



Practising calculations in chemistry

Learning objectives

- 1 Calculate the relative formula mass of a compound given its formula and appropriate relative atomic masses.
- 2 Calculate the percentage by mass of an element from a given formula.
- 3 Calculate masses of reactants and products from balanced equations using the mole equation.

Introduction

In chemistry, it is not enough just to know which substances react, we also need to know how much of each substance is involved. This part of chemistry is called quantitative chemistry.

By mastering these skills, you will gain a deeper understanding of how chemists use maths to make chemistry precise, reliable and useful in the real world.

Data

All the information below can be found on the periodic table but is reproduced here for you to refer to.

Element	Symbol	Relative atomic mass	Element	Symbol	Relative atomic mass
Hydrogen	H	1	Potassium	K	39
Carbon	C	12	Calcium	Ca	40
Nitrogen	N	14	Iron	Fe	56
Oxygen	O	16	Copper	Cu	63.5
Sodium	Na	23	Zinc	Zn	65
Magnesium	Mg	24	Bromine	Br	80
Aluminium	Al	27	Silver	Ag	108
Sulfur	S	32	Iodine	I	127
Chlorine	Cl	35.5	Lead	Pb	207



Calculating relative formula masses

1.1 Calculate the relative formula mass of methane, CH_4

1 x C and 4 x H

Relative atomic mass of carbon = 12

Relative atomic mass of hydrogen = 1

1 x _____ = _____

4 x _____ = _____

_____ + _____ = _____

1.2 Calculate the relative formula mass of sodium hydroxide, NaOH

1 x Na, 1 x O and 1 x H

Relative atomic mass of sodium = _____

Relative atomic mass of oxygen = _____

Relative atomic mass of hydrogen = _____

1 x _____ = _____

1 x _____ = _____

1 x _____ = _____

_____ + _____ + _____ = _____

1.3 Calculate the relative formula mass of sulfuric acid, H_2SO_4

_____ x H, _____ x S and _____ x O

Relative atomic mass of hydrogen = _____

Relative atomic mass of sulfur = _____

Relative atomic mass of oxygen = _____

1.4 Calculate the relative formula mass of zinc nitrate, $\text{Zn}(\text{NO}_3)_2$



Calculating the percentage by mass of an element in a compound from a given formula

2.1 Calculate the percentage by mass of **carbon, C** in methane, CH₄

_____ atom of carbon. Mass of carbon is 12.

Total mass of CH₄ = _____ x C, _____ x H = 12 + (4 x 1) = _____

% by mass = $\frac{12}{\quad} \times 100 = \quad\%$

2.2 Calculate the percentage by mass of **calcium, Ca** in calcium carbonate, CaCO₃

_____ atom of calcium. Mass of calcium is _____.

Total mass of CaCO₃ = 1 x Ca, 1 x C and 3 x O = _____ + _____ + (3 x _____) = _____

% by mass = $\frac{\text{mass of Ca}}{\text{total mass of CaCO}_3} \times 100 = \text{---} \times 100 = \text{---}\%$

2.3 Calculate the percentage by mass of **oxygen, O** in sulfur dioxide, SO₂

_____ atoms of oxygen. Mass of oxygen is _____ x _____ = _____.

Total mass of SO₂ = _____ x S, _____ x O = _____ + (_____ x _____) = _____

% by mass = _____ x 100 = _____ %

2.4 Calculate the percentage by mass of **nitrogen, N** in ammonium sulfate (NH₄)₂SO₄

_____ atoms of nitrogen. Mass of nitrogen is _____.

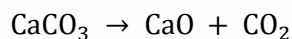
Total mass of (NH₄)₂SO₄ = _____

% by mass = _____ %



Calculating the mass of reactants and products from balanced equations using the mole equation

- 3.1. What mass of calcium oxide is formed when 10 g of calcium carbonate is completely decomposed?



Step 1: Fill out the table with the information from the question. This has been completed for you.

On the left, write the formula for the substance that you know the mass of. On the right, write the formula of the substance you need to find the mass of. The balancing number tells you the ratio.

Substance	CaCO ₃	CaO
Ratio	1	1
Mass (g)	10	
<i>M_r</i>		
Moles		

Step 2: Work out the relative formula mass of CaCO₃.

Step 3: Work out the moles of CaCO₃ using $\text{moles} = \frac{\text{mass}}{M_r}$.

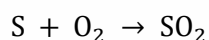
Step 4: The ratio is a 1:1 ratio, therefore the number of moles of CaCO₃ and CaO are the same.

Step 5: Work out the relative formula mass of CaO.

Step 6: Work out the mass of CaO using the mole equation $\text{mass} = \text{moles} \times M_r$.



3.2. What mass of sulfur dioxide is produced when 2.4 g of sulfur is burnt?



Step 1: Fill out the table with the information from the question. This has been completed for you.

Substance	S	SO ₂
Ratio	1	1
Mass (g)	2.4	
M_r		
Moles		

Step 2: Find out the relative atomic mass of S.

Step 3: Work out the moles of S using $\text{moles} = \frac{\text{mass}}{M_r}$.

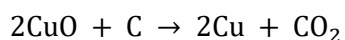
Step 4: The ratio is a 1:1 ratio, therefore the number of moles of S and SO₂ are the same.

Step 5: Work out the relative formula mass of SO₂.

Step 6: Work out mass of SO₂ using the mole equation $\text{moles} = \frac{\text{mass}}{M_r}$. You need to rearrange the equation by multiplying both sides by M_r .



3.3. What mass of carbon is needed to react with 8 g of copper(II) oxide?

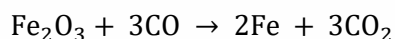


Apply the rules from above to answer this question.

Note: For step 4, the ratio is no longer 1:1, therefore you must divide the number of moles of CuO by 2 to find the moles of C.

Substance	CuO	C
Ratio	2	1
Mass (g)	8	
M_r		
Moles		

3.4. What mass of iron(III) oxide is needed to react with carbon monoxide to produce 112 g of iron?



Apply the rules from above to answer this question.
