# Lesson Element

# Balancing Equations – Let’s Balance!

## Instructions and answers for teachers

These instructions cover the learner activity section which can be found on [page 7](#_Learner_Activity). This Lesson Element supports OCR GCSE (9-1) Gateway Science Chemistry A and the Twenty First Century Science Chemistry B qualifications.

**When distributing the activity section to the learners either as a printed copy or as a Word file you will need to remove the teacher instructions section.**

### Mapping to specification level (Learning outcomes)

**GCSE (9–1) Gateway Science Chemistry A/Combined Science A**

C2.1c calculate relative formula masses of species separately and in a balanced chemical equation

C3.1b use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations **and half equations**

C3.1c use the names and symbols of common elements from a supplied periodic table to write formulae and balanced chemical equations where appropriate

C3.1e **construct balanced ionic equations**

C3.1f describe the physical states of products and reactants using state symbols (s, l, g and aq)

**GCSE (9–1) Twenty First Century Science Chemistry B/Combined Science B**

C1.1.10 use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations

C1.1.11 use arithmetic computations and ratios when balancing equations

### Introduction

This lesson element is an alternative way to introduce learners to bonding. The research shows that learners have a problem with stoichiometry, often not really understanding why they are balancing equations. The balancing of equations is necessary to ensure that the reaction in question observes the rule for the conservation of mass. Learners also struggle with the concept that chemical reactions cannot produce any different elements. For example, if you begin with a magnesium compound you cannot suddenly make a compound that uses aluminium if aluminium is not present.

Learners are expected to be familiar with atoms and compounds and how to write common chemical compound using symbols; aware that reactants and products can be written in equation format and should be familiar writing these in words.

### Notes for teachers

The following activities can form a lesson or be embedded into lessons. They include images to show how products are made from reactants, a modelling activity and a Learner Task Sheet to practise what has been learnt.

### Activity 1a: Reactions

Slide 1 contains an image which allows learners to explore the idea that although chemical reactions make new substances those substances must be made from the starting materials.

Learners should be shown the first slide and decide in small groups what the image is trying to say. This would give the teacher the opportunity to assess what the learners already know and expel /explore any misconceptions they may have. For example, leaners struggle to understand the concept of a chemical reaction, often not understanding that the new substances that are being made can only contain the elements that they started off with. This is usually down to them not fully understanding the definitions of compounds, elements and mixtures that they studied at Key Stage 3. Learners who struggle with this could be asked to list the elements found in products. This could help them to make the connection with this concept.

Another task learners could be asked to do is to name the chemicals used to make a cake and then be asked what happens to these chemicals when the cake is made. They could also be given a simple word equation such as carbon + oxygen makes carbon dioxide and be asked to suggest what chemicals make the product.

### Activity 1b:

Learners should be shown the second slide. This is a short activity to explore the views of learners by asking them to suggest the reasons why the second word equation is not correct. In this activity, learners would be expected to see that water contains hydrogen and oxygen, and carbon does not.

### Activity 2a: Let’s build!

#### Apparatus:

* Lego for modelling – different colours to use for different chemicals

To begin learners should be introduced to modelling the reactions with Lego using simple reactions. For example:

Hydrogen + oxygen water

Carbon + oxygen carbon monoxide

Learners could be asked to show how they would model the reactions using the Lego and to explain their model to others in their class / group.

### Activity 2b:

This part of the activity focusses on modelling the law of the conservation of mass.

Show the third slide containing information about chemical masses and ensure that the learners fully comprehend what the animation is showing. Learners can be shown how this can be modelled using the Lego for the above reactions eg twelve blocks all of the same size to represent the carbon atom should all be stuck together and the mass measured on a balance. The same should be done with sixteen blocks all of the same size but maybe a different colour representing oxygen. These two masses should be added together and the result noted.

Both of the models should then be stuck together and the mass should be measured to show that the mass is the same thus demonstrating the law of the conservation of mass. The learners could then be asked to comment upon why 12 blocks were used for carbon and 16 were used for oxygen.

Learners could be asked to do this for another simple compound to practise and consolidate learning.

### Activity 2c:

The learners should now be able to explain why equations need balancing. They should be shown the final slide and in groups they should explain what it shows and how this could link to a model using Lego. This could be done as a presentation or a simple mini-whiteboard explanation.

From the slide the learners should be able to see that without balancing the equation the masses are different on both sides of the equation which does not adhere to the law of conservation of mass. Learners do not always realise that this is the reason for balancing equations in the first place.

### Activity 3: Let’s Balance!

This activity takes the learner through a simple method for balancing equations which develop in complexity.

#### Suggested answers to Learner Task Sheet

#### Balance the following equations

1. CaCO3 + 2 HCl CaCl2  + CO2 + H2O

|  |  |  |  |
| --- | --- | --- | --- |
| **Reactants** | | **Products** | |
| Carbon | X 1 | Carbon | X 1 |
| Oxygen | X 3 | Oxygen | X 3 |
| Calcium | X 1 | Calcium | X 1 |
| Hydrogen | X 1 | Hydrogen | X 2 |
| Chlorine | X 1 | Chlorine | X 2 |

1. Na2S2O3 + 2 HCl 2 NaCl + S + SO2 + H2O

|  |  |  |  |
| --- | --- | --- | --- |
| **Reactants** | | **Products** | |
| Sodium | X 2 | Sodium | X 1 |
| Oxygen | X 3 | Oxygen | X 3 |
| Sulphur | X 2 | Sulphur | X 2 |
| Hydrogen | X 1 | Hydrogen | X 2 |
| Chlorine | X 1 | Chlorine | X 1 |

