BASIC CONCEPT OF CHEMISTRY

TOPIC-WISE STUDY MATERIAL

BY

EXAMS ROAD

"Bringing Excellence to Students"

Importance of Chemistry

Chemistry has a direct impact on our life and has wide range of applications in different fields. These are given below:

(A) In Agriculture and Food:

(i) It has provided chemical fertilizers such as urea, calcium phosphate, sodium nitrate, ammonium phosphate etc.

(ii) It has helped to protect the crops from insects and harmful bacteria, by the use ‘ of certain effective insecticides, fungicides and pesticides.

(iii) The use of preservatives has helped to preserve food products like jam, butter, squashes etc. for longer periods.

(B) In Health and Sanitation:

(i) It has provided mankind with a large number of life-saving drugs. Today, dysentery and pneumonia are curable due to discovery of sulpha drugs and penicillin life-saving drugs. Cisplatin and taxol have been found to be very effective for cancer therapy and AZT (Azidothymidine) is used for AIDS victims.

(ii) Disinfectants such as phenol are used to kill the micro-organisms present in drains, toilet, floors etc.

(iii) A low concentration of chlorine i.e., 0.2 to 0.4 parts per million (ppm) is used ’ for sterilization of water to make it fit for drinking purposes.

(C) Saving the Environment:

The rapid industrialisation all over the world has resulted in lot of pollution.

Poisonous gases and chemicals are being constantly released in the atmosphere. They are polluting environment at an alarming rate. Scientists are working day and night to develop substitutes which may cause lower pollution. For example, CNG (Compressed Natural Gas), a substitute of petrol, is very effective in checking pollution caused by automobiles.

(D) Application in Industry:

Chemistry has played an important role in developing many industrially ^ manufactured fertilizers, alkalis, acids, salts, dyes, polymers, drugs, soaps,
detergents, metal alloys and other inorganic and organic chemicals including new materials contribute in a big way to the national economy.

• Matter

Anything which has mass and occupies space is called matter.

For example, book, pencil, water, air are composed of matter as we know that they have mass and they occupy space.

• Classification of Matter

There are two ways of classifying the matter:

(A) Physical classification

(B) Chemical classification

(A) Physical Classification:

Matter can exist in three physical states:

1. Solids 2. Liquids 3. Gases

1. Solids: The particles are held very close to each other in an orderly fashion and there is not much freedom of movement.

Characteristics of solids: Solids have definite volume and definite shape.

2. Liquids: In liquids, the particles are close to each other but can move around. Characteristics of liquids: Liquids have definite volume but not definite shape.

3. Gases: In gases, the particles are far apart as compared to those present in solid or liquid states. Their movement is easy and fast.

Characteristics of Gases: Gases have neither definite volume nor definite shape. They completely occupy the container in which they are placed.

(B) Chemical Classification:

Based upon the composition, matter can be divided into two main types:

1. Pure Substances 2. Mixtures.

1. Pure substances: A pure substance may be defined as a single substance (or matter) which cannot be separated by simple physical methods.

Pure substances can be further classified as (i) Elements (ii) Compounds

(i) Elements: An element consists of only one type of particles. These particles may be atoms or molecules.

For example, sodium, copper, silver, hydrogen, oxygen etc. are some examples of elements. They all contain atoms of one type. However, atoms of different elements are different in nature. Some elements such as sodium . or copper contain single atoms held together as their constituent particles whereas in some others two or more atoms combine to give molecules of the element. Thus, hydrogen, nitrogen and oxygen gases consist of molecules in which two atoms combine to give the respective molecules of the element.

(ii) Compounds: It may be defined as a pure substance containing two or more elements combined together in a fixed proportion by weight and can be decomposed into these elements by suitable chemical methods. Moreover, the properties of a compound are altogether different from the constituting elements.

The compounds have been classified into two types. These are:

(i) Inorganic Compounds: These are compounds which are obtained from non-living sources such as rocks and minerals. A few
examples are: Common salt, marble, gypsum, washing soda etc.

(ii) Organic Compounds are the compounds which are present in plants and animals. All the organic compounds have been found to contain carbon as their essential constituent. For example, carbohydrates, proteins, oils, fats etc.

2. Mixtures: The combination of two or more elements or compounds which are not chemically combined together and may also be present in any proportion, is called mixture. A few examples of mixtures are: milk, sea water, petrol, lime water, paint glass, cement, wood etc.

Types of mixtures: Mixtures are of two types:

(i) Homogeneous mixtures: A mixture is said to be homogeneous if it has a uniform composition throughout and there are no visible boundaries of separation between the constituents.

For example: A mixture of sugar solution in water has the same sugar water composition throughout and all portions have the same sweetness.

(ii) Heterogeneous mixtures: A mixture is said to be heterogeneous if it does not have uniform composition throughout and has visible boundaries of separation between the various constituents. The different constituents of a heterogeneous mixture can be seen even with naked eye.

For example: When iron filings and sulphur powder are mixed together, the mixture formed is heterogeneous. It has greyish-yellow appearance and the two constituents, iron and sulphur, can be easily identified with naked eye.

• Differences between Compounds and Mixtures

Compounds

1. In a compound, two or more elements are combined chemically.
2. In a compound, the elements are present in the fixed ratio by mass. This ratio cannot change.
3. CompoUnds are always homogeneous i.e., they havethe same composition throughout.

