SAMPLE CONTENT

3804 MCQs

# 25 YEARS PREVIOUS SOLVED PAPERS

1999 – 2023

# MHT-CET

CHAPTER-WISE & TOPIC-WISE

# CHEMISTRY

- Quick Review
- Important Formulae
- Smart Keys
- Statistical analysis of all the shifts of 2023

Target Publications® Pvt. Ltd.

25 YEARS 1999 - 2023

# MHT-CET

# PREVIOUS SOLVED PAPERS

# CHEMISTRY

Chapter-wise & Topic-wise

## Salient Features

- A compilation of 25 years of MHT-CET questions ***(1999-2023)*** that aligns with the most recent MHT-CET syllabus
- **‘3804’** unique MCQs
- Chapter-wise and Topic-wise segregation of MCQs
- MCQs arranged in year-wise flow in each topic
- Quick Review provided for the revision of concepts
- Includes Important Study Techniques for holistic learning:

  **- Thinking Hatke**

  **- Caution**

  **- Shortcuts**
- Solutions provided wherever required
- Trend analysis of all the shifts of MHT-CET 2023 examination in the form of:
  - Graphs of difficulty levels of each shift
  - Tables of Chapter-wise analysis of all shifts

Sample Content

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**TEID: 3293**

# REFACE

Target's **'MHT-CET Chemistry: Previous Solved Papers (PSP)'** is a compilation of past 25 years' (1999-2023) questions asked in the MHT-CET examinations conducted by State Common Entrance Test Cell, Maharashtra State. This book is curated as per the **latest MHT-CET syllabus**.

The book consists of chapter-wise categorization of questions. Each chapter goes with a topic-wise flow. All the questions pertaining to a topic are arranged year-wise in a flow that concludes with the latest year. A special topic **Concept fusion** is drafted at the end of the MCQ section to cover multifarious questions. We have provided answers to all the questions and detailed solutions are given wherever required. The solutions will serve as valuable learning tools in understanding the concepts.

Selection of **unique MCQs** is prioritized while making this book to prevent the recurrence of identical questions. This will enable students to save time spent on repetitive questions.

We have infused several **Smart Keys** such as **Cautions, Thinking Hatke and Shortcuts**. These Important Study Techniques are created to help students with key objectives such as time management, easy memorization, revision and non-conventional yet simple methods for MCQ solving. To ensure adequate revision, each chapter begins with a **Quick Review**, followed by all the key **Formulae** wherever applicable.

A statistical analysis of the number of questions asked per chapter in each shift of MHT-CET 2023 examination is offered in tabular form. This analysis would help students understand the weighting allotted to each chapter. A graphical representation of analysis of all the papers (12 papers of PCM group & 12 papers of PCB group) is also included at the start of the book to elaborate on the breakdown of the difficulty level of questions asked in the examination. Studying these representations should undoubtedly aid students in planning their study strategy for the examination. *There is a possibility that the weightage to a chapter and the level of difficulty of the question paper in the future examination may vary.*

This book would provide students with confidence regarding their exam preparedness. We are confident that this book will comprehensively cater to the needs of students and effectively assist them to achieve their goal.

Publisher

**Edition:** First

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.

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*A book affects eternity; one can never tell where its influence stops.*

Sample Content

**Disclaimer**

This reference book is transformative work based on the latest Textbooks of Std. XI and XII Chemistry published by the Maharashtra State Bureau of Textbook Production and Curriculum Research, Pune. We the publishers are making this reference book which constitutes as fair use of textual contents which are transformed by adding and elaborating, with a view to simplify the same to enable the students to understand, memorize and reproduce the same in examinations.

This work is purely inspired upon the course work as prescribed by the Maharashtra State Bureau of Textbook Production and Curriculum Research, Pune. Every care has been taken in the publication of this reference book by the Authors while creating the contents. The Authors and the Publishers shall not be responsible for any loss or damages caused to any person on account of errors or omissions which might have crept in or disagreement of any third party on the point of view expressed in the reference book.

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# FEATURES

**Quick Review**

**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**

**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.

**Topic-wise Segregation**

MCQs are **segregated topic-wise** in each chapter. This is our attempt to cater to individualistic pace and preferences of studying a chapter in students and enable easy assimilation of questions based on the specific concept.

**Concept Fusion**

**Concept Fusion** topic encompasses questions whose solutions require knowledge of concepts covered in different topics from same chapter or from different chapters.

**Shortcuts**

**Shortcuts** incorporate important theoretical or formula based short tricks, beneficial in solving MCQs.

**Thinking Hatke**

**Thinking Hatke** reveals quick witted approach to crack the specific question.

**Caution**

**Caution** apprises students about mistakes often made while solving MCQs.

Sample Content

# INDEX




Evaluating your grasp of the content through chapter-specific tests is the most effective method for gauging your readiness with each topic.
Scan the adjacent QR code to know more about our ***"MHT-CET Chemistry Test Series with Answer Key & Solutions"*** book for the MHT-CET Entrance examination.

Practicing test Papers is the only way to assess your preparedness for the Exams.
Scan the adjacent QR code to know more about our ***"MHT-CET 21 Question Paper Set"*** book for the MHT-CET Entrance examination. Separate books for **PCM group** and **PCB group** are available.

A competitive exam book should contain comprehensive subject coverage, practice questions and effective examination strategies.
Scan the adjacent QR code to know more about our ***"MHT-CET Triumph Chemistry"*** book for the MHT-CET Entrance examination.

Sample Content

# 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 |

Sample Content

# CHEMISTRY

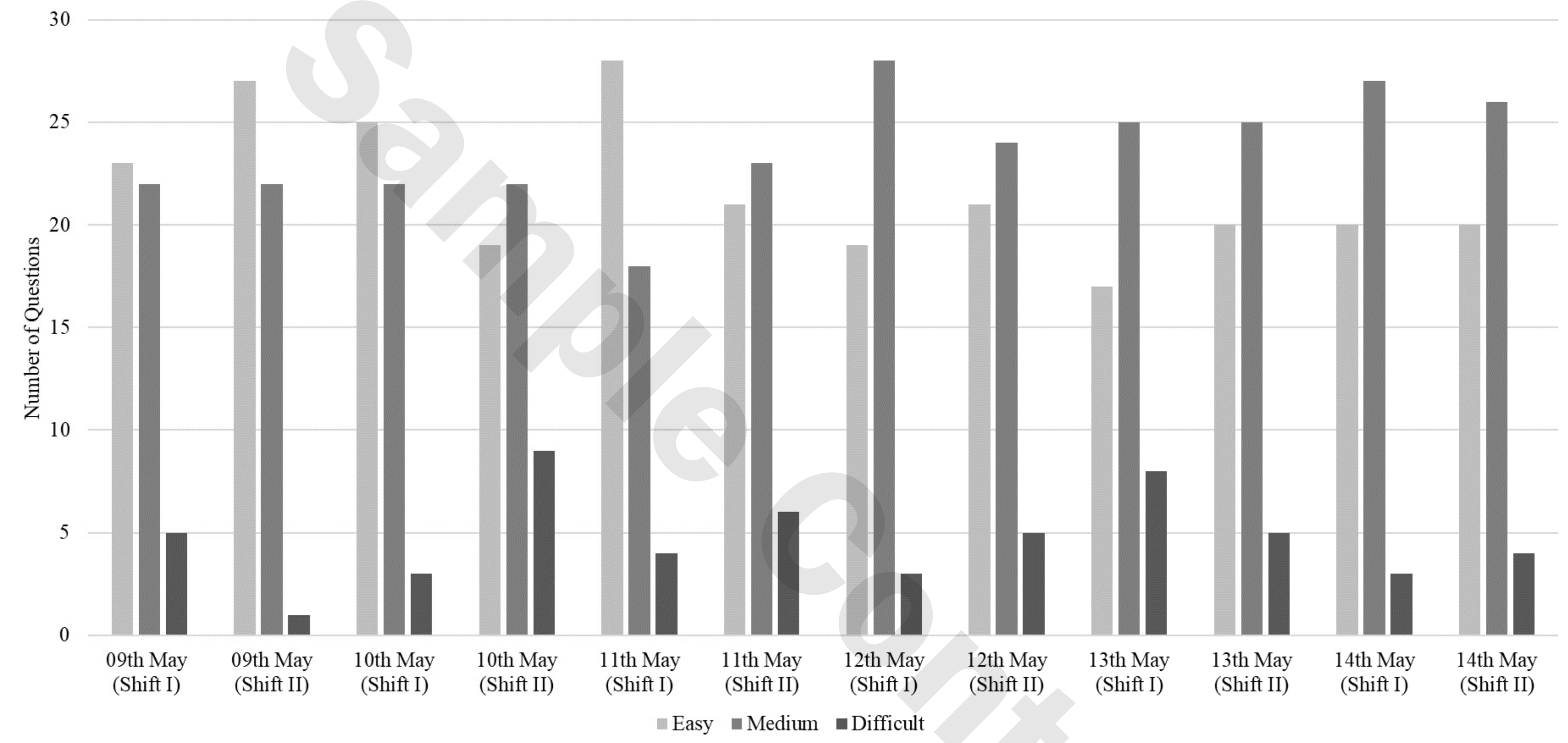
## Chapter-wise Analysis of MHT-CET 2023 Exam Papers (PCM Group)

| Ch. No. | Std. | Chapter Name | 09th May Shift I | 09th May Shift II | 10th May Shift I | 10th May Shift II | 11th May Shift I | 11th May Shift II | 12th May Shift I | 12th May Shift II | 13th May Shift I | 13th May Shift II | 14th May Shift I | 14th May Shift II | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11th | Some Basic Concepts of Chemistry | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| 4 | 11th | Structure of Atom | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 24 |
| 5 | 11th | Chemical Bonding | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| 6 | 11th | Redox Reactions | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 11 |
| 8 | 11th | Elements of Group 1 and Group 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| 10 | 11th | States of Matter: Gaseous and Liquid States | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| 11 | 11th | Adsorption and Colloids | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 10 |
| 14 | 11th | Basic Principles of Organic Chemistry | 2 | 2 | 1 | 1 | 1 | 2 | 0 | 2 | 1 | 2 | 1 | 1 | 16 |
| 15 | 11th | Hydrocarbons | 1 | 0 | 1 | 1 | 1 | 0 | 2 | 1 | 1 | 1 | 1 | 1 | 11 |
| 1 | 12th | Solid State | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 36 |
| 2 | 12th | Solutions | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 36 |
| 3 | 12th | Ionic Equilibria | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 36 |
| 4 | 12th | Chemical Thermodynamics | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 36 |
| 5 | 12th | Electrochemistry | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 37 |
| 6 | 12th | Chemical Kinetics | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 36 |
| 7 | 12th | Elements of Groups 16, 17 and 18 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 24 |
| 8 | 12th | Transition and Inner Transition Elements | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 25 |
| 9 | 12th | Coordination Compounds | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 24 |
| 10 | 12th | Halogen Derivatives | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 37 |
| 11 | 12th | Alcohols, Phenols and Ethers | 3 | 3 | 2 | 3 | 4 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 33 |
| 12 | 12th | Aldehydes, Ketones and Carboxylic Acids | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 35 |
| 13 | 12th | Amines | 1 | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 26 |
| 14 | 12th | Biomolecules | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 24 |
| 15 | 12th | Introduction to Polymer Chemistry | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 24 |
| 16 | 12th | Green Chemistry and Nanochemistry | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 |
| | | Total | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 600 |

Sample Content

# CHEMISTRY

## Difficulty level-wise Analysis of MHT-CET 2023 Exam Papers (PCM Group)




Sample Content

**E – Easy:** Questions whose answers can be directly and easily answered by the information given in Std. XI and XII Textbooks.
**M – Medium:** These questions require students to identify and apply the appropriate concepts which they studied from Std. XI and XII Textbooks.
**D – Difficult:** The most Challenging Questions that require application of various concepts and encourage students to think beyond the information given in the textbooks.

**Analysis**

- **Analysis of questions by difficulty level:** Although the proportion of easy, medium, and difficult questions varies amongst the twelve papers, the quantity of easy and medium questions is nearly equal, with a few difficult questions.
  This demonstrates that the entrance exam places a strong emphasis on careful reading, comprehension of the text, and application of principles. When studying for the entrance exam, it is advisable that students pay close attention to each chapter, concentrate on comprehending various chemical reactions, and practice solving numerical problems.

# CHEMISTRY

## Chapter-wise Analysis of MHT-CET 2023 Exam Papers (PCB Group)

| Ch. No. | Std. | Chapter Name | 15th May Shift I | 15th May Shift II | 16th May Shift I | 16th May Shift II | 17th May Shift I | 17th May Shift II | 18th May Shift I | 18th May Shift II | 19th May Shift I | 19th May Shift II | 20th May Shift I | 20th May Shift II | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11th | Some Basic Concepts of Chemistry | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
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| 5 | 11th | Chemical Bonding | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 11 |
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| 10 | 11th | States of Matter: Gaseous and Liquid States | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 |
| 11 | 11th | Adsorption and Colloids | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 |
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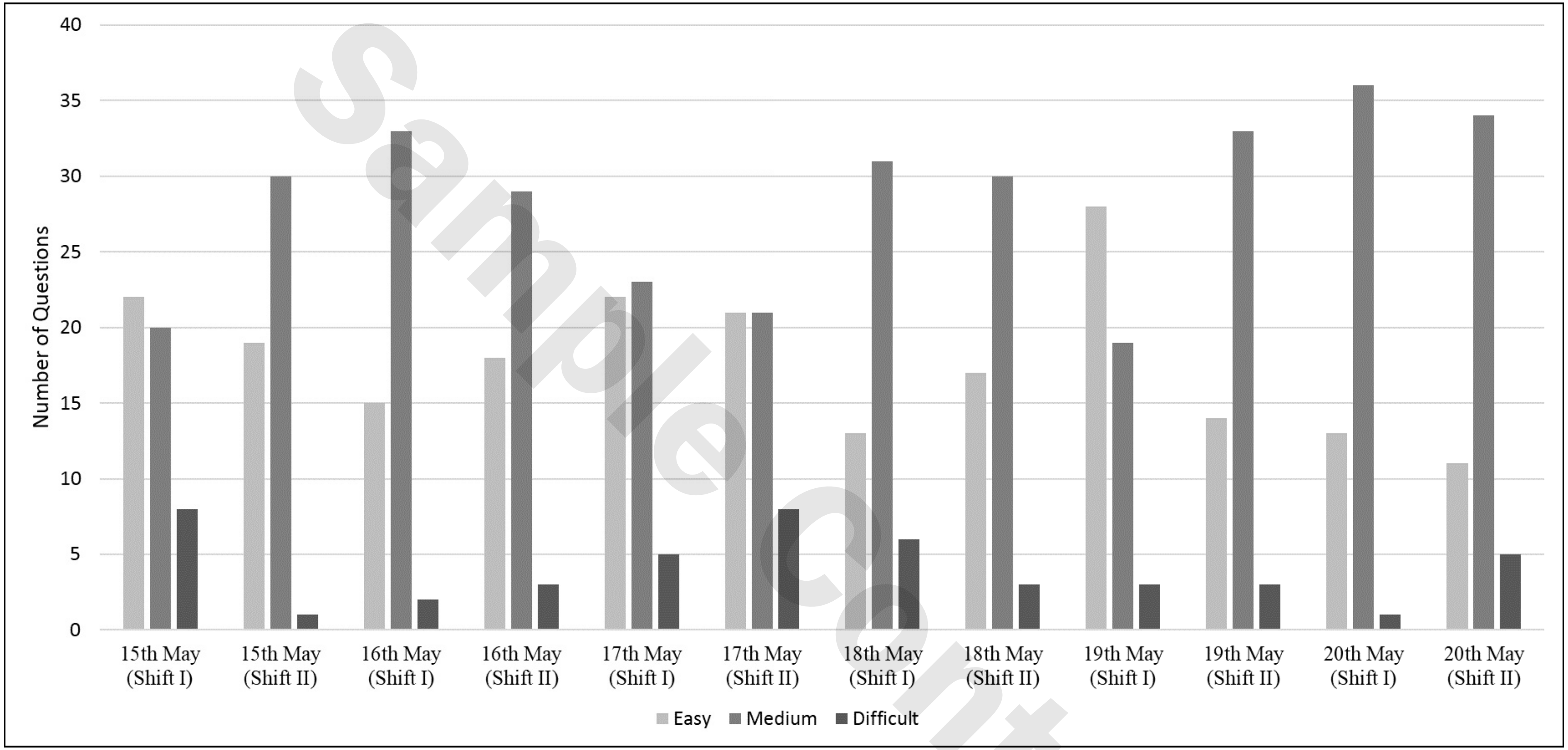
| 13 | 12th | Amines | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 23 |
| 14 | 12th | Biomolecules | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 24 |
| 15 | 12th | Introduction to Polymer Chemistry | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 25 |
| 16 | 12th | Green Chemistry and Nanochemistry | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| | | Total | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 600 |

Sample Content

# CHEMISTRY

## Difficulty level-wise Analysis of MHT-CET 2023 Exam Papers (PCB Group)

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Sample Content

Sample Content

Chapter

# 2 Solutions



## Quick Review

- **Classification of mixtures:**

**Mixtures**
Combination of two or more substances

- **Homogeneous mixture**: Uniform composition of components
  - True solution
- **Heterogeneous mixture**: Nonuniform composition of components
  - Colloid
  - Suspension

- **Types of solutions (depending on the states of solute and solvent):**

| State of solute | State of solvent | Examples |
|---|---|---|
| Solid | Liquid | Sea water, benzoic acid in benzene, sugar in water |
| Solid | Solid | Metal alloys such as brass, bronze. |
| Solid | Gas | Iodine in air |
| Liquid | Liquid | Gasoline, ethanol in water |
| Liquid | Solid | Amalgams of mercury with metals i.e., mercury in silver |
| Liquid | Gas | Chloroform in nitrogen |
| Gas | Liquid | Carbonated water ($CO_2$ in water), oxygen in water. |
| Gas | Solid | $H_2$ in palladium |
| Gas | Gas | Air ($O_2$, $N_2$, Ar and other gases) |

- **Classification of solution (according to the amount of solute):**

**Binary true solution**
Consists of a solvent and a solute

- **Unsaturated solution**: Contains less amount of solute than that can be dissolved in solvent at given temperature.
- **Saturated solution**: Contains maximum (equilibrium) amount of solute that can be dissolved in solvent at given temperature.
- **Supersaturated solution**: Contains greater than the equilibrium amount of solute.

Sample content

## ➢ Expressing concentration of solutions:

**Molarity (M)**

- $\frac{\text{No. of moles of solute}}{\text{Volume of solution in L}}$
- Temperature dependent
- 

| | | |
|---|---|---|
| 1 Molar solution | : | 1 M |
| Semimolar solution | : | M/2 = 0.5 M |
| Decimolar solution | : | M/10 = 0.1 M |
| Centimolar solution | : | M/100 = 0.01 M |
| Millimolar solution | : | M/1000 = 0.001 M |

**Molality (m)**

- $\frac{\text{No. of moles of solute}}{\text{Mass of solvent in kg}}$
- Temperature independent
- 

| | | |
|---|---|---|
| 1 Molal solution | : | 1 m |
| Semimolal solution | : | m/2 = 0.5 m |
| Decimolal solution | : | m/10 = 0.1 m |
| Centimolal solution | : | m/100 = 0.01 m |
| Millimolal solution | : | m/1000 = 0.001 m |

## ➢ Solubility of a solute in a solvent:

**Solubility of a solute**: It is the amount of solute per unit volume of saturated solution at a specific temperature. It is expressed in mol $L^{-1}$.

**Factors affecting solubility**

| | |
|---|---|
| **Nature of solute and solvent** | Compounds with similar chemical character are more readily soluble in each other: '*Like dissolves like*' |
| **Temperature** | **Solids in liquid:** For an endothermic process, solubility increases with increase of temperature. For an exothermic process, solubility decreases with increase of temperature. |
| | **Gases in liquid:** Solubility decreases with increase of temperature |
| **Pressure** | **Solids in liquid:** Pressure has no effect on the solubilities of solids and liquids as they are incompressible. |
| | **Gases in liquid:** Solubility increases with increasing pressure |

## ➢ Laws:

| | |
|---|---|
| **Henry's law** | **Statement:** *The solubility of a gas in a liquid is directly proportional to the pressure of the gas over the solution.*<br>$S \propto P$ or $\mathbf{S = K_H P}$<br>where, S is the solubility of the gas in mol $L^{-1}$, P is the pressure of the gas in bar over the solution. $K_H$ is Henry's law constant and its unit is mol $L^{-1}$ $bar^{-1}$. |
| **Raoult's law** | **Statement:** *The partial vapour pressure of any volatile component of a solution is equal to the vapour pressure of the pure component multiplied by its mole fraction in the solution.*<br>**For a binary solution of two volatile components:**<br>$P_1 = P_1^0 x_1$ and $P_2 = P_2^0 x_2$<br>Using Dalton's law of partial pressures,<br>Total vapour pressure (P) is given by:<br>$P = P_1 + P_2 = P_1^0 x_1 + P_2^0 x_2 = \left(P_2^0 - P_1^0\right) x_2 + P_1^0$<br>**Composition of vapour phase:** If $y_1$ and $y_2$ are the mole fractions of the components 1 and 2, respectively, in the vapour phase; then using Dalton's law of partial pressures: $P_1 = y_1 P$ and $P_2 = y_2 P$ |

Sample Content

➢ **Binary solution of two volatile liquids:**

**Binary solution of two volatile liquids**

**Ideal Solution**
- Obey Raoult's law
- $\Delta_{mix} H = 0$
- $\Delta_{mix} V = 0$
- Vapour pressure of ideal solution always lies between vapour pressures of pure components
- Solute-solvent interactions ≈ solvent-solvent and solute-solute interactions.
- **E.g.** Benzene + Toluene

