scale

1. Identify the CORRECT formula to calculate pH of a solution.
(A) $pH = -\log_{10}[H^+]$
(B) $pH = \log_{10}[H^+]$
(C) $pH = -\log_{10}[OH^-]$
(D) $pH = \log_{10}[H^+] \times \log_{10}[OH^-]$

2. The pH of 0.01 M HCl solution is _____.
(A) 1.0 (B) 2.0
(C) 1.7 (D) 12.0

3. The pH of a solution is 3.12. The pOH of this solution is _____.
(A) 10.48 (B) 10.52
(C) 10.88 (D) 11.12

4. The concentration of H^+ ions in acidic solition is 0.01 M. What is the concetration of OH^- ions in the solution?
(A) 1×10^{-7} (B) 1×10^{-2}
(C) 1×10^{-12} (D) 1×10^{-10}

5. The pH of 10^{-4} M KOH solution will be:
(A) 4 (B) 11
(C) 10.5 (D) 10

6. For an aqueous neutral solution at 298 K, $[H_3O^+]$ is equal to _____ M.
(A) 1×10^{7} (B) 1×10^{-7}
(C) 1×10^{14} (D) 1×10^{-14}

7. Which of the following is CORRECT for an acidic solution?
(A) $[H_3O^+] < 1 \times 10^{-7}$ M
(B) pH > 7
(C) $[H_3O^+] = [OH^-]$
(D) $[H_3O^+] > [OH^-]$

3.7 Hydrolysis of salts

1. Which among the following salts does NOT undergo hydrolysis?
(A) KNO_3 (B) Na_2CO_3
(C) CH_3COONH_4 (D) $CuCl_2$

2. $(NH_4)_2CO_3$ is a salt of _____.
(A) weak acid and weak base
(B) weak acid and strong base
(C) strong acid and strong base
(D) strong acid and weak base

3. Which among the following is an example of salt of weak acid and strong base?
(A) NH_4CN (B) Na_2SO_4
(C) KCl (D) KCN

4. Copper sulphate solution prepared by dissolving copper sulphate crystals in water become turbid due to the formation of _____.
(A) $Cu(OH)_2$ (B) $CuCl_2$
(C) CuO (D) Cu

5. Which salt will give acidic solution on hydrolysis?
(A) KCN (B) KCl
(C) NH_4Cl (D) CH_3COONa

6. An aqueous solution of which of the following will have a pH greater than 7?
(A) NH_4Cl (B) KCN
(C) Na_2SO_4 (D) KNO_3

7. Which of the following is CORRECT for a salt of weak acid and weak base?
(I) If $K_a = K_b$, the solution is neutral.
(II) If $K_a > K_b$, the solution is basic.
(III) If $K_a < K_b$, the solution is acidic.
(A) Only (I) (B) Both (I) and (II)
(C) Both (II) and (III) (D) Only (III)

3.8 Buffer solutions

1. _____ is added to commercial jams and jellies to increase their shelf life.
(A) Magnesium hydroxide
(B) Sodium acetate
(C) Tartaric acid
(D) Sodium benzoate

2. An acidic buffer solution is prepared by mixing _____.
(A) weak acid + its salt of strong base
(B) strong acid + its salt of weak base
(C) weak acid + its salt of weak base
(D) strong acid + its salt of strong base

3. Which of the following is CORRECT Henderson-Hasselbalch equation for calculating pH of acidic buffer?
(A) $pH = pK_b + \log_{10} \frac{[Salt]}{[Base]}$
(B) $pH = pK_a - \log_{10} \frac{[Salt]}{[Acid]}$
(C) $pH = pK_a + \log_{10} \frac{[Acid]}{[Salt]}$
(D) $pH = pK_a + \log_{10} \frac{[Salt]}{[Acid]}$

4. Which among the following is NOT a property of buffer solution?
(A) pH of the buffer solution depends on the volume of solution.
(B) pH of buffer solution remains constant even if it is kept for a long time.
(C) pH of buffer solution does not change appreciably upon addition of small amount of strong acid or base.
(D) Buffer solution can be diluted without change in pH.

5. The buffer system which helps to maintain the pH of blood between 7.36 to 7.42 is _____.
(A) H_2CO_3 / HCO_3^-
(B) NH_4OH / NH_4Cl
(C) CH_3COOH/CH_3COO^-
(D) CH_3COONH_4

6. When citric acid is added to milk of magnesia, _____ is formed which is a buffer.
(A) magnesium hydroxide
(B) magnesium citrate
(C) sodium citrate
(D) ammonium citrate

7. In qualitative analysis, for the precipitation of III A group radicals, a pH of _____ is required.
(A) 2 to 3 (B) 6 to 7
(C) 8 to 10 (D) 13 to14

3.9 Solubility product

1. Precipitation of which of the following compounds is responsible for kidney stone?
(A) $CaCO_3$ (B) CaC_2O_4
(C) $Ca_5(PO_4)_3OH$ (D) $CaCl_2$

2. Which is the CORRECT representation for the solubility product (K_{sp}) of Ag_2CrO_4?
(A) $[Ag^+]^2 [CrO_4^{2-}]$ (B) $[2Ag^+] [CrO_4^{2-}]$
(C) $[Ag^+] [2\,CrO_4^{2-}]$ (D) $[2Ag^+]^2 [CrO_4^{2-}]$

3. The number of moles of a compound that dissolve to give one litre of saturated solution is called its _____.
(A) molar solubility
(B) solubility product
(C) ionic product
(D) effective concentration

4. The CORRECT relationship between molar solubility (S) and solubility product (K_{sp}) for salt, $Al(OH)_3$ is _____.
(A) $K_{sp} = S^3$ (B) $K_{sp} = 4S^3$
(C) $K_{sp} = 27S^3$ (D) $K_{sp} = 27S^4$

5. If S and K_{sp} are respectively solubility and solubility product of a sparingly soluble salt AX, then _____.
(A) $S = K_{sp}$ (B) $S = K_{sp}^2$
(C) $S = \sqrt{K_{sp}}$ (D) $S = \frac{1}{2}K_{sp}$

6. If the solubility product K_{sp} of a sparingly soluble salt MX_2 at 25 °C is 1.0×10^{-11}, the solubility of the salt in mole litre^{-1} at this temperature will be _____.
(A) $\sqrt[2]{\frac{1.0\times10^{-11}}{4}}$ (B) $\sqrt[3]{\frac{1.0\times10^{-11}}{4}}$
(C) $\sqrt[3]{\frac{1.0\times10^{-11}}{2}}$ (D) $\sqrt[3]{\frac{4}{1.0\times10^{-11}}}$

7. Which among the following is INCORRECT?
(A) K_{sp} expression contains only equilibrium concentrations of the ions.
(B) K_{sp} changes with concentrations of the ions.
(C) K_{sp} is applicable for saturated solution of the sparingly soluble salt.
(D) K_{sp} is temperature dependent.

