Stoichiometry

Topic: Introduction to Matter & Atomic Theory

Multiple Choice Questions (MCQs)

1. What was the central idea of ancient Greek philosophers regarding matter?
   (a) Matter is made of indivisible atoms.
   (b) Everything is composed of a single elemental substance.
   (c) Matter is composed of energy waves.
   (d) All matter is made of earth, fire, and water only.
   Answer: (b)
2. Who proposed the atomic theory that led to rapid progress in chemistry in the 19th century?
   (a) Democritus
   (b) J.J. Thomson
   (c) John Dalton
   (d) Ernest Rutherford
   Answer: (c)
3. The atomic theory proposed at the start of the 19th century was later modified because:
   (a) it was completely wrong.
   (b) It failed to explain the states of matter.
   (c) Further observations revealed the atom's complex internal structure.
   (d) It could not define what an element is.
   Answer: (c)
4. The main goal of this chapter, as stated in the introduction, is to:
   (a) teach you how to perform chemical experiments.
   (b) Acquaint you with the fundamental concepts about matter.

(c) Explain the complete history of atomic theory.

(d) Prepare you for university-level chemistry.

Answer: (b)

5. The knowledge gained from this chapter is specifically mentioned to help you in:

   (a) your final examinations.

   (b) Understanding physics.

   (c) Grade XI.

   (d) Daily life applications.

   Answer: (c)

Short Questions

1. **What was the belief of ancient Greek philosophers about the composition of matter?**

   Ancient Greek philosophers debated the fundamental composition of all matter. Some, like Thales, believed everything was made from a single elemental substance such as water. Others, like Anaximenes, proposed air as the primary element. A more popular view, later championed by Empedocles and Aristotle, was that there were four fundamental elements: earth, air, fire, and water.

2. **Describe the evolution of the atomic theory as mentioned in the introduction.**

   The introduction outlines a key evolution in atomic theory. At the beginning of the 19th century, John Dalton proposed an atomic theory that successfully explained many chemical phenomena and accelerated progress in chemistry. However, by the end of that century, new scientific observations and experiments revealed that the atom was not the ultimate, indivisible particle, but had a complex internal structure, leading to the modern atomic model in the 20th century.

3. **What is the stated purpose of learning the concepts in this chapter?**
   The primary purpose of this chapter, as stated, is to familiarize the student with the basic and foundational concepts related to matter. It aims to provide essential definitions and an understanding of the composition of substances, which will serve as a crucial building block for more advanced studies in chemistry, specifically in the following grade (Grade XI).

Topic: Empirical and Molecular Formulas

Multiple Choice Questions (MCQs)

1. A chemical formula that gives the simplest whole-number ratio of atoms in a compound is called:
   (a) Molecular Formula
   (b) Structural Formula
   (c) Empirical Formula
   (d) Displayed Formula
   Answer: (c)
2. What is the empirical formula of hydrogen peroxide, whose molecular formula is H_2O_2?
   (a) H_2O_2
   (b) HO
   (c) HO_2
   (d) H_4O_4
   Answer: (b)
3. The molecular formula of glucose is $C_6H_{12}O_6$What is its empirical formula?
   (a) $C_6H_{12}O_6$
   (b) $C_3H_6O_3$
   (c) CH_2O
   (d) $C_2H_4O_2$
   Answer: (c)

4. What is the molecular formula of benzene, which has an empirical formula of CH and contains 6 carbon and 6 hydrogen atoms per molecule?
   (a) CH
   (b) C_2H_2
   (c) C_3H_3
   (d) C_6H_6
   Answer: (d)
5. For which of the following compounds is the empirical formula different from its molecular formula?
   (a) Water (H2O)
   (b) Carbon Dioxide (CO2)
   (c) Glucose (C6H12O6)
   (d) Ammonia (NH3)
   Answer: (c)
6. The molecular formula provides information about:
   (a) the arrangement of atoms in space.
   (b) the simplest ratio of atoms.
   (c) the actual number of each type of atom in a molecule.
   (d) the type of bonds between atoms.
   Answer: (c)

Short Questions

1. **Differentiate between an empirical formula and a molecular formula with a suitable example.**
   The empirical formula shows the simplest whole-number ratio of atoms of each element in a compound. In contrast, the molecular formula shows the actual number of atoms of each element present in a single molecule of the compound. For example, for hydrogen peroxide, the empirical formula is HO (a 1:1 ratio), while the molecular formula is H2O2, showing the actual count of two hydrogen and two oxygen atoms.

2. **Identify the empirical and molecular formulas of benzene from the options $C_6H_6$and CH. Justify your answer.**
   For benzene, the empirical formula is CH, and the molecular formula is C_6H_6. This is because the empirical formula represents the simplest 1:1 ratio of carbon to hydrogen atoms. The molecular formula, C_6H_6 confirms this ratio while also showing that each molecule is actually composed of 6 carbon and 6 hydrogen atoms.

3. **What are the empirical formulas of water (H_2O) and carbon dioxide (CO_2)? Explain why.**
   The empirical formula for both water (H_2O) and carbon dioxide (CO_2) is the same as their molecular formulas. For water, the ratio of H:O is 2:1, which is already the simplest whole-number ratio. Similarly, for carbon dioxide, the ratio of C:O is 1:2, which is also the simplest ratio. Therefore, no further simplification is needed.

4. **Why are the empirical and molecular formulas the same for many compounds like ammonia (NH_3) and methane (CH_4)?**
   The empirical and molecular formulas are the same for compounds like ammonia (NH_3) and methane (CH_4) because the molecular formula itself already represents the simplest whole-number ratio of the atoms present. In NH_3, the N:H ratio is 1:3, and in CH_4, the C:H ratio is 1:4. These ratios cannot be simplified further into smaller whole numbers, making the molecular formula identical to the empirical formula.

Topic: Formulae of Common Elements and Compounds

Multiple Choice Questions (MCQs)

1. Which of the following elements exists as a diatomic molecule?
   (a) Helium
   (b) Neon
   (c) Fluorine
   (d) Argon
   Answer: (c)
2. What is the formula for the compound Copper (II) sulphate?
   (a) CuS
   (b) Cu2SO4
   (c) CuSO4
   (d) Cu2S
   Answer: (c)
3. From the table, which of these is a compound of carbon, hydrogen, and oxygen?
   (a) Hydrochloric acid
   (b) Sodium hydroxide
   (c) Glucose
   (d) Copper (II) sulphate
   Answer: (c)
4. The formula Br2 represents:
   (a) an atom of bromine.
   (b) a compound of bromine.
   (c) a molecule of the element bromine.
   (d) an ion of bromine.
   Answer: (c)
5. Which compound listed has a formula that indicates it is composed of three different elements?

(a) Water (H_2O)

(b) Sodium Hydroxide (NaOH)

(c) Hydrochloric acid (HCl)

(d) Carbon dioxide (CO_2)

Answer: (b)

Short Questions

1. **Using examples from the table, explain the difference between the formula of an element and the formula of a compound.**
   The formula of an element shows the composition of its molecules in their natural state. For example, hydrogen exists as H_2, a molecule of two hydrogen atoms. The formula of a compound shows the atoms of different elements chemically combined. For example, water is H_2O, a molecule containing two different elements, hydrogen and oxygen, in a fixed ratio.
2. **List three elements from the table that naturally exist as diatomic molecules.**
   According to the table provided, three elements that exist as diatomic molecules are:

1. Hydrogen (H_2)
2. Oxygen (O_2)
3. Nitrogen (N_2)
   (Other correct answers include Fluorine F_2, Chlorine Cl_2, and Bromine Br_2).

3. **Identify a compound from the table that contains a metal and write its formula.**
   One compound from the table that contains a metal is Sodium Hydroxide. Its formula is NaOH. The metal present in it is Sodium (Na). Another example is Copper (II) sulphate ($CuSO_4$), which contains the metal Copper (Cu).
4. **What does the formula $C_6H_{12}O_6$ tell you about a molecule of glucose?**
   The molecular formula $C_6H_{12}O_6$ for glucose provides specific information about its composition. It indicates that a single molecule of glucose is made

up of three different elements: carbon (C), hydrogen (H), and oxygen (O). Furthermore, it reveals the exact number of each atom: 6 carbon atoms, 12 hydrogen atoms, and 6 oxygen atoms.

Topic: Molecular Mass and Formula Mass

Multiple Choice Questions (MCQs)

1. **Molecular mass is defined as:**
   (a) The mass of one molecule in grams.
   (b) The sum of the atomic masses of all atoms in a molecule.
   (c) The mass of the heaviest atom in a molecule.
   (d) The mass of a substance in a mole.
   Answer: (b)
2. **What is the molecular mass of water (H_2O), given atomic masses: H=1.008, O=16.00?**
   (a) 17.008 amu
   (b) 18.000 amu
   (c) 18.016 amu
   (d) 16.00 amu
   Answer: (c)
3. **The term "Formula Mass" is used instead of "Molecular Mass" for which type of compounds?**
   (a) Covalent compounds
   (b) Molecular compounds
   (c) Ionic compounds
   (d) Gaseous elements
   Answer: (c)
4. **A "Formula Unit" refers to:**
   (a) A single molecule of an ionic compound.
   (b) The simplest ratio of cations to anions in an ionic compound.

