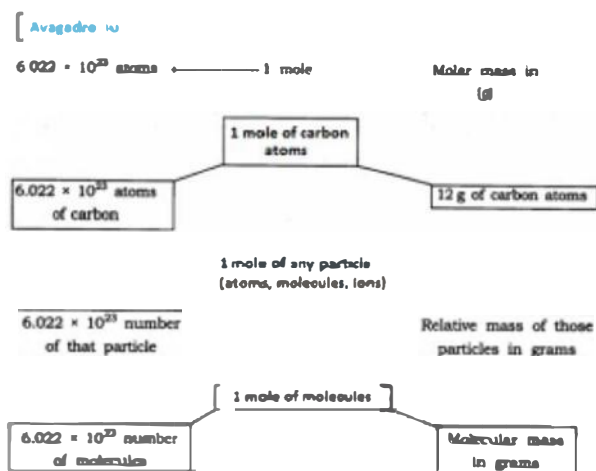


NCERT SOLUTIONS

CLASS IX SCIENCE

CHAPTER 3- ATOMS AND MOLECULES

General Question: Illustrate the relationship between a mole, Avogadro's number and Mass.



Q1. A reaction is taking place wherein, 5g of sodium carbonate reacts with 7.2 gm of ethanoic acid. The products are 4.2g carbon dioxide, 3g water and 5g sodium ethanoate. Prove how these observations are in coherence with the law of mass conservation.

Ans.

Sodium carbonate + ethanoic acid $\rightarrow$ water + carbon dioxide + Sodium ethanoate

5g 7.2g 3g 4.2g 5g

LHS = RHS

12.2g = 12.2g

This observation thus shows that during a chemical reaction, mass of reactant = mass of product.

Q2. Hydrogen reacts with oxygen in the ratio 1:8 by mass to form water. How much oxygen is required to completely react with 4g of hydrogen?

Ans.

We know hydrogen and water mix in the ratio 1: 8.

Thus, 1: 8 = 4: x (where x is the amount of oxygen)

x = 8 * 4

= 32g

Therefore, 32g of oxygen would be required to completed react with 4g of hydrogen.

Q3. Which postulate of Dalton's Atomic theory is the result of the law of conservation of mass?

Ans.

The postulate of Dalton's Atomic theory which is a result of the law of conservation of mass is, "Atoms can neither be created nor destroyed".

Q4. Which postulate of Dalton's Atomic theory can explain the law of definite proportions?

Ans.

The postulate which can explain the law of definite proportions is that the relative number and the kinds of atoms are constant in a given compound.

Q5. What is an atomic mass unit?

Ans.

An atomic mass unit is a unit of mass used to express weights of atoms and molecules where one atomic mass is equal to $\frac{1}{12}$ the mass of one carbon-12 atom.

Q6. Why aren't atoms visible to a naked eye?

Ans.

Firstly, atoms are very very minute, measuring in nanometers. Secondly, except for atoms of noble gasses, they do not exist independently. For these basic reasons, we cannot see an atom with our naked eye.

Q7. Write the formulae for the following:

Carbon dioxide
Calcium hydroxide
Ammonium chloride
Aluminum chloride

Ans.

Carbon dioxide- CO_2 , Calcium hydroxide- $\text{Ca}(\text{OH})_2$, Ammonium Chloride – NH_4Cl , Aluminum Chloride – AlCl_3

Q8. What does chemical formula mean?

Ans.

The symbolic representation of a chemical compound is called its chemical formulae. E.g. chemical formulae of salt is NaCl .

Q9. Find the number of atoms the following possess: – (i) H_2O molecule (ii) H_2S molecule

Ans.

H_2O 3 atoms present

H_2S 3 atoms present.

Q10. Find out the molecular masses of CO_2 , O_2 , H_2 , Cl_2 , NH_3 , C_2H_2 , CH_3OH .