1. NaOH + HCl NaCl + H2O – Already balanced

|  |  |  |  |
| --- | --- | --- | --- |
| **Reactants** | | **Products** | |
| Sodium | X 1 | Sodium | X 1 |
| Oxygen | X 1 | Oxygen | X 1 |
| Hydrogen | X 2 | Hydrogen | X 2 |
| Chlorine | X 1 | Chlorine | X 1 |

1. C6H12O6 2 C2H5OH + 2 CO2

|  |  |  |  |
| --- | --- | --- | --- |
| **Reactants** | | **Products** | |
| Carbon | X 6 | Carbon | X 3 |
| Hydrogen | X 12 | Hydrogen | X 6 |
| Oxygen | X 6 | Oxygen | X 3 |

1. C6H12O6  +6 O2 6 CO2 + 6 H2O

|  |  |  |  |
| --- | --- | --- | --- |
| **Reactants** | | **Products** | |
| Carbon | X 6 | Carbon | X 1 |
| Hydrogen | X 12 | Hydrogen | X 2 |
| Oxygen | X 8 | Oxygen | X 3 |

### Extension ideas:

At this point learners will have been introduced to formulae and their construction. So to build on this they could construct their own balanced symbol equations based upon simple word equations they have been given.

**For example:**

Iron Oxide + Aluminium Aluminium Oxide + Iron

3FeO + 2Al Al2O3  + 3Fe

Sodium Hydroxide + hydrochloric acid Sodium chloride + water

NaOH + HCl NaCl + H2O

They would use the same process to balance the equation as before.

### Supporting information

Before this unit of work is undertaken teachers should be familiar with the definitions of elements mixtures and compounds.

Teachers should be familiar with balancing equations such as using online resources, for example, the Khan academy <https://www.khanacademy.org/test-prep/mcat/physical-processes/stoichiometry/v/balancing-chemical-equations>

For practice examples: <http://www.rsc.org/learn-chemistry/wiki/Category:Balancing_equations>

Knowledge of using oxidation numbers to determine the formulae of compounds, as well as a familiarity with the periodic table, is also necessary. Help with this can be found at the following [www.youtube.com/watch?v=OU7GkayF3dc](http://www.youtube.com/watch?v=OU7GkayF3dc)*.*

Teachers can also access lots of useful information on this subject at [www.rsc.org](http://www.rsc.org) in the education section.

<http://www.rsc.org/learn-chemistry/resource/res00001088/definitions-in-chemistry> – helps with definitions.

<https://www.rsc.org/cpd/resource/RES00001328/quantitative-chemistry> also is useful for looking at aspects of quantitative chemistry (Calculating masses as well as writing equations).

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# Lesson Element

# Balancing Equations – Let’s Balance!

## Learner Activity



1. Balance anything that does not contain oxygen first
2. Next balance any waters
3. Next balance any hydrogen or oxygen molecules
4. Finally balance all single elements last.

### Example 1

C + O2 CO2

|  |  |  |  |
| --- | --- | --- | --- |
| Reactants | | Products | |
| Carbon | X 1 | Carbon | X 1 |
| Oxygen | X 2 | Oxygen | X 2 |

The numbers of elements on both sides of the equation are equal therefore the equation is balanced.

### Example 2

C + O2 CO

|  |  |  |  |
| --- | --- | --- | --- |
| Reactants | | Products | |
| Carbon | X 1 | Carbon | X 1 |
| Oxygen | X 2 | Oxygen | X 1 |

The numbers of elements on both sides of the equation are NOT equal therefore the equation needs to be balanced. Therefore follow the Golden Rules!

To do this we must put a 2 in front of the CO molecule so it becomes:

2CO – splitting the molecule is not allowed so we cannot have C2O

Now balance the oxygen on each side. There are an equal number on either side. However the number of carbons on both sides is not equal.

SO If we now follow Golden Rule 4 of balancing elements last of all we can put a 2 in front of the carbon on the right hand side to balance the equation.

2C + O2 2CO

As a final check that the balancing is correct we now add up the combined masses on each side. DO NOT forget to multiply the masses by any number in front of the element or compound. For example CO has a mass of 28 but because there is a 2 in front of it. The mass on the right hand side of the equation is now 56g.

#### Balance the following equations

1. CaCO3 + HCl CaCl2  + CO2 + H2O

|  |  |  |  |
| --- | --- | --- | --- |
| **Reactants** | | **Products** | |
| Carbon | X 1 | Carbon | X 1 |
| Oxygen | X 3 | Oxygen | X 3 |
| Calcium |  | Calcium |  |
| Hydrogen |  | Hydrogen |  |
| Chlorine |  | Chlorine |  |

1. Na2S2O3 + HCl NaCl + S + SO2 + H2O

|  |  |  |  |
| --- | --- | --- | --- |
| **Reactants** | | **Products** | |
| Sodium |  | Sodium |  |
| Oxygen |  | Oxygen |  |
| Sulphur |  | Sulphur |  |
| Hydrogen |  | Hydrogen |  |
| Chlorine |  | Chlorine |  |

1. NaOH + HCl NaCl + H2O

|  |  |  |  |
| --- | --- | --- | --- |
| **Reactants** | | **Products** | |
| Sodium |  | Sodium |  |
| Oxygen |  | Oxygen |  |
| Hydrogen |  | Hydrogen |  |
| Chlorine |  | Chlorine |  |

1. C6H12O6 C2H5OH + CO2

|  |  |  |  |
| --- | --- | --- | --- |
| **Reactants** | | **Products** | |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

1. C6H12O6  + O2 CO2 + H2O

|  |  |  |  |
| --- | --- | --- | --- |
| **Reactants** | | **Products** | |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |