**4.4 Formulas of Compounds**

**Percentage Composition**

The values of molar masses of elements in compounds can be used to find the percentage composition of the compound once its formula is known.

**Worked Example 4.4a**

**A company is producing aluminium from alumina (Al2O3) and they want to know the mass of aluminium that can be extracted from a given quantity of alumina.**

**Calculate the percentage of aluminium in alumina.**

In general for a selected element in a compound:

$$\% by mass of the element= \frac{mass of element in 1 mole of compound}{mass of 1 mole of compound} ×100\%$$

**Empirical Formulas**

The empirical formula of a compound is the formula that gives the simplest whole number ratio, by number of moles, of each element in the compound.

To determine the empirical formula, an experimentally determined ratio by mass must be converted to a ratio by numbers of atoms.

**Worked Example 4.4b**

**A compound of carbon and oxygen is found to contain 27.3% carbon and 72.7% oxygen by mass. Calculate the empirical formula of the compound.**

|  |  |  |
| --- | --- | --- |
|  | Carbon | Oxygen |
| Step 1. Mass (m) in grams  |  |  |
| Step 2. Amount in moles (n) |  |  |
| Step 3. Divide all amounts by the smallest number from Step 2 |  |  |
| Step 4. Obtain the simplest whole number mole ratio. |  |  |

**The empirical formula of this compound is:**

**Worked example 4.4c**

**9.0 g of a compound of only carbon, hydrogen and oxygen is found to contain 4.8 g of oxygen and 3.6 g of carbon. Calculate the empirical formula of the compound.**

**Worked example 4.4d**

**A sample of a compound of aluminium and oxygen has a mass of 2.36 g. It contains 1.25 g of aluminium. What is the empirical formula of this compound?**

**Molecular Formulas**

A molecular formula gives the actual number of atoms in one molecule of a compound and not the simplest whole number ratio as with empirical formulas. Note that the empirical and molecular formula can be the same.

|  |  |  |
| --- | --- | --- |
| Compound | Empirical formula | Molecular formula |
| Methane | CH4 | CH4 |
| Hydrogen peroxide | HO | H2O2 |
| Ethane | CH3 | C2H6 |

The molecular formula is always a whole number multiple of the empirical formula. A molecular formula can be obtained from the empirical formula if the molar mass of a compound is known.

**Worked example 4.4e**

**A compound has the empirical formula CH. The molar mass of this compound is 78 g mol-1. What is the molecular formula of the compound?**

**Worked example 4.4f**

**A sample of a hydrocarbon was found to contain 7.2 g of carbon and 1.5 g of hydrogen. The molar mass of this compound was determined to be 58 g mol-1. What is the molecular formula of the compound?**

**Key Terms**

Amount of substance mass spectrum relative atomic mass

Avogadro’s constant molar mass relative formula mass

Empirical formula mole relative isotopic mass

Isotopes molecular formula relative molecular mass

Mass spectrometer percentage by mass of an element

**Text Questions: 14 – 18**

**Worksheet: 10**

**Chapter Review: 19 – 44, 51**

**Area of Study Review: Multiple Choice: 1 – 17**

 **Short-answer: 18 - 24, 27, 30, 32 – 34.**