4 In a compound, constituents cannot be separated by physical methods

5. In a compound, the constituents lose their identities i.e., i compound does not show the characteristics of the constituting elements.

Mixtures

1. In a mixture, or more elements or compounds are simply mixed and not combined chemically.
2. In a mixture the constituents are not present in fixed ratio. It can vary
3. Mixtures may be either homogeneous or heterogeneous in nature.
4. Constituents of mixtures can be separated by physical methods.

5, In a mixture, the constituents do not lose their identities i.e., a mixture shows the characteristics of all the constituents .

We have discussed the physical and chemical classification of matter.

• Properties of Matter and Their Measurements

Physical Properties: Those properties which can be measured or observed without changing the identity or the composition of the substance.

Some examples of physical properties are colour, odour, melting point, boiling point etc.

Chemical **Properties:** It requires a chemical change to occur. The examples of chemical properties are characteristic reactions of different substances. These include acidity, basicity, combustibility etc.

• Units of Measurement

Fundamental Units: The quantities mass, length and time are called fundamental quantities and their units are known as fundamental units.

There are seven basic units of measurement for the quantities: length, mass, time, temperature, amount of substance, electric current and luminous intensity.

Si-System: This system of measurement is the most common system employed throughout the world.

It has given units of all the seven basic quantities listed above.

Definitions of Basic SI Units

1. Metre: It is the length of the path travelled by light in vacuum during a time interval of 1/299792458 of a second.
2. Kilogram: It is the unit of mass. It is equal to the mass of the international prototype of the kilogram. ,
3. Second: It is the duration of 9192631, 770 periods of radiation which correspond to the transition between the two hyper fine levels of the ground state of caesium- 133 atom.
4. Kelvin: It is the unit of thermodynamic temperature and is equal to 1/273.16 of the thermodynamic temperature of the triple point of water.
5. Ampere: The ampere is that constant current which if maintained in two straight parallel conductors of infinite length, of negligible circular cross section and placed, 1 metre apart in vacuum, would produce between these conductors a force equal to 2 x 10-7 N per metre of length.

6. Candela: It may be defined as the luminous intensity in a given direction, from a source which emits monochromatic radiation of frequency 540 x 1012 Hz and that has a radiant intensity in that direction of 1/ 683 watt per steradian.
7. Mole: It is the amount of substance which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon -12. Its symbol is 'mol'.

• Mass and Weight

Mass: Mass of a substance is the amount of matter present in it.
The mass of a substance is constant.
The mass of a substance can be determined accurately in the laboratory by using an analytical balance. SI unit of mass is kilogram.

Weight: It is the force exerted by gravity on an object. Weight of substance may vary from one place to another due to change in gravity.
Volume: Volume means the space occupied by matter. It has the units of (length)3. In SI units, volume is expressed in metre3 (m3). However, a popular unit of measuring volume, particularly in liquids is litre (L) but it is not in SI units or an S.I. unit.
Mathematically,
1L = 1000 mL = 1000 cm3 = 1dm3.
Volume of liquids can be measured by different devices like burette, pipette, cylinder, measuring flask etc. All of them have been calibrated.

Question 1:

How many significant figures should be present in the following calculation?

$$\frac{2.5 \times 1.25 \times 3.5}{2.01}$$

(a) 2 (b) 3 (c) 4 (d) 6

Question 2:

$^{35}_{17}Cl$ and $^{37}_{17}Cl$ are two isotopes of chlorine. If average atomic mass is 35.5, then ratio of these two isotopes is

(a) 35 : 37 (b) 1 : 3
(c) 3 : 1 (d) 2 : 1

Question 3:

74.5 g of a metallic chloride contain 35.5 g of chlorine. The equivalent weight of the metal is
(a) 19.5
(b) 35.5
(c) 39.0
(d) 78.0

Question 4:

In an experiment, 4 g of M_2O_x oxide was reduced to 2.8 g of the metal. If the atomic mass of the metal is 56 g mol^{-1}, the number of O-atoms in the oxide is

(a) 1 (b) 2
(c) 3 (d) 4

Question 5:

The vapour density of a volatile chloride of a metal is 95 and the specific heat of the metal is 0.13 cal/g. The equivalent weight of the metal will be approximately
(a) 6
(b) 12
(c) 18
(d) 49

Question 6:

In an experiment, 4 g of M_2O_x oxide was reduced to 2.8 g of the metal. If the atomic mass of the metal is 56 g mol^{-1}, the number of O-atoms in the oxide is

(a) 1
(b) 2
(c) 3
(d) 4

Question 7:

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

[NCERT Exemplar]

(a) 12.044×10^{20} molecules
(b) 6.022×10^{23} molecules
(c) 1×10^{23} molecules
(d) 12.044×10^{23} molecules

Question 8:

If 1 mL of water contains 20 drops, then number of molecules in one drop of water is

(a) 6.023×10^{23}
(b) 1.376×10^{26}
(c) 1.344×10^{18}
(d) 4.346×10^{20}

Question 9:

What is the percentage of cation in ammonium dichromate?
(a) 14.29%
(b) 80%
(c) 50.05%
(d) 20.52%

Question 10:

In a compound C, H and N are present in 9 : 1 : 3.5 by weight. If molecular weight of compound is 108, the molecular formula of compound is

(a) $C_2H_6N_2$
(b) C_3H_4N
(c) $C_6H_8N_2$
(d) $C_9H_{12}N_3$

Question 11:

A gas is found to have a formula $(CO)_x$. If its vapour density is 70, the value of x is

(a) 2.3
(b) 3.0
(c) 5.0
(d) 6.0

Question 12:

A sample of $CaCO_3$ is 50% pure. On heating 1.12 L of CO_2 (at STP) is obtained. Residue left (assuming non-volatile impurity) is

(a) 7.8 g (b) 3.8 g (c) 2.8 g (d) 8.9 g

Question 13:

Polyethylene can be produced from calcium carbide according to the following sequence of reactions.

$$CaC_2 + H_2O \longrightarrow CaO + HC{\equiv}CH$$

$$n(HC{\equiv}CH) + nH_2 \longrightarrow -\!\!(CH_2-CH_2)\!\!-_n$$

The mass of polyethylene, which can be produced from 20.0 kg of CaC_2 is

(a) 6.75 kg
(b) 7.75 kg
(c) 8.75 kg
(d) 9.75 kg

Question 14:

One mole of chlorine combines with certain weight of a metal giving 111 g of its chloride. The same amount of metal can displace 2 g of hydrogen from an acid. The atomic weight of the metal is

(a) 40
(b) 20
(c) 80
(d) None of these

Question 15:

1.520 g of hydroxide of a metal on ignition gave 0.995 g of oxide. The equivalent weight of metal is

(a) 1.52
(b) 0.995
(c) 190
(d) 9

Question 16:
The mass of carbon anode consumed (given only C02) in production of 270 kg of aluminium metal from bauxite by the Hall process is (atomic mass of Al =27)
(a) 180 kg
(b) 270 kg
(c) 540 kg
(d)90kg

Question 17:
What volume of a solution of hydrochloric acid containing 73g of acid per litre would sufficient for exact neutralisation of sodium hydroxide obtained by allowing 0.46 g of metallic sodium to act upon water?
(Cl = 35.5, Na = 23.0, 0 = 16)
(a)10mL
(b)20mL
(c) 30 mL
(d) 40 mL

Question 18:
0.5 g of fuming H2SO4(oleum) is diluted with water. This solution is completely neutralised by 26.7 mL of 0. 4 N NaOH. The percentage of free S03 in the sample is
(a) 30.6%
(b) 40.6%
(c) 20.6%
(d) 50%

Question 19:
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 evaporated of 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)
(a) $200 cm^3$
(b) $500 cm^3$
(c) $400 cm^3$
(d) $300 cm^3$

Question 20:

100 mL each of 0.5 N NaOH, N/5 HCl and N/10 H_2SO_4 are mixed together. The resulting solution will be

(a) acidic (b) neutral
(c) alkaline (d) None of these

Question 21:

Equal volumes of 0.1 M $AgNO_3$ and 0.2 M NaCl are mixed. The concentration of NO_3^- ions in the mixture will be

(a) 0.1 M (b) 0.05 M
(c) 0.2 M (d) 0.15 M

Question 22:

The isotopic abundance of C-12 and C-14 is 98% and 2%, respectively. What would be the number of C-14 isotope in 12 g carbon sample?

(a) 1.032×10^{22} (b) 3.01×10^{23}
(c) 5.88×10^{23} (d) 6.02×10^{23}

Question 23:

The number of moles of $KMnO_4$ that will be needed to react with one mole of sulphide ion in acidic solution is

(a) 3/5 (b) 4/5
(c) 2/5 (d) 1

Question 24:

Concentrated aqueous sulphuric acid is 98% H_2SO_4 by mass and has a density of 1.80 g mL^{-1}. Volume of acid required to make one litre of 0.1 M H_2SO_4 solution is

(a) 11.10 mL (b) 16.65 mL
(c) 22.20 mL (d) 5.55 mL

Question 25:

An aqueous solution of glucose is 10% in strength. The volume in which 1g mole of it is dissolved will be

(a) 18 L
(b) 92 L
(c)0.9L
(d)1.8L

Question 26:

If 30 mL of H_2 and 20 mL of O_2 reacts to form water, what is left at the end of the reaction?

(a) 10 mL of H_2 (b) 5 mL of H_2
(c) 10 mL of O_2 (d) 5 mL of O_2

Question 27:
0.45 g acid of molecular weight 90 was neutralise by 20 mL of 0.5 N KOH. The basicity of acid is
(a) 2
(b) 4
(c) 1
(d) 3

Question 28:

In an oxidation-reduction reaction MnO_4^- is converted to Mn^{2+}. What is the number equivalent of $KMnO_4$ (molecular weight =158) present in 250 mL of 0.04 M $KMnO_4$ solution?

(a) 0.02 (b) 0.05
(c) 0.04 (d) 0.07

Direction (Q. NO. 29) In the following question more than one of the answers may be correct. Select the correct answers and mark it according to the codes.
Codes
(a) I, II and III are correct
(b) I and II are correct
(c) II and IV are correct
(d) I and III are correct

Question 29:

Direction (Q. NOS. 31-34) Each of these questions contains two statements : Statement I and II. Each of these questions also has four

alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (fe), (c) and (d) given below.
(a) Statement I is true, Statement II is true; Statement II is a correct explanation for Statement I
(b) Statement I is true, Statement II is true; Statement II is not a correct explanation for Statement I
(c) Statement I is true, Statement II is false
(d) Statement I is false, Statement II is true

Question 30:

Match the following Column I and Column II and choose the correct code given below.

