

## 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 - Electronic configuration - Predicting the number of protons, neutrons and electrons - Chemical bonds .
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.
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.
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 B<sub>12</sub> is necessary for proper health. It is used in the treatment of anemia. Vitamin B<sub>12</sub> has the molecular formula, C<sub>63</sub>H<sub>88</sub>CoN<sub>14</sub>O<sub>14</sub>P. How many elements are present in Vitamin B<sub>12</sub>?

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

**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 ( $\text{NH}_3$ ) and hydrogen ion ( $\text{H}^+$ ) 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?

<u>Formula</u>	<u>Name</u>
A) $\text{AlCl}_3$	Aluminium chloride
B) $\text{NaNO}_3$	Sodium nitrate
C) $\text{CaO}$	Carbon monoxide
D) $\text{H}_2\text{SO}_4$	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 ( $\text{C}_2\text{H}_6$ )                      B) 26.0 g benzene ( $\text{C}_6\text{H}_6$ )  
C) 2.00 moles oxalic acid ( $\text{H}_2\text{C}_2\text{O}_4$ )                      D) 5.00 g methane ( $\text{CH}_4$ )

### v) Calculating the Number of Grams:

**Example 2.6:** Which of the following substances contains the greatest mass of chlorine ( $\text{Cl}_2$ )?

- A) 5.0 g  $\text{Cl}_2$   
B) 0.50 mole  $\text{Cl}_2$   
C) 0.10 mole  $\text{KCl}$   
D) 30.0 g  $\text{MgCl}_2$

### vi) Calculating the Mass of one Atom:

**Example 2.7:** What is the mass of one atom of carbon, C?

- A)  $1.99 \times 10^{-23}$  g      B)  $0.502 \times 10^{23}$  g  
C)  $0.502 \times 10^{-23}$  g      D)  $1.99 \times 10^{23}$  g

### vii) Atoms and Mole Ratio in a Compound:

**Example 2.8:** For baking soda,  $\text{NaHCO}_3$ , what is the molar ratio of C to O?

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

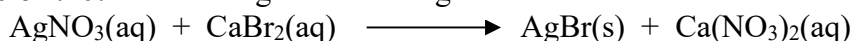
### viii) Calculating the Number of Atoms and Molecules:

**Example 2.9:** One mole of any element contains:

- A)  $3.011 \times 10^{23}$  atoms  
B)  $6.022 \times 10^{23}$  atoms  
C)  $1.506 \times 10^{23}$  atoms  
D)  $12.04 \times 10^{23}$  atoms

### ix) Balancing Chemical Equations:

**Example 2.10:** Considering the following reaction:



the coefficient before AgBr is:

- A) 1                      B) 2                      C) 4                      D) 5

### x) Predicting the Products of Chemical Reactions:

**Example 2.11:** Sodium carbonate reacts with hydrochloric acid to form three products; salt, water and ..... gas:

- A) Hydrogen  
B) Carbon monoxide  
C) Chlorine  
D) Carbon dioxide

### **xi) Predicting the Mole Ratio from a Balanced Chemical Equation:**

**Example 2.12:** Given the balanced equation:

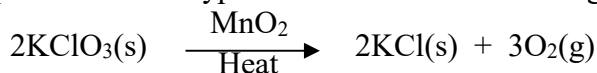


the proper molar ratio for the mole conversion:  $\text{O}_2 \longrightarrow \text{HCN}$  is:

- A) 3 moles  $\text{O}_2$ /1 mole HCN  
B) 2 moles  $\text{O}_2$ /2 moles HCN  
C) 2 moles HCN /3 moles  $\text{O}_2$   
D) 3 moles  $\text{O}_2$ /2 moles HCN

### xii) Predicting the Type of Chemical Reaction:

**Example 2.13:** What type of reaction is the following?



- A) Single displacement  
B) Decomposition  
C) Double displacement  
D) Combustion

### 3- Chemical Equilibrium for Acids, Bases, Salts and Oxidation-Reduction Reactions:

### i) Predicting the Number of Ions in a Formula Unit:

**Example 3.1:** How many ions per formula unit would you find if you dissolve  $\text{KClO}_3$  in water?

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

**See example 2.2**

**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)  $\text{HC}_2\text{H}_3\text{O}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{C}_2\text{H}_3\text{O}_2^-(\text{aq})$   
B)  $\text{Zn}^{2+}(\text{aq}) + \text{H}_2(\text{g}) \rightleftharpoons \text{Zn}(\text{s}) + 2\text{H}^+(\text{aq})$   
C)  $\text{HNO}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{NO}_2^-(\text{aq})$   
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  $\text{NaNO}_2$  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)  $\text{HCl}$  and  $\text{NH}_3$                       B)  $\text{CH}_3\text{COOH}$  and  $\text{NaOH}$   
C)  $\text{HCOOH}$  and  $\text{KOH}$                       D)  $\text{HCl}$  and  $\text{NaOH}$

**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 .....

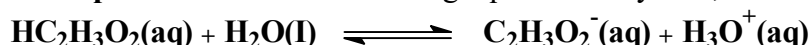
- A) -6                      B) +6                      C) -8                      D) +8

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

- A)  $1.0 \times 10^{-14} \text{ M}$                       B)  $1.0 \times 10^{-7} \text{ M}$                       C)  $1.0 \times 10^{-12} \text{ M}$                       D)  $1.0 \times 10^2 \text{ M}$

**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)  $\text{HCl}$  and  $\text{NaCl}$                       B)  $\text{KOH}$  and  $\text{HCl}$   
C)  $\text{NH}_3$  and  $\text{NH}_4\text{Cl}$                       D)  $\text{BaCl}_2$  and  $\text{AgNO}_3$

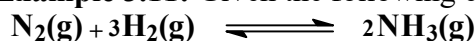
**vii) Acid-Base Titration:**

**Example 3.10:** What volume of 1.80 M of an automobile sulfuric acid,  $(\text{H}_2\text{SO}_4)$  neutralizes  $42.10 \text{ cm}^3$  of 1.90 M  $\text{NaOH}$ ?

- A)  $22.2 \text{ cm}^3$                       B)  $42.1 \text{ cm}^3$                       C)  $44.4 \text{ cm}^3$                       D)  $39.9 \text{ cm}^3$

**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 ( $K_{sp}$ ):**

**Example 3.12:** The solubility product ( $K_{sp}$ ) of  $\text{Ag}_2\text{CrO}_4$  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

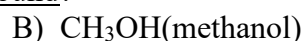
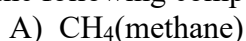
C) 0.255 M

D) 0.542 M

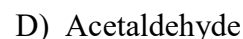
**5- Organic Compounds and Functional Groups:**

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

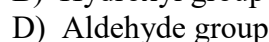
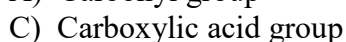
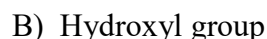
**Example 5.1:** Not all carbon containing compounds are organic compounds. Which one of the following compounds is an inorganic compound?



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



**Example 5.3:** What is the functional group ( $-\overset{\overset{\text{O}}{\parallel}}{\text{C}}-$ ) in  $\text{CH}_3-\overset{\overset{\text{O}}{\parallel}}{\text{C}}-\text{CH}_3$ .



## **Data You May Need**

### **Physical Constants:**

Avogadro's number =  $6.022 \times 10^{23}$  objects/mole

### **Atomic Masses:**

H = 1.01;      C = 12.0;      N = 14.0;      O = 16.0;      Mg = 24.3;      S = 32.1  
Cl = 35.5;      K = 39.1

### **Atomic Number:**

H = 1;      N = 7;      Mg = 12