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ACADEMIC COACHING

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# CHEMISTRY

## Module 3

## REACTIVE CHEMISTRY

**STUDENT BOOKLET**

**Theory Covered:**

1. Physical and Chemical changes
    - 1.1. Chemical equations
    - 1.2. Physical change
    - 1.3. Chemical change

**YEAR 11**

Name:

Class:

In **Module 3: Reactive Chemistry**

1. Physical vs Chemical change
2. Chemical reactions
3. Metal reactivity
4. Redox reactions and Galvanic cells
5. Rates of reactions

# 1. Physical vs Chemical change

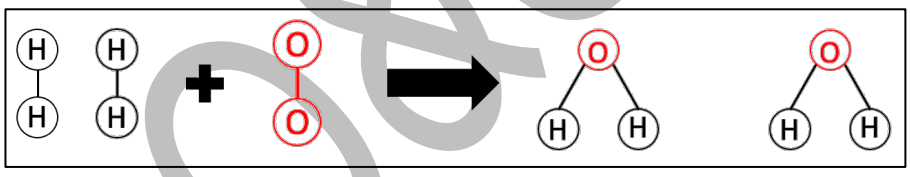
## In this booklet:

- *Investigate a variety of reactions to identify possible indicators of chemical change*

There are several indicators for chemical change observable in chemical reaction:

1. **Production of gas**
    a. Effervescence: formation of bubbles from within a liquid
    b. Odour: scent/smell
2. **Change in colour**
3. **Change in temperature**
4. **Precipitate formation**

- *Use modelling to demonstrate*
    - *The rearrangement of atoms to form new substances*
    - *The conservation of atoms in a chemical reaction*




- Construct balanced equations to represent chemical reactions

There are three steps to follow when balancing a chemical equation

1. Balance the metals first
2. Balance the non-metals second, excluding the hydrogen atoms and oxygen atoms
3. Balance hydrogen, then oxygen

## 1.1 Physical change

- In the syllabus, we are required to be able to describe and contrast physical changes from chemical changes
- A physical changes are generally changes to the …… of a substance.

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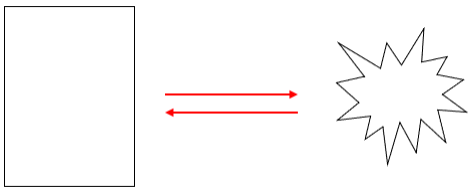


Diagram: a piece of paper being crushed into a ball

- This is an example of a physical change as ……. are being formed.
  - It is still the same piece of paper
- It is also easy to **reverse** this process as all that is required is to roll the ball out to its original form
- Therefore, another feature of physical change is that they are …….

Physical changes are defined by four features:

1. ……
2. ……
3. ……
4. ……

- Physical changes do not alter the ……. of a substance.
- The only change that is occurring is to the …… of the substance
- Generally these physical processes are **reversible**
  - They have

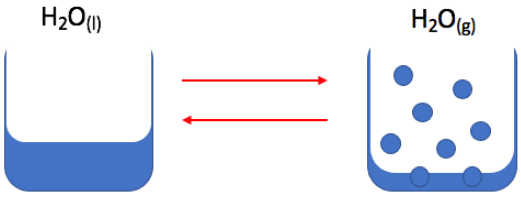
    ……

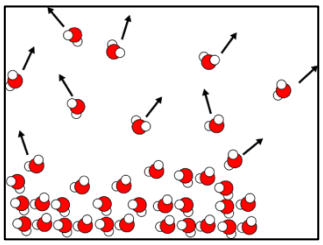
    ……

Examples

- Changing the shape of structures e.g. crushing, bending
- Changing the states of substances e.g. melting, boiling, freezing, dissolving

In chemistry, an example of physical change is the boiling of water



- The process of boiling involves turning water from a liquid to a gaseous state
- All that is happening is the $H_2O$ molecules are separated from each other due to increased energy from heat

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- Recall: The kinetic particle theory states that the energy of molecules plays a role in determining the state of matter

## 1.2 <u>Chemical change</u>

- A chemical change is a change to the …… of a substance.

