# $10^{TH}$ CHEMISTRY ANSWERS 2020-2021
## UNIT-7
## ATOMS AND MOLECULES

**I. Choose the best answer:**

1. Which of the following has the smallest mass?
   a. $6.023 \times 10^{23}$ atoms of He  **b. 1 atom of He**
   c. 2 g of He  d. 1 mole atoms of He
2. Which of the following is a triatomic molecule?
   a. Glucose  b. Helium
   **c. Carbon dioxide**  d. Hydrogen
3. The volume occupied by 4.4 g of $CO_2$ at S.T.P
   a. 22.4 litre  **b. 2.24 litre**
   c. 0.24 litre  d. 0.1 litre
4. Mass of 1 mole of Nitrogen atom is
   a. 28 amu  b. 14 amu
   c. 28 g  **d. 14 g**
5. Which of the following represents 1 amu?
   a. Mass of a C – 12 atom  b. Mass of a hydrogen atom
   **c. 1/12th of the mass of a C – 12 atom**  d. Mass of O – 16 atom
6. Which of the following statement is incorrect?
   a. 12 gram of C – 12 contains Avogadro's number of atoms.
   b. One mole of oxygen gas contains Avogadro's number of molecules.
   **c. One mole of hydrogen gas contains Avogadro's number of atoms**.
   d. One mole of electrons stands for $6.023 \times 10^{23}$ electrons.
7. The volume occupied by 1 mole of a diatomic gas at S.T.P is
   a. 11.2 litre  b. 5.6 litre
   **c. 22.4 litre**  d. 44.8 litre
8. In the nucleus of $_{20}Ca^{40}$, there are
   a. 20 protons and 40 neutrons  **b. 20 protons and 20 neutrons**
   c. 20 protons and 40 electrons  d. 40 protons and 20 electrons
9. The gram molecular mass of oxygen molecule is
   a. 16 g  b. 18 g
   **c. 32 g**  d. 17 g
10. 1 mole of any substance contains _____ molecules.
   **a. $6.023 \times 10^{23}$**  b. $6.023 \times 10^{-23}$
   c. $3.0115 \times 10^{23}$  d. $12.046 \times 10^{23}$

**II. Fill in the blanks**

1. Atoms of different elements having **same** mass number, but **different** atomic numbers are called isobars.
2. Atoms of different elements having same number of **neutrons** are called isotones.
3. Atoms of one element can be transmuted into atoms of other element by **artificial transmutation**
4. The sum of the numbers of protons and neutrons of an atom is called its **mass number**
5. Relative atomic mass is otherwise known as **standard atomic weight**
6. The average atomic mass of hydrogen is **1.008** amu.
7. If a molecule is made of similar kind of atoms, then it is called **homo** atomic molecule.
8. The number of atoms present in a molecule is called its **atomicity**

9. One mole of any gas occupies **22400** ml at S.T.P

10. Atomicity of phosphorous is **4**

**III. Match the following**

| | | **Moles=** $\frac{Mass}{GAM}$ **(or)** $\frac{Mass}{GMM}$ | |
|---|---|---|---|
| 1 | 8 g of $O_2$ | $\frac{8}{32} = \frac{1}{4}$ | 4 moles **(4)** |
| 2 | 4 g of $H_2$ | $\frac{4}{2} = \frac{2}{1}$ | 0.25 moles **(1)** |
| 3 | 52 g of He | $\frac{52}{4} = \frac{13}{1}$ | 2 moles **(2)** |
| 4 | 112 g of $N_2$ | $\frac{112}{28} = \frac{4}{1}$ | 0.5 moles **(5)** |
| 5 | 35.5 g of $Cl_2$ | $\frac{35.5}{71} = \frac{1}{2}$ | 13 moles **(3)** |

**IV. True or False: (If false give the correct statement)**

1. Two elements sometimes can form more than one compound. **True.**
2. Noble gases are Diatomic. **False .**
   **Noble gases are monoatomic.**
3. The gram atomic mass of an element has no unit .**False .**
   **The relative atomic mass of an element has no unit.**
4. 1 mole of Gold and Silver contain same number of atoms. **True.**
5. Molar mass of $CO_2$ is 42g. **False .**
   **Molar mass of $CO_2$ is 44g.**

**V. Assertion and Reason:**

**Answer the following questions using the data given below:**

i) A and R are correct, R explains the A.

ii) A is correct, R is wrong.

iii) A is wrong, R is correct.

iv) A and R are correct, R doesn't explains A.

