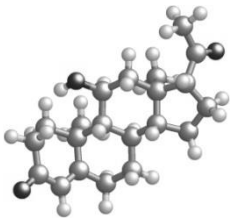

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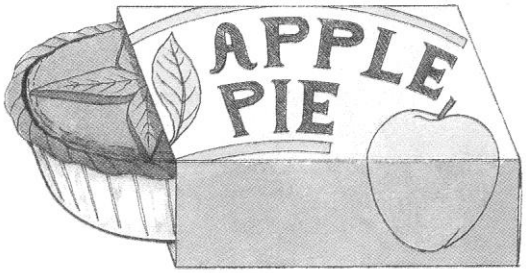
Class: ……

Date: …… **/** …… **/** ……

Elementary Pie – Percentage Composition



Think about an apple pie or a cake that you buy from the supermarket. There is usually a table of information on the packet. This tells you how much carbohydrate, fat and protein there is in each 100 g of the pie.

Apple Pie Nutritional Information Average Values per 100 g	
Protein	3 g
Carbohydrate	54 g
Fat	11 g

- The components of the apple pie given on the label only add up to 3 + 54 + 11 = 68 g. What chemical makes up the missing 32 g that is not included on the label?

……

……

- Why is it useful to know the percentage composition of a food product?

……..

In a similar way, it is possible to state the percentage composition of a chemical compound.

- Why might it be useful to know the percentage composition of a chemical compound?

……..

The percentage composition of a chemical compound could be measured experimentally or calculated from its formula and the relative atomic masses of the elements in it.

- For example, consider the compound sodium oxide (formula, Na_2O):

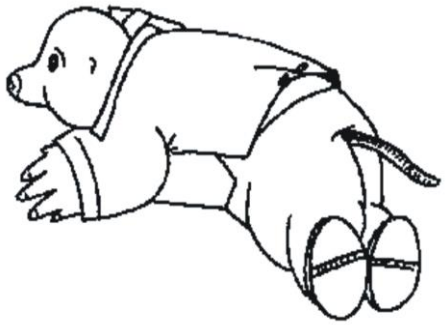
The mass of 1 mole of sodium oxide = 23.0 + 23.0 + 16.0 = 62.0 g

Of this, 23.0 + 23.0 = 46.0 g is sodium and 16.0 g is oxygen.

The percentage composition of sodium oxide, by mass, is therefore:

Sodium: (46.0 ÷ 62.0) × 100 = **74.2%**

Oxygen: (16.0 ÷ 62.0) × 100 = **25.8%**



To summarise:

$$\text{Percentage (by mass) of an element in a compound} = \frac{\text{mass of element in 1 mole of the compound}}{\text{mass of 1 mole of the compound}} \times 100$$

Question 1.

Calculate the percentage composition, by mass, of calcium nitrate (formula, $Ca(NO_3)_2$):

Question 2.

Which of the following fertilisers contains the largest percentage, by mass, of nitrogen?

ammonium nitrate – NH_4NO_3 potassium nitrate – KNO_3 ammonium sulphate – $(NH_4)_2SO_4$

Question 3.

Calculate the percentage, by mass, of water of crystallisation in copper(II) sulphate-5-water (formula, $CuSO_4 \cdot 5H_2O$):

Simple Empirical and True Molecular Formulae

The *empirical formula* of a compound is the simplest formula which represents its composition. It shows the elements that are present in the compound and the simplest ratio of the amounts of those elements.

- For example, magnesium chloride was found to have the following percentage composition:

Mg = 25.5% and Cl = 74.5%

	Magnesium = 25.5%	**Chlorine** = 74.5%
Divide the percentage by the element's relative atomic mass to calculate moles of each element:	25.5 ÷ 24.3 = 1.05 mol	74.5 ÷ 35.5 = 2.10 mol
To simplify the ratio, divide through by the smallest answer:	1.05 ÷ 1.05 = 1	2.10 ÷ 1.05 = 2
The simple empirical formula:	**$MgCl_2$**	

Question 4.

A compound of carbon and hydrogen was found to have the following percentage composition:
C = 75.0% and H = 25.0%. Calculate the empirical formula of the compound:

Question 5.

A compound of sodium, sulphur and oxygen was found to have the following percentage composition:
Na = 32.4%, S = 22.6% and O = 45.0%. Calculate the empirical formula of the compound:

Question 6.

A 0.4764 g sample of an oxide of iron was reduced by a stream of carbon monoxide. The mass of iron that remained was 0.3450 g. Calculate the empirical formula of the oxide:

The *true molecular formula* of a compound is a multiple of the empirical formula. To calculate the true molecular formula of a compound, an additional piece of information is required – the compound's *relative molecular mass*.

- For example, a compound of carbon and hydrogen was found to have the following percentage composition:

C = 80.0% and H = 20.0%

And a relative molecular mass of 30.0

	Carbon = 80.0%	**Hydrogen** = 20.0%
Divide the percentage by the element's relative atomic mass to calculate moles of each element:	80.0 ÷ 12.0 = 6.67 mol	20.0 ÷ 1.0 = 20.0 mol
To simplify the ratio, divide through by the smallest answer:	6.67 ÷ 6.67 = 1	20.0 ÷ 6.67 = 3
The simple empirical formula:	CH_3	
M_r of CH_3:	$CH_3 = 12.0 + (3 \times 1.0) = 15.0$	
Ratio of M_r:	$30.0 \div 15.0 = 2$	
True molecular formula:	$2 \times CH_3 = \mathbf{C_2H_6}$	

Question 7.

A compound of carbon and hydrogen was found to have the following percentage composition:
C = 85.7% and H = 14.3% and a relative molecular mass of 84.0. Calculate the true molecular formula of the compound:

Question 8.

A compound of carbon, hydrogen and oxygen was found to have the following percentage composition:
C = 40.0%, H = 6.67% and O = 53.3% and a relative molecular mass of 60.0. Calculate the true molecular formula of the compound:

- Scan the QR code below for the answers to this assignment.

http://www.chemist.sg/mole/elementary_pie_ans.pdf