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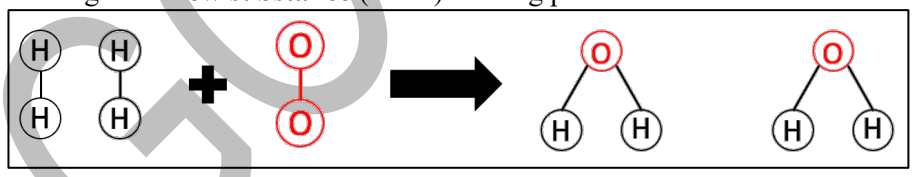
E.g the formation of water through hydrogen gas and oxygen gas

- This is a chemical change as a **new substance** (water) is being produced from our reactants




- The water molecules contain bonds between the oxygen and hydrogen atoms
- In order to form these bonds, the bonds within the oxygen gas and hydrogen gas must be **broken** first
- Therefore, we have the breaking and reformation of bonds

Features of a chemical change

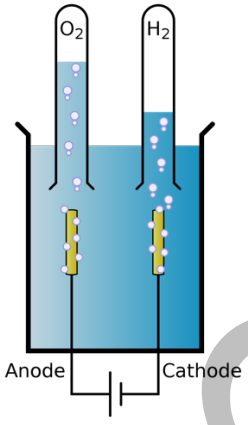
1. ……
2. ……
3. ……
4. ……

Consider the reverse reaction

- The reverse reaction to the production of water is achieved through Electrolysis
- Electrolysis involves the use of electricity to break the bonds of $H_2O$ to produce Oxygen gas and Hydrogen gas

$$2H_2O_{(l)} \rightarrow 2H_{2(g)} + O_{2(g)}$$

- We can see higher energy requirements are necessary to reverse this reaction




Note:

- Hydrogen gas takes up more space compared to Oxygen gas on the electrolysis setup
- ……

Therefore, Hydrogen gas has twice the volume

**Indicators of Chemical Change**

There are indicators that allow us to determine whether or not a chemical change has occurred

These indicators of chemical changes are:

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- Effervescence is the formation of bubbles, whereas an odour is when the gas produced has a distinct scent

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- A precipitate is a solid substance that is formed from a solution

Note: Change in colour and temperature are **not definite** indicators of a chemical change
Consider the boiling of water: there is a temperature change, but no chemical change.

**Summary**

| Physical Changes | Chemical Changes |
|---|---|
| A physical change has no new substance being produced | A chemical change has a new substance being produced |
| Physical changes alter the physical form of a substance | Chemical changes alter the chemical composition of a substance |
| Lower energy requirements | Higher energy requirements |
| Easy to reverse | Difficult to reverse as chemical bonds must be broken and reformed |

## 1.3 Chemical equations

- Chemical equations are a fundamental skill that is used frequently in Chemistry
- Chemical equations are used to represent chemical reactions

A chemical equation is composed of …….

- Reactants are the substances that start chemical reactions
- Products are the substances that are produced due to the chemical reaction

Chemical equations always follow the same basic structure

**Reactants → Products**

- The reactants are always on the left and the products are always on the right
  - The arrow means 'to react together to form'
- There are two types of arrows

  → : irreversible (one-way) reaction

  ⇌ : reversible (two-way) reaction

There are TWO types of chemical equations

1. Word equations

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2. Symbol equations

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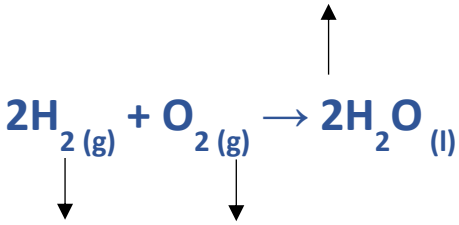
- Word equations use the names of chemical substances to represent a change
- Symbol equations use the chemical symbols of elements to represent a change
  - These chemical symbols are found on the periodic table

- Symbol equations are used more frequently as they provide more information

Consider the symbol equation below




From the equation, three pieces of information are provided.