	Column I		Column II
A.	$6\text{ g C} \xrightarrow[\text{Combustion}]{\text{Excess } O_2}$	1.	44.8 L CO_2
B.	$56\text{ g CO} \xrightarrow[\text{Combustion}]{\text{Excess } O_2}$	2.	22.4 L CO_2
C.	$10.6\text{ g } Na_2CO_3 \xrightarrow{\text{Excess HCl}}$	3.	11.2 L CO_2
D.	$100\text{ g } CaCO_3 \xrightarrow{\Delta}$	4.	2.24 L CO_2

Codes

	A	B	C	D
(a)	1	4	3	2
(b)	2	1	4	3
(c)	3	1	4	2
(d)	4	2	3	1

Question 31:

Statement I Equivalent weight of ozone in the change $O_3 \rightarrow O_2$ is 8.

Statement II 1 mole of O_3 on decomposition gives $\frac{3}{2}$ moles of O_2.

Question 32:

Statement I The molality of the solution does not change with change in temperature.

Statement II The molality of the solution is expressed in units of moles per 1000 g of solvent.

Question 33:

Statement I A solution which contains one gram equivalent of solute per litre of solution is known as molar solution.

Statement II Normality = molarity

$$\times \frac{\text{Molecular weight of solute}}{\text{Equivalent weight of solute}}$$

Normality formula in chemistry is one of the important term used to measure the concentration of a solution.

Question 34:
Statement I Normality and molarity can be calculated from each other.
Statement II Normality is equal to the product of molarity and n.

Question 35:

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 two gases in the mixture? **[CBSE-AIPMT 2015]**

(a) 1 : 4 (b) 4 : 1
(c) 16 : 1 (d) 2 : 1

Question 36:
When 22.4 L of H_2(g) is mixed with 11.2 L of Cl_2(g) each at STP, the moles of HCl (g) formed is equal to
(a)1 mole of HCl (g)
(b)2 moles of HCl (g)
(c) 0.5 mole of HCl (g)
(d)5 mole of HCl (g)

Question 37:

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; 0=16) **[CBSE-AIPMT 2014]**

(a) Mg, 0.16 g
(b) O_2, 0.16 g
(c) Mg, 0.44 g
(d) O_2, 0.28 g

Question 38:

10^{21} molecules are removed from 200 mg of CO_2. The moles of CO_2 left are **[AIIMS 2013]**

(a) 2.88×10^{-3}
(b) 28.8×10^{-3}
(c) 288×10^{-3}
(d) 28.8×10^{-3}

Question 39:

The decomposition of a certain mass of $CaC0_3$ gave 11.2 dm^3 of CO_2 gas at STP. The mass of KOH required to completely neutralise the is [AIIMS 2012]
(a)56 g
(b) 28 g
(c) 42 g
(d) 20 g

Question 40:

A metal oxide has the formula A2O3. It can be reduced by hydrogen to give free metal and water. 0.1596 g of this metal oxide requires 6 mg of hydrogen for complete reduction. What is the atomic weight of metal?
(A)3
(b) 57.3
(c) 55.8
(d) 59.3

Question 41:

The weight of iron which will be converted into its oxide (Fe_30_4) by the action of 18 g of steam on it will be (atomic weight of Fe = 56)
(a) 168 g
(b)84g
(c) 42 g
(d) 21 g

Question 42:

Statement I Equal moles of different substances contain same number of constituent particles. Statement II Equal weights of different substances contain the same number of constituent particles.

(a) Statement I is true, Statement II is true; Statement II is a correct explanation for Statement I

(b) Statement I is true, Statement II is true; Statement II is not a correct explanation for Statement I

(c) Statement I is true, Statement II is false

(d) Statement I is false, Statement II is true

Question 43:

The number of atoms in 0.1 mole of a triatomic gas is ($N_A = 6.02 \times 10^{23}$ mol^{-1}) **[CBSE-AIPMT 2010]**

(a) 6.026×10^{22}
(b) 1.806×10^{23}
(c) 3.600×10^{23}
(d) 1.800×10^{22}

Question 44:

0.037 g of an alcohol, R—OH was added to C_2H_5MgI and the gas evolved measured 11.2 cc at STP. The molecular mass of R—OH will be **[AIIMS 2010]**

(a) 47
(b) 79
(c) 77
(d) 74

Question 44:

0.037 g of an alcohol, R—OH was added to C_2H_5MgI and the gas evolved measured 11.2 cc at STP. The molecular mass of R—OH will be **[AIIMS 2010]**

(a) 47
(b) 79
(c) 77
(d) 74

Question 45:

The equivalent weight of H_3PO_2, when it disproportionates into PH_3 and H_3PO_3 is **[AIIMS 2010]**

(a) 82
(b) 61.5
(c) 41
(d) 20.5

Answers:

1. (a)	2. (c)	3. (c)	4. (c)	5. (b)	6. (b)	7. (a)	8. (c)	9. (a)	10. (c)
11. (c)	12. (a)	13. (c)	14. (a)	15. (d)	16. (d)	17. (a)	18. (c)	19. (b)	20. (c)
21. (b)	22. (a)	23. (c)	24. (d)	25. (d)	26. (d)	27. (a)	28. (b)	29. (b)	30. (c)
31. (b)	32. (b)	33. (d)	34. (a)	35. (d)	36. (a)	37. (a)	38. (a)	39. (b)	40. (c)
41. (c)	42. (c)	43. (b)	44. (d)	45. (b)					