1. **Assertion:** Atomic mass of aluminium is 27
   **Reason:** An atom of aluminium is 27 times heavier than 1/12th of the mass of the C – 12 atom.

**i) A and R are correct, R explains the A.**

2. **Assertion:** The Relative Molecular Mass of Chlorine is 35.5 a.m.u.
   **Reason:** The natural abundance of Chlorine isotopes are not equal.

**iii) A is wrong, R is correct**.

**VI. Short answer questions**

1. Define : Relative atomic mass.
   - **Relative atomic mass of an element is the ratio between the average mass of its isotopes to $\frac{1}{12^{th}}$ part of the mass of a carbon-12 atom.**
   - **It is denoted as $A_r$.**
- **It is otherwise called "Standard Atomic Weight".**
- **Relative Atomic Mass is only a ratio, so it has no unit.**

**Relative atomic mass** $= \dfrac{\textit{Average mass of the isotopes of the element}}{\frac{1}{12^{th}} \textit{ of the mass of one carbon}-12 \textit{ atom.}}$

2. Write the different types of isotopes of oxygen and its percentage abundance.
   - **Oxygen is the most abundant element in both the Earth's crust and the human body.**
   - **It exists as a mixture of three stable isotopes in nature.**

| Isotope | Mass (amu) | % abundance |
|---|---|---|
| ${}_{8}O^{16}$ | 15.9949 | 99.757 |
| ${}_{8}O^{17}$ | 16.9991 | 0.038 |
| ${}_{8}O^{18}$ | 17.9992 | 0.205 |

3. Define : Atomicity
   - **The number of atoms present in the molecule is called its 'atomicity'.**
   - **Atomicity of a Homoatomic element** $= \dfrac{\textit{Molecular mass}}{\textit{Atomic Mass}}$
4. Give any two examples for heterodiatomic molecules.
   **HCl, HI, CO, NaCl, NO**
5. What is Molar volume of a gas?
   - **One mole of any gas occupies 22.4 litre or 22400 ml at S.T.P.**
   - **This volume is called as molar volume.**
6. Find the percentage of nitrogen in ammonia.
   **Gram molar mass of ammonia ($NH_3$) = 1(N) + 3(H) = 1(14) + 3(1) = 17g**

   **Mass percentage of nitrogen in ammonia** $= \dfrac{\textit{mass of nitrogen } x \ 100}{\textit{Molar mass of ammonia}}$

   $= \dfrac{14 \ x \ 100}{17} =$ **82. 35 %**

   **Mass percentage of hydrogen in ammonia** $= \dfrac{\textit{mass of hydrogen } x \ 100}{\textit{Molar mass of ammonia}}$

   $= \dfrac{3 \ x \ 100}{17} =$ **17. 65 %**

**VII. Long answer questions**

1. Calculate the number of water molecules present in one drop of water which weighs 0.18 g.

   **Gram molar mass of water ($H_2O$)= 2(H )+ 1 (O) = 2(1) + 1(16) = 2 + 16 = 18 g**

   **Number of moles** $= \dfrac{\textit{Mass}}{\textit{Gram Molar mass}} = \dfrac{0.18}{18}$ **= 0.01 moles.**

   **Number of molecules = Number of moles x Avogadro number**

   **= 0.01 x 6.023 $\times 10^{23}$ = 6.023x$10^{21}$ molecules**

2. $N_2 + 3 H_2 \longrightarrow 2 NH_3$
   (The atomic mass of nitrogen is 14, and that of hydrogen is 1)

1mole of nitrogen (**28g**) + 3 moles of hydrogen (**6g**) → 2 moles of ammonia ( **2×17=34 g**) .

