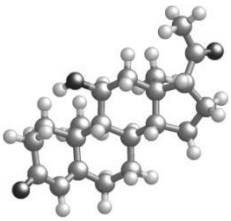


Chem!stry

Name: …… **( )**

Class: ……

Date: …… **/** …… **/** ……

Secondary Two Science – Exploring Interactions – Chemical Changes

1. Introduction

Introduction – The world around us is made-up of chemicals. Some of these chemicals are composed of only one type of atom (elements) and some of these chemicals are composed of two or more atoms of different chemical elements bonded together (compounds). For example, sodium (symbol Na) and chlorine (symbol C*l*) are both *chemical elements* which react together to form the *compound* sodium chloride (formula NaC*l*).

The human body itself is an intricate system composed of very complex compounds – such as carbohydrates, fats and proteins – all of which interact with each other.

human body ↔ organ systems ↔ organs ↔ tissues ↔ cells ↔ organelles ↔ compounds

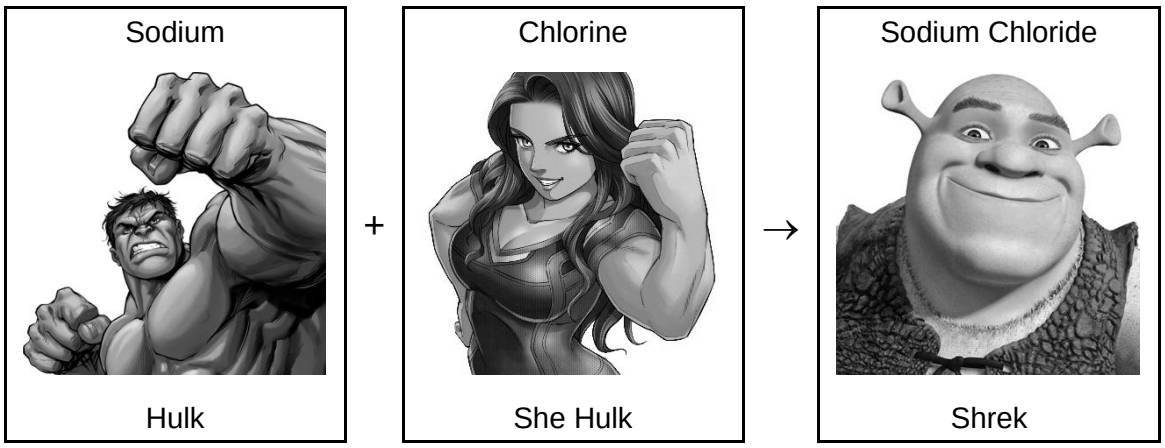
scale – macroscopic scale – microscopic

• Video: The reaction between sodium and water.	• Video: The reaction between iron and chlorine.	• Video: The reaction between sodium and chlorine.

Sodium is a metallic element. Like most metallic elements, sodium is a solid at room temperature, but it will melt and turn into a liquid at 98 °C. Sodium reacts vigorously with water to produce flammable hydrogen gas and lots of energy – not the sort of element that you would want to put in your mouth!

Chlorine is a non-metallic green-yellow gas at room temperature. Its highly toxic and corrosive properties led it to being used as a chemical weapon in World War I – not the sort of element that you would want to breath in!

Although sodium and chlorine are very reactive and harmful as the pure elements, something remarkable happens when they interact with each other – they react to form a new substance known as sodium chloride, or *common table salt*, which is safe enough for us to eat!



- What other analogies can you think of to describe the changes that take place when sodium reacts with chloride to form sodium chloride?

2. Essential Questions

(a) In the introduction, what is one example of a physical change, and what is one example of a chemical change?

(b) What criteria do we use to classify a change as either physical or chemical? What key characteristics do these changes have?

(c) Why are the properties of the reaction products (*e.g.* sodium chloride) often very different from the properties of the original reactants (*e.g.* sodium and chlorine)?

(d) How do chemical changes occur?

(e) How can chemical changes be classified and what are examples of these chemical changes / reactions in our everyday lives? What are some examples of chemical changes that are **(i)** beneficial, **(ii)** harmful?

(f) How can chemical changes (chemical reactions) be represented clearly and concisely using symbols?

(g) Which chemicals are soluble in water and which chemicals are insoluble in water? How can these solubility rules allow Scientists to include more useful information in the balanced chemical equations that they write? [Optional enrichment for students]

(h) What properties do chemicals have that allows them to be classified as either acids or alkalis?

(i) What are the typical chemical changes (chemical reactions) that acids and alkalis undergo?

(j) Many of the reactions of acids and alkalis produce a gas as one of the reaction products. What are the properties of these gases, and how can these properties be used to uniquely identify each gas?

(k) How can the acidity or alkalinity of a substance be measured, represented and changed?

(l) What are examples of situations in which the acidity or alkalinity of a substance must be carefully monitored and controlled?

- If you already know the answers to some of these questions, write them here.

  ……..

  ……..

  ……..

  ……..

- What questions would you like to ask about this topic?

  ……..

  ……..

  ……..

  ……..

3. Desired Learning Outcomes

(a) Differentiate between physical and chemical changes.

(b) Understand that chemical changes can occur when chemicals interact with each other. Chemical changes can also occur when chemicals and energy interact with each other. The products of these chemical changes are different from the original starting materials.

(c) Identify chemical changes as combustion, thermal decomposition and oxidation.

(d) Describe some benefits and harmful effects of chemical changes.

(e) Derive the solubility rules for common chemicals in water – the general rules and their exceptions. [Optional enrichment for students]

(f) Interpret chemical equations.

(g) Write balanced chemical equations.

(h) Describe the meanings of the terms acid and alkali in terms of the ions they produce in aqueous solution and their effects on Universal Indicator.

(i) Describe the characteristic properties of acids as in reactions with metals, bases and carbonates.

(j) Describe *neutralisation* as the reaction between hydrogen ions (from an acid) and hydroxide ions (from an alkali) to produce water:

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

(k) Describe the characteristic properties of bases in reactions with acids and with ammonium salts.

(l) Describe the characteristic tests for the three gases; hydrogen, carbon dioxide and ammonia.

(m) Describe how to test hydrogen ion concentration and hence relative acidity using Universal Indicator and the pH scale.

(n) Describe the importance of measuring and controlling the pH of substances, *e.g.* measuring and controlling the pH of soil to grow crops effectively.

4. Macroconcepts

Interactions between the components of a system cause changes to take place.

(a) What are some examples of this statement?

……

……

(b) What are some general ideas about the concept of *change*?

……

……

(c) What are some general ideas about the concept of *systems*?

……

……

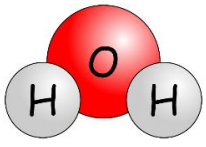
(d) Do interactions always cause changes to take place, and is change always caused by interactions?

……

……

5. Physical Changes

Water is a compound with the formula H_2O. This means that a single molecule of water is composed of two atoms of the element hydrogen (symbol – H) bonded to one atom of the element oxygen (symbol – O). Water can exist in different states, solid (s) liquid (*l*) and gas (g) which can change from one form to another as shown below.



$$H_2O(s) \underset{z}{\overset{w}{\rightleftharpoons}} H_2O(l) \underset{y}{\overset{x}{\rightleftharpoons}} H_2O(g)$$

ice — liquid water — steam

(a) What does the symbol $\rightleftharpoons$ represent?

……

(b) Name the changes represented by the symbols ***w***, ***x***, ***y*** and ***z***.

……

(c) The changes represented by symbols ***w***, ***x***, ***y*** and ***z*** are physical changes. What are the general characteristics of physical changes?

……

……

• Interactive animation on the states of matter.

- From the interactive animation…

→ State three things that you have learned about the states of matter:

→ State two interesting facts about the states of matter:

→ State one question that you still have about the states of matter:

……

……

……

6. Chemical Changes

During cellular respiration in the mitochondria of cells, glucose reacts with oxygen to from carbon dioxide and water, releasing energy in the process.

reactants			→	products		
glucose	+	oxygen	→	carbon dioxide	+	water
$C_6H_{12}O_6$	+	$6O_2$	→	CO_2	+	$6H_2O$

(a) What does the symbol → represent?

……...

(b) Explain why cellular respiration is **not** classified as a physical change.

……...

……...

(c) Cellular respiration is classified as a chemical change. What are the general characteristics of a chemical change that make it different from a physical change?

……...

……...

……...

……...

(d) The chemical name for common table salt is sodium chloride, formula NaC*l*. Solid sodium chloride, NaC*l*(s), dissolves in water to form an aqueous solution of sodium chloride, NaC*l*(aq), represented by the equation given below.

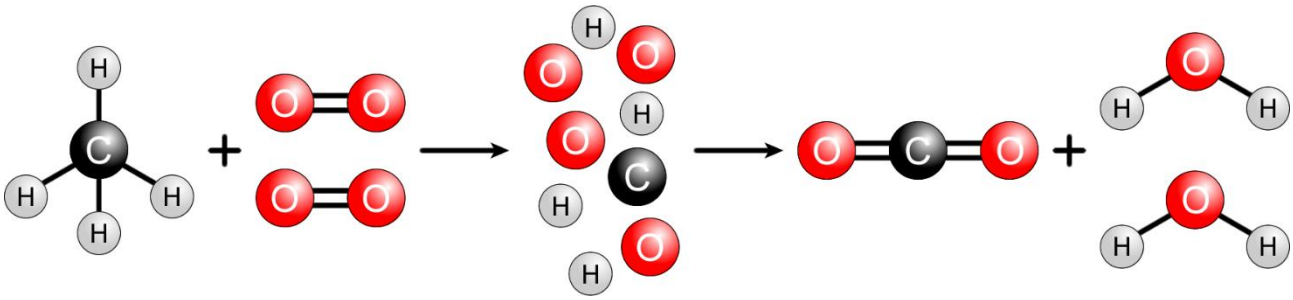
$$\underset{\text{solid sodium chloride}}{NaCl(s)} \xrightarrow{\text{add water}} \underset{\text{aqueous sodium chloride}}{NaCl(aq)}$$

Explain whether dissolving sodium chloride in water is a physical change or a chemical change.

……...

……...

(e) The diagram below represents the reaction between methane, CH_4, and oxygen, O_2, to form carbon dioxide, CO_2, and water, H_2O. The black lines represent bonds between the atoms.



The chemical properties (the reactivity of the chemical and the way that it reacts) and physical properties (for example, melting point and density) of the reaction products are different from those of the starting materials. With reference to the diagram, give possible reasons to explain this.

……...

……...

……...

……...

7. Types of Chemical Change

(a) Combustion

Combustion is a chemical reaction in which a substance is heated in the presence of oxygen to form one or more new substances. Heat and light are usually given out during combustion. For example, when petrol undergoes combustion in the engine of a moving car, chemical potential energy in the petrol is converted into kinetic energy.

petrol + oxygen $\rightarrow$ carbon dioxide + water

(b) Thermal Decomposition

Thermal decomposition is the process by which a single substance breaks down into two or more simpler substances upon heating. For example, calcium carbonate, which makes up egg shells and the shells of sea creatures, decompose on heating to produce calcium oxide and carbon dioxide.

calcium carbonate $\rightarrow$ calcium oxide + carbon dioxide

(c) Oxidation

Oxidation is a chemical change that takes place when a chemical gains oxygen. Common examples of oxidation include the rusting of iron and cellular respiration. Iron reacts slowly with oxygen and water to produce rust – a reddish-brown flaky solid. In the mitochondria of cells, a carefully controlled reaction between glucose and oxygen takes place producing carbon dioxide and water as the products. The energy released during this reaction is used for growth and repair of the organism.