- The number of molecules, which is represented by the large co-efficient. If there is no co-efficient in front of a substance, it is assumed to be 1
- The number of atoms, which is represented using the subscripts (smaller numbers). If there is no subscript, it is assumed to be 1
- The state of matter the substance is in. These are denoted using subscript letters in brackets

The equation above shows that we have 2 molecules of Hydrogen gas reacting with 1 molecule of Oxygen gas to produce 2 molecules of liquid Water

In total, there are 4 Hydrogen atoms and 2 Oxygen atoms

In chemical equations, the states of matter is denoted using different letters:

(s) Solid

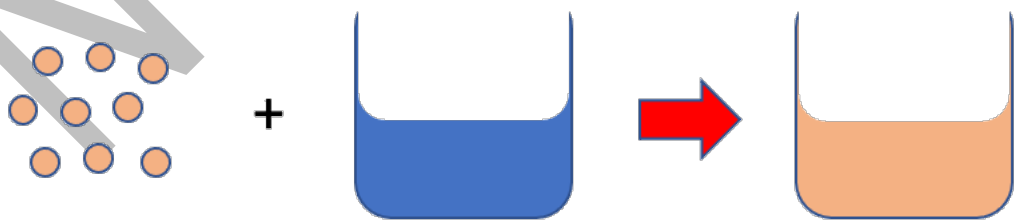
(l) Liquid

(g) Gaseous

(aq) Aqueous

An aqueous substance is any substance that is dissolved in water

Consider the diagram below:



- Table salt (NaCl) is a solid when not exposed to water. However, when the salt is mixed with water it dissolves

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**Practice 1**

Consider the chemical reaction below:

$$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$$

State the number of atoms for each element present in the reaction

### 1.4 Balancing equations

When writing chemical equations, it is important to consider the Law of Conservation of Mass

This law states that:

If we apply this law to chemical reactions:

- The mass of the products in a chemical reaction must equal to the mass of the reactants

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This is achieved through the balancing of chemical equations

- Balancing equations is an important skill to master for HSC Chemistry

Consider the electrolysis of water below:

$$2H_2O_{(l)} \rightarrow 2H_{2\,(g)} + O_{2\,(g)}$$

The equation is balanced as there are equal number of reactant and product atoms

- 4 Hydrogen atoms on both sides of the chemical equation
- 2 Oxygen atoms on both sides of the chemical equation

There are two main rules to follow when balancing chemical equations

1. Write the chemical equation using chemical symbols
    - Ensure that the chemical substance exists in nature e.g. Oxygen doesn't exist as "O", but rather exists as a diatomic molecule "$O_2$"

2. Put numbers in front of each chemical species to balance the chemical equation
    - Do **NOT** change the subscript of the chemical substance - this will produce a different substance
    - E.g. "$O_2$" is Oxygen gas, whereas "$O_3$" is Ozone

There are three steps to follow when balancing a chemical equation

1. Balance the metals first
2. Balance the non-metals second, excluding the hydrogen atoms and oxygen atoms
3. Balance hydrogen, then oxygen

**Example 1**

Balance the chemical equation below:

Iron (III) oxide reacts with carbon monoxide to produce iron solid and carbon dioxide gas

**Practice 2**

Balance the chemical equations below:

a) Sodium phosphate reacts with magnesium chloride to produce sodium chloride and magnesium phosphate

b) $KI + KClO_3 + HCl \rightarrow I_2 + H_2O + KCl$

c) Octane ($C_8H_{18}$) burns in oxygen gas to produce carbon dioxide and water

**Practice 3**

The production of sulfur trioxide gas involves the combination of sulfur dioxide gas and oxygen gas.

a) Construct a balanced chemical equation for this reaction. (1 mark)

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b) If 4500 molecules of oxygen was reacted, how many molecules of sulfur trioxide were formed? (1 mark)

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The contact process involves the production of sulfuric acid ($H_2SO_4$) through the combination of sulfur trioxide gas and water.

c) Given your answer in part b), how many molecules of sulfuric acid was created? (2 marks)

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**Practice 4**

Explain the difference between a physical and chemical change by using boiling vs electrolysis of water (3 marks)

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**Practice 5**

"Toasting of bread is a physical change as there are no new substances formed". Discuss why this statement is false. (3 marks)

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