8. The condition, between ionic product (IP) and solubility product (K_{sp}), for precipitation of a sparingly soluble salt to occur is _____.
(A) $IP < K_{sp}$
(B) $IP = K_{sp}$
(C) $IP > K_{sp}$
(D) Both (A) and (B)

3.10 Common ion effect

1. Which of the following when added to CH_3COOH solution can suppress the ionization of CH_3COOH?
(A) CH_3COONa (B) NH_4OH
(C) NaCl (D) NH_4Cl

2. Which of the following can be used to remove hardness of water?
(A) $CaCl_2$ (B) $CaSO_4$
(C) $Ca(OH)_2$ (D) $CaCO_3$

3. Identify the INCORRECT statement.
(A) The reagent used to precipitate group II basic radicals is H_2S gas + dilute HCl.
(B) The phenomenon due to which dissociation of H_2S is suppressed in the presence of HCl is known as common ion effect.
(C) Common ion effect is a special case of Le-Chatelier's principle.
(D) The solubility of a sparingly soluble compound increases with the presence of a common ion in solution.

Critical Thinking

3.2 Types of electrolyte

1. Which of the following ionization reaction is CORRECT for a weak electrolyte HF in dilute aqueous solution?
(A) $H^+_{(aq)} + F^-_{(aq)} \longrightarrow HF_{(aq)}$
(B) $HF_{(aq)} \rightleftharpoons H^+_{(aq)} + F^-_{(aq)}$
(C) $HF_{(aq)} \longrightarrow 2H^+_{(aq)} + F^-_{(aq)}$
(D) $HF_{(aq)} \longrightarrow H^+_{(aq)} + F^-_{(aq)}$

2. If acetic acid is 1.3 % dissociated in 0.1 M solution, the equilibrium concentration of H^+ ions is _____ mol L^{-1}.
(A) 1.3×10^{-3} (B) 1.3×10^{-2}
(C) 1.3×10^{-1} (D) 1.3×10^{-4}

3.3 Acids and bases

1. Which of the following is classified as a conjugate acid-base pair?
(A) H^+/Cl^- (B) HCl/OH^-
(C) H_3O^+/H_2O (D) NaCl/NaOH

2. The Bronsted-Lowry acids in the reversible reaction
$HCO^-_{3(aq)} + OH^-_{(aq)} \rightleftharpoons CO^{2-}_3 + H_2O_{(l)}$ are _____.
(A) OH^- and CO^{2-}_3 (B) OH^- and H_2O
(C) HCO^-_3 and H_2O (D) HCO^-_3 and CO^{2-}_3

3. Which of the following is INCORRECT for an acid-base reaction between HCl and NH_3?
(A) HCl and Cl^- is a conjugate acid-base pair.
(B) NH^+_4 and NH_3 is a conjugate acid-base pair.
(C) HCl and NH^+_4 are proton acceptors.
(D) NH_3 and Cl^- behave as bases.

4. In the reaction $B(OH)_3 + 2H_2O \longrightarrow [B(OH)_4]^- + H_3O^+$
$B(OH)_3$ functions as _____.
(A) Bronsted acid (B) Lewis acid
(C) Protonic acid (D) Lewis base

5. Identify the CORRECT statement.
(A) BF_3 is a Lewis base.
(B) Arrhenius theory is applicable to only aqueous solutions.
(C) All Lewis acids are also Bronsted acids.
(D) When water reacts with ammonia, H_3O^+ ions are formed.

3.4 Ionization of acids and bases

1. A weak monoprotic acid in a 0.1 M solution dissociates to 0.001 %. Its dissociation constant is _____.
(A) 1.0×10^{-3} (B) 1.0×10^{-6}
(C) 1.0×10^{-8} (D) 1.0×10^{-11}

2. The degree of dissociation of 0.1 M lactic acid (a monobasic acid) is 4.0%. The value of K_a is _____.
(A) 1.6×10^{-5} (B) 1.6×10^{-4}
(C) 1.6×10^{-3} (D) 1.6×10^{-2}

3. What should be the concentration of solution for 2% dissociation of CH_3COOH?
($K_a = 1.8 \times 10^{-5}$)
(A) 4.5 M (B) 0.45 M
(C) 0.045 M (D) 0.0045 M

4. A weak monobasic acid (HA) is 16% dissociated in its 0.03 M solution. The percent dissociation in its 0.12 M solution is _____.
(A) 8 (B) 9 (C) 10 (D) 16

3.6 pH Scale

1. Statement 1: The pH of water increases with increase in temperature.
Statement 2: The dissociation of water into H^+ and OH^- is an exothermic reaction.
Select the CORRECT option:
(A) Both the statements are true.
(B) Both the statements are false.
(C) Statement 1 is true but statement 2 is false.
(D) Statement 1 is false but statement 2 is true.

2. The pH of 1 millimolar HCl solution is _____.
(A) 1 (B) 3 (C) 2 (D) 4

3. The ratio of pH of 0.05 M and 0.005 M H_2SO_4 solutions will be _____.
(A) 2 : 1 (B) 1 : 2
(C) 1 : 1.5 (D) 1.5 : 1

4. The pH of an aqueous solution is 6. The $[OH^-]$ of the solution will be _____.
(A) 10^{-8} M (B) 10^{-6} M
(C) 10^{-7} M (D) 10^{+8} M

5. 'a' moles of a monoacidic strong base BOH are dissolved in one litre of the solution. The pH of the solution will be _____.
(A) $-\log_{10} a$ (B) $14 - \log_{10} a$
(C) $14 + \log_{10} a$ (D) $-\log_{10} (14 - a)$

6. Which of the following solution will have pOH equal to 11 at 298 K?
(A) 1×10^{-6} M HCl
(B) 1×10^{-3} M HCl
(C) 1×10^{-3} M NaOH
(D) 1×10^{-5} M NaOH

7. If degree of dissociation of a 0.01 M weak acid solution is 10^{-3}, its pOH will be _____.
(A) 12 (B) 11 (C) 10 (D) 9

8. If the pH of a 0.1 M monoacidic base at 298 K is 9.0, the value of K_b and pK_b at the same temperature are _____ respectively.
(A) 1×10^{-9}, 9.0 (B) 1×10^{-5}, 5.0
(C) 1×10^{-10}, 10.0 (D) 1×10^{-4}, 4.0

9. 20 mL of an acidic solution having pH 3 is diluted 5 times. The H^+ concentration in this solution will be _____.
(A) 0.12×10^{-3} M (B) 2×10^{-4} M
(C) 0.2×10^{-4} M (D) 2×10^{-3} M

10. The pH of 10^{-8} M of HCl is _____.
(A) equal to 8 (B) equal to 7
(C) less than 7 (D) greater than 7

3.7 Hydrolysis of salts

1. 'X' is a salt of strong acid and strong base.
In an aqueous solution of 'X', _____.
(i) neither cation nor anion of the salt reacts with water
(ii) there is equal number of H^+ and OH^- ions
(iii) the cations hydrolyse to a greater extent than the anions.
Choose the CORRECT option to complete the above statement.
(A) (i) and (ii) (B) (ii) and (iii)
(C) (i) and (iii) (D) (i), (ii) and (iii)

2. Aqueous solution of which of the following salt will turn red litmus blue?
(A) $CuSO_4$ (B) HCOOK
(C) NH_4NO_3 (D) NaCl

3. Which of the following salts will give the highest pH in water?
(A) KCl (B) NaCl
(C) Na_2CO_3 (D) $CuSO_4$

4. K_a for HCN is 4.0×10^{-10} and K_b for NH_4OH is 1.8×10^{-5}. The pH of aqueous solution of NH_4CN will be _____.
(A) equal to 1 (B) less than 7
(C) equal to 7 (D) more than 7

3.8 Buffer solutions

1. Which among the following pairs of solution does NOT form an acidic buffer solution?
(A) CH_3COOH and CH_3COONa
(B) H_3PO_4 and Na_3PO_4
(C) $HClO_4$ and $NaClO_4$
(D) H_2CO_3 and Na_2CO_3

2. Which of the following forms a basic buffer solution?
(A) Acetic acid and sodium acetate
(B) Sodium hydroxide and ammonium chloride
(C) Ammonium hydroxide and ammonium chloride
(D) Ammonium hydroxide and sodium sulphate

3. A buffer solution contains 0.1 M of acetic acid and 0.1 M of sodium acetate. What will be its pH, if pK_a of acetic acid is 4.75?
(A) 4.00 (B) 4.75
(C) 5.00 (D) 5.25

4. A buffer solution is prepared in which the concentration of NH_3 is 0.30 M and the concentration of NH_4^+ is 0.30 M. If the equilibrium constant, pK_b for NH_3 equals 4.74, what is the pH of this solution?
(A) 4.74 (B) 9.08
(C) 9.26 (D) 11.72

5. The pOH of a buffer solution made by mixing 25 mL of 0.02 M NH_4OH and 25 mL of 0.2 M NH_4Cl at 25 °C is _____.
[pK_b of NH_4OH = 4.8]
(A) 5.8 (B) 2.8 (C) 4.8 (D) 3.8

6. Match the buffer solutions to their uses.

	Buffer solution		Use
i.	Sodium citrate	a.	To stabilize penicillin
ii.	Sodium benzoate	b.	In qualitative analysis of group IIIA radicals
iii.	NH_4OH/NH_4Cl	c.	To maintain blood pH
iv.	HCO_3^- / H_2CO_3	d.	To preserve jams and jellies

(A) i – a; ii – d; iii – b; iv – c
(B) i – d; ii – a; iii – c; iv – b
(C) i – b; ii – a; iii – d; iv – c
(D) i – a; ii – b; iii – d; iv – c

3.9 Solubility product

1. The molar solubility of a sparingly soluble salt, M_xX_y in its saturated solution at a given temperature is 'S'. The CORRECT relation between 'S' and K_{sp} of it is (K_{sp} = solubility product) _____.
(A) $S = \left(\frac{K_{sp}}{x^x y^y}\right)^{\frac{1}{x+y}}$ (B) $S = \frac{K_{sp}}{x^x y^y}$
(C) $S = \left(\frac{K_{sp}}{x^x y^y}\right)^{x+y}$ (D) $S = \frac{x^x y^y}{K_{sp}}$

2. Select the CORRECT match.
(A) Salt AB_2 : $K_{sp} = S^2$
(B) Salt AB : $K_{sp} = 4S^3$
(C) Salt A_2B : $K_{sp} = 4S^3$
(D) Salt AB_2 : $K_{sp} = 27S^4$

3. At a certain temperature, the solubility product of $CaSO_4$ is 6.4×10^{-5}. The solubility of salt in mol L^{-1} is _____.
(A) 8×10^{-10} (B) 8×10^{-2}
(C) 8×10^{-3} (D) 1.6×10^{-3}

4. A saturated solution of $Ca_3(PO_4)_2$ contains 2.0×10^{-8} M of Ca^{2+} and 1.6×10^{-5} M of PO_4^{3-} at a certain temperature. The solubility product (K_{sp}) of $Ca_3(PO_4)_2$ at that temperature is:
(A) 8.00×10^{-34} (B) 2.048×10^{-34}
(C) 2.048×10^{-33} (D) 3.20×10^{-34}

5. K_{sp} for $Cr(OH)_3$ is 2.7×10^{-31}. What is its solubility in mol dm^{-3}?
(A) 1×10^{-8} (B) 8×10^{-8}
(C) 1.1×10^{-8} (D) 0.18×10^{-8}

6. At 25°C, the maximum amount of PbI_2 that can be dissolved in 1.00 L of pure water is 1.0 mmol to form a saturated solution.
The solubility product, K_{sp}, for PbI_2 at 25°C is:
(A) 1.0×10^{-9} (B) 4.0×10^{-9}
(C) 4.0×10^{-10} (D) 1.0×10^{-6}

7. Solubility products (K_{sp}) of the salts of types MX, MX_2 and M_3X at temperature T are 4.0×10^{-8}, 3.2×10^{-14} and 2.7×10^{-15} respectively. Solubilities (in mol dm^{-3}) of the salts at temperature T are in the order:
(A) $MX > MX_2 > M_3X$
(B) $M_3X > MX_2 > MX$
(C) $MX_2 > M_3X > MX$
(D) $MX > M_3X > MX_2$

8. Two sparingly soluble salts A_2X and BX have the same value of solubility product 4.0×10^{-12}. The value of the ratio of their molar solubilities $\left(\frac{S_{A_2X}}{S_{BX}}\right)$ = _____.
(A) 10 (B) 20
(C) 50 (D) 60

9. When equal volumes of the following solutions containing Ag^+ ions and Cl^- ions are mixed, precipitation of AgCl ($K_{sp} = 1.8 \times 10^{-10}$) will occur only with _____.
(A) 10^{-4} M Ag^+ and 10^{-4} M Cl^-
(B) 10^{-5} M Ag^+ and 10^{-5} M Cl^-
(C) 10^{-6} M Ag^+ and 10^{-6} M Cl^-
(D) 10^{-10} M Ag^+ and 10^{-10} M Cl^-

10. K_{sp} of an electrolyte AB is 1×10^{-10}. When $[A^+] = 10^{-5}$ M, which of the following concentrations of B^- will NOT give precipitate of AB?
(A) 5×10^{-6} (B) 1.5×10^{-5}
(C) 2×10^{-5} (D) 5×10^{-5}

3.10 Common ion effect

1. In which of the following, solubility of AgCl is least?
(A) 0.1 M $CaCl_2$ (B) 0.1 M $AlCl_3$
(C) 0.1 M KCl (D) pure water

2. The addition of NaCl to AgCl decreases the solubility of AgCl because _____.
(A) the value of solubility product decreases
(B) a common ion (Cl^-) is present
(C) solution becomes unsaturated
(D) the value of equilibrium constant increases

Concept Fusion

1. Any species that accepts a share in an electron pair is called an acid. Which among the following theory suggests this concept?
(A) Arrhenius theory
(B) Bronsted-Lowry theory
(C) Lewis theory
(D) Ostwald's theory

2. Statement 1: According to Ostwald's dilution law, the degree of dissociation (α) of a weak acid is directly proportional to $\sqrt{c}$.
Statement 2: For an aqueous neutral solution at 298 K, pH = 7.
Select the appropriate option.
(A) Both the statements are correct.
(B) Both the statements are incorrect.
(C) Only statement 1 is correct.
(D) Only statement 2 is correct.

3. The following statements are CORRECT, EXCEPT:
(A) The process of tooth decay occurs due to dissolution of enamel composed of hydroxypatite in acidic medium.
(B) A salt of strong acid and strong base does not undergo hydrolysis.
(C) A buffer solution resists drastic changes in pH when a small amount of strong acid or base is added to it.
(D) The value of ionic product of water decreases as temperature increases.

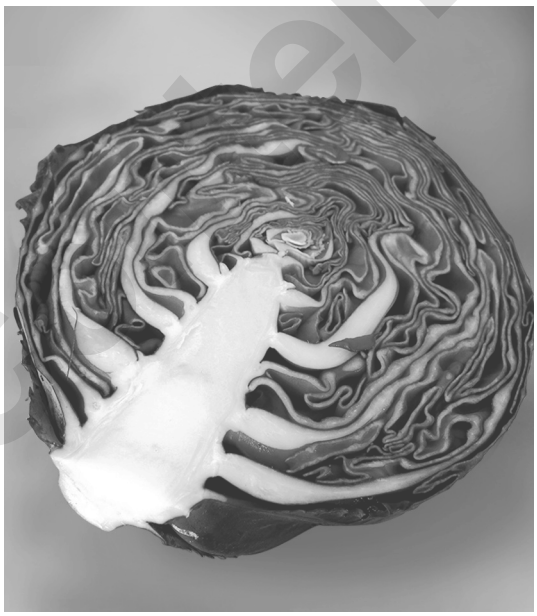
4. At a given temperature, dissociation constant of formic acid and acetic acid are 1.8×10^{-4} and 1.8×10^{-5} respectively. At what concentration of acetic acid solution, the H_3O^+ ion concentration is same as that of 0.002 M formic acid solution?
(A) 0.01 M (B) 0.002 M
(C) 0.02 M (D) 0.2 M

5. pH of a saturated solution of $Ca(OH)_2$ is 9. The solubility product (K_{sp}) of $Ca(OH)_2$ is _____.
(A) 0.25×10^{-10} (B) 0.125×10^{-15}
(C) 0.5×10^{-10} (D) 0.5×10^{-15}

6. Identify the INCORRECT statement.
(A) The saline solution used for intravenous injection must contain buffer system to maintain the proper pH of the blood.
(B) A solution of CH_3COONH_4 is neutral.
(C) AgCl is a weak electrolyte.
(D) The dissociation of HCN can be suppressed by the addition of HCl.

7. Identify the INCORRECT statement.
(A) Solubility of AgCl in NaCl solution is less than that in water.
(B) The degree of dissociation of a weak base is inversely proportional to square root of its concentration.
(C) Any species that accepts a share in an electron pair is called Lewis base.
(D) Aqueous solution of ammonium chloride is acidic.

Red cabbage as a pH indicator



The red cabbage plant changes its colour according to the acidity or basicity of the soil in which it is cultivated. In acidic soils, the leaves are reddish; in neutral soils the leaves are purple, while in alkaline soils the leaves are greenish-yellow coloured. This is because they contain chemicals from the naturally coloured anthocyanin family of compounds.
The juice of red cabbage can be used as a home-made pH indicator. The juice is red, pink, or magenta in acids, (pH < 7), purple in neutral solutions (pH ~ 7), and ranges from blue to greenish yellow in alkaline solutions (pH > 7).

MHT-CET Previous Years' Questions

1. The conjugate acid and base differ with respect to each other by _____. **[2010]**
(A) water (B) hydroxide ion
(C) hydronium ion (D) proton

2. Acidic nature of NH_4Cl is due to _____. **[2010]**
(A) reaction of cation and anion with water
(B) reaction of anion with water
(C) reaction of cation with water
(D) no reaction

3. Solubility product of the salt A_2X_3 is 1.08×10^{-13}. Its solubility is _____. **[2011]**
(A) 1×10^{-5} M (B) 1×10^{-15} M
(C) 1×10^{-3} M (D) 1×10^{-13} M

4. What is the pH of millimolar solution of ammonium hydroxide which is 20% dissociated? **[2014]**
(A) 3.699 (B) 10.301
(C) 4.691 (D) 9.301

5. Fraction of the total number of moles of an electrolyte dissociated when equilibrium is attained is known as _____. **[2021]**
(A) van't Hoff factor
(B) degree of dissociation
(C) degree of hydrolysis
(D) percentage dissociation

6. A weak monobasic acid is 0.1 % dissociated in 0.04 M solution. Calculate dissociation constant of acid. **[2021]**
(A) 4.5×10^{-6} (B) 2.8×10^{-6}
(C) 4.0×10^{-8} (D) 2.5×10^{-8}

7. What is the relation between solubility and solubility product for lead iodide? **[2021]**
(A) $K_{sp} = 8S^3$ (B) $K_{sp} = 4S^3$
(C) $K_{sp} = S^2$ (D) $K_{sp} = 27S^4$

8. Calculate molar concentration of NH_4OH if it is 4% dissociated. ($K_b = 1.6 \times 10^{-5}$) **[2021]**
(A) 0.2 M (B) 0.01 M
(C) 0.02 M (D) 0.1 M

9. The solubility product of a sparingly soluble salt AX_2 is 3.2×10^{-8}. What is it's solubility in mol dm^{-3}? **[2021]**
(A) 2.8×10^{-4} (B) 1.6×10^{-5}
(C) 2.0×10^{-3} (D) 4.0×10^{-6}

10. A weak monobasic acid is 10% dissociated in 0.05 M solution. What is its percentage dissociation in 0.10 M solution? **[2021]**
(A) 5.27 % (B) 7.17 %
(C) 10.3 % (D) 4.5 %

11. Which among the following salts undergoes hydrolysis? **[2021]**
(A) Na_2SO_4 (B) KCl
(C) NH_4Cl (D) KNO_3

12. Which among the following species can act as an acid as well as base according to Bronsted-Lowry theory? **[2022]**
(A) HSO_4^- (B) H_3O^+
(C) Cl^- (D) SO_4^{2-}

13. The degree of dissociation of weak acid is 7.2×10^{-4}. What is the value of its percent dissociation in 0.025 M solution? **[2022]**
(A) 0.80 % (B) 0.062%
(C) 8.2% (D) 0.072%

14. What is the pH of the solution containing 1.342×10^{-3} M H^+ ions? (log 1.342 = 0.1277) **[2022]**
(A) 3.57 (B) 2.38
(C) 2.87 (D) 1.28

15. What is the percentage dissociation of 0.1 M acetic acid? ($K_a = 10^{-5}$) **[2022]**
(A) 0.1 % (B) 0.01 %
(C) 1 % (D) 10 %

16. A weak monobasic acid is 2% dissociated in it's 0.01 M solution. What is the dissociation constant of weak acid? **[2022]**
(A) 4×10^{-6} (B) 2.5×10^{-6}
(C) 3×10^{-6} (D) 2×10^{-6}

17. What is the pH of millimolar solution of NaOH? **[2022]**
(A) 13 (B) 11 (C) 3 (D) 12

18. A solution has $[H^+] = 0.001$ M. What is the value of $[OH^-]$? **[2022]**
(A) 1 M (B) 10^{-3} M
(C) 10^{-11} M (D) 10^{-2} M

19. According to Bronsted-Lowry theory, the acids in the following reaction are **[2022]**
$ClO_4^- + HCO_3^- \longrightarrow HClO_4 + CO_3^{2-}$
(A) ClO_4^- and CO_3^{2-}
(B) ClO_4^- and HCO_3^-
(C) HCO_3^- and $HClO_4$
(D) $HClO_4$ and CO_3^{2-}

20. Which of the following is a Lewis acid but not a Bronsted acid? **[2022]**
(A) HNO_3 (B) HSO_4^-
(C) NH_3 (D) BCl_3

21. What is the pH of buffer solution containing 4×10^{-3} mol dm^{-3} of acetic acid and 0.4 mol dm^{-3} of sodium acetate? (log 100 = 2.0000, $pK_a = 4.76$) **[2022]**
(A) 2.50 (B) 2.0
(C) 6.76 (D) 4.80

22. Which among the following is the conjugate acid of R-NH_2? **[2022]**
(A) R^+ (B) $R - \overset{+}{N}H_3$
(C) $R - \overset{-}{N}H$ (D) R – NH – OH

23. What is the pH of 5×10^{-3} M H_2SO_4 solution? **[2022]**
(A) 5 (B) 3 (C) 4 (D) 2

24. The solubility of $BaSO_4$ is 3.6×10^{-5} mol dm^{-3} at 298 K. What is it's solubility product? **[2022]**
(A) 2.3×10^{-9} (B) 6.12×10^{-9}
(C) 1.3×10^{-9} (D) 5.0×10^{-9}

25. Aqueous solutions of ammonium chloride, potassium cyanide and sodium formate are respectively **[2022]**
(A) basic, acidic, basic
(B) acidic, acidic, basic
(C) acidic, basic, acidic
(D) acidic, basic, basic

26. The $[H^+]$ in lemon juice is found to be 0.0063 M. What is pH value of lemon juice (log 6.3 = 0.7993)? **[2022]**
(A) 2.8 (B) 5.2 (C) 3.8 (D) 2.2

27. Why the pH of aqueous solution of copper sulphate is less than 7? **[2022]**
(A) It is a salt of strong acid and weak base.
(B) It is a salt of weak acid and weak base.
(C) It is a salt of strong acid and strong base.
(D) It is a salt of weak acid and strong base.

28. Dissociation constant of acetic acid is 1.8×10^{-5}. Calculate the concentration of acetic acid if it's degree of dissociation is 0.02. **[2022]**
(A) 0.9 M (B) 0.045 M
(C) 0.02 M (D) 0.4 M

29. A buffer solution is prepared by mixing 0.2 M sodium acetate and 0.1 M acetic acid. If pK_a for acetic acid is 4.7, find the pH. **[2023]**
(A) 3.0 (B) 4.0
(C) 5.0 (D) 2.0

30. Solubility of a salt A_2B_3 is 1×10^{-3} mol dm^{-3}. What is the value of its solubility product? **[2023]**
(A) 1.08×10^{-13} (B) 8.1×10^{-15}
(C) 2.7×10^{-15} (D) 2.0×10^{-13}

31. Find $[OH^-]$ if a monoacidic base is 3% ionised in it's 0.04 M solution. **[2023]**
(A) 3.1×10^{-2} mol L^{-1}
(B) 4.5×10^{-3} mol L^{-1}
(C) 9.0×10^{-2} mol L^{-1}
(D) 1.2×10^{-3} mol L^{-1}