Hints and Solutions

1. Least precise term 2.5 has two signficant figures. Hence, the answer should have two significant figures

$$\frac{2.5 \times 1.25 \times 3.5}{2.01} = 5.4415 \approx 5.4$$

2. Average atomic mass, $\bar{A} = \dfrac{x \times a + y \times b}{x + y}$

$$35.5 = \frac{35x_1 + 37y_2}{x_1 + y_2}$$

$$\frac{x_1}{y_2} = \frac{3}{1}$$

$$\therefore \quad x_1 : y_2 = 3 : 1$$

3. Equivalent weight of metal

$$= \frac{\text{weight of metal}}{\text{weight of chlorine combined}} \times 35.5$$

$$= \left(\frac{74.5 - 35.5}{35.5}\right) \times 35.5 = 39$$

4. Mass of oxygen in oxide $= 4 - 2.8$

$$= 1.2 \text{ g}$$

Equivalent weight of metal $= \dfrac{\text{mass of metal}}{\text{mass of oxygen combined}} \times 8$

$$= \frac{2.8}{1.2} \times 8 = 18.67$$

Valency of metal $= \dfrac{\text{atomic weight of metal}}{\text{equivalent weight of metal}}$

$$= \frac{56}{18.67} = 2.99 \approx 3$$

5. Molecular weight of metal chloride $= 95 \times 2 = 190$

[molecular weight $= 2 \times$ vapour density]

Atomic weight of metal $= \dfrac{6.4}{0.13} = 49.23$

Let the metal chloride be MCl_n.

$$49.23 + n \times 35.5 = 190$$

$$n = 3.9 \approx 4$$

Equivalent weight of metal $= \dfrac{49.23}{4} = 12.3$

6. Mass of one atom $= 2.66 \times 10^{-23}$ g

Mass of N_0 atoms $= 2.66 \times 10^{-23} \times 6.023 \times 10^{23}$ g mol^{-1}

$=$ atomic mass

Thus, number of moles in 32 g $= \dfrac{32}{2.66 \times 10^{-23} \times 6.023 \times 10^{23}}$

7. One mole of any substance contains 6.022×10^{23} atoms/molecules.

Hence, number of millimoles of H_2SO_4

$$= \text{molarity} \times \text{volume in mL.}$$

$$0.02 \times 100 = 2 \text{ millimoles}$$

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

Number of molecules = Number of moles $\times N_A$

$$= 2 \times 10^{-3} \times 6.022 \times 10^{23}$$

$$= 12.044 \times 10^{20} \text{ molecules}$$

8. 22400 mL water contains water molecules $= 6.023 \times 10^{23}$

In 1 mL, the number of water molecules $= \dfrac{6.023 \times 10^{23}}{22400}$

Since, 1 mL contains 20 drops,

$\therefore$ number of water molecules in

$$1 \text{ drop} = \frac{6.023 \times 10^{-23}}{22400 \times 20} = 1.344 \times 10^{18} \text{ molecules}$$

9. $(NH_4)_2Cr_2O_7$ has molecular weight 252.07 g/mol and ammonium cation have molecular weight 18.039 g/mol. Since, there are two ammonium cation per mole of ammonium dichromate.

$$\text{Hence, \% of } NH_4^+ = \frac{\text{number of parts by weight } NH_4^+}{\text{molecular weight of } (NH_4)_2Cr_2O_7} \times 100$$

$$= \frac{18.039 \text{g} / \text{mol} \times 2}{252.07 \text{ g mol}} \times 100$$

$$= 14.29\%$$

10.

Element	Ratio (by weight)	Atomic weight	Mole ratio	Simplest mole ratio
C	9	12	$\frac{9}{12} = 0.75$	$\frac{0.75}{0.25} = 3$
H	1	1	$\frac{1}{1} = 1.00$	$\frac{1.00}{0.25} = 4$
N	3.5	14	$\frac{3.5}{14} = 0.25$	$\frac{0.25}{0.25} = 1$

$\therefore$ Empirical formula = C_3H_4N

and empirical formula weight = $3 \times 12 + 4 \times 1 + 14 = 54$

Molecular weight = 108

$$\because \quad n = \frac{\text{molecular weight}}{\text{empirical formula of weight}}$$

$$\therefore \quad n = \frac{108}{54} = 2$$

$\therefore$ Molecular formula = (empirical formula)$_n$

$$= (C_3H_4N)_2 = C_6H_8N_2$$

11. Molecular weight = 2 × vapour density

$$= 2 \times 70 = 140$$

$$\therefore \quad (CO)_x = 140$$

$$\Rightarrow \quad (12 + 16)_x = 140$$

$$\therefore \quad (28)_x = (28)_5 \Rightarrow x = 5$$

12. $CaCO_3(s) \xrightarrow{\Delta} CaO(s)\downarrow + CO_2(g)\uparrow$

$CaCO_3(s)$	$CaO(s)$	$CO_2(g)$
1 mol = 100 g	1 mol = 56 g	22.4 L at STP
0.05 mol = 5 g pure	0.05 mol = 2.8 g	1.12 L at STP

Impure $CaCO_3$ taken = 10 g (5g pure $CaCO_3$ + 5g impurity, as $CaCO_3$ is 50% pure)

(Here, wt. of CO_2 = 2.2g So, wt. of CaO = 5−2.2 = 2.8g)

