

A Guide to Representing Chemical Change

Teaching Approach

In this series of nine lessons learners will learn how to represent chemical changes they observe as balanced chemical equations. The series develops the skill of how to balance chemical equations, using a variety of methods from visual representation, using tables until learners can balance chemical equations by inspection. It is therefore essential that the videos be watched in sequence. The task video should be viewed at the end of the series.

In order for learners to grasp the concept of balancing chemical equations, a practical approach is essential. The series provides learners with the opportunity of seeing the chemical reactions. The key to a good understanding of the theme, Representing Chemical Change, is to link the real chemical change taking place in an experiment with a representation of this change. In this series the chemical change is represented by writing word equations, drawing diagrams and writing balanced chemical equations. Provide learners with the opportunity to use coloured circles to develop the skill of balancing chemical equations. This will also highlight the importance of the law of conservation of matter and atoms in a chemical reaction.

The series explores the reactions of Group I, II and the transition metals with oxygen; the reaction of the metal oxides formed and water; the reaction of the alkali metals and the alkaline earth metals with water and the reactions of metals with acids. The reactions of non-metals with oxygen and their oxides with water are also investigated and, finally, the reaction of the halogens with metals is investigated. Writing balanced chemical equations for reactions is a skill that is covered thoroughly throughout this series

It may not be possible to conduct many of the experiments in the classroom and the video can be incorporated into lessons on representing chemical change. Learners can see the macroscopic changes that happen during the chemical reactions and the approach used for learning to write balanced chemical equations focuses on the sub-microscopic level, linking the law of conservation of mass and atoms to the symbolic representation when writing balanced chemical equation. Since the videos incorporate all three levels of representation in chemistry, and help to develop conceptual understanding.

The series addresses all the specific aims in Physical Sciences which promotes knowledge and skills in scientific inquiry and problem solving; the construction and application of scientific and technological knowledge; an understanding of the nature of science and its relationships to technology and society.

According to the curriculum documents, balanced chemical equations represent chemical change and illustrate the Law of Conservation of Matter. Balanced chemical equations are fundamentally important for understanding the quantitative basis of chemistry, which always needs to start with a balanced chemical reaction equation, before carrying out a quantitative study of the chemical reaction. For this reason the key steps required for learners to take are identified in this series. These steps are explained and repeated with each new example. It is important to contextualise this learning instead of expecting learners to simply do numerous worksheets balancing endless, meaningless equations. This series uses the context of the reactions of metals and non-metals for the following reasons:

- Metals and mining are a very important part of the South Africa economy and the burning of coal produces acidic oxides that impact on the environment.
- The reactions of metals and non-metals will enhance learners' understanding of the Periodic Table.
- The reactions of the alkali and alkaline earth metals, some non-metals like phosphorus and metals with halogens are exciting and spectacular.
- Teachers and learners will be familiar with this context.

Video Summaries

Some videos have a 'PAUSE' moment, at which point the teacher or learner can choose to pause the video and try to answer the question posed or calculate the answer to the problem under discussion. Once the video starts again, the answer to the question or the right answer to the calculation is given

Mindset suggests a number of ways to use the video lessons. These include:

- Watch or show a lesson as an introduction to a lesson
- Watch or show a lesson after a lesson, as a summary or as a way of adding in some interesting real-life applications or practical aspects
- Design a worksheet or set of questions about one video lesson. Then ask learners to watch a video related to the lesson and to complete the worksheet or questions, either in groups or individually
- Worksheets and questions based on video lessons can be used as short assessments or exercises
- Ask learners to watch a particular video lesson for homework (in the school library or on the website, depending on how the material is available) as preparation for the next day's lesson; if desired, learners can be given specific questions to answer in preparation for the next day's lesson

1. Introduction to Reactions

In this lesson the importance of metals in our world is introduced. How iron is extracted from iron ore in a blast furnace is examined as the context to introduce the steps required to represent chemical change in the form of a balanced chemical equation.

