

# MP Board Class 12 Chemistry Question Paper with Solutions(Memory Based)

## General Instructions

1. The question paper consists of six sections — Section A to Section F.
2. Time allowed is **3 hours 15 minutes** and the maximum marks are **90**.
3. All questions are compulsory unless otherwise stated.
4. Section A contains Multiple Choice Questions (MCQs). Choose the correct answer from the given options.
5. Section B includes:
  - True/False questions
  - Fill in the blanks
  - Very short answer questions (one or two words)
6. Section C contains short answer type questions.
7. Section D contains long descriptive questions with internal choices.
8. Section E contains long answer questions. Attempt the required number as instructed.
9. Section F consists of Map Work. Mark and label the places correctly on the outline map of India.
10. Figures to the right indicate full marks for each question.
11. Write neatly and draw diagrams wherever necessary.
12. Write answers only in the space provided or as instructed.

**1. The pressure of solution that just prevents the flow of solvent is called:**

- (A) Vapour Pressure
- (B) Osmotic Pressure
- (C) Partial Pressure
- (D) Gas pressure

**Correct Answer:** (B) Osmotic Pressure

**Solution:**

**Concept:**

When a solution and pure solvent are separated by a semipermeable membrane, solvent molecules naturally move from the solvent side to the solution side. This process is called osmosis.

**Definition:**

The minimum pressure that must be applied to a solution to just stop the flow of solvent through a semipermeable membrane is called **osmotic pressure**.

**Explanation:**

- Solvent flows from lower solute concentration to higher solute concentration.
- Applying external pressure on the solution side can stop this flow.
- The required pressure to stop osmosis is called osmotic pressure.

$$\pi = CRT$$

where,

- $\pi$  = osmotic pressure
- $C$  = molar concentration
- $R$  = gas constant
- $T$  = temperature

Answer: (B) Osmotic Pressure

**Quick Tip**

Osmotic pressure is a colligative property — it depends only on the number of solute particles, not their nature.

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**2. How much charge is required for the 1 mol  $\text{Al}^{3+}$  to Al?**

- (A) 1F
- (B) 2F
- (C) 4F
- (D) 3F

**Correct Answer:** (D) 3F

**Solution:**

**Concept:**

The charge required in electrolysis is calculated using Faraday's laws. 1 Faraday (F) is the charge carried by 1 mole of electrons.

$$1F = 96500 \text{ C}$$

**Step 1: Write the Reduction Reaction**



This shows:

- 1 mole of  $\text{Al}^{3+}$  requires 3 moles of electrons.

### Step 2: Convert Electrons to Faradays

- 1 mole electrons = 1 Faraday
- 3 moles electrons = 3 Faradays

$$\boxed{\text{Required charge} = 3F}$$

#### Quick Tip

Number of Faradays required = number of electrons involved in the half-reaction.

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**3. For a chemical reaction with rise in temperature by  $10^{\circ}\text{C}$  the rate constant is nearly:**

- (A) No change
- (B) Tripled
- (C) Doubled
- (D) Ten time increases

**Correct Answer:** (C) Doubled

**Solution:**

**Concept:**

The effect of temperature on reaction rate is explained by the Arrhenius equation. A general empirical rule in chemical kinetics states:

**Van't Hoff Rule:**

For many reactions, the rate of reaction approximately doubles for every  $10^{\circ}\text{C}$  rise in temperature.

$$k \propto e^{-E_a/RT}$$

An increase in temperature increases the number of molecules having energy greater than activation energy, thus increasing the rate constant.

**Explanation:**

- Higher temperature  $\rightarrow$  more energetic molecular collisions.

- Greater fraction of molecules overcome activation energy.
- Rate constant increases significantly.

Empirically:

Increase of  $10^{\circ}\text{C} \Rightarrow \text{Rate} \approx 2\times$

Rate constant nearly doubles

#### Quick Tip

This is an approximate rule; actual increase depends on activation energy of the reaction.

4. Total number of elements are in d-block is .....

- (A) 39
- (B) 40
- (C) 38
- (D) 36

**Correct Answer:** (B) 40

**Solution:**

**Concept:**

The d-block elements are those in which the last electron enters the  $(n - 1)d$  subshell. These elements are also called transition elements and are located in the middle of the periodic table.