Ans.

$$\text{H}_2 = 1 \times 2 = 2\text{u}$$

$$\text{O}_2 = 16 \times 2 = 32\text{u}$$

$$\text{CO}_2 = 1 \times 12 + 2 \times 16 = 44\text{u}$$

$$\text{Cl}_2 = 35.5 \times 2 = 71\text{u}$$

$$\text{NH}_3 = 1 \times 14 + 3 \times 1 = 17\text{u}$$

$$\text{C}_2\text{H}_2 = 2 \times 12 + 2 \times 1 = 26\text{u}$$

$$\text{CH}_3\text{OH} = 12 + 3 \times 1 + 16 + 1 = 32\text{u}$$

Q11. Work out the formula unit masses of K_2CO_3 , ZnO , Na_2O .

(Atomic masses of $\text{Zn}=65\text{u}$, $\text{Na}=23\text{u}$, $\text{K}=39\text{u}$, $\text{C}=12\text{u}$ and $\text{O}=16\text{u}$)

Ans.

$$\text{ZnO} = 65\text{u} + 16\text{u} = 81\text{u}$$

$$\text{Na}_2\text{O} = (23\text{u} \times 2) + 16\text{u} = 46\text{u} + 16\text{u} = 62\text{u}$$

$$\text{K}_2\text{CO}_3 = (39\text{u} \times 2) + 12\text{u} + 16\text{u} \times 3 = 138\text{u}$$

Q12. What is the mass of 1 carbon atom, if one mole of carbon atoms weigh 12gm?

Ans.

$$1 \text{ mole of carbon atoms, } 6.022 \times 10^{23} = 12\text{g}$$

Therefore, mass of 1 carbon atom = $12/6.022 \times 10^{23}$

$$= 1.99 \times 10^{-23} \text{g}$$

Q13. Out of 100g of sodium and 100g of iron which one is heavier?

(Atomic mass of Na=23u, Fe= 56u)

$$23\text{g of Na} = 6.022 \times 10^{23} \text{atoms}$$

$$100\text{g Na} = \frac{100}{23} \times 6.022 \times 10^{23} = 2.6182 \times 10^{24} \text{atoms}$$

$$56\text{g of Fe} = 6.022 \times 10^{23} \text{atoms}$$

$$100\text{g of Fe} = \frac{100}{56} \times 6.022 \times 10^{23} = 1.057 \times 10^{24} \text{atoms}$$

Thus, it is evident from the above calculations that 100g of Na has more atoms.

Q14. A 0.20g compound of oxygen and boron was found to contain 0.080g of boron and 0.12g. Calculate the percentage composition of the compound by weight.

Ans.

Compound Boron + Oxygen

0.20 0.080 0.12

Percentage composition of boron:

0.20g 0.040g

$$100 \times (0.080/0.20) = 40\%$$

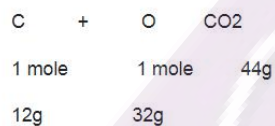
Percentage composition of oxygen:

$$100 \times (0.12/0.20) = 60\%$$

Q15. 3g of carbon is burnt in 8g of oxygen, 11g of carbon dioxide is the by-product. What mass of CO₂ is formed when 3g of carbon is burnt in 40g of oxygen? Which law of chemical combination does the answer follow?

Ans.

The chemical reaction of carbon burning in oxygen is:



It is given that 3g of carbon requires 8g gram of oxygen to produce 11g of carbon-dioxide. Thus when 3g of carbon burns in 40g of oxygen, we still get 11g of carbon dioxide with 40-8= 32g of oxygen remaining. The answer follows the law of constant proportion.

Q16. What do you understand by polyatomic ions?

Ans.

Polyatomic ions are ions that contain more than one atom but they behave as a single unit e.g. CO₃²⁻, H₂PO₄⁻.

Q17. What is the chemical formula of the following compounds?

Methane

Vinegar, Sodium Thiosulphate

Calcium Carbonate

Potassium Hydroxide

Magnesium chloride.

Ans.

Methane- CH_4

Vinegar - CH_3COOH

Sodium Thiosulphate - $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$

Calcium Carbonate - CaCO_3

Potassium Hydroxide - KOH

Magnesium Chloride - MgCl_2

Q18. What are the names of the elements present in the following compounds:

Potash Alum, Quick lime, Plaster of Paris, Common Salt and Baking powder

Ans.

