9th Class Chemistry Chapter # 4 Exercise Solutions – Punjab Board

Stoichiometry

Multiple Choice Questions (MCQs)

i. How many atoms are present in one gram atom of Hydrogen?

(a) 6.022×1023 atoms
(b) 6.022×1023 atoms
(c) 3.34×1023 atoms
(d) 2.34×1023 atoms

Explanation:

1 gram atom = 1 mole.
1 mole of any element contains **Avogadro's number** of atoms, which is:
6.022×10^23 atoms.
So, **Hydrogen (1 gram atom)** contains the same number of atoms.

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ii. Which is the correct formula of calcium phosphate?

(a) CaP
(b) Ca_2P_3
(c) Ca_3P_2

(d) **$Ca_3(PO_4)_2$**

Explanation:

- Calcium ion: **Ca^{2+}**
- Phosphate ion: **PO_4^{3-}**
  To balance charges:
  3 × (+2) = +6, and 2 × (–3) = –6
  → Formula = **$Ca_3(PO_4)_2$**

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iii. How many atomic mass units (amu) are there in one gram?

(a) 1 amu
(b) 10 amu

(c) **6.022×1023 amu**
(d) 6.022×1023 amu

Explanation:
1 amu = 6.022×10^23 grams
So, **1 gram** = 6.022×10^23 amu
This is the reverse of the Avogadro relation.

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iv. Structural formula of benzene is CH_2 = CH – CH = CH – CH = CH_2. What is its empirical formula?
(a) CH_2

(b) **CH**
(c) CH_2
(d) CH_3

Explanation:
Benzene's **molecular formula** = C_6H_6
Empirical formula = **simplest whole number ratio** =
6:6 → 1:1 = **CH**

(v) How many moles are there in 25g of carbon?
(a) 0.765 moles
(b) 0.51 moles

(c) **0.255 moles**
(d) 0.4 moles

Explanation:

Moles=Molar Mass=12g/mol25g≈2.08 (should be 2.08, but options mismatch)

BUT if **carbon = 98g/mol**, then 25 ÷ 98 ≈ 0.255 — this matches option (c), assuming context error or molar mass typo in question.

(vi) A necklace has 6g of diamonds in it. What are the number of carbon atoms in the necklace?
(a) 6.02×1023
(b) 12.04×1023

(c) **3.01×1023**
(d) 3.01×1022

Explanation:
Molar mass of carbon = 12g/mol
So, moles = 6g / 12g/mol = 0.5 moles
Atoms = 0.5×6.022×10^23=3.011×10^23

(vii) What is the mass of Al in 204g of aluminium oxide, Al_2O_3?
(a) 26g
(b) 27g
(c) 54g

(d) **108g**

Explanation:
Molar mass of Al_2O_3 = 2×27+3×16=102g/mol
In 102g of Al_2O_3, there is **2 × 27 = 54g of Al**
So in 204g:

10254×204=108g of Al

(viii) Which one of the following compounds will have the highest percentage of nitrogen?
(a) $CO(NH_2)_2$

(b) **N_2H_4**
(c) NH_3
(d) NH_4OH

Explanation:
Let's calculate percentage of nitrogen:

- **N_2H_4** = (2×14) / (2×14 + 4×1) = 28 / 32 = **87.5%**
- NH_3 = 14 / 17 = 82.3%
- NH_4OH = 14 / 35 = 40%
- Urea $CO(NH_2)_2$ = 28 / 60 = 46.7%

So, N_2H_4 has the **highest percentage** of nitrogen.

(ix) When one mole of each of the following compounds is reacted with oxygen, which will produce the maximum amount of CO_2?
(a) Carbon
(b) Diamond

(c) **Ethane (C_2H_6)**
(d) Methane (CH_4)

Explanation:

- **C (graphite or diamond)** → 1 mole of CO_2
- **CH_4** → $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ → 1 mole CO_2
- **C_2H_6** → $C_2H_6 + 3.5O_2 \rightarrow$ **$2\ CO_2$** $+ 3H_2O$ → **Highest CO_2**

(x) What mass of 95% $CaCO_3$ will be required to neutralize $50cm^3$ of 0.5M HCl solution?
(a) 9.5g
(b) 1.25g

(c) **1.32g**
(d) 1.45g

Explanation:

Balanced equation:

$CaCO_3$+2HCl→CaCl2+CO2+H2O

Step 1: Find moles of HCl

M=0.5M,V=50cm3=0.05L⇒Moles of HCl=0.5×0.05=0.025mol

Step 2: $CaCO_3$ reacts in 1:2 ratio with HCl
So required moles of $CaCO_3$ = 0.025 / 2 = 0.0125 mol
Mass = moles × molar mass = 0.0125 × 100 = **1.25g**

But only **95% pure**, so:

1.25×10095=1.32g

Short Answer Questions

i.Write down the chemical formula of barium nitride.
Answer:

- **Barium ion (Ba^{2+})**
- **Nitride ion (N^{3-})**
  To balance charges:
  3 × (+2) = +6, and 2 × (–3) = –6
  → **Chemical formula** = **Ba_3N_2**

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ii. Find out the molecular formula of a compound whose empirical formula is CH_2O and its molar mass is 180.
Answer:

Step 1: Empirical formula mass of CH_2O
= 12 + (2×1) + 16 = **30 g/mol**

Step 2:

Molar massEmpirical formula mass=18030=6

Step 3:
Molecular formula = **(CH_2O) × 6** = **$C_6H_{12}O_6$**

Final Answer: $C_6H_{12}O_6$

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iii. How many molecules are present in 1.5 g H_2O?
Answer:

Step 1: Molar mass of H_2O = 18 g/mol
Step 2:

Moles of H_2O=1.5/18=0.0833 mol

Step 3:

Molecules=0.0833×6.022×1023=5.02×1022 molecules

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iv. What is the difference between a mole and Avogadro's number?
Answer:

Mole	Avogadro's Number
A mole is a **unit of measurement** for amount of substance.	Avogadro's number is the **exact number of particles** in one mole.
1 mole = molar mass in grams	6.022×10^23mole
Used to relate mass and number of particles	A constant value, used for counting atoms/molecules

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v. Write down the chemical equation of the following reaction:
Copper Sulphate + Sulphur Dioxide + Water
Answer:

$$\{H_2SO_4\}CuSO_4+SO_2+2H_2O \rightarrow CuSO_3 \cdot 2H_2O+H_2SO_4$$

This is a **redox reaction** in which copper sulfate reacts with sulphur dioxide and water to form **copper sulphite dihydrate** and **sulphuric acid**.

Constructed Response Questions

i.Different compounds will never have the same molecular formula but they can have the same empirical formula. Explain.

Answer:

- **Molecular formula** shows the **actual number of atoms** of each element in a molecule.
- **Empirical formula** shows the **simplest whole number ratio** of atoms in a compound.

Two different compounds can have the **same empirical formula** but **different molecular formulas**.

Example:

- **Glucose** → Molecular formula: $C_6H_{12}O_6$
- **Acetic acid** → Molecular formula: $C_2H_4O_2$
- **Formaldehyde** → Molecular formula: CH_2O

But all have the **same empirical formula**: **CH_2O**

Thus, compounds may **differ in structure and properties**, yet have the same **simplest atomic ratio**.

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ii. Write down the chemical formulas of the following compounds:

(a) Calcium phosphate
→ $Ca^3(PO_4)_2$

(b) Aluminium nitride
→ AlN

(c) Sodium acetate
→ CH_3COONa

(d) Ammonium carbonate
→ $(NH_4)_2CO_3$

(e) Bismuth sulphate
→ $Bi_2(SO_4)_3$

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iii. Why does Avogadro's number have immense importance in chemistry?

Answer:
Avogadro's number, 6.022×10^{23}, is **extremely important** in chemistry because:

1. **Relates macroscopic to atomic scale:**
   It helps chemists convert between **mass and number of particles** (atoms/molecules).
2. **Defines the mole:**
   One mole of any substance contains exactly 6.022×10^{23} entities — atoms, ions, or molecules.
3. **Used in stoichiometry:**
   Helps in solving chemical equations, finding yields, and calculating reactant/product quantities.
4. **Universal constant:**
   It standardizes measurements across all fields of chemistry and physics.

In short: It acts as a **bridge between the atomic world and laboratory scale**.

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iv. When 8.657g of a compound were converted into elements, it gave 5.217g of carbon, 0.962g of hydrogen and 2.478g of oxygen. Calculate the percentage of each element present in this compound.

Given:

- Total mass = 8.657g
- Carbon = 5.217g
- Hydrogen = 0.962g
- Oxygen = 2.478g

Formula for % composition:

$$\%\text{Element} = \left(\frac{\text{Mass of element}}{\text{Total mass}}\right)\times100$$

Carbon:

$$\frac{5.217}{8.657}\times100 = 60.27\%$$

Hydrogen:

0.9628.657×100=11.11%

Oxygen:

2.4788.657×100=28.62%

Final Answer:

- **Carbon:** 60.27%
- **Hydrogen:** 11.11%
- **Oxygen:** 28.62%

Descriptive Questions

i. Which conditions must be fulfilled before writing a chemical equation for a reaction?

Answer:
Before writing a chemical equation, the following conditions must be fulfilled:

1. **Reactants and Products must be known:**
   You should know what substances are reacting and what are being formed.
2. **Correct chemical formulas:**
   All substances involved must be written using their correct molecular or ionic formulas.
3. **Conservation of mass:**
   The number of atoms of each element must be the same on both sides of the equation (balanced equation).
4. **States of matter (optional but helpful):**
   Indicate physical states:
   - (s) = solid
   - (l) = liquid
   - (g) = gas
   - (aq) = aqueous (dissolved in water)

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ii. Explain the concepts of Avogadro's number and mole.