(c) The mass of one atom of an element.

(d) The number of molecules in one mole.

Answer: (b)

5. **Why is the concept of a molecule less applicable to ionic compounds like common salt (NaCl)?**

   (a) Because they are too small.

   (b) Because they consist of arrays of ions rather than discrete molecules.

   (c) Because they do not have a fixed mass.

   (d) Because they are always gases.

   Answer: (b)

6. **What is the formula mass of NaCl, given Na=23 amu and Cl=35.5 amu?**

   (a) 58.5 amu

   (b) 36.5 amu

   (c) 48.0 amu

   (d) 59.0 amu

   Answer: (a)

Short Questions

1. **Define molecular mass. Calculate the molecular mass of nitric acid (HNO_3). (Atomic masses: H=1, N=14, O=16)**

   Molecular mass is the sum of the atomic masses of all the atoms present in a molecule of a substance. For nitric acid (HNO_3), the calculation is as follows: Mass of one H atom = 1 amu, mass of one N atom = 14 amu, and mass of three O atoms = $3 \times 16 = 48$ amu. Therefore, the molecular mass of HNO_3 is $1 + 14 + 48 = 63$ amu.

2. **Differentiate between molecular mass and formula mass, stating the type of compound each term is applied to.**

   Molecular mass is the sum of atomic masses in a single molecule and is used for covalent or molecular compounds, such as water (H_2O). Formula mass is the sum of atomic masses in a formula unit and is used for ionic compounds, which do not exist as discrete molecules but as large lattices of ions. For example, the formula mass of NaCl is used instead of a molecular mass.

3. **What is a formula unit? Explain with the example of common salt.**
   A formula unit is the simplest representative ratio of cations to anions in an ionic compound. It is the smallest, electrically neutral collection of ions that represents the substance. For common salt, the crystal lattice is made of numerous sodium (Na^+) and chloride (Cl^-) ions, but the simplest ratio is 1:1. Therefore, the formula unit is NaCl.
4. **Why is the term 'molecular mass' not appropriate for ionic compounds like sodium chloride?**
   The term 'molecular mass' is not appropriate for ionic compounds because they do not exist as separate, individual molecules. Instead, they form a continuous three-dimensional lattice or array of positively and negatively charged ions. Since there is no discrete molecule, we use the 'formula mass' based on the simplest repeating unit, the formula unit.

Topic: Chemical Formula and Name of Binary Ionic Compounds

Multiple Choice Questions (MCQs)

1. **A binary ionic compound is composed of:**
   (a) Two different metals.
   (b) Two different non-metals.
   (c) A metal cation and a non-metal anion.
   (d) Two polyatomic ions.
   Answer: (c)
2. **What is the correct name for the compound formed from Mg^{2+} and O^{2-} ions?**

(a) Magnesium oxygen

(b) Magnesium oxide

(c) Magnesium dioxide

(d) Monomagnesium dioxide

Answer: (b)

3. **What is the first step in writing the chemical formula of a binary ionic compound?**

(a) Balance the charges.

(b) Write the symbols for the cation and anion with their charges.

(c) Add the suffix '-ide' to the anion.

(d) Write the final formula without charges.

Answer: (b)

4. **The fundamental rule for determining the formula of an ionic compound is that:**

(a) The cation must always have a +1 charge.

(b) The total positive charge must equal the total negative charge.

(c) The compound must be soluble in water.

(d) The anion is always written first.

Answer: (b)

5. **What is the correct chemical formula for a compound containing Al^{3+} and S^{2-} ions?**

(a) AlS

(b) Al_2S_3

(c) Al_3S_2

(d) AlS_3

Answer: (b)

6. **The name "potassium chloride" indicates that the compound contains:**

(a) K^+ and Cl^{2-} ions.

(b) K^{2+} and Cl^- ions.

(c) K^+ and Cl^- ions.

(d) K and Cl atoms.

Answer: (c)

Short Questions

1. **Describe the rules for naming a binary ionic compound.**
   To name a binary ionic compound, the name of the metal cation (the first element) is written first, unchanged. This is followed by the name of the non-metal anion (the second element), but the ending of the non-metal's name is changed to the suffix '-ide'. For example, the compound formed from sodium and chlorine is called sodium chloride, and from magnesium and nitrogen is magnesium nitride.
2. **List the steps involved in writing the chemical formula of a binary ionic compound.**
   The steps are: First, write the symbol for the cation and then the anion, along with their respective charges. Second, balance these charges by finding the smallest whole numbers that make the total positive charge equal the total negative charge. Third, use these numbers as subscripts for the respective ions. Finally, write the final formula, omitting any subscript that is '1' and dropping the charges.
3. **Explain with an example why the formula of an ionic compound is its formula unit and not a molecule.**
   Ionic compounds form a crystal lattice where each ion is surrounded by ions of the opposite charge, making it impossible to identify a single, distinct molecule. The formula unit shows the simplest ratio of ions that results in a neutral compound. For example, in aluminium oxide, the Al^{3+} and O^{2-} ions combine in a 2:3 ratio to balance charge, giving the formula unit Al_2O_3, which represents the simplest neutral ratio in the entire crystal.
4. **Apply the rules to determine the chemical formula for a compound made from calcium ions (Ca^{2+}) and fluoride ions (F^-).**
   To write the formula for calcium fluoride: First, write the ions: Ca^{2+} and F^-.

The total positive charge is +2, and each F^- has a -1 charge. To balance the +2 charge, we need two fluoride ions (2 × -1 = -2). This gives a charge balance of +2 and -2. Therefore, the coefficients are 1 for Ca and 2 for F. The final formula is CaF_2.

5. **What is the significance of charge balance when writing the formula of an ionic compound?**
   Charge balance is fundamental because all stable ionic compounds are electrically neutral. The sum of the positive charges from the cations must exactly equal the sum of the negative charges from the anions. This principle ensures that the compound has no net electric charge, which is a requirement for its stability. It is the key rule used to determine the correct subscripts in the chemical formula.

Topic: Avogadro's Number and the Mole

Multiple Choice Questions (MCQs)

1. **A mole is a unit that measures:**
   (a) Mass
   (b) Volume
   (c) Amount of substance
   (d) Concentration
   Answer: (c)
2. **Avogadro's number, NA*NA*, is equal to:**
   (a) 6.022×10^{13}
   (b) 6.022×10^{23}
   (c) 6.022×10^{33}
   (d) 6.022×10^{43}
   Answer: (b)
3. **Which of the following analogies is used in the text to explain the concept of a mole?**

(a) A meter and a centimeter

(b) A kilogram and a gram

(c) A dozen eggs and a ream of paper

(d) A liter and a milliliter

Answer: (c)

4. **One mole of oxygen gas (O_2) contains:**

   (a) 6.022×10^{23}atoms

   (b) 6.022×10^{23} molecules

   (c) 16 grams of oxygen

   (d) 1 atom of oxygen

   Answer: (b)

5. **The value of Avogadro's number is:**

   (a) A theoretically calculated number.

   (b) The same for all substances.

   (c) Different for different elements.

   (d) An experimentally determined number.

   Answer: (d)

Short Questions

1. **What is a mole? Why do chemists use this unit for counting particles?**
   A mole is the standard SI unit for measuring the amount of a substance. It is defined as the amount of substance that contains
   exactly 6.022×10^{23} elementary entities (atoms, molecules, ions, etc.).
   Chemists use this unit because atoms and molecules are extremely small and numerous. Counting them individually is impossible, so the mole provides a practical way to work with measurable quantities of a substance on a macroscopic scale.
2. **Define Avogadro's number. What is its significance in chemistry?**
   Avogadro's number, denoted as NA is 6.022×10^{23}. This is the number of constituent particles (atoms, molecules, or ions) present in one mole of a

substance. Its significance is profound as it forms a bridge between the microscopic world of atoms and the macroscopic world we can measure. It allows chemists to relate the mass of a sample to the number of particles it contains.

3. **Draw an analogy between a dozen and a mole to explain the concept.**
   Just as a dozen is a counting unit that represents 12 items (e.g., a dozen eggs means 12 eggs), a mole is a counting unit that represents 6.022×10^{23} particles. For example, a dozen books and a dozen cars both represent 12 items, just as a mole of carbon atoms and a mole of water molecules both represent 6.022×10^{23} of their respective particles, even though their masses are different.

