Algebra and equations

In this worksheet, we will use the same estimation and checking skills you may have practised in maths, but we will apply them to real chemical reactions.

Learning objectives

1 Make estimates of the results of simple calculations.

2 Recognise mass is conserved during a chemical reaction.

3 Understand the symbols used in word and symbol equations.

Making estimates

We make estimates in several ways in chemistry:

- When you are doing a calculation, round each number to one significant figure before you start, so 38 becomes 40 and 5.2 becomes 5. This gives you a rough answer quickly. Once you have completed the full calculation, compare it to your estimate.
- When you are looking at a table of results, you might estimate a missing value by spotting a pattern in the data and using it to suggest a value that fits. You are not guessing; you are reasoning from the evidence in front of you. A good estimate will be consistent with the trend in the rest of the data; you should always be able to explain why your value makes sense.
- When you are reading a graph, estimation means reading off a value that falls between or beyond the plotted points. You are using the shape and direction of the graph to make a reasonable estimate.

Conservation of mass

In any chemical reaction, atoms are never created or destroyed. They are rearranged to form new substances. This means that the total mass of everything you start with (the reactants) must equal the total mass of everything that is produced (the products). If you carry out a reaction and the mass appears to decrease, then a gas may have been made during the reaction and been released into the air. If the mass seems to have increased after a reaction, then it is likely that a gas from the surrounding air has also been involved in the reaction. For example, when magnesium burns it reacts with the oxygen in air.

Writing a word equation

A word equation summarises a chemical reaction using the names of the substances involved, with an arrow (→) separating the reactants on the left from the products on the right.

$$\text{magnesium} + \text{oxygen} \rightarrow \text{magnesium oxide}$$

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Writing a chemical symbol equation

A symbol equation uses chemical symbols and formulas instead of names, making it universally understood regardless of what language we speak. In a formula, a subscript number written below and after an element's symbol tells you how many atoms of that element are in 1 unit of the substance, so H_2O means there are 2 hydrogen atoms joined to one oxygen atom. When writing or checking a symbol equation, count the atoms of each element on both sides of the arrow. If the numbers match, the equation is balanced.

$$2Mg + O_2 \rightarrow 2MgO$$

$Mg = 2$	$Mg = 2$
$O = 2$	$O = 2$

Questions

1. Estimate the result of 4.8 × 9.3.

(a) Round each number to 1 significant figure.

_____

(b) Estimate the answer.

_____

2. A learner adds increasing amounts of hydrochloric acid to marble chips and measures the volume of carbon dioxide gas which is produced. Here are the results:

Volume of hydrochloric acid added (cm³)	Volume of carbon dioxide gas released (cm³)
10	24
20	48
30	
40	96
50	120

(a) Estimate the volume of carbon dioxide produced when 30 cm³ of acid was used.

_____

(c) Explain how you decided on your answer.

_____

_____

_____

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3. Look at each of the statements about conservation of mass. Decide if each statement is true or false and write your answer into the table.

Statement	Is this statement true or false?
In a chemical reaction, atoms are destroyed to make new substances.	
The total mass of the reactants used equals the total mass of the products made.	
If a gas escapes during a reaction, then the law of conservation of mass is no longer correct.	
Atoms are rearranged, not created or destroyed in a chemical reaction.	

4. Zinc reacts with hydrochloric acid to produce zinc chloride and hydrogen gas.

(a) Write a word equation for this chemical reaction.

_____

(b) A learner measures the mass before and after the reaction happens in an open beaker. Here are the results:

	Mass (g)
Before the reaction	62.4
After the reaction	60.7

The learner says, 'mass has not been conserved because the mass has gone down after the reaction.'

Explain why the learner is incorrect.

_____

_____

_____

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5.

(a) Identify the correct chemical formula for carbon dioxide.

A. CO

B. Co

C. CO_2

D. C_2O

E. $2CO$

Answer = _____

b) What does the subscript $_2$ in O_2 mean?

_____

_____

6. A learner has written the following symbol equation for hydrogen burning in oxygen.

$$H_2 + O_2 \rightarrow H_2O$$

(a) Complete the table below to show the number of atoms on each side of the equation.

Atoms on the left side of the equation	Atoms on the right side of the equation
$H =$	$H =$
$O =$	$O =$

(b) Is the equation balanced? Circle one answer: **Yes / No**

(c) Select the correct balanced equation from the list below.

A. $H_2 + O_2 \rightarrow H_2O_2$

B. $H_2 + O_2 \rightarrow 2H_2O$

C. $2H_2 + O_2 \rightarrow 2H_2O$

D. $H_2 + O \rightarrow H_2O$

Answer = _____

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