CHEMISTRY-XI

{PART -1}

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CONTENTS

Chapter 1

Basic Concepts of Chemistry

❑ Atomic Weight

$$\text{Atomic weight of an element} = \frac{\text{Weight of 1 atom of the element}}{\text{Weight of 1 atom of hydrogen}}$$

When we state that the atomic weight of chlorine is 35.5, we mean that an atom of chlorine is 35.5 times heavier than an atom of hydrogen. It was later felt that the standard for reference for atomic weight may be oxygen, the advantage being that the atomic weights of most other elements became close to whole numbers.

$$\text{Atomic weight of an element} = \frac{\text{Weight of 1 atom of the element}}{\frac{1}{16}\times \text{weight of 1 atom of oxygen}}$$

The modern reference standard for atomic weights is carbon isotope of mass number 12.

$$\boxed{\text{Atomic weight of an element} = \frac{\text{Weight of 1 atom of the element}}{\frac{1}{12}\times \text{weigth of 1 atom of carbon} - 12}}$$

On this basis, atomic weight of oxygen 16 was changed to 15.9994.

Nowadays atomic weight is called relative atomic mass and denoted by amu (atomic mass unit). The standard for atomic mass is C^{12}.

(i) Atomic weight is not a weight but a number.

(ii) Atomic weight is not absolute but relative to the weight of the standard reference element (C^{12}).

(iii) Gram atomic weight is atomic weight expressed in grams, but it has a special significance with reference to a mole.

Dulong and Petit measured the specific heats of a number of metals and found that the product of the specific heat and the atomic weight is a constant, having an approximate value of 6.4.

Specific heat (cal/g-deg) $\times$ atomic weight (g/g–atom) ; 6.4 (cal/deg.g.atom).

This correlation has been used to 'correct' the atomic weights of some **elements in the periodic table. Dulong and Petit's law is applicable only to metals.**

❑ Molecular Mass

Molecular mass of a substance is an additive property and can be calculated by adding the atomic masses of all the atoms of different elements present in one molecule.

❑ Methods of determining Molecular Masses

(a) Vapour density method

$$\textbf{V. D.} = \frac{1}{2}\,\frac{\text{Mass of volatile substance}}{\text{Volume of vapour of its chloride at STP}} \times \mathbf{22400}$$

Molecular mass = 2 × V.D.

LAWS OF CHEMICAL COMBINATION

Law of conservation of mass:

For any chemical change total mass of active reactants are always equal to the mass of the product formed. It is a derivation of Dalton's atomic theory 'atoms neither created nor destroyed'.
Total masses of reactants = Total masses of products + Masses of unreacted reactants

Law of constant composition

A chemical compound always contains same elements in definite proportion by mass and it does not depend on the source of compound.

For example

$$C + O_2 \longrightarrow CO_2$$

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

$$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$$

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

The composition of CO2 obtained by different means always having same C:O ratio = $\frac{12}{32} = 0.375$

Law of multiple proportion:

When two elements combine to form two or more than two different compounds then the different masses of one element B which combine with fixed mass of the other element bear a simple ratio to one another.
For example: Carbon forms two oxides in oxygen

Carbon monoxide $\underset{12}{C} + \frac{1}{2}\underset{16}{O_2} = CO$

Carbon oxide $\underset{12}{C} + \underset{32}{O_2} = CO_2$

The ratio of masses of oxygen in CO and CO2 for fixed mass of carbon (12) is 16 : 32 = 1: 2.

Gay Lussac's law of Combining Volumes:

At given temperature and pressure the volumes of all gaseous reactants and products bear a simple whole number ratio to each other.

For example

$$\underset{1\ \text{voume}}{H_{2(g)}} + \underset{1\ \text{volume}}{Cl_{2(g)}} \longrightarrow \underset{2\ \text{volumes}}{2HCl_{(g)}}\ [1:1:2]$$

i.e. one volume of hydrogen reacts with one volume of chlorine to form two volumes of HCl gas. i.e. the ratio by volume which gases bears is 1:1:2 which is a simple whole number ratio.

❑ Avogadro Hypothesis

It states that equal volumes of gases at the same temperature and pressure contain equal number of molecules. It means that 1 ml of hydrogen, oxygen, ammonia, or a mixture of gases taken at the same temperature and pressure contains the same number of molecules

Application

(b) [To establish the relationship between molecular weight and vapour density of a gas. The absolute density of gas is the weight of 1 litre (dm^3) of the gas at S.T.P. [Standard Temperature (0°C and Pressure (1 atmosphere)].

The relative density or vapour density of gas = $\dfrac{\text{Density of the gas}}{\text{Density of hydrogen}}$

Vapour density of a gas = $\dfrac{\text{Weight of 1 litre of gas at STP}}{\text{Weight of 1 litre of hydrogen at STP}}$

$$= \frac{\text{Weight of a certain volume of the gas}}{\text{Weight of the same volume of hydrogen at the same temperature and pressure}}$$

So the vapour density of a gas is defined as the ratio of the weight of a certain volume of the gas to the weight of the same volume of hydrogen at the same temperature and pressure.

∴ **Vapour density (V.D.) of a gas**

$$= \frac{\text{Weight of 'V' litres of the gas}}{\text{Weight of 'V' litres of hydrogen at the same temperature and pressure}}$$

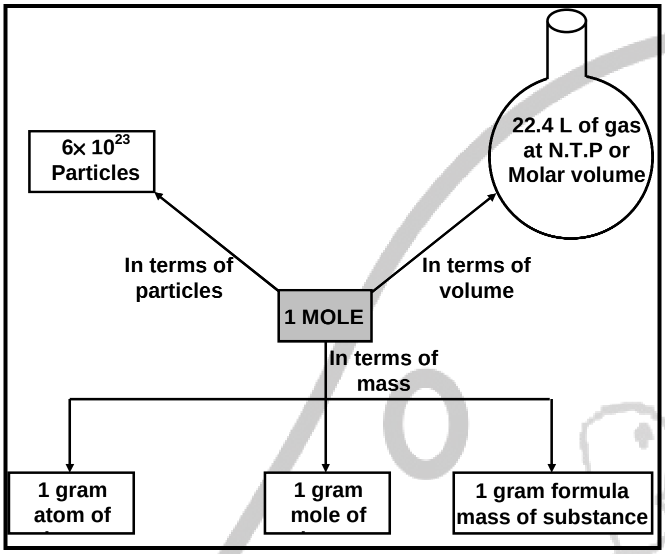
Let 'V' litres of the gas contains 'n' molecules.

V.D. of a gas = $\dfrac{1}{2}\times$ **Molecular weight of the gas**

$\therefore$ **Molecular weight of the gas = 2 × Vapour density of the gas.**

(c) **The volume occupied by a gram molecular weight of any gas is called a molar volume and it is 22.4 L at STP.**

Mole Concept



❑ Mole-Particle Relationship

A mole is a collection of 6.023 × 10^{23} particles, ions, atoms etc.

i.e. (i) 6.023 × 10^{23} atoms of Na constitute one mole atom of Na.

(ii) 6.023 × 10^{23} molecules of oxygen constitutes 1 mole of oxygen molecules.

(iii) 6.023 × 10^{23} electrons constitute one mole of electrons.

❑ Mole-Weight Relationship

One mole of every substance weighs equal to the gram atomic weight of the substance or to the gram molecular weight of the substance.

e.g. (i) 1 mole of sodium weighs 23 g of Na.

(ii) 1 mole of $CaCO_3$ weighs 100 g.

❑ Mole-Volume Relationship

One mole of every gas occupies 22.4 lit. of volume at STP.

i.e. 1 mole of O_2 occupies 22400 ml of volume at STP.

1 mole of He occupies 22400 ml of volume at STP.

Concept of Limiting Reagent

In reactions involving more than one reactant, one has to identify first, of all the reactant, which is completely consumed (limiting reagent), one can identify the limiting reagent as follow

$$\begin{array}{lccc} & N_2 & +\,3H_2 \longrightarrow & 2NH_3 \\ \text{Initial mole} & 5 & 12 & - \end{array}$$

If N_2 is the limiting reactant moles of NH_3 produced = 10. If H_2 is the limiting reactant moles of NH_3 produced = $\frac{3}{2}\times 12 = 8$. The reactant producing the least number of mole of the product is the limiting reactant, hence H_2 is the limiting reactant.

The limiting reactant can also be ascertained by knowing the initial number of equivalents or milli equivalents of each reactant. The reactant with least number of equivalents or milli equivalents is the limiting reactant. The equivalent methods to identify the limiting reactant used not require balancing of chemical equation.

Concentration of solutions

- Molarity (M)

It is defined as the number of moles of solute present in one litre of solution.

Molarity (M) = $\frac{\text{number of moles of solute}}{\text{Volume of solution (in litres)}}$

Let the weight of solute be w g, molar mass of solute be M_1g./mol and the volume of solution be V litre. Number of moles of solute = $\frac{\text{weight of solute}}{\text{Atomic or molar mass of solute}} = \frac{w}{M_1}$

$$\therefore \quad \boxed{M = \frac{w}{M_1} \times \frac{1}{V(\text{in litres})}}$$

$\therefore$ **Number of moles of solute =** $\frac{w}{M_1} = M \times V$ **(in litres)**

- **Normality (N)**

It is defined as the number of moles of equivalents of a solute present in one litre of solution.

Normality (N) = $\frac{\text{number of equivalents of solute}}{\text{Volume of solution (in litres)}}$

Let the weight of solute be w g, equivalent mass of solute be E g/eqv. And the volume of solution be V litre.

Number of equivalents of solute = $\frac{\text{weight of solute}}{\text{Equivalent mass of solute}} = \frac{w}{E}$

$\therefore \quad N = \frac{w}{E} \times \frac{1}{V(\text{in litres})}$

$\therefore$ **Number of equivalents of solute = $N \times V$ (in litre)**

Equivalent Mass

Equivalent mass = $\frac{\text{Atomic or molecular mass}}{\text{'n' factor}} = \frac{M_1}{n}$

$\therefore$ **Number of equivalents of solute =** $\frac{w}{E} = \frac{w}{M_1/n} = \frac{w \times n}{M_1}$

$\therefore$ **Number of equivalents of solute = n × number of moles of solute**

Also, $N = \frac{w}{M_1/n} \times \frac{1}{v\ (\text{in litre})} = \frac{w}{M_1} \times \frac{1}{V\ (\text{in litre})} \times n$

$N = M \times n$

$\therefore$ **Normality of solution = n × molarity of solution.**

Parts per million parts (ppm):

For every dilute solution, i.e., when a very small quantity of a solute is present in large quantity of a solution, the concentration of the solute is expressed in terms of ppm. It is defined as the mass of the solute present in one million (10^6) parts by mass of the solution. Thus for a solute A,

$$ppm_A = \frac{\text{mass of A}}{\text{mass of solution}} \times 10^6$$

- **Relation between molarity and molality**

$$m = \frac{1000 \times M}{(1000 \times d - M \times m_1)}$$

(Where d = density of solution)

- **Relationship between molality (m) and mole fraction (x2):**

$$m = \frac{1000x_2}{x_1 M_1}$$

- **Relationship between molarity (M) and mole fraction (x2):**

$$M = \frac{1000dx_2}{x_1M_1 + x_2M_2}$$

Other relation involving Molarity

- For dilution only $M_1 V_1 = M_2 V_2$
- It two solutions of the same solute are mixed, molarity of the resulting solution will be

$$M = \frac{M_1V_1 + M_2V_2}{(V_1 + V_2)}$$

- Volume of water that should be added to get V_2 volume of solution of molarity M_2 from V_1 volume of solution of molarity M_1

$$V_2 - V_2 = \left(\frac{M_1 - M_2}{M_2}\right)V_1$$

Molarity of mixture of two solutions of same substance

M (V1 + V2) = M1V1 + M2V2

1M, 10M, M/10, M/5, M/2, M/100 are called molar, decamolar deci-molar, penti-molar, semi-molar, and centi-molar solution respectively.

Normality of mixture if same type of substance are mixed e.g. all acids or all bases.

$N_1V_1 + N_2V_2 + N_3V_3 = N (V_1 + V_2 + V_3)$

1N, 10 N, N/10 are called normal, decanormal, decinormal respectively.

'n' Factors

In Non Redox Change

(i) **n-factor for element: Valency of the element**

(ii) **For Acids:** Acids will be treated as species which furnish H^+ ions when dissolved in a solvent. The n factor of an acid is the no. of acidic H^+ ions that a molecule of the acid would give when dissolved in a solvent (Basicity).

e.g. for HCl (n = 1), HNO_3 (n = 1), H_2SO_4 (n = 2), H_3PO_4 (n = 3) and H_3PO_3 (n = 2)

(iii) **For Bases:** Bases will be treated as species which furnish OH^- ions when dissolved in a solvent. The n factor of a base is the no. of OH^- ions that a molecule of the base would give when dissolved in a solvent (Acidity).

e.g. NaOH (n = 1), $Ba(OH)_2$ (n = 2), $al(OH)_3$ (n = 3), etc.

(iv) **For Salts:** A salts reacting such that no atom of the salt undergoes any change in oxidation state. **e.g. $2AgNO_3 + MgCl_2 \longrightarrow Mg(NO_3)_2 + 2AgCl$**

In this reaction it can be seen that the oxidation state of Ag, N, O, Mg and Cl remains the same even in the product. The n factor for such a salt is the total chare on cation or anion.

CH: BASIC CONCEPTS OF CHEMISTRY
(SUBJECTIVE ASSIGNMENT)

LAWS & AVG. ATOMIC MASS

SOLVED EXAMPLES

***EX*:In an experiment, 2.4 g of Iron oxide on reduction with Hydrogen yield 1.68 g of Iron. In another experiment 2.9 g of Iron oxide give 2.03 g of Iron on reduction with Hydrogen. Show that the above data illustrates the law of constant proportions.**

***Solution*:In the first experiment:**

The mass of Iron oxide = 2.4 g ; The mass of Iron after reduction = 1.68 g.

Mass of Oxygen = Mass of Iron oxide – Mass of Iron $\Rightarrow (2.4-1.68)=0.72$ g .

Ratio of Oxygen and Iron = 0.72 : 1.68 $\Rightarrow 1:2.33$.

In the second experiment :

The mass of Iron oxide = 2.9 g ; The mass of Iron after reduction = 2.03 g.

Mass of Oxygen = Mass of Iron oxide – Mass of Iron $\Rightarrow (2.9-2.03)=0.87$ g .

Ratio of Oxygen and Iron = 0.87 : 2.03 $\Rightarrow 1:2.33$.

Thus, the data illustrate the law of constant proportions, as in both the experiments the ratio of Oxygen and Iron is the same.

EX: Carbon is found to form two oxides, which contain 42.9% and 27.3% of carbon respectively. Show that these figures illustrate the law of multiple proportions.

Solution: **Step 1:** To calculate the percentage composition of carbon and oxygen in each of the two oxides

	First oxide	Second oxide	
Carbon	42.9%	27.3%	(Given)
Oxygen	57.1%	72.7%	

(by difference)

Step 2: To calculate the weights of carbon which combine with a fixed weight i.e., one part by weight of oxygen in each of the two oxides.

In the first oxide, 57.1 parts by weight of oxygen combine with carbon = 42.9 parts.

$\therefore$ 1 part by weight of oxygen will combine with carbon $\frac{42.9}{57.1}=0.751$

In the second oxide 72.7 parts by weight of oxygen combine with carbon = 27.3 parts.

$\therefore$ 1 part by weight of oxygen will combine with carbon $\frac{27.3}{72.7}=0.376$

Step 3: To compare the weights of carbon which combine with the same weight of oxygen in both the oxides-

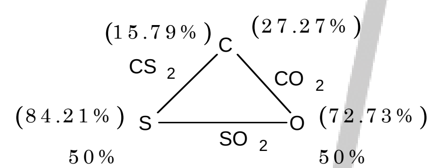
The ratio of the weights of carbon that combine with the same weight of oxygen (1 part) is 0.751: 0.376 or 2:1

Since this is a simple whole number ratio, so the above data illustrate the law of multiple proportions.

EX: Carbon dioxide contains 27.27% of carbon, carbon disulphide contains 15.79% of carbon and sulphur dioxide contains 50% of sulphur. Are these figures in agreement with the law of reciprocal proportions?

Sol. 1 g C will combine with S = $\frac{84.21}{15.79}=5.33$g

1 g C will combine with O = $\frac{72.73}{27.27}=2.67$g



$\therefore$ Ratio of masses of S and O which combine with fixed mass of carbon (viz 1 g)
= 5.33 : 2.67
= 2 : 1

Ratio of masses of S and O which combine directly with each other = 50:50=1:1.

Thus the two ratio are simple multiple of each other.

UNSOLVED QUESTIONS

1. Two students performed the same experiment separately and each one of them recorded two readings of mass which are given below. Correct reading of mass is 3.0 g. On the basis of given data, mark the correct option out of the following statements.

Student	**Readings**
(i)	(ii)
A 3.01	2.99
B 3.05	2.95

(i) Results of both the students are neither accurate nor precise.
(ii) Results of student A are both precise and accurate.
(iii) Results of student B are neither precise nor accurate.
(iv) Results of student B are both precise and accurate.

2. Calculate the atomic mass (average) of chlorine using the following data : [NCERT]

% Natural	Abundance	Molar Mass
35Cl	75.77	34.9689
37Cl	24.23	36.9659

3. A metal forms two oxides, one contains 46.67% of the metal and another 63.94% of the metal. Show that these results are in accordance with the law of multiple proportion.

4. Why are the atomic masses of most of the elements fractional?
Ans. because most of the elementsoccur in nature as a constant mixture ofisotopes. The atomic masses are actuallythe average relative masses of the isotopesdepending on their abundance.

5. Elements X and Y form two different compounds. In the first, 0.324 g of X is combined with 0.471 g of Y. In the second, 0.117 g of X is combined with 0.509 g of Y. Show that these data illustrate the law of multiple proportions.

6. 1.08 g of copper wire was allowed to react with nitric acid. The resulting solution was dried and ignited when 1.35 g of copper oxidewas obtained. In another experiment 2.30 g of copper oxide was heated in presence of hydrogen yielding 1.84 g of copper. Show that the above data are in accordance with law of constant proportion.

7. Carbon and oxygen are known to form two compounds. The carbon content in one of these is 42.9% while in the other it is 27.3%. Show that this data is in agreement with the law of multiple proportions.

8. Ammonia contains 82.35% of nitrogen and 17.65% of hydrogen. Water contains 88.90% of oxygen and 11.10% of hydrogen. Nitrogen trioxide contains 63.15% of oxygen and 36.85% of nitrogen. Show that these data illustrate the law of reciprocal proportions.

EMPIRICAL FORMULA

1. $Fe_2(S0_4)_3$ is emprical formula of a crystalline compound of iron. It is used in water and sewage treatment to aid in the removal of suspended impurities. Calculate the mass percentage of iron, sulphur and oxygen in this compound.

2. A hydrate of iron (III) thiocyanate $Fe(SCN)_3$, was found to contain 19% H2O. What is the formula of the hydrate.

3. A substance on analysis, gave the following percentage composition, Na = 43.4%, C = 11.3%, 0 = 43.3% calculate its empirical formula **[ANS. Na_2CO_3]**

4. A carbon compound on analysis gave the following percentage composition, carbon 14.5%, hydrogen 1.8 %, chlorine 64.46 %, oxygen 19.24 %. Calculate the empirical formula of the compound.

Ans. $C_2H_3Cl_3O_2$

5. Calculate the empirical formula of a compound having percentage composition :
potassium (K)= 26.57, chromium (Cr) = 35.36; oxygen (O) = 38.07. (Given the atomic weights of KI, Cr and O as 39; 52 and 16 respectively

Ans. $K_2Cr_2O_7$

6. An organic compound on analysis was found to contain 16.27% carbon, 0.67% and 72.2% chlorine. The vapour density of the compound is equal to 73.75. Calculate the empiricial for mula and molecular formula of the compound

Ans. So molecular formula = C_2HCl_3O

7. . 5.325 g sample of methyl benzoate, a compound used in the manufacture of perfumes is found to contain 3.758 g of carbon, 0.316 g hydrogen and 1.251 g of oxygen. What is empirical formula of compound. If mol. weight of methyl benzoate is 136.0, calculate its molecular formula.

8. 0.6 g of a compound occupies 224 cc at NTP. It contains 6.67% H. 40% C and the rest is oxygen.
Calculate :
(i) Molecular mass of the compound
(ii) Empirical formula
(iii) Molecular formula
Ans. (i) 60, (ii) CH2O(iii) C2H4O 2

9. (a) Butyric acid conrtains only C, H and O.
A 4.24 mg sample of butyric acid is completely burned. It gives 8.45 mg of CO2 and 3.46 mg of water. What is the mass percentage of each element in butyric acid?
(b) If the elemental composition in butyric acid is 54.2% C; 9.2% H and 36.6% O, determine the empirical formula.
(c) Molecular mass of butyric acid is 88.
What will be its molecular formula?
Ans. (b) C2H4O (c) C4H8O2

D.P. – 1

1. An organic compound has following percentage composition : C - 48%, H = 8% and N = 28%. Calculate the empirical formula of the compound.
Ans. $C_4H_8N_2O$

2. Chemical analysis of a carbon compound gave the following percentage composition by weight of the elements present, carbon = 10.06 %, hydrogen = 0.84 %, chlorine = 89.10 %, Calculate the empirical formula of the compound. **Ans** $C_1H_1Cl_3 \text{ or } CHCl_3$.

3. A compound has the following composition Mg = 9.76%,S = 13.01%, 0 = 26.01, H_2O = 51.22, what is its empirical formula?

4. A compound on analysis gave the following percentage composition C = 54.54%, H, 9.09% 0 = 36.36. The vapour density of the compound was found to be 44. Find out the molecular formula of the compound. **Ans:-** $C_4H_8O_2$

5. A carbon compound contains 12.8 % carbon, 2.1 % hydrogen, 85.1 % bromine. The molecular weight of the compound is 187.9. Calculate the molecular formula.

Ans $(CH_2Br)_2 = C_2H_4Br_2$

6. The percentage composition of an organic compound is given below. Its molecular weight is 136. Calculate its molecular formula.

Ans. $(C_4H_4O)_2 = C_8H_8O_2$

NCERT CORNER

1. How much copper can be obtained from 100 g of copper sulphate (CuSO4) ? How much copper can be obtained from 100 g of copper sulphate (CuSO4) ?

2. Calculate the mass per cent of different elements present in sodium sulphate (Na_2SO_4).

3. Determine the empirical formula of an oxide of iron which has 69.9% iron and 30.1% dioxygen by mass.

4. A compound contains 4.07 % hydrogen, 24.27 % carbon and 71.65 % chlorine. Its molar mass is 98.96 g. What are its empirical and molecular formulas **? [NCERT][ANS.** CH_2Cl, $C_2H_4Cl_2$**]**

5. A welding fuel gas contains carbon and hydrogen only. Burning a small sample of it in oxygen gives 3.38 g carbon dioxide , 0.690 g of water and no other products.
A volume of 10.0 L (measured at STP) of this welding gas is found to weigh 11.6 g. Calculate (i) empirical formula, (ii) molar mass of the gas, and (iii) molecular formula. [NCERT]

MOLE CONCEPT

1. Calculate the mass of
(a) 1 molecule of N2
(b) 1 molecule of H2O
(c) 100 molecules of sucrose
[ans. 4.65x10^{-23} g, 2.99x10^{-23} g, 5.68x10^{-20} g]

2. How many molecules of water are present in the one mL of water? **[ans. 3.34 * 1O^{22} molecules]**

3. How many molecules are present in one mL of water vapours of STP? **[ans. 2.69 x 10^{19} molecules]**

4. How many molecules and atoms of Sulphur are present in 0.1 mole of S8 molecules
[ans. 4.816 x 10^{23} atoms]

5. How many g of S are required to produce 10 moles and 10g of H_2SO_4 respectively?
[ans. 320 g, 3.265 g]

6. Calculate the Number of molecules of H2SO4 present in 100 mL of 0.02M H2SO4 solution ?

7. One mole of any substance contains 6.022 × 1023 atoms/molecules. Number of molecules of H2SO4 present in 100 mL of 0.02M H2SO4 solution is ______.
(i) 12.044 × 1020 molecules
(ii) 6.022 × 1023 molecules
(iii) 1 × 1023 molecules
(iv) 12.044 × 1023 molecules

8. Calculate the mass of 1u (atomic mass unit) in grams**. [ans. 1.66x10-24g]**

9. Calculate the weight of carbon monoxide having same number of oxygen atoms as are present in 88 g of carbon dioxide**.[ans. 112 g]**

10. From 280 mg of CO, 10^{21} molecules are removed. How many g and mole of CO are left?
[ans. 8.34 x 10-3]

D.P. – 2

1. How many carbon atoms are present in 0.35 mole of C6H1206? **.[ans. 1.26 x 1024 carbon atoms]**

2. Calculate the number of CI- and Ca+2 ions in 333 g anhydrous CaCI2.
[ans. 3 *N* ions of Ca^{2+}, 6 *N* ions of CI]

3. How many nitrogen atoms are in 0.25 mole of $Ca(N0_3)_2$? **[ans. 3.0 x 10^{23}]**

4. silver is very precious metal and is used in Jwellery. One million atoms of silver weigh 1.79 x 10^{-16} g. Calculate the atomic mass of silver.**[ans. 107.8]**

5. How many moles and how many grams of NaCl are present in 250 ml of a 0.50 M NaCl solution?**[ans. 0.125 *m*ol, 7.3125 g]**

6. Calculate the number of moles, no. of molecules & no of atoms of 4.48 dm^3 O_2 at STP.

[2.4088 x 10^{23} atoms]

7. Calculate the number of molecules in
a) 11 x 10^{-3} kg CO_2 and
b) 5.6 dm^3 of CO_2 at STP (mol. wt. of CO_2 = 44)**[1.505 x 10^{23} molecules, 1.505 x 10^{23} molecules]**

NCERT CORNER

1. Calculate the number of electrons in 17.0 g NH3.

2. In three moles of ethane (C2H6), calculate the following: **[NCERT]**
(i) Number of moles of carbon atoms.
(ii) Number of moles of hydrogen atoms.

3. In three moles of ethane (C2H6) calculate the following:
(a) Number of moles of carbon
(b) Number of moles of hydrogen atom
(c) Number of moles of ethane
[ans. 6 moles, 18 moles, 1.08 x 10^{24}]

4 Which one of the following will have largest number of atoms? **[NCERT]**
(i) 1 g Au (s) (ii) 1 g Na (s)
(iii) 1 g Li (s) (iv) 1 g of Cl2(g)

5. Calculate the number of atoms in each of the following
(a) 52 mol of Argon (b) 52 u of Helium
(c) 52 g of Helium**[ans. 3.13 x 10^{25}atoms, 13 atoms, 7.83 x 10^{24} atoms]**

6. (i) Calculate the total number of electrons present in one mole of methane.

(ii) Find (a) the total number and (b) the total mass of neutrons in 7 mg of 14C.
(Assume that mass of a neutron = 1.675×10^{-27} kg).
(iii) Find (a) the total number and (b) the total mass of protons in 34 mg of NH3 at STP.
[NCERT][ANS. 6.022×10^{24}, a)2.4092×10^{21}, b) 4.0352×10^{-6} kg, a) 1.2046×10^{22}, b) 2.0176×10^{-5} kg]

STOICHIOMETRIC CALCULATIONS

1. Chlorophyll, the green colouring matter of plants contains 2.68% of magnesium by weight. Calculate the number of magnesium atoms in 2.00 g of chlorophyll (at. Mass of Mg = 24**).** **[ans. 1.3×10^{21} atoms]**

2. Pure oxygen is prepared by thermal decomposition of KClO3 according to the equation :

$$KClO_3(s) \xrightarrow{\Delta} KCl(s) + \frac{3}{2}O_2(g)$$

Calculate the volume of oxygen gas liberated at STP by heating 12.25 g KClO3 (*s*).

3. What weight of oxygen gas are required to convert 0.6×10^{-3} kg hydrogen into water. Also calculate weight of water produced.
ANS. wt. of O_2 = 4.8×10^{-3} kg , 5.4×10^{-3} kg H_2O

4. Calculate the volume of ozone that could be obtained by using 89.6 dm^3 oxygen at NTP
ANS. 59.73 dm^3 at NTP

5. Hydrogen gas is prepared in the laboratory by reacting dilute HCl with granulated zinc. Following reaction takes place.
Zn + 2HCl –> ZnCl2 + H2
Calculate the volume of hydrogen gas liberated at STP when 32.65 g of zinc reacts with HCl. atomic mass ofZn = 65.3 u.

6. When $C_4H_{10}$is burned in excess oxygen, the following reaction occurs :
2 *C*4*H*10 (*g*) + 13*O*2 (*g*)→8*CO*2 (*g*)+10*H*2*O* (*g*)
What volume of oxygen at NTP is required to burn 36 g of C_4H10?

7. What volume of 0.250M HNO3 reacts with 42.4 mL of 0.150MNa2CO3 in the following reaction?

8. NiSO4 reacts with Na3PO4 to give a yellow green precipitate of Ni3(PO4)2 and a solution of Na2SO4.

3NiSO4(aq) + 2Na3PO4(aq) → Ni3(PO4)2 (s) + 3Na2SO4(aq)
How many mL of 0.375M NiSO4 will react with 45.7 mL of 0.265M Na3PO4?

9. A 1-g sample of $KClO_3$ was heated under such conditions that a part of it decomposed according to the equation
(a) $2KClO_3 \longrightarrow 2KCl + 3O_2$
and the remaining underwent change according to the equation
(b) $4KClO_3 \longrightarrow 3KClO_4 + KCl$
If the amount of O_2 evolved was 146.8 mL at NTP, calculate the percentage by weight of $KClO_4$ in the residue
Ans. 49.8%

D.P. – 3

1. Calculate the number of molecules present in of a gas at STP Ans. 3.01 $\times 10^{12}$

2. How many moles of potassium chlorate to be heated to produce 5.6 litre oxygen?**[ans. 1/6 mole KCl03]**

3. Calculate the volume of CO_2 formed at STP by heating 4.2 g of $NaHCO_3$.
Ans. 0.56 L

4. Calculate the amount of $CaCO_3$ required to be heated in order to collect 1.12 litre of CO_2 at STP. **Ans.** 5 g

5. Calculate the mass of CO2 that would be obtained by completely dissolving 10kg of pure CaCO3 in HCl.

CaCO3 + 2 HCl → CaCl2 + H2O + CO2

ANS. 4.4 kg of CO2

NCERT CORNER

1. Calculate the amount of water (g) produced by the combustion of 16 g of methane.**[NCERT][ANS. 36 g]**

2. How many moles of methane are required to produce 22 g CO2 (g) after combustion? [NCERT][ANS. 0.5]

3. In a reaction

$A + B_2 \longrightarrow AB_2$

Identify the limiting reagent, if any, in the following reaction mixtures. [NCERT]

(i) 300 atoms of A + 200 molecules of B

(ii) 2 mol A + 3 mol B

(iii) 100 atoms of A + 100 molecules of B

(iv) 5 mol A + 2.5 mol B

(v) 2.5 mol A + 5 mol B

4. Chlorine is prepared in the laboratory by treating manganese dioxide (MnO2) with aqueous hydrochloric acid according to the reaction

4 HCl (aq) + MnO2(s) → 2H2O (l) + MnCl2(aq) + Cl2 (g)

How many grams of HCl react with 5.0 g of manganese dioxide?

5. Calcium carbonate reacts with aqueous HCl to give CaCl2 and CO2 according to the reaction,

$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$

What mass of $CaCO_3$ is required to react completely with 25 mL of 0.75 M HCl?

LIMITING REAGENT

1. The reactant which is entirely consumed in reaction is known as limiting reagent.

In the reaction 2A + 4B→3C + 4D, when 5 moles of A react with 6 moles of B, then

(i) which is the limiting reagent?

(ii) calculate the amount of C formed?

2. 3*g* H_2reacts with 29 *g* $O_2$to yield H_2O .

(i) Which i the limiting reactant?

(ii) Calculate the maximum amount of *H2O* that can be formed.

(iii) Calculate the amount of one of the reactants which remains unreacted.

Ans. (i) *H*2 , (ii) 1.5 moles (iii) 0.1562

3. Calcium carbonate reacts with aqueous HCl to give CaCl2 and CO2 according to the reaction given below:

$CaCO_3$ (s) + 2HCl (aq) → $CaCl_2$(aq) + CO_2(g) + H_2O(*l*)

What mass of CaCl2 will be formed when 250 mL of 0.76 M HCl reacts with 1000 g of CaCO3? Name the limiting reagent. Calculate the number of moles of CaCl2 formed in the reaction.

4. 500 mL of 0.25 M $Na_2SO_4$is added to an aqueous solution of 15g of *BaCl*2 resulting in the formation of white precipitate of insoluble *BaSO*4. How many moles and how many grams of *BaSO*4 are formed?

Ans. 0.0721 mole, 16.77 g

5. 50 g of $CaCO_3$ is allowed to react with 73.5 g of H_3PO_4. Calculate :

(i) Amount of $Ca_3(PO_4)_2$ formed (in moles)

(ii) Amount of unreacted reagent (in moles)

6. According to the reaction $K_2Cr_2O_7$ + 14 HCl ⟶ $2CrCl_3 + 2KCl + 3Cl_2 + 7H_2O$ when 2.98g of $K_2Cr_2O_7$ and 5.84 g of HCl were reacted. Then calculate :

(a) The limiting reagent

(b) Maximum amount of $CrCl_3$ which can be produced

(c) The amount of excess reagent remaining after the reaction is complete ?

(d) How much ml of Cl_2 will be evolved at STP after the reaction is complete ?

Ans. (i) $K_2Cr_2O_7$, (ii) 3.21 gm, (iii) 0.73 g HCl, (iv) 672 ml

7. Carbon disulphide, CS_2, can be made from by-product SO_2. The overall reaction is

$5C + 2SO_2 \rightarrow CS_2 + 4CO$

How much CS_2 can be produced from 440 kg of waste SO_2 with 60 kg of coke if the SO_2 conversion is 80%?

8. 30 mL of 0.1 MBaCl2 is mixed with 40 mL of 0.2 MAl2(S04)3. What is the weight of BaS04 formed?

$BaCl2 + Al2(S04)3 \longrightarrow BaS04 + A1Cl3$

D.P. – 4

1. 0.5 mol each of H2S and SO2 are mixed together in a reaction flask in which the following reaction takes place :
2H2S (*g*) + SO2 (*g*) → 2H2O (*l*) + 3S (*s*)
Calculate the number of moles of sulphur formed.

2. A mixture of 1.0 mole of Al and 3.0 mole of Cl2 are allowed to react as:

$2Al(S) + 3Cl_2 \rightarrow 2A1Cl_3(s)$

(a) Which is limiting reagent?

(b) How many moles of A1Cl3 are formed?

(c) Moles of excess reagent left unreactcd

3. *8 gm of methane is burnt with 4.48L of O_2 at STP. Find out the volume of CO_2 gas produced at STP and also the weight of CO_2 gas.* **Wt. of CO_2 = 4.4 gms of CO_2**

4. According to the reaction , $SO_2 + H_2S \longrightarrow S + H_2O$, when 6.4 g of SO_2 is reacted with 4 g H_2S. Calculate :
(a) The limiting reagent
(b) Maximum amount of sulphure which can be produced
(c) The amount of excess reagent remaining after the reaction is complete ?
ANS (i) SO_2, (ii) 6.4 gm, (iii) 0.6 gm

NCERT CORNER

1. Calculate the amount of carbon dioxide that could be produced when
(i) 1 mole of carbon is burnt in air.
(ii) 1 mole of carbon is burnt in 16 g of dioxygen.
(iii) 2 moles of carbon are burnt in 16 g of dioxygen.

2. 50.0 kg of N2 (g) and 10.0 kg of H2 (g) are mixed to produce NH3 (g). Calculate the NH3 (g) formed. Identify the limiting reagent in the production of NH3 in this situation.
[NCERT][ANS. 56.1 kg, dihydrogen]

CONCENTRATION OF SOLUTION

1. 0.5 g of a substance is dissolved in 25 g of a solvent. Calculate the percentage amount of the substance in the solution.
2. If the concentration of glucose (C6H12O6) in blood is 0.9 g L–1, what will be the molarity of glucose in blood?

3. A solution is 25% H2O, 25% C2 H5 OH and 50% acetic acid by mass. Calculate mole fraction of each component.**[ans. 0.502, 0.196, 0.302]**

4. If the density of methanol is 0.793 kgL-1, what is the volume needed for making 2.5 L of its 0.25 M solution? .**[ans. 25.2 mL]**

5. What volume of 10 M HCl and 3 M HCl should be mixed to get 1L of 6 M HCl solution?**[ans. 572 mL.s]**

6. A sample of H_2S0_4 (density 1.787 g mL-1) is labelled as 80% by weight. What is molarity of acid? What volume of acid has to be used to make 1 litre of 0.2 MH2S04 ? **[ans. 14.59, 13.71 mL]**

7. Find the molality of H2S04 solution whose specific gravity is 1.98 g mL-1 and 90% by volume H2S04. **[ans. 8.50]**

8. Suppose 5 g of acetic acid are dissolved in one litre of ethanol. Assume no reaction in between them. Calculate molality of resulting solution if density of ethanol is 0.789 g/mL. **[ans. 0.1056]**

9. 4 g of NaOH are present in 0.1 dm3 solution have specific gravity 1.038 g/mL. Calculate : (a) mole fraction of NaOH; (b) molality of NaOH solution; (c) molarity of NaOH solution; (d) normality of NaOH solution. **[ans. (a) 0.018, (b) 1.002 m (c) 1 M, (d) 1 N]**

10. Calculate the amount of oxalic acid ($H_2C_20_4.2H_20$) required to obtain 250 mL of deci-molar solution. **[ans. 3.15 g]**

11. Calculate normality of mixture obtained by mixing :

(a) 100 mL of 0.1 NH2S04 + 50 mL of 0.25 *N* NaOH.

(b) 100 mL of 0.2 MH2S04 + 200 mL of 0.2 M HCl.

(c) 100 mL of 0.2 M H2S04 + 100 mL of 0.2 M NaOH.

(d) 1 g equivalent of NaOH + 100 mL of 0.1 *N* HCl.

[ans. (a) 0.0167, (b) 0.267, (c)0.1, (d) 9.9]

12. Calculate the molarity and molality of a given solution of ethanol in water, if Ihe mole fraction of ethanol is 0.04 and its density is 0.97g/mL -1

13. You are given one litre each of 0.183 M HCI and 0.381 M HCI. What is the maximum value of 0.243 M HCI which you can make from these solution. (No water is added).

14. What weight of AgCl will be precipitated when a solution containing 4.77 g NaCl is added to a solution of 4.77 g of $AgNO_3$?
ans. 4.87 g

15. How much $BaCl_2$ would be needed to make 250 ml of a solution having same concentration of Cl^- as the one containing 3.78 g of NaCl per 100 ml ? ans. 16.80

16. Commercially available concentrated hydrochloric acid contains 38% HCI by mass. (a) What is the molarity of this solution? The density is 1.19 g mL-1

(b) What volume of concentrated HCI is required to make 1.00 litreof 0.10 MHCI?. **[ans. (a) 12.4, (b) 8.06 mL]**

17. A water sample has 20.0 ppm (by mass) Cl_2 present in it. Calculate the quantity of Cl_2 present in 100 ml water. (Density of water = 1.0 g ml^{-1}.)

D.P. – 10

1. 214.2 g of sugar syrup contains 34.2 g of sugar. Calculate :
(a) molality of the solution
(b) mole fraction of sugar in the syrup. **ANS 0.555 m, 0.0099**

2. A solution has three components A, B, C. mole fraction of A and B are 0.50, 0.20 respectively. What is the mole fraction of C?**[ans. 0.30]**

3. A solution is prepared by dissolving 18.25g of NaOH in distilled water to give 200 ml of solution. Calculate the molarity of the solution.
[ans. 2.28 M]

D.P. – 11

1. How much volume of 10M HCl should be diluted with water to prepare 2.00L of 5M HCl.
1.00L

2. What volume of water is required to make 0.20 N solution from 1600 mL of 0.2050 N solution? **[ans. 40 mL]**

3. How many g of a 5.0 % by weight NaCl solution are necessary to yield 3.2 g NaCl ? **ans. 64 gm**

4. Calculate the concentration of a solution obtained by mixing 300 **g** 25% by weight solution of NH4Cl and 150 g of 40% by weight solution of NH4C1. **[ans. 30%]**

5. The density of 3M solution of $Na_2S_2O_3$ is 1.25g ml^{-1}. Calculate

(a) the % by weights of $Na_2S_2O_3$
(b) mole fraction of $Na_2S_2O_3$
(c) the molalities of Na^+ and $S_2O_3^{-2}$ ions.

ans. (a) 37.92 (b) 0.065 (c) 3.865

6. What is the strength in g per litre of a solution of H2S04, 12 ml ol which neutralized 15 mL of M10 NaOH solution?[ans. 6.125 g/litre]

D.P. – 12

1. A solution of glucose in water is labelled as 10 per cent w/w, what would be the molality and mole fraction of each component in the £ solution? If the density of the solution is 1.2 g mL-1, then what shall be the molarity of the solution? [ans. 0.617 m, 0.67 M, 0.011,0.989]

2. A sample of H_2SO_4 (density 1.787g ml^{-1}) is labelled as 86% by weight. What is molarityof acid ? What volume of acid has to be used to make 1 litre of 0.2M H_2SO_4? ans. 12.75

3. What volume of 96 % H_2SO_4 solution (density 1.83 g/ml) is required to prepare 4 litre of 3.0 M H_2SO_4 solution ?
ans. 669.4 m*l*

4. 100 g of 1 molal ethylene glycol solution is prepared in the laboratory. Determine % by mass of each component.
ans. 5.84 % ethylene glycol, 94.16% solvent

5. What volume of dilute nitric acid, of density 1.11 g/mL and 19 % HNO_3 by weight, contains 10 g HNO_3?
ans. 47.416 ml

6. Calculate the resulting molarity of the solution that is obtained by adding 5 g of NaOH to 200 mL of M/4 NaOH solution (density = 1.05 g cm^{-3}). The density of resulting solution is 1.08 g cm^{-3}.
ans. 0.88 M

NCERT CORNER

1. A solution is prepared by adding 2 g of asubstance A to 18 g of water. Calculatethe mass per cent of the solute.[NCERT]
[ANS. 10 %]

2. Calculate the molarity of NaOH in thesolution prepared by dissolving its 4 g inenough water to form 250 mL of thesolution.[NCERT][ANS 0.4 M]

3. What is the concentration of sugar (C12H22O11) in mol L–1 if its 20 g are dissolved in enough water to make a final volume up to 2L? **[NCERT]**

4. How are 0.50 mol Na2CO3 and 0.50 M Na2CO3 different?

5. Pressure is determined as force per unit area of the surface. The SI unit of pressure, pascal is as shown below :1Pa = 1N m–2
If mass of air at sea level is 1034 g cm^{-2}, calculate the pressure in pascal. **[NCERT]**

6. Calculate the mass of sodium acetate (CH3COONa) required to make 500 mL of 0.375 molar aqueous solution. Molar mass of sodium acetate is 82.0245 g $mol^{-1.}$

7. If the density of methanol is 0.793 kg L–1, what is its volume needed for making 2.5 L of its 0.25 M solution? **[NCERT]**

8. Calculate the concentration of nitric acid in moles per litre in a sample which has a density, 1.41 g mL–1 and the mass per cent of nitric acid in it being 69%.**[NCERT]**

9. The density of 3 M solution of NaCl is1.25 g mL–1. Calculate molality of thesolution.
[NCERT] **[ANS 2.79 m]**

10. Calculate the molarity of a solution of ethanol in water in which the mole fraction of ethanol is 0.040 (assume the density of water to be one). **[NCERT]**

11. A sample of drinking water was found to be severely contaminated with chloroform, CHCl3, supposed to be carcinogenic in nature. The level of contamination was 15 ppm (by mass). **[NCERT]**
(i) Express this in percent by mass.
(ii) Determine the molality of chloroform in the water sample.

