

**Topics Covered by Chemistry Aptitude Test for
Admission and Placement**

Subject	Items
1- Atomic structure for chemical compounds and their physical properties	Elements, compounds and mixtures - State of Matter and Properties - Chemical symbols - Predicting the number of elements in a compound - Predicting the number of atoms in a compound - Density - Periodic table - Atomic structure - Eelectronic configuration - Predicting the number of protons, neutrons and electrons - Chemical bonds - Isotopes.
2- Chemical equations and naming of inorganic compounds-chemical calculations	Chemical formulae - Naming of inorganic compounds – Ionic compounds - Calculating the formula mass - Calculating the number of moles - Calculating the number of grams - Calculating the mass of one atom - Atom and mole ratio in a compound - Calculating the number of atoms and molecules - Balancing chemical equations - Predicting the products of chemical reactions - Predicting the mole ratio from a balanced chemical equation - Predicting the type of chemical reaction – Calculating the percentage.
3- Chemical equilibrium for acids, bases, salts and oxidation - reduction reactions	Predicting the number of ions in a formula unit - Assigning oxidation numbers - Assigning atoms changing their oxidation state in redox reactions - Acids and bases - Acid-base reactions - Calculating the $[H^+]$ and pH - Calculating the $[OH^-]$ and pOH - Acid dissociation constants (K_a) - Base dissociation constants (K_b) - Buffer solutions - Acid - base titration - Equilibrium expressions - Equilibrium constants - The solubility and solubility product (K_{sp}).
4- Solution chemistry	Molarity – Saturated, Unsaturated and Supersaturated solutions.
5- Organic compounds and functional groups	Hydrocarbon compounds - Aromatic hydrocarbons – Functional groups.

Details of the Test Topics

The students should be able to understand the following basic concepts in chemistry and solve problems related to items for each concept.

1- Atomic Structure for Chemical Compounds and Their Physical Properties:

i) Elements, Compounds and Mixtures:

Example 1.1: Vitamin B₁₂ is necessary for proper health. It is used in the treatment of anemia. Vitamin B₁₂ has the molecular formula, C₆₃H₈₈CoN₁₄O₁₄P. How many elements are present in Vitamin B₁₂?

- A) 5 B) 181 C) 6 D) 7

Example 1.2: Which of the following is classified as a mixture?

- A) Water B) A pure gold coin C) Table salt D) Air

ii) State of Matter and Properties:

Example 1.3: Which of the following substances exist as a liquid under ordinary conditions of temperature and pressure?

- A) Sodium carbonate B) Carbon monoxide
C) Mercury D) Hydrogen

Example 1.4: How many phases are present in the following well-mixed system: [sand + salt + sugar + water + gasoline]

- A) 5 B) 3 C) 2 D) 4

Example 1.5: All of the following are properties of oxygen. Which one represents a chemical property?

- A) It is a gas at 25°C B) It causes iron to form rust
C) It can be compressed D) It freezes at -219°C

Example 1.6: A safety razor blade, made of iron and with a density greater than that of water, can be made to float on water if placed carefully. Which of the following properties is responsible for this phenomenon?

- A) Specific heat B) Surface tension C) Melting point D) Viscosity

iii) Chemical Symbols:

Example 1.7: Which of the following elements is paired with the wrong symbol?

- A) Silver - Ag B) Nitrogen - Ni
C) Magnesium - Mg D) Lithium - Li

iv) Predicting the Number of Elements in a Compound & Predicting the Number of Atoms in a Compound:

Example 1.8: Which of the following oxyanions (anion containing oxygen atoms) contain four oxygen atoms?

- A) Nitrate B) Sulfate C) Carbonate D) Bicarbonate

See example 1.1

v) Density:

Example 1.9: A graduated cylinder contains 50.0 mL of water. Uniform stones, each weighing 5.000 g and having a density of 2.5 g/mL, are placed into the graduated cylinder until the water level rises to 130.0 mL. How many stones are in the cylinder?