Potash alum - Potassium Aluminum Sulphate

Elements - Potassium, Aluminum, Sulphur, Oxygen and Hydrogen

Quick lime - Calcium oxide

Elements- Calcium and oxygen

Plaster of Paris - Calcium Sulphate

Elements - Calcium, Sulphur, Oxygen and Hydrogen

Common Salt - Sodium Chloride

Elements - Sodium and chlorine

Baking Powder - Sodium Hydrogen Carbonate

Elements- Sodium, Hydrogen, Carbon and Oxygen.

Q19. Find the molar mass of the following compounds:

Hydrochloric Acid (HCl)

Ammonia (NH_3)

Nitric Acid (HNO_3)

Acetic Acid (CH_3COOH)

Acetone ($\text{C}_3\text{H}_6\text{O}$)

Ans.

$\text{HCl} = 1 + 35.5 = 36.5\text{g}$

$\text{NH}_3 = 14 + 1 \times 3 = 17\text{g}$

$\text{HNO}_3 = 1 + 14 + 16 \times 3 = 63\text{g}$

$\text{CH}_3\text{COOH} = 12 + 3 \times 1 + 12 + 16 \times 2 + 1 = 60\text{g}$

$\text{C}_3\text{H}_6\text{O} = 12 \times 3 + 6 \times 1 + 16 = 58\text{g}$

Q20. Find the mass of:

1 mole of oxygen

5 moles of chlorine atoms

10 moles of ammonia

Ans.

1 mole of oxygen = 16g

5 mole of chlorine atoms = $5 \times 35.5 = 177.5\text{g}$

1 mole of ammonia(NH_3) = $14 + 3 \times 1 = 17\text{g}$

Thus, 10 moles of ammonia = $10 \times 17 = 170\text{g}$.

Q21. Convert the given mass into mole:

1. 10g of chlorine gas.
2. 12g of Carbon dioxide.
3. 10 gram of oxygen gas.

Ans.

a) Given mass of chlorine gas = 10g.

Molar mass of chlorine gas = 71g.

Thus, mole of 10g of chlorine gas = $10/71 = 0.1408$ moles.

b) Given mass of CO_2 = 12g.

Molar mass of CO_2 = $12 + 16 \times 2 = 44\text{g}$.

Thus, mole 12g of CO_2 = $12/44 = 0.272$ moles.

c) Given mass of O_2 = 10g.

Molar mass of O_2 = $16 \times 2 = 32\text{g}$.

Thus, mole of 10g of O_2 = $10/32 = 0.3125$ moles.

Q22. Find the mass of:

a) 2 moles of water molecules.

b) 5 moles of carbon dioxide molecules.

Ans.

a) Mole of water molecules = 0.2

Molar mass of H_2O = $1 \times 2 + 16 = 18\text{g}$

Mass of 0.2 moles of H_2O = $18 \times 0.2 = 3.6\text{g}$

b) Mole of CO_2 molecule = 0.5.

Molar mass of CO_2 = $12 + 16 \times 2 = 44\text{g}$.

Mass of 0.5 moles of CO_2 = $0.5 \times 44 = 22\text{g}$.

Q23. What is the number of molecules of Sulphur (S_8) present in 32g of solid sulphur?

Ans.

Molar mass of sulfur = $256\text{g} = 6.022 \times 10^{23}$ molecule

Given mass of sulfur = 32g

Therefore, the number of molecules = $\frac{32}{256} \times 6.022 \times 10^{23}$

$= 7.5 \times 10^{22}$ molecules.

Q24. Find the number of aluminum ions present in 0.046g of aluminum oxide. (For an element, the mass of its ion and atom are the same)

Ans.

Molar mass of aluminum oxide, Al_2O_3 = $(2 \times 27) + (3 \times 16) = 102\text{g}$

Now,

0.046g of Al_2O_3 contains = $\frac{0.046}{102} \times 6.022 \times 10^{23}$ aluminum ions

102g of Al_2O_3 contains = $2 \times 6.022 \times 10^{23}$ aluminium ions

Therefore,

0.046 g Al_2O_3 contains = $\times 10^{23}$

= 5.432×10^{20} Al^{3+} ions.