3. Calculate the number of moles in

i ) 27g of Al

**Number of moles** $= \frac{Mass}{Gram\ Atomic\ mass} = \frac{27}{27}$ **= 1 mole**

ii) $1.51 \times 10^{23}$ molecules of $NH_4Cl$

**Number of moles** $= \frac{Number\ of\ molecules}{Avogadro\ number} = \frac{1.51x10^{23}}{6.023x10^{23}} = \frac{1}{4}$ **= 0.25 moles**

4. Give the salient features of "Modern atomic theory".

**'The main postulates of modern atomic theory' are as follows:**

i. **An atom is no longer indivisible .**
   **(after the discovery of the electron, proton, and neutron).**
ii. **Atoms of the same element may have different atomic mass.**
   **(discovery of isotopes $_{17}Cl^{35}$, $_{17}Cl^{37}$).**
iii. **Atoms of different elements may have same atomic masses.**
   **(discovery of Isobars $_{18}Ar^{40}$, $_{20}Ca^{40}$).**
iv. **Atoms of one element can be transmuted into atoms of other elements.**
   **In other words, atom is no longer indestructible**
   **(discovery of artificial transmutation).**
v. **Atoms may not always combine in a simple whole number ratio**
   **(E.g. Glucose $C_6H_{12}O_6$ C:H:O = 6:12:6 or 1:2:1 and**
   **Sucrose $C_{12}H_{22}O_{11}$ C:H:O = 12:22:11).**
vi. **Atom is the smallest particle that takes part in a chemical reaction.**
vii. **The mass of an atom can be converted into energy ($E = mc^2$).**

5. Derive the relationship between Relative molecular mass and Vapour density.

**Relative molecular mass (Hydrogen scale) :**

**The Relative Molecular Mass of a gas or vapour is the ratio between the mass of one molecule of the gas or vapour to mass of one atom of Hydrogen.**

**Relative molecular mass (hydrogen scale)** $= \frac{Mass\ of\ 1\ molecule\ of\ a\ gas\ or\ vapour\ at\ STP}{Mass\ of\ 1\ atom\ of\ hydrogen}$

—— **(equation 1)**

**Vapour Density:**

**Vapour density is the ratio of the mass of a certain volume of a gas or vapour, to the mass of an equal volume of hydrogen, measured under the same conditions of temperature and pressure.**

**Vapour Density (V.D.)** $= \frac{Mass\ of\ a\ given\ volume\ of\ gas\ or\ vapour\ at\ STP}{Mass\ of\ the\ same\ volume\ of\ hydrogen}$

**According to Avogadro's law, equal volumes of all gases contain equal number of molecules.**

**Thus, let the number of molecules in one volume = n, then**

**Vapour Density at S.T.P** $= \frac{Mass\ of\ 'n'\ molecules\ of\ a\ gas\ or\ vapour\ at\ S.T.P.}{Mass\ of\ 'n'\ molecules\ of\ Hydrogen}$

**Cancelling 'n' which is common, we get**

**Vapour Density** $= \dfrac{\text{Mass of 1 molecule of a gas or vapour at S.T.P.}}{\text{Mass of 1 molecule of Hydrogen}}$

**However,Since hydrogen is diatomic,**

**Vapour Density** $= \dfrac{\text{Mass of 1 molecule of a gas or vapour at S.T.P.}}{\text{Mass of 2 atoms of Hydrogen}}$

**When we compare the formula of vapour density with relative molecular mass, they can be represented as**

**Vapour Density** $= \dfrac{\text{Mass of 1 molecule of a gas or vapour at S.T.P.}}{2 \times \text{Mass of 1 atom of Hydrogen}}$ **(equation 2)**