Topic: Gram Atomic Mass, Gram Molecular Mass, and Gram Formula Mass

Multiple Choice Questions (MCQs)

1. **The gram atomic mass of an element is the mass of:**
   (a) One atom of the element in grams.
   (b) 6.022×10^{23} atoms of the element.
   (c) The element's nucleus in grams.
   (d) The element's most common isotope.
   Answer: (b)
2. **If the atomic mass of oxygen is 16 amu, what is its gram atomic mass?**
   (a) 16 mg
   (b) 16 kg
   (c) 16 g
   (d) 32 g
   Answer: (c)

3. **The gram molecular mass of water (H_2O) is 18 g. This means:**
   (a) One molecule of water has a mass of 18 g.
   (b) 6.022×10^{23} water molecules have a mass of 18 g.
   (c) The mass of any sample of water is 18 g.
   (d) Water is composed of 18 atoms.
   Answer: (b)
4. **For an ionic compound like NaCl, the term used is:**
   (a) Gram Molecular Mass
   (b) Gram Atomic Mass
   (c) Gram Formula Mass
   (d) Gram Ionic Mass
   Answer: (c)
5. **What is the gram formula mass of KCl if its formula mass is 74.5 amu?**
   (a) 74.5 mg
   (b) 74.5 g
   (c) 39.0 g
   (d) 35.5 g
   Answer: (b)
6. **A sample with a mass equal to the gram molecular mass of a compound contains:**
   (a) Only one molecule.
   (b) 6.022×10^{23} formula units.
   (c) 6.022×10^{23} molecules.
   (d) The same number of particles as its atomic mass.
   Answer: (c)

Short Questions

1. **Define gram atomic mass, gram molecular mass, and gram formula mass.**
   Gram atomic mass is the atomic mass of an element expressed in grams, and

it contains one mole of atoms of that element. Gram molecular mass is the molecular mass of a substance expressed in grams, containing one mole of its molecules. Gram formula mass is the formula mass of an ionic compound expressed in grams, representing one mole of its formula units.

2. **Why does one mole of carbon atoms (12 g) and one mole of sulfur atoms (32 g) have different masses?**
   One mole of any element always contains the same number of atoms, 6.022×10^{23}. However, the mass of one mole depends on the mass of the individual atoms. A carbon atom has an atomic mass of 12 amu, so one mole weighs 12 g. A sulfur atom is heavier, with an atomic mass of 32 amu, so one mole weighs 32 g. The same number of heavier atoms results in a larger total mass.
3. **What is the relationship between the atomic mass of an element (in amu) and the mass of one mole of that element (in grams)?**
   The numerical value of the atomic mass of an element (in atomic mass units, amu) is exactly equal to the mass of one mole of that element (in grams). For example, carbon has an atomic mass of 12 amu, so its gram atomic mass is 12 g. This relationship is fundamental, as it allows us to use the periodic table to find the mass of one mole of any element directly.
4. **Differentiate between gram molecular mass and gram formula mass, stating the type of substance each applies to.**
   Gram molecular mass applies to covalent compounds (and elements that exist as molecules) and represents the mass of one mole of molecules of that substance, e.g., 18 g for H_2O. Gram formula mass applies to ionic compounds, which do not form discrete molecules, and represents the mass of one mole of the compound's formula units (the simplest ratio of ions), e.g., 58.5 g for NaCl.
5. **Calculate the gram molecular mass of glucose ($C_6H_{12}O_6$). (Atomic masses: C=12, H=1, O=16)**
   To find the gram molecular mass of glucose, first calculate its molecular

mass. It is (6 × 12) + (12 × 1) + (6 × 16) = 72 + 12 + 96 = 180 amu. Therefore, the gram molecular mass, which is this value expressed in grams, is 180 grams. This means that one mole of glucose molecules has a mass of

Topic: Molar Mass and Mole-Mass Calculations

Multiple Choice Questions (MCQs)

1. **The term that encompasses gram atomic mass, gram molecular mass, and gram formula mass is:**
   (a) Atomic Mass
   (b) Avogadro's Number
   (c) Molar Mass
   (d) Formula Unit
   Answer: (c)
2. **What is the molar mass of Nitrogen gas (N_2)?**
   (a) 14 g
   (b) 28 g
   (c) 7 g
   (d) 6.02 x 10^{23} g
   Answer: (b)
3. **If you have 2 moles of sodium (Na), what is its mass? (Atomic mass of Na = 23)**
   (a) 11.5 g
   (b) 23 g
   (c) 46 g
   (d) 6.02 x 10^{23} g
   Answer: (c)
4. **The mass of 0.25 moles of CO_2 is: (Molar mass of CO_2 = 44 g/mol)**
   (a) 11 g
   (b) 44 g

(c) 176 g

(d) 0.25 g

Answer: (a)

5. **What is the molar mass of sucrose ($C_{12}H_{22}O_{11}$)? (C=12, H=1, O=16)**

   (a) 180 g/mol

   (b) 342 g/mol

   (c) 210 g/mol

   (d) 150 g/mol

   Answer: (b)

6. **The key strategy for solving a mole-to-mass conversion problem is to:**

   (a) Divide the given mass by Avogadro's number.