**Non-Ideal Solution**
- Do not obey Raoult's law
- $\Delta_{mix} H \neq 0$, $\Delta_{mix} V \neq 0$

Positive deviations from Raoult's law
- Solute-solvent interactions < solute-solute interactions or solvent-solvent interactions
- Vapour pressure of solution is higher than those of pure components.
- **E.g.** Ethanol + Acetone, Carbon disulphide + Acetone

Negative deviations from Raoult's law
- Solute-solvent interactions > solute-solute or solvent-solvent interactions
- Vapour pressure of solution is lower than those of pure components.
- **E.g.** Phenol + Aniline, Chloroform + Acetone

➢ **Colligative properties of nonelectrolyte solutions:**

**Colligative properties** — Effect of adding nonvolatile, nonelectrolyte solute to solvent

**Vapour pressure lowering**: Vapour pressure of solution is **less** than that of pure solvent

$$\Delta P = P_1^0 x_2 = P_1^0 \times \frac{W_2 M_1}{W_1 M_2}$$

**Boiling point elevation**: Boiling point of solution is **greater** than that of pure solvent

$$\Delta T_b = T_b - T_b^0 = K_b m = K_b \times \frac{1000 W_2}{M_2 W_1}$$

**Freezing point depression**: Freezing point of solution is **less** than that of pure solvent

$$\Delta T_f = T_f^0 - T_f = K_f m = K_f \times \frac{1000 W_2}{M_2 W_1}$$

**Osmotic pressure**: Higher the concentration of solution, **greater** is the osmotic pressure

$$\pi = MRT = \frac{W_2}{M_2 V} \times RT$$

Sample content

➢ **Types of solution depending on the osmotic pressure of two solutions:**

| | | |
|---|---|---|
| **Isotonic** (Iso means equal) | Two or more solutions having the same osmotic pressure are said to be isotonic solutions. | **E.g.** 0.1 M urea solution and 0.1 M sucrose solution are isotonic. |
| **Hypertonic** (Hyper means higher) | If two solutions have unequal osmotic pressures, the more concentrated solution with higher osmotic pressure is said to be hypertonic solution. | **E.g.** If osmotic pressure of sucrose solution is higher than that of urea solution, the sucrose solution is hypertonic to urea solution. |
| **Hypotonic** (Hypo means lower) | A solution having an osmotic pressure lower than that of another solution owing to lower concentration of solute is called hypotonic solution. | **E.g.** If osmotic pressure of sucrose solution is higher than that of urea solution, the urea solution is hypotonic to sucrose solution. |

➢ **van't Hoff factor:**

**van't Hoff factor**

- For non-electrolytes, van't Hoff factor (i) is equal to 1. **E.g.** Glucose, urea
- For electrolytes undergoing dissociation, van't Hoff factor (i) is greater than 1. **E.g.** NaCl, $CaCl_2$
- For strong electrolytes, i = No. of particles in solution after dissociation (n)
- For weak electrolytes, $\alpha = \frac{i-1}{n-1}$
- Inclusion of van't Hoff factor modifies the equations for colligative properties:
  $\Delta P = i P_1^0 x_2$,
  $\Delta T_b = i K_b m$,
  $\Delta T_f = iK_f m$,
  $\pi = iMRT$

Sample Content

## Formulae

**1.** Henry's law:
$S = K_H P$
S = solubility,
P = pressure of the gas,
$K_H$ = Henry's constant

**2.** Raoult's law: For a binary solution of two volatile components
$P_1 = P_1^0 x_1$, $P_2 = P_2^0 x_2$
$P_1^0$ is the vapour pressure of pure component 1 and $P_1$ is the partial vapour pressure of component 1 in solution.
$x_1$ is the mole fraction of component 1 in solution.
$P_2^0$ is the vapour pressure of pure component 2 and $P_2$ is the partial vapour pressure of component 2.
$x_2$ is the mole fraction of component 2 in solution.

**3.** Dalton's law of partial pressures:
$P = P_1 + P_2$ **OR** $P = P_1^0 x_1 + P_2^0 x_2$
P is the total pressure of solution.

**4.** Composition of vapour phase (binary solution of two volatile components):
$P_1 = y_1 P$, $P_2 = y_2 P$
$y_1$ and $y_2$ as the mole fractions of two components in the vapour.
$P_1$ and $P_2$ are the partial pressures of two components in the vapour.
P is the total vapour pressure.

**5.** Raoult's law: For a solution containing a non-volatile solute
$P_1 = P_1^0 x_1$
$P_1$ is the vapour pressure of the solution,
$P_1^0$ is the vapour pressure of pure solvent,
$x_1$ is its mole fraction in solution.

**6.** Relative lowering of vapour pressure:

$$\frac{\Delta P}{P_1^0} = \frac{P_1^0 - P_1}{P_1^0} = x_2 = \frac{n_2}{n_1 + n_2}$$

$P_1^0$ = vapour pressure of pure solvent,
$P_1$ = vapour pressure of solution,
$x_2$ = Mole fraction of solute,
$n_1$ = Moles of solvent, $n_2$ = Moles of solute

**7.** Molecular mass determination from lowering of vapour pressure:

$$\frac{P_1^0 - P_1}{P_1^0} = \frac{\Delta P}{P_1^0} = \frac{W_2 M_1}{W_1 M_2}$$

$W_2$ = Mass of solute,
$W_1$ = Mass of solvent,
$M_2$ = Molar mass of solute,
$M_1$ = Molar mass of solvent

**8.** Elevation of boiling point:

i. $\Delta T_b = T_b - T_b^0$

$\Delta T_b$ = Elevation in boiling point,
$T_b$ = Boiling point of solution,
$T_b^0$ = Boiling point of pure solvent.

ii. $\Delta T_b = K_b m$

m = Molality of solution,
$K_b$ = boiling point elevation constant

iii. $\Delta T_b = \frac{1000 K_b W_2}{M_2 W_1}$

$\Delta T_b$ = Elevation in boiling point,
$K_b$ = Molal elevation constant,
$W_1$ = Mass of solvent,
$W_2$ = Mass of solute,
$M_2$ = Molar mass of solute

**9.** Molecular mass determination from elevation of boiling point:

Molecular mass of solute,

$$M_2 = \frac{1000\ K_b W_2}{\Delta T_b W_1}$$

**10.** Depression of freezing point:

i. $\Delta T_f = T_f^0 - T_f$

$\Delta T_f$ = Depression in freezing point,
$T_f$ = Freezing point of solution,
$T_f^0$ = Freezing point of pure solvent.

ii. $\Delta T_f = K_f m$

m = Molality of solution
$K_f$ = Freezing point depression constant

iii. $\Delta T_f = \frac{1000 K_f W_2}{M_2 W_1}$

$\Delta T_f$ = Depression in freezing point,
$K_f$ = Molal depression constant,
$W_2$ = Mass of solute,
$W_1$ = Mass of solvent,
$M_2$ = Molar mass of solute

**11.** Molecular mass determination from depression of freezing point:

Molecular mass of solute,

$$M_2 = \frac{1000\ K_f W_2}{\Delta T_f W_1}$$

**12.** Osmotic pressure ($\pi$):

$\pi$ = MRT = CRT
M = C = Concentration of solution in mol $L^{-1}$,
R = Gas constant (0.08206 atm $dm^{-3}$ $K^{-1}$ $mol^{-1}$),
T = Temperature in Kelvin

**13.** Molecular mass from osmotic pressure:

$$\pi = \frac{W_2 RT}{M_2 V} \quad \text{OR} \quad M_2 = \frac{W_2 RT}{\pi V}$$

$\pi$ = Osmotic pressure,
R = Gas constant,
$M_2$ = Molecular mass of solute,
$W_2$ = Mass of solute,
T = Temperature in Kelvin,
V = volume in $dm^3$

**14.** van't Hoff factor (i):

$$i = \frac{\text{Colligative property of electrolyte solution}}{\text{Colligative property of nonelectrolyte solution of the same concentration}}$$

$$= \frac{(\Delta T_f)}{(\Delta T_f)_0} = \frac{(\Delta T_b)}{(\Delta T_b)_0} = \frac{(\Delta P)}{(\Delta P)_0} = \frac{(\pi)}{(\pi)_0}$$

$$= \frac{\text{Actual moles of particles in solution after dissociation}}{\text{Moles of formula units dissolved in solution}}$$

$$= \frac{\text{Formula mass of substance}}{\text{Observed molar mass of substance}}$$

$$= \frac{M_{\text{Theoretical}}}{M_{\text{Observed}}}$$

**15.** Modified equations for colligative properties by inclusion of van't Hoff factor:

i. $\Delta P = i\ P_1^0 x_2 = i\frac{W_2 M_1}{M_2 W_1}$

ii. $\Delta T_b = iK_b m = i\frac{1000 K_b W_2}{M_2 W_1}$

iii. $\Delta T_f = iK_f m = i\frac{1000 K_f W_2}{M_2 W_1}$

iv. $\pi = iMRT = i\frac{W_2 RT}{M_2 V}$

**16.** Degree of dissociation ($\alpha$):

$$\alpha = \frac{i-1}{n-1}$$

i = van't Hoff factor,
n = Moles of ions obtained from dissociation of 1 mole of electrolyte

Sample Content

## Multiple Choice Questions

### 2.2 Types of solutions

1. What type of solution is obtained when benzoic acid is added in benzene? **[2020]**
(A) Solid in liquid (B) Liquid in solid
(C) Solid in solid (D) Liquid in liquid

2. Which of the following statement is **NOT** correct about solution? **[2020]**
(A) The three states of matter solid, liquid and gas may play the role of either solute or solvent.
(B) True solution is a heterogeneous mixture of two or more substances with fixed composition.
(C) The component of solution which constitutes smaller part is called solute.
(D) When water is solvent, the process of solvation is known as hydration.