CaO(s) left = 2.8 g

Impurity = 5.0 g

Total residue = 7.8 g

13. $nCaC_2 \xrightarrow{H_2O} nHC{\equiv}CH \xrightarrow{\text{Polymerisation}} {-}\!(CH_2{-}CH_2)_n\!{-}$

$nCaC_2$: $40 + 2 \times 12 = 64$

$(CH_2-CH_2)_n$: $(12 + 2 \times 1 + 12 + 2 \times 1)_n = 28n$

$64\,n$ kg CaC_2 gives = $28n$ kg polyethylene

$$20 \text{ kg } CaC_2 \text{ gives} = \frac{28n \times 20}{64n}$$

$$= 8.74\text{kg} \simeq 8.75 \text{ kg}$$

14. Weight of Cl_2 = 71 g

Weight of chloride = 111 g

Weight of metal = 111 − 71 = 40 g

Equivalent of Cl = Equivalent of metal $\dfrac{71}{35.5} = \dfrac{40}{E}$

$E = 20$

E g metal will displace 1g H_2 and since, 2 g H_2 is displaced by same amount. Thus, $2E$ g of metal are used. Therefore, $2E$ (= 2 × 20 = 40) is atomic weight of metal.

15. $$\frac{W_{hydroxide}}{E_{metal} + E_{OH^-}} = \frac{W_{oxide}}{E_{metal} + E_{O}}$$

$$\frac{1.520}{E+17} = \frac{0.995}{E+8} \Rightarrow E = 9$$

16. $$2\,Al_2O_3 + 3C \longrightarrow 4Al + 3CO_2$$

$3 \times 12 = 36$ $4 \times 27 = 108$

$\because$ 108 kg of Al required C = 36 kg

270 kg of Al required C $= \frac{36 \times 270}{108} = 90$ kg

17. $$Na + H_2O \longrightarrow NaOH + \frac{1}{2}H_2$$

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

M eq of Na = M eq of NaOH

= M eq of HCl

[Meq = molarity equations $M_1V_1 = M_2V_2$]

$$\frac{0.46}{23} \times 1000 = \frac{73}{36.5} \times V$$

$$\left(\text{Meq} = N \times V \text{ and N (HCl)} = \frac{73}{36.5}\right)$$

$\therefore$ $V = 10$ mL

18. Meq of H_2SO_4 + Meq of SO_3 = Meq of NaOH

$$\frac{0.5-a}{49} \times 1000 + \frac{a}{80/2} \times 1000 = 26.7 \times 0.4$$

$$\therefore \quad a = 0.103$$

$$\% \text{ of } SO_3 = \frac{0.103}{0.5} \times 100 = 20.6\%$$

19. According to the question, the reaction occurs as

$$\underset{\substack{74 \\ (=1\text{ mol})}}{Ca(OH)_2} + \underset{\substack{44 \\ (=1\text{ mol})}}{CO_2} \longrightarrow \underset{\substack{100 \\ (=1\text{ mol})}}{CaCO_3} + \underset{\substack{74 \\ (=1\text{ mol})}}{H_2O}$$

Given, 50 mL of 0.5 M $Ca(OH)_2$ reacts with excess of CO_2.

$\therefore$ Number of millimoles of $Ca(OH)_2$ reacted = 25 mmol

$\because$ 1 mole of $Ca(OH)_2$ gives 1 mole of $CaCO_3$.

$\therefore$ Number of millimoles of $CaCO_3$ formed = 25

$\therefore$ Number of milliequivalent

$$= \frac{\text{weight (in mg)}}{\text{equivalent weight}} = \frac{25 \times 100}{50} = 50$$

Number of milliequivalent of $CaCO_3$ = 50

As, volume of $CaCO_3$ solution = 50 mL

So, normality of $CaCO_3$ solution = 1 N

[milliequivalent = $N \times V$ (in mL)]

Normality of HCl = 0.1N [given]

Volume of HCl = ?

$$N_{HCl} \times V_{HCl} = N_{CaCO_3} \times V_{CaCO_3}$$

$$0.1 \times V_{HCl} = 1 \times 50$$

$$V_{HCl} = \frac{50}{0.1} = 500 \text{ cm}^3$$

20. Meq of NaOH $= 100 \times 0.5 = 50$

Meq of HCl $= \left(\frac{1}{5}\right) \times 100 = 20$

Meq of $H_2SO_4 = \left(\frac{1}{10}\right) \times 100 = 10$

Total Meq of acid $= 20 + 10 = 30$

Total Meq of base (NaOH) $= 50$

Meq of NaOH left $= 50 - 30 = 20$

Thus, resulting solution is alkaline in nature.

21. Millimoles of $AgNO_3 = 0.1 \times V$

Millimoles of NaCl $= 0.2 \times V$

Millimoles of $[NO_3^-] = 0.1 \times V$

Total volume of mixture $= V + V = 2V$

$$[NO_3^-] = \frac{\text{millimoles of } [NO_3^-]}{\text{total volume}} = \frac{0.1 \times V}{2V} = 0.05$$

22. Weight of C-14 isotope in 12 g sample $= \frac{2 \times 12}{100}$

Number of C-14 isotope $= \frac{2 \times 12 \times 6.02 \times 10^{23}}{100 \times 14}$

$= 1.032 \times 10^{22}$ atoms

23. $2MnO_4^- + 6H^+ + 5\,SO_3^{2-} \longrightarrow 2\,Mn^{2+} + 5SO_4^{2-} + 3H_2O$

$\because$ 5 moles of sulphide ion react with = 2 moles of MnO_4^-

$\therefore$ 1 mole of sulphide ion react with $= \frac{2}{5}$ moles of MnO_4^-

24. $\text{Normality} = \frac{\text{weight} \times \text{density} \times 10}{\text{equivalent weight}} = \frac{98 \times 1.8 \times 10}{49} = 36\,N$

$$\because \quad N_1V_1 = N_2V_2$$

$$\therefore \quad 36 \times V = 0.2 \times 1000$$

$$V = \frac{0.2 \times 1000}{36} = 5.55\,mL$$

25. 10% glucose solution means 10 g $= \frac{10}{180}$ moles are present in 100 cc i.e., 0.1 L

[Molecular weight of glucose $C_6H_{12}O_6 = 180$]

Hence, 1 mole of glucose will present in $= \frac{0.1 \times 180}{10} = 1.8\,L$

26.

$2H_2$	+	O_2	$\longrightarrow$	$2H_2O$
2 mol		1 mol		2 mol
2 vol		1 vol		2 vol
30 mL		15 mL		30 mL

Therefore, oxygen is in excess and amount of oxygen left

$$= 20 - 15 = 5\,mL$$

27. Basicity $= \frac{\text{molecular weight}}{\text{equivalent weight}}$

Now, gram equivalents of acid = gram equivalents of KOH

$$\Rightarrow \quad \frac{0.45}{E} = \frac{20 \times 0.5}{1000} \Rightarrow E = 45$$

$\therefore$ Basicity = 2

28. $$MnO_4^- \longrightarrow Mn^{2+}$$

Changing in oxidation number $= (+7) - (+2) = 5$

$\therefore$ Normality of solution $5 \times 0.04 = 0.20$ N

Volume = 250 mL

Number of equivalents of $KMnO_4$ =

normality × volume of solution (L)

$\therefore$ Number of equivalent of $KMnO_4 = 0.20 \times \frac{250}{1000} = 0.05$

29. Number of atoms $= \frac{\text{mass}}{\text{atomic mass}} \times N_A$

(i) Number of atoms in 560 g Fe $= \frac{560}{56} \times N_A = 10N_A$

(ii) Number of atoms in 70 g N $= \frac{70}{14} \times N_A = 5N_A$

(iii) Number of atoms in 20 g H $= \frac{20}{1} \times N_A = 20N_A$

(iv) Number of atoms in 72 g C $= \frac{72}{12} \times N_A = 6N_A$

(v) Number of atoms in 42 g N $= \frac{42}{14} \times N_A = 3N_A$

$\therefore$ Number of atoms in 560 g Fe

$= 2 \times$ number of atoms in 70 g N

$= \frac{1}{2} \times$ number of atoms in 20 g H

30. (A) $\underset{12\text{ g}}{C} \xrightarrow[\text{combustion}]{\text{Excess } O_2} \underset{22.4\text{ L}}{CO_2}$

$\because$ 12 g carbon on combustion gives = 22.4 L CO_2

$\therefore$ 6 g carbon on combustion will give $= \frac{22.4 \times 6}{12}$ CO_2

$= 11.2$ L CO_2

(B) $\underset{2(12+16)}{2CO} \xrightarrow[\text{combustion}]{\text{Excess } O_2} \underset{\substack{2 \times 22.4\text{ L} \\ = 44.8\text{L}}}{2CO_2}$

56 g carbon monoxide on combustion gives 44.8 L CO_2

(C) $\underset{\substack{2 \times 23 + 12 + 3 \times 16 \\ = 106\text{ g}}}{Na_2CO_3} \xrightarrow{\text{Excess HCl}} 2NaCl + H_2O + \underset{22.4\text{L}}{CO_2}$

$\because$ 106 g sodium carbonate gives = 22.4 LCO_2

$\therefore$ 10.6 g sodium carbonate will give $= \frac{22.4 \times 10.6}{106}$

$= 2.24$ L CO_2

(D) $\underset{\substack{40 + 12 + 3 \times 16 \\ = 100\text{ g}}}{CaCO_3} \longrightarrow CaO + \underset{22.4\text{ L}}{CO_2}$

$\therefore$ 100 g calcium carbonate on decomposition gives

$= 22.4$ L CO_2

31. $2O_3 \longrightarrow 3O_2$

$2 \text{ mol } O_3 \equiv 3 \text{ mol } O_2 = 3 \times 2 \text{eq } O_2$

$[M = \text{molecular weight of } O_3 = 48]$

$$E_{O_3} = \frac{M}{6} = \frac{48}{6} = 8$$

32. Molality does not depend upon volume of the solution as molarity or normality. So, it does not depend upon temperature.