   (b) Use the molar mass as a conversion factor.

   (c) Multiply the moles by Avogadro's number.

   (d) Balance the chemical equation first.

   Answer: (b)

Short Questions

1. **Define Molar Mass. How is it related to the gram atomic, molecular, and formula mass?**

   Molar mass is defined as the mass of one mole of a substance expressed in grams. It is an umbrella term that encompasses gram atomic mass (for elements), gram molecular mass (for covalent compounds), and gram formula mass (for ionic compounds). In essence, all three are specific types of molar mass, representing the mass of one mole of atoms, molecules, or formula units, respectively.

2. **Calculate the molar mass of ozone (O_3). How many grams are in 9.05 moles of ozone?**

   The molar mass of ozone (O_3) is calculated as 3 atoms × 16 g/mol = 48 g/mol. This means one mole of O_3 has a mass of 48 grams. To find the mass of 9.05 moles, we multiply: Mass = number of moles × molar mass = 9.05

mol × 48 g/mol = 434.4 grams. Therefore, 9.05 moles of ozone have a mass of 434.4 g.

3. **Differentiate between gram formula mass and gram molecular mass, providing one example of each.**
   Gram molecular mass is the mass of one mole of molecules of a covalent compound. For example, the gram molecular mass of water (H_2O) is 18 g. Gram formula mass is the mass of one mole of formula units of an ionic compound. For example, the gram formula mass of sodium chloride (NaCl) is 58.5 g. The key difference lies in the particle being counted: molecules for covalent substances versus formula units for ionic substances.
4. **What mass of carbon dioxide (CO_2) is produced when 0.25 moles of it is formed? (C=12, O=16)**
   First, calculate the molar mass of CO_2: 12 + (16 × 2) = 44 g/mol. The relationship is that 1 mole of CO_2 has a mass of 44 g. Therefore, the mass of 0.25 moles is calculated as: 0.25 mol × 44 g/mol = 11 g. So, 0.25 moles of CO_2 have a mass of 11 grams.

Topic: Chemical Equations and Balancing

Multiple Choice Questions (MCQs)

1. **A chemical equation is defined as:**
   (a) A list of all known elements.
   (b) The symbolic representation of a chemical reaction.
   (c) A method for calculating molar mass.
   (d) The physical state of a substance.
   Answer: (b)
2. **In a chemical equation, the substances written on the left side of the arrow are:**

(a) Products

(b) Catalysts

(c) Reactants

(d) Precipitates

Answer: (c)

3. **What does the symbol (aq) represent in a chemical equation?**

   (a) A solid substance

   (b) A liquid substance

   (c) A gaseous substance

   (d) A substance dissolved in water

   Answer: (d)

4. **What is the first step in writing a chemical equation?**

   (a) Balance the atoms on both sides.

   (b) Identify reactants and products and write a word equation.

   (c) Write the physical states of all substances.

   (d) Add coefficients to the products.

   Answer: (b)

5. **Which of the following is the correct word equation for the burning of magnesium?**

   (a) Magnesium oxide → Magnesium + Oxygen

   (b) Magnesium + Oxygen → Magnesium oxide

   (c) Magnesium + Oxide → Magnesium Oxygen

   (d) Magnesium + Water → Magnesium oxide

   Answer: (b)

Short Questions

1. **What is a chemical equation? Identify the reactants and products in the burning of coal ($C + O_2 \rightarrow CO_2$).**

   A chemical equation is a symbolic representation of a chemical reaction. It shows the substances that react and the substances that are formed. In the reaction for the burning of coal, $C + O_2 \rightarrow CO_2$, the reactants are carbon (C) and oxygen (O_2), which are the starting materials. The product is carbon dioxide (CO_2), which is the substance formed as a result of the reaction.

