# *Chemical reactions* **Teacher background notes**

**In this investigation, four different types of chemical reactions are performed one at a time. Students then test their understanding by performing six further reactions and then for each one: predict the products, identify the type of reaction and write balanced word and symbol equations.**

**This CLE represents an extension to what is required at Year 10 in Chemical sciences. The Australian Curriculum does not require students to write formula or write and balance symbol equations.**

## Australian Curriculum: Science links

## Learning intentions

Students will be able to:

* observe and understand different types of chemical reactions;
* identify the reactants in a chemical reaction and relate them to the reaction type;
* predict the products for a given chemical reaction type;
* write word and balanced symbol equations for reactions;
* construct conclusions based on evidence.

## Suggested time for this CLE

The time needed to complete the *Chemical reactions* CLE will depend on the depth of the students’ prior knowledge, the time to perform the five investigations and follow up with any further extension activities. Allow 2–3 hours.

## Prior conceptual knowledge

Science / Year 9 / Science Understanding / Chemical sciences

*Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed* ([ACSSU178](http://www.australiancurriculum.edu.au/science/curriculum/f-10?layout=1#cdcode=ACSSU178&level=9))

*Chemical reactions, including combustion and the reactions of acids, are important in both non-living and living systems and involve energy transfer*([ACSSU179](http://www.australiancurriculum.edu.au/science/curriculum/f-10?layout=1#level10))

Prior to undertaking this CLE, students should be competent at writing chemical formulas for ionic and molecular compounds from their chemical names, using valence rules. Ideally, they should have some experience with writing word and symbol equations for reactions and perhaps even attempting to balance them.

## New concepts to be introduced

Students should be familiar with some different reaction types from their study of chemistry in Year 9. According to the Australian Curriculum these should include combustion and reactions with acids (metals, bases, carbonates). These reaction types are extended in Year 10 to commonly include (although not definitively) synthesis, decomposition and precipitation reactions. Further, their knowledge of word equations is extended to include symbol equations.

### Synthesis (also known as combination)

Synthesis involves the making of a compound by combining simpler substances, which can be elements or compounds. Valence rules are used to determine the formula of the resulting compound. The general form of this reaction is:

A + B → AB

element element compound

or or

compound compound

For example, the reaction between carbon and oxygen would result in the synthesis of carbon dioxide.

carbon + oxygen → carbon dioxide

Burning a substance in oxygen is a special type of synthesis reaction that is known as combustion.

### Decomposition

Decomposition involves the breaking down of compounds into simpler substances. It is the opposite of synthesis. Heat, electricity, or a catalyst can be used to provide the energy required to decompose a compound. The products might be elements or simpler compounds. The general form of this reaction is:

AB → A + B

compound element element

or or

compound compound

For example, the decomposition of aluminium oxide would produce aluminium and oxygen.

aluminium oxide → aluminium + oxygen

### Single displacement

This reaction occurs when one element displaces another from a compound. The general form of this reaction is:

A + BC → B + AC

element compound element compound

For example, a metal might react with an ionic solution: copper can displace the silver in silver nitrate to form silver and copper nitrate. A metal reacting with an acid is also a single displacement reaction; magnesium displaces hydrogen when it is added to sulfuric acid and forms hydrogen gas and magnesium sulfate.

copper + silver nitrate → silver + copper nitrate

magnesium + sulfuric acid → magnesium sulfate + hydrogen

### Double displacement

In these reactions, the positive and negative parts of two different ionic compounds are interchanged. One way of teaching these types of reactions and how to predict their products is with an analogy of swapping dance partners.

AB + CD → CB + AD

All of the substances involved in the reaction are compounds and they could all be ionic compounds or an acid added to an ionic compound or an acid added to a base.

A Google image search may reveal a diagram with the atoms in the compounds shown in different colours, making the swap over of ‘partners’ more visible. Students could even be asked to draw their own version of the atoms involved in the reaction.

When reacting two ionic solutions, sometimes one of the product compounds is insoluble and forms a solid substance, which is known as a **precipitate**. Such a reaction could be called a **precipitation reaction**. Over time the precipitate will settle to the bottom of the container. Solubility tables in student textbooks will help students to predict if a particular product would form a precipitate.

The reaction between lead nitrate and potassium iodide is an interesting one. These are both colourless solutions, yet, when they combine, they swap partners to produce lead iodide and potassium nitrate. Lead iodide is bright yellow and insoluble and forms as a solid in the solution. Potassium nitrate is a colourless solution.

As an example in writing symbol equations, this reaction can be written as:

lead nitrate + potassium → lead iodide + potassium

iodide nitrate

Pb(NO3)2(aq) + 2 KI(aq) → Pb I2(s) + 2 KNO3(aq)

The (aq) symbol represents ‘aqueous’ which means the compound is dissolved in water. The (s) means solid or insoluble in water. Other state indicators include (l) – liquid and (g) – gas.

Always write the word equation on one line even when long chemical names are involved. Underneath, write the symbols using the valence rules. Balance from the left and work across dealing with each element separately. Including states at Year 10 is optional but necessary in precipitation reactions to indicate which of the products forms a precipitate.

## Possible misconceptions

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| **STUDENTS MAY THINK…** | **INSTEAD OF THINKING…** |
| The products of a chemical reaction are only determined by experimentation. | The products of a chemical reaction can be predicted from knowledge of the different types of chemical reactions. |
| There are an endless number of different types of chemical reactions. | Chemical reactions can be grouped into general types and the products can be predicted. |
| That a chemical reaction involves atoms ‘changing’ | That a chemical reaction involves the same atoms, rearranging themselves to form different substances. |
| A gas has no mass. | In a gas, the particles spread out far from each other and those particles have mass, so a gas has mass. |
| A gas product in a reaction was there in the beginning before the reaction started, it was just hidden or dissolved. | A gas product in a reaction is not present before the reaction started but is formed by the rearrangement of the atoms during the reaction. |
| Any brown solid substance formed in a chemical reaction must be ‘rust’. | Rust is iron oxide and can only be formed if iron is present to react with oxygen; another common brown solid substance is copper. |
| That mass increases during a precipitation reaction as solids weigh more than liquids. | Mass is always conserved in a chemical reaction. |
| That a precipitation reaction just ‘goes murky’. | A solid forms from the rearrangement of the atoms i.e. when the chemicals swap partners. |

## Links to further information

Chemical reactions slideshow:

‘Types of reactions year 10’, *Slideshare* website, [http://www.slideshare.net/kwebb3192/types-of-reactions-year-10](http://www.slideshare.net/kwebb3192/types-of-reactions-year-10?next_slideshow=1) (July 2012)

How to balance a chemical equation slideshow: ‘Balancing chemical reactions’, *Slideshare* website, <http://www.slideshare.net/amburkes/balancing-chemical-reactions> (May 2011)