OBJECTIVE QUESTIONS (BASIC CONCEPTS OF CHEMISTRY)

CBSE LEVEL

NUMERICAL QUESTIONS

Level - I

1. The vapour density of gas is 22. It cannot be
   1) Carbon dioxide 2) Nitrus oxide
   3) Propane 4) Methane
2. The vapour density of ethyl alcohol vapour is
   1) 46 2) 23 3) 92 4) 69
3. Boron has two isotopes ^{10}Band ^{11}B whose relative abundances are 20% and 80% respectively. Atomic weight of Boron is
   1) 10 2) 11 3) 10.5 4) 10.8
4. The percentage of Carbon in is
   1) 27.27% 2) 29.27%
   3) 30.27% 4) 26.97%
5. The number of moles present in 24.5gms of is
   1) 2.5 2) 0.5 3) 4 4) 0.25
6. Neon has two isotpoes Ne^{20} and Ne^{22}. If atomic weight of Neon is 20.2, the ratio of the relative abundances of the isotopes is
   1) 1 : 9 2) 9 : 1 3) 70 % 4) 80 %
7. The percentage of oxygen in pure NaOH is (atomic wt. Of Na=23)
   1) 40 2) 16 3) 8 4) 23
8. 0.4 grams of a Volatile liquid on vapourisation gave 112 m*l* of N_2 at S.T.P. The molecular weight of the liquid is
   1) 40 2) 80 3) 120 4) 160
9. 0.5 grams of a compound contains 0.2 gm. of potassium. The percentage weight of potassium in that compound is
   1) 80 2) 60 3) 40 4) 20
10. A compound has 40%of carbon by weight. If molecular weight of the compound is 90, the number of carbon atoms present in 1 molecule of the compound are
    1) 3 2) 2 3) 1 4) 5
11. The percentage weight of Deuterium in heavy water
    1) 80% 2) 60% 3) 40% 4) 20%
12. A compound has 20% of nitrogen by weight. If one molecule of the compound contains two nitrogen atoms, the molecular weight of the compound is
    1) 35 2) 70 3) 140 4) 280
13. Haemoglobin contrains 0.33% of Fe by weight. If 1 molecule of Haemoglobin contains two Fe atoms, the molecular weight of Haemoglobin will be (at. wt. of Fe=56)
    1) 67000 2) 34000
    3) 17000 4) 20000
14. The weight of 4gm. atoms of nitrogen is
    1) 56 gms. 2) 112 gms.
    3) 42 gms. 4) 28 gms.
15. Maximum number of atoms are present in
    1) 11.2 lit. of SO_2 at STP
    2) 22.4 lit. of Helium at STP
    3) 2.0 gms. of hydrogen
    4) 11.2 litres of methane at STP
16. The number of carbon atoms present in 2.8 gms of carbon monoxide are
    1) 3.01×10^{23} 2) 3.01×0^{22}
    3) 6.02×10^{23} 4) $6.02 \text{ x } 10^{22}$
17. Maximum number of atoms are present in
    1) 14 gms. of carbon monoxide
    2) 2 gms. of hydrogen
    3) 11.2 lit. of nitrogen at STP
    4) 1.5 gm atoms of helium
18. Which of the following has highest mass
    1) 50 gms of iron
    2) 5 moles of nitrogen
    3) 1 gm atom of silver
    4) 5×10^{23} atoms of carbon
19. The volume of 1.5 gm atoms of helium gas under standard conditions of temperature and pressure is
    1) 22.4 lit 2) 33.6 lit
    3) 44.8 lit 4) 11.2 lit
20. 1.5 moles of oxygen atoms are present in
    1) 0.5 moles of $BaCO_3$
    2) 1 mole of $BaCO_3$
    3) 2 moles of $BaCO_3$

4) 0.25 moles of $BaCO_3$

21. The vapour density of a gas is 11.2. The volume occupied by 11.2 gms. of the gas at S.T.P. is
1) 11.2 lit 2) 4 lit.
3) 2 lit 4) 22.4 lit

22. Maximum number of electrons are present in
1) 2.24 lit. of SO_2 at S.T.P.
2) 0.2 moles of NH_3
3) 1.5 gm moles of oxygen
4) 2 mole atoms of of sulphur

23. A pair of gasses having same number of molecules are
1) 22 gm of CO_2 and 72 gm of N_2
2) 11 gm of CO_2 an 28 gm of N_2
3) 44 gm of CO_2 and 7 gm of N_2
4) 11 gm of CO_2 and 7 gm of N_2

24. The density of water is 1 gm/ml. The number of molecules present in 1 litre of water are
1) 18 2) 18×1000
3) $6.023\ 10^{23}$ 4) $55.55 \times 6.023 \times 10^{23}$

25. Which of the follwing contians less number of molecules
1) 11 gms of CO_2 2) 32 gm of SO_2
3) 2 gms of hydrogen4) 4 gms of helium

26. Which of the following contains more number of moles of the substance in it
1) 90 gms of water
2) 130 gms of Carbon dioxide
3) 89.6 ltrs of oxygen at S.T.P.
4) 12 gms of Hydrogen

27. The gas having same number of molecules as 16g. of oxygen is
1) 16g. of O_3
2) 16g. of SO_3
3) 48g. of SO_3
4) 1gm of hydrogen

28. Which of the following contains maximum number of molecules
1) 4 gm of hydrogen
2) 22.4 ltrs of oxygen at S.T.P.
3) Carbon Dioxide obtained by heating 1 mole of calcium carbonate
4) 4 gm of helium

29. Substance having more number of moles is
1) 90 gms of water
2) 112 litre of hydrogen at S.T.P.
3) 24 gm of helium gas
4) 3.01×10^{24} molecules of CO_2

30. Substance having maximum number of molecules is
1) 44.8 lit of H_2 at S.T.P.
2) 2 gms of helium
3) 16 gms of methane
4) 33 gms of CO_2

31. The weight of gaseous mixture containing 6.02×10^{23} molecules of nitrogen and 3.01×10^{23} molecules of sulphur dioxide
1) 46 2) 92 3) 60 4) 30

32. When equal masses of methane and sulphur dioxide are taken, then the ratio of their molecules is
1) 1 : 1 2) 1 : 2 3) 2 : 1 4) 4 : 1

33. 10 grams of each O_2, N_2 and Cl_2 are kept in three bottles. The correct order of arrangment of bottles containing decreasing number of Molecules.
1) O_2, N_2, Cl_2 2) Cl_2, N_2, O_2
3) Cl_2, O_2, N_2 4) N_2, O_2, Cl_2

34. 0.5 moles of a gas (Mol.wt.20) occupies 11.2 litres at STP. The volume occupied by 0.25 mole of a lighter gas (Mol. Wt.=2) at STP will be
1) 11.2 lit 2) 5.6 lit
3) 2.8 lit 4) 22.4 ltrs

35. The number of and Ca^{+2} ions in 222g. of $CaCl_2$ are
1) 4N, 2N 2) 2N, 4N
3) 1N, 2N 4) 2N, 1N

36. The number of neutrons in one mole of hydrogen is
1) N 2) 0.5N 3) 0 4) 2N

37. The no. of gram atoms present in 10 gms of Ca CO_3 are
1) 5 2) 0.5 3) 0.05 4) 0.02

38. The no. of electrons present in one mole of Azide ion are
1) 21N 2) 20N 3) 22N 4) 43N

39. Which of the following gives more no. of ions
1) 1 mole of $K_4 [Fe(CN)_6]$
2) 1 mole of $[Co(NH_3)_6] Cl_3$
3) 1 mole of NaCl
4) 1 mole of $K_3[Fe(CN)_6]$

40. If the weight of 5.6 litres of a gas at S.T.P is 11 grams, the gas is
1) Phosphine 2) Phosgene
3) Nitric oxide 4) Nitrous oxide

41. Thge mass of Hydrogen at S.T.P. that is present in a vessel which can hold 4 grams of oxygen under similar conditions is
1) 1 gram 2) 0.5 grams
3) 0.25 gms. 4)0.125 gm

42. Volume occupied by 4 grams of Ethylene at S.T.P. in litres is
1) 22.4 2) 11.2
3) 5.6 4) 3.2

43. If the mass of an electron is 9×10^{-28} grams, weight of one mole of electrons is
1) 9×10^{-28} gm 2) 6×10^{-28}
3) 1.008 gm 4) 0.00054 gm

44. Weight of 1 atom of Hydrogen is
1) 1.66×10^{-24} gm 2) 10^{23} gm
3) 10^{22} gm 4) 10^{24} gm

45. The density of a gas at S.T.P. is 1.40 grams per litre. The molecular weight of the gas is
1) 28 2) 30 3) 31.4 4) 35

46. 200 c.c. of a gas measured at S.T.P. has a mass of 0.268g. Molecular weight of the gas is
1) 16 2) 2 3) 28 4) 30

47. Which one of the following contains same number of atoms as there are in 12 grams of magnesium?
1) 12 grams carbon
2) 40 grams of calcium
3) 16 grams of oxygen
4) 7 grams of carbon monoxide

48. How many moles of Barium carbonate will contain 1.5 moles of oxygen atoms
1) 1 mole 2) 0.5 mole
3) 0.25 mole 4) 0.4 mole

49. 76 grams of Fluorine contains
1) 4 gram atoms of fluorine
2) 2 moles of fluorine
3) 12 x 10^{23} fluorine molecules
4) all the above

50. Number of gram atoms of oxygen present in 0.3 mole of $(COOH)_2.2H_2O$ is
1) 9 2) 18 3) 0.9 4) 1.8

51. Number of milli moles in 1.0 gram of water
1) 1.0 2) 18
3) 55.55 4) 100

52. Number of oxygen atoms present in 1 gram of calcium carbonate are
1) 6×10^{21} 2) 1.8×10^{22}
3) 6×10^{22} 4) 8×10^{22}

53. The number of atoms present in 10 gms of $CaCO_3$ are
1) 5N 2) 0.5N
3)5 4) N

54. Number of electrons in 1.8 grams of H_2O are
1) 6.02 x 10^{23} 2) 3.01×10^{23}
3) 0.602×10^{23} 4) 60.22×10^{23}

55. The number of moles of water present in 90 grams of water are
1) 9 2) 6 3) 5 4) 0.5

56. Which one of the following pairs of gases contain the same number of molecules at S.T.P.
1) 11 grams of CO_2 and 14 grams of CO
2) 14 grams of C_2H_4 and 16 grams of methane
3) 16 grams of oxygen and 17 grams of Hydrogen sulphide
4) 4 grams of helium and 4 grams of hydrogen

57. 8 gms of O_2 has the same number of molecules as
1) 7 gm CO 2) 14 gm of CO
3) 22 gm of CO_2 4) 44 gms of CO_2

58. The total volume of mixture of 2 gms of helium and 7 gms of nitrogen under S.T.P. conditions is
1) 22.4 lit 2) 11.2 lit
3) 16.8 lit 4) 5.6 lit

59. The mass of one oxygen molecule is
1) 2.656×10^{-23} 2) 5.312×10^{-23} gm
3) 1.66×10^{24} gm 4) 32 gm

60. In the formation of SO_2 and SO_3 the ratio of the weights of oxygen which combines with 10kg of sulphur is
1) 1 : 1 2) 3 : 2 3) 2 : 3 4) 3 : 4

61. 0.5 gm of an organi compound on combustion produced some gaseous products, which were passed into caustic potash solution. The increase in weight of potash solution was found to be 1.5 gms. The percentage of carbon in the compound is nearly.
1) 82% 2) 40% 3) 60% 4) 75%

62. Ferric sulphate on heating gives sulphur trioxide. The ratio between the weights of oxygen and sulphur present in SO_3 obtained by heating 1 kg of ferric sulphate is
1) 2 : 3 2) 1 : 3 3) 3 : 1 4) 3 : 2

63. X and Y are two different elements having their atomic masses in 1 : 2 ratio. The compound formed by the combination of X and Y contains 50% of X by weight. The empirical formula of the compound is
1) X_2 Y 2) XY_2 3) XY 4) X_4Y

64. An organic compound contains 86.47% carbon and 6.33% hydrogen. The emperical formula of the compound is
1) $C_{16}H_{14}O$ 2) $C_{10}H_{14}O$
3) $C_6H_{12}O$ 4) $C_{14}H_{16}O$

65. The empirical formula of a gaseous compound is CH_2. The density of the compound is 1.25 gm/lit. at S.T.P. The molecular formula of the compound is
1) C_2H_4 2) C_3H_6
3) C_6H_{12} 4) C_4H_8

66. The molecular formula of a compound which contains 30.5% of N_2 and 69.5% O_2 by weight and a molecular weight of 92 is
1) N_2O_4 2) NO_2
3) N_2O_3 4) N_2O

67. The empirical formula of an organic compound is CH_2O. Its vapour density is 45. The molecular formula of the compound is
1) CH_2O 2) $C_2H_4O_2$
3) $C_3H_6O_3$ 4) $C_6H_{12}O_6$

68. A compound contains 92.3% of carbon and 7.7% of hydrogen. The molecule of the compound is 39 times heavier than hydrogen molecule. The molecular formula of the compound is
1) C_3H_3 2) C_2H_2 3) C_2H_4 4) C_6H_6

69. The emperical formula weight of a compound containing carbon and hydrogen is 13. The molecule of the compound is 39 times heavier than a molecule of hydrogen. The molecular formula of hte compound.
1) CH 2) C_3H_3
3) $C_{13}H_{13}$ 4) C_6H_6

70. Emperical formula of a compound is CH_2 and its molecular weight is 84. The molecular formula of the compound is
1) C_4H_8 2) C_6H_6
3) C_6H_8 4) C_6H_{12}

71. A certain compound contains Calcium, Carbon and Nitrogen in the mass ratio, 20 : 6 : 14. The empirical formula of the compound is
1) CaCN 2) CaC_2N
3) $Ca(CN)_2$ 4) $CaCN_2$

72. A Gaseous compound of Nitrogen and Hydrogen contains 12.5% by weight of Hydrogen. The density of the compound relative to Hydrogen is 16, the molecular formula of the compound is
1) NH_2 2) NH_3
3) NH_4 4) N_2H_4

73. The relative number of atoms of different elements in a compound are as follows: A = 1.33, B = 1 and C = 1.5. The emperical formula of the compound is
1) $A_2B_2C_3$ 2) ABC
3) $A_8B_6C_9$ 4) $A_3B_3C_4$

74. 2.79 gms of iron (At. Wt = 55.8) is completely converted to rust. The weight of oxygen in the rust is
1) 1.2 gms 2) 2.4 gm
3) 4.8 gm 4) 3.6 gm

75. 20 gms of sulphur on burning in air produced 11.2 its of SO_2 at STP. The percentage of unreacted sulphur
1) 80% 2) 20%
3) 60% 4) 40%

76. 60 gms of lime stone on heating produced 22 gms of CO_2. The percentage of $CaCO_3$ in limestone is
1) 80% 2) 60%
3) 83.3% 4) 87.66%

77. 40 gms of carbon is allowed to burn in 56 litres of oxygen measured at STP. The percentage of unreacted carbon is
1) 50% 2) 75%
3) 25% 4) 40%

78. 0.7 moles of potassium sulphate is allowed to react with 0.9 moles of barium chloride in aqueous solutions. The number of moles of the substance precipitated in the reaction is
1) 1.4 moles of potassium chloride
2) 0.7 moles of barium sulphate
3) 1.6 moles of potassium chloride
4) 1.6 moles of barium sulphate

79. In a reaction if 7 grams of CO is completely oxidised to CO_2, the weight of CO_2 formed in grams is
1) 14 2) 11
3) 44 4) 30

80. Equal amounts of zinc is allowed to react with excess of H_2SO_4 and excess of NaOH separately. The ratio between the weights of H_2 formed is
1) 1 : 2 2) 1 : 1
3) 1 : 3 4) 2 : 1

81. To get 5.6 lit of CO_2 at STP, weight of $CaCO_3$ to be decomposed is
1) 100 gm 2) 50 gm
3) 25 gm 4) 75 gm

82. $KCIO_3$ decomposes to KCI and O_2. If the volume of O_2 obtained in this reaction is 1.12 lit at STP, weight of KCI formed in the reaction is
1) 7.45 grams 2) 2.48 grams
3) 4.96 grams 4) None

83. The volume of H_2 at STP required to completely reduce 160 gms of Fe_2O_3 is
1) 3 × 22.4 litres 2) 2 × 22.4 litres
3) 22.4 litres 4) 11.2 litres

84. The weight of SO_2 formed when 20 gms of sulphur is burnt in excess of O_2 is
1) 32 gm 2) 64 gm
3) 40 gm 4) 60 gm

85. The number of moles of Fe_2O_3 formed when 0.5 moles of O_2 and 0.5 moles of Fe are allowed to react are
1) 0.25 2) 0.5
3) 3/8 4) None

86. If 0.5 mole of $BaCl_2$ is mixed with 0.2 mole of Na_3PO_4, the maximum number of moles of $Ba_3(PO_4)_2$ formed are
1) 0.7 2) 0.5
3) 0.3 4) 0.1

87. The amount of NaCl and CO_2 formed when 1.06 gms of Na_2CO_3 reacts with excess of HCl are
1) 1.17 gms & 0.44 gm
2) 0.585 gm and 0.44 gm
3) 0.585 gm and 0.22 gm
4) 1.17 gm and 0.22 gm

88. If 12.0 lit of H_2 and 8.0 lit of O_2 are allowed to react, the O_2 left unreacted will be
1) 4.0 lit 2) 6.0 lit
3) 1.0 lit 4) 2.0 lit

89. When 10 ml of hydrogen and 12.5ml of chlorine are allowed to react the final mixture contains under the same condtions
1) 22.5 ml of HCl
2) 12.5 ml of HCl
3) 20 ml of HCl and 2.5 ml of chlorine
4) 20 ml of HCl only

90. If 5 ml of methane is completely burnt the volume of oxygen required and the volume of CO_2 formed under the same conditions are

1) 5 ml, 10 ml 2) 10 ml, 5 ml
3) 5 ml, 15 ml 4) 10 ml, 10 ml

91. 60 lit of pure dry O_2 is subjected to silent electric discharge; if only 10% of it is convereted to ozone, then volume of O_3 formed is
1) 4 lit 2) 6 lit
3) 40 lit 4) 3 lit

92. The no. of moles of hydroxide ions produced by one mole of Na_2CO_3 on hydrolysis is
1) 4 2) 2
3) 3 4) 0

93. How many grams of H_3PO_4 is required to completely neutralize 120g of NaOH
1) 49 2) 98
3) 196 4) 9.8

94. The volume in lit of CO_2 liberated at S.T.P when 10g of 90% pure lime is heated completely is
1) 2.016 2) 20.16
3) 2.24 4) 22.4

95. 23g of sodium will react with ethyl alcohol to give
1) 1 mole of H_2
2) 1/2 mole of H_2
3) 1 mole of O_2
4) 1 mole of NaOH

96. 26 cc of CO_2 are passed over red hot coke. The volume of CO evolved is
1) 15cc 2) 10cc
3) 32cc 4) 52cc

97. The weight of $KMnO_4$ required to completely oxidise 0.25 moles of $FeSO_4$ in acid medium is .... (molecular weight of $KMnO_4$ = 158)
1) 5.8 2) 1.5
3) 7.9 4) 0.79

98. The volume of phosgene formed at STP when 11.2 lit of chlorine reacts with carbonmonoxide is
1) 11.2 lit 2) 22.4 lit
3) 5.6 lit 4) 44.8 lit

99. The mass of Na_2CO_3 required to prepare 500 ml of 0.1M solution is
1) 10.6 g 2) 5.3 g 3) 2.65 g 4) 7.95 g

100. If 100 ml hydrogen chloride is completely decomposed the volume of H_2 formed will be (P and T are constant)
1) 20 ml 2) 200 ml 3) 100 ml 4) 50 ml

101. The weight of oxygen required to completely react with 27 gms of 'Al' is
1) 8 gm 2) 16 gm 3) 32 m 4) 24 gm

102. If 0.7 moles of Barium Chloride is treated with 0.4 mole of potassium sulphate, number of moles of barium sulphate formed are
1) 0.7 2) 0.4 3) 0.35 4) 0.2

103. The no. of moles of CO_2 produced when 3 moles of HCl reacts with excess of $CaCO_3$ is
1) 1 2) 1.5
3) 2 4) 2.5

KEY

1) 4	2) 2	3) 4	4) 1	5) 4
6) 2	7) 1	8) 2	9) 3	10) 1
11) 4	12) 3	13) 2	14) 1	15) 4
16) 4	17) 2	18) 2	19) 2	20) 1
21) 1	22) 4	23) 4	24) 4	25) 1
26) 4	27) 4	28) 1	29) 3	30) 1
31) 3	32) 4	33) 4	34) 2	35) 1
36) 3	37) 2	38) 3	39) 1	40) 4
41) 3	42) 4	43) 4	44) 1	45) 3
46) 4	47) 4	48) 2	49) 4	50) 4
51) 3	52) 2	53) 2	54) 1	55) 3
56) 3	57) 1	58) 3	59) 2	60) 3
61) 1	62) 4	63) 1	64) 1	65) 1
66) 1	67) 3	68) 4	69) 4	70) 4
71) 4	72) 4	73) 3	74) 1	75) 2
76) 3	77) 3	78) 2	79) 2	80) 2
81)3	82) 2	83) 1	84) 3	85) 1
86) 4	87) 1	88) 4	89) 3	90) 2
91) 1	92) 2	93) 2	94) 1	95) 2
96) 4	97) 3	98) 1	99) 2	100) 4
101)4	102) 2	103) 2		

COMPETITION SECTION

OBJECTIVE QUESTIONS

1. How many H-atoms are present in 0.046 g of ethanol? [BITSAT 2003]
   1) 6×10^{20} 2) 1.2×10^{21}
   3) 3×10^{21} 4) 3.6×10^{21}
2. Which has maximum number of atoms? [DCE 2003]
   1) 2.0 mol of S_8 2) 6.0 mol of S
   3) 5.5 mol of SO_2 4) 4.48 L of CO_2 at 5TP
3. A gas has a vapour density 11.2. The volume occupied by 1g of the gas at NTP is [BCECE 2004]
   1) 1 L 2) 11.2 L
   3) 22.4 L 4) 4 L
4. The number of atoms in 4.25 g of NH_3 is approximately [MHT CET 2003]
   1) 6×10^{23} 2) 2×10^{23}
   3) 1.5×10^{23} 4) 1×10^{23}
5. 0.1 mole of a carbohydrate with empirical formula CH_2O contains 1 g of hydrogen. What is its molecular formula? [Kerala CEE 2008]
   1) $C_5H_{10}O_5$ 2) $C_6H_{12}O_6$
   3) $C_4H_8O_4$ 4) $C_3H_6O_3$
   5) $C_2H_4O_2$
6. Law of constant composition is same as the law of [WB JEE 2007]
   1) Conservation of mass 2) Conservation of energy
   3) Multiple proportion 4) Definite proportion
7. One mole of CO_2 contains [Manipal 2010]
   1) 3 g atoms of CO_2 2) 18.1×10^{23} molecules of CO_2
   3) 6.02×10^{23} atoms of O 4) 6.02×10^{23} atoms of C
8. The number of gram molecules of chlorine in 6.02×10^{25} hydrogen chloride molecules is [KCET 2007]
   1) 10 2) 100
   3) 50 4) 5
9. Which has maximum number of atoms? [WB JEE 2007]
   1) 24 g of C 2) 56 g of Fe
   3) 26 g of Al 4) 108 g of Ag
10. The number of formula units of calcium fluoride, CaF_2 present in 146.4 g of CaF_2 (the molar mass of CaF_2 is 78.08 g/mol) is [VITEEE 2008]
    1) $1.129 \times 10^{24} CaF_2$ 2) $1.146 \times 10^{24} CaF_2$
    3) $7.808 \times 10^{24} CaF_2$ 4) $1.877 \times 10^{24} CaF_2$
11. How many moles of $Al_2(SO_4)_3$ would be in 50 g of the substance? [JamiaMilliaIslamia 2006]
    1) 0.083 mol 2) 0.952 mol
    3) 0.481 mol 4) 0.140 mol
12. 1 L oxygen gas at STP will weigh [JCECE 2010]
    1) 1.43 g 2) 2.24 g
    3) 11.2 g 4) 22.4 g
13. Which has the highest weight? [Manipal 2010]
    1) 1 m^3 of water 2) A normal adult man
    3) 10 L of Hg 4) All have same weight
14. The mass of 1 mole of electrons is [UP SEE 2006]
    1) 9.1×10^{-28} g 2) 1.008 mg
    3) 0.55 mg 4) 9.1×10^{-27} g
15. The maximum number of molecules are present in [UP SEE 2007]
    1) 15 L of H_2 gas at STP 2) 5 L of N_2 gas at STP
    3) 0.5 g of H_2 gas 4) 10 g of O_2 gas
16. Arrange the following in the order of increasing mass (atomic mass; O = 16, Cu = 63, N = 14)
    1. One atom of oxygen
    2. One atom of nitrogen
    3. 1×10^{-10} mole of oxygen
    4. 1×10^{-10} mole of copper
    5. [Kerala CEE 2011]

    1) $II < I < III < IV$ 2) $I < II < III < IV$
    3) $III < II < IV < I$ 4) $IV < II < III < I$
    5) $II < IV < I < III$
17. Which of the following contains maximum number of molecules? [Kerala CEE 2004]
    1) 100 cc of CO_2 at STP 2) 150 cc of N_2 at STP
    3) 50 cc of SO_2 at STP 4) 150 cc of O_2 at STP
    5) 200 cc of NH_3 at STP
18. The mass of 112cm^3 of CH_4 gas at STP is [DCE 2006]
    1) 0.16 g 2) 0.8 g
    3) 0.08 g 4) 1.6 g
19. Number of atoms in 560 g of Fe (atomic mass 56 g mol^{-1}) is [JamiaMilliaIslamia 2005]
    1) Twice that of 70 g N 2) Half that of 20 g H
    3) Both are correct 4) None of these

20. Mass of 0.1 mole of methane is [KCET 2008]
1) 1 g 2) 16 g
3) 1.6 g 4) 0.1 g

21. A gas is found to have formula $[CO]_x$. Its vapour density is 70, the x is [BCECE 2007]
1) 3.0 2) 3.5
3) 5.0 4) 6.5

22. An unknown element forms an oxide. What will be the equivalent weight of the element if the oxygen content is 20% by weight? [WB JEE 2008]
1) 16 2) 32
3) 8 4) 64

23. A bivalent metal has an equivalent mass of 32. The molecular mass of the metal nitrate is [Manipal 2009]
1) 182 2) 168
3) 192 4) 188

24. In the disproportionation reaction $3HClO_3 \rightarrow HClO_4 + Cl_2 + 2O_2 + H_2O$, the equivalent mass of the oxidising agent is (molar mass of $HClO_3 = 84.45$) [Kerala CEE 2011]
1) 16.89 2) 32.22
3) 84.45 4) 28.15
5) 29.7

25. The equivalent weight of $KMnO_4$ for acid solution is [Manipal 2010]
1) 79 2) 52.16
3) 158 4) 31.6

26. If we consider that $\frac{1}{6}$, in place of $\frac{1}{12}$, mass of carbon atom is taken to be the relative atomic mass unit, the mass of one mole of a substance will [AIEEE 2005]
1) Be a function of the molecular mass or the substance 2) Remain unchanged
3) Increase two fold 4) Decrease twice

27. If molecular weight of $KMnO_4$ is M, then its equivalent weight in acidic medium would be [WB JEE 2007]
1) M 2) $\frac{M}{2}$
3) $\frac{M}{5}$ 4) $\frac{M}{3}$

28. In a compound C, H and N are present is 9 : 1 : 3.5 by weight. If molecular weight of the compound is 108, then the molecular formula of the compound is [BCECE 2008]
1) $C_2H_6N_2$ 2) C_3H_4N
3) $C_6H_8N_2$ 4) $C_9H_{12}N_3$

29. An organic compound has an empirical formula (CH_2O) its vapour density is 45. The molecular formula of the compound is [Manipal 2006]
1) CH_2O 2) C_2H_5O
3) C_2H_2O 4) $C_3H_6O_3$

30. An organic compound contains 49.3% carbon, 6.84% hydrogen and its vapour density is 73. Molecular formula of the compound is [RPET 2004]
1) $C_3H_5O_2$ 2) $C_4H_{10}O_2$
3) $C_6H_{10}O_4$ 4) $C_3H_{10}O_2$

31. The empirical formula of a compound isCH_2. One mole of this compound has a mass of 56 g. its molecular formula is [MP PET 2006]
1) C_3H_6 2) C_4H_8
3) CH_2 4) C_2H_2

32. An organic compound containing C and H has 92.3% of carbon, its empirical formula is [EAMCET 2004]
1) CH 2) CH_3
3) CH_2 4) CH_4

33. An aqueous solution containing 6.5 g of NaCl of 90% purity was subjected to electrolysis. After the complete electrolysis, the solution was evaporated to get solid NaOH. The volume of 1 M acetic acid required to neutralise NaOH obtained above is [Manipal 2009]
1) 1000 cm^3 2) 2000 cm^3
3) 100 cm^3 4) 200 cm^3

34. Excess of carbon dioxide is passed through 50 mL of 0.5 M calcium hydroxide solution. After the completion of the reaction, the solution was evaporate was evaporated to dryness. The solid calcium carbonate was completely neutralised with 0.1 N hydrochloric acid. The volume of hydrochloric acid required is (Atomic mass of calcium=40) [Manipal 2009]
1) 300 cm^3 2) 200 cm^3
3) 500 cm^3 4) 400 cm^3

35. Stoichiometric ratio of sodium dihydrogen orthophosphate and sodium hydrogen orthophosphate required for synthesis of $Na_5P_3O_{11}$ is [Guj CET 2011]
1) 1.5 : 3 2) 3 : 1.5
3) 1 : 1 4) 2 : 3

36. The ratio of amounts of H_2S needed to precipitate all the metal ions from 100 mL

of 1 M $AgNO_3$ and 100mL of $CuSO_4$, will be [Manipal 2008]

1) 1 : 1 2) 1 : 2
3) 2 : 1 4) None of these

37. 2 g of mixture of CO and CO_2 on reaction with excess I_2O_5 produced 2.54 g of I_2. What would be the mass % of CO_2 in the original mixture? [WB JEE 2007]

1) 60 2) 30
3) 70 4) 35

38. The stoichiometry of the following reaction is
$K_2S_2O_8(aq) + 2KI(aq) \rightarrow 2K_2SO_4(aq) + I_2(aq)$ [J&K CET 2008]

1) 2 : 2 2) 1 : 1
3) 1 : 2 4) 2 : 1

39. Air contains 20%O_2 by volume. How much volume of air will be required for 100 cc of acetylene? [DCE 2007]

1) 500 cc 2) 1064 cc
3) 212.8 cc 4) 1250 cc

40. For the reaction, $Fe_2O_3 + 3CO \rightarrow 2\,Fe + 3CO_2$ the volume of carbon monoxide required to reduce one mole of ferric oxide is [KCET 2008]

1) 22.4 dm^3 2) 44.8 dm^3
3) 67.2 dm^3 4) 11.2 dm^3

41. Consider a titration of potassium dichromate solution with acidified Mohr's salt solution using diphenylamine as indicator. The number of moles of Mohr's salt required per mole of dichromate is [IIT JEE 2007]

1) 3 2) 4
3) 5 4) 6

42. Mixture $X = 0.02$ mole of $[Co(NH_3)_5SO_4]Br$ and 0.02 mole of $[Co(NH_3)_5Br]SO_4$ was prepared in 2 L of solution.
1 L of mixture X + excess $AgNO_3 \rightarrow Y$
1 L of mixture X + excess $BaCl_2 \rightarrow Z$
Number of moles of Y and Z are [IIT JEE 2003]

1) 0.01, 0.01 2) 0.02, 0.01
3) 0.01, 0.02 4) 0.02, 0.02

43. When 10 g of methane is completely burnt in oxygen, the heat evolved is 560 kJ. What is the heat of combustion (in kJ mol^{-1}) of methane? [EAMCET 2003]

1) −1120 2) −968
3) −896 4) −560

44. The decomposition of a certain mass of $CaCO_3$ gave 11.2 dm^3 of CO_2 gas at STP. The mass of KOH required to completely neutralise the gas is [JamiaMilliaIslamia 2008]

1) 56 g 2) 28 g
3) 42 g 4) 20 g

45. Sodium bicarbonate on heating decomposes to form sodium carbonate, CO_2 and water. If 0.2 moles of sodium bicarbonate is completely decomposed, how many moles of sodium carbonate is formed? [J&K CET 2006]

1) 0.1 2) 0.2
3) 0.05 4) 0.025

46. The mass of $BaCO_3$ produced when excess CO_2 is bubbled through a solution of 0.205 mole $Ba(OH)_2$ is, [UP SEE 2004]

1) 81 g 2) 40.5 g
3) 20.25 g 4) 162 g

47. 100 g of $CaCO_3$ is treated with 1 L of 1 N HCI. What would be the weight of CO_2 liberated after the completion of the reaction?
[Kerala CEE 2005]

1) 55 g 2) 11 g
3) 22 g 4) 33 g
5) 44 g

48. On combustion of 4 g of the methane, 10.46 kJ of heat is liberated. Heat of combustion of methane is [MP PET 2003]

1) 83.68 kJ 2) 10.46 kJ
3) 41.84 kJ 4) 20.93 kJ

49. What is the weight of oxygen that is required for the complete combustion of 2.8 kg of ethylene? [BCECE 2006]

1) 9.6 kg 2) 96.0 kg
3) 6.4 kg 4) 2.8 kg

50. When 10 g of 90% pure lime stone is heated completely, the volume (in litres) of CO_2 is liberated at STP is [RPET 2007]

1) 22.4 2) 2.24

51. $KMnO_4$ reacts with oxalic acid according to the equation
$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$ Here, 20 mL of 0.1 M $KMnO_4$ is equivalent to [J&K CET 2003]

1) 20 mL of 0.5 M H_2C 2) 50 mL of 0.1 M H_2C
3) 50 mL of 0.1 M H_2C 4) 20 mL of 0.1 M H_2C

52. The enthalpy of combustion of methane at 25^0C is 890kJ. The heat liberated when 3.2 g of methane is burnt in air is [AMU 2006]

1) 445 kJ 2) 278 kJ
3) -890 kJ 4) 178 kJ

53. What amount of bromine will be required

to convert 2 g of phenol into 2, 4, 6-tribromo phenol? [UP SEE 2007]

1) 20.44 g 2) 6.00 g
3) 4.00 g 4) 10.22 g

54. Amount of oxalic acid present in a solution can be determined by its titration with $KMnO_4$ solution in the presence of H_2SO_4. The titration given unsatisfactory result when carried out in the presence of HCl because HCl [AIEEE 2008]

1) Gets oxidised by oxalic acid to chlorine
2) Furnishes H^+ ions in addition to those from oxalic acid
3) reduces permanganate to Mn^{2+}
4) Oxidises oxalic acid to carbon dioxide and water

55. In the reaction,
$2Al(s) + 6HCl(aq) \rightarrow 2Al^{3+}(aq) + 6Cl^-(aq) + 3H_2(g)$ [AIEEE 2007]

1) 6 L HCl (aq) is consumed for every 3 L $H_2(g)$ produced
2) 33.6 L $H_2(g)$ is produced regardless of temperature and pressure for every mole Al that reacts
3) 67.2 L $H_2(g)$ at STP is produced for every mole Al that reacts
4) 11.2 L $H_2(g)$ at STP is produced for every mole $HCl(aq)$ consumed

56. 2.76 g of silver carbonate on being strongly heated yield a residue weighing [JamiaMilliaIslamia 2004]

1) 2.16 g 2) 2.48 g
3) 2.64 g 4) 2.32 g

57. Equal weights of Zn metal and iodine are mixed together and I_2 is completely converted to ZnI_2. What fraction by weight of original Zn remains unreacted? (Zn = 65, I = 127)

1) 0.34 2) 0.74
3) 0.84 4) Unable to predict

58. If 0.5 mole of $BaCl_2$ is mixed with 0.2 mole of Na_3PO_4, the maximum number of moles f $Ba_3(PO_4)_2$ that can be formed is

1) 0.7 2) 0.5
3) 0.03 4) 0.10

59. On analysis a certain compound was found to contain iodine and oxygen in the ratio of 254 g of iodine (at. mass 127) and 80 g oxygen (at. mass 16). What is the formula of the compound?

1) IO 2) I_2O
3) I_2O_3 4) I_2O_5

60. Cyclohexanol is dehydrated to cyclohexene on heating with concH_2SO_4. The cyclohexene obtained from 100 g cyclohexanol will be
(If yield of reaction is 75%)

1) 61.5 g 2) 75.0 g
3) 20.0 g 4) 41.0 g

61. In the following reaction, which choice has value twice that of the equivalent mass of the oxidizing agent?
$SO_2 + H_2O \longrightarrow 3S + 2H_2O$

1) 64 2) 32
3) 16 4) 48

62. An organic compound contains 20.0% C, 6.66% H, 47.33% N and the rest was oxygen. Its molar mass is 60 g mol^{-1} the molecular formula of the compound is

1) CH_4N_2O 2) $C_2H_4NO_2$
3) CH_3N_2O 4) $CH_4N_2O_2$

63. Two elements X (at. Wt. 75) and Y (at. wt. 16) combine to give a compound having 75.8% of X. The formula of compound will be

1) XY 2) X_2Y
3) XY_3 4) X_2Y_3

64. Insulin contains 3.4% sulphur. What will be the minimum molecular weight of insulin?

1) 94.117 2) 1884
3) 941.176 4) 976

65. NO reacts with O_2 to form No_2. When 10 g of NO_2 is formed during the reaction, the mass of O_2 consumed is

1) 1.90 g 2) 5.0 g
3) 3.48 g 4) 13.9 g

66. Arsenic forms two oxides, one of which contains 65.2% and the other 75.5% of the element. Hence, equivalent masses of arsenic are in the ratio

1) 1 : 2 2) 3 : 5
3) 13 : 15 4) 2 : 1

67. A metal oxide is reduced by heating it in a stream of hydrogen. It is found that after complete reduction, 3.15 g of oxide yielded 1.05 g of metal. From the above data we can say that

1) The atomic weight of metal is 8
2) The atomic weight of metal is 4
3) The equivalent weight of metal is 4
4) The equivalent weight of metal is 8

68. The reaction of calcium with water is represented by the equation,

$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$
What volume of H_2, at STP would be liberated when 8 g of calcium completely reacts with water?
1) $4480\ cm^3$ 2) $2240\ cm^3$
3) $1120\ cm^3$ 4) $0.4\ cm^3$

69. 100 mL of 0.1 N hypo decolourised iodine by the addition of x gram of crystalline copper sulphate to excess of KI. The value of $'x'$ is
(molecular wt. of $CuSO_4, 5H_2O$ is 250)
1) 5.0 g 2) 1.25 g
3) 2.5 g 4) 4 g

70. Two oxides of a metal contain 50% and 40% metal (M) respectively. If the formula of fist oxide is MO_2, the formula of second oxide will be
1) MO_2 2) MO_3
3) M_2O 4) M_2O_3

ANSWER KEY

1)	4	2)	3	3)	1
4)	1	5)	1	6)	4
7)	4	8)	2	9)	1
10)	1	11)	4	12)	1
13)	1	14)	3	15)	1
16)	1	17)	5	18)	3
19)	3	20)	3	21)	3
22)	2	23)	4	24)	1
25)	4	26)	2	27)	3
28)	3	29)	4	30)	3
31)	2	32)	1	33)	3
34)	3	35)	2	36)	2
37)	2	38)	3	39)	4
40)	3	41)	4	42)	1
43)	3	44)	2	45)	1
46)	2	47)	3	48)	3
49)	1	50)	4	51)	2
52)	4	53)	4	54)	3
55)	4	56)	1	57)	2
58)	4	59)	4	60)	1
61)	2	62)	1	63)	4
64)	3	65)	3	66)	2
67)	3	68)	1	69)	3
70)	2				

(Previous Year Questions)
AIPMT/NEET & AIIMS (2006-2016)

AIPMT 2008

1. What volume of oxygen gas (O_2) measured at 0°C and 1 atm, is needed to burn completely 1L, of propane gas (C_3H_8) measured under the same conditions: -
(1) 5 L (2) 10 L
(3) 7 L (4) 6L

2. Volume occupied by one molecule of water (density =1 gcm^{-3}) is :-
(1) $3.0 \times 10^{-23}\ cm^3$ (2) $5.5 \times 10^{-23}\ cm^3$
(3 $9.0 \times 10^{-23}\ cm^3$ (4) $6.023 \times 10^{-23}\ cm^3$

3. How many moles of lead (II) chloride will be formed from a reaction between 6.5 g of PbO and 3.2 g of HCl ? (Atomic wt. of Pb=207)
(1) 0.011 (2) 0.029
(3) 0.044 (4) 0.333

4. An organic compound contains carbon, hydrogen and oxygen. Its elemental analysis gives C, 38.71% and H, 9.67%. The empirical formula of the compound would be :-
(1) CHO (2) CH_4O
(3) CH_3O (4) CH_2O

AIPMT 2009

5. 10g of hydrogen and 64 g of oxygen were filled in a steel vessel and exploded. Amount of water produced in this reaction will be :-
(1) I mol (2) 2 mol
(3) 3 mol (4) 4 mol

AIPMT 2010

6. The number of atoms in 0.1 mol of a triatomic gas is :- ($N_A = 6.02 \times 10^{23}\ mol^{-1}$)
(1) 1.800×10^{22} (2) 6.026×10^{22}
(3) 1.806 xlO^{23} (4) 3.600×10^{23}

AIPMT Mains 2011

7. Which has the maximum number of molecules among the following ?
(1) 64 g SO_2 (2) 44 g CO_2
(3) 48 g O_3 (4) 8 g H_2

NEET UG 2013

8. An excess of $AgNO_3$ is added to 100 mL of a 0.01 M solution of dichlorotetraaquachromium(III) chloride. The number of moles of AgCl precipitated would be :-

(1) 0.01 (2) 0.001 (3) 0.002 (4) 0.003

AIPMT 2014

9. Equal masses of H_2, O_2 and methane have been taken in a container of volume V at temeprature 27°C in identical conditions. The ratio of the volumes of gases H_2: O_2 : methane would be :

(1) 8 : 16 : 1 (2) 16 : 8 : 1

(3) 16 : 1 : 2 (4) 8 : 1 : 2

10. When 22.4 litres of H_2(g) is mixed with 11.2 litres of Cl_2(g), each at S.T.P., the moles of HCl (g) formed is equal to :-

(1) 1 mol of HCl (g) (2) 2 mol of HCl (g)

(3) 0.5 mol of HCl (g) (4) 1.5 mol of HCl (g)

11. 1.0 g of magnesium is burnt with 0.56 g O_2 in a closed vessel. Which reactant is left in excess and how much ?

(At. wt. Mg = 24 ; O = 16)

(1) Mg, 0.16 g (2) O_2, 0.16 g

(3) Mg, 0.44 g (4) O_2, 0.28 g

AIPMT 2015

12. A mixture of gases contains H_2 and O_2 gases in the ratio of 1 : 4 (w/w). What is the molar ratio of the two gases in the mixture ?

(1) 4 : 1 (2) 16 : 1 (3) 2 : 1 (4) I : 4

Re-AIPMT 2015

13. The number of water molecules is maximum in :-

(1) 18 gram of water (2) 18 moles of water

(3) 18 molecules of water

(4) 1.8 gram of water

14. If avogadro number N_A, is changed from 6.022×10^{23} mol^{-1} to 6.022×10^{20} mol^{-1}, this would change :

(1) the ratio of chemical species to each other in a balanced equation

(2) the ratio of elements to each other in a compound

(3) the definition of mass in units of grams

(4) the mass of one mole of carbon

15. 20.0 g of a magnesium carbonate sample decomposes on heating to give carbon dioxide and 8.Og magnesium oxide. What will be the percentage purity of magnesium carbonate in the sample ? (At. Wt. : Mg = 24)

(1) 60 (2) 84 (3) 75 (4) 96

16. What is the mass of the precipitate formed when 50 mL of 16.9% solution of $AgNO_3$ is mixed with 50 mL of 5.8% NaCl solution ? (Ag = 107.8, N = 14, O = 16, Na = 23, Cl = 35.5)

(1) 7 g (2) 14 g (3) 28 g (4) 3.5 g

NEET-I 2016

17. Equal moles of hydrogen and oxygen gases are placed in a container with a pin-hole through which both can escape. What fraction of the oxygen escapes in the time required for one-half of the hydrogen to escape ?