2. Structure Metals with Oxygen

In this lesson the reactions of alkali metals, alkali earth metals and transition metals in oxygen are investigated. The product formed in each reaction is a metal oxide. The skill of writing balanced chemical equations is developed throughout this lesson.

3. Metal Oxides with Water

This lesson shows how the alkali metal oxides and alkali earth metal oxides react with water to form a metal hydroxide. Simple experiments are conducted by dissolving the oxides in water and testing them with litmus paper. Learners are required to write balanced chemical equations for these reactions.

4. Metals with Water and Acids

This lesson investigates the reactions of the alkali metals with water, some of the alkali earth metals with hot water and the reaction of iron with water. This lesson also highlights the ability of metals to displace hydrogen from a molecule or compound such as water and acids.

5. Non-metals with Oxygen

The combustion of non-metals in oxygen and how some oxides of non-metals are dissolved in water are investigated. This lesson shows learners how to balance more difficult equations.

6. Halogens and Metals

In this lesson learners see the reactions of metals with halogens. Learners not only write balanced equations but interpret balanced equations in terms of conservation of atoms and mass using relative atomic masses

Resource Material

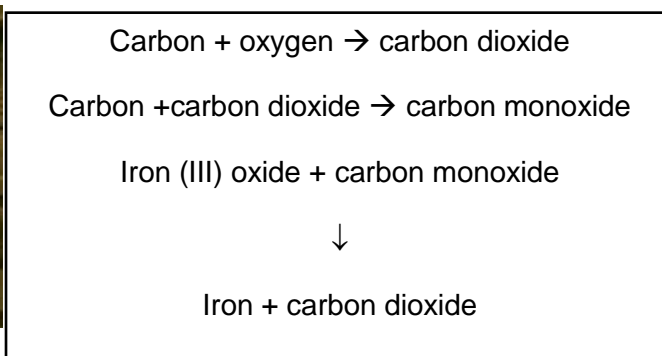
1. Introduction to Reactions	https://phet.colorado.edu/en/simulation/balancing-chemical-equations	A simulation that needs to be downloaded that introduces balancing chemical equations.
	http://www.youtube.com/watch?v=B735turDoM	Video introducing the skill of balancing chemical equations.
	http://www.wikihow.com/Balance-Chemical-Equations	A guide on how to balance chemical equations.
2. Metals with Oxygen	http://www.tutorvista.com/content/science/science-ii/metals-non-metals/chemical-properties-metals.php	Summary of reaction of metals with oxygen, water and acids
	http://www.youtube.com/watch?v=hQyJXiSvUA	Video showing the reactions of metals with oxygen.
	http://www.youtube.com/watch?v=0KonBvfnzdo	Video of reactions of Group One or alkali metals.
3. Metal Oxides with Water	http://www.sciencegeek.net/Chemistry/taters/EquationBalancing.htm	On-line exercise to balance chemical equations by filling in missing coefficients.
	http://www.s-cool.co.uk/gcse/chemistry/extraction-of-metals/revise-it/the-blast-furnace	Summary of reactions taking place in a blast furnace.
4. Metals with Water and Acids	http://www.docbrown.info/page03/AcidsBasesSalts04.htm	Summary of reaction of metals with acids.
	http://www.docbrown.info/page04/MetalsExtract.htm	Extraction of metals from their ores with chemical reactions for extension.
	http://www.rsc.org/chemsoc/visualelements/pages/data/intro_groupii_data.html	Reactions of alkali earth metals with balanced chemical equations.
5. Non-metals with	http://chemed.chem.purdue.edu/elements/main_pages/11.2.html	Overview comparing reactions of metal oxides versus non-metal oxides.

Oxygen	http://www.youtube.com/watch?v=J904M8YUdSQ	Video on reaction of non-metals with oxygen.
	http://www.docbrown.info/page03/Noble_Gases.htm	Extraction of metals from their ores with chemical reactions for extension.
6. Halogens and Metals	http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_pre_2011/periodic_table/group7rev2.shtml	Summary with some reaction animation on reactions of halogens.