**Counting d-block Elements:**

The d-block consists of four transition series:

- 3d series: Sc (21) to Zn (30)  $\rightarrow$  10 elements
- 4d series: Y (39) to Cd (48)  $\rightarrow$  10 elements
- 5d series: Hf (72) to Hg (80)  $\rightarrow$  10 elements
- 6d series: Rf (104) to Cn (112)  $\rightarrow$  10 elements

**Total Number:**

$$10 + 10 + 10 + 10 = 40$$

40

#### Quick Tip

Each transition series contains 10 elements because d-subshell can hold a maximum of 10 electrons.

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**5. Acetylation of salicylic acid produces:**

- (A) Aspirin
- (B) DDT
- (C) Phenol
- (D) BHC

**Correct Answer:** (A) Aspirin

**Solution:**

**Concept:**

Acetylation is a chemical reaction in which an acetyl group ( $-COCH_3$ ) is introduced into a compound. Salicylic acid undergoes acetylation to form a widely used analgesic drug.

**Reaction:**

Salicylic acid reacts with acetic anhydride in presence of an acid catalyst (like conc.  $H_2SO_4$ ).



**Product Formed:**

Acetylsalicylic acid is commonly known as **Aspirin**.

**Explanation:**

- The phenolic  $-OH$  group of salicylic acid gets acetylated.
- This reduces irritation and enhances medicinal properties.
- Aspirin is used as a pain reliever, antipyretic, and anti-inflammatory drug.

Answer: Aspirin

**Quick Tip**

Aspirin is acetylsalicylic acid — formed by acetylation of the phenolic OH group of salicylic acid.

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**6. Calculate the mass percentage of benzene if 22 g of benzene is dissolved in 122 g of carbon tetrachloride.**

**Correct Answer:** Mass percentage of benzene = 15.28%

**Solution:**

**Concept:**

Mass percentage (w/w) expresses the concentration of a component in a solution.

$$\text{Mass \%} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

### Step 1: Identify Given Values

- Mass of benzene (solute) = 22 g
- Mass of carbon tetrachloride (solvent) = 122 g

### Step 2: Find Total Mass of Solution

$$\text{Mass of solution} = 22 + 122 = 144 \text{ g}$$

### Step 3: Calculate Mass Percentage

$$\begin{aligned}\text{Mass \% of benzene} &= \frac{22}{144} \times 100 \\ &= 15.28\%\end{aligned}$$

$$\boxed{15.28\%}$$

#### Quick Tip

Always add solute and solvent masses to get total solution mass before calculating mass percentage.

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## 7. State Henry's Law regarding the solubility of gases in liquids and mention two daily-life applications.

**Correct Answer:** Henry's Law states that at constant temperature, the solubility of a gas in a liquid is directly proportional to the partial pressure of that gas above the liquid.

### Solution:

#### Concept:

Henry's Law explains how gases dissolve in liquids under pressure. It is important in chemistry, environmental science, and many real-life situations involving gas-liquid equilibrium.

#### Statement of Henry's Law:

At constant temperature, the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas above the liquid.

#### Mathematical Expression:

$$p \propto x$$

or

$$p = k_H x$$

where,

- $p$  = partial pressure of the gas
- $x$  = mole fraction (solubility) of gas in liquid
- $k_H$  = Henry's Law constant

### Daily-Life Applications:

1. **Carbonated Beverages:** Soft drinks are bottled under high pressure so that more  $CO_2$  dissolves in the liquid. When opened, pressure decreases and gas escapes as fizz.
2. **Deep-Sea Diving:** Divers use special gas mixtures because high pressure increases nitrogen solubility in blood. Rapid ascent can cause nitrogen bubbles (decompression sickness).

#### Quick Tip

Higher pressure increases gas solubility, while higher temperature usually decreases it.

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### 8. Describe the Standard Hydrogen Electrode (SHE) with a labeled diagram and its cell reaction.

**Correct Answer:** The Standard Hydrogen Electrode (SHE) consists of a platinum electrode in contact with  $1\text{ M } H^+$  ions and hydrogen gas at  $1\text{ atm}$  pressure. It serves as the reference electrode with zero potential.

#### Solution:

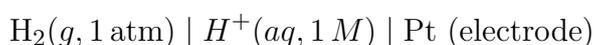
#### Concept:

The Standard Hydrogen Electrode (SHE) is used as a universal reference electrode to measure electrode potentials. Its standard electrode potential is defined as zero volts under standard conditions.