33. A solution which contains one gram [illegible] solution is known as molar solution (M).

$$\text{Normality} = \text{molarity} \times \frac{\text{molecular weight of solute}}{\text{equivalent weight of solute}}$$

34. Normality = molarity × n

(where n = molecular weight of solute/ equivalent weight. of solute)

35. The ratio of H_2 and O_2 by weight $= 1:4$

$\therefore$ The ratio of H_2 and O_2 by moles $= \frac{1}{2} : \frac{4}{16} = 2:1$

36.

$$H_2(g) + Cl_2(g) \longrightarrow 2HCl(g)$$

Initial volume 22.4 L 11.2 L 2 mol

22.4 L volume at STP is occupied by $Cl_2 = 1 \text{ mol}$

$\therefore$ 11.2L volume will be occupied by

$$Cl_2 = \frac{1 \times 11.2}{22.4} mol = 0.5 mol$$

Thus, $$\underset{}{H_2(g)} + \underset{1\ mol}{Cl_2(g)} \longrightarrow \underset{0.5\ mol}{2HCl(g)}$$

Since, Cl_2 possesses minimum number of moles, thus it is the limiting reagent.

As per equations,

$$1\ mol\ Cl_2 = 2L\ mol\ HCl$$

$$\therefore \quad 0.5\ mol\ Cl_2 = 2 \times 0.5 mol\ HCl$$
$$= 1.0\ mol\ HCl$$

Hence, 1.0 mol of HCl (*g*) is produced by 0.5 mole of Cl_2 [or 11.2 L]

37. The balanced chemical equation is

$$\underset{24\ g}{Mg} + \underset{16\ g}{\frac{1}{2}O_2} \longrightarrow \underset{40\ g}{MgO}$$

From the above equation, it is clear that 24 g Mg reacts with 16 g O_2.

Thus, 1.0 g Mg reacts with $\frac{16}{24} O_2 = 0.67\ g\ O_2$

But only 0.56 g O_2 is available which is less than 0.67 g. Thus, O_2 is the limiting reagent.

Further, 16 g O_2 reacts with 24 g Mg.

$\therefore$ 0.56 g O_2 will react with Mg $= \frac{24}{16} \times 0.56 = 0.84$ g

$\therefore$ Amount of Mg left unreacted $= 1.0 - 0.84 = 0.16$ g Mg

$\therefore$ Amount of Mg left unreacted $= 1.0 - 0.84 = 0.16\,g$ Mg

Hence, Mg is present in excess and 0.16 g Mg is left behind unreacted.

38. 1 mole of $CO_2 = 6.023 \times 10^{23}$ molecules of CO_2

$$= 44\,g \text{ of } CO_2$$

$$\therefore 10^{21} \text{ molecules of } CO_2 = \frac{44}{6.023 \times 10^{23}} \times 10^{21}\,g\ CO_2$$

$$= 7.31 \times 10^{-2} g = 73.1\,mg$$

$$\therefore \quad CO_2 \text{ left} = 200 - 73.1 = 126.9\,mg$$

$$\text{Hence, moles of } CO_2 \text{ left} = \frac{\text{given mass}}{\text{molar mass}} = \frac{126.9 \times 10^{-3}}{44}$$

$$= 2.88 \times 10^{-3} \text{ mol}$$

39.

$$\underset{\substack{39+16+1 \\ = 56\,g}}{KOH} + \underset{22.4\,dm^3}{CO_2} \longrightarrow KHCO_3$$

$\because$ $22.4\,dm^3$ CO_2 required KOH $= 56\,g$

$$\therefore 11.2\,dm^3\ CO_2 \text{ will require KOH} = \frac{56 \times 11.2}{22.4} = 28\,g$$

40. $\underset{0.1596\text{ g}}{A_2O_3} + \underset{0.006\text{ g}}{3H_2} \longrightarrow 2A + 3H_2O$

0.006 g of H_2 reduces 0.1596 g of A_2O_3

$$6 \text{ g of } H_2 \text{ will reduce} = \frac{0.1596 \times 6}{0.006}$$

$$= 159.6 \text{g of } A_2O_3$$

Thus, molar mas of A_2O_3 = 159.6 g

Let, atomic weight of $A = x$

$$\therefore \quad 2x + 3 + 16 = 159.6$$

$$2x = 159.6 - 48 = 111.6$$

$$x = 55.8$$

41. $\underset{3 \times 56\text{ g}}{3Fe} + \underset{4 \times 18\text{ g}}{4H_2O} \longrightarrow Fe_3O_4 + 4H_2$

= 168 g = 72 g

$\because$ 72 g steam requires Fe = 168 g

$$\therefore \text{ 18 g steam requires Fe} = \frac{168 \times 18}{72} = 42 \text{ g}$$

42. Equal moles of different substances contain same number of constituent particles but equal weights of different substances do not contain the same number of constituent particles.

43. Number of atoms = number of moles $\times N_A \times$ atomicity

$$= 0.1 \times 6.02 \times 10^{23} \times 3$$

$$= 1.806 \times 10^{23} \text{ atoms}$$

44. $\underset{0.037}{R\text{—}OH} + C_2H_5MgI \longrightarrow \underset{11.2\ cc}{C_2H_6} + RMgI$

$\because$ 11.2 cc gas is evolved by alcohol = 0.037 g

$\therefore$ 22400 cc gas will be evolved by alcohol

$$= \frac{0.037}{11.2} \times 22400$$

$$= 74\ g$$

45. The reaction can be written as

$$3H_3\overset{+1}{P}O_2 \longrightarrow \overset{-3}{P}H_3 + 2H_3\overset{+3}{P}O_3$$

Molecular weight of $H_3PO_3 = 3 + 31 + 48$

$$= 82$$

$$\text{Equivalent weight} = \frac{82}{1-(-3)} + \frac{82}{1-3}$$

$$= \frac{82}{4} + \frac{82}{2}$$

$$= 61.5$$