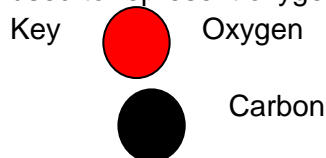
Task

Question 1

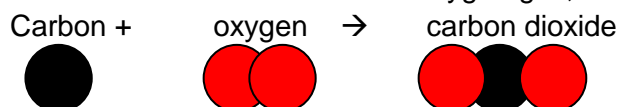
In a blast furnace iron three oxide is mixed with coke. The coke reacts with oxygen gas to form carbon dioxide. The carbon dioxide reacts with the coke to form carbon monoxide. The carbon monoxide reacts with the iron three oxide to form molten iron and carbon dioxide gas. The hot, liquid iron is poured off, cooled and rolled into sheets of iron.



The reaction between coke and oxygen can be represented using coloured circles. Red is used to represent oxygen and black is used to represent carbon.



The carbon in coke reacts with oxygen gas, a diatomic molecule, to form carbon dioxide gas.



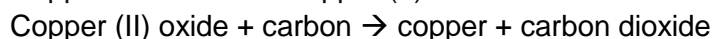
1.1 Write down a balanced chemical equation for this reaction.

1.2 Use black and red circles to help you write a balanced chemical equation for the reaction.

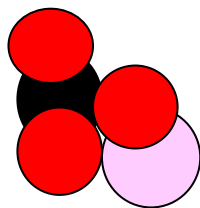


Question 2

In the extraction of copper metal, copper carbonate decomposes to form copper (II) oxide and carbon dioxide gas



The following representation shows the decomposition of copper carbonate. The pink circle represents copper, black represents carbon and red represents oxygen.



Copper carbonate

- 2.1 Complete the representation and write a balanced chemical equation for this reaction.
- 2.2 Draw a representation to help you write a balanced chemical equation for:
Copper (II) oxide + carbon \rightarrow copper + carbon dioxide

Question 3

Construct tables to help you balance equations for:

- 3.1 Sodium + oxygen \rightarrow sodium oxide
3.2 Potassium + oxygen \rightarrow potassium oxide

Question 4

Construct tables to help you balance equations for:

- 4.1 Barium + oxygen \rightarrow barium oxide
4.2 Magnesium + sulfur \rightarrow magnesium sulfide

Question 5

Construct tables to help you balance equations for:

- 5.1 Potassium oxide + water \rightarrow potassium hydroxide
5.2 Barium oxide + water \rightarrow barium hydroxide

Question 6

- 6.1 Write balanced chemical equations for
Potassium + water \rightarrow
Magnesium + water \rightarrow
6.2 Explain what test can be done to confirm that the gas produced is hydrogen gas.

Question 7

Metals and non metals burn in oxygen.

- 7.1 What type of oxides form when metals from Group 1 and Group 2 burn in oxygen?
7.2 What type of oxides form when non metals burn in oxygen?
7.3 Describe a simple test you can conduct to show what types of oxides form in each case.

Question 8

The overall reaction for the rusting of iron is iron plus oxygen reacts to form iron three oxide.

- 8.1 Write a balanced equation for rusting.
8.2 Find out ways in which rusting of iron can be prevented

Question 9

Write balanced chemical equations for the reaction of zinc in sulfuric acid and nitric acid.

Question 10

Sulfuric acid is produced industrially in a process known as the contact process. Write balanced chemical equations for the following reactions in the production of sulfuric acid.

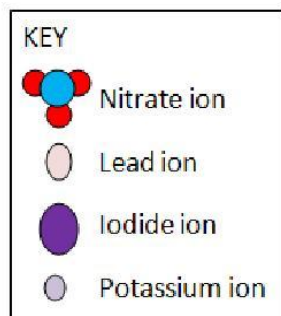
- 10.1 Sulfur dioxide + oxygen \rightarrow sulfur trioxide
10.2 Sulfur trioxide + water \rightarrow sulfuric acid

Question 11

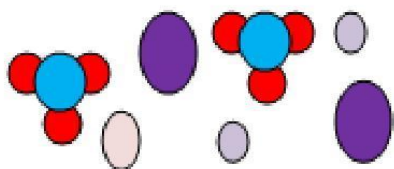
- 11.1 Write a balanced chemical equation for the reaction between aluminium and iodine to form aluminium iodide.
- 11.2 Show that matter is conserved by calculating the total mass of the reactants and the total mass of the products.