**By Substituting equation(1) to Equation (2) and we arrive at the following formula ,**

**Vapour Density** $= \dfrac{\text{Relative molecular mass}}{2}$

**Now on cross multiplication, we get,**

**2 × vapour density = Relative molecular mass of a gas**

**(Or)**

**Relative molecular mass = 2 × Vapour density**

**VIII. HOT question**

1. Calcium carbonate is decomposed on heating in the following reaction

   $CaCO_3 \rightarrow CaO + CO_2$

**i.** How many moles of Calcium carbonate are involved in this reaction?

**1 mole**

**ii.** Calculate the gram molecular mass of calcium carbonate involved in this reaction

**Gram molecular mass of calcium carbonate ($CaCO_3$) =1(Ca)+1(C)+3(O)**

**= 1(40)+1(12)+3(16) = 40+12+48 = 100g**

**iii.** How many moles of $CO_2$ are there in this equation?

**1 mole**

**IX. Solve the following problems :**

1. How many grams are there in the following?

i. 2 moles of hydrogen molecule, $H_2$

**Gram molecular mass of Hydrogen = 2 g**

**Mass = No. Of moles X Gram molecular mass = 2 X 2 = 4g**

ii. 3 moles of chlorine molecule, $Cl_2$

**Gram molecular mass of Chlorine = 2 × 35.5 = 71 g**

**Mass = No. Of moles X Gram molecular mass = 3 X 71= 213g**

iii. 5 moles of sulphur molecule, $S_8$

**Gram Molecular Mass of sulphur = 8 X 32= 256 g**

**Mass = No. Of moles X Gram molecular mass = 5 X 256 = 1280g**

iv. 4 moles of phosphorous molecule, $P_4$

**Gram Molecular Mass of phosphorous = 4 X 31 = 124 g**

**Mass = No. Of moles X Gram molecular mass = 4 X124 = 496g**

2. Calculate the % of each element in calcium carbonate.

   (Atomic mass: C-12, O-16, Ca -40)

**Gram molecular mass of calcium carbonate ($CaCO_3$) =1(Ca)+1(C)+3(O)**

**=1(40 )+ 1(12) + 3(16) = 40 + 12 + 48 = 100g**

**Mass percentage of calcium in $CaCO_3$** $= \frac{\textit{mass of calcium}\ x\ 100}{\textit{Molar mass of CaCO3}}$

$= \frac{40\ x\ 100}{100}$ = **40 %**

**Mass percentage of carbon in $CaCO_3$** $= \frac{\textit{mass of carbon}\ x\ 100}{\textit{Molar mass of CaCO3}}$

$= \frac{12\ x\ 100}{100}$ = **12 %**

**Mass percentage of oxygen in $CaCO_3$** $= \frac{\textit{mass of oxygen}\ x\ 100}{\textit{Molar mass of CaCO3}}$

$= \frac{48\ x\ 100}{100}$ = **48 %**

3. Calculate the % of oxygen in $Al_2(SO_4)_3$. (Atomic mass: Al-27, O-16, S -32)

**Gram molecular mass of Aluminium Sulphate $Al_2(SO_4)_3$ = 2(Al)+3(S)+12(O)**

**= 2(27)+3(32)+12(16) = 54+96+192 = 342g**

**Mass percentage of oxygen in $Al_2(SO_4)_3$** $= \frac{\textit{mass of oxygen}\ x\ 100}{\textit{Molar mass of Aluminium Sulphate}}$

$= \frac{192\ x\ 100}{342}$ = **56.14 %**

**Mass percentage of Aluminium in $Al_2(SO_4)_3$** $= \frac{\textit{mass of Aluminium}\ x\ 100}{\textit{Molar mass of Aluminium Sulphate}}$

$= \frac{54\ x\ 100}{342}$ = **15.79 %**

**Mass percentage of Sulphur in $Al_2(SO_4)_3$** $= \frac{\textit{mass of Sulphur}\ x\ 100}{\textit{Molar mass of Aluminium Sulphate}}$

$= \frac{96\ x\ 100}{342}$ = **28.07 %**

4. Calculate the % relative abundance of B -10 and B -11, if its average atomic mass is 10.804 amu.

Average atomic mass

= (Mass of 1st isotope × % abundance of 1st isotope) + (Mass of 2nd isotope × % abundance of 2nd isotope)

| S.No. | ISOTOPE | MASS | % Relative Abundance |
|---|---|---|---|
| 1 | Boron-10 | 10 | x |
| 2 | Boron-11 | 11 | 100-x |