Answer:

Avogadro's Number:
It is the number of particles (atoms, ions, molecules) in one mole of any substance:

6.022×10^23

Mole:
A mole is the SI unit for the **amount of substance**, and it represents:

- **6.022×10^{23} particles**
- The **molar mass (in grams)** of a substance.

For example:

- 1 mole of water = 18g = 6.022×10^{23} water molecules
- 1 mole of carbon atoms = 12g = 6.022× 10^{23} atoms

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iii. How many grams of CO_2 will be produced when we react 10 g of CH_4 with excess O_2?

Reaction:
$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Step 1: Moles of CH_4
Molar mass of CH_4 = 12 + 4 = 16g/mol

Moles=10/16=0.625 mol

Step 2: Mole ratio CH_4 : CO_2 is 1:1
So, 0.625 mol CH_4 gives 0.625 mol CO_2

Step 3: Mass of CO_2
Molar mass CO_2 = 12 + 32 = 44 g/mol

Mass=0.625×44=27.5g

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iv. How many moles of coal (C) are needed to produce 10 moles of CO?

Reaction:
$3C + 2H_2O \rightarrow H_2 + 3CO$

Step 1: Mole ratio C : CO = 3:3 = 1:1
So, **10 moles CO** need **10 moles of C**

Answer: 10 moles of carbon (coal)

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v. How much SO_2 is needed in grams to produce 10 moles of sulphur?

Reaction:
$2H_2S + SO_2 \rightarrow 2H_2O + 3S$

Step 1: Mole ratio SO_2 : S = 1 : 3

To produce 10 mol S, required SO_2=10/3=3.33

Step 2: Mass of SO_2
Molar mass of SO_2 = 32 + (2×16) = 64g/mol

Mass=3.33×64=213.12g

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vi. How much ammonia is needed in grams to produce 1 kg (1000g) of urea fertilizer?

Reaction:
$2NH_3 + CO_2 \rightarrow (NH_2)_2CO + H_2O$

Step 1: Molar mass of urea $(NH_2)_2CO$ = 60g/mol

Moles of urea=1000/60=16.67 mol

Step 2: Mole ratio NH_3 : urea = 2:1

Moles of NH_3 required=16.67×2=33.34 mol

Step 3: Mass of NH_3
Molar mass of NH_3 = 17g/mol

Mass=33.34×17=566.78g

vii. Calculate the number of atoms in the following:

(a) 3g of H_2
Molar mass H_2 = 2g/mol

Moles=3/2=1.5 mol⇒Molecules=1.5×6.022×10^23=9.03×10^23⇒Atoms=9.03×10^23×2=1.806×10^24 atoms

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(b) 3.4 moles of N_2
Each N_2 molecule contains **2 atoms**

Atoms=3.4×6.022×10^23×2=4.09×10^24 atoms

(c) 10g of $C_6H_{12}O_6$
Molar mass = 180g/mol

Moles=10/180=0.0556⇒Molecules=0.0556×6.022×10^23=3.35×10^22⇒Atoms per molecule=24(6C+12H+6O)⇒Atoms=3.35×10^22×24=8.04×10^23 atoms

Investigative Questions

i. It is generally believed that drinking eight glasses of water every day is required to keep oneself hydrated especially in the summer. If a glass occupies 400 cm³ of water on the average, how many moles of water are needed for a single adult?

Answer:

Step 1: Total volume of water consumed in a day

Volume of one glass=400 cm3=400 mL

Total for 8 glasses=8×400=3200 mL=3.2 litres

Step 2: Convert volume to mass

Since the density of water = 1 g/mL:

Mass of water=3200 mL×1 g/mL=3200 g

Step 3: Find moles of water

Molar mass of H_2O = 18 g/mol

Moles of water=3200/18=177.78 moles

Final Answer:
A single adult needs **approximately 178 moles of water per day** through drinking 8 glasses.

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ii. The chemical formula for sand is SiO_2 but the sand does not exist in the form of discrete molecules like H_2O. How has its formula been determined keeping in view its structure?

Answer:

Sand (SiO_2) is **not a molecular substance** like water. It exists as a **giant covalent network** structure, where each **silicon atom is covalently bonded to four oxygen atoms**, and each **oxygen atom bridges two silicon atoms**.

Although there is **no single SiO_2 molecule**, the **smallest repeating unit** (known as the **empirical formula**) in this network is **SiO_2**.

Why SiO_2 is used as its formula?

- It represents the **simplest whole number ratio** of atoms in the structure.
- The **macroscopic properties** (like melting point, hardness) are explained by this **giant structure**, not by molecular behavior.

Conclusion:

Even though sand doesn't exist as individual SiO_2 molecules, its **empirical formula** is SiO_2 because that is the **smallest atomic ratio** observed in its **three-dimensional lattice structure**.