Question 12

When a solution of lead nitrate and potassium iodide are mixed together, a precipitate of lead iodide forms.



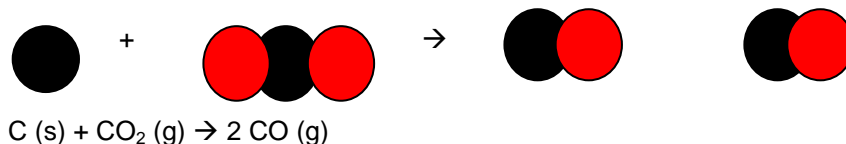
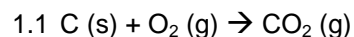
A representation of the simplest ratio of ions at the instant they mix:



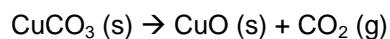
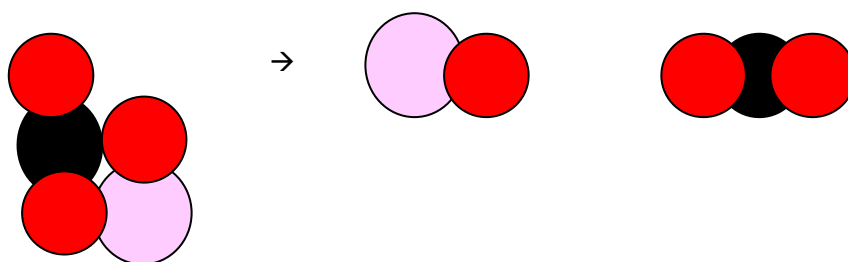
- 12.1 Explain what a precipitate is.
- 12.2 Write a balanced chemical equation for this precipitate reaction.
- 12.3 Show that matter is conserved in this precipitate reaction by calculating the total mass of the reactants and the total mass of the products.

Task Answers

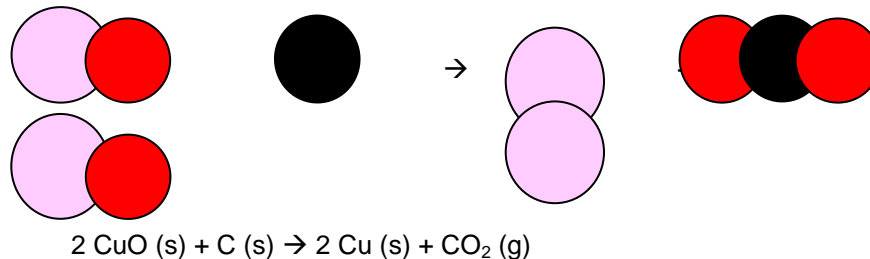
Question 1



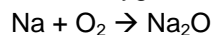
Question 2



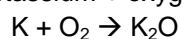
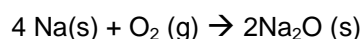
2.2



Question 3

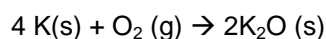


Reactants			Products		
Sodium atoms	4	4	Sodium atoms	2	4
Oxygen atoms	2		Oxygen atoms	4	2



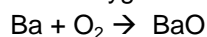
Reactants			Products		
Potassium	4	4	Potassium	2	4

atoms		atoms	
Oxygen atoms	2	Oxygen atoms	4 2

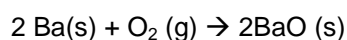


Question 4

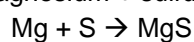
4.1 Barium + oxygen \rightarrow Barium oxide



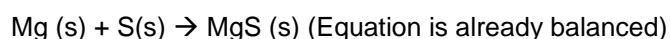
Reactants		Products	
Barium atoms	4 2	Barium atoms	4 2
Oxygen atoms	2	Oxygen atoms	4 2