- A) 60 B) 40 C) 32 D) 25

vi) Periodic Table, Atomic Structure and Electronic Configuration-Predicting the Number of Protons, Number of Neutrons and Electrons:

Example 1.10: The electron configuration of the magnesium atom (Mg) in the outermost shell (last energy level) is:

- A) $2s^22p^5$ B) $3s^2$ C) $2s^22p^1$ D) $3s^23p^1$

Example 1.11: How many neutrons are in the ion: $^{52}_{24}\text{Cr}^{3+}$?

- A) 24 B) 28 C) 25 D) 27

vii) Chemical Bonds:

Example 1.12: The bond formed between ammonia molecule (NH_3) and hydrogen ion (H^+) is known as:

- A) Ionic bond B) Covalent bond
C) Coordinate covalent bond (dative bond) D) Metallic bond

2- Chemical Equations and Naming of Inorganic Compounds-Chemical Calculations:

i) Chemical Formulae & Naming of Inorganic Compounds:

Example 2.1: Choose the pair of name and formula that do not match?

- | Formula | Name |
|----------------------------|--------------------|
| A) AlCl_3 | Aluminium chloride |
| B) NaNO_3 | Sodium nitrate |
| C) CaO | Carbon monoxide |
| D) H_2SO_4 | Sulfuric acid |

ii) Ionic Compounds:

Example 2.2: How many ions per formula unit would you find if you dissolve $(\text{NH}_4)_2[\text{Ce}(\text{NO}_3)_6]$ in water?

- A) 3 B) 9 C) 2 D) 6

iii) Calculating the Formula Mass:

Example 2.3: Calculate the molar mass of $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$.

- A) 120.37 g/mole B) 126.14 g/mole
C) 246.54 g/mole D) 222.57 g/mole

iv) Calculating the Number of Moles:

Example 2.4: How many moles of nitrogen (N) atoms are in 75.0 g of penicillin, $\text{C}_{16}\text{H}_{18}\text{O}_4\text{N}_2\text{S}$? [molar mass of penicillin = 334.28 g/mole]

- A) 0.224 B) 0.896 C) 0.449 D) 0.296

Example 2.5: Which of the following contains 2.00 moles of carbon atoms?

- A) 60.0 g ethane (C_2H_6) B) 26.0 g benzene (C_6H_6)
C) 2.00 moles oxalic acid ($\text{H}_2\text{C}_2\text{O}_4$) D) 5.00 g methane (CH_4)

ii) **Assigning Oxidation Numbers and Atoms changing their Oxidation State in Redox Reactions:**

Example 3.2: Which of the following is an oxidation-reduction reaction?

- A) $\text{HC}_2\text{H}_3\text{O}_2(\text{aq}) + \text{H}_2\text{O}(\ell) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{C}_2\text{H}_3\text{O}_2^-(\text{aq})$
B) $\text{Zn}^{2+}(\text{aq}) + \text{H}_2(\text{g}) \rightleftharpoons \text{Zn}(\text{s}) + 2\text{H}^+(\text{aq})$
C) $\text{HNO}_2(\text{aq}) + \text{H}_2\text{O}(\ell) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{NO}_2^-(\text{aq})$
D) $2\text{H}_2\text{O}(\text{g}) \rightleftharpoons 2\text{H}_2(\text{g}) + \text{O}_2(\text{g})$

Example 3.3: The oxidation number of nitrogen atom in NaNO_2 is:

- A) +3 B) -2 C) -3 D) +1

iii) **Acids and Bases, and Acid-Base Reactions:**

Example 3.4: A neutral solution can be obtained by mixing equal volumes of the same concentration of:

- A) HCl and NH_3 B) CH_3COOH and NaOH
C) HCOOH and KOH D) HCl and NaOH

iv) **Calculating the $[\text{H}^+]$ and pH, and Calculating $[\text{OH}^-]$ and pOH:**

Example 3.5: The pH is defined as:

- A) $\text{pH} = -\log [\text{H}^+]$ B) $\text{pH} = \log [\text{H}^+]$
C) $\text{pH} = [\text{H}^+]$ D) $\text{pH} = [\text{H}^+]^2$

Example 3.6: A solution in which $[\text{H}^+] = 10^{-6}$ has a pH of

- A) -6 B) +6 C) -8 D) +8

Example 3.7: Lemon juice has a $[\text{H}^+]$ of 0.01 M. What is the $[\text{OH}^-]$?

- A) 1.0×10^{-14} M B) 1.0×10^{-7} M C) 1.0×10^{-12} M D) 1.0×10^2 M

v) **Acid Dissociation Constants (K_a) and base Dissociation Constants (K_b):**

Example 3.8: Given the following equilibrium system, what is the expression of K_a ?



- A) $K_a = \frac{[\text{C}_2\text{H}_3\text{O}_2^-][\text{H}_3\text{O}^+]}{[\text{HC}_2\text{H}_3\text{O}_2]}$ B) $K_a = \frac{[\text{HC}_2\text{H}_3\text{O}_2]}{[\text{C}_2\text{H}_3\text{O}_2^-][\text{H}_3\text{O}^+]}$
C) $K_a = \frac{[\text{C}_2\text{H}_3\text{O}_2^-][\text{H}_3\text{O}^+]}{[\text{HC}_2\text{H}_3\text{O}_2][\text{H}_2\text{O}]}$ D) $K_a = \frac{[\text{HC}_2\text{H}_3\text{O}_2][\text{H}_2\text{O}]}{[\text{C}_2\text{H}_3\text{O}_2^-][\text{H}_3\text{O}^+]}$

vi) **Buffer Solutions:**

Example 3.9: Which of the following constitute a buffer?

- A) HCl and NaCl B) KOH and HCl
C) NH_3 and NH_4Cl D) BaCl_2 and AgNO_3

vii) **Acid-Base Titration:**

Example 3.10: What volume of 1.80 M of an automobile sulfuric acid, (H_2SO_4) neutralizes 42.10 cm^3 of 1.90 M NaOH ?

- A) 22.2 cm^3 B) 42.1 cm^3 C) 44.4 cm^3 D) 39.9 cm^3

viii) **Equilibrium Expressions and Equilibrium Constants:**

Example 3.11: Given the following equilibrium system, what is the expression of K_c ?



- A) $K_c = [\text{NH}_3]^2 / [\text{N}_2] + 3[\text{H}_2]$ B) $K_c = [\text{NH}_3]^2 / [\text{N}_2][\text{H}_2]^3$
C) $K_c = [\text{N}_2][\text{H}_2]^3 / [\text{NH}_3]^2$ D) $K_c = 2[\text{NH}_3] / [\text{N}_2] + 3[\text{H}_2]$

ix) **The Solubility and Solubility Product Constant (K_{sp}):**

Example 3.12: The solubility product constant (K_{sp}) of Ag_2CrO_4 is given by:

- A) $K_{sp} = 2[\text{Ag}^+][\text{CrO}_4^{2-}]$ B) $K_{sp} = 1/[\text{Ag}^+]^2[\text{CrO}_4^{2-}]$
C) $K_{sp} = [2\text{Ag}^+][\text{CrO}_4^{2-}]$ D) $K_{sp} = [\text{Ag}^+]^2[\text{CrO}_4^{2-}]$

4- **Solution Chemistry:**

- **Molarity:**

Example 4.1: What is the molarity of a solution made by dissolving 2.40 mole of KI in enough water to make 2.75 L of solution?

- A) 0.200 M B) 0.873 M C) 0.255 M D) 0.542 M

5- **Organic Compounds and Functional Groups:**

- **Hydrocarbon Compounds, Aromatic Hydrocarbons, and Functional Groups:**

Example 5.1: Not all carbon containing compounds are organic compounds. Which one the following compounds is an inorganic compound?

- A) CH_4 (methane) B) CH_3OH (methanol)
C) CH_2Cl_2 (dichloromethane) D) CaCO_3 (calcium carbonate)

Example 5.2: Which of the following is an aromatic compound?

- A) Methane B) Ethanol C) Benzene D) Acetaldehyde

Example 5.3: What is the functional group the compound (-C-) in $\text{CH}_3\text{-C(=O)-CH}_3$?

- A) Carbonyl group B) Hydroxyl group
C) Carboxylic acid group D) Aldehyde group