$$\text{glucose} + \text{oxygen} \rightarrow \text{carbon dioxide} + \text{water}$$

8. Solubility Rules – Optional Enrichment for Students

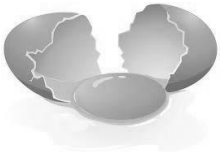
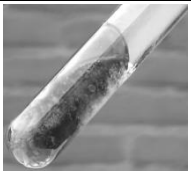
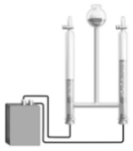
(a) The solubility of chemicals in water can be established experimentally. Adding many different chemicals to water and observing whether or not they dissolve allows enduring patterns to be identified.

- All ammonium salts are …… in water.
- All potassium salts are …… in water.
- All sodium salts are …… in water.
- All carbonates are …… in water except for …… which are …….
- All chlorides are …… in water except for …… which are …….
- All hydroxides are …… in water except for …… which are …….
- All nitrates are …… in water.
- All sulfates are …… in water except for …… which are …….

(b) Based upon these solubility rules, what are the solubilities of the following chemicals in water – are they soluble or insoluble? Tick the appropriate box ☑ to record your answer.

(i)	Sodium carbonate	soluble ☐	insoluble ☐
(ii)	Zinc nitrate	soluble ☐	insoluble ☐
(iii)	Copper(II) hydroxide	soluble ☐	insoluble ☐
(iv)	Silver chloride	soluble ☐	insoluble ☐
(v)	Iron(II) sulfate	soluble ☐	insoluble ☐

9. How do Chemical Changes Occur?

Interactions Between Matter	Examples (Click on the picture in the document.pdf to view a video of the chemical change)	
Mixing	Combining Chemicals Together: Some chemicals react when mixed together at room temperature without the need for heating. *e.g.* Glycerol and potassium manganate(VII) react together spontaneously, releasing heat and light.	
Heat	Cooking an Egg: Proteins in the egg are denatured by heat and changed colour and texture.	
Heat	Thermal Decomposition: When a substance is broken down into two or more simpler substances by the effect of heat. *e.g.* Heating sugar until it turns brown: sugar → carbon + water vapour	
Oxygen (oxidation)	Rusting: Iron rusts in the presence of oxygen and water: iron + oxygen + water → iron(III) oxide	
Oxygen (oxidation)	Combustion: A chemical reacts with oxygen when heated. *e.g.* Petrol reacts with oxygen to produce carbon dioxide and water, releasing energy in the process: petrol + oxygen → carbon dioxide + water	
Oxygen (oxidation)	Cellular Respiration: This process occurs in animal and plant cells. A controlled reaction between glucose and oxygen produces carbon dioxide and water, releasing energy in the process: glucose + oxygen → carbon dioxide + water	
Light	Photosynthesis: This process occurs in the chloroplasts of green plants. Carbon dioxide and water are converted into glucose and oxygen in the presence of sunlight: carbon dioxide + water → glucose + oxygen	
Light	X-Ray Films: X-ray films are coated with silver bromide crystals on a thin plastic base. The silver bromide crystals are then converted to silver and bromine by X-rays, producing an image on the x-ray film.	
Electricity	Electrolysis: This is the chemical decomposition of a substance when an electric current passes through it. *e.g.* electrolysis of water: water → hydrogen (gas) + oxygen (gas)	
Electricity	Electroplating: The process in which a substance is coated with a metal with the passage of an electric current. *e.g.* the silver plating of cutlery and jewellery.	