2. **List the steps involved in writing a chemical equation.**
   The steps for writing a chemical equation are: First, identify the reactants and products and write a word equation. Second, replace the names of the reactants and products with their correct chemical formulas. Third, indicate the physical states of each substance using the symbols (s) for solid, (l) for liquid, (g) for gas, and (aq) for aqueous solution. The final, crucial step, which is implied, is to balance the equation so that the number of atoms of each element is equal on both sides.
3. **Write a balanced chemical equation for the burning of hydrogen to produce water. Include physical states.**
   The word equation for the reaction is: Hydrogen + Oxygen → Water. Writing the chemical formulas gives: $H_2 + O_2 \rightarrow H_2O$. This equation is unbalanced. To balance it, we place a 2 in front of H_2O and a 2 in front of H_2: $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$. This shows that two molecules of hydrogen gas react with one molecule of oxygen gas to form two molecules of liquid water.
4. **Write a balanced chemical equation for the burning of magnesium to produce magnesium oxide.**
   The word equation is: Magnesium + Oxygen → Magnesium Oxide. Replacing with formulas gives: $Mg + O_2 \rightarrow MgO$. Balancing the oxygen atoms requires a 2 in front of MgO, which then unbalances the magnesium. Placing a 2 in front of Mg on the reactant side gives the balanced equation: $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$.

Topic: Balancing Chemical Equations

Multiple Choice Questions (MCQs)

1. **A balanced chemical equation obeys the law of:**
   (a) Multiple Proportions
   (b) Conservation of Mass
   (c) Definite Proportions
   (d) Conservation of Energy
   Answer: (b)
2. **In a balanced chemical equation:**
   (a) The number of molecules of all substances are equal.
   (b) The number of atoms of each element is the same on both sides.
   (c) The mass of products is greater than the mass of reactants.
   (d) The subscripts in the formulas are changed to balance the atoms.
   Answer: (b)
3. **What is the first step recommended for balancing the equation $CH_4 + O_2 \rightarrow CO_2 + H_2O$?**
   (a) Balance the oxygen atoms first.
   (b) Put a '2' in front of CH_4.
   (c) Balance the carbon atoms.
   (d) Put a '2' in front of H_2O to balance hydrogen atoms.
   Answer: (d)
4. **When balancing an equation, you should:**
   (a) Change the subscripts in the chemical formulas.
   (b) Write coefficients in front of the formulas.
   (c) Ignore the physical states of the substances.
   (d) Always start with the element with the highest number of atoms.
   Answer: (b)
5. **The balanced equation for $CH_4 + O_2 \rightarrow CO_2 + H_2O$ is:**
   (a) $CH_4 + O_2 \rightarrow CO_2 + 2H_2O$

(b) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

(c) $2CH_4 + O_2 \rightarrow 2CO_2 + H_2O$

(d) $CH_4 + 3O_2 \rightarrow CO_2 + 2H_2O$

Answer: (b)

Short Questions

1. **What is a balanced chemical equation? State the fundamental principle it is based upon.**
   A balanced chemical equation is one where the number of atoms for each element is identical on both the reactant and product sides. This is based on the Law of Conservation of Mass, which states that matter cannot be created or destroyed in a chemical reaction. The rearrangement of atoms during a reaction only changes their bonding partners, not their number or type.
2. **List the steps involved in balancing the chemical equation $CH_4 + O_2 \rightarrow CO_2 + H_2O$.**
   First, check and note that carbon is already balanced. Second, balance hydrogen by placing a coefficient '2' before H_2O, giving 4 H atoms on each side. Third, balance oxygen atoms; the products now have 4 O atoms (2 from CO_2 and 2 from $2H_2O$), so a coefficient '2' is placed before O_2 on the reactant side. Finally, verify that all atoms are balanced: C=1, H=4, O=4 on both sides.
3. **Why is it incorrect to change the subscripts in a chemical formula when balancing an equation?**
   Changing the subscript in a chemical formula alters the fundamental identity of the compound. For example, changing H_2O to H_2O_2 would change water into hydrogen peroxide, a completely different substance with different properties. Balancing is done by adjusting the number of molecules, not by changing what the molecules are, which is achieved by writing coefficients in front of the formulas.