Q25. Multiple choice questions:

Choose the option:

1. The atomicity H_2SO_4 is:

(a)12 (b)7

(c)19 (d)8

2. The chemical formula for acetic acid is:

(a) CH_3COOH (b) CaCl_2

(c) CaO (d) CaCO_3

3. The symbol for gold is:

(a) Cd (b) Hg

(c) Gd (d) Au

4. Noble gas molecules have:

(a) diatomic (b) triatomic

(c) monoatomic (d) none of the above

5. The valency of oxygen in a water molecule is:

(a)1 (b)2

(c)3 (d)5

6. The molar mass of Ethyne, C_2H_2 is:

(a) 26g (b) 21g

(c) 25g (d) 15g

7. How many moles of oxygen are present in 3.2g of oxygen atoms?

(a) 0.2moles (b) 0.9 moles

(c) 1.2 moles (d) 1 moles.

8. Which among the following is not proposed by Dalton in his atomic theory?

(a) Atoms cannot be divided further

(b) Only atoms of the same elements can combine to form compounds.

(c) Atoms of different elements have different sizes, masses and chemical properties.

(d) Atoms can neither be created nor destroyed.

9. Pick the wrong one out:

(a) 1 mole of hydrogen = 1g

(b) 1 mole of oxygen = 32g

(c) 1 mole of Carbon = 18g

(d) 1 mole of chlorine = 35.5g

10. From the following compounds which one has a molecular mass of 106.

(a) Na_2CO_3 (b) H_2SO_4

(c) CaCl (d) none of the above

Ans. 1-(b) . 2- (a) . 3- (d) . 4 -(c) . 5- (b) . 6- (a) . 7 -(a) . 8 - (b) . 9- (c) . 10- (a).

Q26.State the law of mass conservation.

Ans.

According to this law, mass can neither be created nor destroyed in a chemical reaction or a physical transformation.

Q27.What do you understand by the law of constant proportion?

Ans.

According to the Law of constant proportion, a chemical compound always has its compounding elements in definite proportion by mass, irrespective of the source and the type of chemical reaction.

Q28.Who was responsible for coining the term atom?

Ans.

In modern science, John Dalton widely used it and he can be said to be responsible for coining it, but a more factually correct answer would be a Greek philosopher who goes by the name of Lucretius.

Q29.Define atom.

Ans.

Atom is the smallest particle of matter which can take part in a chemical reaction.

Q30.What is a molecule?

Ans.

A molecule is a group of atoms bonded together which represents the most fundamental unit of a chemical compound capable of taking part in a chemical reaction.

Q31.What is atomicity?

Ans.

Atomicity is the number of atoms in a molecule.

Q32.Define atomic mass unit.

Ans.

The Atomic mass unit is the sum of the atomic masses of all the atoms in a molecule.

Q32.What is the atomicity of oxygen and phosphorous?

Ans.

Atomicity of oxygen, $O_2 = 2$ and atomicity of phosphorous, $P_4 = 4$.

Q33. Define ion.

Ans.

An ion is an atom or a molecule with an electric charge (+ve or -ve), caused by gain or loss of a single or multiple electrons.

Q34. Provide a difference between cations and anions, along with an example for each.

Ans.

Cations are positively charged ions, e.g. Fe^{2+} whereas, anions are negatively charged ions, e.g. F^-

Q35. Define Avogadro's constant.

Ans.

Avogadro's Constant (6.022×10^{23}) is the number of atoms of an element present in one mole of that element.

Q36. Calculate the molecular mass of glucose, $C_6H_{12}O_6$.

Ans.

Molecular mass of $C_6H_{12}O_6 = (12 \times 6) + 12 + (16 \times 6)$
 $= 180u$.

Q37. What is the unit to measure the size of an atom, and what is the size of a hydrogen atom?

Ans.

An atom's size is measured in nanometers and a hydrogen atom is 0.1 nm.

Q38. What does IUPAC stand for? State any one of its roles.

Ans.

IUPAC stands for the International Union of Pure and Applied Chemistry. One of its roles is to approve the naming of elements.

Q39. What is the Latin name for the following elements: gold, silver, sodium, potassium?

Ans.

Gold – Aurum, Silver- Argentum, Sodium – Natrium, Potassium – Kalium.

Q40. What is the ratio by mass of the constituent elements in CO_2 , NH_3 and H_2O ?

Ans.