#### Construction of SHE:

- A platinum electrode coated with platinum black is used.
- The electrode is immersed in a solution containing  $1\text{ M}$  hydrogen ions (usually acid).
- Pure hydrogen gas is bubbled over the platinum surface at  $1\text{ atm}$  pressure.
- Temperature is maintained at  $25^\circ\text{C}$  ( $298\text{ K}$ ).

#### Labeled Diagram (Text Representation):



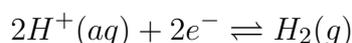
#### Parts:

- Platinum electrode (inert conductor)
- Acidic solution providing  $H^+$
- Hydrogen gas inlet

### Cell Reaction of SHE:

SHE can act as anode or cathode depending on the other electrode.

### Half-cell reaction:



### Key Features:

- Standard electrode potential = 0.00 V
- Reversible electrode
- Used to determine electrode potentials of other half-cells

#### Quick Tip

SHE is always written on the left side when used as a reference electrode, and all standard electrode potentials are measured relative to it.

## 9. Differentiate between the Order of Reaction and Molecularity.

**Correct Answer:** Order of reaction is the sum of powers of concentration terms in the rate law and is determined experimentally, whereas molecularity is the number of reacting species involved in an elementary step and is always a whole number.

### Solution:

#### Concept:

Order of reaction and molecularity are important terms in chemical kinetics that describe reaction rates. Though related to reaction mechanisms, they differ in meaning and determination.

#### Difference Between Order of Reaction and Molecularity:

Basis	Order of Reaction	Molecularity
Definition	Sum of powers of concentration terms in rate law	Number of reacting species in an elementary step
Determination	Determined experimentally	Determined from reaction mechanism
Possible Values	Can be zero, fractional, or integer	Always a whole number (1, 2, 3)
Applicability	Applies to overall reaction	Applies only to elementary reactions
Dependence	Depends on rate law	Independent of rate law
Example	Rate = $k[A]^1[B]^{1/2}$ (fractional order possible)	Bimolecular reaction involves two molecules

### Summary:

- Order gives experimental rate dependence.
- Molecularity describes actual molecular collisions in a single step.

### Quick Tip

For elementary reactions, order and molecularity may be the same, but for complex reactions they usually differ.

## 10. Define Specific Conductivity and Cell Constant, including their units.

**Correct Answer:** Specific conductivity is the conductance of a solution of unit length and unit cross-sectional area, while cell constant is the ratio of distance between electrodes to their cross-sectional area.

### Solution:

#### Concept:

Conductance of electrolytic solutions depends on both the nature of the solution and the geometry of the conductivity cell. Specific conductivity and cell constant help standardize these measurements.

### 1. Specific Conductivity (Conductivity, $\kappa$ ):

**Definition:** Specific conductivity is the conductance of a solution contained between two electrodes that are 1 cm apart and have a cross-sectional area of 1 cm<sup>2</sup>.

It measures the ability of ions to conduct electricity in a solution.

#### Formula:

$$\kappa = \frac{1}{R} \cdot \frac{l}{A}$$

where,

- $R$  = resistance
- $l$  = distance between electrodes
- $A$  = cross-sectional area

#### Unit:

$$\text{S cm}^{-1} \quad (\text{or SI unit: S m}^{-1})$$

### 2. Cell Constant:

**Definition:** Cell constant is the ratio of the distance between the electrodes to the cross-sectional area of the electrodes.

$$\text{Cell constant} = \frac{l}{A}$$

It depends only on the geometry of the conductivity cell.

#### Unit:

$$\text{cm}^{-1}$$

## Relation Between Them:

$$\kappa = \text{Conductance} \times \text{Cell constant}$$

### Quick Tip

Cell constant remains fixed for a given conductivity cell, while specific conductivity changes with concentration and temperature.

## 11. Why do transition elements (d-block) show variable oxidation states and magnetic properties?

**Correct Answer:** Transition elements show variable oxidation states due to involvement of both  $(n-1)d$  and  $ns$  electrons in bonding, and magnetic properties due to presence of unpaired electrons in d-orbitals.

### Solution:

#### Concept:

Transition elements (d-block elements) have partially filled d-orbitals. Their electronic configuration allows flexibility in electron participation during bonding, leading to unique chemical and physical properties.

### 1. Variable Oxidation States:

#### Reason:

- The energy difference between  $ns$  and  $(n-1)d$  orbitals is very small.
- Both types of electrons can participate in bond formation.
- As a result, different numbers of electrons may be lost or shared.

#### Example:

- Iron: +2 and +3
- Manganese: +2 to +7

Thus, multiple oxidation states are observed.

### 2. Magnetic Properties:

#### Reason:

- Magnetic behavior depends on presence of unpaired electrons.
- Partially filled d-orbitals often contain unpaired electrons.

#### Types of Magnetism:

- **Paramagnetism:** Due to unpaired electrons (most transition metals)
- **Diamagnetism:** When all electrons are paired

- **Ferromagnetism:** Strong magnetic ordering (e.g., Fe, Co, Ni)

### Summary:

- Variable oxidation states arise from participation of both *s* and *d* electrons.
- Magnetic properties arise from unpaired d-electrons.

### Quick Tip

Greater the number of unpaired d-electrons, stronger is the paramagnetic behavior of a transition element.

**12. Explain why Scandium (Z=21) is a transition element while Zinc (Z=30) is not.**

**Correct Answer:** Scandium is a transition element because it has a partially filled d-subshell in its atom or common oxidation state, whereas zinc has a completely filled d-subshell in both atom and its common ion, so it is not considered a transition element.

### Solution:

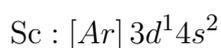
#### Concept:

A transition element is defined as an element that has:

- A partially filled d-orbital in its ground state, or
- Forms at least one ion with an incomplete d-subshell.

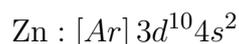
### Electronic Configuration:

#### Scandium (Z = 21):



- Contains one electron in the *3d* orbital.
- d-subshell is partially filled.
- Hence, it satisfies the definition of a transition element.

#### Zinc (Z = 30):



- d-orbital is completely filled ( $3d^{10}$ ).
- Common ion:  $\text{Zn}^{2+} = [\text{Ar}] 3d^{10}$
- d-subshell remains fully filled even after ion formation.

### Conclusion:

- **Scandium:** Partially filled d-orbital → Transition element.
- **Zinc:** Fully filled d-orbital in atom and ion → Not a transition element.

#### Quick Tip

Elements of group 12 (Zn, Cd, Hg) are not true transition elements because their d-orbitals are completely filled.

### 13. What is Lanthanoid Contraction? State its consequences.

**Correct Answer:** Lanthanoid contraction is the gradual decrease in atomic and ionic radii of lanthanoids with increasing atomic number due to poor shielding by 4f electrons. It leads to similarities in properties of elements and affects periodic trends.

#### Solution:

#### Concept:

Lanthanoids (elements from La to Lu) involve filling of the 4f orbitals. These electrons do not shield nuclear charge effectively, resulting in a steady increase in effective nuclear attraction across the series.

#### Definition of Lanthanoid Contraction:

Lanthanoid contraction refers to the gradual decrease in atomic and ionic sizes of lanthanoid elements from lanthanum (La) to lutetium (Lu) with increasing atomic number.

#### Reason:

- Addition of electrons occurs in the 4f orbitals.
- 4f electrons have poor shielding effect.
- Effective nuclear charge increases across the series.
- This pulls electrons closer to the nucleus, reducing size.

#### Consequences of Lanthanoid Contraction:

1. **Similarity Between 4d and 5d Elements:** Elements of second and third transition series (e.g., Zr and Hf) have nearly identical atomic radii and similar properties.
2. **Decrease in Basic Strength of Hydroxides:** Basicity of lanthanoid hydroxides decreases from  $\text{La}(\text{OH})_3$  to  $\text{Lu}(\text{OH})_3$  due to decreasing ionic size.
3. **Difficulty in Separation of Lanthanoids:** Similar sizes and chemical properties make their separation challenging.
4. **Effect on Periodic Trends:** Influences atomic size and properties of elements following lanthanoids in the periodic table.

### Quick Tip

Poor shielding by 4f electrons is the key reason behind lanthanoid contraction and its wide impact on periodic properties.

**14. Provide chemical equations for reactions such as Aldol Condensation, Cross Aldol Condensation, Wurtz Reaction, Fittig Reaction, and Hoffmann Bromamide Reaction.**

**Correct Answer:** These are important name reactions in organic chemistry involving carbon-carbon bond formation and functional group transformations.

**Solution:**

**Concept:**

Named organic reactions help in understanding reaction mechanisms and synthetic pathways. Below are standard chemical equations for each reaction.

**1. Aldol Condensation:**

Occurs between two molecules of aldehyde or ketone having  $\alpha$ -hydrogen in presence of dilute base.



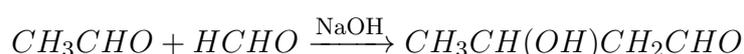
On heating (dehydration):



**2. Cross Aldol Condensation:**

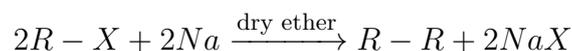
Occurs between two different carbonyl compounds.

Example: Acetaldehyde + Formaldehyde

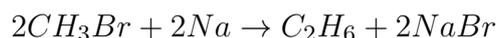


**3. Wurtz Reaction:**

Coupling of alkyl halides using sodium metal in dry ether to form higher alkanes.

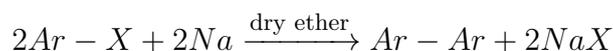


Example:



**4. Fittig Reaction:**

Coupling of aryl halides with sodium in dry ether to form biaryl compounds.



Example:



## 5. Hoffmann Bromamide Reaction (Hofmann Rearrangement):

Conversion of amide to primary amine with one less carbon using bromine and alkali.



### Quick Tip

Hofmann bromamide reaction shortens the carbon chain by one carbon — a key exam point.

## 15. Show how to convert substances like Benzene to Aniline or Phthalimide to N-alkyl phthalimide.

**Correct Answer:** Benzene can be converted to aniline via nitration followed by reduction, while phthalimide can be converted to N-alkyl phthalimide by alkylation using alkyl halides in presence of base.

### Solution:

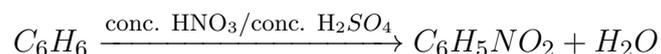
#### Concept:

Organic conversions involve stepwise reactions such as electrophilic substitution, reduction, and nucleophilic substitution. These transformations are important in synthetic organic chemistry.

### 1. Conversion of Benzene to Aniline:

#### Step 1: Nitration of Benzene

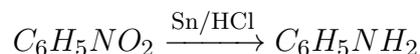
Benzene undergoes electrophilic substitution with concentrated nitric acid in presence of concentrated sulfuric acid.



(Product: Nitrobenzene)

#### Step 2: Reduction of Nitrobenzene

Nitrobenzene is reduced using Sn/HCl, Fe/HCl, or catalytic hydrogenation.



(Product: Aniline)

#### Overall Conversion:



### 2. Conversion of Phthalimide to N-alkyl Phthalimide:

This reaction is part of Gabriel synthesis (alkylation step).

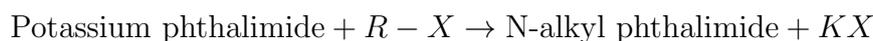
#### Step 1: Formation of Potassium Phthalimide

Phthalimide reacts with KOH.



## Step 2: Alkylation

Potassium phthalimide reacts with alkyl halide.



### Importance:

- Intermediate step in Gabriel synthesis of primary amines.
- Prevents formation of secondary or tertiary amines.

### Quick Tip

Benzene  $\rightarrow$  Aniline requires nitration followed by reduction, while phthalimide alkylation is a key step in Gabriel synthesis.

## 16. Contrast DNA and RNA or Globular and Fibrous Proteins.

**Correct Answer:** DNA and RNA differ in structure, sugar type, bases, and function. Globular and fibrous proteins differ in shape, solubility, and biological roles.

### Solution:

#### Concept:

Biomolecules such as nucleic acids and proteins show structural and functional diversity. Understanding their differences helps explain their biological roles.

#### Option 1: Difference Between DNA and RNA

Basis	DNA	RNA
Full Name	Deoxyribonucleic acid	Ribonucleic acid
Sugar	Deoxyribose	Ribose
Strands	Double-stranded	Usually single-stranded
Bases	A, T, G, C	A, U, G, C (Uracil replaces thymine)
Location	Mainly nucleus	Nucleus and cytoplasm
Function	Genetic information storage	Protein synthesis
Stability	More stable	Less stable

#### Option 2: Difference Between Globular and Fibrous Proteins

Basis	Globular Proteins	Fibrous Proteins
Shape	Spherical or compact	Long and thread-like
Solubility	Generally soluble in water	Insoluble in water
Function	Metabolic and regulatory roles	Structural roles
Examples	Enzymes, hemoglobin	Keratin, collagen
Structure	Complex tertiary structure	Mostly secondary structure

### Quick Tip

DNA stores genetic information, RNA expresses it, while globular proteins are functional and fibrous proteins are structural.

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