3. An amalgam of mercury with sodium is an example of _______. **[2020]**
(A) liquid in liquid solution
(B) solid in liquid solution
(C) solid in solid solution
(D) liquid in solid solution

4. Hydrogen in palladium is an example of a solution of _______. **[2021]**
(A) gas in solid (B) liquid in gas
(C) gas in liquid (D) gas in gas

5. Air is an example of a solution of _______. **[2021]**
(A) gas in solid (B) gas in liquid
(C) liquid in gas (D) gas in gas

6. What type of solution is sea water? **[2022]**
(A) Liquid in solid (B) Liquid in liquid
(C) Solid in liquid (D) Solid in solid

7. What is the relation between molality of the solution and molar mass of solute? **[2022]**
(A) $m = \frac{1000\,W_1}{M_2W_2}$ (B) $m = \frac{M_2W_2}{1000\,W_1}$
(C) $m = \frac{1000\,W_2}{M_2W_1}$ (D) $m = \frac{M_2W_1}{1000\,W_2}$

8. What type of solution is carbonated water? **[2022]**
(A) Liquid in liquid (B) Gas in solid
(C) Liquid in gas (D) Gas in liquid

9. What is the unit of molality? **[2022]**
(A) mol $kg^{-1}$ K (B) mol $kg^{-1}$
(C) mol $dm^{-3}$ (D) mol kg

10. What type of solution is bronze? **[2022]**
(A) Gas in solid (B) Solid in liquid
(C) Liquid in solid (D) Solid in solid

11. What type of solution is the ethyl alcohol in water? **[2023]**
(A) Liquid in solid (B) Solid in liquid
(C) Liquid in liquid (D) Gas in liquid

12. What type of following solutions is the gasoline? **[2023]**
(A) Liquid as solute and liquid as solvent
(B) Liquid as solute and solid as solvent
(C) Solid as solute and liquid as solvent
(D) Gas as solute and liquid as solvent

13. What type of solution is obtained when chloroform is mixed with excess dinitrogen? **[2023]**
(A) Solid as solute and gas as solvent
(B) Liquid as solute and gas as solvent
(C) Gas as solute and liquid as solvent
(D) Gas as solute and solid as solvent

### 2.4 Solubility

1. '$K_H$' is Henry's constant and has the unit: **[2019]**
(A) atm $mol^{-1}$ $dm^3$ (B) mol $dm^{-3}$ $atm^{-1}$
(C) atm mol $dm^{-3}$ (D) $mol^{-1}$ $dm^3$ $atm^{-1}$

2. The Henry's law constant for oxygen is $1.3 \times 10^{-3}$ mol $dm^{-3}$ $atm^{-1}$. If partial pressure of oxygen is 0.46 atmosphere, what is the concentration of dissolved oxygen at 25°C and 1 atm pressure? **[2020]**
(A) $2.82 \times 10^{-3}$ mol $dm^{-3}$
(B) $5.98 \times 10^{-4}$ mol $dm^{-3}$
(C) $3.53 \times 10^{-4}$ mol $dm^{-3}$
(D) 5.98 mol $dm^{-3}$

3. Henry's law is a relation between _______. **[2020]**
(A) temperature and pressure
(B) pressure and solubility
(C) volume and solubility
(D) pressure and volume

4. Solubility of a gas in liquid increases with: **[2020]**
(A) decrease in pressure and increase in temperature.
(B) decrease in pressure and decrease in temperature.
(C) increase in pressure and increase in temperature.
(D) increase in pressure and decrease in temperature.

Sample Content

5. Calculate solubility of a gas in $H_2O$ at 0.75 bar if Henry's law constant for the gas is $7 \times 10^{-4}$ mol $L^{-1}$ $bar^{-1}$? **[2021]**
(A) $0.75 \times 10^{-4}$ mol $L^{-1}$
(B) $5.25 \times 10^{-4}$ mol $L^{-1}$
(C) $4.20 \times 10^{-5}$ mol $L^{-1}$
(D) $3.5 \times 10^{-4}$ mol $L^{-1}$

6. In which of the following salts, the solubility increases appreciably with increase in temperature? **[2021]**
(A) KBr (B) NaBr
(C) NaCl (D) KCl

7. Henry's law constant for $CH_3Br$ is 0.16 mol $L^{-1}$ $bar^{-1}$ at 298 K. What is solubility of $CH_3Br$ in water at 380 mm Hg? **[2021]**
(A) 0.24 mol $L^{-1}$ (B) 0.08 mol $L^{-1}$
(C) 0.32 mol $L^{-1}$ (D) 0.16 mol $L^{-1}$

8. What is the value of Henry's law constant for $CH_3Br$ if its solubility is 0.08 mol $L^{-1}$ at 0.5 bar? **[2021]**
(A) 0.50 mol $L^{-1}$ $bar^{-1}$
(B) 0.40 mol $L^{-1}$ $bar^{-1}$
(C) 0.16 mol $L^{-1}$ $bar^{-1}$
(D) 0.08 mol $L^{-1}$ $bar^{-1}$

9. What is Henry's law constant if solubility of a gas in water at 298 K and 1 bar pressure is $7 \times 10^{-4}$ mol $L^{-1}$? **[2021]**
(A) $2.0 \times 10^{-5}$ mol $L^{-1}$ $bar^{-1}$
(B) $7.0 \times 10^{-4}$ mol $L^{-1}$ $bar^{-1}$
(C) $3.5 \times 10^{-3}$ mol $L^{-1}$ $bar^{-1}$
(D) $3.1 \times 10^{-5}$ mol $L^{-1}$ $bar^{-1}$

10. Calculate the solubility of gas in water at 260 mm Hg and 25 °C, if Henry's law constant of gas is 0.159 mol $dm^{-3}$ $atm^{-1}$ at 25 °C. **[2022]**
(A) $3.8 \times 10^{-2}$ mol $dm^{-3}$
(B) $2.7 \times 10^{-2}$ mol $dm^{-3}$
(C) $5.4 \times 10^{-2}$ mol $dm^{-3}$
(D) $1.2 \times 10^{-2}$ mol $dm^{-3}$

11. Calculate the solubility of gas in water at 1.2 atm and 25 °C if Henry's law constant is 0.145 mol $dm^{-3}$ $atm^{-1}$ at 25 °C. **[2022]**
(A) 0.174 mol $dm^{-3}$ (B) 0.31 mol $dm^{-3}$
(C) 0.45 mol $dm^{-3}$ (D) 0.25 mol $dm^{-3}$

12. Which of the following lawls represents the quantitative relationship between the solubility of gas in liquid and its pressure? **[2022]**
(A) Henry's law (B) Charles' law
(C) Raoult's law (D) Avogadro's law

13. In which of following salts solubility increases appreciably with increase in temperature? **[2022]**
(A) KCl (B) NaCl
(C) $KNO_3$ (D) NaBr

14. Calculate the solubility of a gas in water at 0.8 atm and 25°C. [Henry's law constant is $6.85 \times 10^{-4}$ mol $dm^{-3}$ $atm^{-1}$] **[2022]**
(A) $3.94 \times 10^{-4}$ mol $dm^{-3}$
(B) $2.74 \times 10^{-4}$ mol $dm^{-3}$
(C) $6.85 \times 10^{-4}$ mol $dm^{-3}$
(D) $5.48 \times 10^{-4}$ mol $dm^{-3}$

15. Calculate Henry's law constant if the solubility of certain gas in water at 25°C and 1 atm is $6.85 \times 10^{-4}$ mol $dm^{-3}$. **[2022]**
(A) $4.0 \times 10^{-4}$ mol $dm^{-3}$ $atm^{-1}$
(B) $3.42 \times 10^{-4}$ mol $dm^{-3}$ $atm^{-1}$
(C) $2.3 \times 10^{-4}$ mol $dm^{-3}$ $atm^{-1}$
(D) $6.85 \times 10^{-4}$ mol $dm^{-3}$ $atm^{-1}$

16. Calculate the solubility of a gas dissolved in water at 0.75 atm if the solubility of gas in water at 25°C and 1 atm is $6.85 \times 10^{-4}$ mol $dm^{-3}$. (Henry's law constant is $6.85 \times 10^{-4}$ mol $dm^{-3}$ $atm^{-1}$) **[2022]**
(A) $7.5 \times 10^{-4}$ mol $dm^{-3}$
(B) $10.2 \times 10^{-4}$ mol $dm^{-3}$
(C) $5.14 \times 10^{-4}$ mol $dm^{-3}$
(D) $2.5 \times 10^{-4}$ mol $dm^{-3}$

17. Calculate the pressure of gas if the solubility of gas in water at 25°C is $6.85 \times 10^{-4}$ mol $dm^{-3}$. (Henry's law constant is $6.85 \times 10^{-4}$ mol $dm^{-3}$ $bar^{-1}$) **[2022]**
(A) 1 bar (B) 0.5 bar
(C) 1.5 bar (D) 2.0 bar

18. Which among the following gases exhibits very low solubility in water at room temperature? **[2023]**
(A) $O_2$ (B) $CO_2$
(C) $NH_3$ (D) HCl

19. The solubility of a gas in a liquid is directly proportional to the pressure of the gas over the solution. Identify the law for this statement. **[2023, 2022]**
(A) Henry's law (B) Raoult's law
(C) Dalton's law (D) Avogadro's law

20. What is the solubility of a gas in water at 25°C if partial pressure is 0.18 atm? ($K_H$ = 0.16 mol $dm^{-3}$ $atm^{-1}$) **[2023]**
(A) 0.029 mol $dm^{-3}$ (B) 0.022 mol $dm^{-3}$
(C) 0.032 mol $dm^{-3}$ (D) 0.038 mol $dm^{-3}$

Sample Content

**21.** Which among following salts shows decrease in solubility with increase in temperature? **[2023]**
(A) $Na_2SO_4$ (B) $KNO_3$
(C) $NaNO_3$ (D) KBr

**22.** What is the solubility of gas in water at 25 °C if partial pressure is 0.346 bar [Henry's law constant is 0.159 mol $dm^{-3}$ $bar^{-1}$]? **[2023]**
(A) 0.055 mol $dm^{-3}$ (B) 0.028 mol $dm^{-3}$
(C) 0.083 mol $dm^{-3}$ (D) 0.11 mol $dm^{-3}$

**23.** Which among the following salts exhibits inverse relation between its solubility and temperature? **[2023]**
(A) NaBr (B) $NaNO_3$
(C) $KNO_3$ (D) $Na_2SO_4$

**24.** What is Henry's law constant of a gas if solubility of gas in water at 25ºC is 0.028 mol $dm^{-3}$?
[Partial pressure of gas = 0.346 bar] **[2023]**
(A) 0.081 mol $dm^{-3}$ $bar^{-1}$
(B) 0.075 mol $dm^{-3}$ $bar^{-1}$
(C) 0.093 mol $dm^{-3}$ $bar^{-1}$
(D) 0.049 mol $dm^{-3}$ $bar^{-1}$

**25.** Which among the following salts dissolves in water with the absorption of heat? **[2023]**
(A) $Na_2SO_4$ (B) $CaCl_2$
(C) $Li_2SO_4 \cdot H_2O$ (D) KCl

**26.** Calculate Henry's law constant if solubility of nitrogen gas in water at 25°C is $6.85 \times 10^{-4}$ mol $dm^{-3}$.
[Partial pressure of nitrogen gas = 0.9 bar] **[2023]**
(A) $6.85 \times 10^{-4}$ mol $dm^{-3}$ $bar^{-1}$
(B) $4.71 \times 10^{-4}$ mol $dm^{-3}$ $bar^{-1}$
(C) $3.43 \times 10^{-4}$ mol $dm^{-3}$ $bar^{-1}$
(D) $7.6 \times 10^{-4}$ mol $dm^{-3}$ $bar^{-1}$

**27.** Calculate the partial pressure of oxygen if its solubility in water is 3.2 mg $dm^{-3}$.
($K_H = 2 \times 10^{-3}$ mol $dm^{-3}$ $atm^{-1}$) **[2023]**
(A) 0.03 atm (B) 0.04 atm
(C) 0.05 atm (D) 0.06 atm