**Average Atomic Mass = (atomic mass of B-10 × % relative abundance) + (atomic mass of B-11 × % relative abundance)**

$$\mathbf{10.804} = \frac{10x}{100} + \frac{11(100-x)}{100}$$

**10.804 × 100 = (10x) + 1100 - (11x) = 1100 - x**

**1100 - x = 1080.4**

**x = 1100 - 1080.4 = 19.6%**

**Therefore , 100-x = 100-19.6 = 80.4%**

**% abundance of B-10 = 19.6 %**

**% abundance of B-11 = 80.4 %**

**EXTRA BOOK INSIDE QUESTIONS:**

1. Define Atomic Number
   - The number of protons present in the nucleus of an atom OR the number of elecrons present in an atom is known as the atomic number of an atom.
   - It is denoted by the symbol Z
   - Atomic number(Z) = Number of protons = Number of electrons
2. Define Mass number (Pg.92)
   - The sum of the number of protons and neutrons of an atom is called its mass number.
   - It is denoted by the symbol A
   - Atomic number(Z) = Number of protons + Number of Neutrons
3. Define Atomic Mass Unit (Pg.92)
   Atomic mass unit is one-twelfth of the mass of a carbon-12 atom; an isotope of carbon, which contains 6 protons and 6 neutrons.
4. Define Gram Atomic Mass (Pg.93)

- If the atomic mass of an element is expressed in grams, it is called as Gram Atomic Mass
- Gram Atomic Mass of hydrogen = 1 g
- Gram Atomic Mass of carbon = 12 g
- Gram Atomic Mass of nitrogen = 14 g
- Gram Atomic Mass of oxygen = 16 g

5. Define Average Atomic Mass (Pg.93)

The average atomic mass of an element is the weighted average of the masses of its naturally occurring isotopes.

Average atomic mass

= (Mass of 1st isotope × % abundance of 1st isotope) + (Mass of 2nd isotope × % abundance of 2nd isotope)

6. Define Molecule (Pg.94)

A molecule is a combination of two or more atoms held together by strong chemical forces of attraction, i.e. chemical bonds.

7. Define Gram molecular Mass (Pg.96)
   - If the molecular mass of a compound is expressed in grams, it is called Gram Molecular Mass.
   - Gram Molecular Mass of water = 18 g
   - Gram Molecular Mass of carbon dioxide = 44 g
   - Gram Molecular Mass of ammonia = 17 g
   - Gram Molecular Mass of HCl = 36.5 g
8. Define Hetero atomic Molecule (Pg.94)
   - The molecule that consists of atoms of different elements is called hetero atomic molecule.
   - A compound is a hetero atomic molecule.
   - **HCl, HI, CO, NaCl, NO** , etc
9. Define Relative Molecular Mass (Pg.95)

The Relative Molecular Mass of a molecule is the ratio between the mass of one molecule of the substance to $\frac{1}{12^{th}}$ mass of an atom of Carbon -12.

Relative Molecular Mass is only a ratio.

So, it has no unit .

10. What are the Applications of Avogadro Law ? (Pg.99)

**APPLICATIONS OF AVOGADRO'S LAW**

i. It explains Gay-Lussac's law.
ii. It helps in the determination of atomicity of gases.
iii. Molecular formula of gases can be derived using Avogadro's law
iv. It determines the relation between molecular mass and vapour density.
v. It helps to determine gram molar volume of all gases (i.e, 22.4 litre at S.T.P)

11. Differenciate between Atoms and Molecules (Pg.96)

| **Atom** | **Molecule** |
|---|---|
| An atom is the smallest particle of an element. | A molecule is the smallest particle of an element or compound. |

| | |
|---|---|
| Atom does not exist in free state except in noble gas. | Molecule exists in a free state. |
| Except some of noble gas, other atoms are highly reactive | Molecules are less reactive |
| Atom does not have a chemical bond | Atoms in a molecule are held by chemical bonds |

12. State Avogadro Law and Explain with an illustration (Pg.98)

The Avogadro's law states that "equal volumes of all gases under similar conditions of temperature and pressure contain equal number of molecules".

