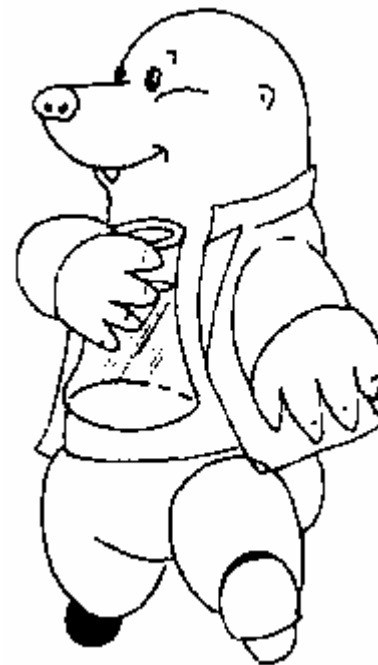


The Mole



A Chemist's Best Friend

A Chemist's Best Friend?

- A **mole** (also known as Avogadro's Number) is the number that is used in making calculations involving atoms and molecules.
- Given the relatively microscopic size of atoms and molecules, it would be rather difficult (read: utterly pointless) to calculate amounts in terms of numbers of atoms.

So, we use the mole.



- A mole, (mol for short) is equal to

$$6.022 \times 10^{23}$$

atoms or molecules or ions or electrons, or anything.

Atomic mass

- The **atomic mass** given for an element on the periodic table measured out in grams is equal to one mole of atoms of that element.
- Example: carbon, at. Mass = 12.011 therefore the mass of one mole of carbon would be 12.011 grams.

Molar Mass

- Thus, the **Molar Mass (MM)** of elements and compounds is the mass, in grams, equal to the atomic and formula masses of those elements and compounds.
- The unit of Molar Mass is **grams/mole**
- Practice in Calculating Molar Masses

Empirical and Molecular Formulas

- Believe it or not, there is more than one kind of chemical formula
- Judging from the heading of this section, they would be **empirical** and **molecular** formulas.

Empirical and Molecular Formulas

- **Empirical formulas** give the *lowest whole number ratio* of the atoms in a compound
- **Molecular formulas** give the *exact composition* of one molecule of a compound.

Empirical and Molecular Formulas

- Examples



- HO

- CH

- CH

- NO

- NO₂

H₂O₂

C₂H₂

C₆H₆

NO

N₂O₄

Calculating Empirical Formulas

- Empirical formulas can be calculated using experimental data:
- Given that a certain compound is
 - 69.58% Ba,
 - 6.090% C
 - 24.32% O,
- calculate the empirical formula of this compound.

Calculating Empirical Formulas

- Assume that you have 100.00 g of the compound:
- Therefore:
 - $69.58\% \text{ Ba} = 69.58 \text{ g Ba}$
 - $6.090\% \text{ C} = 6.090 \text{ g C}$
 - $24.32\% \text{ O} = 24.32 \text{ g O}$

Calculating Empirical Formulas

- Convert the mass of each element to moles of that element:

$$\text{Ba} = (69.58 \text{ g Ba})(1 \text{ mol Ba}/137.3 \text{ g Ba}) = 0.5068 \text{ mol Ba}$$

$$\text{C} = (6.090 \text{ g C})(1 \text{ mol C}/12.01 \text{ g C}) = 0.5071 \text{ mol C}$$

$$\text{O} = (24.32 \text{ g O})(1 \text{ mol O}/16.00 \text{ g O}) = 1.520 \text{ mol O}$$

Calculating Empirical Formulas

- Divide through each value by the smallest number of moles to get a
- 1 : 1.001 : 2.999 ratio, which rounds of nicely to give the formula BaCO_3

Calculating Molecular Formulas

- **Molecular formulas can be calculated using empirical formulas**
- Given that the empirical formula of a compound is CH and the molar mass is 104 g/mol , calculate the molecular formula.

Calculating Molecular Formulas

- The mass of C = 12.0 g/mol
- The mass of H = 1.01 g/mol
- Therefore, the empirical formula mass = 13.0 g/mol

Calculating Molecular Formulas

- Find the number of CH units in the compound
 - # CH units = $(104 \text{ g/mol})(1 \text{ mol}/13.0 \text{ g}) = 8.00 \text{ units}$
- Molecular formula = $8(\text{CH})$ or C_8H_8