**28.** Calculate the solubility of nitrogen gas dissolved in water at 25°C if partial pressure of nitrogen gas is 0.7 bar.
($K_H = 6.85 \times 10^{-4}$ mol $dm^{-3}$ $bar^{-1}$) **[2023]**
(A) $4.795 \times 10^{-4}$ mol $dm^{-3}$
(B) $5.480 \times 10^{-4}$ mol $dm^{-3}$
(C) $2.745 \times 10^{-4}$ mol $dm^{-3}$
(D) $6.85 \times 10^{-4}$ mol $dm^{-3}$

**29.** Calculate the solubility of gas in water at 25°C and 0.328 atm.
[$K_H$ = 0.159 mol $dm^{-3}$ $atm^{-1}$ at 25°C] **[2023]**
(A) $4.1 \times 10^{-2}$ mol $dm^{-3}$
(B) $2.5 \times 10^{-2}$ mol $dm^{-3}$
(C) $5.21 \times 10^{-2}$ mol $dm^{-3}$
(D) $1.56 \times 10^{-2}$ mol $dm^{-3}$

## 2.5 Vapour pressure of solutions of liquids in liquids

**1.** Which of the following solutions shows negative deviation from Raoult's law? **[2021]**
(A) Benzene + Toluene
(B) Carbon disulphide + Acetone
(C) Ethanol + Acetone
(D) Phenol + Aniline

**2.** Which of the following solutions shows positive deviation from Raoult's law? **[2021]**
(A) Ethanol + Acetone
(B) Chloroform + Acetone
(C) Benzene + Toluene
(D) Phenol + Aniline

**3.** Which of the following solutions behaves nearly as an ideal solution? **[2021]**
(A) Benzene + toluene
(B) Chloroform + acetone
(C) Phenol + aniline
(D) Ethanol + acetone

**4.** Which of the following conditions is obeyed by an ideal solution? **[2021]**
(A) Vapour pressure of solution > Vapour pressure of solvent
(B) $\Delta_{mix}V \neq 0$
(C) Magnitude of solute and solvent interactions are comparable
(D) $\Delta_{mix}H \neq 0$

**5.** Which of the following mathematical expressions is CORRECT regarding Raoult's law for a binary mixture of two volatile liquids if $x_2$, $x_1$ are mole fractions and $P_1^0, P_2^0$ are vapour pressure of pure liquids? **[2022]**
(A) $P = (P_2^0 - P_1^0)x_2 + P_1^0$
(B) $P = (P_2^0 - P_1^0)x_1 + P_1^0$
(C) $P = (P_1^0 + P_2^0)x_1 - P_2^0$
(D) $P = (P_2^0 - P_1^0)x_2 - P_1^0$

Sample Content

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To see complete chapter buy **Target Notes**

Sample Content

18. Which of the following solutions has minimum freezing point depression? **[2022]**
(A) 0.2 m $MgCl_2$ (B) 2 m $AlCl_3$
(C) 0.2 m KCl (D) 0.1 m NaCl

19. Which of the following solutions exhibits lowest value of boiling point elevation assuming complete dissociation? **[2023]**
(A) 0.1 m $AlCl_3$
(B) 0.01 m $MgCl_2$
(C) 1 m KCl
(D) 0.5 m NaCl

20. What is osmotic pressure of solution of 1.7 g $CaCl_2$ in 1.25 $dm^3$ water at 300 K if van't Hoff factor and molar mass of $CaCl_2$, are 2.47 and 111 g $mol^{-1}$ respectively?
[R = 0.082 $dm^3$ atm $mol^{-1}$ $K^{-1}$] **[2023]**
(A) 0.625 atm (B) 0.744 atm
(C) 0.827 atm (D) 0.936 atm

21. Calculate osmotic pressure of 0.2 M aqueous KCl solution at 0°C if van't Hoff factor for KCl is 1.83. [R = 0.082 $dm^3$ atm $mol^{-1}$ $K^{-1}$] **[2023]**
(A) 8.2 atm (B) 9.4 atm
(C) 10.6 atm (D) 6.5 atm

22. Which among the following solutions has minimum boiling point elevation? **[2023]**
(A) 0.1 m NaCl (B) 0.2 m $KNO_3$
(C) 0.1 m $Na_2SO_4$ (D) 0.05 m $CaCl_2$

23. If 0.15 m aqueous solution of KCl freezes at –0.51°C, calculate van't Hoff factor of KCl. (cryoscopic constant of water is 1.86 K kg $mol^{-1}$) **[2023]**
(A) 1.45 (B) 1.26
(C) 1.82 (D) 3.00

24. Calculate van't Hoff factor of $K_2SO_4$ if 0.1 m aqueous solution of $K_2SO_4$ freezes at –0.43 °C and cryoscopic constant of water is 1.86 K kg $mol^{-1}$. **[2023]**
(A) 2.3 (B) 2.7
(C) 3.1 (D) 3.5

25. Which among the following equimolar solutions has maximum value of osmotic pressure assuming complete ionisation? **[2023]**
(A) $Li_2SO_4$ (B) KCl
(C) $Al_2(SO_4)_3$ (D) $BaCl_2$

26. If 0.01 m aqueous solution of an electrolyte freezes at –0.056 °C. Calculate van't Hoff factor for an electrolyte. (Cryoscopic constant of water = 1.86 K kg $mol^{-1}$) **[2023]**
(A) 1.30 (B) 2.33
(C) 3.00 (D) 4.11

27. A 0.5 m aqueous solution of monofluoro acetic acid freeze at −1.0 °C. Calculate the van't Hoff factor of monofluoro acetic acid if cryoscopic constant of water is 1.86 K kg $mol^{-1}$. **[2023]**
(A) 1.08 (B) 2.10
(C) 1.30 (D) 2.15

28. Which from following substances in their solutions of same concentration generates the highest osmotic pressure? **[2023]**
(A) $Li_2SO_4$ (B) KCl
(C) $Al_2(SO_4)_3$ (D) $BaCl_2$

29. Calculate van't Hoff factor for formic acid if 0.01 M aqueous solution of formic acid freezes at –0.021 °C and cryoscopic constant of water is 1.86 K kg $mol^{-1}$. **[2023]**
(A) 1.13 (B) 2.26
(C) 0.39 (D) 1.82

30. Which of the following solutions having same concentration exhibits the highest elevation in boiling point? **[2023]**
(A) NaCl (B) $AlPO_4$
(C) $MgCl_2$ (D) KCl

31. Which among the following solution has minimum freezing point depression assuming complete ionisation? **[2023]**
(A) 0.1 m NaCl
(B) 0.2 m $KNO_3$
(C) 0.1 m $Na_2SO_4$
(D) 0.05 m $CaCl_2$

## Concept Fusion

1. Identify the CORRECT statement from the following: **[2020]**
(A) Vapour pressure of a solution containing a non-volatile solute is always less than vapour pressure of pure solvent.
(B) Liquids having greater intermolecular forces have lower boiling points.
(C) Boiling point of pure solvent is always greater than boiling point of its solution containing a non-volatile solute.
(D) Vapour pressure of a solution containing a non-volatile solute is always greater than vapour pressure of pure solvent.

2. Which of the following concentration terms depends on temperature? **[2023]**
(A) Molality
(B) Molarity
(C) Mole fraction
(D) Percent by mass

Sample Content

## Answers and Solutions to MCQs

### 2.2 Types of solutions

| | | | | | |
|---|---|---|---|---|---|
| 1. | (A) | 2. | (B) | 3. | (D) |
| 4. | (A) | 5. | (D) | 6. | (C) |
| 7. | (C) | 8. | (D) | 9. | (B) |
| 10. | (D) | 11. | (C) | 12. | (A) |
| 13. | (B) | | | | |

### 2.4 Solubility

**1. (B)**

Henry's constant, $K_H = \frac{S}{P} = \frac{\text{mol dm}^{-3}}{\text{atm}}$

$\therefore$ Unit of $K_H$ = mol dm$^{-3}$ atm$^{-1}$

**2. (B)**

According to Henry's law,

$S = K_H \times P$

$\therefore S = 1.3 \times 10^{-3}$ mol dm$^{-3}$ atm$^{-1}$ $\times$ 0.46 atm

$= 5.98 \times 10^{-4}$ mol dm$^{3}$

**3. (B)** **4. (D)**

**5. (B)**

According to Henry's law,

$S = K_H P = 7 \times 10^{-4}$ mol L$^{-1}$ bar$^{-1}$ $\times$ 0.75 bar

$= 5.25 \times 10^{-4}$ mol L$^{-1}$

**6. (A)**

Solubility of KBr increases appreciably with increase in temperature whereas solubility of NaBr, NaCl and KCl changes slightly with increase in temperature.

**7. (B)**

$P = 380 \text{ mm Hg} \times \frac{1}{760 \text{ mm Hg / atm}}$

= 0.5 atm $\times$ 1.013 bar/atm

= 0.5065 bar

According to Henry's law,

$S = K_H P = 0.16$ mol L$^{-1}$ bar$^{-1}$ $\times$ 0.5065 bar

= 0.08 mol L$^{-1}$

**8. (C)**

$S = K_H P$

$\therefore K_H = \frac{S}{P} = \frac{0.08 \text{ mol / L}}{0.5 \text{ bar}}$ = 0.16 mol L$^{-1}$ bar$^{-1}$

**9. (B)**

$K_H = \frac{S}{P} = \frac{7 \times 10^{-4} \text{mol L}^{-1}}{1 \text{ bar}} = 7 \times 10^{-4}$ mol L$^{-1}$ bar$^{-1}$

**Thinking Hatke - Q.9**

Solubility of a gas (S) in a liquid is equal to $K_H$, when pressure of the gas over the solution is 1 bar.

**10. (C)**

$P = 260 \text{ mm Hg} \times \frac{1}{760 \text{ mm Hg / atm}}$ = 0.342 atm

According to Henry's law,

$S = K_H P = 0.159$ mol dm$^{-3}$ atm$^{-1}$ $\times$ 0.342 atm

$= 5.4 \times 10^{-2}$ mol dm$^{-3}$

**11. (A)**

According to Henry's law,

$S = K_H P$ = 0.145 mol dm$^{-3}$ atm$^{-1}$ $\times$ 1.2 atm

= 0.174 mol dm$^{-3}$

**12. (A)**

**13. (C)**

Solubility of $KNO_3$ increases appreciably with increase in temperature whereas solubility of NaCl, NaBr and KCl changes slightly with temperature.

**14. (D)**

According to Henry's law,

$S = K_H P = 6.85 \times 10^{-4}$ mol dm$^{-3}$ atm$^{-1}$ $\times$ 0.8 atm

$= 5.48 \times 10^{-4}$ mol dm$^{-3}$

**15. (D)**

According to Henry's law,

$S = K_H P$

$K_H = \frac{S}{P} = \frac{6.86 \times 10^{-4} \text{ mol dm}^{-3}}{1 \text{ atm}}$

$= 6.85 \times 10^{-4}$ mol dm$^{-3}$ atm$^{-1}$

**16. (C)**

According to Henry's law,

$S = K_H P = 6.85 \times 10^{-4}$ mol dm$^{-3}$ atm$^{-1}$ $\times$ 0.75 atm

$= 5.14 \times 10^{-4}$ mol dm$^{-3}$

**17. (A)**

Henry's law: $S = K_H P$

$\therefore P = \frac{S}{K_H} = \frac{6.85 \times 10^{-4} \text{ mol dm}^{-3}}{6.85 \times 10^{-4} \text{ mol dm}^{-3} \text{ bar}^{-1}}$ = 1 bar

**Thinking Hatke - Q.17**

Since solubility of a gas (S) in a liquid is equal to $K_H$, pressure of the gas over the solution is 1 bar.