(1) 1/8 (2) 1/4 (3) 3/8 (4) 1/2

NEET-II 2016

18. Suppose the elements X and Y combine to form two compounds XY_2 and X_3Y_2. When 0.1 mole of XY_2 weighs 10g and 0.05 mole of X_3Y_2 weighs 9 g, the atomic weights of X and Y are

(1) 20, 30 (2) 30, 20

(3) 40, 30 (4) 60, 40

AIIMS 2016

19. An organic compound, on analysis, was found to contain 71.7% of chlorine, 4.04% of hydrogen and rest is carbon. If its molecular weight is 99. Then calculate molecular formula :-

(1) $CHCl_3$ (2) $C_2H_4Cl_2$

(3) $C_2H_2Cl_2$ (4) CH_3Cl

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	**1**	**1**	**2**	**3**	**4**	**3**	**4**	**2**	**3**	**1**	**1**	**1**	**2**	**4**	**2**
Que.	16	17	18	19											
Ans.	**1**	**1**	**3**	**2**											

(PREVIOUS YEARS)

AIEEE &JEE-MAINS PROBLEMS

1. Number of atoms in 560g of Fe (atomic mass 56g mol^{-1}) is : **[AIEEE 2002]**
(1) Twice that of 70g N (2) Half that of 20g H(3) Both (1) and (2) (4) None of these

2. In an organic compound of molar mass 108 g mol^{-1} C,H and N atoms are present in 9 : 1 : 3.5 by weight. Molecular formula can be :
[AIEEE 2002]
(1) $C_6H_8N_2$ (2) $C_7H_{10}N$
(3) $C_5H_6N_3$ (4) $C_4H_{18}N_3$

3. When $KMnO_4$ acts as an oxidising agent and ultimately forms MnO_4^{2-}, MnO_2, Mn_2O_3 and Mn^{2+}, then the number of electrons transferred in each case i **[AIEEE 2002]**
(1) 4, 3, 1, 5 (2) 1, 5, 3, 7
(3) 1, 3, 4, 5 (4) 3, 5, 7, 1

4. Which of the following is a redox reaction? **[AIEEE 2002]**
(1) $NaCl + KNO_3$ $NaNO_3 + KCl$
(2) $CaC_2O_4 + 2\ HCl$ $CaCl_2 + H_2C_2O_4$
(3) $Mg(OH)_2 + 2NH_4Cl$ $MgCl_2 + 2NH_4OH$
(4) $Zn + 2\ AgCN$ $2\ Ag + Zn(CN)_2$

5. Which of the following concentration factor is affected by change in temperature ?
[AIEEE 2002]
(1) Molarity (2) Molality
(3) Mole fraction (4) Weight fraction

6. What volume of hydrogen gas at 273 K and 1 atm pressure will be consumed in obtaining 21.6 gm of elemental boron (atomic mass = 10.8) from the reduction of boron trichloride by hydrogen-
[AIEEE 2003]
(1) 44.8 lit. (2) 22.4 lit.
(3) 89.6 lit. (4) 67.2 lit.

7. 6.02×10^{20} molecules of urea are present in 100 ml of its solution. The concentration of urea solution is - **[AIEEE 2004]**
(1) 0.001 M (2) 0.01 M
(3) 0.02 M (4) 0.1 M

8. If we consider that 1/6, in place of 1/12, mass of carbon atom is taken to be the relative atomic mass unit, the mass of one mole of a substance will
[AIEEE 2005]
(1) decrease twice (2) increase two fold
(3) remain unchanged
(4) be a function of the molecular mass of the substance

9. The oxidation state of Cr in $[Cr(NH_3)_4Cl_2]^+$ is :
[AIEEE 2005]
(1) + 3 (2) + 2
(3) + 1 (4) 0

10. The oxidation state of chromium in the final product formed by the reaction between KI and acidified potassium dichromate solution is :
[AIEEE 2005]
(1) + 4 (2) + 6
(3) + 2 (4) + 3

11. Two solution of a substance (non electrolyte) are mixed in the following manner. 480 ml of 1.5M first solution + 250 ml of 1.2M second solution. What is the molarity of the final mixture ?
[AIEEE 2005]
(1) 2.70M (2) 1.344M
(3) 1.50M (4) 1.20M

12. Which of the following chemical reactions depicts the oxidizing behaviour of H_2SO_4?
[AIEEE 2006]
(1) $2HI + H_2SO_4 \rightarrow I_2 + SO_2 + 2H_2O$
(2) $Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$
(3) $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$
(4) $2PCl_5 + H_2SO_4 \rightarrow 2POCl_3 + 2HCl + SO_2Cl_2$

13. How many moles of magnesium phosphate, $Mg_3(PO_4)_2$ will contain 0.25 mole of oxygen atoms ? **[AIEEE-2006]**
(1) 0.02 (2) 3.125×10^{-2}
(3) 1.25×10^{-2} (4) 2.5×10^{-2}

14. Density of a 2.05M solution of acetic acid in water is 1.02 g/ml. The molality of the solution is :
[AIEEE-2006]
(1) 1.14 mol kg^{-1} (2) 3.28 mol kg^{-1}
(3) 2.28 mol kg^{-1} (4) 0.44 mol kg^{-1}

15. In the reaction **[AIEEE-2007, 3/120]**
$2Al_{(s)} + 6HCl_{(aq)}$ $2Al^{3+}_{(aq)} + 6Cl^-_{(aq)} + 3H_2(g)$
(1) 6L $HCl_{(aq)}$ is consumed for every 3L H_2 produced
(2) 33.6 L $H_{2(g)}$ is produced regardless temperature and pressure for every moles that reacts.
(3) 67.2 L $H_{2(g)}$ at STP is produced for every mole of Al that reacts .

(4) 11.2 L $H_{2(g)}$ at STP is produced for every mole of $HCl_{(aq)}$ consumed.

16. The density (in g mL^{-1}) of a 3.60 M sulphuric acid solution that is 29% (H_2SO_4 molar mass = 98 g mol^{-1}) by mass will be : **[AIEEE-2007, 3/120]**

(1) 1.22 (2) 1.45
(3) 1.64 (4) 1.88

17. A 5.2 molal aqueous solution of methyl alcohol, CH_3OH, is supplied. What is the mole fraction of methyl alcohol in the solution? **[AIEEE-2011, 3/120]**

(1) 0.100 (2) 0.190
(3) 0.086 (4) 0.050

18. The molality of a urea solution in which 0.0100 g of urea, $[(NH_2)_2CO]$ is added to 0.3000 dm^3 of water at STP is: **[Re. Paper AIEEE-2011, 3/120]**

(1) 5.55×10^{-4} (2) 33.3 m
(3) 3.33×10^{-2} m (4) 0.555 m

19. The density of a solution prepared by dissolving 120 g of urea (mol. mass = 60 u) in 1000 g of water is 1.15 g/mL. The molarity of this solution is : **[AIEEE-2012, 4/120]**

(1) 0.50 M (2) 1.78 M
(3) 1.02 M (4) 2.05 M

20. For the following reaction, the mass of water produced from 445 g of $C_{57}H_{110}O_6$ is :
$2C_{57}H_{110}O_6(s) + 163O_2(g) \rightarrow 114CO_2(g) + 110\ H_2O(l)$

(1) 495 g (2) 490 g
(3) 890 g (4) 445 g

21. 20 mL of 0.1 M H_2SO_4 solution is added to 30 mL of 0.2 M NH_4OH solution. The pH of the resulatant mixture is : [pk_b of NH_4OH = 4.7].
(1) 9.4 (2) 5.0 (3) 9.0 (4) 5.2

22. The amount of sugar ($C_{12}H_{22}O_{11}$) required to prepare 2 L of its 0.1 M aqueous solution is :
(1) 68.4 g (2) 17.1 g (3) 34.2 g (4) 136.8 g

23. 25 ml of the given HCl solution requires 30 mL of 0.1 M sodium carbonate solution. What is the volume of this HCl solution required to titrate 30 mL of 0.2 M aqueous NaOH solution?

(1) 25 mL (2) 50 mL
(3) 12.5 mL (4) 75 mL

24. 8g of NaOH is dissolved in 18g of H_2O. Mole fraction of NaOH in solution and molality (in mol kg^{-1}) of the solutions respectively are :

(1) 0.167, 11.11 (2) 0.2, 22.20
(3) 0.2, 11.11 (4) 0.167,22.20

25. A mixture of 2.3 g formic acid and 4.5 g oxalic acid is treated with conc. H_2SO_4. The evolved gaseous mixture is passed through KOH pellets. Weight (in g) of the remaining product at STP will be

(1) 1.4 (2) 3.0 (3) 2.8 (4) 4.4

ANSWER KEY

1.(3)	**2.**(1)	**3.**(3)	**4.**(4)	**5.**(1)
6.(4)	**7.**(2)	**8.**(3)	**9.**(1)	**10.**(4)
11.(2)	**12.**(1)	**13.**(2)	**14.**(3)	**15.**(4)
16.(1)	**17.**(3)	**18.**(1)	**19.**(4)	**20.**(1)
21.(3)	**22.**(1)	**23.**(1)	**24.**(1)	**25.**(3)

NCERT EXAMPLER PROBLEMS

Multiple Choice Questions

1. What will be the molarity of a solution, which contains 5.85 g of NaCl(s) per 500 mL?

(i) 4 mol L^{-1} (ii) 20 mol L^{-1}
(iii) 0.2 mol L^{-1} (iv) 2 mol L^{-1}

2. If 500 mL of a 5M solution is diluted to 1500 mL, what will be the molarity of the solution obtained?

(i) 1.5 M (ii) 1.66 M
(iii) 0.017 M (iv) 1.59 M

3. The number of atoms present in one mole of an element is equal to Avogadro number. Which of the following element contains the greatest number of atoms?

(i) 4g He (ii) 46g Na
(iii) 0.40g Ca (iv) 12g He

4. If the concentration of glucose ($C_6H_{12}O_6$) in blood is 0.9 g L^{-1}, what will be the molarity of glucose in blood?

(i) 5 M (ii) 50 M
(iii) 0.005 M (iv) 0.5 M

5. What will be the molality of the solution containing 18.25 g of HCl gas in 500 g of water?

(i) 0.1 m (ii) 1 M
(iii) 0.5 m (iv) 1 m

6. One mole of any substance contains 6.022×10^{23} atoms/molecules. Number of molecules of H_2SO_4 present in 100 mL of 0.02M H_2SO_4 solution is ______.
(i) 12.044×10^{20} molecules
(ii) 6.022×10^{23} molecules
(iii) 1×10^{23} molecules
(iv) 12.044×10^{23} molecules

7. What is the mass percent of carbon in carbon dioxide?
(i) 0.034% (ii) 27.27%
(iii) 3.4% (iv) 28.7%

8. The empirical formula and molecular mass of a compound are CH_2O and 180 g respectively. What will be the molecular formula of the compound?
(i) $C_9H_{18}O_9$ (ii) CH_2O
(iii) $C_6H_{12}O_6$ (iv) $C_2H_4O_2$

9. If the density of a solution is 3.12 g mL^{-1}, the mass of 1.5 mL solution in significant figures is _______.
(i) 4.7g (ii) 4680×10^{-3}g
(iii) 4.680g (iv) 46.80g

10. Which of the following statements about a compound is incorrect?
(i) A molecule of a compound has atoms of different elements.
(ii) A compound cannot be separated into its constituent elements by physical methods of separation.
(iii) A compound retains the physical properties of its constituent elements.
(iv) The ratio of atoms of different elements in a compound is fixed.

11. Which of the following statements is correct about the reaction given below:
$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(g)$
(i) Total mass of iron and oxygen in reactants = total mass of iron and oxygen in product therefore it follows law of conservation of mass.
(ii) Total mass of reactants = total mass of product; therefore, law of multiple proportions is followed.
(iii) Amount of Fe_2O_3 can be increased by taking any one of the reactants (iron or oxygen) in excess.
(iv) Amount of Fe_2O_3 produced will decrease if the amount of any one of the reactants (iron or oxygen) is taken in excess.

12. Which of the following statements indicates that law of multiple proportion is being followed.
(i) Sample of carbon dioxide taken from any source will always have carbon and oxygen in the ratio 1:2.
(ii) Carbon forms two oxides namely CO_2 and CO, where masses of oxygen which combine with fixed mass of carbon are in the simple ratio 2:1.
(iii) When magnesium burns in oxygen, the amount of magnesium taken for the reaction is equal to the amount of magnesium in magnesium oxide formed.
(iv) At constant temperature and pressure 200 mL of hydrogen will combine with 100 mL oxygen to produce 200 mL of water vapour.

Assertion and Reason Type

Choose the correct option out of the choices given below each question.
(i) Both A and R are true and R is the correct explanation of A.
(ii) A is true but R is false.
(iii) A is false but R is true.
(iv) Both A and R are false.

1. ***Assertion (A) :*** The empirical mass of ethene is half of its molecular mass.
Reason (R) : The empirical formula represents the simplest whole number ratio of various atoms present in a compound.

2. ***Assertion (A) :*** One atomic mass unit is defined as one twelfth of the mass of one carbon-12 atom.
Reason (R) : Carbon-12 isotope is the most abundunt isotope of carbon and has been chosen as standard.

3. ***Assertion (A) :*** Significant figures for 0.200 is 3 where as for 200 it is 1.
Reason (R) : Zero at the end or right of a number are significant provided they are not on the right side of the decimal point.

4. ***Assertion (A) :*** Combustion of 16 g of methane gives 18 g of water.
Reason (R) : In the combustion of methane, water is one of the products.

ANSWERS

Multiple Choice Questions
1. (iii) 2. (ii) 3. (iv) 4. (iii)
5. (iv) 6. (i) 7. (ii) 8. (iii) 9. (i) 10. (iii)
11. (i) 12. (ii)

Assertion and Reason Type
1. (i) 2. (ii) 3. (iii) 4. (iii)

Chapter 2

Atomic Structure

Some Important Subatomic Particles

SN.	Particles	Nature	Charge	Mass
1.	**Electron ($_{-1}e^{0}$)** Discovered by J.J. THOMSON	**Negatively charged particle**	**-1.602×10^{-19}C or $- 4.8 \times 10^{-10}$ esu.**	**0.00059 amu or 9.1×10^{-31} kg**
2.	**Proton ($_1H^1$)** Discovered by GOLDSTEIN	**Hydrogen nucleus**	**$+ 1.602 \times 1^{-19}$C or $+ 4.8 \times 10^{-10}$ esu.**	**1.00758 amu. or 1.673×10^{-27} kg**
3.	**Neutron ($_0n^1$)** Discovered by CHADWICK	**Neutral particle**	**zero charge.**	**1.00893 amu or 1.675×10^{-27} kg**

Atomic terms

(e) Isotopes

Atoms of the element with same atomic number but different mass number e.g. $_1H^1$, $_1H^2$, $_1H^3$. There are three isotopes of hydrogen.

(f) Isobars

Atoms having the same mass number but different atomic numbers, e.g. $_{15}P^{32}$ and $_{16}S^{32}$ are called isobars.

(g) Isotones

Atoms having the same number of neutrons but different number of protons or mass number, e.g. $_6C^{14}$, $_8O^{16}$, $_7N^{15}$ are called isotones.

(h) Isoelectronic

Atoms, molecules or ions having same number of electrons are isoelectronic e.g. N_2,CO, CN^-.

(i) Nuclear isomers

Nuclear isomers (isomeric nuclei) are the atoms with the same atomic number and same mass number but with different radioactive properties.

Example of nuclear isomers is

Uranium –X (half life 1.4 min) and

Uranium –Z (half life 6.7 hours)

The reason for nuclear isomerism is the different energy states of the two isomeric nuclei.

Other examples are

$_{30}Zn^{69}$ $_{30}Zn^{69}$

($T_{1/2}$ = 13.8 hr) ($T_{1/2}$ = 57 min)

$_{35}Br^{80}$ $_{35}Br^{80}$

($T_{1/2}$ = 4.4 hour) ($T_{1/2}$ = 18 min)

(j) Isosters

Molecules having same number of atoms and also same number of electrons are called isosters.

E.g., (i) N_2 and CO (ii) CO_2 and N_2O (iii) HCl and F_2

Clark Maxwell's Theory of Radiations

Clark Maxwell (1856) gave this theory. Main points of this theory are

(i) Light is traveling in the form of waves of very small wave length.

(ii) Energy gets emitted or absorbed by a body constantly

(iii) Radiation of only one wave length could be possibly given out by a black body irrespective of its temperature.

(iv) Energy of radiation has been proportional to intensity of radiation.

This theory is able to explain clearly: Optical phenomena such as interference, refraction, diffraction, polarisation etc.

Limitations of wave theory: **This theory is not able to explain black body radiations (radiations which are emitted by hot bodies), and photo-electric effect (ejection of electrons when light is incident metal surfaces).**

Planck's Theory of Radiations

Classical wave theory of radiations is not able to explain black body radiations photo-electric effect, etc. In order to explain these facts. Planck (1901) gave a theory called Planck's quantum theory of radiation

The various postulates of quantum theory of radiations are as follows:

(i) A radiation has energy. As light and heat are radiations, they are also associated with energy.

(ii) Radiant energy is not emitted or absorbed continuously but discontinuously in the form of small packets called photons. Photon is not a material body but is considered to be a massless packet of energy.

(iii) The energy E of a photon is related to the frequency of radiation, ν ; the two being related as $E = h\nu$ Where h is planck's constant.

(iv) Whenever a body emits or absorbs energy, it does so in whole number multiples of photons, i.e., $nh\nu$ where n = 1, 2, 3 and never 1.2, 2.5, 3.7 etc.

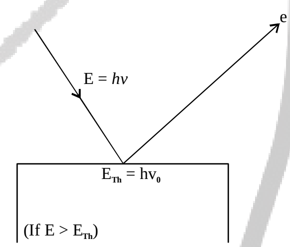
Application of theory: **This theory has explained many phenomena and helped in the researches of atomic structure.**

Photoelectric Effect

It was observed by J.J. Thomson and P. Lenard that when a beam of light of suitable wavelength or frequency is allowed to fall on the surface of a metal, the electrons are emitted (or ejected) from the surface of the metal. This phenomenon of emission of electrons is known as "photoelectric effect". The electrons emitted are known as photoelectrons.

Let us consider a metallic surface struck by a photon beam having energy hν (ν = the frequency of striking photon).

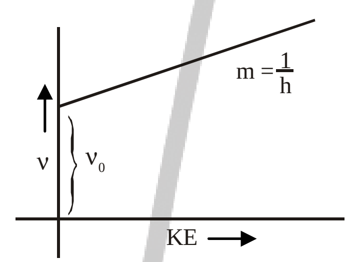
A certain amount of this supplied energy is consumed by the bonded electron to get free from the metal-surface. The amount of energy thus required is known as work function (ϕ).



The remaining the supplied energy is converted into the kinetic energy of the free electrons. So,

$$\underset{\text{Supplied photon energy}}{h\nu} = \underset{\text{Work Function}}{W} + \underset{\text{Kinetic energy of ejected } e^-}{KE} \quad .....(1)$$

When the energy of the striking photon is equal to the work function then, frequency of the striking photon is known as THRESHOLD FREQUENCY (ν_0).



So,

$$h\nu_0 = W \quad ...(2)$$

By equation (1) and (2)

$$h\nu = h\nu_0 + KE$$

or $$\nu = \nu_0 + KE \times \frac{1}{h}$$

A straight line is observed when ν is plotted against KE and the slope is equal to $\frac{1}{h}$.

Note :

- **Energy of the photoelectrons emitted depends on the energy of striking photons.**
- **The number of electrons emitted from the metal surface depends on the intensity of the striking photons.**

Rutherfords Scattering Experiment

In 1911 Ernst Rutherford carried out a series at experiments using α-particles. A beam of α-particles was directed against a thin foil of about 0.0004 cm thickness of gold, platinum, silver or copper. The following observations were made

(i) Most of the α-particles (more than 99%) went straight without suffering any deflection.

(ii) A few of them got deflected through small angles.

(iii) a very few (approximately 0.005%) did not pass through the foil at all but suffered large deflections (more than 90°) or even come back in more or less the direction from which they have come. Following conclusion were drawn from the above observations.

(a) Since most of the α-particles went straight through the metal foil undeflected, it means that there must be very large empty space with in the atom.

(b) A few of the α-particles were deflected from their original paths through moderate angles; it was conclude that whole of the positive charge is concentrated and the space occupied by this positive charge is very small in the atom. When α-particles come closer to this point, they suffer a force of repulsion and deviate from their paths.

The positively charged heavy mass which occupies only a small volume in an atom is called nucleus. It is supposed to be present at the centre of the atom.

(c) A very few of the α-particles suffered strong deflections or even returned on their path indicating that the nucleus is rigid and α-particles recoil due to direct collision with the heavy positively charged mass.

Rutherford concluded that the number of particles N scattered at an angle θ is such that

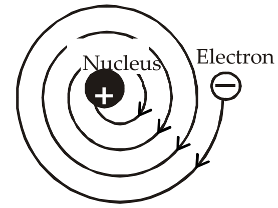
$$N \propto \frac{1}{\sin^4\left(\frac{\theta}{2}\right)}$$

Drawback of The Rutherford's Model

Following serious objections against the Rutherford's model were reported.

(i) It could not explain how the electrons and protons could be close-packed to give a stable nucleus.

(ii) When an electron revolves around the nucleus, it will radiate out energy, resulting in the loss of energy. This loss of energy will make the electron to move slowly and consequently it will be moving in a spiral path and ultimately fall inside the nucleus. Thus, the atom remains unstable. Fortunately, the atom is stable.



(iii) If an electron loses energy continuously, the observed spectrum would be continuous and have broad bands merging into one another. But most of the atoms give line spectra. Thus Rutherford's model could not explain the origin of spectral line.

(iv) Electron is too large to be in the small space of the nucleus. How were the objections remedied? The drawbacks of Rutherford's model could be overcome in the following way

Bohr's Model

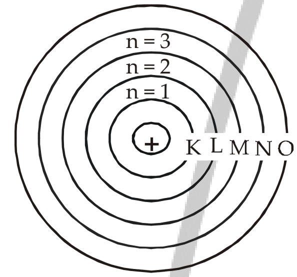
Niel Bohr applied the concept of Max Planck to the problem of revolving electron around hydrogen nucleus and gave the following main points of what is now known as Bohr's theory of atomic structure. The various postulates of Bohr's theory are as follow.

(i) That within the atom an electron can move in certain specific orbits without radiating out any energy. Such orbits are termed as stationary orbits. These orbits are numbered as 1, 2, 3, 4 etc., or K, L, M, N, etc., starting from the nucleus.

(ii) The mathematical condition for stationary orbits is that the angular momentum for the moving electron is an integral multiple of $h/2\pi$, where h is the Planck's constant.

or $$mvr = n\frac{h}{2\pi}$$

where mvr denotes the angular momentum and n is called principal quantum number and is equal to 1, 2, 3…



Oribit-like representation of various energy levels

(iii) Even though an electron in privileged orbit is constantly accelerated, it does not radiate energy. Thus, the total energy of an electron in stationary state remains constant.

(iv) When an electron gets energy, it will go to higher energy orbits, Similarly in the reverse process, the excited electron jumps down to lower energy level by emitting absorbed energy in the form of radiations of suitable wavelength.

The frequency of this radiations (ν) is given by the difference in energy between the initial and final orbits.

$$E_2 - E_1 = h\nu \qquad \ldots(1)$$

Expression For Radius (r_n)

For a system composed of two oppositely charged ions (+Ze and $-e^-$), the electrostatic force of attraction is,

$$F = \frac{1}{4\pi\epsilon_0} \cdot \frac{(Ze)(e)}{r^2}$$

Because electron having mass m is revaluing around nucleus, centrifugal force is given by

$$= \frac{mv^2}{r}$$

Since the electron keeps on revolving at a fixed distance r from the nucleus; the two forces must balance each other

$$\frac{1}{4\pi\epsilon_0} \cdot \frac{Ze^2}{r^2} = \frac{mv^2}{r} \qquad \text{...(1)}$$

Also according to Bohr's Postulate.

$$\mathbf{Mvr} = \frac{nh}{2\pi} \qquad \text{...(2)}$$

Rewriting equation (2) we get

$$m^2v^2r^2 = \frac{n^2h^2}{4\pi^2}$$

or $$mv^2 = \frac{n^2h^2}{4\pi^2 mr^2}$$

or $$\frac{mv^2}{r} = \frac{n^2h^2}{4\pi^2 mr^3} \qquad \text{...(3)}$$

Using equation (1) and (3)

$$\frac{1}{4\pi\epsilon_0} \cdot \frac{Ze^2}{r^2} = \frac{n^2h^2}{4\pi^2 mr^3}$$

or $$r = \frac{n^2h^2\epsilon_0}{Ze^2\pi m}$$

$$r = \frac{h^2\epsilon_0}{e^2\pi m}\left(\frac{n^2}{Z}\right) \qquad \text{...(4)}$$

on putting the values of constants, radius of nth orbit can be given by $\boxed{r_n = 0.529\frac{n^2}{Z}\ \text{Å}}$

Expression For Energy (E_n)

Total energy = Kinetic energy + Potential energy

$$= \frac{1}{2}mv^2 + \left(-\frac{1}{4\pi\epsilon_0}\cdot\frac{Ze^2}{r}\right)$$

$$= \frac{1}{8\pi\epsilon_0}\frac{Ze^2}{r} - \frac{1}{4\pi\epsilon_0}\cdot\frac{Ze^2}{r}$$

$$= -\frac{1}{8\pi\epsilon_0}\frac{Ze^2}{r}$$

Substituting *r* from (4)

Total energy (E_n) $= -\frac{1}{8\pi\epsilon_0}\cdot\frac{Ze^2 \times e^2\pi mZ}{h^2\epsilon_0 \times n^2}$

$$= -\frac{Z^2e^4m}{8\epsilon_0^2h^2n^2}$$

$$E_n = -\frac{e^4m}{8\epsilon_0^2h^2}\left[\frac{Z^2}{n^2}\right]$$

$$\boxed{E_n = -13.6\times\frac{Z^2}{n^2}eV}$$

Significance of negative value of energy: **The energy of an electron at infinity is arbitrarily assumed to be zero. When an electron moves and comes under the influence of nucleus it does work and spends its energy in this process. Thus the energy of the electron decreases and it becomes less than zero i.e., it acquires a negative value.**

Expression For Velocity (v_n)

$$mvr = \frac{nh}{2\pi}$$

$$v = \frac{nh}{2\pi mr}$$

On putting the value of '*r*'

$$= \frac{nh\times\pi mZe^2}{2\pi m\times h^2\epsilon_0 n^2}$$

$$= \frac{e^2}{2\epsilon_0 h} \times \frac{Z}{n}$$

$$\boxed{V_n = 2.18 \times 10^6 \times \frac{Z}{n} \text{ m/s}}$$

Frequency (ν)

Frequency (ν) = No. of revolutions per second in *n*th orbit

$$= \frac{Vn}{2\pi r_n}$$

Atomic Spectrum

Absorption spectrum : If the atom gains energy the electron passes from a lower energy level to a higher energy level, energy is absorbed that means a specific wave length is absorbed. Consequently, a dark line will appear in the spectrum. This dark line constitutes the ***absorption spectrum.***

Emission spectrum : If the atom loses energy, the electron passes from higher to a lower energy level, energy is released and a spectral line of specific wavelength is emitted. This line constitutes the ***emission spectrum.***

Types of Emission spectra

i) Continuous spectra: When white light from any source such as sun or bulb is analysed by passing through a prism, it splits up into seven different wide bands of colour from violet to red (like rainbow). These colour are so continous that each of them merges into the next. Hence the spectrum is called as continuous spectrum.

ii) Line spectra: When an electric discharge is passed through a gas at low pressure light is emitted. If this light is resolved by a spectroscope, It is found that some isolated coloured lines are obtained on a photographic plate separated from each other by dark spaces. This spectrum is called line spectrum. Each line in the spectrum corresponds to a particular wavelength. Each element gives its own characteristic spectrum.

Spectrum of Hydrogen Atom

These spectral lines were classified into six groups which were named after the name of their discoverer. They are :

(i) Lyman series – U.V. region	**(ii) Balmer series – Visible region**
(iii) Paschen series – I.R. region	**(iv) Brackett series – I.R. region**
(v) Pfund series – I.R. region	**(vi) Humphrey series – I. R. region**

If an electrons jumps from higher orbit (E_2) to lower orbit (E_1), then energy released is given by

$$\Delta E = E_2 - E_1$$

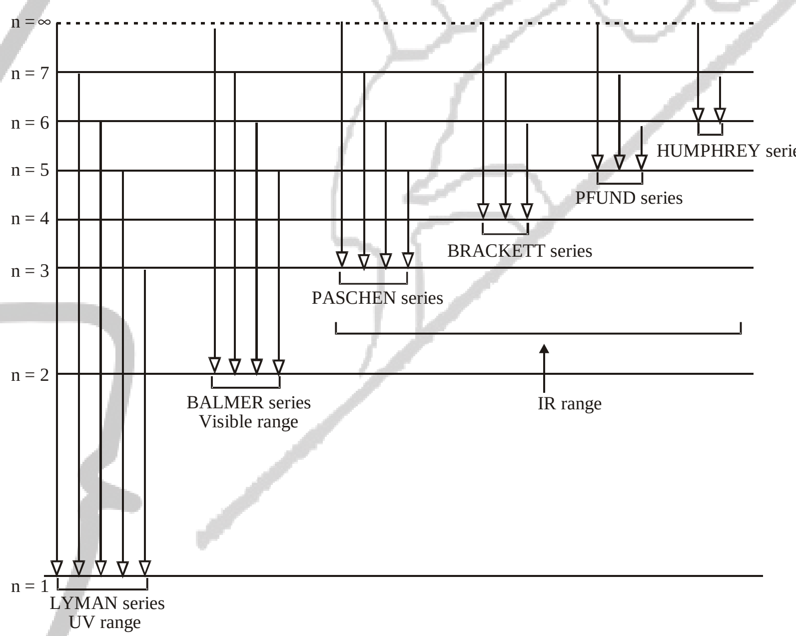
$$\frac{hc}{\lambda} = -\frac{13.6 \times Z^2}{n_2^2} + \frac{13.6 \times Z^2}{n_1^2}$$

or $$\frac{1}{\lambda} = \frac{13.6 \times Z^2}{hc}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$= \boxed{\frac{1}{\lambda} = R_h \times Z^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]}$$

R_h = 109677 cm^{-1}

= 1.097 × 10^7 m^{-1}. R_h is RYDBERG constant.



Failures of Bohr's Theory

(i) It failed to explain spectra of atoms having more than one electron.

(ii) It failed to explain Zeeman effect. When a substance emitting a line spectrum is placed in a magnetic field, its lines would split up into a number of closely spaced lines. This is known as Zeeman effect.

(ii) It failed to explain stark effect. It is similar to Zeeman effect and is produced in a presence of external electrostatic field.

(iv) Although Bohr's theory predicted with great accuracy the positions of spectral lines of hydrogen atom and the singly ionized helium atom but refined spectroscopic analysis has shown that these lines are not simple but have fine structure, i.e., they consist of a number of component lines lying close together.

(v) It is difficult to find the effect of other electrons upon the energy state of any particular electron.

(vi) The pictorial concept of electrons jumping from one orbit to another orbit is not justified because of the uncertainty of their positions and velocities.

(vii) The main objection against Bohr theory is that it involves the use of two theories which are essentially opposed to each other, the quantum theory involved to account for existence of stationary orbits and for frequencies of the radiation while motion of electrons in its orbit obeys the laws of classical mechanics.

(viii) It cannot explain the shapes of molecules formed by the combination of atoms.

(ix) No justification was provided for the principle of quantization of angular momentum, so why angular momentum is $\frac{h}{2\pi},\frac{2h}{2\pi},\frac{3h}{2\pi}$ ...etc. and why it can not be $\frac{1.5h}{2\pi},\frac{1.25}{2\pi}$ etc is explained here.

Modern Concept of Atomic Theory

The modern theory which is usually called wave mechanics was developed by L. de Broglie, E. Schrodinger and Heisenberg.

❑ Wave-Particle Duality

(a) Dual Character of Radiation

Light is known to exhibit dual character i.e., wave and particle character.

(i) According to the wave theory, light is known to travel as wave in the form of crests and troughs. Thus light is having wave character. This wave character of light could be able to explain certain phenomena such as interference, polarization diffraction, etc.

(ii) According to Planck's quantum theory, electromagnetic radiation is assumed to be made up of a stream of discrete energy particles called photons. When an electromagnetic radiation of critical frequency is made to incident on a metallic surface, it is able to eject electrons from its surface. Only corpuscular theory of light could be able to explain this effect. Hence light is having a particle character.

(b) Dual Character of Particle

A French physicist louis de Broglie suggested that

"Matter considered to be made up of discrete particles. Such as atoms and molecules, may also behaves like wave under proper conditions.

This leads to the view that electrons like light may also have wave properties associated with them. It means that electrons has a dual nature, particle and wave.

de-Broglie's Hypothesis

This wave length and velocity are related by the following mathematical equation

$$\lambda = \frac{h}{mv} \qquad \ldots(1)$$

Where h is the Planck's constant and mv is the momentum of the moving particle. Equation is known as de Broglie relationship and can be written as

$$mv = \frac{h}{\lambda} \quad \text{or } mv \propto \frac{1}{\lambda} \qquad \ldots(2)$$

"The momentum of a moving particle is inversely proportional to the wave-length of the waves associated with it."

(c) Proof of de Broglie Equation

Let us first consider the case of a photon. If we consider it to be a wave of frequency ν, its energy is given by

$$E = h\nu \qquad \ldots(3)$$

If we now consider it as a particle of mass m, its energy is given by

$$E = mc^2 \qquad \ldots(4)$$

From equation (3) and (4), we get

$$h\nu = mc^2 \qquad \ldots(5)$$

As the photon travels in free space with velocity of light c, its momentum p is given by

$$P = \text{mass} \times \text{velocity} = mc \qquad \ldots(6)$$

On dividing equation (5) by (6), we get

$$\frac{h\nu}{p} = \frac{mc^2}{mc} = c$$

or $p = \frac{hv}{c} = \frac{h}{\lambda}$ **[Q c = vλ = Frequency × wave length]**

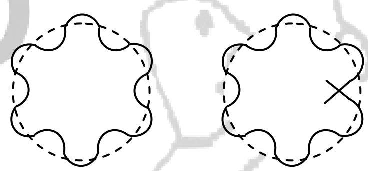
or $\lambda = \frac{h}{p}$ **…(7)**

de-Broglie assumed that the above relation holds good for material particles like electrons, and hence for electrons eq. (7) becomes as

$\lambda = \frac{h}{p} = \frac{h}{mv}$ **…(8)**

(d) de-Broglie Relationship and Bohr's Theory

Application of the de-Broglie's relationship to a moving electron around a nucleus puts some restrictions on the size of orbits. It means that electron is not a mass particle moving in a circular path but is instead a standing wave train (non-energy, radiating motion) extending around the nucleus in the circular path as shown below



For the wave to remain continually in phase, the circumference of the orbit should be an integral multiple of wavelength λ i.e.,

$2\pi r = n\lambda$ …(9)

Where r is the radius of the orbit and n is a whole number.

From equation (8), we get

$\lambda = h/mv$ …(10)

Substituting the value of λ in equation (9), we get

$2\pi r = \frac{nh}{mv}$ **or** $mvr = n\frac{h}{2\pi}$ **…(11)**

Which is the same as Bohr's second postulate. From equation (11) it follows that "Electron can move only in such orbits for which the angular momentum must be an integral multiple of h/2π.

Uncertainty Principle

According to the classical mechanics the position and momentum of a moving electron can be determined with great accuracy. When an electron is considered as a wave, it is, however, not possible to know the exact location of the electron on the wave as it (wave) is extending throughout a region of space. Thus, The question arises

"If an electron is exhibiting dual nature (wave and particle), is it possible to know the exact position of the electron in space at some given instant?"

The answer to this question is given by Heisenberg which states that **"It is impossible to determine simultaneously the position and momentum of the electron with any desired accuracy."**

Mathematical Relation

Heisenberg's principle can be stated mathematically as

$$\Delta p \times \Delta x \geq h/4\pi \qquad \ldots(1)$$

Where Δp is the uncertainty in the determination of the momentum and Δx, the uncertainty in the determination of position.

Alternative statement

Sometimes instead of measuring position and momentum of the system, its energy E and the time t for which it remains in that energy state are measured. In these cases the uncertainty in measurement is represented as

$$\Delta E \times \Delta t \geq h/4\pi \qquad \ldots(2)$$

Quantum Mechanical Picture of Hydrogen Atom

The important features of quantum mechanical model of the atom are:

(i) The energy of electron in atoms is quantized.

The existence of these quantized electronic energy level is a direct result of wave like properties of electrons.

(ii) Both the position and momentum of an electron in an atom can not be determined simultaneously with precision. That is why the path of an electron in an atom can never be determined; we can only talk about the probability.

(iii) An atomic orbital is the wave function ψ for an electron. Whenever an electron is described by a wave function we say that the electron occupies that orbital. In each orbital, the electron has a definite energy. All types of information about the electron in at atom is stored in its orbital wave function ψ.

***(iv)* The probability of finding an electron at a point inside an atom is proportional to $|\psi|^2$. $|\psi|^2$ is known as probability density and is always positive.**

Schrodinger Wave Equation

The behaviour of an electron inside an atom can be expressed through Schrodinger Wave Equation.

$$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}+\frac{\partial^2\psi}{\partial z^2}+\frac{8\pi^2 m}{h^2}[E-V]\psi=0$$

$\psi \rightarrow$ wave function **m $\rightarrow$ mass of electron**

E $\rightarrow$ total energy of electron. **V $\rightarrow$ potential energy of electron.**

(1) Nodes**: Probability of finding electron is zero.**

Number of radial / spherical nodes = n – *l* – 1.

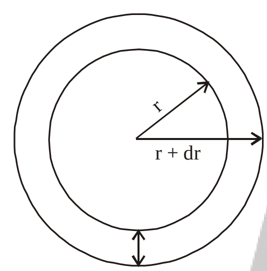
More is the number of nodes more is the energy of orbital.

(2) Nodal point: **The point at which radial probability becomes zero is known as** Nodal Point **= n – l**

(3) Nodal plane: **Number of nodal plane for a subshell = *l***

Radial Probability Distribution

As discussed earlier that Ψ^2 gives the probability distribution for electron with respect to the nucleus. In order to understand the concept of radial probability let us assume that the space around the nucleus is divided into large number of concentric shells of thickness *dr*.



Now, radial probability = probability density × volume of the radial shell = $\Psi^2 \times 4\pi r^2 dr$.

Radial Probability Distribution Curves

The maximum in the curve indicates the most probable value and the corresponding distance from the nucleus is called distance of maximum probability. For hydrogen atom, this radius has a value of 53 pm.

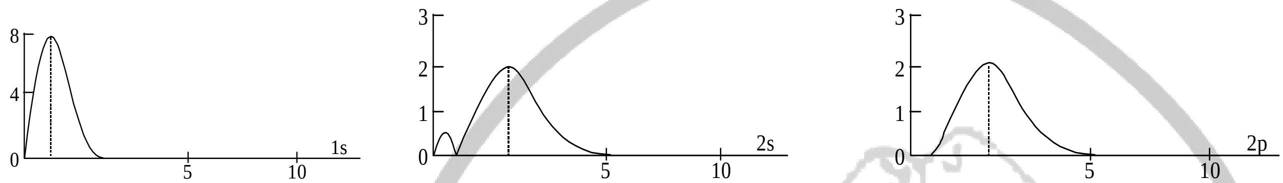
The radial probability distribution curve for 2s orbital shows two maxima, a smaller one near the nucleus and bigger one at a larger distance. In between two maxima, there is one minima where there is no probability of finding the electron (nodal point).

The distance of maximum probability for 2p and 2s orbitals are same and this distance is greater than that of 1s orbital. Hence 1s orbital is nearer to the nucleus in comparison to 2s and 2p orbitals.

The radius of maximum probability of 2s orbital is greater than 2p orbital. In the case of 2s orbital, one additional maxima appears at small distance, this confirms that the 2s electrons spends more time near the nucleus than 2p electrons. Hence, 2s orbital is more penetrating than 2p orbital.

$\Psi \rightarrow$ radial wave function **$\Psi^2 \rightarrow$ radial probability density**

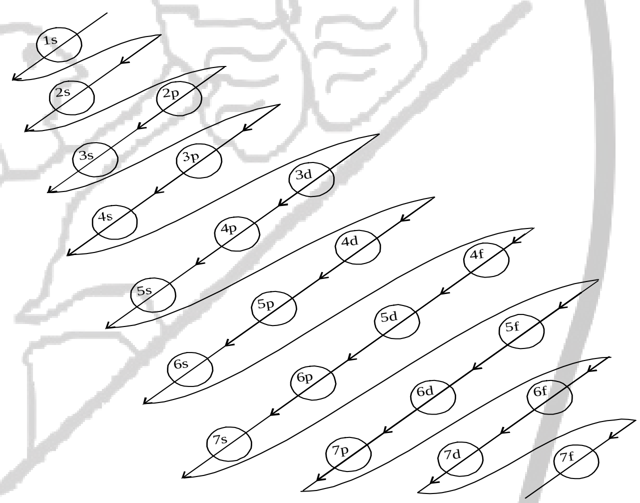
$4\pi r^2\, dr \cdot \Psi^2 \rightarrow$ radial probability



Aufbau Principle

It states that energies of atomic orbitals is governed by (n + *l*) rule. Higher the (n + *l*) value of an orbital higher will be its energy content and the filling of electrons in that orbital will happen in the last. If the (n + *l*) values are same for two different orbitals, then electron will enter in the orbital having smaller value of 'n' first

The energies of various sub levels varies as



1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p < 5s < 4d < 5p < 6s < 4f < 5d < 6p < 7s < 5f < 6d ....

Hunds's Rule

The rule states that pairing of electrons in degenerate* orbitals belonging to a particular sub shell does not take placed till each orbital is occupied by a single electron with parallel spin.

This is done in order to maximize the spin multiplicity of a particular configuration.

Orbitals having equal energy are called degenerate orbitals. When atoms are kept in a magnetic field, the orbitals acquire different energy values. In this way the degeneracy of orbital is lost.

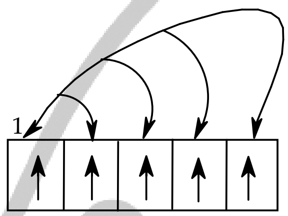
<u>Why half filled and full filled orbital are more stable.</u>

- ❑ Cause of Stabilisty of Completely Filled and Half Filled Sub-Shells

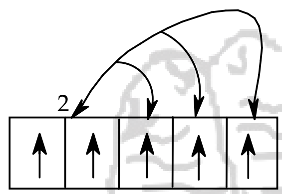
The completely filled and completely half filled sub-shells are stable due to the following reasons.

1. Symmetrical distribution of electrons

It is well known that symmetry leads to stability. The completely field or half filled subshells have symmetrical distribution of electros in them and are therefore more stable. Electrons in the same subshell (here 3d) have equal energy but different spatial distribution. Consequently, their shielding of one-another is relatively small and the electrons are more strongly attracted by the nucleus



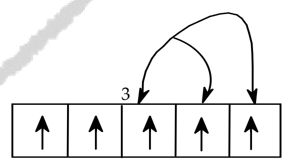
4exchange by electron 1



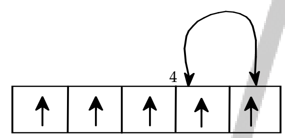
3 exchange by electron 2

2. Exchange Energy

The stabilizing effect arises whenever two or more electrons with the same spin are present in the degenerate orbitals of a subshell. These electrons tend to exchange their positions and the energy relesed due to this exchange is called exchange energy. The number of exchanges that can take place is maximum when the subshell is either half filled or completely filled. As a result the exchange energy is maximum and so is the stability



2 exchange by electron 3



1 exchange by electron 4

Pauli Exclusion Principle

It states that no two electrons in an atom can have the same set of four quantum numbers.

It means that no two electrons in an atom are alike and hence that the total number of electrons in an orbital cannot exceed two.

Quantum Numbers

It is a set of numbers which define the status of an electron inside an atom completely.

The four quantum numbers are

(1) *Principal Quantum No. (n)*

Proposed by Bohr to explain the lines in the atomic spectrum.

It tells us, about

(i) the main orbit in which electrons are located.

(ii) Approximate distance of electron cloud from the nucleus.

(iii) energy associated with the orbit.

(iv) Velocity of the electron in the orbit.

Maximum numbers of electrons in *n*th orbit = $2n^2$.

It can acquire any value ranging from 1 to ∞, and the corresponding orbits are designated as K, L, M, N ······· shells.

Maximum number of orbitals = n^2 in a given orbit

(2) Angular Momentum or Azimuthal Quantum No. (l)

Proposed by Sommerfeld to explain the hyperfine splitting in atomic spectrum

(a) It tells us about

(i) The number of subshells present in a given orbit.

(ii) Relative energies of the subshells.

(iii) Shapes of orbitals.

(iv) Total numbers of orbitals present = $(2l + 1)$

Total numbers of electrons present = $(4l + 2)$.

(b) For a particular value of *n*, *l* can acquire all the values ranging from 0 to $(n - 1)$.

$l = 0$	s-subshell	Spherical	$l = 1$	p-subshell	dumbell
$l = 2$	d-subshell	double dumbbell	$l = 3$	f-subshell	complicated

(c) Angular momentum of an orbital $= \dfrac{h}{2\pi}\sqrt{l(l+1)}$

(3) Magnetic Quantum No (m)

Proposed by Lande to explain the spliting of lines in a magnetic field.

(a) It tells us about,

(i) number of orbitals present in a subshell

(ii) Orientation of orbitals in three dimensional space.

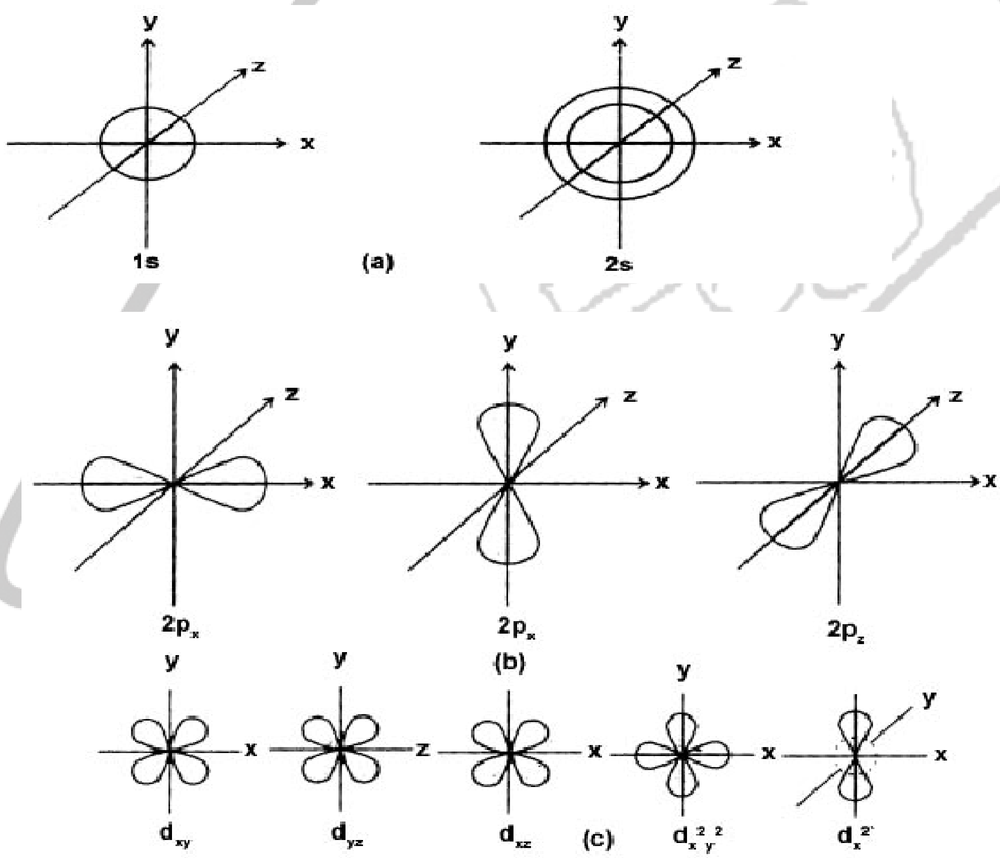
(b) For a particular value of '*l*' 'm' can acquire values from –*l* to +*l* including zero

For s-subshell, $l = 0$, m = 0

For p- subshell, $l = 1$, m = –l, 0, +1 designated as p_x, p_y and p_z.

For d- subshell $l = 2$, m = –2, –1, 0, +1, +2, designated as d_{xy}, d_{yz}, d_{xz} $d_{x^2-y^2}$ and d_{z^2}

For f-subshell $l = 3$, m = –3, – 2, – 1, 0, 1, +1, +2, +3, which are difficult to represent



(4) Spin Quantum No. (m_S)

Proposed by Uhlenbeck & Goudshit, **to explain the magnetic properties of substances.**

***(i)* It tells us about the spinning motion of electrons wheather the spin is in clockwiseor anticlockwise.**

(ii) $S = \pm \frac{1}{2}$ *(iii)* **Spin angular momentum =** $\frac{h}{2\pi}\sqrt{S(S+1)}$

CH: STRUCTURE OF ATOM

(SUBJECTIVE ASSIGNMENT)

QUANTUM THEORY

UNSOLVED QUESTIONS

1. Defne electron volt?

Ans. One electron volt is the energy o f an electron being accelerated by a potential difference of one volt. 1 eV =1.602×10–19 volt coulomb =1.602×10^{-19} J

2. Calculate the energy per mol of the photons of an electromagnetic rad. of wavelength 7600 A^0.

3. 3×10^{18}photons of certain light radiation are found to produce 1.5 J of energy. Calculate the wavelength of light radiation. [Ans. 3975 A^0]

4.A monoatomic ion has a charge of +2. The nucleus of the ion has a mass number of 62. The number of neutrons in the nucleus is 1.21 times that of the number of protons. How many electrons are in the ion? What is the name of the element?

5. Calculate the number of protons emitted in 10 hours by a 60 W sodiumlamp emitting radiations of wavelength 6000 Å.

D.P. – 1

1.The wavelength of a beam of light is 2.8×10^{-5}m. Calculate its (i) frequency (ii) energy of one of its photon. [Ans. (i) 1.07×10^{13} Hz, (ii) 7.09×10^{-21} J]

2. If the energy difference between two electronic states is 214.68*kJ mol*–1 , calculate the frequency of light emitted when an electron is dropped from the higher shell to lower shell. [Ans. 5.395×10^{14}sec–1]

3. How many neutrons and protons are there in the following nuclei?

4. Complete the following table :

Particle	Mass No.	Atomic No.	Protons	Neutrons	Electrons
Nitrogen atom	–	–	–	7	7
Calcium ion	–	20	–	20	–
Oxygen atom	16	8	–	–	–
Bromide ion	–	–	–	45	36

NCERT CORNER

1. Calculate the wavelength, frequency and wave number of a light wave whose period is 2.0 × 10^{-10} s. [NCERT][ANS 5 * 10^{9} s^{-1}, 6 * 10^{2} m, 16.66 m^{-1}]

2. Yellow light emitted from a sodium lamp has a wavelength (λ) of 580 nm. Calculate the frequency (ν) and wave number of the yellow light. [NCERT][ANS. 5.17 × 10^{14} s^{-1}]

3. What is the number of photons of light with a wavelength of 4000 pm that provide 1 J of energy?. **[NCERT][ANS 2.012 × 10^{16}]**

4. Find energy of each of the photons which (i) correspond to light of frequency 3× 10^{15} Hz. (ii) have wavelength of 0.50 A. [**NCERT][ANS. 1.988 × 10^{-18}**, 3.98×10^{-15} J

5. Calculate energy of one mole of photons of radiation whose frequency is 5 ×1014 Hz. ANS. **= 199.51 kJ mol–1**

6. Calculate (a) wavenumber and (b) frequency of yellow radiation having wavelength 5800 Å.

7. In Milikan's experiment, static electric charge on the oil drops has been obtained by shining X-rays. If the static electric charge on the oil drop is −1.282 × 10^{-18}C, calculate the number of electrons present on it. **[NCERT][ANS.*8*]**

8. Lifetimes of the molecules in the excited states are often measured by using pulsed radiation source of duration nearly in the nano second range. If the radiation source has the duration of 2 ns and the number of photons emitted during the pulse source is 2.5 × 10^{15}, calculate the energy of the source.**[NCERT] [ANS. 8.282 × 10^{-10} J.]**

9. In astronomical observations, signals observed from the distant stars are generally weak. If the photon detector receives a total of 3.15 × 10^{-18} J from the radiations of 600 nm, calculate the number of photons received by the detector. **[NCERT][ANS. 10]**

10. A 100 watt bulb emits monochromatic light of wavelength 400 nm. Calculate the number of photons emitted per second by the bulb. **ANS. 2.0 ×10^{20} s-1**

11. A 25 watt bulb emits monochromatic yellow light of wavelength of 0.57μm. Calculate the rate of emission of quanta per second.**[NCERT][ANS. 34.87 × 10^{-20} J]**

12. Electromagnetic radiation of wavelength 242 nm is just sufficient to ionise the sodium atom. Calculate the ionisation energy of sodium in kJ mol−1.**[NCERT][ANS. 494 kJ mol−1]**

13. Neon gas is generally used in the sign boards. If it emits strongly at 616 nm, calculate (a) the frequency of emission, (b) distance traveled by this radiation in 30 s (c) energy of quantum and (d) number of quanta present if it produces 2 J of energy.**[NCERT][ANS. 3.33 × 106 J, 9.0 × 10^9 m, 32.27 × 10^{-20} J, 6.2×10^{18}]**

14. Nitrogen laser produces a radiation at a wavelength of 337.1 nm. If the number of photons emitted is 5.6 × 1024, calculate the power of this laser.**[NCERT][ANS. 3.33 × 10^6 J.]**

15. An element with mass number 81 contains 31.7% more neutrons as compared toprotons. Assign the atomic symbol.**[NCERT][ANS. 35]**

16. An ion with mass number 37 possesses one unit of negative charge. If the ion contains 11.1% more neutrons than the electrons, find the symbol of the ion.**[NCERT][ANS.$_{17}Cl^{37-}$]**

17. An ion with mass number 56 contains 3 units of positive charge and 30.4% more
neutrons than electrons. Assign the symbol to this ion. [NCERT] [ANS. $^{56}_{26}Fe^{3+}$

PHOTOELECTRIC EFFECT

SOLVED EXAMPLES

EX: The minimum energy necessary to overcome the attractive force between the electron and the surface of silver metal is 7.52 × 10^{-19} J. What will be the maximum kinetic energy of the electrons from silver which is being irradiated with ultraviolet light having a wavelength 360 Å?

Solution

KE = hv – hv₀ =

$$\frac{hc}{\lambda} - hv_0 = \frac{(6.63\times10^{-34}\ J.s)\ (3.00\times10^{8}\ m/s)}{3.60\times10^{-8}\ m} -$$

$$(7.52\times10^{-19}\ J) = 4.77\times10^{-19}\ J.$$

EX: **The critical wavelength for producing the photoelectric effect in tungsten is 2600 Å. (a) What is the energy of a quantum at this wavelength in J and in eV? What wavelength would be necessary to produce photoelectrons from tungsten having twice the kinetic energy of those produced at 2200 Å?***Solution*

(a) 260 Å = 2600 × 10^{-10} m

$$E = hv = \frac{hc}{\lambda} = \frac{(6.63\times10^{-34}\ J.s)\ (3.00\times10^{8}\ m/s)}{2600\times10^{-10}\ m} = 7.7\times10^{-19}\ J$$

(b) $KE_{2200} = hv - hv_0 = hc\left(\frac{1}{\lambda_{2200}} - \frac{1}{\lambda_0}\right)$

… (1)

$KE_{new} = hv - hv_0 = hc\left(\frac{1}{\lambda_{new}} - \frac{1}{\lambda_0}\right)$

… (2)

Dividing (2) by (1)

$$2 = \frac{\frac{1}{\lambda_{new}} - \frac{1}{2600}}{\frac{1}{2200} - \frac{1}{2600}} = \frac{2}{2200} - \frac{1}{2600} = \frac{1}{\lambda}, \text{ or}$$

λ = 1900 Å.

UNSOLVED QUESTIONS

1. Which type of metals are likely to exhibit the photoelectric effect?
ans. Metals having low ionisation energy such as potassium, rubidium, caesium, etc. are capable of exhibiting the photoelectric effect. The valence electrons are loosely held and can be easily lost.

2. The energy required to remove an electron from the surface of sodium metal is 2.3 eV. What is the longest wavelength of radiation with which it can show photoelectric effect? **[Ans. 5.397×10^{-7}m]**

3. Light of wavelength 400 nm strikes on a certain metal which has a photoelectric work function of 2.13 eV. Find out the kinetic energy of the most energetic electron. **[Ans. 1.56×10^{-19}J]**

4. A metal surface of threshold frequency 5.3 x 10^{14} sec^{-1} is exposed to a photon of radiation having energy 3.5 x $I0^{-19}$ J. Will it exhibit photoelectric effect?

5. If the critical wavelength for ejection of a photoelectron from a metal surface is 2000 A^0, then what wavelength of light will be required to produce photoelectrons with double the kinetic energy of that produced by light of wavelength 1500 A^0? **[Ans. 1200 A^0]**

6. The critical frequency for emitting photoelectrons from a metal surface is 5 x 10^{14} sec. What should be the frequency of radiation to produce photoelcctrons having twice the kinetic energy of those produced by the radiation of frequency 10^{15} sec^{-1}.

7. The photo-electric emission requires a threshold frequency VQ. For a certain metal Xt = 2200 A and X2 = 1900 A produce electrons with a maximum kinetic energy KEj and KE2, if KE2 = 2KEi, calculate threshold frequency and corresponding *wavelength*.

D.P. – 2

1. The minimum energy required for the emission of photoelectron from the surface of a metal is 4.95 x $I0^{-19}$ J. Calculate the critical frequency and the corresponding wavelength of the photon required to eject the electron, h = 6.6 x 10^{-34} J sec

2. The threshold wavelength of a metal is 230 nm. Calculate the maximum K.E. of the electrons emitted from that metal surface by using UV radiation of wavelength, 180 nm ?
Ans. $K.E._{max} = 24.4 \times 10^{-29}$ J

3. Light of wavelength 300 x 10^{-9} m strikes a metal surface with photoelectric work function of 2.13 eV. Find out the kinetic energy ofthe most energetic photoelectron.

4.For silver metal, the threshold frequency v_o is 1.13 x 10^{17} Hz. What is the maximum kinetic energy of the photoelectrons produced by shining ultraviolet light of 15.0 Å wavelength on the metal?**Ans.5.77 x 10^{-17} J**

5.Light of wavelength 470 nm falls on the surface of potassum metal, elecrons are emitted with a velocity 6.4 x 10^4 m sec^{-1}.
(a) What is the kinetic energy of emitted electron?
(b) What is the minimum amount of energy required to remove an electron from K atom?
Ans. (a) 1.86 x 10^{-21} J (b) 4.2 x 10^{-19} J

D.P. – 3

1.When a certain metal was irradiated with light of frequency 3.2 x 10^{16} Hz, the photoelectron had twice the kinetic energy as did photoelectrons emitted when the same metal was irradiated with light of frequency 2 x 10^{16} Hz. Calculate v_0 for the metal.
Ans. 8 x 10^{15} Hz

2. Calculate the stopping potential necessary to stop all the ejected electrons form the surface is silver metal if it is irradiated with light of wavelength 360 Å and whose work function is 7.52×10^{-19} J.**Ans. 29.8 V**

3.The critical wavelength for producing photoelectrons from tungsten is 2600 Å. What wavelength would be necessary to produce photoelectrons from tungsten having twice the kinetic energy; of those produced at 2200Å?
Ans. 1906.6 Å

D.P. – 4

1. The work function for Cs atom is 1 .9 eV. Find threshold wavelength (λ_0)and threshold frequency (ν_0) of this light radiation. If Cs metal is irradiated with a radiation of wavelength 500 nm and kinetic energyand velocity of emitted electron.

2. Find the frequency of light which ejects electrons from a metal surface fully stopped by a retarding potential of 3 volt. The photo electric effect begins in this metal at frequency of 6×10^{14} sec^{-1}. What is work function of metal?

Ans. **W.F. = 39.78×10^{-20} j, ν = 13.2×10^{14} Hz**

3. When light frequency, ν is shone on a metal surface with threshold frequency ν_0, photoelectrons are emitted with maximum kinetic energy = 1.3×10^{-18} J. If the ratio, $\nu : \nu_0 = 3:1$, calculate the threshold frequency ν_0. **Ans. 9.81×10^{14} Hz**

5. When a photon of frequency 1.0×10^{15} s^{-1} was allowed to hit a metal surface,an electron having 1.988×10^{-19} J of kinetic energy was emitted. Calculate the threshold frequency of this metal. Show that an electron will not be emitted if a photon with a wavelength equal to 600 nm hits the metal surface.

NCERT CORNER

1. Electrons are emitted with zero velocity from a metal surface when it is exposed to radiation of wavelength 6800 A. Calculate threshold frequency and work function (W_0) of the metal.**[NCERT] [ANS. 4.41×10^{14} s–1, 2.922×10^{-19} J]**

2. A photon of wavelength 4×10^{-7} m strikes on metal surface, the work function of the metal being 2.13 eV. Calculate (i) the energy of the photon (eV), (ii) the kinetic energy of the emission, and (iii) the velocity of the photoelectron (1 eV= 1.6020×10^{-19} J).**[NCERT][ANS. 4.97×10^{-19} J, 0.9720 eV, 5.84×10^5 ms^{-1}]**

3. When electromagnetic radiation of wavelength 300 nm falls on the surface of sodium, electrons are emitted with a kinetic energy of 1.68×10^5 J mol^{-1}. What is the minimum energy needed to remove an electron from sodium? What is the maximum wavelength that will cause a photoelectron to be emitted ?
ANS. 3.84×10^{-19} J, 517 nm

4. The work function for caesium atom is 1.9 eV. Calculate (a) the threshold wavelength and (b) the threshold frequency of the radiation. If the caesium element is irradiated with a wavelength 500 nm, calculate the kinetic energy and the velocity of the ejected photoelectron.**[NCERT] [ANS. 6.53 × 10–7 m, 4.593 × 1014 s–1, 9.3149 × 10–20 J]**

5. The threshold frequency ν_0 for a metal is 7.0 $\times 10^{14}$ s^{-1}. Calculate the kinetic energy of an electron emitted when radiation of frequency ν =1.0 $\times 10^{15}$ s^{-1} hits the metal.
ANS. 1.988×10^{-19} J

6. If the photon of the wavelength 150 pm strikes an atom and one of its inner bound electrons is ejected out with a velocity of 1.5 × 107 ms–1, calculate the energy with which it is bound to the nucleus. **[NCERT] [ANS. 12.227×10^{-16} J.]**

7. The ejection of the photoelectron from the silver metal in the photoelectric effectexperiment can be stopped by applying the voltage of 0.35 V when the radiation 256.7 nm is used. Calculate the work function for silver metal.
[NCERT][ANS. 4.48 eV.]

BOHR MODEL & RYDBERG FORMULA

SOLVED EXAMPLES

EX: ***What is the wavelength of second line of Paschen series of Be^{3+} ion?***

Solution: Z = 4 for Beryllium
For Paschen series $n_1 = 3$
For 2^{nd} line $n_2 = 5$

$$\therefore \ \bar{\nu} = R_H \times Z^2\left[\frac{1}{3^2} - \frac{1}{5^2}\right]$$

$$= 109678 \times 4^2 \left[\frac{1}{9} - \frac{1}{25}\right]$$

$$= 109678 \times 4^2 [0.0711]$$

$$= 124769.6 \text{ cm}^{-1}$$

$$\boldsymbol{\lambda = 8.013 \times 10^{-6} \text{ cm}}$$

EX: What transition in a hydrogen spectrum would have the same wavelength as in the Balmer transition n = 4 to n = 2 of He^+ spectrum.

Solution

For an atom $\bar{\nu} = \frac{1}{\lambda} = R_H Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For He^+ spectrum : Z = 2, n_2 = 4, n_1 = 2.

$$\therefore \quad \bar{\nu} = \frac{1}{\lambda} = R_H \times 4\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = \frac{3R_H}{4}$$

For hydrogen spectrum: $\bar{\nu} = \frac{3R_H}{4}$ and $Z = 1$

$$\therefore \quad \bar{\nu} = \frac{1}{\lambda} = R_H \times\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

or $R_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = \frac{3R_H}{4}$ or $\frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{3}{4}$

This means that $n_1 = 1$ and $n_2 = 2$.

UNSOLVED QUESTIONS

1. Calculate the shortest and longest wavelenghts in hydrogen spectrum of Lyman series.**Ans. 9.117×10^{-6} *cm***

2. Light of wavelength 128.18 A is emitted when the electron of a hydrogen atom drops from 5th to 3rd orbit. Find the wavelength of the photon emitted when the electron falls from 3rd to 2nd orbit. **Ans. 6562.8 A^0**

3. What is the distance of separation between 3rd and 4th orbit of H-atom ? **[Ans. 3.703 Å]**

4. What transition of Li^{2+} spectrum will have same wavelength as that of second line of Balmer series in He^+ spectrum?
Ans. n_2=6 to n_1=3

5. The energy of electron in the first Bohr.s obit is . 13.6 eV. Calculate the energy of electron in the first excited state.
[Ans. . 3.4 eV]

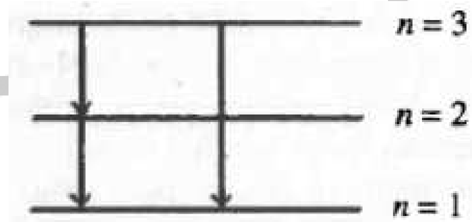
6. What is the energy asociated with the fifth orbit?
(b) Calcualte the radius of fifth Bohr orbit of hydrogen atom.
Ans. (a) -8.72×10^{-20}J, (b) 1.32225 nm

7. If the ionisation potential of hydrogen is 13.6 eV per atom, calculate the ionisation potential of Be^{3+} .**Ans. 217.6 eV**

8. Calculate the ionisation energy of thehydrogen atom. How much energy will berequired to ionise 1 mole of hydrogenatoms? **Ans. I.E. for hydrogen atom=2.178×10^{-18}J; I.E. per mole = 1312 kJ**

9. Calculate the wavelength of the photon which will be emitted when the electron of hydrogen atom jumps from second shell to the first shell. The ionisation energy of hydrogen is 1.312×10^3 $kJ\ mol^{-1}$. **Ans. 1215A**

10. Consider the following two electronic transition possibilities in a hydrogen atom as pictured below:



(1) The electron drops from third Bohr's orbit to second Bohr's orbit followed with the next transition from second to first Bohr's orbit.
(2) The electron drops from third Bohr's orbit to first Bohr's orbit directly.

11. Calculate the wavelength of the spectral line obtained in the spectrum of Li^{2+} ion, when the transition takes place between two levels whose sum is 4 and difference is 2.**Ans.** $\gamma = 1.14\times10^{-6} cm$

12. Show that: (a) The sum of the energies for the transitions n = 3 to n = 2 and n = 2 to n = 1 is equal to the energy of transition for n = 3 to n = 1.
(b) Are wavelengths and frequencies of the emitted spectrum are also additive in the same way as their energies are?

D.P. – 5

1. Calculate the wavelength in angstrom of the photon that is emitted when an electron in Bohr's orbit n = 2 returns to the orbint n = 1in the hydrogen atom. the ionization potential of the ground state of hydrogenatom is 2.17×10^{-11} erg per atom.
Hint : Energy of the electron in the 1st orbit = - (ionisation potential)

$\Delta E = 3/4 \times 2.17 \times 10^{-11}$ erg per atom.
Ans. $\lambda = 1220\ A$

According to Bohr's theory, the electronic energy of H-atom in *n*th Bohr orbit is given by

$$E_n = \frac{-2.17\times10^{-18}}{n^2} J$$

2. Calculate the longest wavelength of light that will be needed to remove an electron from 3rd Bohr orbit of He^+ ion. Ans. 2060 Å.

3. The energies fo the electron in the second and third orbits of the hydrogen atom are -5.42 x 10^{-12} and -2.41 x 10^{-12} ergs respectively. Calculate the wavelength of the emitted radiation when the electron drops from the third to the second orbit. **Ans.6603.9 Å**

4. What is the maximum number of emission lines when the excited electron of an H atom in n = 5 drops to n = 2?

5. Calculate the number of waves made by Bohr electron in one complete revolution in its third orbit. [**Ans.** 3]

NCERT CORNER

1. What is the wavelength of light emitted when the electron in a hydrogen atom undergoes transition from an energy level with *n* = 4 to an energy level with *n* = 2? [NCERT]**[ANS. 486 nm]**

2. Calculate the energy required for the process
$He^+ (g) \rightarrow He^{2+} (g) + e^–$
The ionization energy for the H atom in the ground state is 2.18×10^{-18} J $atom^{-1}$. **[NCERT][ANS. *8.72 * 10^{-18} J*]**

3. What are the frequency and wavelength of a photon emitted during a transition from *n* = 5 state to the *n* = 2 state in the hydrogen atom? **ANS. 4.58×10^{-19}J , 434 nm**

4. Calculate the energy associated with the first orbit of He^+. What is the radius of this orbit? **ANS. 0.02645 nm**

5. Calcualte the shortest and longest wavelenghts in hydrogen spectrum of Balmer series. **Ans.** $9.117\times10^{-6} cm$

6. How much energy is required to ionise a H atom if the electron occupies n = 5 orbit? Compare your answer with the ionization enthalpy of H atom (energy required to remove the electron from n =1 orbit).**[NCERT] [ANS. 8.72 * 10^{-20} J, 2.18 * 10^{-18} J]**

7. The electron energy in hydrogen atom is given by En = (−2.18 × 10−18)/n2 J. Calculate the energy required to remove an electron completely from the *n* = 2 orbit. What is the longest wavelength of light in cm that can be used to cause this transition?**[NCERT][ANS. 5.45 × 10^{-19} J, 3647 A]**

8. (i) The energy associated with the first orbit in the hydrogen atom is −2.18 × 10−18 J atom−1. What is the energy associated with the fifth orbit?

(ii) Calculate the radius of Bohr's fifth orbit for hydrogen atom.**[NCERT][ANS. -8.72×10^{-20} J, 1.5236×10^{6} m^{-1}]**

9. What is the maximum number of emission lines when the excited electron of an H atom in n = 6 drops to the ground state? **[NCERT][ANS. 15]**

10. Emission transitions in the Paschen series end at orbit n = 3 and start from orbit n and can be represented as $v = 3.29 \times 10^{15}$ (Hz) $[1/3^2 - 1/n2]$. Calculate the value of n if the transition is observed at 1285 nm. Find the region of the spectrum. **Ans. $n \approx 5$**

11. What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition n = 4 to n = 2 of He+ spectrum?**[NCERT][ANS. n1 = 1and n2 = 2.]**

12. Calculate the wavelength for the emission transition if it starts from the orbit having radius 1.3225 nm and ends at 211.6 pm. Name the series to which this transition belongs and the region of the spectrum. **[NCERT][ANS.n1 = 5 and n2 = 2, 434 nm]**

HEISENBERG'S PRINCIPLE & DE BROGLIE HYPOTHESIS

SOLVED EXAMPLES

EX: On the basis of Heisenberg's uncertainty principle, show that the electron cannot exist within the nucleus.

Solution **Radius of the nucleus is of the order of 10^{-13} cm and thus uncertainty in position of electron, i.e., (Δx), if it is within the nucleus will be 10^{-13} cm.**

Now $\Delta x . \Delta u \geq \frac{h}{4\pi m}$

$$\Delta u = \frac{6.626\times10^{-27}}{4\times3.14\times9.108\times10^{-28}\times10^{-13}} = 5.79\times10^{12}$$

cm/sec

i.e., order of velocity of electron will be 100 times greater than the velocity of light which is impossible. Thus, possibility of electron to exist is nucleus is zero.

UNSOLVED QUESTIONS

1. Calculate the de Broglie wavelength of an electron travelling at 1% of the speed oflight.
Ans. 242.7 pm

2. Two particles A and B are in motion. If the wavelength associated with particle A is5×10^{-8} *m*, calculate the wavelength associated with particle B if its momentum is half of A.
Ans. 1.2278×10^{-10}*m*

3. Calcualte de Broglie wavelength of an electron that has been accelerated by a 100 volt potential difference.

4. The kinetic energy of an electron is 4.55×10^{-25} J. Calculate the wavelength. [$h=6.6\times10^{-34}$ *Js*; mass of electron $=9.1\times10^{-31}$ *kg*] **Ans. 0.72×10^{-6} *m***

5. At what velocity ratio are the wavelengths of an electron and a proton be equal?
($m . g_e = 9\ 1\times10^{-28}$ and $m\ g_p = 1.6725\times10^{24}$)
Ans. $\frac{v_e}{v_p} = 1.8\times10^{3}$

6. On the basis of Heisenberg's principle, show that an electron cannot exist in the atomic nucleus (radius of nucleus $=10^{-15}$ *m*, mass of electron $=9.1\times10^{-31}$ *kg* $h=6.626\times10^{-34}$ *Js*
Ans. 5.77×10^{10} *m / s*

7. Calculate the uncertainty in the position of a particle when the uncertainty in momentum is (a) 1×10^{-1} *g cm* sec^{-1} , (b)zero.
Ans. 0.527×10^{-24}

8. Calculate the uncertainty in velocity of a cricket ball of mass 150 g if the uncertaintyin its position is of the order of 1 A($h=6.6\times10^{-34}$ *kg* $m^2 s^{-1}$). **Ans. 3.5×10^{-24}*m / s***

9. A proton is accelerated to a velocity of 3×10^{7} ms^{-1} . If the velocity can be measured with a precision of $\pm$ 0.5%. calculate the uncertainty in the position of the proton.

Ans. $2.11\times10^{-13}m$

10. A molecule of O_2 and that of CH_4 travelwith same velocity. What is the ratio of their wavelengths? [**Ans.** 2]

11. Can the uncertainty principle be applied to a stationary electron? Explain.
Ans. No, when velocity is zero, the position becomes definite i.e., fixed. The position can be measured accurately.

12. Which is associated with a de Broglie wave of longer wavelength, a proton or an electron having same velocity?

13. Calculate the ratio between the wavelengths of an electron and a proton, If the proton is moving at half the velocity of the electron (mass of the proton $=1.67\times10^{-27}$ kg; mass of the electron $=9.11\times10^{-28}\,g$)

$$\frac{\lambda_e}{\lambda_p}=916.58$$

14. According to de Broglie, matter should exhibit dual behaviour, that is both particle and wave like properties. However, a cricket ball of mass 100 g doesnot move like a wave when it is thrown by a bowler at a speed of 100 km/h.
Calculate the wavelength of the ball and explain why it does not show wave nature.

15. A 1.0 g particle is shot from a gun with velocity of 100 m/sec. Calculate its de Brogiie wavelength.

16. Calculate the wavelength of a moving electron having 4.55×10^{-25}J . of kinetic energy.

17. Calculate the wavelength of an electron moving with a velocity of 2.05×10^{7} ms^{-1}

18. Two particles *A* and *B* are in motion. If the wavelength associated with particle *A* is 5×10^{-8} m, calculate the wavelength associated with particle *B* if its momentum is half of *A.*

19.A dust particle having mass equial to 10^{-4} g, diameter 10^{-4} cm and velocity 10^{-4} cm sec" . The error in measurement of velocity is 0.1%. Calculate uncertainty in its position. Comment on the result.

D.P. – 6

1. Calculate the wavelength of 1000 kg rocket moving with a velocity of 3000 km per hour, (*h = 6.626* x 10^{-34} Js).

2. The uncertainty in momentum of a particle is 3.31×10^{-2} kg m sec^{-1}. Calculate uncertainty in its position. **Ans. 1.5×10^{-33} m**

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3. The mass of an electron is 9.1×10^{-31} kg. If its K.E. is 3.0×10^{-25}**J,** calculate its wavelength.
Ans. 896.7 nm

4. Calculate the uncertainty in position of a dust particle with mass equal to 1 mg if the uncertainty in its velocity is $5.5\times10^{-20}\,m$ sec^{-1}
Ans. $9.59\times10^{-10}m$

5. Calculate the uncertainty in the velocity of a wagon of mass 2000 kg whose position is known to an accuracy of ±10 m.

6. Calculate the uncertainty in position of a dust particle with mass equal to 1 mg if the uncertainty in its velocity is 5.5×10^{-20} ms^{-1}

7.What is the speed and de Broglie wavelength of an electron that has been accelerated by a potential difference of 300 V?
Ans. 1.028×10^{7} ms^{-1}, 7.08×10^{-11} m

D.P. – 7

1. (a) if a 1 g body is travelling along the x-axis with an uncertainity in velocity of 1 cm/s, what is theoretical uncertainity in its position? (b) If an electron is travelling with uncertainity in velocity of 1 m/s, what is the theoretical uncertainity in its position?
Ans.(a) 3×10^{-30} m (b) 30m.

2.Calculate the uncertainity in velocity of a cricket ball (mass = 0.15 kg) if its uncertainity in position is of the order 0 1 Å.

Ans. 3.51 x 10^{-24} m sec^{-1}

3.With what velocity must an electron travel so that its momentum is equal to that of a photon of wavelength of = 5200 Å?

Ans. 1400 m sec^{-1}

D.P. – 8

1. What is the maximum precision with which the momentum of an electron can be known if the uncertainty in the position of electron is ±0.001Å ? Will there be any problem in describing the momentum if it has a value of $\frac{h}{2\pi a_0}$, where a_0 is Bohr's radius of first orbit, i.e., 0.529 Å? **Ans. 5.27 × 10^{-24} Ns**

2. Calculate the uncertainty in the position (Δx) of an electron, if Δv is 0.1 per cent. Take the velocity of electron = 2.2 × 10^6 m/s and mass of electron = 9.108 × 10^{-31} kg.

Ans. 0.02624765 × 10^{-6} m

NCERT CORNER

1. The mass of an electron is 9.1 × 10^{-31} kg. If its K.E. is 3.0 × 10^{-25} J, calculate its wavelength. **[NCERT][ANS. 8.9625 × 10^{-7} m.]**

2. If the velocity of the electron in Bohr's first orbit is 2.19 × 10^6 ms−1, calculate the de Broglie wavelength associated with it.**[NCERT][ANS. 332 pm]**

3. Calculate the mass of a photon with wavelength 3.6 Å. **ANS. 6.135 × 10^{-29} kg**

4. What will be the wavelength of a ball of mass 0.1 kg moving with a velocity of 10 m s^{-1}? **ANS. 6.626×10^{-34} m**

5. A microscope using suitable photons is employed to locate an electron in an atom within a distance of 0.1 Å. What is the uncertainty involved in the measurement of its velocity? **ANS. 5.79×10^6 m s^{-1}**

6. A golf ball has a mass of 40g, and a speed of 45 m/s. If the speed can be measured within accuracy of 2%, calculate the uncertainty in the position. **ANS. 1.46×10^{-33} m**

7. The velocity associated with a proton moving in a potential difference of 1000 V is 4.37× 10^5 ms−1. If the hockey ball of mass 0.1 kg is moving with this velocity, calculate thewavelength associated with this velocity. [NCERT][ANS.1.516×10^{-38} m]

8. Show that the circumference of the Bohr orbit for the hydrogen atom is an integral multiple of the de Broglie wavelength associated with the electron revolving around the orbit.

9. If the position of the electron is measured within an accuracy of + 0.002 nm, calculate the uncertainty in the momentum of the electron. Suppose the momentum of the electron is h/4πm × 0.05 nm, is there any problem in defining this value.**[NCERT]**
[ANS. 1.055 × 10^{-24} $kgms^{-1}$
Since the magnitude of the actual momentum is smaller than the uncertainty, the value cannot be defined.]

QUANTUM NOS. &ELECTRONIC CONFIG.

SOLVED EXAMPLES

EX: Answer the following :

(a) How many electrons can be filled in all the orbitals with n + *l* = 5 ?

(b) Which of the two is paramagnetic, V (IV) or V (V) and why ?

(c) How many unpaired electrons are present in Pd (Z = 46) ?

(d) The ion of an element has configuration [Ar] $3d^4$ in +3 oxidation state. What will be the electronic configuration of its atom ?

Solution (a)(n + *l*) = 5 has 5s, 4p and 3d orbitals with two, six and ten electrons respectively. Therefore, the total number of electrons are 18.

(b) The configurations are ; V (IV) ; $[Ar^{18}]\ 3d^1$ and V (V) : $[Ar]^{18}$. Therefore, V (IV) is paramagnetic in nature.

(c) The electronic configuration of the element palladium (Z = 46) is $[Kr]^{36}4d^{10}5s^0$. Therefore, it has no unpaired electron.

(d) The configuration of ion is [Ar] $3d^4$. Therefore, the configuration of the atom is [Ar] $3d^5 4s^2$.

EX: Calculate the spherical and planer nodes of following

(a)	4 d	(b)	6 p
(c)	5 f	(d)	5s

Answers **(a) a = 1, 2 (b) = 4, 1, (c) = 1,3 (d) = 4, 0**

UNSOLVED QUESTIONS

1. How many electrons can be accommodated at most in :
(i) $n = 4\ s = +1/2$ (ii) $n=5,\ l=3$
(iii) all the orbitals with $n=3$
(iv) $n=3,\ l=2, m=-1$ and $s=-1/2$
Ans. (i) 16, (ii) 14, (iii) 18, (iv) 1

2. Write the electronic configurations of the following ions: (a) H^- (b) Na^+ (c) O^{2-} (d) F^-

3. Which atoms are indicated by the following configurations?
(a) [He] $2s^1$ (b) [Ne] $3s^2\ 3p^3$ (c) [Ar] $4s^2\ 3d^1$.

4. What values are assigned to quantum numbers *n, l, m* for:
(a) 3s (b) *4pz* (c) $4d_{x^2-y^2}$ (d) $5d_{z^2}$.

5. Given below are the sets of quantum numbers for given orbitals. Name these orbitals.

(a) $n = 3$ $l = 1, m = -1$,
(b) $n = 5$ $l = 2, m = 0$
(c) $n = 4$ $l = 1, m = \pm 1$
(d) $n = 2$ $l = 0, m = 0$
(e) $n = 4$ $l = 2, m = \pm 2$

6. Calculate the angular momentum of the following:
(a) 3rd orbit, (b) 4p orbital,
(c) 3d orbital.

7. What are the numbers of nodes present is:
(a) Is (b) *2s,*
(c)2p, (d) *3p* orbitals ?

8. Which of the two paramagnetic : V^{4+} or V^{5+} and why?

9. Write the :
(a) $n + l$ value for 14th electron in an atom.
(b) Increasing order of filling electron in 4*f*, 5*p* and 6*d* subshells.
(c) *m* and *l* value for last electron of Mg atom. (Mg atomic number is 12)
(d) Subshell in which last electron is present in Ga. (Atomic number is 31)
(e) Sum of spin of all the electron in atomic number 14.

10. A neutral atom of an element has *2K, 8L, 9M* and *2N* electrons. Find out the following:
(a) Atomic no.,
(b) Total no. of s-electrons,
(c) Total no. of p-electrons,
(d) Total no. of d-electrons,
(e) Valency of element,
(f) No. of unpaired electrons.

11. If there were three possible values (-1/2, 0, +1/2) for the spin magnetic quantum number, ms how many elements would there be in the 4th period of periodic table in 4s, 4/p, 4*d* respectively.

12. Calculate total spin, magnetic moment for the atoms having at. no. 7, 24**,** 34 and 36.

13 .What are the four quantum numbers of 19th electron of copper ?

14. Which quantum number is not obtained from solution of Schrondinger wave equation?

15. How many electrons will be present in the sub-shells having m_s, value of -1/2 for $n = 4$?

D.P. – 9

1. Using *s*, *p*, *d*, *f* notations, describe the orbital with the followingquantum numbers.
(a) $n = 3$, $l = 0$, (b) $n = 4$, $l = 2$, (c) $n = 5$, $l = 3$, (d) $n = 1$, $l = 0$

2. Calculate:
(a) Total number of spherical nodes in 3*p* orbital.
(b) Total number of Nodal planes in 3*p* orbital.
(c) What is nodal planes in 3*d* orbital,

3. How many electrons may enter the orbital denoted by
(a) 2p (b) Is (c) 4f (d) 3*d*

4. Write down the elctronic configuration of Fe^{3+} and Ni^{2+}. How many unpaired electrons are present ?

5. An atom of an element has 13 electrons. Its nucleus has 14neutrons. Find out atomic no. and approximate atomic weight. Indicate the ' arrangement of electrons and the electrovalency of the element.

6. Give the name and atomic number of the inert gas atom in which the total number of d-electrons is equal to the difference between the numbers of total p and total s electrons.

7. What are the four quantum numbers of 19th electron of copper ?

NCERT CORNER

1. How many electrons in an atom may have the following quantum numbers?
(a) $n = 4$, $m_s = –½$ (b) $n = 3$, $l = 0$

2. Indicate the number of unpaired electrons in: (a) P, (b) Si, (c) Cr, (d) Fe and (e) Kr.
Ans. 3,2,6,4,0

3. The quantum numbers of six electrons are given below. Arrange them in order of increasing energies. If any of these combination(s) has/have the same energy lists:
1. $n = 4$, $l = 2$, $m_l = -2$, $m_s = -1/2$
2. $n = 3$, $l = 2$, $m_l = 1$, $m_s = +1/2$
3. $n = 4$, $l = 1$, $m_l = 0$, $m_s = +1/2$
4. $n = 3$, $l = 2$, $m_l = -2$, $m_s = -1/2$
5. $n = 3$, $l = 1$, $m_l = -1$, $m_s = +1/2$
6. $n = 4$, $l = 1$, $m_l = 0$, $m_s = +1/2$

Ans. 5(3*p*) < 2(3*d*) = 4(3*d*) < 3(4*p*) = 6(4*p*) <1 (4*d*).

4. What are the atomic numbers of elements whose outermost electrons are represented by (a) 3*s*1 (b) 2*p*3 and (c) 3*p*5?

5. (a) How many sub-shells are associated with $n = 4$? (b) How many electrons will be present in the sub-shells having m_s value of –1/2 for $n = 4$? **Ans.four sub-shells, 16**

6. Point out the followings : (a) How many energy subshells are possible in $n = 3$ level. (b) How many orbitals of all kinds are possible in $n = 3$ level.

7. Using *s*, *p*, *d* notations, describe the orbital with the following quantum numbers.

(a) $n = 1$, $l = 0$; **(b)** $n = 3$; $l = 1$

(c) $n = 4$; $l = 2$; **(d)** $n = 4$; $l = 3$.

8. Explain, giving reasons, which of the following sets of quantum numbers are **not** possible.

(a) $n = 0$, $l = 0$, $m_l = 0$, $m_s = + ½$
(b) $n = 1$, $l = 0$, $m_l = 0$, $m_s = – ½$
(c) $n = 1$, $l = 1$, $m_l = 0$, $m_s = + ½$
(d) $n = 2$, $l = 1$, $m_l = 0$, $m_s = – ½$
(e) $n = 3$, $l = 3$, $m_l = –3$, $m_s = + ½$
(f) $n = 3$, $l = 1$, $m_l = 0$, $m_s = + ½$

9. The bromine atom possesses 35 electrons. It contains 6 electrons in 2*p* orbital, 6 electrons in 3*p* orbital and 5 electrons in 4*p* orbital. Which of these electron experiences the lowest effective nuclear charge?
Answer
Among *p*-orbitals, 4*p* orbitals are farthest from the nucleus of bromine atom with (+35) charge. Hence, the electrons in the 4*p* orbital will experience the lowest effective nuclear charge. These electrons are shielded by electrons present in the 2*p* and 3*p* orbitals along with the *s*-orbitals. Therefore, they will experience the lowest nuclear charge.

10. Among the following pairs of orbitals which orbital will experience the larger effective nuclear charge? (i) 2*s* and 3*s*, (ii) 4*d* and 4*f*, (iii) 3*d* and 3*p*
Ans. (i) 2*s* orbital, (ii) 4*d* , (iii) 3*p*

COMPETITION SECTION

OBJECTIVE QUESTIONS (STRUCTURE OF ATOM)

1. Increasing order (lowest first) for the values of e/m for electron (e), proton (p), neutron (n) and α-particles is [Indraprastha CET 2009,CG PET 2009]
   1) e, p, n, α 2) n, α, p, e
   3) n, p, e, α 4) n, p, α, e
2. The wavelength of a spectral line emitted by hydrogen atom in the Lyman series is $\frac{16}{15R}$ cm. What is the value of n_2?(R=Rydberg constant) [EAMCET 2007]
   1) 2 2) 3
   3) 4 4) 1
3. The wave number of the spectral line in the emission spectrum of hydrogen will be equal to $\frac{8}{9}$ times the Rydberg's constant if the electron jumps from [KCET 2010]
   1) $n = 3$ to $n = 1$ 2) $n = 10$ to $n = 1$
   3) $n = 9$ to $n = 1$ 4) $n = 2$ to $n = 1$
4. The energy of hydrogen atom in its ground state is −13.6 eV. The energy of the level corresponding to the quantum number n=5 is [MHT CET 2006]
   1) −5.4 eV 2) −0.54 eV
   3) −2.72 eV 4) −0.85 eV
5. The number of photons emitted per second by a 60 W source of monochromatic light of wavelength 663 nm is ($h = 6.63 \times 10^{-34}$Js) [Kerala CEE 2009]
   1) 4×10^{-20} 2) 1.54×10^{20}
   3) 3×10^{-20} 4) 2×10^{20}
   5) 1×10^{-20}
6. If the ionisation potential for hydrogen atom is 13.6 eV, then the ionisation potential for He^{+}ion should be [Manipal 2003]
   1) 13.6 eV 2) 6.8 eV
   3) 54.4 eV 4) 72.2 eV
7. Angular momentum of an electron in the n th orbit of hydrogen atom is given by [RPET 2005]
   1) $\frac{nh}{2\pi}$ 2) nh
   3) $\frac{2\pi}{nh}$ 4) $\frac{\pi}{2nh}$
8. The energy of an electron in first Bohr orbit of H-atom is −13. 6 eV. The possible energy value of electron in the excited state of Li^{2+} is [WB JEE 2011]
   1) −122.4 eV 2) 30.6 eV
   3) −30.6 eV 4) 13.6 eV
9. Energy of photon of visible light is [DCE 2006]
   1) 1 eV 2) 1 MeV
   3) 1 eV 4) 1 keV
10. Zeeman effect refers to the [Manipal 2006]
    1) Splitting up of the lines in an emission spectrum in the presence of an external electrostatic field 2) Random scattering of light by colloidal particles
    3) Splitting up of the lines in an emission spectrum in a magnetic field 4) Emission of electrons from metals when light falls upon them
11. Which hydrogen like species will have same radius as that of Bohr orbit hydrogen atom? [IIT JEE 2004]
    1) $n = 2, Li^{2+}$ 2) $n = 2, Be^{3+}$
    3) $n = 2, He^{+}$ 4) $n = 3, Li^{2+}$
12. The velocity of electron in first orbit of H-atoms as compared to the velocity of light is [BITSAT 2005]
    1) $\frac{1}{10}$th 2) $\frac{1}{100}$th
    3) $\frac{1}{1000}$th 4) Same
13. The maximum energy is possessed by an electron, when it is present [Manipal 2004]
    1) In nucleus 2) In ground state
    3) In first excited state 4) At infinite distance from the nucleus
14. The ionisation energy of hydrogen atom is 13.6 eV. What will be the ionisation energy of He^{+}? [WB JEE 2007]
    1) 13.6 eV 2) 54.4 eV
    3) 122.4 eV 4) Zero
15. The ionisation enthalpy of hydrogen atom is 1.312×10^{6}Jmol^{-1}. The energy required to excite the electron in the atom from $n_1 = 1$ to $n_2 = 2$ is [AIEEE 2008]
    1) 8.51×10^{5} J mol^{-1} 2) 6.56×10^{5} J mol^{-1}
    3) 7.56×10^{5} J mol^{-1} 4) 9.84×10^{5} J mol^{-1}
16. Magnitude of kinetic energy in an orbit is equal to [BCECE 2005]
    1) Half of the potential energy 2) Twice of the potential energy
    3) One fourth of the potential energy 4) None of the above
17. The velocities of two particles A and B are

0.05 and $0.02 ms^{-1}$ respectively. The mass of B is five times the mass of A. The ratio of their de-Broglie's wavelength is [BITSAT 2008,AMU 2008,EAMCET 2008]

1) 2: 1 2) 1: 4
3) 1: 1 4) l4: 1

18. Electron density in the YZ plane of $3d_{x^2-y^2}$ orbital is [J&K CET 2008]

1) Zero 2) 0.50
3) 0.75 4) 0.90

19. The number of radial nodes of $3s$ and $2p$-orbitals are respectively [IIT JEE 2005]

1) 2, 0 2) 0, 2
3) 1, 2 4) 2, 11

20. In an atom, an electron is moving with a speed of 600 m/s with an accuracy of 0.005%. Certainity with which the position of the electron can be located is [AIEEE 2010]

1) 1.52×10^{-4}m 2) 5.10×10^{-3}m
3) 1.92×10^{-3}m 4) 3.84×10^{-3}m

21. Calculate the wavelength (in nanometer) associated with a proton moving at $1.0 \times 10^3 ms^{-1}$ (Mass of proton $= 1.67 \times 10^{-27}$kg and $h = 6.63 \times 10^{-34}$ Js) [AIEEE 2009]

1) 0.032 nm 2) 0.40 nm
3) 2.5 nm 4) 14.0 nm

22. The uncertainty in the momentum of an electron is 1.0×10^{-5}kg ms^{-1}. The uncertainty in its position will be [DCE 2005]

1) 1.50×10^{-28}m 2) 1.05×10^{-26}m
3) 5.27×10^{-30}m 4) 5.25×10^{-28}m

23. Which of the following is related with both wave nature and particle nature? [UP SEE 2003]

1) Interference 2) $E = mc^2$
3) Diffraction 4) $E = hv$

24. What accelerating potential is needed to produce an electron beam with an effective wavelength of 0.090Å? [Guj CET 2006]

1) 1.86×10^4eV 2) 1.86×10^2eV
3) 2.86×10^4eV 4) 2.86×10^2eV

25. The uncertainties in the velocities of two particles A and B are 0.05 and $0.02 ms^{-1}$ respecively. The mass of B is five times to that of mass A. What is the ratio of uncertainties $\left(\frac{\Delta x_A}{\Delta x_B}\right)$ in their positions? [EAMCET 2006]

1) 2 2) 0.25
3) 4 4) 1

26. A body of mass 10 mg is moving with a velocity of $100 ms^{-1}$. The wavelength of de-Broglie wave associated with it would be ($h = 6.63 \times 10^{-34}$Js) [KCET 2007]

1) 6.63×10^{-35}m 2) 6.63×10^{-34}m
3) 6.63×10^{-31}m 4) 6.63×10^{-37}m

27. Electron behaves both as a particle and a wave. This was proposed by [AMU 2003]

1) Heisenberg 2) Gilbert N. Lewis
3) de-Broglie 4) L. Rutherford

28. Uncertainty in position of a particle of 25 g in space is 10^{-5}m. Hence, uncertainty in velocity (ms^{-1}) is (Planck's constant $h = 6.6 \times 10^{-34}$Js) [JamiaMilliaIslamia 2005]

1) 2.1×10^{-28} 2) 2.1×10^{-34}
3) 0.5×10^{-34} 4) 5.0×10^{-24}

29. The de-Broglie equation applies [MP PET 2004]

1) To protons only 2) To electrons only
3) All the material objects in motion 4) To neutrons only

30. If helium atom and hydrogen molecules are moving with the same velocity, their wavelength ratio will be [MP PET 2010]

1) 4: 1 2) 1: 2
3) 2: 1 4) 1: 4

31. A particle having a mass of 1.0 mg has a velocity of 3600 km/h. Calculate the wavelength of the particle [Guj CET 2010]

1) 6.626×10^{-28}cm 2) 6.626×10^{-29}cm
3) 6.626×10^{-30}cm 4) 6.626×10^{-31}cm

32. If the quantum number for the 5th electron in carbon atoms are 2,1,1,+1/2, then for the 6th electron, these values would be [RPET 2010]

1) $2, 1, 0, -\frac{1}{2}$ 2) $2, 0, 1, +\frac{1}{2}$
3) $2, 1, 1, -\frac{1}{2}$ 4) $2, 1, -1, + -\frac{1}{2}$

33. Which of the following sets of quantum number is correct for an electron in $4f$-orbital? [JamiaMilliaIslamia 2007]

1) $n = 4, l = 3, m = +4, s = +1/2$ 2) $n = 4, l = 4, m = -4, s = -1/2$
3) $n = 4, l = 3, m = +1, s = +1/2$ 4) $n = 3, l = 2, m = -2, s = +1/2$

34. Which one of the following set of quantum numbers is not possible for electron in the ground state of an atom with atomic number 19? [Kerala CEE 2006]

1) $n = 2, l = 0, m = 0$ 2) $n = 2, l = 1, m = 0$
3) $n = 3, l = 1, m = -1$ 4) $n = 3, l = 2, m = +2$
5) $n = 4, l = 0, m = 0$

35. The correct set of quantum numbers

(n, l and m respectively) for the unpaired electron of chlorine atom is [Kerala CEE 2004]
1) 2, 1, 0 2) 2, 1, 1
3) 3, 1, 1 4) 3, 2, 1
5) 3, 2, -1

36. Which of the following statement is relation to the hydrogen atom is correct? [AIEEE 2005]
1) $3s$, $3p$ and $3d$-orbitals all have the same energy
2) $3s$ and $3p$-orbitals is lower energy than $3d$-orbital
3) $3p$-orbital is lower in energy than $3d$-orbital
4) $3s$-orbital is lower in energy than $3p$-orbital

37. The maximum number of electron in p-orbital with $n = 5, m = 1$ is [JamiaMilliaIslamia 2004]
1) 6 2) 2
3) 14 4) 10

38. What is the maximum number of electrons in an atom that can have the following quantum numbers [Guj CET 2008]
1) 4 2) 15
3) 3 4) 6

39. If $n = 3, l = 0$ and $m = 0$, then atomic number is [BCECE 2004]
1) 12 or 13 2) 13 or 14
3) 10 or 11 4) 11 or 12

40. Which one of the following sets of quantum numbers represents the highest energy level in an atom? [KCET 2011]
1) $n = 4, l = 0, m = 0, s = +\frac{1}{2}$
2) $n = 3, l = 1, m = 1, s = +\frac{1}{2}$
3) $n = 3, l = 2, m = -2, s = +\frac{1}{2}$
4) $n = 3, l = 0, m = 0, s = +\frac{1}{2}$

41. The maximum number of electrons that can have principle quantum number, $n = 3$ and spin quantum number, $m_s = -\frac{1}{2}$, is [IIT JEE 2011]
1) 3 2) 5
3) 7 4) 9

42. When the azimuthal quantum number has the value of 2, the number of orbitals possible are [KCET 2008]
1) 7 2) 5
3) 3 4) 0

43. An electron with values 4, 2, -2 and $+1/2$ for the set of four quantum numbers n, l, m_l and s respectively, belongs to [AMU 2004]
1) $4s$-orbital 2) $4p$-orbital
3) $4d$-orbital 4) $4f$-orbital

44. The correct set of four quantum number for the valence electron of rubidium (Z=37) is [BCECE 2003]
1) $n = 5, l = 0, m = 0, s = +1/2$
2) $n = 5, l = 1, m = 1, s = +1/2$
3) $n = 5, l = 1, m = 1, s = +1/2$
4) $n = 6, l = 0, m = 0, s = +1/2$

45. Which combinations of quantum numbers n, l, m and s for the electron in an atom does not provide a permissible solution of the wave equation? [Manipal 2006]
1) $3, 2, 1, \frac{1}{2}$ 2) $3, 1, 1, -\frac{1}{2}$
3) $3, 3, 1, -\frac{1}{2}$ 4) $3, 2, -2, \frac{1}{2}$

46. The electrons identified by quantum numbers
1. $n = 4, l = 1$
2. $n = 4, l = 0$
3. $n = 3, l = 2$
4. $n = 2, l = 1$

Can be placed in order of increasing energy from the lowest to highest as [J&K CET 2003]
1) IV<II<III<I 2) II<IV<I<III
3) I<III<II<IV 4) III<I<IV<II

47. Which of the following is not possible? [BCECE 2007]
1) $n = 2, l = 1, m = 0$
2) $n = 2, l = 0, m = -1$
3) $n = 3, l = 0, m = 0$
4) $n = 3, l = 1, m = -1$

48. The number of electrons accommodated in an orbit with principle quantum number 2, is [J&K CET 2007]
1) 2 2) 6
3) 10 4) 8

49. The orbital angular momentum of an electron in a d-orbital is [DCE 2007]
1) $\sqrt{6}\frac{h}{2\pi}$ 2) $\sqrt{2}\frac{h}{2\pi}$
3) $\frac{h}{2\pi}$ 4) $\frac{2h}{2\pi}$

50. Which of the following is correct for number of electrons, number of orbitals respectively in n-orbit? [Guj CET 2011]
1) 4, 4 and 8 2) 4, 8 and 16
3) 32, 16 and 4 4) 4, 16 and 32

51. An electron with values 4, 3, -2 and $+\frac{1}{2}$ for the set of four quantum numbers n, l, m_1 and m_s, respectively, belongs to [AMU 2005]
1) $4s$ orbital 2) $4p$ orbital

3) $4d$ orbital 4) $4f$ orbital

52. The set of quantum numbers for the outermost electron for copper in its ground state is [KCET 2010]
1) $4, 1, 1, +\frac{1}{2}$ 2) $3, 2, 2, +\frac{1}{2}$
3) $4, 0, 0, +\frac{1}{2}$ 4) $4, 2, 2, +\frac{1}{2}$

53. Non-directional orbital is [BCECE 2006]
1) $4p$ 2) $4d$
3) $4f$ 4) $3s$

54. What is the electronic configuration of Mn^{2+}? [BCECE 2008]
1) $[Ne]3d^5, 4s^0$ 2) $[Ar]3d^5, 4s^2$
3) $[Ar]3d^5, 4s^0$ 4) $[Ne]3s^5, 4s^2$

55. According to aufbau principle, the correct order of energy of $3d$, $4s$and $4p$-orbitals is [J&K CET 2006]
1) $4p < 3d < 4s$ 2) $4s < 4p < 3d$
3) $4s < 3d < 4p$ 4) $3d < 4s < 4p$

56. The total number of electrons present in all the 's' orbitals, all the 'p' orbitals and all the 'd' orbitals of cesium ion are respectively [DCE 2008]
1) 8, 26, 10 2) 10, 24, 20
3) 8, 22, 24 4) 12, 20, 22

57. What is the atomic number of the element with M^{2+} ion having electronic configuration $[Ar]3d^8$? [Guj CET 2009]
1) 25 2) 28
3) 27 4) 26

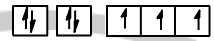
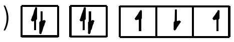
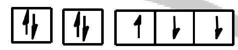
58. Which of the following elements has least number of electrons in its M-shell? [EAMCET 2004]
1) K 2) Mn
3) Ni 4) Sc

59. Correct energy value order is [OJEE 2004]
1) $ns, np, nd, (n-1)f$ 2) $ns, np, (n-1)d, (n-2)f$
3) $ns, np, (n-1)d, (n-1)f$ 4) $ns, (n-1)d, np, (n-1)f$

60. Aufbau principle does not give the correct arrangement of filling up of atomic orbital's in [J&K CET 2003]
1) Cu and Zn 2) Co and Zn
3) Mn and Cr 4) Cu and Cr

61. No two electrons can have the same values of .... quantum numbers. [UP SEE 2004]
1) One 2) Two
3) Three 4) Four

62. What does the electronic configuration $1s^2, 2s^2, 2p^5, 3s^1$ indicate? [Guj CET 2010]
1) Ground state of fluorine 2) Excited state of fluorine
3) Excited state of neon 4) Excited state of the O_2^- ion

63. Ground state electronic configuration of nitrogen atom can be represented as [J&K CET 2003]
1)  2) 
3)  4) 

64. Which of the following has the maximum number of unpaired 'd' electrons? [KCET 2008]
1) Zn^{2+} 2) Fe^{2+}
3) Ni^{3+} 4) Cu^{+}

65. The atomic numbers of elements X, Y and Z are 19, 21 and 25 respectively. The number of electrons present in the M-shell of these elements follow the order [EAMCET 2005]
1) $Z > X > Y$ 2) $X > Y > Z$
3) $Z > Y > X$ 4) $Y > Z > X$

66. Which of the following electronic configuration is not possible? [MHT CET 2003]
1) $1s^2, 2s^2$ 2) $1s^2, 2s^2 2p^6$
3) $[Ar]3d^{10}, 4s^2 4p^2$ 4) $1s^2, 2s^2 2p^2, 3s^1$

67. The highest number of unpaired electrons are in [DCE 2007]
1) Fe 2) Fe^{2+}
3) Fe^{3+} 4) All have equal number of unpaired electrons

68. The potential energy of an electron present in the ground state of Li^{2+} ion is
1) $+\frac{3e^2}{4\pi\varepsilon_0 r}$ 2) $-\frac{3e}{4\pi\varepsilon_0 r}$
3) $-\frac{3e^2}{4\pi\varepsilon_0 r}$ 4) $-\frac{3e^2}{4\pi\varepsilon_0 r^2}$

69. Choose the incorrect relation on the basis of Bohr's theory
1) Velocity of electron $\propto \frac{1}{n}$ 2) Frequency of revolution $\propto \frac{1}{n^2}$
3) Radius of orbit $\propto n^2 Z$ 4) Force on electron $\propto \frac{1}{n^4}$

70. The radius of which of the following orbit is same as that of the first Bohr's orbit of hydrogen atom?
1) $Li^{2+}(n = 2)$ 2) $Li^{2+}(n = 3)$
3) $Be^{3+}(n = 2)$ 4) $He^{+}(n = 2)$

71. According to Bohr's theory, the angular momentum for an electron of 3rd orbit is

1) $3h$ 2) $1.5h$
3) $9h$ 4) $2\frac{h}{\pi}$

72. Which of the following electron transition in hydrogen atom will require largest amount of energy?
1) From $n = 1$ to $n = 2$ 2) From $n = 2$ to $n = 3$
3) From $n = \infty$ to $n = 1$ 4) From $n = 3$ to $n = 5$

73. The velocity of an electron placed in 3rd orbit of H atom, will be
1) 2.79×10^7 cm/s 2) 9.27×10^{27} cm/s
3) 7.29×10^7 cm/s 4) 92.7×10^7 cm/s

74. If E_e, E_α and E_p represent the kinetic energies of an electron, alpha particle and a proton respectively, each moving with same de-Broglie wavelength then
1) $E_e = E_\alpha = E_p$ 2) $E_e > E_\alpha > E_p$
3) $E_\alpha > E_p > E_e$ 4) $E_e > E_p > E_\alpha$

75. If the kinetic energy of an electron is increased four times, the wavelength of the de-Broglie wave associated with it would becomes
1) Half times 2) $\frac{1}{4}$ times
3) Four times 4) Two times

76. The mass of an electron is m, its charge is e and it is accelerated from rest through a potential difference, V. The velocity of electron will be calculated by formula
1) $\sqrt{\frac{V}{m}}$ 2) $\sqrt{\frac{eV}{m}}$
3) $\sqrt{\left(\frac{2eV}{m}\right)}$ 4) None of these

77. Which of the following particles moving with same velocity would be associated with smaller de-Broglie wavelength?
1) Helium molecule 2) Oxygen molecule
3) Hydrogen molecule 4) Carbon molecule

78. The wave nature of electron is verified by
1) De-Broglie 2) Davisson and Germer
3) Rutherford 4) All of these

79. What is the mass of a photon of sodium light with a wavelength of 5890 Å? ($h = 6.63 \times 10^{-27}$ erg-s)
1) 5.685×10^{-33} g 2) 6.256×10^{-33} g
3) 4.256×10^{-33} g 4) 3.752×10^{-33} g

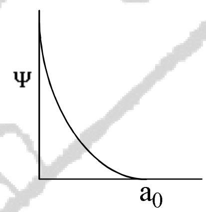
80. Heisenberg's uncertainty principle has no significance for a moving
1) Proton 2) Neutron
3) Electron 4) Cricket ball

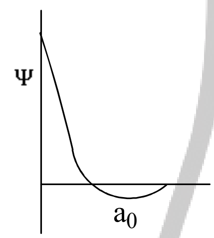
81. The de-Broglie wavelength relates to applied voltage rorα-particles as
1) $\lambda = \frac{12.3Å}{\sqrt{V}}$ 2) $\lambda = \frac{0.286}{\sqrt{V}}Å$
3) $\lambda = \frac{0.101}{\sqrt{V}}Å$ 4) $\lambda = \frac{0.856}{\sqrt{V}}Å$

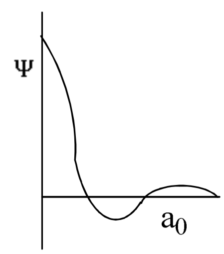
82. The uncertainty in momentum of an electron is 1×10^{-5} kg m/s. the uncertainty in its position will be ($h = 6.62 \times 10^{-34}$ kg m^2/s)
1) 2.36×10^{-28}m 2) 5.25×10^{-28}m
3) 2.27×10^{-30}m 4) 5.27×10^{-30}m

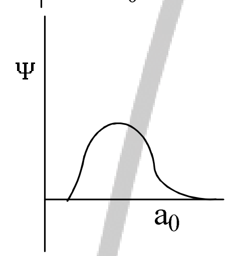
83. What is the wavelength of an α-particle having mass 6.6×10^{-27} kg moving with a speed of 10^5 cm s^{-1}? ($h = 6.6 \times 10^{-34}$kg m^2 − s)
1) 2×10^{-12} m 2) 3×10^{-10} m
3) 1×10^{-10} m 4) 2×10^{-10} m

84. The graph representing node is

1)


2)


3)


4)


85. Choose the incorrect statement
1) The shape of an atomic orbital depends upon the azimuthal quantum number
2) The orientation of an atomic orbital depends upon the magnetic quantum number
3) The energy of an electron in an atomic orbital of multi-electron atom depends on principal quantum number
4) The number of degenerate atomic orbitals of one type depends on the value of azimuthal and magnetic quantum numbers

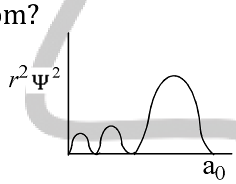
86. The number of spherical nodes in $3p$ orbitals is

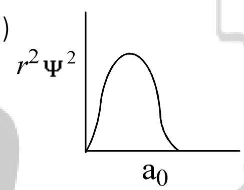
1) 0 2) 1
3) 2 4) 3

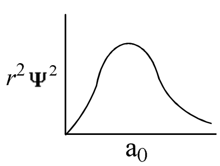
87. The magnitude of the spin angular momentum of an electron is given by
1) $S = \sqrt{s(s+1)}\dfrac{h}{2\pi}$ 2) $S = s\dfrac{h}{2\pi}$
3) $S = \dfrac{3}{2} \times \dfrac{h}{2\pi}$ 4) None of these

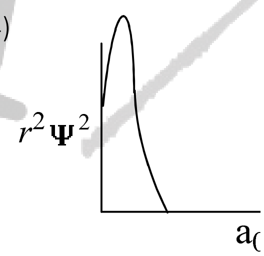
88. The quantum numbers $+\frac{1}{2}$ and $-\frac{1}{2}$ for an electron represent
1) Rotation of electron in clockwise and anticlockwise direction respectively
2) Rotation of electron in anticlockwise and clockwise direction respectively
3) Magnetic moment of electron pointing up and down respectively
4) Two quantum mechanical spin states which have no classical analogue

89. The number of waves in an orbit are
1) n^2 2) n
3) $n-1$ 4) $n-2$

90. Which of the following radial distribution graphs correspond to $n = 3, l = 2$ for an atom?
1)


2)


3)


4)


91. Four different sets of quantum numbers for 4 electrons are given below
$e_1 = 4, 0, 0, -\frac{1}{2} : e_2 = 3, 1, 1, -\frac{1}{2}$
$e_3 = 3, 2, 2, +\frac{1}{2} : e_4 = 3, 0, 0, +\frac{1}{2}$
The order of energy of e_1, e_2, e_3 and e_4 is
1) $e_1 > e_2 > e_3 > e_4$ 2) $e_4 > e_3 > e_2 > e_1$
3) $e_3 > e_1 > e_2 > e_4$ 4) $e_2 > e_3 > e_4 > e_1$

92. A particle A moving with a certain velocity has the de-Broglie wavelength of 1 A°. For particle B with mass 25% of A and velocity 75% of A, calculate the de-Broglie wavelength
1) 3 A° 2) 5.33 A°
3) 6.88 A° 4) 0.48 A°

93. Which of the following represents isotones ?
(1) $_{6}C_{12}$ $_{6}C_{13}$ $_{6}C_{14}$ (2) $_{18}Ar_{38}$ $_{19}K_{39}$ $_{20}Ca_{40}$
(2) $_{8}O_{16}$ $_{8}O_{18}$ (4) $_{32}Ge_{77}$ $_{33}As_{77}$

94. An element has atomic number 30 it contains two unit positive charge, how many proton and
electrons are present in cation respectively ?
(1) 30, 28 (2) 28, 30
(3) 28, 28 (4) 30, 30

95. For a given value of n (principal quantum number) the energy of different subshells can be arranged in order of :-
(1) f > d > p > s (2) s > p > d > f
(3) f > p > d > s (4) s > f > p > d

96. How many number of orbitals are possible in
L-energy level ?
(1) 2 (2) 4 (3) 6 (4) 1

97. The radius of second stationary orbit in Bohr's
atom in R. The radius of 3_{rd} orbit will be :-
(1) 9R (2)R/4
(3)9R/4 (4) 2R

98. Which of the following sets of quantum numbers are correct ?
(1) n = 1 l = 1 m = +2
(2) n = 2 l = 1 m = +1
(3) n = 3 l = 2 m = –2
(4) n = 3 l = 4 m = –2

99. 1 KW radiotransmitter operates at frequency of 800 Hz, how many photons per sec. does it emit:-
(1) $1.6 \times 10_{31}$ (2) $6.023 \times 10_{33}$
(3) $1.86 \times 10_{32}$ (4) $2.85 \times 10_{16}$

100. If m is the magnetic quantum number and ・ is the azimuthal quantum number then :-
(1) m = l + 2 (2) $m = 2l^2 + 1$
(3) l =(m -1)/2 (4) l = 2m + 1

101. An element with mass no. 81 contains 31.7% more neutron as compared to protons so atomic no. is :-
(1) 35 (2) 42
(3) 55 (4) 13

102. In millikans oil drop experiment the charge on oil droplet was found to be –1.282 × 10^{-18} C. How many e^- will be present in oil droplet ?
(1) 4 (2) N_A
(3) 8 (4) $6N_A$

103. How many no. of orbitals associated with the principal quantum no. n = 3 ?
(1) 8 (2) 3
(3) 9 (4) 16

104. Which of the following transition in H atom will emit maximum frequency of photon ?
(1) n = 4 to n = 1 (2) n = 2 to n = 1
(3) n = 4 to n = 2 (4) n = 1 to n = 5

105. The speed of an e^- in Bohr orbit of is proportional to :-
(1)Z/n (2)n^2/Z
(3)Z/n (4) Z/n^2

106. The difference in angular momentum associated with the e^- in two successive orbits of atom is :-
(1) $\frac{h}{\pi}$ (2) $\frac{h}{2\pi}$
(3) $\frac{h}{2}$ (4) $(n-1)\frac{h}{Z}$

107. A hydrogen atom is in its ground state absorbs a photon. The optimum energy of such a photon is :-
(1) 1.5 eV (2) 3.4 eV
(3) 10.2 eV (4) 13.6 eV

108. Which of the following configuration does not follow Hund's rule of maximum multiplicity ?
(1) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$
(2) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6$
(3) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$
(4) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4\ 4s^2$

109. Electron is in one of the 3d orbitals. What are the possible values of n, l and m for this electron ?
(1) n = 3 l = 0 m = 0
(2) n = 3 l = 1 m = –1,0,+1
(3) n = 3 l = 2 m = –2,–1,0,+1,+2
(4) n = 3 l = 3 m = –3,–2,–1,0,+1,+2,+3

110. Electromagnetic radiation of wavelength 242 nm is just sufficient to ionize the sodium atom. What is the ionization energy of sodium per atom ?
(1) 494.5 × 10^{-6} J/atom
(2) 3169.5 × 10^{-10} J/atom
(3) 5.85 × 10^{-15} J/atom
(4) 8.214 × 10^{-19} J/atom

111. The potential energy of an electron in the hydrogen atom is –6.8 eV. Indicate in which excited state, the electron is present :-
(1) First (2) Second
(3) Third (4) Fourth

112. Calculate the minimum and maximum number of electrons which have magnetic quantum number m = +1 and spin quantum number. s = –½ in chromium (Cr) :-
(1) 4, 6 (2) 2, 3
(3) 0, 1 (4) 1, 2

113. The orbital angular momentum of 3p electron is:-
(1) Zero (2) $\sqrt{2}h/2\pi$
(3) $\sqrt{3}h$ (4) $\sqrt{6}h$

114. If the velocity of a particle is reduced to 1/3rd, then percentage increase in its De-Broglie wavelength will be :-
(1) 100% (2) 200%
(3) 50% (4) 33.3%

115. Few electrons have following quantum numbers:-
(a) n = 4,l = 1 (b) n = 4, l = 0
(c) n = 3, l = 2 (d) n = 3, l = 1
Arrange them in increasing order of energy :-
(1) d < b < c < a (2) b < d < a < c
(3) a < c < b < d (4) c < a < d < b

116. The region where probability density function
reduces to zero is called :-
(1) probability density region
(2) nodal surface
(3) orientation surface
(4) wave function

117. If the velocity of an electron in Bohr's first orbit is 2.19×10^6 m/s, what will be the de Broglie
wavelength associated with it ?
(1) 2.19×10^{-6} m (2) 4.38×10^{-6} m
(3) 3.32×10^{-10} m (4) 3.32×10^6 m

118. An element with mass number of 81 contains 31.7 % more neutrons as compared to protons. Find the symbol of the atom :-
(1) $_{34}Se^{81}$ (2) $_{35}Br^{81}$
(3) $_{36}Kr^{81}$ (4) $_{37}Rb^{81}$

119. Which of the following representation of excited
state of atom is impossible ?
(1) [Ne] $3s^2 3p^6 4s^1 3d^6$ (2) [Ne] $1s^2 2p^2 2p^7 3s^2$
(3) $1s^1 2s^1$ (4) [Ne] $3s^2 3p^3 4s^1$

120. In argon atom how many electrons have m = 1 ?
(1) 4 (2) 2 (3) 1 (4) 6

121. The set of quantum nos n = 3, l = 2, m = 0 :-
(1) describes one of the five orbitals of similar type
(2) describes an electron in a 2s orbital
(3) is not allowed
(4) describes an electron in a 3p orbital

122. Which of the following statements about an
electron with m· = +2 is incorrect ?
(1) The electron may have m_s =1/2
(2) The electron is not in a d orbital
(3) The electron could be in the third shell
(4) The electron is in a non spherical orbital

ANSWER KEY

1)	2	2)	3	3)	1
4)	2	5)	4	6)	3
7)	1	8)	3	9)	1
10)	3	11)	3	12)	2
13)	4	14)	2	15)	4
16)	1	17)	1	18)	1
19)	1	20)	3	21)	2
22)	3	23)	4	24)	1
25)	1	26)	3	27)	3
28)	1	29)	3	30)	2
31)	2	32)	4	33)	3
34)	4	35)	3	36)	1
37)	2	38)	4	39)	4
40)	3	41)	4	42)	2
43)	3	44)	1	45)	3
46)	1	47)	2	48)	4
49)	1	50)	3	51)	4
52)	3	53)	4	54)	3
55)	3	56)	2	57)	2
58)	1	59)	4	60)	4
61)	4	62)	3	63)	1
64)	2	65)	3	66)	4
67)	3	68)	3	69)	3
70)	3	71)	1	72)	1
73)	3	74)	4	75)	1
76)	3	77)	2	78)	2
79)	4	80)	4	81)	3
82)	4	83)	3	84)	3
85)	3	86)	2	87)	1
88)	4	89)	2	90)	3
91)	3	92)	2		
93)	2	94)	1	95)	1
96)	2	97)	3	98)	2
99)	3	100)	3	101)	1
102)	3	103)	3	104)	1
105)	1	106)	2	107)	4
108)	4	109)	3	110)	4
111)	1	112)	2	113)	2
114)	2	115)	1	116)	2
117)	3	118)	2	119)	2
120)	1	121)	1	122)	2

(Previous Year Questions)

AIPMT/NEET & AIIMS (2006-2016)

AIPMT 2008

1. If uncertainty in position and momentum are equal, then uncertainty in velocity is ?

(1) $\sqrt{\frac{h}{\pi}}$ (2) $\frac{1}{2m}\sqrt{\frac{h}{\pi}}$

(3) $\sqrt{\frac{h}{2\pi}}$ (4) $\frac{1}{m}\sqrt{\frac{h}{\pi}}$

2. The measurement of the electron position is associated with an uncertainty in momentum, which is equal to 1×10^{-18} g cm s^{-1} . the uncertainty in electron velocity is : (mass of electron = 9×10^{-28}g)

(1) 1×10^{11} cm s^{-1} (2) 1×10^{9} cm s^{-1}

(3) 1×10^{6} cm s^{-1} (4) 1×10^{5} cm s^{-1}

AIPMT 2009

3. Maximum number of electrons in a subshell of an atom is determined by the following :-

(1) $2n^2$ (2) $4\ell + 2$ (3) $2\ell + 1$ (4) $4\ell - 2$

4. Which of the following is not permissible arrangement of electrons in an atom ?

(1) n = 3, ℓ = 2, m = -2, s = -1/2

(2) n = 4, ℓ = 0, m = 0, s = -1/2

(3) n = 5, ℓ = 3, m = 0, s = +1/2

(4) n = 3, ℓ = 2, m = -3, s = -1/2

AIPMT 2010

5. A 0.66 kg ball is moving with a speed of 100 m/s. The associated wavelength will be (h = 6.6×10^{-34} Js) :-

(1) 6.6×10^{-34} m (2) 1.0×10^{-34} m

(3) 1.0×10^{-32} m (4) 6.6×10^{-32} m

AIPMT Pre-2011

6. The total number of atomic orbitals in fourth energy level of an atom is :-

(1) 8 (2) 16 (3) 32 (4) 4

7. The energies E_1 and E_2 of two radiations are 25 eV and 50eV respectively. The relation between their wavelengths i.e. λ_1 and λ_2 be :

(1) $\lambda_1 = \lambda_2$ (2) $\lambda_1 = 2\lambda_2$

(3) $\lambda_1 = 4\lambda_2$ (4) $\lambda_1 = \frac{1}{2}\lambda_2$

8. If n = 6, the correct sequence for filling of electrons will be :

(1) ns → (n-2)f → (n-1)d → np

(2) ns → (n-1)d → (n-2)f → np

(3) ns → (n-2)f → np → (n-1)d

(4) ns → np (n-1)d → (n-2)f

AIPMT Mains 2011

9. According to the Bohr Theory, which of the following transitions in the hydrogen atom will give rise to the least energetic photon ?

(1) n = 5 to n = 3 (2) n = 6 to n = 1

(3) n = 5 to n = 4 (4) n = 6 to n = 5

AIIMS 2011

10. Smallest wavelength occurs for

(1) Lyman series (2) Balmar series

(3) Paschen series (4) Brackett series

11. Which of the following is wrong for Bohr model

(1) It establishes stability of atom

(2) It is contradicted with Heisenberg uncertainity principle

(3) It explain the concept of spectral lines

(4) e^- behaves as particle & wave

AIPMT PRE 2012

12. Maximum number of electrons in a subshell with ℓ = 3 and n = 4 is:

(1) 10 (2) 12 (3) 14 (4) 16

13. The correct set of four quantum numbers for the valence electron of rubidium atom (Z = 37) is:-

(1) 5, 0, 0, + ½ (2) 5, 1, 0, + ½

(3) 5, 1, 1, + ½ (4) 6, 0, 0 + ½

AIPMT MAINS 2012

14. The orbital angular momentum of a p-electron is given as :-

(1) $\frac{3}{2}\frac{h}{\pi}$ (2) $\sqrt{6}.\frac{h}{2\pi}$

(3) $\frac{h}{\sqrt{2}\pi}$ (4) $\sqrt{3}\frac{h}{2\pi}$

AIIMS 2012

15. Threshold frequency of a metal is 5×10^{13}Sec^{-1} upon which $1 \times 10^{+14}$ sec^{-1}

frequency light is focused then maximum kinetic energy of emitted electron :-

(1) 3.3×10^{-21} (2) 3.3×10^{-20}

(3) 6.6×10^{-21} (4) 6.6×10^{-20}

16. In Bohr's orbit $\frac{nh}{2\pi}$ indicates :-

(1) Momentum

(2) Kinetic energy

(3) Potential energy

(4) Angular momentum

NEET UG 2013

17. The value of Planck's constant is 6.63×10^{-34} Js. The speed of light is 3×10^{17} nm s^{-1}. Which value is closest to the wavelength in nanometer of a quantum of light with frequency of 6×10^{15} s^{-1} ?

(1) 75 (2) 10 (3) 25 (4) 50

18. Based on equation $E = -2.178 \times 10^{-18}$ J $\frac{Z^2}{n^2}$ certain conclusions are written. Which of them is **not** correct ?

(1) For n = 1, the electron has a more negative energy than it does for n = 6 which means that the electron is more lossely bound in the smallest allowed orbit.

(2) The negative sign in equation simply means that the energy of electron bound to the nucleus is lower than it would be if the electrons were at the infinite distance from the nucleus

(3) Larger the value of n, the larger is the orbit radius

(4) Equation can be used to calculate the change in energy when the electron change orbit

19. What is the maximum numbers of electrons that can be associated with the following set of quantum numbers ? n = 3; l = 1 and m = -1

(1) 2 (2) 10

(3) 6 (4) 4

AIIMS 2013

20. A particle is moving with 3 times faster than speed of e^-. Ratio of wavelength of particle & electron is 1.8×10^{-4} then particle is :-

(1) Neutron (2) α-particle

(3) Deutron (4) Tritium

AIPMT 2014

21. What is the maximum number of orbitals that can be identified with the following quantum numbers? n = 3, ℓ = 1, m_ℓ = 0

(1) 1 (2) 2

(3) 3 (4) 4

22. Calculate the energy in joule corresponding to light of wavelength 45 nm : (Planck's constant $h = 6.63 \times 10^{-34}$ Js; speed of light $c = 3 \times 10^8$ ms^{-1})

(1) 6.67×10^{15}

(2) 6.67×10^{11}

(3) 4.42×10^{-15}

(4) 4.42×10^{-18}

23. Magnetic moment 2.83 BM is given by which of the following ions ?

(At. nos. Ti = 22, Cr = 24, Mn = 25, Ni = 28):-

(1) Ti^{3+} (2) Ni^{2+}

(3) Cr^{3+} (4) Mn^{2+}

AIIMS 2014

24. The energy of an electron of $2p_y$ orbital is

(1) greater than $2p_x$ orbital

(2) Less than $2p_z$ orbial

(3) same as that of $2p_x$ and $2p_z$ orbital

(4) Equal to 2s orbital

AIPMT 2015

25. Which of the following pairs of ions are isoelectronic and isostructural ?

(1) ClO_3^-, CO_3^{2-} (2) SO_3^{2-}, NO_3^-

(3) ClO_3^-, SO_3^{2-} (4) co_3^{2-}, so_3^{2-}

26. The number of d-electrons in Fe^{2+} (Z = 26) is not equal to the number of electrons in which one of the following?

(1) p-electrons in Cl (Z= 17)

(2) d-electrons in Fe (Z = 26)

(3) p-electrons in Ne (Z= 10)

(4) s-electrons in Mg (Z= 12)

27. Magnetic moment 2.84 B.M. is given by :-

(At. no.), Ni = 28, Ti = 22, Cr = 24, Co = 27)

(1) Ti^{3+} (2) Cr^{2+}

(3) Co^{2+} (4) Ni^{2+}

28. The angular momentum of electron in 'd' orbital is equal to :-

(1) -$\sqrt{2}$ n (2) 2$\sqrt{3}$ h

(3) 0 h (4) $\sqrt{6}$ h

RE-AIPMT 2015

29. Which is the correct order of increasing energy of the listed orbitals in the atom of titanium ?

(At. no. Z = 22)

(1) 3s 3p 3d 4s (2) 3s 3p 4s 3d

(3) 3s 4s 3p 3d (4) 4s 3s 3p 3d

AIIMS 2015

30. In which transition of hydrogen atom have same wavelength as in Balmer series transition of He^+ ion (n = 4 to n =2)

(1) 4 to 2 (2) 3 to 2

(3) 2 to 1 (4) 4 to 1

NEET-I 2016

31. Two electrons occupying the same orbital are distinguished by

(1) Principal quantum number

(2) Magnetic quantum number

(3) Azimuthal quantum number

(4) Spin quantum number

NEET-II 2016

32. Which of the following pairs of d-orbitals will have electron density along the axis ?

(1) $d_{Z^2}, d_{X^2-y^2}$ (2) $d_{xy}, d_{X^2-y^2}$

(3) d_{z^2}, d_{xy} (4) d_{xz}, d_{yz}

33. How many electrons can fit in the orbital for which n = 3 and l = 1 ?

(1) 10 (2) 14 (3) 2 (4) 6

AIIMS 2016

34. Bohr's model is applicable to explain :-

(1) Zeeman effect (2) Stark effect

(3) Bond formation of H_2

(4) Hydrogen spectrum

35. In Bohr's atomic model, radius and energy in orbit(n) is related as :-

(1) $r \propto n^2$, $E \propto \frac{1}{n^2}$ (2) $r \propto \frac{1}{n^2}$, $E \propto n^2$

(3) $r \propto \frac{1}{n}$, $E \propto n$ (4) $E \propto n^2$, $r \propto n^2$

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	2	2	2	4	2	2	2	1	4	1	4	3	1	3	2
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans	4	4	1	I	1	1	4	2	3	3	1	4	4	2	3
Que.	31	32	33	34	35										
Ans.	4	1	3	4	4										

(PREVIOUS YEARS)

AIEEE &JEE-MAINS PROBLEMS

1. Which of the following ions has the maximum magnetic moment? **[AIEEE 2002]**
(A) Mn^{+2} (B) Fe^{+2}
(C) Ti^{+2} (D) Cr^{+2}.

2. Energy of H-atom in the ground state is –13.6 eV, hence energy in the second excited state is **[AIEEE 2002]**
(A) – 6.8 eV (B) – 3.4 eV
(C) – 1.51 eV (D) – 4.53 eV

3. Uncertainity in position of a particle of 25 g in space is 10^{-15} m. Hence, Uncertainity in velocity (in $m.sec^{-1}$) is : (plank's constant, h = 6.6×10^{-34} Js) **[AIEEE 2002]**
(A) 2.1×10^{-18} (B) 2.1×10^{-34}
(C) 0.5×10^{-34} (D) 5.0×10^{-24}

4. The de-Broglie wavelength of a tennis ball of mass 60 g moving with a velocity of 10 m/s is approximately **[AIEEE 2003]**
(A) 10^{-33} m (B) 10^{-31} m
(C) 10^{-16} m (D) 10^{-25} m

5. In Bohr series of lines of hydrogen spectrum, the third line from the red end corresponds to which one of the following inner-orbit jumps of the electron for Bohr orbits in an atom of hydrogen ? **[AIEEE 2003]**
(A) 3 2 (B) 5 2
(C) 4 1 (D) 2 5

6. The numbers of d-electrons retained in Fe^{2+} (atomic number Fe = 26) ion is **[AIEEE 2003]**
(A) 3 (B) 4
(C) 5 (D) 6

7. The orbital angular momentum for an electron revolving in an orbit is given by . This momentum for an s-electron will be given by **[AIEEE 2003]**
(A) +. (B) Zero
(C) (D) .

8. The wavelength of the radiation emitted, when in a hydrogen atom electron falls from infinity to stationary state 1, would be (Rydberg constant = 1.097×10^{7} m^{-1}) **[AIEEE 2004]**
(A) 91 nm (B) 192 nm
(C) 406 (D) 9.1×10^{-6} nm

9. Which of the following set a of quantum numbers is correct for an electron in 4f orbital? **[AIEEE 2004]**
(A) n = 4, l =3, m = +4, s = +1/2
(B) n = 4, l = 4, m = –4, s = –1/2
(C) n = 4, l = 3, m = +1, s = +1/2
(D) n = 3, l=2, m =–2, s = +1/2

10. Consider the ground state of Cr atom (Z = 24). The numbers of electrons with the azimuthal quantum numbers, λ = 1 and 2 are, respectively **[AIEEE 2004]**
(A) 12 and 4 (B) 12 and 5
(C) 16 and 4 (D) 16 and 5

11. Which of the following statements in relation to the hydrogen atom is correct ? **[AIEEE 2005]**
(A) 3s, 3p and 3d orbitals all have the same energy
(B) 3s and 3p orbitals are of lower energy than 3d orbital
(C) 3p orbital is lower in energy than 3d orbital
(D) 3s orbital is lower in energy than 3p orbital

12. In a multi-electron atom, which of the following orbitals described by the three quantum numbers will have the same energy in the absence of magnetic and electric field ? **[AIEEE 2005]**
(i) n = 1, l = 0, m = 0 (ii) n =2, l = 0, m = 0 (iii) n = 2, l = 1, m = 1 (iv) n = 3, l = 2, m =1
(v) n = 3, l = 2, m = 0
(A) (iv) and (v) (B) (iii) and (iv)
(C) (ii) and (iii) (D) (i) and (ii)

13. Uncertainity in the position of an electron (mass = 9.1×10^{-31} Kg) moving with a velocity 300 $m.sec^{-1}$, Accurate upto 0.001%, will be : (h = 6.63 $\times 10^{-34}$ J-s) **[AIEEE 2006]**
(A) 19.2×10^{-2} m (B) 5.76×10^{-2} m
(C) 1.92×10^{-2} m (D) 3.84×10^{-2} m

14. According to Bohr's theory, the angular momentum to an electron in 5^{th} orbit is : **[AIEEE 2006]**
(A) 25 (B) 1.0
(C) 10 (D) 2.5

15. The 'spin-only' magnetic moment [in units of Bohr magneton (μ_{β})] of Ni^{2+} in aqueous solution would be (Atomic number : Ni = 28) **[AIEEE 2006]**
(A) 2.84 (B) 4.90
(C) 0 (D) 1.73

16. Which of the following nuclear reactions will generate an isotope ? **[AIEEE 2007, 3/120]**
(A) Neutron particle emission
(B) Positron emission
(C) α-particle emission
(D) β-particle emission

17. The ionisation enthalpy of hydrogen atom is 1.312×10^{6} J mol^{-1}. The energy required to excite the electron in the atom from n_1 = 1 to n_2 = 2 is **[AIEEE 2008, 3/105]**
(A) 8.51×10^{5} J mol^{-1}
(B) 6.56×10^{5} J mol^{-1}
(C) 7.56×10^{5} J mol^{-1}
(D) 9.84×10^{5} J mol^{-1}

18. Which of the following set of quantum numbers represents the highest energy of an atom ? **[AIEEE 2008, 3/105]**

(A) n = 3, l = 0, m = 0, s = +
(B) n = 3, l = 1, m =1, s = +
(C) n = 3, l = 2, m = 1, s = +
(D) n = 4, l = 0, m = 0, s = +

19. The energy required to break one mole of Cl – Cl bonds in Cl_2 is 242 kJ mol^{-1} . The longest wavelength of light capable of breaking a single Cl – Cl bond is **[AIEEE 2010, 4/144]**
($c = 3 \times 10^8$ m s^{-1} and $N_A = 6.02 \times 10^{23}$ mol^{-1})
(A) 594 nm (B) 640 nm
(C) 700 nm (D) 494 nm

20. Ionisation energy of He^+ is **[AIEEE 2010, 4/144]**
19.6×10^{-18} J $atom^{-1}$. The energy of the first stationary state (n = 1) of Li^{2+} is :
(A) 4.41×10^{-16} J $atom^{-1}$
(B) -4.41×10^{-17} J $atom^{-1}$
(C) -2.2×10^{-15} J $atom^{-1}$
(D) 8.82×10^{-17} J $atom^{-1}$

21. A gas absorbs a photon of 355 nm and emits at two wavelengths. If one of the emission is at 680 nm, the other is at : **[AIEEE 2011, 4/120]**
(A) 1035 nm (B) 325 nm
(C) 743 nm (D) 518 nm

22. The frequency of light emitted for the transition n = 4 to n = 2 of He^+ is equal to the transition in H atom corresponding to which of the following? **[AIEEE 2011, 4/120]**
(A) n = 2 to n = 1 (B) n = 3 to n = 2
(C) n = 4 to n = 3 (D) n = 3 to n = 1

23. The electrons identified by quantum numbers n and : **[AIEEE 2012, 4/120]**
(a) n = 4, = 1 (b) n = 4, = 0
(c) n = 3, = 2 (d) n = 3, = 1
can be placed in order of increasing energy as :
(A) (c) < (d) < (b) < (a)
(B) (d) < (b) < (c) < (a)
(C) (b) < (d) < (a) < (c)
(D) (a) < (c) < (b) < (d)

[JEE-MAINS-2019-1]

24. For emission line of atomic hydrogen from $n_i = 8$ to $n_f = n$ the plot of wave number (v) against $1/n^2$ will be (The Rydberg constant, R_H is in wave number unit).
(1) Linear with slope - R_H
(2) Linear with intercept - R_H
(3) Non linear
(4) Linear with slope R_H

25. The 71^{st} electron of an element X with an atomic number of 71 enters into the orbital :
(1) 4f (2) 6p (3) 6s (4) 5d

26. The difference in the number of unpaired electrons of a metal ion in its high-spin and low-spin octahedral complexes is two. The metal ion is :
(1) Fe^{2+} (2) Co^{2+} (3) Mn^{2+} (4) Ni^{2+}

27. The ground state energy of hydrogen atom is
–13.6 eV. The energy of second excited state He^+ ion in eV is :
(1) –6.04 (2) –27.2 (3) –54.4 (4) –3.4

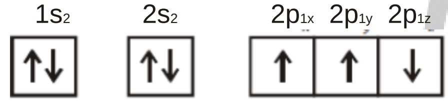
28. The de Broglie wavelength (l) associated with
a photoelectron varies with the frequency (*v*) of the incident radiation as, [v_0 is thershold frequency] :

(1) $\lambda \propto \dfrac{1}{(v-v_0)^{\frac{3}{2}}}$ (2) $\lambda \propto \dfrac{1}{(v-v_0)^{\frac{1}{2}}}$

(3) $\lambda \propto \dfrac{1}{(v-v_0)^{\frac{1}{4}}}$ (4) $\lambda \propto \dfrac{1}{(v-v_0)}$

29. Magnesium reacts with an element (X) to form an
ionic compound. If the ground state electronic configuration of (X) is $1s^2\,2s^2\,2p^3$, the simplest formula for this compound is
(1) Mg_2X_3 (2) MgX_2 (3) Mg_2X (4) Mg_3X_2

30. Which one is a wrong statement ?
(1) Total orbital angular momentum of electron in 's' orbital is equal to zero
(2) An orbital is designated by three quantum numbers while an electron in an atom is designated by four quantum numbers.
(3) The electronic configuration of N atom is
$1s^2$ $2s^2$ $2p_{1x}$ $2p_{1y}$ $2p_{1z}$



(4) The value of m for d_{z^2} is zero

31. Match the metal ions given in Column I with the spin magnetic moments of the ions given in Column IIand assign the *correct* code :

Column I	Column II
a. Co^{3+}	i. 8 B.M.
b. Cr^{3+}	ii. 35 B.M.
c. Fe^{3+}	iii. 3 B.M.
d. Ni^{2+}	iv. 24 B.M.
	v. 15 B.M.

	a	b	c	d
(1)	iv	v	ii	i

(2) i	ii	iii	iv
(3) iv	i	ii	iii
(4) iii	v	i	ii

ANSWER KEY

1.(A)	**2.**(C)	**3.**(A)	**4.**(A)	**5.**(B)	
6.(D)	**7.**(B)	**8.**(A)	**9.**(C)	**10.**(B)	
11.(A)	**12.**(A)	**13.**(C)	**14.**(D)	**15.**(A)	
16.(A)	**17.**(D)	**18.**(C)	**19.**(D)	**20.**(B)	
21.(C)	**22.**(A)	**23.**(B)	**24.**(4)	**25.**(1)	
26.(2)	**27.**(1)	**28.**(2)	**29.**(4)	**30.**(3)	**31.**(1)

NCERT EXAMPLER PROBLEMS

Multiple Choice Questions

1. The number of radial nodes for 3*p* orbital is __________.
(i) 3 (ii) 4 (iii) 2 (iv) 1

2. Number of angular nodes for 4*d* orbital is __________.
(i) 4 (ii) 3 (iii) 2 (iv) 1

3. Which of the following is responsible to rule out the existence of definite paths or trajectories of electrons?
(i) Pauli's exclusion principle.
(ii) Heisenberg's uncertainty principle.
(iii) Hund's rule of maximum multiplicity.
(iv) Aufbau principle.

4. Total number of orbitals associated with third shell will be __________.
(i) 2 (ii) 4 (iii) 9 (iv) 3

5. Orbital angular momentum depends on __________.
(i) *l* (ii) *n* and *l*
(iii) *n* and *m* (iv) *m* and *s*

6. Chlorine exists in two isotopic forms, Cl-37 and Cl-35 but its atomic mass is 35.5. This indicates the ratio of Cl-37 and Cl-35 is approximately
(i) 1:2 (ii) 1:1 (iii) 1:3 (iv) 3:1

7. The pair of ions having same electronic configuration is __________.
(i) Cr^{3+}, Fe^{3+} (ii) Fe^{3+}, Mn^{2+}
(iii) Fe^{3+}, Co^{3+} (iv) Sc^{3+}, Cr^{3+}

8. For the electrons of oxygen atom, which of the following statements is correct?
(i) Z_{eff} for an electron in a 2*s* orbital is the same as Z_{eff} for an electron in a 2*p* orbital.
(ii) An electron in the 2*s* orbital has the same energy as an electron in the 2*p* orbital.
(iii) Z_{eff} for an electron in 1*s* orbital is the same as Z_{eff} for an electron in a 2*s* orbital.
(iv) The two electrons present in the 2*s* orbital have spin quantum numbers m_s but of opposite sign.

9. If travelling at same speeds, which of the following matter waves have the shortest wavelength?
(i) Electron (ii) Alpha particle (He^{2+})
(iii) Neutron (iv) Proton

Assertion and Reason Type-I

Choose the correct option out of the choices given below each question.
(i) Both A and R are true and R is the correct explanation of A.
(ii) A is true but R is false.
(iii) A is false but R is true.
(iv) Both A and R are false.

1. ***Assertion (A) :*** All isotopes of a given element show the same type of chemical behaviour.
Reason (R) : The chemical properties of an atom are controlled by the number of electrons in the atom.

2. ***Assertion (A) :*** Black body is an ideal body that emits and absorbs radiations of all frequencies.
Reason (R) ***:*** The frequency of radiation emitted by a body goes from a lower frequency to higher frequency with an increase in temperature.

3. ***Assertion (A) :*** It is impossible to determine the exact position and exact momentum of an electron simultaneously.
Reason (R) : The path of an electron in an atom is clearly defined.

ANSWERS

Multiple Choice Questions
1. (iv) 2. (iii) 3. (ii) 4. (iii) 5. (i)
6. (iii) 7. (ii) 8. (iv) 9. (ii)

Assertion and Reason Type
1. (i) 2. (ii) 3. (iii)

Assertion and Reason Type-II

(A) If both Assertion and Reason are true and the Reason is a correct explanation of the Assertion.
(B) If both Assertion and Reason are true but Reason is not a correct explanation of the Assertion.
(C) If Assertion is true but the Reason is false.
(D) If the Assertion is false but the Reason is true.
(E) If both Assertion and Reason are false.

Q1. A: The radius of the first orbit of hydrogen atom is 0.529Å.
R: Radius for each circular orbit (r_n) = 0.529Å (n^2/Z), where n = 1, 2, 3 and Z = atomic number.

Q2.A:The transition of electrons $n_3 \rightarrow n_2$ in H atom will emit greater energy than $n_4 \rightarrow n_3$.
R: n_3 and n_2 are closer to nucleus than n_4.

Q3. A:In H atom when electrons jump from 1s to 2s orbital, atom becomes cation.
R: H atom has only one electron.

Q4. Assertion : For n = 3, l = 0, 1 & 2, and m = 0, 0, $\pm$ 1, & 0, $\pm$1, $\pm$2
Reason : For a given value of n, the values of are all integers from 0 to n-1 and for a given value of the values of m are all integers from to including 0.

Q5.(A) A special line will be seen for $2p_x$ - $2p_y$ transition.
(R) Energy is released in the form of wave of light when the electron drops from $2p_x$ to $2p_y$ orbital.

Q6.(A) Limiting line in the Balmer series has a wavelength of 364.4 mm.
(R) Limiting line is obtained for a jump of electron from n = ∞.

Q7.(A) Each electron in an atom has two spin quantum number.
(R) Spin quantum numbers are obtained by solving schrodinger wave equation.

Q8.A: The main shell with principal quantum number n = 2 has four orbitals present in it.
R : Number of orbitals present in a shell is given by n^2.

Q9.A: Ten distinct set of four quantum numbers are possible for d-subshell.
R : d-subshell splits into five orbitals.

Q10.A: $3d_{z^2}$ orbital is spherically symmetrical
R: $3d_{z^2}$ orbital is the only d-orbital which is spherical in shape.

Q11.A: Fine lines are observed in spectra if an atom is placed in a magnetic field.
R: Degenerate orbitals split in the presence of magnetic field

Q12.A; Spin quantum number can have the value +½ or –½.
R: (+) sign here signifies the wave function.

Q13.A:Magnetic quantum number can have the value *l* = 0, ..., (n–1)
R: Magnetic quantum number specifies the number of orbitals.

Q14.A:An orbital cannot have more than two electrons, moreover, if an orbital has two electrons they must have opposite spins.
R: No two electrons in an atom can have same set of all the four quantum numbers.

15. A: A spectral line will be observed for $2p_x$-$2p_y$ transition.
R: The energy will be released in the form of electromagnetic radiations.

16. A: Cs is used in photoelectric cells.
R: Cs is an alkali metal.

17. A: The energy of an electron is largely determined by its principle quantum number.
R: 2s subshell has higher energy than 1s.

18. A: Fe^{3+}(g) ion is more stable than Fe^{2+}(g).
R: Fe^{3+}(g) ion has higher magnetic moment than Fe^{2+}(g) ion.

19. A: de-Broglie's equation and uncertainity principle are applicable to moving bodies.
R: These have siginificance to microscopic as well as macroscopic particles.

ANSWERS

Q1.A Q2.B Q3.D Q4.A Q5.E Q6.A
Q7.E Q8.A Q9.A Q10.E Q11.A Q12.C
Q13.D Q14.A 15.D 16.B 17.B 18.B 19.C

Chapter 3

Periodic Properties

MODERN PERIODIC TABLE

Old convention	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	0
New convention	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

← S– Block → ← p - Block →

← d - Block →

1	H																	He
2	Li	Be											B	C	N	O	F	Ne
3	Na	Mg											Al	Si	P	S	Cl	Ar
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6	Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7	Fr	Ra	Ac**															

✯ Lanthanids * (4f-Series)	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
✯ Actinids ** (5f-Series)	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

← f-Block →

The modern periodic law may thus be stated as:

'The properties of elements are periodic functions of their atomic numbers'.

In the periodic table the horizontal rows constitute periods while the vertical rows constitute groups.

Periods: There are seven periods or horizontal rows in the table.

1. The first period is made up of only 2 elements, namely, hydrogen and the noble gas helium.
2. The Second Period Contains 8 element It starts with lithium, an alkali metal of Group I.
3. The Third Period Which begins with sodium also contains 8 elements.
4. The Fourth Period, begins, again, with an alkali metal, potassium. This period, consists of 18 elements from potassium (Z = 19) to the noble gas, krypton (Z = 36).

5. The Fifth Period, like the fourth period, also consists of 18 elements (Z = 37 to 54). It begins with rubidium (Z = 37) and ends with xenon (Z = 54) which, again, is a noble gas.

6. The Sixth Period is also a long period. It consists of 32 elements (Z = 55 to 86).

7. The Seventh Period: Consists of radioactive elements with atomic numbers 87 to 112. So far, elements upto atomic number 108 only have been discovered.

Classification of Elements into s, p, d and f Blocks

The elements, as arranged in the long form of the periodic table, can also be divided into four blocks known as s, p, d and f blocks. This classification depends upon the type of the orbitals (s, p, d or f) into which the last electron of the atoms of the elements enters.

❑ s-Block Elements

The elements whose atoms receive the last electron in the s orbital of their outermost energy shell are called s block elements.

This block consists of elements of Groups IA and IIA in which the s orbitals are being progressively filled.

The elements of Group IA have the general ground state electronic configuration ns^1 and are called alkali metals.

The elements of Group IIA have the general ground state electronic configuration ns^2 and are called alkaline earth metals.

❑ p-Block Elements

The elements whose atoms receive the last electron in their p orbitals are called p block elements. The atoms of elements of Groups IIIA etc. IVA, VA, VIA, VIIA and Zero involving one, two, three, four, five and six electrons respectively, in p orbitals in the outermost shells, constitute p block. The general electronic configuration for the atoms of the elements of this block may be written as ns^2 np^{1-6}.

❑ d-Block Elements

The atoms of elements lying between s and p blocks have the s and p orbitals completely filled. Thus, the elements in which the last electron enters the d orbitals of their last but one (penultimate) energy shells are called d block elements. The general electronic configurations of d block elements may be written as $(n-1)d^{1-10}$ ns^{1-2}. These elements are also called transition elements. This block consists of three rows called First, Second and Third transition series which involve the filling of 3d, 4d and 5d orbitals, respectively.

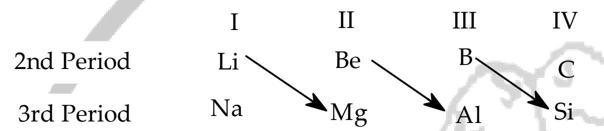
❑ f-Block Elements

The elements in which the last electron enters the f orbitals of their atoms are called f block elements. In these elements, the last electron enters the third to the outermost (ante penultimate), i.e., (n – 2) f energy shell. It consists of two series of 14 elements each placed (Z = 57) and the other follows actinium, Ac (Z = 89) in the order of increasing atomic numbers. These series are called lanthanides (from cerium to lutetium) and actinides (from thorium to lawrencium), respectively. In lanthanides, 4f orbitals and in actinides, 5f orbitals are being progressively filled.

The electronic configuration of the antepenultimate orbit of lanthanides is $4s^2\ p^6\ d^{10}\ f^{1-14}$ and of actinides is $5s^2\ p^6\ d^{10}\ f^{1-14}$.

❑ Diagonal Relationship

The first three members of second period (Li, Be and B) not only show similarities with the members of their own groups but show similarities with the elements diagonally placed in the higher groups. This resemblance is termed diagonal relationship.



Periodicity in Properties

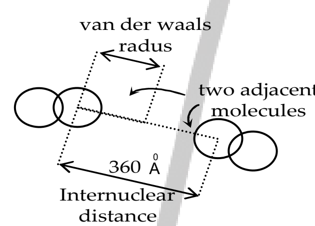
When elements are arranged in the increasing order of atomic number, elements with similar properties recur at regular intervals in the periodic table. This is called periodicity in properties. The cause of periodicity in properties is due to recurrence of similar outer electronic configuration at certain regular intervals.

Covalent Radius

One half of the distance between the nuclei of two covalently bonded atoms of the same element in a molecule, is taken as the covalent radius of the atom of that element.

❑ Vander Waals' Radius

The vander Waals' radius is defined as one half of the distance between the nuclei of two adjacent identical atoms belonging to two neighbouring molecules of an element in the solid state.



❑ Periodic Trends in Covalent Radii

Generally speaking, the covalent radii decrease in moving form left to right in any given period and increase in moving from top to bottom in any given group.

❑ Variation of Covalent Radii in a Period

The greater the effective nuclear charge, the greater would be the force with which the electron is pulled toward the nucleus.

There is more and more reduction in the covalent radii in moving from left to right across the period i.e., from Li to F).In the case of noble gases, the atomic radii are only the van der Waals' radii which are, therefore, larger than the covalent radii of other elements.

Variation of Covalent Radii in a Group

It is seen that there is increase in covalent radius on moving from top to bottom. This may be explained as follows: In moving down a group, the number of the principal shell increases and, therefore, the size of the atom increases. Hence, the radius of the atom increases in moving from top to bottom in a group.

$r_{Cs} > r_{Rb} > r_K > r_{na} > r_{Li}$

Ionic Radius

It may be defined as the distance from the nucleus of an ion up to which it has influence on its electron charge cloud.

Radii of Cations and Anions

A positive ion, i.e., a cation, results from the loss of one or more electrons from the outer shell called the valence shell of an atom. In the formation of positive ion, the outer shell of electrons is generally removed completely. The cation, therefore, is much smaller than the corresponding atom. At the same time, with the elimination of one or more outer electrons from an atom, the number of electrons decreases while the nuclear charge remains the same. The nuclear charge per electron increases and the electrons are, therefore, pulled in more towards the nucleus than before. This effect also tends to decrease the radius of the cation.

During the change of an atom into a negative ion, i.e., an anion, one or more electrons are added to the valency shell of the atom. As a result, the same nuclear charge acts on a larger number of electrons. In other words, effective nuclear charge per electron is reduced and, therefore, the electrons are held less tightly be the nucleus and the electron charge cloud expands. Thus, the radius of a negative ion is invariably larger than that of the corresponding atom.

Variation of Ionic Radii in Iso-Electronic ions

Iso-electronic ions are those which have the same number of electrons but differ in the charge on their nuclei .

All of them contain the same number of electrons. They differ only in the charge on the nucleus. It is evident that as the nuclear charge increases, the electrons **are held more and more tightly by the nucleus with the result that the ionic radius decreases.**

Radii of Iso-electronic Ions

Ion	N^{3-}	O^{2-}	F^{-}	Na^{+}	Mg^{2+}
Number of electons	10	10	10	10	10
Charge on the nucleus	+7	+8	+9	+11	+12
Radius ($\overset{0}{A}$)	1.71	1.40	1.36	0.95	0.60

Ionisation Energy (IE)

$$M(g) \longrightarrow M^+(g) + e^-$$

The energy required to bring about the above change is called ionization energy. Evidently, the smaller the ionization energy, the easier it is for the neutral atom to change into a positive ion.

Ionisation energy is measured in electron-volts (eV) as well as in joules or kilojoules.

$$M \xrightarrow{(IE)_1} M^+ + e^-$$

$$M^+ \xrightarrow{(IE)_2} M^{2+} + e^-$$

$$M^{2+} \xrightarrow{(IE)_3} M^{3+} + e^-$$

If one electron has been taken out of an atom, it becomes increasingly difficult to remove the second and subsequent electrons from the resulting positively charged ion on account of electrostatic attraction. This is due to the fact that after the removal of an electron, the number of electrons decreases while the nuclear charge remains the same. Consequently, the remaining electrons are held more lightly by the nucleus and it becomes difficult to remove the second electron. Therefore, the second ionization energy is greater than the first ionization energy and, similarly, the third ionization energy is grater than the second ionization energy and so on. Thus, $(IE)_3 > (IE)_2 > (IE)_1$.

❑ Factors Determining Ionisation Energy

The ionization energy of an element depends upon the following factors.

1. **Atomic size.** The larger the atomic size, the smaller is the ionization energy.

The reason for this is that as the size of the atom increases, the outer electrons lie farther away from the nucleus. Hence, according to Coulomb's law, the attractive pull of the nucleus on the outer electrons decreases and it becomes easier to knock out an electron from the outer shell of the atom.

2. **Nuclear charge.** The force of attraction between the nucleus and the outermost electrons increases with increase in nuclear charge.

3. **Number of electrons is the inner shells.** The larger the number of electrons in the inner shells, the smaller is the ionization energy.

The electrons in the inner shells act as a screen or shield between the nucleus and the electrons in the outermost shell. This is known as screening effect or shielding effect. The larger the number of electrons in the inner shells, the greater is the screening effect. Consequently, the electrons in the valency shell experience less attraction from the nucleus. Hence, the ionization energy would be low.

4. **Penetration effect or the effect of removal of s, p, d and f electrons from the same energy shell.** The s electrons in their motion around the nucleus have greater probabilities of coming closer to the nucleus from the p, d or f electrons of the same principal energy shell. Thus, the s electrons experience more attraction from the nucleus than the p, d or f electrons of the same principal energy shell. It follows, therefore, that ionization energy for pulling out an s electron or an f

electron of the same principal energy shell in the order of their mention. We may thus say that ionization energy corresponding to the elimination of an electron from a given energy level decreases in the order s > p > d > f electron.

5. **Electronic configurations.** Certain electronic configurations are more stable than others. For example, if an atom has fully filled or exactly half-filled orbitals, its ionization energy is higher than expected normally from its position in the periodic table.

Further, it is seen that He, Ne, Ar, Kr, Xe and Rn have highest ionization energies in their respective periods. This shows that an atom with s^2p^6 configuration (the so-called octet configuration) in its outer shell is highly stable.

Variation of Ionisation Energy in the Periodic Table.

(a) Variation in group. In general, the ionization energy decreases in going from top to bottom in a group.

There are some exceptions, however. For example, the first ionization energy of indium is less than that of thallium in Group III and first ionization energy of Sn is less than that of Pb in Group IV.

(b) Variation along a period. In general, the ionization energy increases as we move along a period from left to right

Ionization energies of boron and oxygen are unexpectedly lower than the ionization energies of their preceding elements beryllium and nitrogen, respectively. These anomalies are explained as xzzzzzzzzzzngfollows :

nnmnmmnhence the ionization energy of boron is less than that of beryllium.

Electronic configuration of nitrogen $(1s^2 2s^2 p_x^1 p_y^1 p_z^1)$, in which all the p orbitals are exactly half-filled, is more stable than the electronic configuration of oxygen $(1s^2 2s^2 p_x^2 p_y^1 p_z^1)$, . Therefore, ionization energy of oxygen is less than that of nitrogen.

Electron Affinity (EA)

Electron affinity **is defined as the amount of energy released when an electron is added to a gaseous isolated atom.**

$$\underset{\text{Atom}}{X(g)} + e^- \longrightarrow \underset{\text{Anion}}{X^-(g)} + \text{ Energy (EA)}$$

The greater the energy released in the process of taking up the extra electron, the greater is the electron affinity. The electron affinity of an atom measures the tightness with which it binds an additional electron to itself.

❑ Variation of Electron Affinity in the Periodic Table

In general, electron affinity decreases in going from top to bottom in a group and increases in going from left to right across a period.

This can be easily explained. On moving down a group, the atomic size increases and, therefore, the effective nuclear attraction for the electron decreases. Consequently, the atom will have less tendency to attract additional electron towards itself, i.e., its electron affinity would decrease.

On moving across a period, on the other hand, the atomic size decreases and hence the force of attraction exerted by the nucleus on the electrons increases. Consequently, the atom has a greater tendency to attract the additional electron, i.e., its electron affinity increases.

It is seen that **halogens have high electron affinities.** This is due to their strong tendency to gain an additional electron to change into the stable s^2p^6 configuration.

The electron affinity decreases from CI $\rightarrow$ Br $\rightarrow$ 1, I.e., on moving down the group, as discussed above.

However, **electron affinity of fluorine is unexpectedly low**. It cannot be explained by any simple mechanism. It is probably due to small size of the atom. The addition of an extra electron produces high electron charge density in a relatively compact 2p subshell resulting in strong electron–electron repulsion. The repulsive forces between electrons imply low electron affinity.

Apart from the size of the atom discussed above. The electronic configurations of the elements also influence their electron affinities considerably. This is illustrated below.

Electron affinities of noble gases are zero. This is because their atoms have stable s^2p^6 configurations in their valency shells and there are no chances for addition of an extra electron.

Electron affinities of beryllium, magnesium, calcium and nitrogen are also practically zero. This is attributed to the extra stability of the fully completed s orbitals in Be ($2s^2$), Mg ($3s^2$) and Ca ($4s^2$) and of the exactly half-filled 2p orbitals in N ($2s^2p_x^1p_y^1p_z^1$). Thus, if an atom has fully filled or exactly half-filled orbitals, its electron affinity would be practically zero.

❑ Successive Electron Affinities

The second and higher electron affinities are also possible. However, after the addition of one electron ,the atom becomes negatively charged and the second electron is to be added to a negatively charged ion. The addition of second electron is opposed by the coulombic force of repulsion and energy has to be supplied for the addition of the second electron.

Thus, in the case of oxygen, the first electron affinity $(EA)_1$, is positive since 140.9 kJ is released when a mole of O atoms get converted to O^- ions.

However, the second electron affinity $(EA)_2$ is negative since 770 kJ of energy has to be supplied to convert 1 mole of O^- ions to O^{2-} ions.

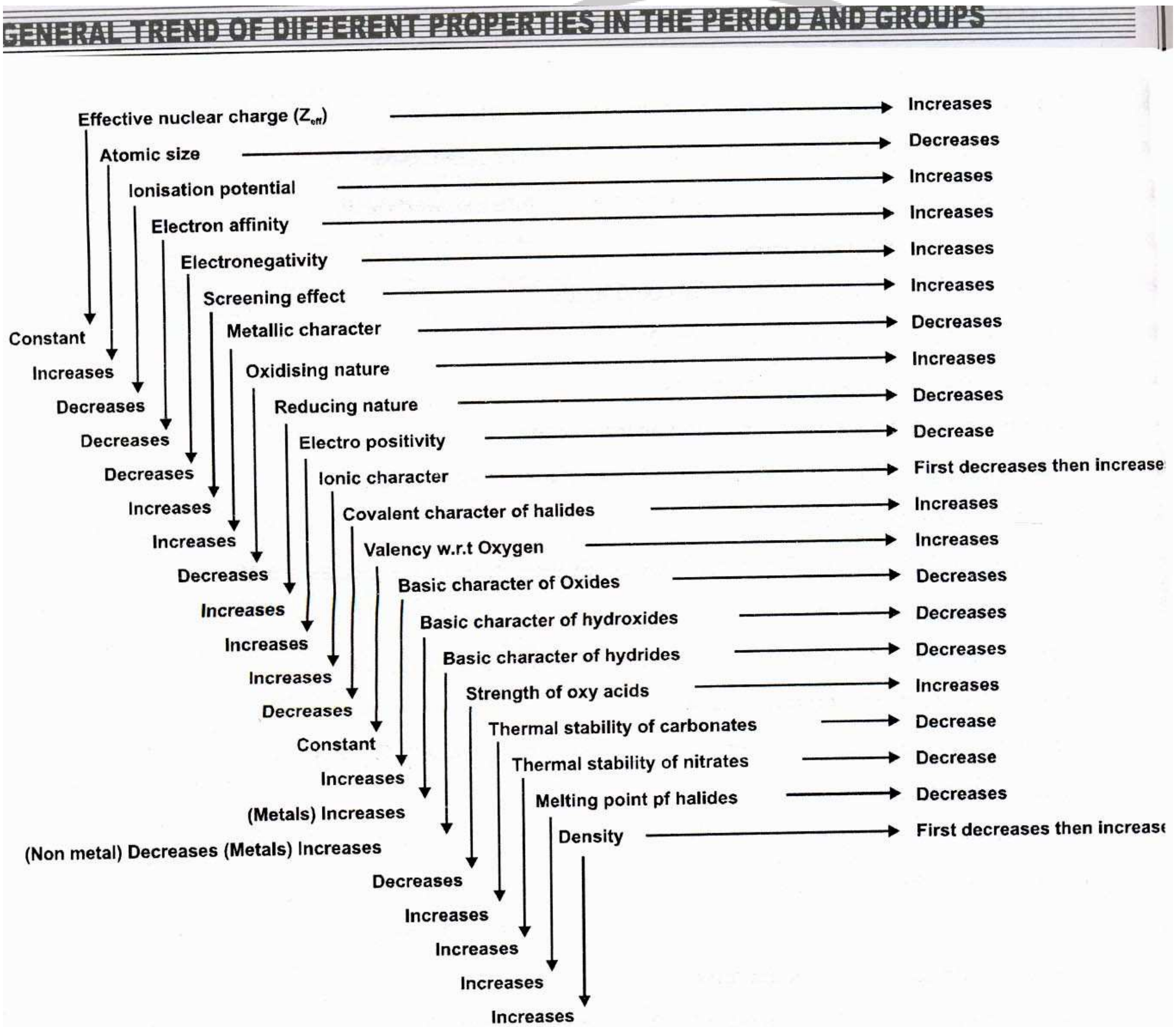
Thermodynamically, however, the energy released is given a negative sign and energy absorbed is given a positive sign.

Accordingly, when a specie has a positive electron affinity, ΔH, accompanying the addition of an electron to the specie, is negative and if it has a negative electron affinity, ΔH is positive.

Electronegativity

Pauling's Approach. **Pauling defined electronegativity as the power of an atom in a molecule to attract electrons to itself.**

GENERAL TREND OF DIFFERENT PROPERTIES IN THE PERIOD AND GROUPS


GENERAL TREND OF DIFFERENT PROPERTIES IN THE PERIOD AND GROUPS

Property	Along the period (→)	Down the group (↓)
Effective nuclear charge (Z_{eff})	Increases	Constant
Atomic size	Decreases	Increases
Ionisation potential	Increases	Decreases
Electron affinity	Increases	Decreases
Electronegativity	Increases	Decreases
Screening effect	Increases	Increases
Metallic character	Decreases	Increases
Oxidising nature	Increases	Decreases
Reducing nature	Decreases	Increases
Electro positivity	Decrease	Increases
Ionic character	First decreases then increase	Increases
Covalent character of halides	Increases	Decreases
Valency w.r.t Oxygen	Increases	Constant
Basic character of Oxides	Decreases	Increases
Basic character of hydroxides	Decreases	(Metals) Increases
Basic character of hydrides	Decreases	(Non metal) Decreases (Metals) Increases
Strength of oxy acids	Increases	Decreases
Thermal stability of carbonates	Decrease	Increases
Thermal stability of nitrates	Decrease	Increases
Melting point pf halides	Decreases	Increases
Density	First decreases then increase	Increases

COMPETITION SECTION

OBJECTIVE QUESTIONS (PERIODIC PROPERTIES)

Quantum number, Electronic configuration and Shape of orbitals

1. Be's 4th electron will have four quantum numbers

[MNR 1985]

	n	l	m	s
(a)	1	0	0	+1/2
(b)	1	1	+1	+1/2
(c)	2	0	0	– 1/2
(d)	2	1	0	+1/2

2. The quantum number which specifies the location of an electron as well as energy is **[DPMT 1983]**

(a) Principal quantum number
(b) Azimuthal quantum number
(c) Spin quantum number
(d) Magnetic quantum number

3. The shape of an orbital is given by the quantum number

[NCERT 1984; MP PMT 1996]

(a) n (b) l
(c) m (d) s

4. In a given atom no two electrons can have the same values for all the four quantum numbers. This is called

[BHU 1979; AMU 1983; EAMCET 1980, 83;
MADT Bihar 1980; CPMT 1986, 90, 92; NCERT 1978, 84;
RPMT 1997; CBSE PMT 1991; MP PET 1986, 99]

(a) Hund's rule
(b) Aufbau's principle
(c) Uncertainty principle
(d) Pauli's exclusion principle

5. Nitrogen has the electronic configuration $1s^2, 2s^2 2p_x^1 2p_y^1 2p_z^1$ and not $1s^2, 2s^2 2p_x^2 2p_y^1 2p_z^0$ which is determined by

[DPMT 1982, 83, 89; MP PMT/PET 1988; EAMCET 1988]

(a) Aufbau's principle (b) Pauli's exclusion principle
(c) Hund's rule (d) Uncertainty principle

6. Which one of the following configuration represents a noble gas

(a) $1s^2, 2s^2 2p^6, 3s^2$
(b) $1s^2, 2s^2 2p^6, 3s^1$
(c) $1s^2, 2s^2 2p^6$
(d) $1s^2, 2s^2 sp^6, 3s^2 3p^6, 4s^2$

7. The electronic configuration of silver atom in ground state is

[CPMT 1984, 93]

(a) $[Kr]3d^{10} 4s^1$ (b) $[Xe]4f^{14} 5d^{10} 6s^1$
(c) $[Kr]4d^{10} 5s^1$ (d) $[Kr]4d^9 5s^2$

8. Principal, azimuthal and magnetic quantum numbers are respectively related to **[CPMT 1988; AIIMS 1999]**

(a) Size, shape and orientation
(b) Shape, size and orientation
(c) Size, orientation and shape
(d) None of the above

9. Correct set of four quantum numbers for valence electron of rubidium (Z = 37) is

[IIT 1984; JIPMER 1999; UPSEAT 2003]

(a) $5, 0, 0, +\frac{1}{2}$ (b) $5, 1, 0, +\frac{1}{2}$
(c) $5, 1, 1, +\frac{1}{2}$ (d) $6, 0, 0, +\frac{1}{2}$

10. The correct ground state electronic configuration of chromium atom is

(a) $[Ar]3d^5 4s^1$ (b) $[Ar]3d^4 4s^2$
(c) $[AR]3d^6 4s^0$ (d) $[Ar]4d^5 4s^1$

11. $2p$ orbitals have **[NCERT 1981; MP PMT 1993, 97]**

(a) $n = 1, l = 2$ (b) $n = 1, l = 0$
(c) $n = 2, l = 1$ (d) $n = 2, l = 0$

12. Electronic configuration of H^- is **[CPMT 1985]**

(a) $1s^0$ (b) $1s^1$
(c) $1s^2$ (d) $1s^1 2s^1$

13. The quantum numbers for the outermost electron of an element are given below as $n = 2, l = 0, m = 0, s = +\frac{1}{2}$. The atoms is

(a) Lithium (b) Beryllium
(c) Hydrogen (d) Boron

14. Principal quantum number of an atom represents

[EAMCET 1979; IIT 1983; MNR 1990;UPSEAT 2000, 02]

(a) Size of the orbital
(b) Spin angular momentum
(c) Orbital angular momentum
(d) Space orientation of the orbital

15. An element has the electronic configuration $1s^2, 2s^2 2p^6, 3s^2 3p^2$. Its valency electrons are

[NCERT 1973]
[CPMT 1983, 89, 93; NCERT 1973; MP PMT 1989;

(a) 6 (b) 2
(c) 3 (d) 4

16. The magnetic quantum number specifies

[MNR 1986; BHU 1982; CPMT 1989, 94; MP PET 1999; AFMC 1999; AMU (Engg.) 1999]

(a) Size of orbitals (b) Shape of orbitals
(c) Orientation of orbitals (d) Nuclear stability

17. Which of the following sets of quantum numbers represent an impossible arrangement [IIT 1986; MP PET 1995]

	n	l	m	m_s
(a)	3	2	– 2	$(+)\frac{1}{2}$
(b)	4	0	0	$(-)\frac{1}{2}$
(c)	3	2	–3	$(+)\frac{1}{2}$
(d)	5	3	0	$(-)\frac{1}{2}$

18. If $n = 3$, then the value of 'l' which is incorrect [CPMT 1994]

(a) 0 (b) 1
(c) 2 (d) 3

19. Which orbital is dumb-bell shaped [MP PMT 1986; MP PET/PMT 1998]

(a) s-orbital (b) p-orbital
(c) d-orbital (d) f-orbital

20. The total number of unpaired electrons in d - orbitals of atoms of element of atomic number 29 is [CPMT 1983]

(a) 10 (b) 1
(c) 0 (d) 5

21. The shape of $2p$ orbital is [CPMT 1983; NCERT 1979]

(a) Spherical (b) Ellipsoidal
(c) Dumb-bell (d) Pyramidal

22. The magnetic quantum number for an electron when the value of principal quantum number is 2 can have [CPMT 1984]

(a) 3 values (b) 2 values
(c) 9 values (d) 6 values

23. Which one is the correct outer configuration of chromium [AIIMS 1980, 91; BHU 1995]

(a) | ↑ | ↑ | ↑ | ↑ | | ↑↓ |
(b) | ↑↓ | ↑↓ | ↑ | | | |
(c) | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ |
(d) | ↑↓ | ↑↓ | ↑ | ↑ | ↑ | ↑ |

24. The following has zero valency [DPMT 1991]

(a) Sodium (b) Beryllium
(c) Aluminium (d) Krypton

25. The number of electrons in the valence shell of calcium is [IIT 1975]

(a) 6 (b) 8
(c) 2 (d) 4

26. The valence electron in the carbon atom are [MNR 1982]

(a) 0 (b) 2
(c) 4 (d) 6

27. For the dumb-bell shaped orbital, the value of l is [CPMT 1987, 2003]

(a) 3 (b) 1
(c) 0 (d) 2

28. Chromium has the electronic configuration $4s^1 3d^5$ rather than $4s^2 3d^4$ because

(a) $4s$ and $3d$ have the same energy
(b) $4s$ has a higher energy than $3d$
(c) $4s^1$ is more stable than $4s^2$
(d) $4s^1 3d^5$ half-filled is more stable than $4s^2 3d^4$

29. The electronic configuration of calcium ion (Ca^{2+}) is [CMC Vellore 1991]

(a) $1s^2, 2s^2 2p^6, 3s^2 3p^6, 4s^2$
(b) $1s^2, 2s^2 sp^6, 3s^2 3p^6, 4s^1$
(c) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^2$
(d) $1s^2, 2s^2 sp^6, 3s^2 3p^6 3d^5$
(e) $1s^2, 2s^2 2p^6, 3s^2 3p^6, 4s^0$

30. The structure of external most shell of inert gases is [JIPMER 1991]

(a) $s^2 p^3$ (b) $s^2 p^6$
(c) $s^1 p^2$ (d) $d^{10} s^2$

31. The two electrons in K sub-shell will differ in [MNR 1988; UPSEAT 1999, 2000; Kerala PMT 2003]

(a) Principal quantum number
(b) Azimuthal quantum number
(c) Magnetic quantum number
(d) Spin quantum number

32. A completely filled d-orbital (d^{10}) [MNR 1987]

(a) Spherically symmetrical
(b) Has octahedral symmetry
(c) Has tetrahedral symmetry
(d) Depends on the atom

33. If magnetic quantum number of a given atom represented by –3, then what will be its principal quantum number [BHU 2005]

(a) 2 (b) 3

(c) 4 (d) 5

34. The total number of orbitals in an energy level designated by principal quantum number n is equal to **[AIIMS 1997; J&K CET 2005]**

(a) $2n$ (b) $2n^2$

(c) n (d) n^2

35. The number of orbitals in the fourth principal quantum number will be

(a) 4 (b) 8

(c) 12 (d) 16

36. Which set of quantum numbers are not possible from the following

(a) $n=3, l=2, m=0, s=-\frac{1}{2}$

(b) $n=3, l=2, m=-2, s=-\frac{1}{2}$

(c) $n=3, l=3, m=-3, s=-\frac{1}{2}$

(d) $n=3, l=0, m=0, s=-\frac{1}{2}$

37. The four quantum number for the valence shell electron or last electron of sodium (Z = 11) is **[MP PMT 1999]**

(a) $n=2, l=1, m=-1, s=-\frac{1}{2}$

(b) $n=3, l=0, m=0, s=+\frac{1}{2}$

(c) $n=3, l=2, m=-2, s=-\frac{1}{2}$

(d) $n=3, l=2, m=2, s=+\frac{1}{2}$

38. The explanation for the presence of three unpaired electrons in the nitrogen atom can be given by **[NCERT 1979; RPMT 1999; DCE 1999, 2002; CPMT 2001; MP PMT 2002; Pb. PMT / CET 2002]**

(a) Pauli's exclusion principle

(b) Hund's rule

(c) Aufbau's principle

(d) Uncertainty principle

39. The maximum energy is present in any electron at

(a) Nucleus

(b) Ground state

(c) First excited state

(d) Infinite distance from the nucleus

40. The electron density between $1s$ and $2s$ orbital is

(a) High (b) Low

(c) Zero (d) None of these

41. For ns orbital, the magnetic quantum number has value

(a) 2 (b) 4

(c) – 1 (d) 0

42. The maximum number of electrons that can be accommodated in the M^{th} shell is

(a) 2 (b) 8

(c) 18 (d) 32

43. For a given value of quantum number l, the number of allowed values of m is given by

(a) $l+2$ (b) $2l+2$

(c) $2l+1$ (d) $l+1$

44. The number of radial nodes of 3*s* and 2*p* orbitals are respectively. **[IIT-JEE 2005]**

(a) 2, 0 (b) 0, 2

(c) 1, 2 (d) 2, 1

45. Which of the sub-shell is circular

(a) $4s$ (b) $4f$

(c) $4p$ (d) $4d$

46. Which electronic configuration for oxygen is correct according to Hund's rule of multiplicity

(a) $1s^2, 2s^2 2p_x^2 2p_y^1 2p_z^1$ (b) $1s^2, 2s^2 2p_x^2 2p_y^2 2p_z^0$

(c) $1s^2, 2s^2 2p_x^3 2p_y^1 2p_z^0$ (d) None of these

47. If value of azimuthal quantum number l is 2, then total possible values of magnetic quantum number will be

(a) 7 (b) 5

(c) 3 (d) 2

48. The type of orbitals present in Fe is

(a) s (b) s and p

(c) s, p and d (d) s, p, d and f

49. The shape of d_{xy} orbital will be

(a) Circular (b) Dumb-bell

(c) Double dumb-bell (d) Trigonal

50. In any atom which sub-shell will have the highest energy in the following

(a) $3p$ (b) $3d$

(c) $4s$ (d) $3s$

51. Which electronic configuration is not observing the ($n+l$) rule

(a) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^1, 4s^2$

(b) $1s^2, 2s^2 sp^6, 3s^2 3p^6 3d^7, 4s^2$

(c) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^5, 4s^1$

(d) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^8, 4s^2$

52. The four quantum numbers of the outermost orbital of K (atomic no. =19) are **[MP PET 1993, 94]**

(a) $n=2, l=0, m=0, s=+\frac{1}{2}$

(b) $n=4, l=0, m=0, s=+\frac{1}{2}$

(c) $n=3, l=1, m=1, s=+\frac{1}{2}$

(d) $n=4, l=2, m=-1, s=+\frac{1}{2}$

53. The angular momentum of an electron depends on **[BHU 1978; NCERT 1981]**

(a) Principal quantum number
(b) Azimuthal quantum number
(c) Magnetic quantum number
(d) All of these

54. The electronic configuration of copper $({}_{29}Cu)$ is

(a) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^9, 4s^2$
(b) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}, 4s^1$
(c) $1s^2 . 2s^2 2p^6, 3s^2 3p^6, 4s^2 4p^6$
(d) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}$

55. The number of orbitals in $2p$ sub-shell is **[NCERT 1973; MP PMT 1996]**

(a) 6 (b) 2
(c) 3 (d) 4

56. The number of orbitals in d sub-shell is **[MNR 1981]**

(a) 1 (b) 3
(c) 5 (d) 7

57. A sub-shell $l=2$ can take how many electrons **[NCERT 1973, 78]**

(a) 3 (b) 10
(c) 5 (d) 6

58. Pauli's exclusion principle states that **[MNR 1983; AMU 1984]**

(a) Two electrons in the same atom can have the same energy
(b) Two electrons in the same atom cannot have the same spin
(c) The electrons tend to occupy different orbitals as far as possible
(d) Electrons tend to occupy lower energy orbitals preferentially
(e) None of the above

59. For d electrons, the azimuthal quantum number is **[MNR 1983; CPMT 1984]**

(a) 0 (b) 1
(c) 2 (d) 3

60. For p-orbital, the magnetic quantum number has value

(a) 2 (b) 4, – 4
(c) – 1, 0, +1 (d) 0

61. For $n=3$ energy level, the number of possible orbitals (all kinds) are **[BHU 1981; CPMT 1985; MP PMT 1995]**

(a) 1 (b) 3
(c) 4 (d) 9

62. Which of the following ions is not having the configuration of neon

(a) F^- (b) Mg^{+2}
(c) Na^+ (d) Cl^-

63. Elements upto atomic number 103 have been synthesized and studied. If a newly discovered element is found to have an atomic number 106, its electronic configuration will be **[AIIMS 1980]**

(a) $[Rn]5f^{14}, 6d^4, 7s^2$ (b) $[Rn]5f^{14}, 6d^1, 7s^2 7p^3$
(c) $[Rn]5f^{14}, 6d^6, 7s^0$ (d) $[Rn]5f^{14}, 6d^5, 7s^1$

64. Ions which have the same electronic configuration are those of

(a) Lithium and sodium (b) Sodium and potassium
(c) Potassium and calcium (d) Oxygen and chlorine

65. When the azimuthal quantum number has a value of $l=0$, the shape of the orbital is **[MP PET 1995]**

(a) Rectangular (b) Spherical
(c) Dumbbell (d) Unsymmetrical

66. The magnetic quantum number for valency electrons of sodium is **[CPMT 1988; MH CET 1999]**

(a) 3 (b) 2
(c) 1 (d) 0

67. The electronic configuration of an element with atomic number 7 *i.e.* nitrogen atom is **[CPMT 1982, 84, 87]**

(a) $1s^2, 2s^1, 2p_x^3$ (b) $1s^2, 2s^2 2p_x^2 2p_y^1$
(c) $1s^2, 2s^2 2p_x^1 2p_y^1 2p_z^1$ (d) $1s^2, 2s^2 2p_x^1 2p_y^2$

68. In a multi-electron atom, which of the following orbitals described by the three quantum members will have the same energy in the absence of magnetic and electric fields **[AIEEE 2005]**

(1) $n=1, l=0, m=0$ (2) $n=2, l=0, m=0$

(3) $n=2, l=1, m=1$ (4) $n=3, l=2, m=0$

(5) $n=3, l=2, m=0$

(a) (1) and (2) (b) (2) and (3)

(c) (3) and (4) (d) (4) and (5)

69. Which of the following represents the electronic configuration of an element with atomic number 17 **[AMU 1982]**

(a) $1s^2, 2s^2 2p^6, 3s^1 3p^6$ (b) $1s^2, 2s^2 2p^6, 3s^2 3p^4, 4s^1$

(c) $1s^2, 2s^2 2p^6, 3s^2 3p^5$ (d) $1s^2, 2s^2 2p^6, 3s^1 3p^4, 4s^2$

70. The shape of s-orbital is **[NCERT 1978]**

(a) Pyramidal (b) Spherical

(c) Tetrahedral (d) Dumb-bell shaped

71. When $3d$ orbital is complete, the new electron will enter the **[EAMCET 1980; MP PMT 1995]**

(a) $4p$-orbital (b) $4f$-orbital

(c) $4s$-orbital (d) $4d$-orbital

72. In a potassium atom, electronic energy levels are in the following order **[EAMCET 1979; DPMT 1991]**

(a) $4s > 3d$ (b) $4s > 4p$

(c) $4s < 3d$ (d) $4s < 3p$

73. Fe (atomic number = 26) atom has the electronic arrangement **[NCERT 1974; MNR 1980]**

(a) 2, 8, 8, 8 (b) 2, 8, 16

(c) 2, 8,14, 2 (d) 2, 8, 12, 4

74. Cu^{2+} will have the following electronic configuration **[MP PMT 1985]**

(a) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}$

(b) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^9, 4s^1$

(c) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^9$

(d) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}, 4s^1$

75. Which one is the electronic configuration of Fe^{+2} **[MADT Bihar 1982; AIIMS 1989]**

(a) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^6$

(b) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^4, 4s^2$

(c) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^5, 4s^1$

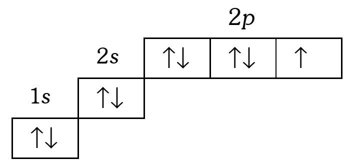
(d) None of these

76. How many electrons can be fit into the orbitals that comprise the 3^{rd} quantum shell $n=3$ **[MP PMT 1986, 87; Orissa JEE 1997]**

(a) 2 (b) 8

(c) 18 (d) 32

77. Which element is represented by the following electronic configuration



(a) Nitrogen (b) Oxygen

(c) Fluorine (d) Neon

78. If the value of azimuthal quantum number is 3, the possible values of magnetic quantum number would be **[MP PMT 1987; RPMT 1999; AFMC 2002; KCET 2002]**

(a) 0, 1, 2, 3 (b) 0, – 1, – 2, – 3

(c) 0, ± 1, ± 2, ± 3 (d) ± 1, ± 2, ± 3

79. Krypton $(_{36}Kr)$ has the electronic configuration $(_{18}Ar)$ $4s^2, 3d^{10}, 4p^6$. The 37^{th} electron will go into which one of the following sub-levels **[CBSE PMT 1989; CPMT 1989; EAMCET 1991]**

(a) $4f$ (b) $4d$

(c) $3p$ (d) $5s$

80. If an electron has spin quantum number of $+\frac{1}{2}$ and a magnetic quantum number of -1, it cannot be presented in an **[CBSE PMT 1989; UPSEAT 2001]**

(a) d-orbital (b) f-orbital

(c) p-orbital (d) s-orbital

81. The azimuthal quantum number is related to **[BHU 1987, 95]**

(a) Size (b) Shape

(c) Orientation (d) Spin

82. The total number of electrons that can be accommodated in all the orbitals having principal quantum number 2 and azimuthal quantum number 1 is **[CPMT 1971, 89, 91]**

(a) 2 (b) 4

(c) 6 (d) 8

83. Electronic configuration of C is **[CPMT 1975]**

(a) $1s^2, 2s^2 2p^2$ (b) $1s^2, 2s^2 2p^3$

(c) $1s^2, 2s^2$ (d) $1s^2, 2s^2 2p^6$

84. There is no difference between a $2p$ and a $3p$ orbital regarding **[BHU 1981]**

(a) Shape (b) Size

(c) Energy (d) Value of n

85. The electronic configuration of chromium is **[MP PMT 1993; MP PET 1995; BHU 2001; BCECE 2005]**

(a) $[Ne]3s^2 3p^6 3d^4, 4s^2$ (b) $[Ne]3s^2 3p^6 3d^5, 4s^1$
(c) $[Ne]3s^2 3p^6, 4s^2 4p^4$ (d) $[Ne]3s^2 3p^6 3d^1, 4s^2 4p^3$

86. The shape of p-orbital is [MP PMT 1993]
(a) Elliptical (b) Spherical
(c) Dumb-bell (d) Complex geometrical

87. The electronic configuration (outermost) of Mn^{+2} ion (atomic number of $Mn = 25$) in its ground state is [MP PET 1993]
(a) $3d^5, 4s^0$ (b) $3d^4, 4s^1$
(c) $3d^3, 4s^2$ (d) $3d^2, 4s^2 4p^2$

88. The principal quantum number represents [CPMT 1991]
(a) Shape of an orbital
(b) Distance of electron from nucleus
(c) Number of electrons in an orbit
(d) Number of orbitals in an orbit

89. When the azimuthal quantum number has a value of $l = 1$, the shape of the orbital is [MP PET 1993]
(a) Unsymmetrical (b) Spherically symmetrical
(c) Dumb-bell (d) Complicated

90. How many electrons can be accommodated in a sub-shell for which $n = 3, l = 1$ [CBSE PMT 1990]
(a) 8 (b) 6
(c) 18 (d) 32

91. For azimuthal quantum number $l = 3$, the maximum number of electrons will be EAMCET 1991; RPMT 2002; CBSE PMT 2002]
(a) 2 (b) 6
(c) 0 (d) 14

92. An ion has 18 electrons in the outermost shell, it is [CBSE PMT 1990]
(a) Cu^+ (b) Th^{4+}
(c) Cs^+ (d) K^+

93. The order of filling of electrons in the orbitals of an atom will be
(a) $3d, 4s, 4p, 4d, 5s$ (b) $4s, 3d, 4p, 5s, 4d$
(c) $5s, 4p, 3d, 4d, 5s$ (d) $3d, 4p, 4s, 4d, 5s$

94. The quantum number which may be designated by s, p, d and f instead of number is BHU 1980]
(a) n (b) l
(c) m_l (d) m_s

95. Which of the following represents the correct sets of the four quantum numbers of a $4d$ electron [MNR 1992; UPSEAT 2001; J&K CET 2005]
(a) $4, 3, 2, \frac{1}{2}$ (b) 4, 2, 1, 0
(c) $4, 3, -2, +\frac{1}{2}$ (d) $4, 2, 1, -\frac{1}{2}$

96. Which of the following statements is not correct for an electron that has the quantum numbers $n = 4$ and $m = 2$ [MNR 1993]
(a) The electron may have the quantum number $s = +\frac{1}{2}$
(b) The electron may have the quantum number $l = 2$
(c) The electron may have the quantum number $l = 3$
(d) The electron may have the quantum number $l = 0, 1, 2, 3$

97. The set of quantum numbers not applicable for an electron in an atom is
(a) $n = 1, l = 1, m_l = 1, m_s = +1/2$
(b) $n = 1, l = 0, m_l = 0, m_s = +1/2$
(c) $n = 1, l = 0, m_l = 0, m_s = -1/2$
(d) $n = 2, l = 0, m_l = 0, m_s = +1/2$

98. Correct configuration of Fe^{+3} [26] is [CPMT 1994; BHU 1995; KCET 1992]
(a) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^5$
(b) $1s^2, 2s^2 sp^6, 3s^2 3p^6 3d^3, 4s^2$
(c) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^6, 4s^2$
(d) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^5, 4s^1$

99. Azimuthal quantum number for last electron of Na atom is [CBSE PMT 1991; BHU 1995]
(a) 1 (b) 2
(c) 3 (d) 0

100. A $3p$ orbital has [IIT 1995]
(a) Two spherical nodes
(b) Two non-spherical nodes
(c) One spherical and one non-spherical nodes
(d) One spherical and two non-spherical nodes [CBSE PMT 1991]

101. All electrons on the $4p$ sub-shell must be characterized by the quantum number(s) [MP PET 1996]
(a) $n = 4, m = 0, s = \pm\frac{1}{2}$ (b) $l = 1$
(c) $l = 0, s = \pm\frac{1}{2}$ (d) $s = \pm\frac{1}{2}$

102. The electronic configuration of the element of atomic number 27 is

(a) $1s^2, 2s^2 2p^6, 3s^2 3p^6, 4s\,(\uparrow\downarrow)\,4p\,(\uparrow\downarrow)(\uparrow\downarrow)(\uparrow\downarrow)\,5s\,(\uparrow)$

(b) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d\,(\uparrow\downarrow)(\uparrow\downarrow)(\uparrow\downarrow), 4s\,(\uparrow\downarrow)\,4p\,(\uparrow)$

(c) $1s^2, 2s^2 2p^6, 3s^2 3p^6, 3d\,(\uparrow\downarrow)(\uparrow\downarrow)(\uparrow\downarrow)(\uparrow\downarrow), 4s\,(\uparrow)$

(d) $1s^2, 2s^2 2p^6, 3s^2 3p^6, 3d\,(\uparrow\downarrow)(\uparrow\downarrow)(\uparrow)(\uparrow)(\uparrow)\,4s\,(\uparrow\downarrow)$

103. When the value of the principal quantum number n is 3, the permitted values of the azimuthal quantum numbers l and the magnetic quantum numbers m, are

	l	m
(a)	0	0
	1	$+1, 0, -1$
	2	$+2, +1, 0, -1, -2$
(b)	1	1
	2	$+2, 1, -1$
	3	$+3, +2, 1, -2, -3$
(c)	0	0
	1	1, 2, 3
	2	$+3, +2, 1, -2, -3$
(d)	1	0, 1
	2	0, 1, 2
	3	0, 1, 2, 3

104. The number of possible spatial orientations of an electron in an atom is given by its

(a) Spin quantum number
(b) Spin angular momentum
(c) Magnetic quantum number
(d) Orbital angular momentum

105. Which of the following sets of orbitals may degenerate

(a) $2s, 2p_x, 2p_y$ (b) $3s, 3p_x, 3d_{xy}$
(c) $1s, 2s, 3s$ (d) $2p_x, 2p_y, 2p_z$

106. The set of quantum numbers $n = 3, l = 0, m = 0, s = -1/2$ belongs to the element

(a) Mg (b) Na
(c) Ne (d) F

107. An electron has principal quantum number 3. The number of its (i) sub-shells and (ii) orbitals would be respectively **[MP PET 1997]**

(a) 3 and 5 (b) 3 and 7
(c) 3 and 9 (d) 2 and 5

108. What is the electronic configuration of $Cu^{2+} (Z = 29)$ of least position **[MP PET/PMT 1998; MP PET 2001]**

(a) $[Ar] 4s^1 3d^8$ (b) $[Ar] 4s^2 3d^{10} 4p^1$
(c) $[Ar] 4s^1 3d^{10}$ (d) $[Ar] 3d^9$

109. The correct electronic configuration of $Ti (Z = 22)$ atom is **[MP PMT 1999]**

(a) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$
(b) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4$
(c) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4$
(d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^3$

110. Which of the following configuration is correct for iron **[CBSE PMT 1999]**

(a) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$
(b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$
(c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^7$
(d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$

111. Which of the following set of quantum numbers belong to highest energy

(a) $n = 4, l = 0, m = 0, s = +\frac{1}{2}$
(b) $n = 3, l = 0, m = 0, s = +\frac{1}{2}$
(c) $n = 3, l = 1, m = 1, s = +\frac{1}{2}$
(d) $n = 3, l = 2, m = 1, s = +\frac{1}{2}$

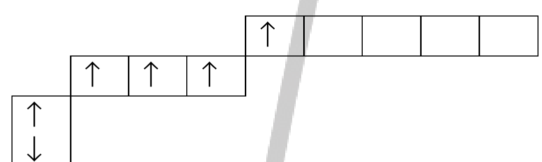
112. Which quantum number will determine the shape of the subshell **[CPMT 1999; Pb. PMT 1998]**

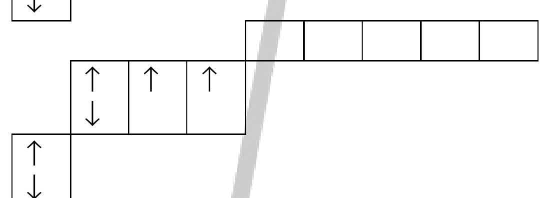
(a) Principal quantum number
(b) Azimuthal quantum number
(c) Magnetic quantum number
(d) Spin quantum number

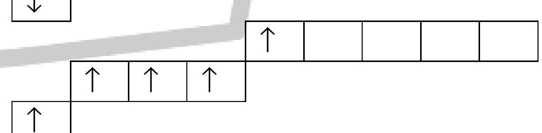
113. For the $n = 2$ energy level, how many orbitals of all kinds are possible

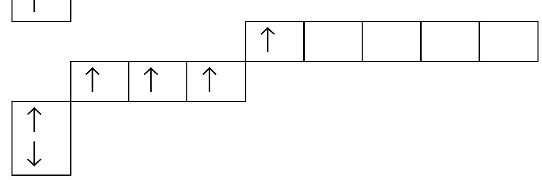
(a) 2 (b) 3
(c) 4 (d) 5

114. Which one is in the ground state **[DPMT 1996]**

(a)


(b)


(c)


(d)


115. When the principal quantum number $(n=3)$, the possible values of azimuthal quantum number (l) is **[Bihar MEE 1996; KCET 2000]**

(a) 0, 1, 2, 3 (b) 0, 1, 2
(c) − 2, – 1, 0, 1, 2 (d) 1, 2, 3
(e) 0, 1

116. Which statement is not correct for $n=5$, $m=3$ **[CPMT 1996]**

(a) $l=4$ (b) $l=0,1,3; s=+\frac{1}{2}$
(c) $l=3$ (d) All are correct

117. $1s^2 2s^2 2p^6 3s^1$ shows configuration of **[CPMT 1996]**

(a) Al^{3+} in ground state (b) Ne in excited state
(c) Mg^{+} in excited state (d) None of these

118. Five valence electrons of p^{15} are labelled as

AB		X	Y	Z
3s			3p	

If the spin quantum of B and Z is $+\frac{1}{2}$, the group of electrons with three of the quantum number same are **[JIPMER 1997]**

(a) AB, XYZ, BY (b) AB
(c) XYZ, AZ (d) AB, XYZ

119. Electronic configuration of Sc^{21} is **[BHU 1997]**

(a) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$
(b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^2$
(c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^0 3d^3$
(d) $1s^2 2s^2 2p^6 3s^2 3p^2 4s^2 3d^2$

120. If $n+l=6$, then total possible number of subshells would be **1997]**

(a) 3 (b) 4
(c) 2 (d) 5

121. An electron having the quantum numbers $n=4, l=3, m=0$, $s=-\frac{1}{2}$ would be in the orbital **[Orissa JEE 1997]**

(a) $3s$ (b) $3p$
(c) $4d$ (d) $4f$

122. Which of the following sets of quantum numbers is not allowed **[Orissa JEE 1997]**

(a) $n=1, l=0, m=0, s=+\frac{1}{2}$
(b) $n=1, l=1, m=0, s=-\frac{1}{2}$
(c) $n=2, l=1, m=1, s=+\frac{1}{2}$
(d) $n=2, l=1, m=0, s=-\frac{1}{2}$

123. For which of the following sets of four quantum numbers, an electron will have the highest energy **[CBSE PMT 1994]**

	n	l	m	s
(a)	3	2	1	+1/2
(b)	4	2	1	+1/2
(c)	4	1	0	−1/2
(d)	5	0	0	−1/2

124. The electronic configuration of gadolinium (atomic no. 64) is

(a) $[Xe]4s^8 5d^9 6s^2$ (b) $[Xe]4s^7 5d^1 6s^2$
(c) $[Xe]4s^3 5d^5 6s^2$ (d) $[Xe]4f^6 5d^2 6s^2$

125. An e^- has magnetic quantum number as -3, what is its principal quantum number **[BHU 1998]**

(a) 1 (b) 2
(c) 3 (d) 4

126. The number of quantum numbers required to describe an electron in an atom completely is **[CET Pune 1998]**

(a) 1 (b) 2
(c) 3 (d) 4

127. The electronic configuration $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$ **[AFMC 1997; Pb. PMT 1999; CBSE PMT 2001; AIIMS 2001]**

(a) Oxygen (b) Nitrogen
(c) Hydrogen (d) Fluorine

128. Which one of the following set of quantum numbers is not possible for $4p$ electron **[EAMCET 1998]**

(a) $n=4, l=1, m=-1, s=+\frac{1}{2}$
(b) $n=4, l=1, m=0, s=+\frac{1}{2}$
(c) $n=4, l=1, m=2, s=+\frac{1}{2}$
(d) $n=4, l=1, m=-1, s=+\frac{1}{2}$

129. Which of the following orbital is not possible **[RPMT 1999]**

(a) $3f$ (b) $4f$
(c) $5f$ (d) $6f$

130. Which set of quantum numbers for an electron of an atom is not possible **[RPMT; DCE 1999]**

(a) $n=1, l=0, m=0, s=+1/2$
(b) $n=1, l=1, m=1, s=+1/2$

(c) $n = 1, l = 0, m = 0, s = -1/2$

(d) $n = 2, l = 1, m = -1, s = +1/2$

131. Electronic configuration of ferric ion is ET 2000]

(a) $[Ar]3d^5$ (b) $[Ar]3d^7$

(c) $[Ar]3d^3$ (d) $[Ar]3d^8$

132. What is the maximum number of electrons which can be accommodated in an atom in which the highest principal quantum number value is 4 **[MP PMT 2000]**

(a) 10 (b) 18

(c) 32 (d) 54

133. Which of the following electronic configurations is not possible **[CPMT 2000]**

(a) $1s^2\ 2s^2$ (b) $1s^2 2s^2 2p^6$

(c) $3d^{10} 4s^2 4p^2$ (d) $1s^2 2s^2\ 2p^2 3s^1$

134. The electronic configuration of an element is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$. This represents its **[IIT Screening 2000]**

(a) Excited state (b) Ground state

(c) Cationic form (d) Anionic form

135. Which of the following set of quantum numbers is possible **[AIIMS 2001]**

(a) $n = 3;\ l = 2;\ m = 2$ and $s = +\frac{1}{2}$

(b) $n = 3;\ l = 4;\ m = 0$ and $s = -\frac{1}{2}$

(c) $n = 4; l = 0;\ m = 2$ and $s = +\frac{1}{2}$

(d) $n = 4;\ l = 4;\ m = 3$ and $s = +\frac{1}{2}$

136. Which of the following set of quantum number is not valid **[AIIMS 2001]**

(a) $n = 1,\ l = 2$ (b) $3 = 2,\ m = 1$

(c) $m = 3,\ l = 0$ (d) $3 = 4,\ l = 2$

137. Which one pair of atoms or ions will have same configuration **[JIPMER 2001]**

(a) F^+ and Ne (b) Li^+ and He^-

(c) Cl^- and Ar (d) Na and K

138. Which of the following sets of quantum number is not possible **[MP PET 2001]**

(a) $n = 3; l = +2; m = 0; s = +\frac{1}{2}$

(b) $n = 3; l = 0; m = 0; s = -\frac{1}{2}$

(c) $n = 3; l = 0; m = -1; s = +\frac{1}{2}$

(d) $n = 3; l = 1; m = 0; s = -\frac{1}{2}$

139. Which of the following set of quantum numbers is correct for the 19th electron of chromium **[DCE 2001]**

	n	*l*	*m*	*s*
(a)	3	0	0	1/2
(b)	3	2	– 2	1/2
(c)	4	0	0	1/2
(d)	4	1	–1	1/2

140. When the value of azimuthal quantum number is 3, magnetic quantum number can have values **[DPMT 2001]**

(a) + 1, 0, – 1

(b) + 2, + 1, 0, – 1, – 2

(c) – 3, – 2, – 1, – 0, + 1, + 2, + 3

(d) + 1, – 1

141. The quantum numbers $n = 2,\ l = 1$ represent **[AFMC 2002]**

(a) 1*s* orbital (b) 2*s* orbital

(c) 2*p* orbital (d) 3*d* orbital

142. The magnetic quantum number of valence electron of sodium (*Na*) is

(a) 3 (b) 2

(c) 1 (d) 0

143. Azimuthal quantum number defines **[AIIMS 2002]**

(a) *e*/*m* ratio of electron

(b) Spin of electron

(c) Angular momentum of electron

(d) Magnetic momentum of electron

144. Quantum numbers of an atom can be defined on the basis of

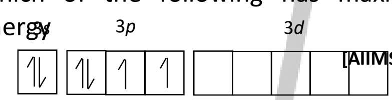
(a) Hund's rule

(b) Aufbau's principle

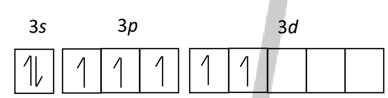
(c) Pauli's exclusion principle

(d) Heisenberg's uncertainty principle

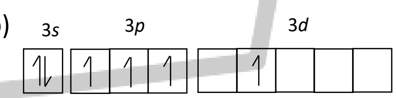
145. Which of the following has maximum energy **[AIIMS 2002]**



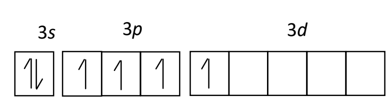
(a)



(b)



(c)



(d)

146. The total magnetic quantum numbers for *d*-orbital is given by

(a) 2 (b) $0, \pm 1, \pm 2$

(c) 0, 1, 2 (d) 5

147. The outer electronic structure $3s^2 3p^5$ is possessed by **[Pb. PMT 2002; Pb. CET 2001]**

(a) *Cl* (b) *O*

(c) *Ar* (d) *Br*

148. Which of the following set of quantum number is not possible **[Pb. PMT 2002]**

	n	*l*	m_1	m_2
(a)	3	2	1	+ 1/2
(b)	3	2	1	− 1/2
(c)	3	2	1	0
(d)	5	2	− 1	+ 1/2

149. The configuration $1s^2, 2s^2 2p^5, 3s^1$ shows **[Pb. PMT 2002]**

(a) Excited state of O_2^-

(b) Excited state of neon

(c) Excited state of fluorine

(d) Ground state of fluorine atom

150. The quantum number '*m*' of a free gaseous atom is associated with

(a) The effective volume of the orbital

(b) The shape of the orbital

(c) The spatial orientation of the orbital

(d) The energy of the orbital in the absence of a magnetic field

151. Correct statement is **[BHU 2003]**

(a) $K = 4s^1$, $Cr = 3d^4 4s^2$, $Cu = 3d^{10} 4s^2$

(b) $K = 4s^2$, $Cr = 3d^4 4s^2$, $Cu = 3d^{10} 4s^2$

(c) $K = 4s^2$, $Cr = 3d^5 4s^1$, $Cu = 3d^{10} 4s^2$

(d) $K = 4s^1$, $Cr = 3d^5 4s^1$, $Cu = 3d^{10} 4s^1$

152. Number of orbitats in *h* sub-shell is **[BHU 2003]**

(a) 11 (b) 15

(c) 17 (d) 19

153. Electronic configuration $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^5, 4s^1$ represents **[CPMT 2003]**

(a) Ground state (b) Excited state

(c) Anionic state (d) All of these

154. Which of the following sets is possible for quantum numbers **[RPET 2003]**

(a) $n = 4, l = 3, m = -2, s = 0$

(b) $n = 4, l = 4, m = +2, s = -\frac{1}{2}$

(c) $n = 4, l = 4, m = -2, s = +\frac{1}{2}$

(d) $n = 4, l = 3, m = -2, s = +\frac{1}{2}$

155. For principle quantum number $n = 4$ the total number of orbitals having $l = 3$ **[Orissa JEE 2002]** **[AIIMS 2004]**

(a) 3 (b) 7

(c) 5 (d) 9

156. The number of $2p$ electrons having spin quantum number $s = -1/2$ are

(a) 6 (b) 0

(c) 2 (d) 3

157. Which of the following sets of quantum numbers is correct for an electron in $4f$ orbital **[AIEEE 2004]**

(a) $n = 4, l = 3, m = +1, s = +\frac{1}{2}$

(b) $n = 4, l = 4, m = -4, s = -\frac{1}{2}$

(c) $n = 4, l = 3, m = +4, s = +\frac{1}{2}$

(d) $n = 3, l = 2, m = -2, s = +\frac{1}{2}$

158. Consider the ground state of $(Z = 24)$. The numbers of electrons with the azimuthal quantum numbers, $l = 1$ and 2 are, respectively **[AIEEE 2004]**

(a) 16 and 4 (b) 12 and 5

(c) 12 and 4 **[AIIMS 2003]** (d) 16 and 5

159. The four quantum numbers of the valence electron of potassium are

(a) 4, 1, 0 and $\frac{1}{2}$ (b) 4, 0, 1 and $\frac{1}{2}$

(c) 4, 0, 0 and $+\frac{1}{2}$ (d) 4, 1, 1 and $\frac{1}{2}$

160. Which of the following electronic configuration is not possible according to Hund's rule **[Kerala PMT 2004]**

(a) $1s^2 2s^2$ (b) $1s^2 2s^1$

(c) $1s^2 2s^2 2p_x^1 2p_y^1 2p_x^1$ (d) $1s^2 2s^2 2p_x^2$

(e) $1s^2 2s^2 2p_x^2 2p_y^1 2p_z^1$

161. The ground state term symbol for an electronic state is governed by **[UPSEAT 2004]**

(a) Heisenberg's principle

(b) Hund's rule

(c) Aufbau principle

(d) Pauli exclusion principle

162. The electronic configuration of element with atomic number 24 is **[Pb. CET 2004]**

(a) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^4, 4s^2$

(b) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}$

(c) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^6$

(d) $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^5 4s^1$

163. The maximum number of electrons in p-orbital with $n = 5, m = 1$ is [Pb. CET 2003]
(a) 6 (b) 2
(c) 14 (d) 10

164. Number of two electron can have the same values of …… quantum numbers [UPSEAT 2004]
(a) One (b) Two
(c) Three (d) Four

165. The number of orbitals present in the shell with $n = 4$ is [UPSEAT 2004]
(a) 16 (b) 8
(c) 18 (d) 32

166. Which of the following electronic configuration is not possible [MHCET 2003]
(a) $1s^2 2s^2$ (b) $1s^2, 2s^2 2p^6$
(c) $[Ar] 3d^{10}, 4s^2 4p^2$ (d) $1s^2, 2s^2 2p^2, 3s^1$

167. p_x orbital can accommodate [MNR 1990; IIT 1983; MADT Bihar 1995; BCECE 2005]
(a) 4 electrons
(b) 6 electrons
(c) 2 electrons with parallel spins
(d) 2 electrons with opposite spins

168. The maximum number of electrons that can be accommodated in 'f' sub shell is [CPMT 1983, 84; MP PET/PMT 1988; BITS 1988]
(a) 2 (b) 8
(c) 32 (d) 14

169. The number of electrons which can be accommodated in an orbital is [DPMT 1981; AFMC 1988]
(a) One (b) Two
(c) Three (d) Four

170. The number of electrons in the atom which has 20 protons in the nucleus [CPMT 1981, 93; CBSE PMT 1989]
(a) 20 (b) 10
(c) 30 (d) 40

171. The maximum number of electrons accommodated in $5f$ orbitals are [MP PET 1996]
(a) 5 (b) 10
(c) 14 (d) 18

172. The maximum number of electrons in an atom with $l = 2$ and $n = 3$ is
(a) 2 (b) 6
(c) 12 (d) 10

173. The configuration $1s^2 2s^2 2p^5 3s^1$ shows [AIIMS 1997]
(a) Ground state of fluorine atom
(b) Excited state of fluorine atom
(c) Excited state of neon atom
(d) Excited state of ion O_2^-

174. For sodium atom the number of electrons with $m = 0$ will be
(a) 2 (b) 7
(c) 9 (d) 8

175. The number of electrons that can be accommodated in dz^2 orbital is
(a) 10 (b) 1
(c) 4 (d) 2

176. Number of unpaired electrons in $1s^2 2s^2 2p^3$ is
(a) 2 (b) 0
(c) 3 (d) 1

177. Total number of unpaired electrons in an atom of atomic number 29 is
(a) 1 (b) 3
(c) 4 (d) 2

178. The number of unpaired electrons in $1s^2, 2s^2 2p^4$ is [NCERT 1984; CPMT 1991; MP PMT 1996, 2002]
(a) 4 (b) 2
(c) 0 (d) 1

179. The maximum number of electrons that can be accommodated in a $3d$ subshell is
(a) 2 (b) 10
(c) 6 (d) 14

180. The maximum number of electrons which each sub-shell can occupy is
(a) $2n^2$ (b) $2n$
(c) $2(2l+1)$ (d) $(2l+1)$

181. Number of unpaired electrons in the ground state of beryllium atom is
(a) 2 (b) 1
(c) 0 (d) All the above

182. How many unpaired electrons are present in Ni^{2+} cation (atomic number = 28) MP PMT 1995; Kerala PMT 2003]
(a) 0 (b) 2
(c) 4 (d) 6

183. The number of unpaired electrons in an O_2 molecule is [MNR 1983]
(a) 0 (b) 1
(c) 2 [MP PET/PMT 1998] (d) 3

184. The number of unpaired electrons in a chromic ion Cr^{3+} (atomic number = 24) is [MNR 1986; CPMT 1992
(a) 6 (b) 4
(c) 3 (d) 1

185. $3d^{10} 4s^0$ electronic configuration exhibits by

(a) Zn^{++} (b) Cu^{++}
(c) Cd^{++} (d) Hg^{++}

186. Which of the following metal ions will have maximum number of unpaired electrons [CPMT 1996]
(a) Fe^{+2} (b) CO^{+2}
(c) Ni^{+2} (d) Mn^{+2}

187. Which of the metal ion will have highest number of unpaired electrons
(a) Cu^{+} (b) Fe^{2+}
(c) Fe^{3+} (d) Co^{2+}

188. The maximum number of unpaired electron can be present in d orbitals are
(a) 1 (b) 3
(c) 5 (d) 7

189. The molecule having one unpaired electron is
(a) NO (b) CO
(c) CN^{-} (d) O_2

190. A filled or half-filled set of p or d-orbitals is spherically symmetric. Point out the species which has spherical symmetry
(a) Na (b) C
(c) Cl^{-} (d) Fe

191. The atom of the element having atomic number 14 should have [AMU 1984]
(a) One unpaired electron (b)Two unpaired electrons
(c) Three unpaired electrons (d)Four unpaired electrons

192. An atom has 2 electrons in K shell, 8 electrons in L shell and 6 electrons in M shell. The number of s-electrons present in that element is [CPMT 1989]
(a) 6 (b) 5
(c) 7 (d) 10

193. The number of unpaired electrons in carbon atom in excited state is
(a) One (b) Two
(c) Three (d) Four

194. Maximum number of electrons present in 'N' shell is [EAMCET 1984]
(a) 18 (b) 32
(c) 2 (d) 8

195. The number of d electrons in Fe^{+2} (atomic number of $Fe = 26$) is not equal to that of the [MNR 1993]
(a) p-electrons in Ne (At. No.= 10)
(b) s-electrons in Mg (At. No.= 12)
(c) d-electrons in Fe
(d) p-electrons in Cl^{-} (At. No. of Cl = 17)

196. A transition metal X has a configuration $[Ar]3d^4$ in its $+3$ oxidation state. Its atomic number is [EAMCET 1990]
(a) 25 (b) 26
(c) 22 (d) 19

197. The total number of electrons present in all the p-orbitals of bromine are
(a) Five (b) Eighteen
(c) Seventeen (d) Thirty five

198. Which of the following has the maximum number of unpaired electrons
(a) Mg^{2+} (b) Ti^{3+}
(c) V^{3+} (d) Fe^{2+}

199. Which of the following has more unpaired d-electrons [CBSE PMT 1999]
(a) Zn^{+} (b) Fe^{2+}
(c) N^{3+} (d) Cu^{+}

200. Maximum electrons in a d-orbital are [CPMT 1999]
(a) 2 (b) 10
(c) 6 (d) 14

201. The number of unpaired electrons in $Fe^{3+} (Z = 26)$ are [NCERT 1983] [KCET 2000]
(a) 5 (b) 6
(c) 3 (d) 4

202. How many unpaired electrons are present in cobalt [*Co*] metal [RPMT 2002]
(a) 2 (b) 3
(c) 4 (d) 7

203. The number of unpaired electrons in nitrogen is [Pb. CET 2002]
(a) 1 (b) 3
(c) 2 (d) None of these

204. Which of the following has the least energy [MNR 1987]
(a) $2p$ (b) $3p$
(c) $2s$ (d) $4d$

205. Pauli's exclusion principle states that [CPMT 1983, 84]
(a) Nucleus of an atom contains no negative charge
(b) Electrons move in circular orbits around the nucleus
(c) Electrons occupy orbitals of lowest energy
(d) All the four quantum numbers of two electrons in an atom cannot be equal

206. For the energy levels in an atom, which one of the following statements is correct [AIIMS 1983]
(a) There are seven principal electron energy levels

(b) The second principal energy level can have four sub-energy levels and contains a maximum of eight electrons

(c) The M energy level can have maximum of 32 electrons

(d) The $4s$ sub-energy level is at a higher energy than the $3d$ sub-energy level

207. The statements [AIIMS 1982]

(i) In filling a group of orbitals of equal energy, it is energetically preferable to assign electrons to empty orbitals rather than pair them into a particular orbital.

(ii) When two electrons are placed in two different orbitals, energy is lower if the spins are parallel.

are valid for

(a) Aufbau principle
(b) Hund's rule
(c) Pauli's exclusion principle
(d) Uncertainty principle

208. According to Aufbau's principle, which of the three $4d, 5p$ and $5s$ will be filled with electrons first [MADT Bihar 1984]

(a) $4d$
(b) $5p$
(c) $5s$
(d) $4d$ and $5s$ will be filled simultaneously

209. The energy of an electron of $2p_y$ orbital is [AMU 1984]

(a) Greater than that of $2p_x$ orbital
(b) Less than that of $2p_x$ orbital
(c) Equal to that of $2s$ orbital
(d) Same as that of $2p_z$ orbital

210. Which of the following principles/rules limits the maximum number of electrons in an orbital to two [CBSE PMT 1989]

(a) Aufbau principle
(b) Pauli's exclusion principle
(c) Hund's rule of maximum multiplicity
(d) Heisenberg's uncertainty principle

211. The electrons would go to lower energy levels first and then to higher energy levels according to which of the following [BHU 1990; MP PMT 1993]

(a) Aufbau principle
(b) Pauli's exclusion principle
(c) Hund's rule of maximum multiplicity
(d) Heisenberg's uncertainty principle

212. Energy of atomic orbitals in a particular shell is in the order [AFMC 1990]

(a) $s < p < d < f$ (b) $s > p > d > f$
(c) $p < d < f < s$ (d) $f > d > s > p$

213. Aufbau principle is not satisfied by [MP PMT 1997]

(a) Cr and Cl (b) Cu and Ag
(c) Cr and Mg (d) Cu and Na

214. Which of the following explains the sequence of filling the electrons in different shells [AIIMS 1998; BHU 1999]

(a) Hund's rule (b) Octet rule
(c) Aufbau principle (d) All of these

215. Aufbau principle is obeyed in which of the following electronic configurations [AFMC 1999]

(a) $1s^2 2s^2 2p^6$ (b) $1s^2 3p^3 3s^2$
(c) $1s^2 3s^2 3p^6$ (d) $1s^2 2s^2 3s^2$

216. Following Hund's rule which element contains six unpaired electron

(a) *Fe* (b) *Co*
(c) *Ni* (d) *Cr*

217. Electron enters the sub-shell for which $(n+l)$ value is minimum. This is enunciated as [RPMT 2000]

(a) Hund's rule
(b) Aufbau principle
(c) Heisenberg uncertainty principle
(d) Pauli's exclusion principle

218. The atomic orbitals are progressively filled in order of increasing energy. This principle is called as [MP PET 2001]

(a) Hund's rule (b) Aufbau principle
(c) Exclusion principle (d) de-Broglie rule

219. The correct order of increasing energy of atomic orbitals is [MP PET 2002]

(a) $5p < 4f < 6s < 5d$ (b) $5p < 6s < 4f < 5d$
(c) $4f < 5p < 5d < 6s$ (d) $5p < 5d < 4f < 6s$

220. The orbital with maximum energy is [CPMT 2002]

(a) 3*d* (b) 5*p*
(c) 4*s* (d) 6*d*

221. *p*-orbitals of an atom in presence of magnetic field are [Pb. PMT 2002]

(a) Two fold degenerate (b) Non degenerate
(c) Three fold degenerate (d) None of these

Answers

1	c	2	a	3	b	4	d	5	c
6	c	7	c	8	a	9	a	10	a
11	c	12	c	13	a	14	a	15	d
16	c	17	c	18	d	19	b	20	c
21	c	22	a	23	c	24	d	25	c
26	c	27	b	28	d	29	e	30	b
31	d	32	a	33	c	34	d	35	d
36	c	37	b	38	b	39	d	40	c
41	d	42	c	43	c	44	a	45	a
46	a	47	b	48	c	49	c	50	b
51	c	52	b	53	b	54	b	55	c
56	c	57	b	58	e	59	c	60	c
61	d	62	d	63	d	64	c	65	b
66	d	67	c	68	d	69	c	70	b
71	a	72	c	73	c	74	c	75	a
76	c	77	c	78	c	79	d	80	d
81	b	82	c	83	a	84	a	85	b
86	c	87	a	88	b	89	c	90	b
91	d	92	a	93	b	94	b	95	d
96	d	97	a	98	a	99	d	100	c
101	b	102	d	103	a	104	c	105	d
106	a	107	c	108	d	109	a	110	d
111	d	112	b	113	c	114	b	115	b
116	a	117	c	118	b	119	a	120	a
121	d	122	b	123	b	124	b	125	d
126	d	127	b	128	c	129	a	130	b
131	a	132	c	133	d	134	b	135	a
136	a	137	c	138	c	139	c	140	c
141	c	142	d	143	c	144	c	145	b
146	d	147	a	148	c	149	b	150	c
151	d	152	a	153	a	154	d	155	b
156	d	157	a	158	b	159	c	160	d
161	c	162	d	163	b	164	c	165	a
166	d	167	d	168	d	169	b	170	a
171	c	172	d	173	c	174	b	175	d
176	c	177	a	178	b	179	b	180	c
181	c	182	b	183	c	184	c	185	a
186	d	187	c	188	c	189	a	190	c
191	b	192	a	193	d	194	b	195	d
196	a	197	c	198	d	199	b	200	b
201	a	202	b	203	b	204	c	205	d
206	b	207	b	208	c	209	d	210	b
211	a	212	a	213	b	214	c	215	a
216	d	217	b	218	b	219	b	220	d
221	b								

ASSIGNMENT-2

1. The cause of periodicity in properties is due to
(a) increasing atomic radius
(b) increasing atomic weights
(c) number of electrons in the valency orbit
(d) the recurrence of similar outer electronic configuration at certain reular intervals of 2,8,8,18,18 and 32

2. Group 18 (or zero group) elements are best called as
(a) inert gases (b) rare gases
(c) noble gases (d) inactive gases

3. Which of the following are shown separately at the bottom of the periodic table ?
(a) 3 d Block elements (b) 4 d Block elements
(c) 5 d Block elements
(d) Inner transition elements.

4. Which of the following statements in incorrect ?
(a) The elements of subgroups A are all normal elements
(b) The elements of subgroups B are all transition elements
(c) The elements on the left of the periodic table are metals, on the right are non-metals and in the middle are metalloids.
(d) d-Block elements are also called transition elements .

5. f-Block elements are called inner transition elements because
(a) they have properties similar to those of transition elements
(b) they have been taken out of the transition elements
(c) the last electron enters into the f – orbital of penultimate shell
(d) the last electron enters into the f – orbital of the ante – penultimate shell.

6. The 3 d- transition series contains elements having atomic numbers ranging from
(a) 22 to 30 (b) 21 to 30
(c) 21 to 31 (d) 21 to 29.

7. The element with the electronic configuration $[Xe]4f^7 5d^1 6s^2$ lies in the
(a) s- block (b) d – block
(c) f – block (d) actinoid series

8. The atom having the valence shell electronic configuration $4s^2 4p^2$ would be in
(a) group 2 or IIA and period 3
(b) group 12 or IIB and period 4
(c) group 14 or IVA and period 4
(d) group 14 or IVA and period 3.

9. Which one of the following is an alkaline earth metal

(a) $[Ar]3d^2\ 4s^2$ (b) $[Xe]6s^2$
(c) $[Ar]3d^{10}\ 4s^2$ (d) $[Ne]3s^2\ 3p^2$

10. Which of the following sets includes only transition elements ?
(a) Z = 11,14,22,42 (b) 13,33,54,83
(c) 24,39,74,80 (d) 19,32,51,101.

11. The physical properties of vanadium are more closely related to
(a) titanium (b) tungsten
(c) niobium (d) nobelium.

12. Which atomic number out of the following cannot be accommodated in the present setup of the long form of the periodic table ?
(a) 112 (b) 118 (c) 120 (d) 116.

13. An element with atomic number 114 must exhibit properties similar to that of
(a) platinum (b) arsenic (c) lead (d) mercury

14. The electronic configuration of the element which is just above the element with atomic number 43 in the same periodic group is
(a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^2$
(b) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^5$
(c) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^1$
(d) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1\ 4p^6$.

15. A transition element X has the configuration [Ar] d^4 in its + 3 oxidation state. Its atomic number is
(a) 25 (b) 26 (c) 22 (d) 19

16. Name the element in the periodic table forming maximum number compounds.
(a) C (b) H (c) O (d) F

17. The IUPAC name of the element with atomic number Z = 109 is
(a) Unp (b) Uns (c) Uno (d) Une

18. Which of the following does not exhibit the periodicity in properties of the elements ?
(a) Ionization enthalpy (b) N / P ratio
(c) Electronegativity (d) Atomic radius

19. Which of the following sets of atomic numbers belong to that of alkali metals ?
(a) 1,12,30,4, 62 (b) 37,19,3, 55
(c) 9,17,35,53 (d) 12,20,56,58

20.Which of the following pairs of atomic numbers represents elements belonging to the same group ?
(a) 11 and 20 (b) 12 and 30
(c) 13 and 31 (d) 14 and 33

21. Element with atomic number 56 belongs to which block ?
(a) s (d) p (c) d (d) f

22. Ha is an alphabetical symbol of
(a) hafnium (b) hassnium
(c) hahnium (d) helium

23. Which of the following is not an actinoid ?
(a) Curium (b) Californium
(c) Uranium (d) Terbium

24. An element X belongs to fourth period and fifteenth group of the periodic table. Which one of the following is true regarding the outer electronic configuration of X ? It has
(a) partially filled d- orbitals and completely filled s – ortitals
(b) completely filled s – orbital and completely filled p – orbitals
(c) completely filled s – orbital and half filled p – orbitals
(d) half filled d – orbitals and completely filled s – orbital
(e) completely filled d, s and p orbitals.

25. Which of the following is the atomic number of metal ?
(a) 32 (b) 34 (c) 36 (d) 38

26. Which of the following element is represented by electronic configuration $1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^1$?
(a) Nitrogen (b) Oxygen
(c) Fluorine (d) Sulphur

27. The number of elements know at that time when Mendeleev arranged them in the periodic table was
(a) 63 (b) 60 (c) 71 (d) 65

28. Elements of I B and II B are called
(a) normal elements (b) trasition elements
(c) alkaline earth metals (d) alkali metals

29. In which one of the following sets, elements have nearly same atomic radii ?
(a) Li, Be, B, C (b) Mg, Ca, Sr, Ba
(c) Fe, Co, Ni, Cu (d) $O, S, Se, Te.$

30. In which of the following species, the size of the first species is not more than the second ?
(a) Li, F (b) Fe^{2+}, Fe^{3+}
(c) Na^+, F^- (d) S, O

31. Which of the following species has the same number of electrons in the outermost as well as the penultimate shell
(a) Mg^{2+} (b) O^{2-}
(c) F^- (d) Ca^{2+}

32. Identify the wrong statement in the following

(a) Amongst isoelectronic species, smaller the positive charge on the cation smaller is the ionic radius.
(b) Amongst isoelctronic species, greaster the negative charge on the anion larger is the ionic radius.
(c) Atomic radius of the elements increases as one moves down the first group of the periodic table.
(d) Atomic radius of the elements decreases as one moves across from left to right in the 2nd period of the periodic table.

33. Which of the following pairs has almost same atomic radii
(a) Al, Ga (b) Be, Mg
(c) Mg, Al (d) B, Be

34. In which of the following pairs, the ionization enthalpy of the first species is less than that of the second
(a) N, P (b) Be^+, Be
(c) N, N^- (d) S, P

35. For a given value of n (principal quantum number), ionization enthalpy is highest for
(a) d – electrons (b) f – electrons
(c) p – electrons (d) s – electrons.

36. The lowest fist ionization enthalpy would be associated with which of the following structures
(a) $1s^2 2s^2 2p^6 3s^1$
(b) $1s^2 2s^2 2p^5$
(c) $1s^2 2s^2 2p^6$
(d) $1s^2 2s^2 2p^6 3s^2 3p^2$.

37. The correct order of decreasing first ionization enthalpy is
(a) $C > B > Be > Li$
(b) $C > Be > B > Li$
(c) $B > C > Be > Li$
(d) $Be > Li > B > C$.

38. Which of the following order is wrong ?
(a) $NH_3 < PH_3 < AsH_3 - Acidic$
(b) $Li < Be < B < C < -IE_1$
(c) $Al_2O_3 < MgO < Na_2O < K_2O < -Basic$
(d) $Li^{2+} < Na^{2+} < K^+ < Cs^+ - Ionic\,radius$

39. In a given shell, the order of screening effect is
(a) $s > p > d > f$ (b) $f > d > p > s$
(c) $p < d < s < f$ (d) $d > f < s > p$
(e) $f > p > s > d$

40. The electronic configuration of the atom having maximum difference in first and second ionization enthalpies is
(a) $1s^2 2s^2 2p^6 3s^1$
(b) $1s^2 2s^2 2p^6 3s^2$
(c) $1s^2 2s^2 2p^1$
(d) $1s^2 2s^2 2p^6 3s^2 3p^1$
(e) $1s^2 2s^2 2p^3$

41. The correct order of decreasing second ionization enthalpy of Ti (22), V (23), Cr (24) and Mn (25) is
(a) $Mn > Cr > Ti > V$
(b) $Ti > V > Cr > Mn$
(c) $Cr > Mn > V > Ti$
(d) $V > Mn > Cr > Ti$

42. Which two elements in the periodic table would you expect to combine in the most violent fashion ?
(a) H and O (b) Cl and F
(c) Mg and N (d) Cs and F

43. The correct order of ionization enthalpy of C,N, O and F is
(a) $F < N < C < O$
(b) $C < N < O < F$
(c) $C < O < N < F$
(d) $F < O < N < C$

44. Among the following, the element of highest first ionization enthalpy is
(a) C (b) F (c) Be (d) N
(e) Ne

45. Which of the following has maximum ionization enthalpy
(a) Al (b) P
(c) Si (d) Mg

46. Born-Haber cycle can be used to estimate
(a) lattice energy of ionic crystals
(b) electron-gain enthalpy
(c) elelctronegativity
(d) both (a) and (b).

47. Which of the following species has highest electron gain enthalpy with – ve sign ?
(a) F^- (b) O
(c) O^- (d) Na^+

48. For electron gain enthalpy of halogen (with – ve sign) which of the following is correct ?
(a) $Br > F$ (b) $F > Cl$
(c) $Br > Cl$ (d) $F > I$

49. Which one of the following arrangements represents the correct order of electron gain enthalpy (with negative sign) of the given atomic species ?
(a) $F < Cl < O < S$
(b) $S < O < Cl < F$
(c) $O < s < F < Cl$
(d) $Cl < F < S < O$

50. What is the value of electron gain enthalpy of Na^+ if IE_1 of Na = 5.1 eV ?
(a) – 5.1 eV (b) – 10.2 eV
(c) + 2.55 eV (d) + 10.2 eV

51. The element with positive electrons gain enthalpy is
(a) hydrogen (b) sodium (c) oxygen
(d) fluorine (e) neon

52. Highest electron gain enthalpy is shown by
(a) O^- (b) F^- (c) Cl_2 (d) F_2

53. Electron gain enthalpy (with negative sign) of
(a) carbon is greater than oxygen
(b) sulphur is lesser than oxygen
(c) iodine is higher than bromine
(d) bromine is lesser than chlorine

54. Formations of which is least favoured energetically
(a) Li^- (b) Be^- (c) B^- (d) F^-

55. The element having very high ionization enthalpy but zero electron gain enthalpy is
(a) H (b) F (c) He (d) Be

56. Which of the following element has the highest electronegativity ?
(a) As (b) Sb (c) P (d) S.

57. Which of the following sets of elements has the strongest tendency to form anions ?
(a) P,S,Cl (b) N,O,F
(c) V,Cr,Mn (d) Ga,In,Tl.

58. Electronegativity value for the elements help in predicting
(a) polarity of bonds (b) dipole moments
(c) valency of elements
(d) position in the electrochemical series.

59. The electronic configurations of the elements X,Y,Z and J are given below. Which element has the highest metallic character ?
(a) X = 2,8,4 (b) Y = 2,8,8
(c) Z = 2,8,8,1 (d) J = 2,8,8,7.

60. Which indicates the correct variation in electronegativities ?
(a) $F > N < O > C$
(d) $F > N > O > C$
(c) $F < N < O < C$
(d) $F > N > O < C$.

61. The outermost electronic configuration of the most electronegative element is
(a) $ns^2\ np^3$ (b) $ns^2\ np^4$
(c) $ns^2\ np^5$ (d) $ns^2\ np^6$

**62. The correct order of decreasing electronegativity value among the elements I –beryllium, II – oxygen,
II – nitrogen and IV – magnesium is**
(a) $(II) > (III) > (I) > (IV)$
(b) $(III) > (IV) > (II) > (I)$
(c) $(I) > (II) > (III) > (IV)$
(d) $(I) > (II) > (IV) > (III)$
(d) $(II > (III) > (IV) > (I)$

63. The correct order of electronegativities of the groups given is
(a) $-CH_3 > -CH_3 > -CN > -OH$
(b) $-OH > -CN > -CF_3 > -CH_3$
(c) $-CF_3 > -CN > -OH > -CH_3$
(d) $-CF_3 > OH > -CN > -CH_3$

64. In general, maximum difference in electronegativities is observed when we move from
(a) second to third period
(b) third to fourth period
(c) fourth to fifth period
(d) fifth to sixth period

65. Amongst the following oxides which is least acidic ?
(a) Al_2O_3 (b) B_2O_3
(c) CO_2 (d) NO_2

66. The hydride ion is isoelectronic with
(a) Li (b) He^+
(c) He (d) Be.

67. Which of the following oxides is not expected to react with sodium hydroxide
(a) BeO (b) B_2O_3
(c) CaO (d) SiO_2

68. The EN of H, X, O are 2.1, 0.8 and 3.5 respectively. Comment on the nature of compound H–O–X, that is :
(1) Basic (2) Acidic
(3) Amphoteric (4) Can't be predicted

69. In lanthanum (Z=57), the 57_{th} electron enter in
(1) 6p orbital (2) 5d orbital
(3) 6s orbital (4) 4f orbital

70. In Mendeleev periodic table, total number of groups are :
(1) 8 (2) 9 (3) 18 (4) 12

71. Select incorrect order of electronegativity of element :
(1) N_2O_5 (EN of N-atom) > NO_2(EN of N-atom)
(2) CH_4 (EN of C-atom) > CO_2 (EN of C-atom)
(3) Cu^{2+} > Cu^+ (EN)
(4) O–F < P–F (bond polarity)

72. Among the lanthanide, which is radioactive :
(1) Lu (2) Pm (3) Pr (4) Eu

73. Which of the following will have least value of EA :
(1) O (2) S (3) F (4) Se

74. How many elements of 6th periods will have electron in 6d.

(1) 32 (2) 18 (3) 0 (4) 8

75. Comment on the EN of Sb in SbF_3 and SbF_5 :

(2) (1) EN of Sb (SbF_3) > EN of Sb (SbF_5)
(3) (2) EN of Sb (SbF_3) < EN of Sb (SbF_5)
(4) (3) EN of Sb is identical in both the cases
(5) (4) Can't be predicted

76. An element with electronic configuration $[Xe]4f^{14}5d^{9}6s^{1}$ is :
(1) An alkali metal (2) A transition element
(3) An inert gas (4) A rare earth

77. If size difference Cl–F = x and I–Br = y then correct relation between x and y would be :
(1) x = y (2) x > y
(3) x < y
(4) data insufficient to make comment

78. Which of the following set is of volatile metal ?
(1) Cu, Ag, Cl (2) Zn, Cd, Hg
(3) Au, Ag, Zn (4) Li, Na, K

79. Select the correct ionic radius order :
(1) $P^{3-} < P^{2-}$ (2) $P^{3-} < S^{2-}$
(3) $Na^{+} < Mg^{2+}$ (4) $S^{2-} > Ca^{2+}$

80. Which set of the element or ions represents a collection of isoelectronic species ?
(1) N^{3-}, F^{-}, Na^{+} (2) Ca^{2+}, Cs^{+}, Br^{-}
(3) Be^{2+}, Al^{3+}, Cl^{-} (4) Na^{+}, Ca^{2+}, Mg^{2+}

81. What is the total number of p-electrons in a single sulphur atom in the ground state :
(1) 4 (2) 6 (3) 10 (4) 16

82. Which one of following ions has minimum magnetic moment :
(1) Cu^{2+} (2) Ni^{2+} (3) Co^{3+} (4) Fe^{2+}

83. For which of following element its $IP_1 < IP_2$:
(1) N (2) Be (3) Ne (4) All

84. Out of first 105 element, how many element will have electrons in their f-subshell :
(1) 48 (2) 47 (3) 57 (4) 58
(2) Which pair of symbols identifies two elements
(3) that are metalloids :
(4) (1) B and Ge (2) Mg and Si
(5) (3) P and As (4) Ti an V

85. Out of first 105 element, how many element will have electrons in their f-subshell :
(1) 48 (2) 47 (3) 57 (4) 58

86. Which pair of symbols identifies two elements that are metalloids :
(1) B and Ge (2) Mg and Si
(3) P and As (4) Ti an V

87. Which metal requires the least enrgy to exhibit the photoelectric effect :
(1) Cs (2) Ca (3) Cu (4) Hg

88. Select the correct order of 2nd ionization energy of C, N, O and F :
(1) C > N > O > F (2) N > C > O > F
(3) C < N < O < F (4) O > F > N > C

89. In which of the following pair, the radius of 2nd species is greater than that of the first ?
(1) Na, Mg (2) O^{2-}, N^{3-}
(3) Li^{+}, Be^{2+} (4) Ba^{2+}, Sr^{2+}

90. Aluminium is diagonally related to :
(1) Li (2) Be
(3) Sa (4) B

91. Which of the following order of EA is not correct:-
(1) $O^{+} < S^{+}$ (2) N > S
(3) $F < F^{+}$ (4) $O > O^{-}$
2

92. In which of the following property inert gas have minimum value in a period ?
(1) Atomic Radius (2) $Z_{eff.}$
(3) I.P. (4) E.A.
4

93. Correct order is :-
(1) Atomic Radius Li < Be < B
(2) I.P. Li < Be < B
(3) E.A. Li < Be < B
(4) EN Li < Be < B
4

94. Incorrect order of E.A. is :-
(1) Be < N < B < O (2) Al < P < Si < S
(3) N < P < C < Si (4) P < N < Si < C

4

95. Incorrect order of I.P.

(1) Tl < Al (2) $Cu^{+} > Zn^{+}$
(3) Cu < Zn (4) Pd > Ag

1

96. IInd IP is Maximum for :-
(1) Boron (2) Beryllium
(3) Magnesium (4) Aluminium

1

ANSWER KEYS

1.(d) **2.(c)** **3.(d)**

4.(c)	**5.(d)**	**6.(b)**
7.(c)	**8.(c)**	**9.(b)**
10.(c)	**11.(c)**	**12.(c)**
13.(c)	**14.(a)**	**15.(a)**
16.(b)	**17.(d)**	**18.(b)**
19.(b)	**20.(a)**	**21.(a)**
22.(c)	**23.(d)**	**24.(c)**
25.(d)	**26.(a)**	**27.(a)**
28.(b)	**29.(c)**	**30.(c)**
31.(d)	**32.(a)**	**33.(a)**
34.(d)	**35.(d)**	**36.(a)**
37.(b)	**38.(b)**	**39.(a)**
40.(a)	**41.(c)**	**42.(c)**
43.(c)	**44.(e)**	**45.(b)**
46.(d)	**47.(b)**	**48.(d)**
49.(c)	**50.(a)**	**51.(e)**
52.(a)	**53.(d)**	**54.(b)**
55.(c)	**56.(d)**	**57.(b)**
58.(a)	**59.(c)**	**60.(a)**
61.(c)	**62.(a)**	**63.(c)**
64.(a)	**65.(a)**	**66.(c)**
67.(c)	**68.(1)**	
69.(2)	**70.(1)**	**71.(2)72.(2)**
73.(1)	**74.(3)**	**75.(2)76.(2)**
77.(2)	**78.(2)**	**79.(4)80.(1)**
81.(3)	**82.(1)**	**83.(4)84.(1)**
85.(1)	**86.(1)**	**87.(4)88.(2)**
89.(2)	**70.(1)**	**71.(2)72.(2)**
73.(1)	**74.(3)**	**75.(2)76.(2)**
77.(2)	**78.(2)**	**79.(4) 80.(1)**
81.(3)	**82.(1)**	**83.(4) 84.(1)**
85.(1)	**86.(1)**	**87.(4) 88.(2)**

(Previous Year Questions)

AIPMT/NEET & AIIMS (2006-2016)

AIPMT 2006

1. Which of the following is the most basic oxide?

(1) SeO_2 (2) Al_2O_3

(3) Sb_2O_3 (4) Bi_2O_3

AIPMT 2007

2. Identify the correct order of the size of the following

(1) $Ca^{2+} < K^+ < Ar < Cl^- < S^{2-}$

(2) $Ar < Ca^{2+} < K- < Cl^- < S^{2-}$

(3) $Ca^{2-} <$ ArcK- $< Cl^- < S^{2-}$

(4) $Ca^{2+} < K^+ < Ar < S^{2-} < Cl^-$

AIPMT 2008

3. The correct order of decreasing second ionisation enthalpy of Ti(22) , V(23) , Cr(24) and Mn(25) is :

(1) Mn > Cr > Ti > V (2) Ti > V > Cr > Mn

(3) Cr > Mn > V > Ti (4) V > Mn > Cr > Ti

AIPMT 2009

4. Which of the following oxides is not expected to react with sodium hydroxide ?

(1) BeO (2) B_2O_3

(3) CaO (4) SiO_2

5. Amongst the elements with following electronic configurations, which one of them may have the highest ionization energy ?

(1) $[Nel3s^23p^1$ (2) $[Ne]3s^23p3$

(3) $[Ne]3s^23p^2$ (4) $[Ar]3d^{10}4s^24p^3$

AIPMT 2010

6. Among the elements Ca. Mg, P and Cl. the order of increasing atomic radii is :-

(1) Cl < P < Mg < Ca (2) P < Cl < Ca < Mg

(3) Ca < Mg < P < Cl (4) Mg < Ca < Cl < P

7. The correct order of the decreasing ionic radii among the following isoelectronic species is :-

(1) $K^+ > Ca^{2+} > Cl^- > S^2$-

(2) $Ca^{2+} > K- > S^{2-} > Cl^-$

(3) $Cl^- > S^{2-} > Ca^{2-} > K^+$

(4) $S^{2-} > Cl^- > K^+ > Ca^{2+}$

8. Which of the following represents the correct order $_v$ / of increasing electron gain enthalpy with negative sign for the elements O, S, F and Cl ?

(1) S < O < Cl < F (2) Cl < F < O < S

(3) O < S < F < Cl (4) F < S < O < Cl

AIIMS 2010

9. Which is correct order of IP_1 :-

(1) Na > Al (2) Mg > Al

(3) Ga > Ca (4) Mg > Be

AIPMT Mains-2011

10. What is the value of electron gain enthalpy of Na^+ if IE_1 of Na = 5.1 eV :-

(1) +0.2 eV (2) -5.1 eV

(3) -10.2 eV (4) +2.55 eV

AIPMT Pre.-2012

11. Identify the **wrong** statement in the following:

(1) Atomic radius of the elements increases as one moves down the first group of the periodic table

(2) Atomic radius of the elements decreases as one- moves from left to right in the 2nd period of the periodic table

(3) Amongst isoelectronic species, smaller the positive charge on the cation, smaller is the ionic radius

(4) Amongst isoelectronic species, greater the negative charge on the anion, larger is the ionic radius

NEET-UG 2013

12. Which of the following lanthanoid ions is diamagnetic? (Atoms, Ce = 58, Sm = 62, Eu = 63, Yb = 70)

(1) Yb^{2+} (2) Ce^{2+} (3) Sm^{2+} (4) Eu^{2+}

AIIMS 2013

13. The 1st Ionisation enthalpy of Na, Mg and Si are 496, 737, 776 $kJmol^{-1}$ respectively then what will be the 1st ionisation enthalpy of Al in $kJmol^{-1}$:-

(1) > 766 $kJmol^{-1}$

(2) > 496 and < 737 $kJmol^{-1}$

(3) > 737 and < 766 $kJmol^{-1}$

(4) > 496 $kJmol^{-1}$

AIPMT 2014

14. Which of the following orders of ionic radii is correctly represented ?

(1) $H^- > H^+ > H$ (2) $Na^+ < F^- < O^{2-}$

(3) $F^- > O^{2-} > Na^+$ (4) $Al^{3+} > Mg^{2+} > N^{3-}$

15. Be^2+ is isoelectronic with which of the following ions?

(1) H^+ (2) Li^+ (3) Na^+ (4) Mg^2+

16. Acidity of diprotic acids in aqueous solutions increases in the order :-

(1) $H_2S < H_2Se < H_2Te$

(2) $H_2Se < H_2S < H_2Te$

(3) $H_2Te < H_2S < H_2Se$

(4) $H_2Se < H_2Te < H_2S$

17. Reason of lanthanoid contraction is :-

(1) Negligible screening effect of T orbitals

(2) Increasing nuclear charge

(3) Decreasing nuclear charge

(4) Decreasing screening effect

AIIMS2014

18. Correct order of atomic radius is :-

(1) V > Ti (2) Cl > S

(3) Rb > Cs (4) Ne > Be

19. Incorrect order of acidic strength is :-

(1) $H_2S > H_2Se$ (2) HI > HBr

(3) HBr > HCl (4) $H_2Te > H_2S$

AIPMT 2015

20. The species Ar, K^+ and Ca^{2+} contain, the same number of electrons. In which order do their radii increase ?

(1) $Ca^{2+} < Ar < K^+$ (2) $Ca^{2+} < K^+ < Ar$

(3) $K^+ < Ar < Ca^{2+}$ (4) $Ar < K^+ < Ca^{2+}$

21. The number of d-electrons in Fe^{2+} (Z = 26) is not equal to the number of electrons in which one of the following?

(1) p-electrons in Cl (Z = 17)

(2) d-electrons in Fe (Z = 26)

(3) p-electrons in Ne (Z = 10)

(4) s-electrons in Mg (Z = 12)

22. Because of lanthanoid contraction, which of the following pairs of elements have nearly same atomic // radii ? (Numbers in the brackets are atomic numbers).

(1) Zr (40) and Nb (41)

(2) Zr (40) and Hf (72)

(3) Zr (40) and Ta (73)

(4) Ti (22) and Zr (40)

Re-AIPMT 2015

23. Gadolinium belongs to 4f series. It's atomic number is 64. Which of the following is the correct , electronic configuration of gadolinium ?

(1) [Xe] $4f^7 5d^1 6s^2$ (2) [Xe] $4f^6 5d^2 6s^2$

(3) [Xe] $4f^8 6d^2$ (4) [Xe] $4f^9 55^1$

24. The formation of the oxide ion, O^{2-} (g) , from oxygen atom requires first an exothermic and then an endothermic step as shown below :

$$O(g) + e^- \rightarrow O^-_{(g)} \ ; \Delta_f H^\ominus = -141 \text{ kJ mol}^{-1}$$

$$O^-(g) + e^- \rightarrow O^{2-}_{(g)} \ ; \Delta_f H^\ominus = +780 \text{ kJ mol}^{-1}$$

Thus process of formation of O^{2-} in gas phase is unfavourable even thought O^{2-} is isoelectronic with neon. It is due to the fact that,

(1) Oxygen is more electronegative

(2) Addition of electron in oxygen results in larger size of the ion

(3) Hectron repulsion outweighs the stability gained by achieving noble gas configuration

(4) O^- ion has comparatively smaller size than oxygen atom

25. Which is the correct order of increasing energy of the listed orbitals in the atom of titanium ?

(At. no. Z = 22)

(1) 3s 3p 3d 4s (2) 3s 3p 4s 3d

(3) 3s 4s 3p 3d (4) 4s 3s 3p 3d

AIIMS 2015

26. Smallest ionic radius is :-

(1) La^{3+} (2) U^{3+} (3) Yb^{3+} (4) Cf^{3+}

27. Second IP of La is most likely to second IP of which element :-

(1) Be (2) Ba (3) Ca (4) Zn

28. Electronic configuration of Al with excluding bonded electron in aluminate ion

(1) [Ne] (2) [Ar]

(3) [Ne]$3s^2$ (4) [Ar]$4s^2$

NEET-I 2016

29. In which of the following options the order of arrangement does not agree with the variation of property indicated against it ?

(1) $Al^{3+} < Mg^{2+} < Na^+ < F$ (increasing ionic size)

(2) B < C < N < O (increasing first ionisation enthalpy)

(3) I < Br < Cl < F (increasing electron gain enthalpy)

(4) Li < Na < K < Rb (increasing metallic radius)

AIIMS 2016

30. The biggest gap in electronegativity is :-

(1) B → Al (2) Al → Ga

(3) Ga → In (4) In → Tl

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	**4**	**1**	**3**	**3**	**2**	**1**	**4**	**3**	**2**	**2**	**3**	**1**	**2**	**2**	**2**
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	**1**	**1**	**4**	**1**	**2**	**1**	**2**	**1**	**3**	**2**	**3**	**3**	**1**	**2,3**	**1**

(PREVIOUS YEARS)

AIEEE &JEE-MAINS PROBLEMS

1. Which one of the following ions has the highest value of ionic radius ?
[AIEEE-2004, 3/225]

(1) Li^+ (2) B^{3+}
(3) O^{2-} (4) F^-

2. The formation of the oxide ion $O^{2-}_{(g)}$ requires first an exothermic and then an endothermic step as shown below :

$O_{(g)} + e^- = O^-_{(g)}$; ΔH° = – 142 $kJmol^{-1}$

$O^-_{(g)} + e^- = O^{2-}_{(g)}$; ΔH° = 844 $kJmol^{-1}$

[AIEEE-2004, 3/225]

This is because :
(1) oxygen is more electronegative.
(2) oxygen has high electron affinity.
(3) O^- ion will tend to resist the addition of another electron.
(4) O^- ion has comparatively larger size than oxygen atom.

3. Among Al_2O_3, SiO_2, P_2O_3 and SO_2 the correct order of acid strength is :**[AIEEE-2004, 3/225]**

(1) $SO_2 < P_2O_3 < SiO_2 < Al_2O_3$
(2) $SiO_2 < SO_2 < Al_2O_3 < P_2O_3$
(3) $Al_2O_3 < SiO_2 < SO_2 < P_2O_3$
(4) $Al_2O_3 < SiO_2 < P_2O_3 < SO_2$

4. Which of the following oxides is amphoteric in nature ? **[AIEEE-2005, 1½/225]**
(1) CaO (2) CO_2
(3) SiO_2 (4) SnO_2

5. In which of the following arrangements the order is NOT according to the property indicated against it ? **[AIEEE-2005, 3/225]**
(1) $Al^{3+} < Mg^{2+} < Na^+ < F^-$ – increasing ionic size
(2) B < C < N < O – increasing first ionisation enthalpy
(3) I < Br < F < Cl – increasing electron gain enthalpy (with negative sign)
(4) Li < Na < K < Rb – increasing metallic radius

6. Which of the following factors may be regarded as the main cause of lanthanide contraction ?
(1) Greater shielding of 5d electrons by 4f electrons. **[AIEEE 2005, 4½ / 225]**
(2) Poorer shielding of 5d electron by 4f electrons.
(3) Effective shielding of one of 4f electrons by another in the sub-shell.
(4) Poor shielding of one of 4f electron by another in the sub-shell.

7. The lanthanide contraction is responsible for the fact that : **[AIEEE-2005, 3/225]**
(1) Zr and Y have about the same radius
(2) Zr and Nb have similar oxidation state
(3) Zr and Hf have about the same radius
(4) Zr and Zn have same oxidation state.

8. The increasing order of the first ionization enthalpies of the elements B, P, S and F (lowest first) is : **[AIEEE-2006, 4/220]**
(1) F < S < P < B (2) P < S < B < F
(3) B < P < S < F (4) B < S < P < F

9. Which of the following statements is true ? **[AIEEE-2006, 4/220]**
(1) H_3PO_3 is a stronger acid than H_2SO_3.
(2) In aqueous medium, HF is a stronger acid than HCl.
(3) $HClO_4$ is a weaker acid than $HClO_3$.
(4) HNO_3 is a stronger acid than HNO_2.

10. Lanthanoid contraction is caused due to : **[AIEEE-2006, 4/220]**
(1) the appreciable shielding on outer electrons by 4*f* electrons from the nuclear charge
(2) the appreciable shielding on outer electrons by 5*f* electrons from the nuclear charge
(3) the same effective nuclear charge from Ce to Lu
(4) the imperfect shielding on outer electrons by 4f electrons from the nuclear charge

11. The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence. **[AIEEE-2007, 3/120]**
(1) $SiX_2 << GeX_2 << SnX_2 << PbX_2$
(2) $PbX_2 << SnX_2 << GeX_2 << SiX_2$
(3) $GeX_2 << SiX_2 << SnX_2 << PbX_2$
(4) $SiX_2 << GeX_2 << PbX_2 << SnX_2$

12. The set representing the correct order of ionic radius is : **[AIEEE-2009, 4/144]**
(1) $Na^+ > Li^+ > Mg^{2+} > Be^{2+}$
(2) $Li^+ > Na^+ > Mg^{2+} > Be^{2+}$
(3) $Mg^{2+} > Be^{2+} > Li^+ > Na^+$
(4) $Li^+ > Be^{2+} > Na^+ > Mg^{2+}$

13. In which of the following arrangements, the sequence is not strictly according to the property written against it ?
(1) HF < HCl < HBr < HI : increasing acid strength **[AIEEE-2009, 4/144]**
(2) $NH_3 < PH_3 < AsH_3 < SbH_3$: increasing basic strength
(3) B < C < O < N : increasing first ionization enthalpy
(4) $CO_2 < SiO_2 < SnO_2 < PbO_2$: increasing oxidising power

14. The correct sequence which shows decreasing order of the ionic radii of the elements is : **[AIEEE-2010, 4/144]**
(1) $Al^{3+} > Mg^{2+} > Na^+ > F^- > O^{2-}$
(2) $Na^+ > Mg^{2+} > Al^{3+} > O^{2-} > F^-$
(3) $Na^+ > F^- > Mg^{2+} > O^{2-} > Al^{3+}$
(4) $O^{2-} > F^- > Na^+ > Mg^{2+} > Al^{3+}$

15. The outer electron configuration of Gd (Atomic No : 64) is :
[AIEEE 2011 (Cancelled), 4/120]
(1) $4f^3 5d^5 6s^2$ (2) $4f^8 5d^0 6s^2$
(3) $4f^4 5d^4 6s^2$ (4) $4f^7 5d^1 6s^2$

16. Which one of the following orders presents the correct sequence of the increasing basic nature of the given oxides ?
[AIEEE 2011 (Cancelled), 4/120]
(1) $Al_2O_3 < MgO < Na_2O < K_2O$
(2) $MgO < K_2O < Al_2O_3 < Na_2O$
(3) $Na_2O < K_2O < MgO < Al_2O_3$
(4) $K_2O < Na_2O < Al_2O_3 < MgO$

17. The correct order of electron gain enthalpy with negative sign of F, Cl, Br and I, having atomic number 9, 17, 35 and 53 respectively, is:
(1) F > Cl > Br > I (2) Cl > F > Br > I
(3) Br > Cl > I > F (4) I > Br > Cl > F

18. The increasing order of the ionic radii of the given isoelectronic species is :
[AIEEE-2012, 4/144]
(1) Cl^-, Ca^{2+}, K^+, S^{2-} (2) S^{2-}, Cl^-, Ca^{2+}, K^+
(3) Ca^{2+}, K^+, Cl^-, S^{2-} (4) K^+, S^{2-}, Ca^{2+}, Cl^-

19. Which of the following represents the correct order of increasing first ionization enthalpy for

Ca, Ba, S, Se and Ar ? **[JEEMains-2013, 4/120]**
(1) Ca < S < Ba < Se < Ar
(2) S < Se < Ca < Ba < Ar
(3) Ba < Ca < Se < S < Ar
(4) Ca < Ba < S < Se < Ar

20. The first ionisation potential of Na is 5.1 eV. The value of electron gain enthalpy of Na^+ will be : **[JEE Mains-2013, 4/120]**
(1) –2.55 eV (2) –5.1 eV
(3) –10.2 eV (4) +2.55 eV

[JEE-MAINS-2019-1]

21. When the first electron gain enthalpy ($\Delta_{eg}H$) of oxygen is –141 kJ/mol, its second electron gain enthalpy is :
(1) almost the same as that of the first
(2) negative , but less negative than the first
(3) a positive value
(4) a more negative value than the first

22. In general, the properties that decrease and increase down a group in the periodic table, respectively, are :
(1) electronegativity and electron gain enthalpy.
(2) electronegativity and atomic radius.
(3) atomic radius and electronegativity.
(4) electron gain enthalpy and electronegativity.

23. The electronegativity of aluminium is similar to :
(1) Boron (2) Carbon
(3) Lithium (4) Beryllium

24. The element that shows greater ability to form pπ-pπ multiple bonds, is :
(1) Si (2) Ge (3) Sn (4) C

25. Among CaH_2, BeH_2, BaH_2, the order of ionic character is
(1) $BeH_2 < CaH_2 < BaH_2$
(2) $CaH_2 < BeH_2 < BaH_2$
(3) $BeH_2 < BaH_2 < CaH_2$
(4) $BaH_2 < BeH_2 < CaH_2$

26. In the structure of ClF_3, the number of lone pairs of electrons on central atom 'Cl' is
(1) one (2) two (3) four (4) three

27. The correct order of atomic radii in group 13 elements is
(1) B < Al < In < Ga < Tl
(2) B < Al < Ga < In < Tl
(3) B < Ga < Al < Tl < In
(4) B < Ga < Al < In < Tl

ANSWER KEY

1.(3)	**2.**(3)	**3.**(4)	**4.**(4)	**5.**(2)	**6.**(4)
7.(3)	**8.**(4)	**9.**(4)	**10.**(4)	**11.**(1)	**12.**(1)
13.(2)	**14.**(4)	**15.**(4)	**16.**(1)	**17.**(2)	**18.**(3)
19.(3)	**20.**(2)	**21.**(3)	**22.**(2)	**23.**(4)	**24.**(4)
25.(1)	**26.**(2)	**27.**(4)			

NCERT EXAMPLER PROBLEMS

Multiple Choice Questions

1. Consider the isoelectronic species, Na^+, Mg^{2+}, F^- and O^{2-}. The correct order of increasing length of their radii is _________.
(i) $F^- < O^{2-} < Mg^{2+} < Na^+$ (ii) $Mg^{2+} < Na^+ < F^- < O^{2-}$
(iii) $O^{2-} < F^- < Na^+ < Mg^{2+}$ (iv) $O^{2-} < F^- < Mg^{2+} < Na^+$
2. Which of the following is not an actinoid?
(i) Curium (Z = 96) (ii) Californium (Z = 98)
(iii) Uranium (Z = 92) (iv) Terbium (Z = 65)
3. The order of screening effect of electrons of *s*, *p*, *d* and *f* orbitals of a given shell of an atom on its outer shell electrons is:
(i) $s > p > d > f$ (ii) $f > d > p > s$
(iii) $p < d < s > f$ (iv) $f > p > s > d$
4. The first ionisation enthalpies of Na, Mg, Al and Si are in the order:
(i) Na < Mg > Al < Si
(ii) Na > Mg > Al > Si
(iii) Na < Mg < Al < Si
(iv) Na > Mg > Al < Si
5. The electronic configuration of gadolinium (Atomic number 64) is
(i) [Xe] $4f^3 5d^5 6s^2$ (ii) [Xe] $4f^7 5d^2 6s^1$
(iii) [Xe] $4f^7 5d^1 6s^2$ (iv) [Xe] $4f^8 5d^6 6s^2$
6. The statement that is **not** correct for periodic classification of elements is:
(i) The properties of elements are periodic function of their atomic numbers.
(ii) Non metallic elements are less in number than metallic elements.
(iii) For transition elements, the 3*d*-orbitals are filled with electrons after 3*p*-orbitals and before 4*s*-orbitals.
(iv) The first ionisation enthalpies of elements generally increase with increase in atomic number as we go along a period.
7. Among halogens, the correct order of amount of energy released in electron gain (electron gain enthalpy) is:
(i) F > Cl > Br > I (ii) F < Cl < Br < I
(iii) F < Cl > Br > I (iv) F < Cl < Br < I
8. The period number in the long form of the periodic table is equal to
(i) magnetic quantum number of any element of the period.
(ii) atomic number of any element of the period.
(iii) maximum Principal quantum number of any element of the period.
(iv) maximum Azimuthal quantum number of any element of the period.

9. The elements in which electrons are progressively filled in 4*f*-orbital are called
(i) actinoids (ii) transition elements
(iii) lanthanoids (iv) halogens

10. Which of the following is the correct order of size of the given species:
(i) $I > I^- > I^+$ (ii) $I^+ > I^- > I$
(iii) $I > I^+ > I^-$ (iv) $I^- > I > I^+$

11. The formation of the oxide ion, $O^{2-}(g)$, from oxygen atom requires first an exothermic and then an endothermic step as shown below:
$O(g) + e^- \rightarrow O^-(g)$; $\Delta H_V = -141$ kJ mol^{-1}
$O^-(g) + e^- \rightarrow O^{2-}(g)$; $\Delta H_V = +780$ kJ mol^{-1}
Thus process of formation of O^{2-} in gas phase is unfavourable even though O^{2-} is isoelectronic with neon. It is due to the fact that,
(i) oxygen is more electronegative.
(ii) addition of electron in oxygen results in larger size of the ion.
(iii) electron repulsion outweighs the stability gained by achieving noble gas configuration.
(iv) O^- ion has comparatively smaller size than oxygen atom.

12. Comprehension given below is followed by some multiple choice questions.
Each question has one correct option. Choose the correct option. In the modern periodic table, elements are arranged in order of increasing atomic numbers which is related to the electronic configuration. Depending upon the type of orbitals receiving the last electron, the elements in the periodic table have been divided into four blocks, viz, *s*, *p*, *d* and *f*. The modern periodic table consists of 7 periods and 18 groups. Each period begins with the filling of a new energy shell. In accordance with the Arfbau principle, the seven periods (1 to 7) have 2, 8, 8, 18, 18, 32 and 32 elements respectively. The seventh period is still incomplete. To avoid the periodic table being too long, the two series of *f*-block elements, called lanthanoids and actinoids are placed at the bottom of the main body of the periodic table.
(a) The element with atomic number 57 belongs to
(i) *s*-block (ii) *p*-block
(iii) *d*-block (iv) *f*-block
(b) The last element of the *p*-block in 6th period is represented by the outermost electronic configuration.
(i) $7s^2 7p^6$ (ii) $5f^{14} 6d^{10} 7s^2 7p^0$
(iii) $4f^{14} 5d^{10} 6s^2 6p^6$ (iv) $4f^{14} 5d^{10} 6s^2 6p^4$
(c) Which of the elements whose atomic numbers are given below, cannot be accommodated in the present set up of the long form of the periodic table?
(i) 107 (ii) 118
(iii) 126 (iv) 102
(d) The electronic configuration of the element which is just above the element with atomic number 43 in the same group is ________.
(i) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$
(ii) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^3 4p^6$
(iii) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$
(iv) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2$
(e) The elements with atomic numbers 35, 53 and 85 are all ________.
(i) noble gases (ii) halogens
(iii) heavy metals (iv) light metals

13. Electronic configurations of four elements A, B, C and D are given below :
(A) $1s^2 2s^2 2p^6$ (B) $1s^2 2s^2 2p^4$
(C) $1s^2 2s^2 2p^6 3s^1$ (D) $1s^2 2s^2 2p^5$
Which of the following is the correct order of increasing tendency to gain electron :
(i) A < C < B < D (ii) A < B < C < D
(iii) D < B < C < A (iv) D < A < B < C

Assertion and Reason Type-I

Choose the correct option out of the choices given below each question.
(i) Both A and R are true and R is the correct explanation of A.
(ii) A is true but R is false.
(iii) A is false but R is true.
(iv) Both A and R are false

46. ***Assertion (A) :*** Generally, ionisation enthalpy increases from left to right in a period.
Reason (R) : When successive electrons are added to the orbitals in the same principal quantum level, the shielding effect of inner core of electrons does not increase very much to compensate for the increased attraction of the electron to the nucleus.

47. ***Assertion (A) :*** Boron has a smaller first ionisation enthalpy than beryllium.
Reason (R) : The penetration of a 2*s* electron to the nucleus is more than the 2*p* electron hence 2*p* electron is more shielded by the inner core of electrons than the 2*s* electrons.

48. ***Assertion (A) :*** Electron gain enthalpy becomes less negative as we go down a group.
Reason (R) : Size of the atom increases on going down the group and the added electron would be farther from the nucleus.

ANSWERS

Multiple Choice Questions
1. (ii) 2. (iv) 3. (i) 4. (i) 5. (iii) 6. (iii)
7. (iii) 8. (iii) 9. (iii) 10. (iv) 11. (iii)
12.(a) (iii), (b) (iii), (c) (iii), (d) (i), (e) (ii) 13. (i)

Assertion and Reason Type
1. (ii) 2. (iii) 3. (iv)

Assertion & Reason Type-II

1. If both Assertion & Reason are True and Reason is the correct explanation of Assertion.
2. If both Assertion & Reason are True but Reason is not the correct explanation of Assertion.
3. If Assertion is True but Reason is False.
4. If both Assertion & Reason are False.

1. Assertion : First ionization energy for nitrogen is lower than oxygen.

Reason: Across a period effective nuclear charge decreases.

2. Assertion : Ionisation potential of Be (atomic no.4) is less than B (atomic no.5)

Reason: The first electron released from Be is of p-orbital but that from B is of s-orbital.

3. Assertion : The first ionization energy of aluminium is lower than that of magnesium.

Reason: The ionic radius of aluminium is smaller than that of magnesium.

4. Assertion : Oxides are more ionic than corresponding sulphides.

Reason : Oxygen has higher electron affinity than sulphur.

5. Assertion : Removal of s electrons is relatively difficult than removal of p-electron of same main shell.

Reason :s-electrons are closer to the nucleus than p electrons of the same shell and hence are more strongly attracted by the nucleus.

6.Assertion :F atom is small in size than Cl.
Reason :F – F bond in F_2 is stronger than Cl–Cl bond in Cl_2

7.Assertion : Cesium is the most electropositive element.
Reason : Cs has lowest electron affinity.

8. Assertion : The ionisation energy of N is more than that of O.
Reason : Electronic configuration of N is more stable due to half filled 2p orbitals.

9. Assertion : Ion is formed by the loss or gain of electrons by the parent atom.
Reason : Radius of the ion is always smaller than the parent atom.
10. Assertion : The number of protons among the isoelectronic ions of elements are different.
Reason : Isoelectronic ions have same number of electrons as well protons.

11. Assertion : Noble gases have highest ionization energies in their respective periods.
Reason : Noble gas have stable electronic configuration.

12. Assertion : Metallic character increases on going down a group from top to bottom.
Reason : Ionization enrgy decreases on going down a group from top to bottom.

13. Assertion :Mg^{2+} ion is smaller in size than F^-.
Reason : Mg^{2+} has less number of electrons than F^-.

14. Assertion : All the elements belonging to d-block are metals.
Reason : All the elements belonging to p-block are non-metals.

15. Assertion : In lanthanides three outer shells are incomplete.
Reason : lanthanides and actinides constitute the f-block of the periodic table.

16. Assertion : Lithium shows diagonal relation with magnesium.
Reason : Li^+ ion and Mg^{2+} ion have almost equal polarizing power.

17. Assertion : Fluorine has a less negative electron affinity than chlorine.
Reason : There is relatively greater effectiveness of 2p electrons in the small F atom to repel the additional electron entering the atom than do 3p electrons in the larger Cl atom.

ASSERTION & REASON ANSWER KEY

Q.	1	2	3	4	5	6
A.	4	4	2	3	1	3
Q.7	**8**	**9**	**10**	**11**	**12**	**13**
A.2	1	3	3	1	1	3
Q.14	**15**	**16**	**17**			
A.3	2	1	1			