CO_2 by mass of combining elements 12:32 3:8 (C:O)

NH_3 by mass of combining elements 14:3 14:3 (N:H)

H_2O by mass of combining elements 2:16 1:8 (H:O)

Q41. What is valency? Give the valency of the following elements: beryllium, neon, magnesium, hydrogen, chlorine.

Ans.

Valency is the number of electrons an atom can use to combine with other atoms or in other words, it is the combining power of an atom.

Beryllium-2, neon-0, magnesium-2, hydrogen-1, chlorine-2.

Q42. What is a polyatomic ion?

Ans.

Polyatomic ions are composed of two or more atoms acting as a single unit. E.g. NH_4^+

Q43. What are the chemical formulae for: Acetone, copper nitrate and aluminum hydroxide.

Ans.

Acetone- $(CH_3)_2CO$

Copper Nitrate- $Cu(NO_3)$

Aluminum Hydroxide – $Al(OH)_3$

Q44. Calculate the number of moles in:

(i) 36g of H_2O

(ii) 69g of Na

Ans.

(i) Molar mass of H_2O = $2 \times 1 + 16 = 18\text{g}$

Given mass of H_2O = 36g

Therefore, number of moles in 36g of H_2O = $36/18 = 2$ moles

(ii) Molar mass of Na = 23g

Given mass of Na = 69g

Therefore, number of moles in 69g of Na = $69/23 = 3$ moles.

Q45. What are the rules for writing the symbol of an element?

Ans.

Firstly, the symbol has to be IUPAC approved.

The symbols are the first one or two letters of that element in English, Latin, German or Greek. E.g. He for helium, O_2 for oxygen.

And, the first letter of the symbol has to be in upper case and the second letter has to be in lower case e.g. Na, Cl, etc.

Q46. What do you understand from relative atomic and relative molecular mass?

Ans. Relative atomic mass is the ratio of the mass of one atom to the $1/12^{\text{th}}$ mass of a carbon-12 atom.

Relative molecular mass is the ratio of the mass of one molecule of an element to $1/12^{\text{th}}$ of the mass of a carbon-12 atom.

Q47. H_2O is the formula for water. What information do you get from this formula?

Ans.

H_2O represents water

H_2O is a single molecule of water

H_2O is a single mole of water. Thus, it contains 6.022×10^{23} molecules of water.

H_2O contains 2 atoms of hydrogen and 1 atom of oxygen.

H_2O has a molar mass of 18g

Q48. Differentiate between an atom and an ion.

Ans.

Atoms	Ions
Neutral charge	Positively or Negatively charged
Number of electrons and protons is equal	Number of protons and electrons isn't equal

Q48. What is the formula unit mass of CaCl_2 and NaCl.

(Na = 23, Cl = 35.5, Ca = 40)

Ans.

Formula Unit Mass of NaCl = $23 + 35.5 = 58.5\text{u}$

Formula Unit Mass of CaCl_2 = $40 + (2 \times 35.5) = 111\text{u}$.

Q49. The ratio by mass of hydrogen to oxygen in a water molecule is 1: 8. Calculate the ratio of the number of atoms in a water molecule.

Ans.

Element	Ratio by mass	Atomic mass	Mass Ratio	Simplest ratio
			Atomic mass	
H	1	1	1/1 = 1	2
O	8	16	8/16 = 1/2	1

Thus, the ratio of the number of atoms in a water molecule is H: O = 2: 1.

Q50. Write the chemical formula for the following compounds:

(a) Zinc carbonate

(b) Copper phosphate

(c) Aluminum carbonate

(d) Aluminum hydroxide

(e) Magnesium bicarbonate

(f) Calcium sulphide

Ans.

(a) Zinc Carbonate



Formula = ZnCO_3

(b) Copper Phosphate



Formula = $\text{Cu}_3(\text{PO}_4)_2$

(c) Aluminum Carbonate



Formula = $\text{Al}_2(\text{CO}_3)_3$

(d) Aluminum Hydroxide



Formula = $\text{Al}(\text{OH})_3$

(e) Magnesium Bicarbonate



Formula = $\text{Mg}(\text{HCO}_3)_2$

(f) Calcium Sulphide



Formula = CaS

Q51. Write the atomicity of the following compounds:

1. $\text{Al}_2(\text{SO}_4)_3$
2. $\text{Mg}(\text{HCO}_3)_2$
3. ZnCO_3
4. HCL
5. H_2O
6. H_2SO_4

Ans.