Topic: Ionic Equations

Multiple Choice Questions (MCQs)

1. **An ionic equation is a chemical equation in which:**
   (a) Only solids are written.
   (b) All substances are written as molecules.
   (c) Substances dissolved in water are written as individual ions.
   (d) Only gases are shown.
   Answer: (c)
2. **In the reaction $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$, the spectator ions are:**
   (a) H^+ and OH^-
   (b) Na^+ and Cl^-
   (c) H^+ and Cl^-
   (d) Na^+ and OH^-
   Answer: (b)
3. **The net ionic equation for the reaction between HCl and NaOH is:**
   (a) $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$
   (b) $H^+(aq) + Cl^-(aq) + Na^+(aq) + OH^-(aq) \rightarrow Na^+(aq) + Cl^-(aq) + H_2O(l)$
   (c) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
   (d) $Na^+(aq) + Cl^-(aq) \rightarrow NaCl(aq)$
   Answer: (c)
4. **Spectator ions are defined as ions that:**
   (a) Are formed during the reaction.
   (b) Appear only on the product side.
   (c) Do not participate in the actual chemical change.
   (d) Are always anions.
   Answer: (c)

Short Questions

1. **What is an ionic equation? How is it different from a molecular equation?**
   An ionic equation is a chemical equation where soluble ionic compounds dissolved in water are written as dissociated ions. A molecular equation, in contrast, writes all compounds as neutral molecules, even if they are ionic and dissolved. The ionic equation provides a clearer picture of the actual chemical species involved in the reaction.
2. **Explain the terms 'spectator ions' and 'net ionic equation' with a suitable example.**
   Spectator ions are ions that are present in the reaction mixture but do not undergo any chemical change. They appear unchanged on both sides of the ionic equation. The net ionic equation is formed by canceling out these spectator ions, showing only the species that are directly involved in the reaction. For example, in $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$, the net ionic equation is $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$, where Na^+ and Cl^- are the spectator ions.

Topic: Molecular and Structural Formula

Multiple Choice Questions (MCQs)

1. **A structural formula shows:**
   (a) Only the types of atoms in a molecule.
   (b) The arrangement of atoms and bonds in a molecule.
   (c) The total mass of the molecule.
   (d) The number of atoms of each element.
   Answer: (b)

2. **The molecular formula for the structural formula CH_3-CH_2-OH is:**
   (a) C_2H_5O
   (b) C_2H_6O
   (c) CH_3O
   (d) C_2H_5OH
   Answer: (b)
3. **What is the molecular formula of the compound with the structure CH_3-CO-CH_3?**
   (a) C_3H_6O
   (b) C_2H_6O
   (c) C_3H_8O
   (d) CH_3O
   Answer: (a)
4. **To derive a molecular formula from a structural formula, you must:**
   (a) Identify the elements and count the atoms of each.
   (b) Draw the arrangement of atoms.
   (c) Determine the bond lengths.
   (d) Calculate the molar mass.
   Answer: (a)
5. **The structural formula CH_3-CH_2-NH_2 has the molecular formula:**
   (a) C_2H_7N
   (b) C_2H_5N
   (c) CH_3N
   (d) C_2H_8N
   Answer: (a)

Short Questions

1. **Differentiate between a molecular formula and a structural formula.**
   A molecular formula indicates the exact number of each type of atom present in a single molecule of a compound (e.g., C_4H_{10} for butane). A structural

formula shows how these atoms are arranged and bonded to each other (e.g., CH_3-CH_2-CH_2-CH_3 for n-butane). The structural formula provides information about the connectivity and geometry that the molecular formula does not.

2. **Describe the steps to write the molecular formula from a given structural formula.**
   To write a molecular formula from a structural formula, first, identify all the different elements present. Second, list their symbols. Third, carefully count the total number of atoms of each element from the structural diagram, ensuring you account for all atoms in every group (like CH_3, OH, etc.). Finally, write these numbers as subscripts next to the corresponding elemental symbols.
3. **Write the molecular formulas for the following compounds:**
   1. CH_3-CH_2-OH: Count the atoms: Carbon (C) = 2, Hydrogen (H) = 6 (3 from CH_3 and 2 from CH_2 and 1 from OH), Oxygen (O) = 1. So, the molecular formula is **C_2H_6O**.
   2. CH_3-CH_2-NH_2: Count the atoms: Carbon (C) = 2, Hydrogen (H) = 7 (3 from CH_3, 2 from CH_2, and 2 from NH_2), Nitrogen (N) = 1. So, the molecular formula is **C_2H_7N**.
   3. CH_3-CO-CH_3: Count the atoms: Carbon (C) = 3 (1 from each CH_3 and 1 from CO), Hydrogen (H) = 6 (3 from each CH_3 group), Oxygen (O) = 1. So, the molecular formula is **C_3H_6O**.