**18. (A)**

**Thinking Hatke - Q.18**

Gases like $CO_2$, $NH_3$ and HCl do not obey Henry's law as they react with water.

**19. (A)**

Sample Content

**20.** **(A)**

$S = K_H \times P$
$= 0.16 \times 0.18$
$= 0.0288$ mol dm$^{-3}$

**21.** **(A)**

Dissolution of $Na_2SO_4$ in water is an exothermic process. When a substance dissolves in water by an exothermic process, its solubility decreases with an increase in temperature. Hence, solubility of $Na_2SO_4$ in water decreases with increase in temperature.

**22.** **(A)**

$S = K_HP = 0.159$ mol dm$^{-3}$ bar$^{-1}$ $\times$ 0.346 bar
$= 0.055$ mol dm$^{-3}$

**23.** **(D)**

Solubility of $Na_2SO_4$ decreases with increase of temperature.

**24.** **(A)**

$$K_H = \frac{S}{P} = \frac{0.028}{0.346}$$
$= 0.081$ mol dm$^{-3}$ bar$^{-1}$

**25.** **(D)**

Dissolution of $Na_2SO_4$, $CaCl_2$ and $Li_2SO_4{\cdot}H_2O$ in water are exothermic processes while dissolution of KCl in water is an endothermic process.

**26.** **(D)**

$S = K_H \times P$

$\therefore$ $K_H = \frac{S}{P}$

$$= \frac{6.85 \times 10^{-4}\ \text{mol dm}^{-3}}{0.9\ \text{bar}}$$
$= 7.6 \times 10^{-4}$ mol dm$^{-3}$ bar$^{-1}$

**27.** **(C)**

Solubility = 3.2 mg dm$^{-3}$ = $3.2 \times 10^{-3}$ g dm$^{-3}$
Solubility in mol dm$^{-3}$

$$= \frac{3.2 \times 10^{-3}}{32} = 1 \times 10^{-4}\ \text{mol dm}^{-3}$$

$S = K_H P$

$$\therefore \quad P = \frac{S}{K_H} = \frac{1 \times 10^{-4}\ \text{mol dm}^{-3}}{2 \times 10^{-3}\ \text{mol dm}^{-3}\ \text{atm}^{-1}} = 0.05\ \text{atm}$$

**28.** **(A)**

$S = K_HP = 6.85 \times 10^{-4}$ mol dm$^{-3}$ bar$^{-1}$ $\times$ 0.7 bar
$= 4.795 \times 10^{-4}$ mol dm$^{-3}$

**29.** **(C)**

$S = K_H \times P$
$= 0.159 \times 0.328$
$= 0.0521$
$= 5.21 \times 10^{-2}$ mol dm$^{-3}$

## 2.5 Vapour pressure of solutions of liquids in liquids

**1.** **(D)** **2.** **(A)** **3.** **(A)**

**4.** **(C)**

**5.** **(A)**

$P = P_1 + P_2 = P_1^0 x_1 + P_2^0 x_2$

Now, $x_1 = 1 - x_2$

$\therefore$ $P = P_1^0(1 - x_2) + P_2^0 x_2 = P_1^0 - P_1^0 x_2 + P_2^0 x_2$

$P = \left(P_2^0 - P_1^0\right)x_2 + P_1^0$

**6.** **(D)**

The vapour pressure of ideal solution always lies between vapour pressures of pure components.

**7.** **(C)**

**8.** **(C)**

The solutions in which the interactions between solvent and solute molecules are stronger than solute-solute or solvent-solvent interactions exhibit negative deviations. Solution of chloroform and acetone exhibits negative deviation from the Raoult's law.

**9.** **(A)**

## 2.6 Colligative properties of nonelectrolyte solutions

**1.** **(D)** **2.** **(D)** **3.** **(A)**

**4.** **(B)**

## 2.7 Vapour pressure lowering

**1.** **(C)**

Relative lowering of vapour pressure,

$$\frac{\Delta P}{P_1^0} = x_2 = \frac{\frac{W_2}{M_2}}{\frac{W_1}{M_1} + \frac{W_2}{M_2}} = \frac{\frac{9}{180}}{\frac{90}{18} + \frac{9}{180}}$$

$$= \frac{0.05}{5 + 0.05} = 0.0099$$

**2.** **(A)**

$$\frac{P_1^0 - P_1}{P_1^0} = \frac{W_2 \times M_1}{W_1 \times M_2}$$

$$\frac{660 - 600}{660} = \frac{3.6 \times 10^{-3} \times 78}{40 \times 10^{-3} \times M_2}$$

$$M_2 = \frac{3.6 \times 10^{-3} \times 78}{40 \times 10^{-3} \times 0.09} = 78.0\ \text{g mol}^{-1}$$

**3.** **(C)**

Addition of water to 1 molal aqueous solution of KI causes the concentration of the solution to decrease thereby increasing the vapour pressure.

Sample Content

4. **(B)**
For a solution containing a non-volatile solute, relative lowering of vapour pressure,
$\frac{\Delta P}{P_1^0} = x_2$ = Mole fraction of solute

5. **(A)**
$n_2 = \frac{38.4}{384} = 0.1$ mol
$n_1 = \frac{116}{58} = 2$ mol
Mole fraction of solvent ($x_1$)
$= \frac{n_1}{n_1+n_2} = \frac{2}{2+0.1} = 0.95$
By Raoult's law, the vapour pressure of the solution is given by
$P_1 = P_1^0 x_1 = 0.842 \text{ atm} \times 0.95 = 0.7999$ atm

6. **(A)**
Relative lowering of vapour pressure,
$\frac{\Delta P}{P_1^0} = x_2 = \frac{n_2}{n_1+n_2}$

7. **(A)**
Relative lowering of vapour pressure, $\frac{\Delta P}{P_1^0} = x_2$
$\therefore \quad \frac{10}{P_1^0} = 0.2$
$\therefore \quad P_1^0 = 50$ mm of Hg

8. **(D)**
$\frac{P_1^0 - P_1}{P_1^0} = \frac{W_2 \times M_1}{W_1 \times M_2}$
$\frac{450-400}{450} = \frac{1.5 \times 78}{30 \times M_2}$
$M_2 = \frac{1.5 \times 78}{30 \times 0.111} = 35.1 \text{ g mol}^{-1}$

9. **(C)**
$\frac{P_1^0 - P_1}{P_1^0} = \frac{W_2 M_1}{M_2 W_1}$
$\therefore \quad \frac{143 - P_1}{143} = \frac{0.5 \times 154}{100 \times 65}$
$\therefore \quad 143 - P_1 = 1.694$
$\therefore \quad P_1 = 143 - 1.694 = 141.306$ mm Hg
$\approx 141.42$ mm Hg

10. **(B)**
$\frac{P_1^0 - P_1}{P_1^0} = x_2$
$\frac{0.9 - 0.6}{0.9} = 0.333$
Now, $x_1 + x_2 = 1$
$\therefore \quad x_1 = 1 - x_2 = 1 - 0.333 = 0.667$

11. **(B)**
$\frac{P_1^0 - P_1}{P_1^0} = \frac{W_2 M_1}{M_2 W_1}$
$\therefore \quad \frac{24 - P_1}{24} = \frac{6 \times 18}{60 \times 16.2}$
$\therefore \quad P_1 = 21.33 \text{ mm Hg} \approx 21.6$ mm Hg

12. **(A)**
$\frac{P_1^0 - P_1}{P_1^0} = x_2$
$\frac{240 - 216}{240} = 0.1$
Now, $x_1 + x_2 = 1$
$\therefore \quad x_1 = 1 - x_2 = 1 - 0.1 = 0.9$

13. **(C)**
$x_1 = \frac{n_1}{n_1+n_2} = \frac{20}{20+2} = 0.909$
$P_1 = P_1^0 x_1 = 32 \text{ mm Hg} \times 0.909 = 29.1$ mm Hg

14. **(A)**

15. **(B)**
$\Delta P = P_1^0 - P_1 = 120 - 108 = 12$ mm Hg
Relative lowering of vapour pressure, $\frac{\Delta P}{P_1^0} = x_2$
$\therefore \quad x_2 = \frac{12 \text{ mm Hg}}{120 \text{ mm Hg}} = 0.1$
$\therefore$ Mole fraction of solvent ($x_1$) $= 1 - x_2$
$= 1 - 0.1 = 0.9$

16. **(A)**
$\frac{P_1^0 - P_1}{P_1^0} = \frac{W_2 M_1}{M_2 W_1}$
$\therefore \quad \frac{400 - P_1}{400} = \frac{2.4 \times 18}{60 \times 10.8}$
$\therefore \quad 400 - P_1 = 26.67$
$\therefore \quad P_1 = 400 - 26.67 = 373.33$ mm Hg

17. **(C)**
Given: $M_2 = 2M_1, W_2 = \frac{1}{10} W_1$
Relative lowering in vapour pressure of solution is given by
$\frac{\Delta P}{P_1^0} = \frac{W_2 M_1}{M_2 W_1} = \frac{\frac{W_1}{10} \times M_1}{2M_1 \times W_1} = \frac{W_1 M_1}{10 \times 2M_1 \times W_1}$
$\therefore \quad \frac{\Delta P}{P_1^0} = \frac{1}{20}$
Here $P_1^0 = 200$ mm Hg (Given).
$\therefore$ Lowering in vapour pressure, $\Delta P = \frac{200}{20}$
$= 10$ mm Hg

Sample Content

**18.** **(B)**

$$\frac{P_1^0 - P_1}{P_1^0} = x_2$$

$\therefore$ $$\frac{P_1^0}{P_1^0} - \frac{P_1}{P_1^0} = x_2$$

$\therefore$ $x_2 = 1 - 0.15 = 0.85$

**19.** **(A)**

Relative lowering of vapour pressure,

$$\frac{\Delta P}{P_1^0} = \frac{W_2 M_1}{M_2 W_1}$$

$\therefore$ $$0.06 = \frac{2 \times 78}{M_2 \times 60}$$

$\therefore$ $$M_2 = \frac{2 \times 78}{0.06 \times 60} = 43.3 \text{ g mol}^{-1}$$

**20.** **(D)**

Molar mass of glucose ($C_6H_{12}O_6$) = 180 g mol$^{-1}$

$$\frac{P_1^0 - P_1}{P_1^0} = \frac{W_2 M_1}{M_2 W_1}$$

$\therefore$ $$\frac{32 - P_1}{32} = \frac{1.8 \times 18}{180 \times 16.2}$$

$\therefore$ $32 - P_1 = 0.011 \times 32$

$\therefore$ $P_1 = 32 - 0.352 = 31.648 \text{ mm Hg} \approx 31.7 \text{ mm Hg}$

**21.** **(C)**

Relative lowering of vapour pressure,

$$\frac{\Delta P}{P_1^0} = \frac{W_2 M_1}{M_2 W_1}$$

$\therefore$ $$0.025 = \frac{W_2 \times 18 \text{ g mol}^{-1}}{342 \text{ g mol}^{-1} \times 612 \text{ g}}$$

$\therefore$ $$W_2 = \frac{0.025 \times 342 \times 612}{18} = 290.7 \text{ g}$$

**22.** **(D)**

Relative lowering of vapour pressure, $\frac{\Delta P}{P_1^0} = x_2$

where $x_2$ is mole fraction of solute.