1. $\text{Al}_2(\text{SO}_4)_3 = 17$

2. $\text{Mg}(\text{HCO}_3)_2 = 11$
3. $\text{ZnCO}_3 = 5$
4. $\text{HCl} = 2$
5. $\text{H}_2\text{O} = 3$
6. $\text{H}_2\text{SO}_4 = 7$

Q52. What is the difference between 2O , O_2 and O_3 .

Ans.

2O represents 2 atoms of oxygen, and it is not possible for it to exist independently.

O_2 represents an oxygen molecule which has two constituent oxygen atoms.

O_3 represents a single ozone molecule and it does exist independently.

Q53. (a) Explain how atoms exist.

(b) What do you understand by atomicity?

(c) Explain polyatomic ions.

Ans.

(a) Atoms of most elements don't exist independently they exist as molecules, for molecules are more stable. However, atoms of inert gases are chemically unreactive and they exist independently. E.g. helium.

(b) Atomicity is the number of atoms in a molecule. E.g. The atomicity of $\text{H}_2\text{O} = 3$.

(c) A polyatomic ion is an ion composed of multiple atoms acting as a single charged unit.

Q54. Find out

(1) the mass of a single oxygen atom

(2) the mass of a single oxygen molecule

(3) the mass of a mole of oxygen gas

(4) the mass of an oxygen ion

(5) the number of atoms in a mole of an oxygen molecule.

Ans.

(1) Mass of a single oxygen atom

1 mole of oxygen atom = $16\text{gm} = 6.022 \times 10^{23}$ atoms

Therefore, Mass of one oxygen atom = $16 / 6.022 \times 10^{23} = 2.65 \times 10^{-23}$ gm

(2) Mass of a single oxygen atom

1 molecule oxygen = $\text{O}_2 = 2 \times 16 = 32\text{u}$

(3) Mass of a mole of oxygen gas

1 mole of oxygen = $\text{O}_2 = 2 \times 16 = 32\text{u}$

(4) Mass of an oxygen ion = mass of an oxygen atom (since electrons have negligible mass)

(5) Number of atoms in a mole of oxygen molecule

We know, 1 mole of oxygen molecule, $\text{O}_2 = 6.022 \times 10^{23}$ molecules.

1 molecule of $\text{O}_2 = 2$ atoms

Therefore in a mole of O_2 , there are $= 6.022 \times 10^{23} \times 2$ atoms

$= 1.022 \times 10^{24}$ atoms.

Q55. Explain atomic mass and gram atomic mass. Why does mass have different expressions viz, 'u' and 'gm'?

Ans.

Atomic mass is the unit in which the mass of an atom is expressed, where one atomic mass unit is $1/12^{\text{th}}$ the mass of a carbon-12 atom.

Gram atomic mass is the atomic mass of an element expressed in grams.

The mass of an atom or a molecule is expressed in 'u', whereas, the molar mass is expressed in 'gm'.

Q56. Define a mole. Give the importance of the mole.

Ans.

One mole of atoms, molecules, or particles is that amount of the particle(atoms, molecules and ions) whose mass is equal to that particle's atomic or molecular mass in grams. 1 mole = 6.022×10^{23} particles of that substance.

Importance of a mole:-

Atoms and molecules are very small. So it gets bothersome weighing them in grams and trying to count them. Mole concept, however, allows us to count atoms and molecules by weighing macroscopic amounts of materials.

It gives us a universally accepted standard of mass.

It provides a standard for reaction stoichiometry.

Q57. A gold ring has 90% gold and 10% copper.

(a) How many atoms are there in a gram of gold

(b) What is the ratio of gold to copper in this jewelry?

Ans.

(a) 1 gram of gold contains $90/100 = 0.9$ grams of gold

Now, number of moles of gold = Mass of gold/Atomic mass of gold

= $0.9/197 = 0.0046$

Therefore, 0.0046 moles of gold will contain = $0.0046 \times 6.022 \times 10^{23}$

= 2.77×10^{21} atoms.

(b) Ratio of gold : copper = 9 : 1