4.2 Magnesium + sulfur \rightarrow Magnesium sulfide

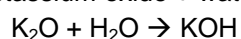


Reactants		Products	
Magnesium atoms	1	Magnesium atoms	1
Sulfur atoms	1	Sulfur atoms	1

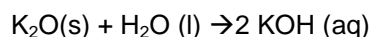


Question 5

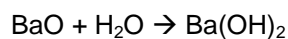
5.1 Potassium oxide + water \rightarrow sodium hydroxide



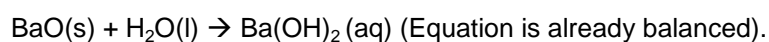
Reactants		Products	
Potassium atoms	2	Potassium atoms	4 2
Oxygen atoms	2	Oxygen atoms	4 2
Hydrogen atom	2	Hydrogen atoms	4 2



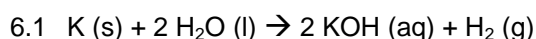
5.2 Barium oxide + water \rightarrow Barium hydroxide



Reactants		Products	
Barium atoms	1	Barium atoms	1
Oxygen atoms	2	Oxygen atoms	2
Hydrogen atom	2	Hydrogen atoms	2



Question 6



6.2 Collect gas and use a glowing splint. A 'small 'popping' sound indicates presence of hydrogen gas.

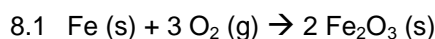
Question 7

7.1 Basic oxides

7.2 Acidic oxides

7.3 Use litmus paper. Blue litmus paper turns red under acidic conditions and red litmus paper turns blue under basic (i.e. alkaline) conditions

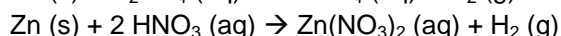
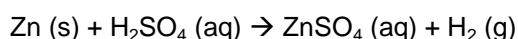
Question 8



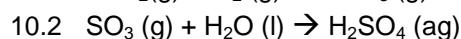
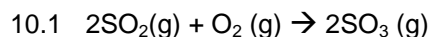
8.2

- Keep away from moisture.
- Paint the metallic surface.
- Apply oil in order to provide an insulation layer between it and air.
- Wipe the surface with a soft dry cloth to remove moisture.
- Chromium plating or galvanising.

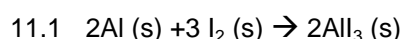
Question 9



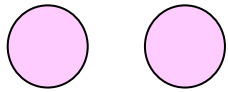
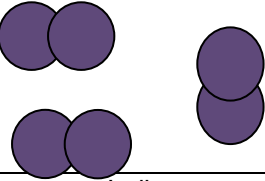
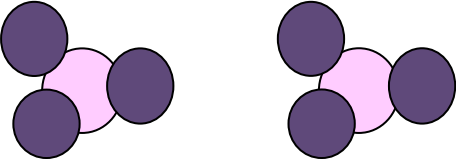
Question 10



Question 11

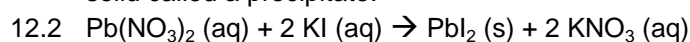


11.2

Reactants		Products
		
Aluminium	Iodine	Aluminium Iodide
(2 x 27)	+ (3 (126,9 x 2))	2 x (27 + (3 x 126,9))
54	+ 761,5	2 x (407,7)
815,4		815,4

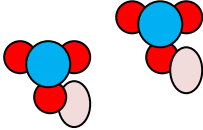
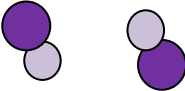
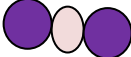
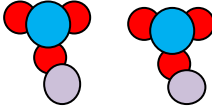
Question 12

12.1 Precipitate reaction – a reaction between reactants in solution that combine to form an insoluble solid called a precipitate.



12.3

Reactants	Products
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Lead Nitrate	Potassium Iodide	Lead Iodide	Potassium Nitrate
$207 + (2 \times (14 + (16 \times 3))) + (2 \times (39 + 127))$ 331 +, 332 663		$207 + (2 \times 127) + (2 \times 39) + (2 \times (14 + (16 \times 3)))$ 461 + 202 663	

Acknowledgements

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