**23.** **(D)**

**24.** **(C)**

$$\frac{P_1^0 - P_1}{P_1^0} = \frac{W_2 M_1}{M_2 W_1}$$

$\therefore$ $$0.06 = \frac{2.3 \text{ g} \times 78 \text{ g mol}^{-1}}{M_2 \times 46 \text{ g}}$$

$\therefore$ $$M_2 = \frac{2.3 \text{ g} \times 78 \text{ g mol}^{-1}}{0.06 \times 46 \text{ g}} = 65 \text{ gram mol}^{-1}$$

**25.** **(C)**

$P_1^0 = 40$ mm, $x_1 = 0.9$, $x_2 = 1 - x_1 = 1 - 0.9 = 0.1$

$$\frac{P_1^0 - P_1}{P_1^0} = x_2$$

$$\frac{40 - P_1}{40} = 0.1$$

$40 - P_1 = 4$

$P_1 = 40 - 4 = 36$ mm Hg

**26.** **(D)**

$n_2 = 1$ mol

$$n_1 = \frac{36}{18} = 2 \text{ mol}$$

Relative lowering of vapour pressure

$$= \frac{P_1^0 - P_1}{P_1^0} = x_2 = \frac{n_2}{n_1 + n_2}$$

$\therefore$ $$\frac{32 \text{ mm Hg} - P_1}{32 \text{ mm Hg}} = \frac{1}{3}$$

$96 \text{ mm Hg} - 3P_1 = 32 \text{ mm Hg}$

$64 \text{ mm Hg} = 3P_1$

$\therefore$ $P_1 = 21.33 \text{ mm Hg} \approx 21.44 \text{ mm Hg}$

**27.** **(A)**

Relative lowering of vapour pressure

$$= \frac{\Delta P}{P_1^0} = \frac{P_1^0 - P_1}{P_1^0}$$

$$= \frac{640 - 590}{640} = 0.078$$

**28.** **(D)**

Using formula,

$$\frac{P_1^0 - P_1}{P_1^0} = \frac{W_2 M_1}{M_2 W_1}$$

$$\frac{32 \text{ mm Hg} - P_1}{32 \text{ mm Hg}} = \frac{3 \text{ g} \times 18 \text{ g mol}^{-1}}{60 \text{ g mol}^{-1} \times 8.1 \text{ g}}$$

$\therefore$ $$\frac{32 \text{ mm Hg} - P_1}{32 \text{ mm Hg}} = 0.1$$

$\therefore$ $32 \text{ mm Hg} - P_1 = 0.1 \times 32 \text{ mm Hg}$

$\therefore$ $32 \text{ mm Hg} - P_1 = 3.2 \text{ mm Hg}$

$\therefore$ $P_1 = 32 \text{ mm Hg} - 3.2 \text{ mm Hg} = 28.8 \text{ mm Hg}$

**29.** **(C)**

Relative lowering of vapour pressure $= \frac{\Delta P}{P_1^0} = x_2$

$$= \frac{W_2 M_1}{M_2 W_1}$$

$\therefore$ $$0.025 = \frac{3 \times 18}{M_2 \times 36}$$

$\therefore$ $$M_2 = \frac{3 \times 18}{0.025 \times 36} = 60 \text{ g mol}^{-1}$$

**30.** **(C)**

$$x_2 = \frac{\Delta P}{P_1^\circ}$$

$\therefore$ $$x_2 = \frac{P_1^0 - P_1}{P_1^0} = \frac{25.8 \text{ mm Hg} - 24.1 \text{ mm Hg}}{25.8 \text{ mm Hg}} = 0.066$$

Sample Content

**31.** **(A)**
Relative lowering of vapour pressure
$= \frac{P_1^0 - P_1}{P_1^0} = 0.025$

$\therefore \frac{17\text{ mm Hg} - P_1}{17\text{ mm Hg}} = 0.025$

$\therefore$ 17 mm Hg – $P_1$ = 0.025 × 17 mm Hg

$\therefore$ 17 mm Hg – $P_1$ = 0.425 mm Hg

$\therefore$ $P_1$ = 17 mm Hg – 0.425 mm Hg = 16.58 mm Hg

**32.** **(A)**
Molar mass of water is 18 g $mol^{-1}$

$\frac{P_1^0 - P_1}{P_1^0} = \frac{W_2M_1}{M_2W_1}$

$\therefore 0.03 = \frac{19\text{ g} \times 18\text{ g mol}^{-1}}{M_2 \times 200\text{ g}}$

$\therefore 0.03 = \frac{1.71\text{ g mol}^{-1}}{M_2}$

$\therefore M_2 = \frac{1.71\text{ g mol}^{-1}}{0.03} = 57.00\text{ g mol}^{-1}$

## 2.8 Boiling point elevation

**1.** **(D)**

$\Delta T_b = K_b\frac{1000W_2}{M_2W_1}$ ;

$K_b = \frac{\Delta T_b M_2 W_1}{1000W_2} = \frac{\Delta T_b \times 100 \times 500}{1000 \times 50} = \Delta T_b$

**2.** **(A)**
Given: m = 0.25 m, $K_b$ = 0.52 K kg $mol^{-1}$
$\Delta T_b = m K_b = 0.25 \times 0.52 = 0.13$ K

**3.** **(D)**
$\Delta T_b = T_b - T_b^0 = 100.18 - 100$
$= 0.18\ ^\circ C = 0.18$ K

$\Delta T_b = K_b \times m$

$\therefore m = \frac{\Delta T_b}{K_b} = \frac{0.18\text{K}}{0.512\text{ K kg mol}^{-1}} = 0.35\text{ mol kg}^{-1}$

**4.** **(D)** **5.** **(B)**

**6.** **(B)**
$\Delta T_b = K_b \times m$

$\therefore K_b = \frac{\Delta T_b}{m}$

where m = Molality of solution

**7.** **(C)**

**8.** **(D)**
Decimolal solution implies that the molality of the solution is 0.1 m.
$\Delta T_b = K_b \times m$
$= 0.52\ ^\circ\text{C kg mol}^{-1} \times 0.1\text{ mol kg}^{-1} = 0.052\ ^\circ\text{C}$
$\Delta T_b = T_b - T_b^0$

$\therefore T_b = \Delta T_b + T_b^0 = 0.052 + 100 = 100.052\ ^\circ\text{C}$

**9.** **(B)**

$M_2 = \frac{1000\ K_b W_2}{\Delta T_b W_1} = \frac{1000 \times 2.77 \times 50}{5.54 \times 150}$
$= 166.6\text{ g mol}^{-1}$

**10.** **(C)**

$M_2 = \frac{1000 \times K_b \times W_2}{\Delta T_b\ W_1}$

$\therefore K_b = \frac{M_2 \times \Delta T_b \times W_1}{1000 \times W_2}$

$= \frac{111\text{g mol}^{-1} \times 8.3\text{K} \times 150\text{ g}}{1000\text{ g kg}^{-1} \times 50\text{ g}}$

$= 2.76\text{ K kg mol}^{-1}$

**11.** **(C)**

**12.** **(C)**
$\Delta T_b = T_b - T_b^0 = 85 - 76 = 9\ ^\circ\text{C} = 9$ K

$M_2 = \frac{1000 K_b W_2}{\Delta T_b W_1}$

$\therefore W_2 = \frac{M_2 \Delta T_b W_1}{1000 K_b} = \frac{120 \times 9 \times 160}{1000 \times 2.7} = 64$ g

**13.** **(B)**
$\Delta T_b = T_b - T_b^0 = 310 - 308 = 2$ K

$M_2 = \frac{K_b \times W_2 \times 1000}{\Delta T_b W_1} = \frac{2.4 \times 5 \times 1000}{2 \times 100}$
$= 60\text{ g mol}^{-1}$

**14.** **(D)**

$\Delta T_b = \frac{K_b \times W_2 \times 1000}{M_2 \times W_1}$

$\therefore W_2 = \frac{\Delta T_b \times M_2 \times W_1}{K_b \times 1000} = \frac{2 \times 60 \times 100}{2.5 \times 1000} = 4.8$ gram

**15.** **(B)**
$\Delta T_b = K_b \times m$

$\therefore m = \frac{\Delta T_b}{K_b} = \frac{1.74}{3} = 0.58\text{ mol kg}^{-1}$

**16.** **(B)**

$M_2 = \frac{K_b \times W_2 \times 1000}{\Delta T_b \times W_1} = \frac{3.5 \times 2 \times 1000}{0.5 \times 80}$
$= 175\text{ g mol}^{-1}$

**17.** **(C)**
$\Delta T_b = K_b \times m$

$\therefore m = \frac{\Delta T_b}{K_b} = \frac{1.75}{5} = 0.35\text{ mol kg}^{-1}$

**18.** **(B)**

$\Delta T_b = \frac{1000 K_b W_2}{M_2 W_1}$

$\therefore K_b = \frac{\Delta T_b \times M_2 \times W_1}{W_2 \times 1000}$

$= \frac{7 \times 132 \times 180}{60 \times 1000} = 2.77\text{ K kg mol}^{-1}$

Sample Content

**19.** **(A)** **20.** **(B)** **21.** **(D)**

**22.** **(C)**

$M_2 = \frac{K_b \times W_2 \times 1000}{\Delta T_b \times W_1} = \frac{2.5 \times 3.5 \times 1000}{0.35 \times 100}$

$= 250 \text{ g mol}^{-1}$

**23.** **(D)**

The aqueous solution contains 36 g glucose per $dm^3$, so mass of solute $W_2$ is 36 g.

Assuming that the density of solution is 1 $g/dm^3$, the mass of solvent (water) is 1000 g.