**Explanation:**

Let us consider the reaction between hydrogen and chlorine to form hydrogen chloride gas

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

1 vol + 1 vol $\rightarrow$ 2 volumes

According to Avogadro's law

1 volume of any gas is occupied by "n" number of molecules.

n molecules + n molecules $\rightarrow$ 2n molecules

if n = 1 then,

1molecule + 1 molecule $\rightarrow$ 2 molecules.

½ molecule + ½ molecule $\rightarrow$ 1 molecule

1 molecule of hydrogen chloride gas is made up of ½ molecule of hydrogen and ½ molecule of chlorine.

Hence, the molecules can be subdivided.

This law is in agreement with Dalton's atomic theory

13. Define mole (Pg.97)

In the SI system, the mole (mol) is the amount of a substance that contains as many elementary entities (atoms, molecules, or other particles) as there are atoms in exactly 12 g (or 0.012 kg) of the carbon-12 isotope

14. What is meant by mole concept ? (Pg.97)

The study of the collection of particles by using mole as the counting unit, in order to express the mass and volume of such unit particles in a bulk of matter is known as mole concept.

15. What is mole of atoms? (Pg.97)

One mole of an element contains $6.023 \times 10^{23}$ atoms and it is equal to its gram atomic mass. i.e., one mole of oxygen atom contains $6.023 \times 10^{23}$ atoms of oxygen and its gram atomic mass is 16 g.

16. What is mole of molecules ? (Pg.97)

One mole of matter contains $6.023 \times 10^{23}$ molecules and it is equal to its gram molecular mass.

i.e., one mole of oxygen molecule contains $6.023 \times 10^{23}$ molecules of oxygen and its gram molecular mass is 32 g.

17. Define Homo atomic molecule (Pg.94)

If the molecule is made of similar kind of atoms, then it is called homo atomic molecule.

Example: $O_2$, $H_2$, $Cl_2$, $F_2$, $S_8$, $P_4$, etc.

18. Define Isotopes .Give example (Pg. 102)

Two or more forms of an element having the same atomic number, but different mass number are called Isotopes ($_{17}Cl^{35}$, $_{17}Cl^{37}$)

19. Define Isobars .Give example (Pg. 102)

Atoms of different elements having the same mass number, but different atomic numbers are called Isobars ($_{18}Ar^{40}$, $_{20}Ca^{40}$).

20. Define Isotones .Give example (Pg. 102)

Atoms of different elements having the same number of neutrons, but different atomic number and different mass number are called Isotones ( $_{6}C^{13}$, $_{7}N^{14}$ ).

## BOOK INSIDE PROBLEM:

### ACTIVITY 7.1 (Pg.No. 95)

| Element | No.of Protons | No. Of Neutrons | Mass Number | Stable Isotope (abundance) | Atomic Mass (amu) Average atomic mass = (Mass of 1st isotope × % abundance of 1st isotope) + (Mass of 2nd isotope × % abundance of 2nd isotope) |
|---|---|---|---|---|---|
| Nitrogen | **7** | **7** | **14** | **N-14(99.6%)** | **(14x0.996)+(15x0.004) = 13.944+0.060 =14.004** |
| | **7** | **8** | **15** | **N-15(0.4%)** | |
| Silicon | **14** | **14** | **28** | **Si-28(92.2%)** | **(28 x0.922)+(29 x0 .047)+ (30 x 0.031) = 25.816+1.363 + 0.93 = 28.109** |
| | **14** | **15** | **29** | **Si-29(4.7%)** | |
| | **14** | **16** | **30** | **Si-30(3.1%)** | |
| Chlorine | **17** | **18** | **35** | **Cl-35(75%)** | **(35 x 0.75)+(37x0.25) =26.25+ 9.25 =35.5** |
| | **17** | **20** | **37** | **Cl-37(25%)** | |