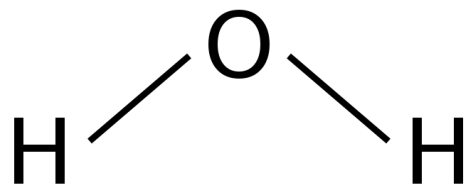
Unit 2: Atoms, Molecules, and Ions

Chemical Formulas and Nomenclature

Chemical formulas are the universal language of chemistry, encapsulating the composition of substances. The molecular formula provides the exact count of atoms in a molecule, revealing its unique identity. In contrast, the empirical formula conveys the simplest whole-number ratio of elements within a compound. Nomenclature, or naming conventions, simplifies communication by assigning precise names to compounds. Prefixes further enhance clarity, denoting the number of atoms in molecular compounds, guiding scientists and students alike in deciphering the intricate world of chemistry.

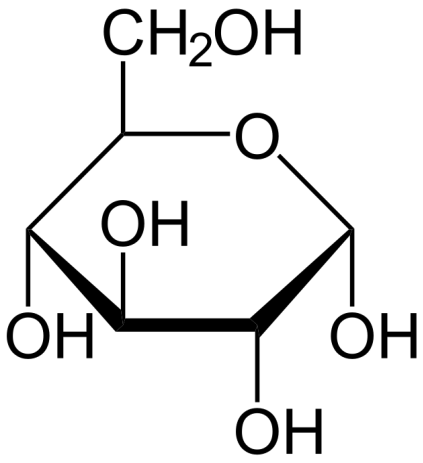


Cite: https://www.chem.fsu.edu/chemlab/chm1045/chem_formulas.html

Above is a lewis diagram, another way to visualize compounds.

1. Explain why chemical formulas are important in chemistry and provide an example of a chemical formula for a common substance.

2. Think about the molecular formula for (C_2H_6)
    a. What does a molecular formula specify about a compound?
    b. What is the empirical formula and how does it relate to the molecular formula for ethane?



Cite: https://en.wikipedia.org/wiki/Glucose

3. Above pictured is glucose. Explain how you would determine the empirical formula of a compound if given its molecular formula, using glucose ($C_6H_{12}O_6$) as an example.

Naming chemical compounds involves using prefixes and suffixes to convey their composition accurately. For molecular compounds, which are formed between nonmetals, start by identifying the elements present. Use prefixes to denote the number of each type of atom. For example, "mono-" represents one, "di-" represents two, and "tri-" represents three. Then, write the element names, with the second element's name modified to end in "ide."

To name ionic compounds, identify the metal cation and nonmetal anion. Begin with the metal's name, specifying its charge with Roman numerals if necessary. Then, write the nonmetal's name, modifying it to end in "-ide."

4. Name the following compounds using the correct suffixes and prefixes:
    a. N_2O_5
    b. CO_2
    c. H_2SO_4
    d. NaCl
    e. MgO

5. Provide an example of a chemical compound and explain how its name is determined using chemical nomenclature.

6. Write the molecular formula for the chemical dinitrogen pentoxide.

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ANSWER KEY

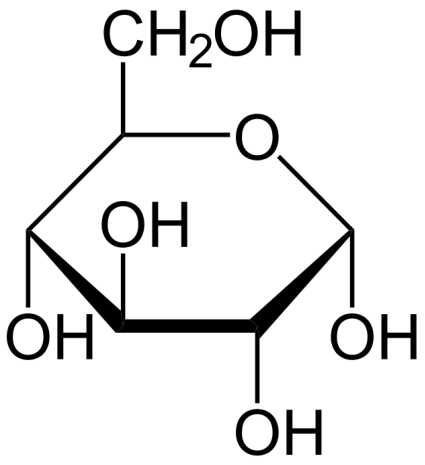
1. Explain why chemical formulas are important in chemistry and provide an example of a chemical formula for a common substance.

Chemical formulas are crucial in chemistry because they represent the type and number of atoms in a compound, aiding in its identification and understanding. For instance, the chemical formula for water is H_2O, signifying two hydrogen (H) atoms and one oxygen (O) atom per molecule.

2. Think about the molecular formula for (C_2H_6)
   a. What does a molecular formula specify about a compound?
   b. What is the empirical formula and how does it relate to the molecular formula for ethane?

a. The molecular formula for ethane is C_2H_6. A molecular formula specifies the number and types of atoms present in a molecule. In the case of C_2H_6, it indicates that the molecule is composed of two carbon atoms and six hydrogen atoms.

b. The empirical formula of a compound represents the simplest whole number ratio of the elements in the compound. For ethane (C_2H_6), the empirical formula is CH_3. This is because the ratio of carbon to hydrogen atoms is 1:3, and the formula is simplified to the smallest whole numbers.



Cite: https://en.wikipedia.org/wiki/Glucose

3. Above pictured is glucose. Explain how you would determine the empirical formula of a compound if given its molecular formula, using glucose ($C_6H_{12}O_6$) as an example.

To determine the empirical formula from the molecular formula, divide the subscripts by their greatest common factor. For glucose ($C_6H_{12}O_6$), the simplest whole-number ratio is **CH_2O**, as each subscript is divisible by 6.
$C_6 / 6 = C$, $H_{12} / 6 = H_2$, $O_6 / 6 = O$, CH_2O.

Naming chemical compounds involves using prefixes and suffixes to convey their composition accurately. For molecular compounds, which are formed between nonmetals, start by identifying the elements present. Use prefixes to denote the number of each type of atom. For example, "mono-" represents one, "di-" represents two, and "tri-" represents three. Then, write the element names, with the second element's name modified to end in "ide."

To name ionic compounds, identify the metal cation and nonmetal anion. Begin with the metal's name, specifying its charge with Roman numerals if necessary. Then, write the nonmetal's name, modifying it to end in "-ide."

4. Name the following compounds using the correct suffixes and prefixes:
    a. N_2O_5
    b. CO_2
    c. H_2SO_4
    d. NaCl
    e. MgO

a) Dinitrogen pentoxide
b) Carbon dioxide
c) Sulfuric acid
d) For NaCl (Ionic)
    i) The cation is Na^+ (sodium).
    ii) The anion is Cl^- (chloride).
    iii) Combine the names to get **sodium chloride**
e) For MgO (Ionic)
    i) The cation is Mg^{2+} (magnesium).
    ii) The anion is O^{2-} (oxide).
    iii) Combine the names to get "magnesium oxide."

5. Provide an example of a chemical compound and explain how its name is determined using chemical nomenclature.

Sodium chloride (NaCl) is an example. Its name is determined by combining the names of the constituent elements, sodium (Na) and chlorine (Cl), with appropriate prefixes or suffixes based on their charges, resulting in sodium chloride.

6. Write the molecular formula for the chemical dinitrogen pentoxide.

The molecular formula for dinitrogen pentoxide is N_2O_5. This chemical formula provides information about the composition of the molecule by specifying the number and types of atoms present. In the case of dinitrogen pentoxide, the molecular formula N_2O_5 indicates that the molecule is composed of two nitrogen atoms and five oxygen atoms.