$\Delta T_b = \frac{1000 K_b W_2}{M_2 W_1}$

$\Delta T_b = \frac{1000 \text{ g kg}^{-1} \times K_b \times 36 \text{ g}}{180 \text{ g} \times 1000 \text{ g}}$

$\Delta T_b = \frac{2K_b}{10}$

$\Delta T_b = T_b - T_b^o$

$T_b = T_b^o + \Delta T_b$

$\therefore \quad T_b = \left(100 + \frac{2K_b}{10}\right)^o C$

**24.** **(A)**

$M_2 = \frac{1000 \ K_b W_2}{\Delta T_b W_1}$

$K_b = \frac{M_2 \times \Delta T_b \times W_1}{1000 \times W_2} = \frac{150 \times 0.65 \times 30}{1000 \times 1.5}$

$= 1.95 \text{ K kg mol}^{-1}$

**25.** **(C)**

$\Delta T_b = K_b \times m$

$1.89 = 3.15 \times m$

$\therefore \quad m = \frac{1.89}{3.15} = 0.6 \text{ mol kg}^{-1}$

**26.** **(A)**

$M_2 = \frac{1000 \ K_b W_2}{\Delta T_b W_1}$

$= \frac{1000 \times 3 \times 5.6}{1.75 \times 50} = 192 \text{ g mol}^{-1}$

**27.** **(A)**

$M_2 = \frac{1000 \ K_b W_2}{\Delta T_b W_1}$

$\therefore \quad K_b = \frac{M_2 \Delta T_b W_1}{1000 \ W_2}$

Now, $W_2$ = one gram mole = $M_2$ g

$W_1$ = 1 kg = 1000 g

$\therefore \quad K_b = \frac{M_2 \times x \times 1000}{1000 \times M_2}$

$= x \text{ K kg mol}^{-1}$

**Thinking Hatke - Q.27**

One gram mole solute dissolved in 1 kg solvent = 1 molal solution

When concentration of solution is 1 molal, elevation in boiling point ($\Delta T_b$) is equal to molal elevation constant ($K_b$).

Therefore, $K_b = x \text{ K kg mol}^{-1}$

**28.** **(C)**

$\Delta T_b = K_b \times m$

$\therefore \quad m = \frac{\Delta T_b}{K_b} = \frac{7.15 \text{ K}}{2.75 \text{ K kg mol}^{-1}} = 2.6 \text{ mol kg}^{-1}$

**29.** **(B)**

$\Delta T_b = T_b - T_b^0 = 84 - 75 = 9 \text{ °C} = 9 \text{ K}$

$\Delta T_b = \frac{1000 K_b W_2}{M_2 W_1}$

$M_2 = \frac{1000 \ K_b W_2}{\Delta T_b W_1} = \frac{1000 \times 2.7 \times 50}{9 \times 150} = 100 \text{ g mol}^{-1}$

**30.** **(B)**

$\Delta T_b = K_b.m$

$\therefore \quad K_b = \frac{\Delta T_b}{m} = \frac{0.68 \text{ K}}{0.34 \text{ mol kg}^{-1}} = 2.0 \text{ K kg mol}^{-1}$

**31.** **(B)**

$\Delta T_b = T_b - T_b^0$

$= 84.27 \text{ °C} - 77.27 \text{ °C}$

$= 7.00 \text{ °C} = 7.00 \text{ K}$

Now,

$M_2 = \frac{1000 \times K_b \times W_2}{\Delta T_b \times W_1}$

$M_2 = \frac{1000 \text{ g kg}^{-1} \times 2.73 \text{ K kg mol}^{-1} \times 50 \text{ g}}{7.00 \text{ K} \times 150 \text{ g}}$

$= 130 \text{ g mol}^{-1}$

**32.** **(A)**

$M_2 = \frac{1000 \times K_b \times W_2}{\Delta T_b \times W_1}$

$= \frac{1000 \times 2.77 \times 30}{7.2 \times 120}$

$= 96.2 \text{ g mol}^{-1}$

**33.** **(A)**

$\Delta T_b = K_b m = 2.5 \text{ K kg mol}^{-1} \times 0.7 \text{ mol kg}^{-1}$

$= 1.75 \text{ K}$

**34.** **(B)**

**35.** **(C)**

$\Delta T_b = K_b m$

$\therefore \quad K_b = \frac{\Delta T_b}{m} = \frac{0.125 \text{ K}}{0.25 \text{ mol kg}^{-1}}$

$= 0.5 \text{ K kg mol}^{-1}$

Sample Content

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To see complete chapter buy **Target Notes**

Sample Content

Sample Content

**18. (D)**

Depression of freezing point is colligative property which depends on number of particles present in solution. Lesser is the number of particles, less will be the depression.

| Solution | Dissociation | Molality of ions after dissociation |
|---|---|---|
| 0.2 m $MgCl_2$ | $MgCl_2 \rightarrow Mg^{2+} + 2Cl^-$ | 3 × 0.2 = 0.6 m |
| 2 m $AlCl_3$ | $AlCl_3 \rightarrow Al^{3+} + 3Cl^-$ | 4 × 2 = 8 m |
| 0.2 m KCl | $KCl \rightarrow K^+ + Cl^-$ | 0.2 × 2 = 0.4 m |
| 0.1 m NaCl | $NaCl \rightarrow Na^+ + Cl^-$ | 0.1 × 2 = 0.2 m |

**19. (B)**

| | Solution | Moles of particles in 1 kg solution |
|---|---|---|
| (A) | 0.1 m $AlCl_3$ | 0.4 |
| (B) | 0.01 m $MgCl_2$ | 0.03 |
| (C) | 1 m KCl | 2 |
| (D) | 0.5 m NaCl | 1 |

0.01 m $MgCl_2$ solution has minimum number of particles in solution, so it shows the lowest value of boiling point elevation.

**20. (B)**

$$\pi = iMRT = \frac{i \times W_2RT}{M_2V}$$

$$\pi = \frac{2.47 \times 1.7\ g \times 0.082\ dm^3\ atm\ mol^{-1}\ K^{-1} \times 300\ K}{111\ g\ mol^{-1} \times 1.25\ dm^3}$$

$= 0.744$ atm

**21. (A)**

$\pi = iMRT$

$= 1.83 \times 0.2 \times 0.082 \times 273$

$= 8.2$ atm

**22. (D)**

$NaCl \longrightarrow Na^+ + Cl^-$

Total ions = 0.1 + 0.1 = 0.2 ions

$KNO_3 \longrightarrow K^+ + NO_3^-$

Total ions = 0.2 + 0.2 = 0.4 ions

$Na_2SO_4 \longrightarrow 2Na^+ + SO_4^{2-}$

Total ions = 0.2 + 0.1 = 0.3 ions

$CaCl_2 \longrightarrow Ca^{2+} + 2Cl^-$

Total ions = 0.05 + 0.1 = 0.15 ions

0.05 m $CaCl_2$ solution has minimum ions in solution, so it shows minimum boiling point elevation.

**23. (C)**

$\Delta T_f = T_f^0 - T_f = 0 - (-0.51°C) = 0.51°C = 0.51$ K

∴ $\Delta T_f = iK_f m$

∴ $i = \frac{\Delta T}{K_f m} = \frac{0.51\ K}{1.86\ K\ kg\ mol^{-1} \times 0.15\ mol\ kg^{-1}} = 1.82$

**24. (A)**

$\Delta T_f = i\ K_f\ m$

∴ $0.43 = i \times 1.86 \times 0.1$

∴ $i = \frac{0.43}{1.86 \times 0.1} = 2.3$

[*Note:* In the question, the freezing point of aqueous solution is changed from −0.43 K to −0.43 °C to apply appropriate textual concepts.]

**25. (C)**

Osmotic pressure is a colligative property that depends on number of particles in solution. The solution having more number of particles will have large osmotic pressure.

Suppose the concentration of each substance is 1 m. Then,

$\underset{1\ m}{Li_2SO_4} \longrightarrow \underset{2.0\ m}{2Li^+} + \underset{1\ m}{SO_4^{2-}}$

Total particles in solution = 3 mol

$\underset{1\ m}{KCl} \longrightarrow \underset{1\ m}{K^+} + \underset{1\ m}{Cl^-}$

Total particles in solution = 2 mol

$\underset{1\ m}{Al_2(SO_4)_3} \longrightarrow \underset{2\ m}{2Al^{3+}} + \underset{3\ m}{3SO_4^{2-}}$

Total particles in solution = 5 mol

$\underset{1\ m}{BaCl_2} \longrightarrow \underset{1\ m}{Ba^{2+}} + \underset{2\ m}{2Cl^-}$

Total particles in solution = 3 mol

Hence, $Al_2(SO_4)_3$ solution gives more number of particles and has the highest osmotic pressure among the given.

**26. (C)**

$\Delta T_f = i \times K_f \times m$

$0.056 = i \times 1.86 \times 0.01$

∴ $i = \frac{0.056}{1.86 \times 0.01} = 3.01$

[*Note:* In the question, the freezing point of aqueous solution is changed from −0.056 K to −0.056 °C to apply appropriate textual concepts.]

**27. (A)**

$\Delta T_f = i \times K_f \times m$

$1.0 = i \times 1.86 \times 0.5$

$i = \frac{1.0}{1.86 \times 0.5} = 1.08$

[*Note:* In the question, the freezing point of the aqueous solution is changed from −1.0 K to −1.0 °C to apply appropriate textual concepts.]

**28.** **(C)**

Osmotic pressure is a colligative property that depends on number of particles in solution. The solution having more number of particles will have large osmotic pressure.

Suppose the concentration of each substance is 1 m. Then,

$Li_2SO_4 \longrightarrow 2Li^+ + SO_4^{2-}$

1 m 2 m 1 m

Total particles in solution = 3 mol

$KCl \longrightarrow K^+ + Cl^-$

1 m 1 m 1 m

Total particles in solution = 2 mol

$Al_2(SO_4)_3 \longrightarrow 2Al^{3+} + 3\,SO_4^{2-}$

1 m 2 m 3 m

Total particles in solution = 5 mol

$BaCl_2 \longrightarrow Ba^{2+} + 2Cl^-$

1 m 1 m 2 m

Total particles in solution = 3 mol

Hence, solution of $Al_2(SO_4)_3$ gives more number of particles and has the highest osmotic pressure among the given.

**29.** **(A)**

Assuming molarity is equal to molality,

$\Delta T_f = i \times K_f \times m$

$\therefore$ $0.021 = i \times 1.86 \times 0.01$

$i = \frac{0.021}{1.86 \times 0.01} = 1.13$

**[*Note:* In the question, the freezing point of the aqueous solution is changed from −0.021 K to –0.021 °C to apply appropriate textual concepts.]**

**30.** **(C)**

One formula unit of $MgCl_2$ dissolved in water produces three ions while given others produce 2 ions each per formula unit. Hence, among given equimolar solutions, $MgCl_2$ solution produces the highest elevation in boiling point

**31.** **(D)**

$NaCl \longrightarrow Na^+ + Cl^-$

0.1 m 0.1 m 0.1 m

Total particles in solution = 0.2 mol

$KNO_3 \longrightarrow K^+ + NO_3^-$

0.2 m 0.2 m 0.2 m

Total particles in solution = 0.4 mol

$Na_2SO_4 \longrightarrow 2Na^+ + SO_4^{2-}$

0.1 m 0.2 m 0.1 m

Total particles in solution = 0.3 mol

$CaCl_2 \longrightarrow Ca^{2+} + 2Cl^-$

0.05 m 0.05 m 0.1 m

Total particles in solution = 0.15 mole

Hence, 0.05 m $CaCl_2$ solution has minimum moles and particles. Hence, it shows minimum freezing point depression.

## Concept Fusion

**1.** **(A)** **2.** **(B)**

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