32. Identify $base_2$ for following equation according to Bronsted-Lowry theory.
$HCl_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + Cl^-_{(aq)}$ **[2023]**
(A) $H_3O^+_{(aq)}$ (B) $H_2O_{(l)}$
(C) $Cl^-_{(aq)}$ (D) $HCl_{(aq)}$

33. Which of the following substances is NOT defined as an acid and base respectively according to Arrhenius theory? **[2023]**
(A) HCl and NaOH
(B) $AlCl_3$ and NH_3
(C) H_2SO_4 and $Cu(OH)_2$
(D) HNO_3 and NH_4OH

34. What is the $[H^+]$ in 0.1 M solution of $Ba(OH)_2$? **[2023]**
(A) 3×10^{-14} (B) 5×10^{-14}
(C) 1×10^{-14} (D) 2×10^{-14}

35. What is the concentration of $[H_3O^+]$ ion in mol L^{-1} of 0.001 M acetic acid ($\alpha = 0.134$)? **[2023]**
(A) 1.34×10^{-4} (B) 1.54×10^{-4}
(C) 1.80×10^{-4} (D) 1.70×10^{-4}

36. Which among the following is NOT an example of salt of strong acid and weak base? **[2023]**
(A) NH_4Cl (B) NH_4NO_3
(C) $CuSO_4$ (D) Na_2SO_4

37. Calculate the pH of 0.01 M strong dibasic acid. **[2023]**
(A) 5.5 (B) 2.5
(C) 2.0 (D) 1.7

38. Which salt from following forms aqueous solution having pH less than 7? **[2023]**
(A) CH_3COONa (B) Na_2SO_4
(C) $CuSO_4$ (D) Na_2CO_3

39. Calculate the concentration of H^+ ions in a solution if pOH is 11. **[2023]**
(A) 10^{-11} M (B) 10^{-8} M
(C) 10^{-6} M (D) 10^{-3} M

40. Acetic acid dissociated to 1.20 % in its 0.01 M solution. What is the value of its dissociation constant? **[2023]**
(A) 2.20×10^{-2} (B) 1.60×10^{-4}
(C) 1.44×10^{-6} (D) 2.40×10^{-4}

41. Find solubility in terms of mol L^{-1} if solubility product of silver bromide is 6.4×10^{-13}. **[2023]**
(A) 4.0×10^{-5} mol L^{-1}
(B) 8.0×10^{-7} mol L^{-1}
(C) 7.5×10^{-5} mol L^{-1}
(D) 6.4×10^{-4} mol L^{-1}

42. Weak acid HX has dissociation constant 1×10^{-5}. Calculate the percent dissociation in its 0.1 M solution. **[2023]**
(A) 2.2% (B) 3.5%
(C) 4.2% (D) 1.0%

43. Calculate the pH of a buffer solution containing 0.01 M salt and 0.004 M weak acid. ($pK_a = 4.762$) **[2023]**
(A) 4.36 (B) 4.76
(C) 5.16 (D) 5.36

44. Identify the salt that undergoes hydrolysis and forms acidic solution from following. **[2023]**
(A) Na_2CO_3 (B) NH_4NO_3
(C) NH_4CN (D) KCN

45. A weak base is 1.42% dissociated in its 0.05 M solution. Calculate its dissociation constant. **[2023]**
(A) 5.5×10^{-5} (B) 4.0×10^{-5}
(C) 1.8×10^{-5} (D) 1.0×10^{-5}

46. What is the pH of 0.005 M NaOH solution? **[2023]**
(A) 2.30 (B) 12.6
(C) 11.7 (D) 3.2

47. What is pH of solution containing 50 mL each of 0.1 M sodium acetate and 0.01 M acetic acid? (pK_a $CH_3COOH = 4.50$) **[2023]**
(A) 2.5 (B) 3.5
(C) 4.5 (D) 5.5

48. A buffer solution is prepared by mixing equimolar acetic acid and sodium acetate. If 'K_a' of acetic acid is 1.78×10^{-5}, find the pH of buffer solution. **[2023]**
(A) 4.75 (B) 8.9
(C) 9.4 (D) 2.6

49. The solubility product of $Mg(OH)_2$ is 1.8×10^{-11} at 298 K. What is its solubility in mol dm^{-3}? **[2023]**
(A) 1.650×10^{-4} (B) 2.120×10^{-4}
(C) 3.184×10^{-4} (D) 4.550×10^{-4}

50. Which among the following salt solution in water is acidic in nature? **[2023]**
(A) $CuCl_2$ (B) NH_4CN
(C) KCN (D) CH_3COONa

51. What is the pH of solution containing 4.62×10^{-4} M H^+ ions? **[2023]**
(A) 8.62 (B) 4.64
(C) 5.66 (D) 3.34

52. What is the molar concentration of acetic acid if value of its dissociation constant is 1.8×10^{-5} and degree of dissociation is 0.02? **[2023]**
(A) 4.6×10^{-3} M (B) 4.5×10^{-2} M
(C) 4.0×10^{-4} M (D) 3.6×10^{-2} M

53. The solubility product of $PbCl_2$ at 298 K is 3.2×10^{-5}. What is it's solubility in mol dm^{-3}? **[2023]**
(A) 8×10^{-6} (B) 2×10^{-2}
(C) 5.6×10^{-3} (D) 5.0×10^{-2}

54. A buffer solution is prepared by mixing 0.1 M ammonia solution and 0.25 M solution of NH_4Cl. What is the value of pK_b to maintain its pOH at 6? **[2023]**
(A) 5.60 (B) 6.40
(C) 1.50 (D) 6.63

55. Which of the following salt solution in pure water has pH equal to 7? **[2023]**
(A) NH_4NO_3 (B) NH_4Cl
(C) KNO_3 (D) KCN

56. Identify the conjugate bases of HCO_3^- and HSO_4^-. **[2023]**
(A) H_2CO_3 and H_2SO_4
(B) CO_3^{2-} and SO_4^{2-}
(C) CO_3^{2-} and H_2SO_4
(D) H_2CO_3 and SO_4^{2-}

57. What is the degree of dissociation of 0.045 M monobasic acid if dissociation constant is 1.8×10^{-5}? **[2023]**
(A) 2×10^{-2} (B) 2×10^{-4}
(C) 4×10^{-2} (D) 4×10^{-4}

58. What is the pH of buffer solution obtained from 0.5 M sodium acetate and 5 M acetic acid? ($pK_a = 4.7447$) **[2023]**
(A) 2.70 (B) 3.74
(C) 4.80 (D) 5.7

59. Find solubility of PbI_2 if its solubility product is 7.0×10^{-9}. **[2023]**
(A) 1.21×10^{-3} mol L^{-1}
(B) 3.228×10^{-3} mol L^{-1}
(C) 2.831×10^{-3} mol L^{-1}
(D) 1.811×10^{-3} mol L^{-1}

60. What is the pH of a solution containing 2.2×10^{-6} M hydrogen ions? **[2023]**
(A) 6.34 (B) 5.66
(C) 4.34 (D) 3.80

61. What is the solubility of $AgCl_{(s)}$ if its solubility product is 1.6×10^{-10}? **[2023]**
(A) 1.26×10^{-5} M (B) 1.00×10^{-9}M
(C) 2.6×10^{-5} M (D) 1.56×10^{-9}M

62. A buffer solution is prepared by mixing 0.01 M weak acid and 0.05 M solution of a salt of weak acid and strong base. What is the pH of buffer solution? (pKa = 4.74) **[2023]**
(A) 3.34 (B) 4.80
(C) 5.44 (D) 6.93

63. Which activity from following is exhibited by Lewis base according to definition? **[2023]**
(A) Accept a pair of electron
(B) Donate a pair of electron
(C) Accept H^+ ions
(D) Donate OH^- ions

64. Calculate the value of dissociation constant of acetic acid if its pK_a value is 4.74. **[2023]**
(A) 5.49×10^{-4} (B) 5.26×10^{-5}
(C) 1.82×10^{-5} (D) 2.80×10^{-4}

65. Which among the following salts turns red litmus blue in its aqueous solution? **[2023]**
(A) Sodium acetate
(B) Copper sulphate
(C) Ammonium chloride
(D) Sodium nitrate

66. What is the pH of 0.002 M KOH solution? **[2023]**
(A) 13.2 (B) 12.4
(C) 11.3 (D) 10.4

67. A monobasic weak acid is 5 % dissociated in its 0.05 M solution. What is the dissociation constant of weak acid? **[2023]**
(A) 1.25×10^{-4} (B) 2.5×10^{-4}
(C) 5×10^{-5} (D) 2.5×10^{-5}

68. What is the concentration of H^+ ions in 0.01 M NaOH solution? **[2023]**
(A) 10^{-12} M (B) 10^{-14} M
(C) 10^{-1} M (D) 10^{-2} M

69. According to Bronsted–Lowry theory identify the bases in following reaction. **[2023]**
$ClO_4^- + HCO_3^- \longrightarrow HClO_4 + CO_3^{2-}$
(A) ClO_4^- and CO_3^{2-}
(B) HCO_3^- and $HClO_4$
(C) ClO_4^- and HCO_3^-
(D) $HClO_4$ and CO_3^{2-}

70. Calculate value of Ka if pH of weak monobasic acid is 3 in its 0.02 M solution. **[2023]**
(A) 5×10^{-4} (B) 5×10^{-5}
(C) 6.25×10^{-4} (D) 7.25×10^{-5}

71. The solubility product of $Ca(OH)_2$ is 5.6×10^{-6} at 298 K. Calculate its solubility in mol dm^{-3} at same temperature. **[2023]**
(A) 3.136×10^{-2} (B) 4.879×10^{-2}
(C) 1.419×10^{-2} (D) 1.12×10^{-2}

72. Identify the species that acts as $acid_2$ according to Bronsted-Lowry theory in the equation started below. **[2023]**
$HCl_{(aq.)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + Cl^-_{(aq)}$
(A) $H_2O_{(l)}$ (B) $HCl_{(aq)}$
(C) $H_3O^+_{(aq)}$ (D) $Cl^-_{(aq)}$

73. What is the value of $[H_3O^+]$ of 0.1 M acetic acid if degree of dissociation is 1.3×10^{-2}? **[2023]**
(A) 2.5×10^{-5} M (B) 1.3×10^{-3} M
(C) 3.1×10^{-3} M (D) 1.8×10^{-5} M

74. Calculate percent dissociation of 0.02 M monoacidic base if $[OH^-]$ is 1.5×10^{-3} M. **[2023]**
(A) 3.5 % (B) 8.5 %
(C) 7.5 % (D) 8.0 %

Evaluation Test

1. If the K_{sp} of a sparingly soluble salt, A_3B_2 in water is 1.08×10^{-8}, its solubility in mol L^{-1} is _____.
(A) 10^{-3} (B) 10^{-2}
(C) 10^{-5} (D) 10^{-4}

2. Which of the following is a salt derived from weak acid and strong base?
(A) $NaNO_3$ (B) Na_2CO_3
(C) CH_3COONH_4 (D) $CuSO_4$

3. The pH of 10^{-5} M KOH solution will be _____.
(A) 5 (B) 11 (C) 9 (D) 10

4. Which of the following CANNOT be a Bronsted acid?
(A) BF_3 (B) HCl
(C) NH_4^+ (D) HCO_3^-

5. In its 0.2 M solution, a weak monoprotic acid ionises to an extent of 60 %. Its hydrogen ion concentration is _____.
(A) 0.6 M (B) 0.2 M
(C) 0.12 M (D) None of these

6. What is the pH of one litre buffer solution containing 0.1 mole of CH_3COOH and 0.1 mole of CH_3COONa? [pK_a of acid = 4.74]
(A) 3.04 (B) 3.74
(C) 4.35 (D) 4.74

7. The CORRECT relationship between molar solubility (S) and solubility product (K_{sp}) for salt, $Cr(OH)_3$ is _____.
(A) $K_{sp} = 27S^5$
(B) $K_{sp} = 4S^3$
(C) $K_{sp} = 27S^4$
(D) $K_{sp} = 27S^3$

8. The H^+ ion concentration of a solution is 0.1 M. Its pH is _____.
(A) 0.01 (B) 0.1
(C) 1.0 (D) 10

9. Which of the following electrolyte dissociates only partially in dilute aqueous solutions?
(A) $Fe(OH)_3$ (B) KOH
(C) HI (D) KCN

10. NH_4Cl solution is _____.
(A) acidic (B) alkaline
(C) amphoteric (D) neutral

11. When a weak monobasic acid is dissolved in water, the degree of dissociation is directly proportional to the _____.
(A) volume of the solution
(B) square root of its concentration
(C) concentration of the solution
(D) square root of the volume of solution

12. How many grams of NaOH must be dissolved in 1 L of solution of give it a pH value of 11?
(A) 0.04 g (B) 0.4 g
(C) 0.1 g (D) 0.01 g

13. An acidic buffer solution can be prepared by mixing the solutions of _____.
(A) sodium chloride and sodium hydroxide
(B) sulphuric acid and sodium sulphate
(C) ammonium chloride and ammonium hydroxide
(D) ammonium acetate and acetic acid

14. The molar solubility of CaF_2 (K_{sp}= 5.3×10^{-11}) in 0.2 M solution of NaF will be _____ M.
(A) 1.3×10^{-10}
(B) 1.3×10^{-11}
(C) 1.3×10^{-8}
(D) 1.3×10^{-9}

15. Conjugate acid of NH_2^- is _____.
(A) NH_4^+ (B) NH_3
(C) NH_2 (D) NH_4OH

16. Which among the following is the least soluble?
(A) MnS ($K_{sp} = 7 \times 10^{-16}$)
(B) FeS ($K_{sp} = 4 \times 10^{-19}$)
(C) PtS ($K_{sp} = 8 \times 10^{-73}$)
(D) NiS ($K_{sp} = 3 \times 10^{-12}$)

17. Which of the following is NOT a weak acid?
(A) HCOOH (B) $HClO_4$
(C) H_2S (D) HF

18. Select the INCORRECT statement.
(A) H_2O acts as a base towards HCl.
(B) All Bronsted bases are also Lewis bases.
(C) H^+ is a Lewis base.
(D) Arrhenius theory is applicable only to aqueous solutions.

19. The compound whose aqueous solution has the highest pH is _____.
(A) Na_2CO_3 (B) NaCl
(C) $CuSO_4$ (D) Na_2SO_4

20. The percent degree of dissociation (α) of a weak monobasic acid solution of 0.1 M with a pH = 5 is _____.
(A) 10^{-9} (B) 10^{-4} (C) 10^{-2} (D) 10^{-5}

21. Which of the following factors influence a chemical system in accordance with the Le-Chatelier's principle?
(A) Concentration only
(B) Pressure only
(C) Temperature only
(D) Concentration, pressure or temperature

22. The Bronsted acids in the reversible reaction, $HCO_{3(aq)}^- + OH^-_{(aq)} \rightleftharpoons CO_{3(aq)}^{2-} + H_2O$ are _____.
(A) OH^- and CO_3^{2-} (B) OH^- and H_2O
(C) HCO_3^- and H_2O (D) HCO_3^- and CO_3^{2-}

23. Which of the following does NOT represent a conjugate acid-base pair?
(A) NH_4^+ and NH_2^- (B) HNO_3 and NO_3^-
(C) HSO_4^- and SO_4^{2-} (D) HCO_3^- and CO_3^{2-}

24. Calculate the concentration of H^+ ions in a solution if pOH is 12.
(A) 10^{-12} M (B) 10^{-10} M
(C) 10^{-4} M (D) 10^{-2} M

25. Ostwald's dilution law gives satisfactory results with the solution of which of the following electrolyte?
(A) HCl (B) HNO_3
(C) CH_3COOH (D) NaOH

26. Acetic acid dissociated to 1.1 % in its 0.01 M solution. What is the value of its dissociation constant?
(A) 1.21×10^{-6} (B) 1.21×10^{-4}
(C) 1.21×10^{-5} (D) 1.21×10^{-3}

27. The value of pK_w at 25 °C is _____.
(A) 7 (B) – 14
(C) 14 (D) 1×10^{-14}

28. The CORRECT order of increasing $[H_3O^+]$ in the following aqueous solutions is _____.
(A) 0.01 M H_2S < 0.01 M H_2SO_4 < 0.01 M NaCl < 0.01 M $NaNO_2$
(B) 0.01 M NaCl < 0.01 M $NaNO_2$ < 0.01 M H_2S < 0.01 M H_2SO_4
(C) 0.01 M $NaNO_2$ < 0.01 M NaCl < 0.01 M H_2S < 0.01 M H_2SO_4
(D) 0.01 M H_2S < 0.01 M $NaNO_2$ < 0.01 M NaCl < 0.01 M H_2SO_4.

29. Which of the following mixture produces buffer solution?

(A) $CH_3COOH + CH_3COONa$

(B) $CH_3COOH + CH_3COOCH_3$

(C) $CH_3COOH + NH_4Cl$

(D) $NaOH + NaCl$

30. Calculate the pH of a buffer solution containing 0.02 M salt and 0.002 M weak acid. ($pK_a = 4.76$)

(A) 3.76 (B) 4.76

(C) 5.16 (D) 5.76

31. Which among the following salt solution in water is neutral in nature?

(A) $CuCl_2$ (B) NH_4CN

(C) KCl (D) CH_3COONa

32. What is the concentration of acetic acid (in moles per dm^3) if value of its dissociation constant is 1.8×10^{-5} and degree of dissociation is 0.01?

(A) 1.8×10^{-3} M

(B) 1.8×10^{-1} M

(C) 1.8×10^{-4} M

(D) 1.8×10^{-2} M

33. The solubility product of AB_2 at 298 K is 4.0×10^{-5}. What is its solubility?

(A) $\sqrt[3]{10^{-4}}$ mol dm^{-3} (B) $\sqrt[3]{10^{-6}}$ mol dm^{-3}

(C) $\sqrt[2]{10^{-5}}$ mol dm^{-3} (D) $\sqrt[3]{10^{-5}}$ mol dm^{-3}

34. The pH of a buffer solution obtained from 0.5 M sodium acetate and 5 M acetic acid is: ($pK_a = x$)

(A) $x - 1$ (B) $x - 0.1$

(C) $x + 1$ (D) $x + 0.5$

35. Statement I: Penicillin preparations are stabilized by addition of sodium citrate as buffer.

Statement II: In qualitative analysis, a pH of 8-10 required for the precipitation of group IIIA cations is maintained using ($NH_4OH + NH_4Cl$) buffer.

Choose the most appropriate answer from the options given below.

(A) Both Statement I and Statement II are true.

(B) Both Statement I and Statement II are false.

(C) Statement I is true but Statement II is false.

(D) Statement I is false but Statement II is true.

Answer Key of the chapter: *Ionic Equilibria* & Evaluation Test is given at the end of the book.

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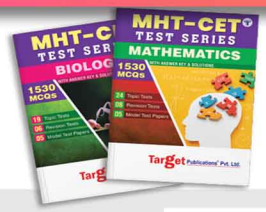

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