10. How are Chemical Changes Represented using Symbols?

hydrogen valency = 1 | oxygen valency = 2 | hydrogen valency = 1 | water formula = H_2O

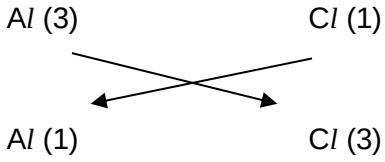
- Valency is defined as the number of electrons that a metal will lose or a non-metal will gain in order to obtain the electronic configuration of a noble gas.
- Valencies of the chemical elements:

	metals			non-metals				
Group number in the Periodic Table	1	2	13	14	15	16	17	18
Number of electrons lost or gained to obtain the electronic configuration of a noble gas	lose 1	lose 2	lose 3	gain 4	gain 3	gain 2	gain 1	0
Valency of chemical elements in that Group of the Periodic Table (refer to the Periodic Table)	1	2	3	4	3	2	1	0

- Valencies of the common polyatomic ions:

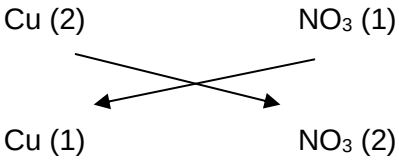
Name	ammonium	hydroxide	nitrate	carbonate	sulfate	phosphate
Formula	NH_4^+	OH^-	NO_3^-	CO_3^{2-}	SO_4^{2-}	PO_4^{3-}
Valency	1	1	1	2	2	3

- Essentially, the formula of a compound is obtained by swapping the valencies of the elements and / or polyatomic ions that are present in the compound, for example:
  Aluminium chloride:



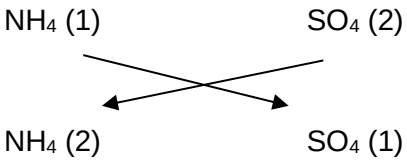
Formula: $AlCl_3$

  Copper(II) nitrate – Note: the (II) means "*copper with a valency of two*" bonded to nitrate:



Formula: $Cu(NO_3)_2$

  Note, ( ) are required when there is more than one of the same polyatomic ion.
  Ammonium sulfate:



Formula: $(NH_4)_2SO_4$

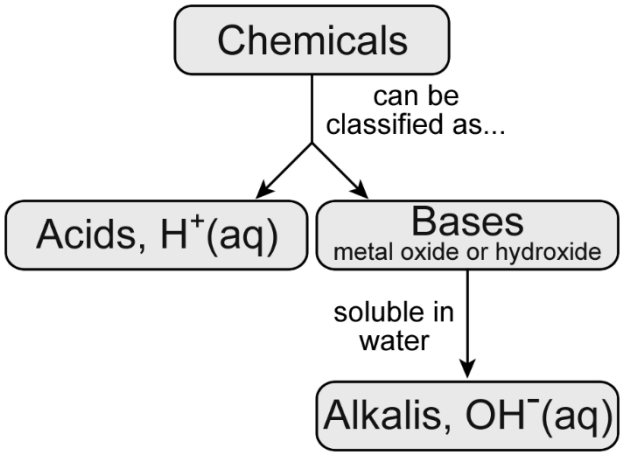
  Note, ( ) are required when there is more than one of the same polyatomic ion.

(a) Write the correct formula for each one of the following compounds in the space provided.

(i)	sodium oxide	……	**(ii)**	magnesium chloride	……
(iii)	aluminium bromide	……	**(iv)**	calcium hydroxide	……
(v)	iron(III) chloride	……	**(vi)**	aluminium oxide	……
(vii)	sodium sulfate	……	**(viii)**	iron(III) nitrate	……
(ix)	potassium phosphate	……	**(x)**	ammonium carbonate	……

• Video: The reaction between carbon disulfide and nitrogen monoxide.	• Video: The decomposition of nitrogen triiodide.	• Video: The reaction between iron(III) oxide and aluminium.

11. Reactions of Acids



(a) The names and formulae and uses of some common acids are given below:

Name of Acid	Formula of Acid	Use or Application of Acid
hydrochloric acid	HCl	found in the stomach – used to digest food
nitric acid	HNO_3	used to make fertilisers and explosives
sulfuric acid	H_2SO_4	found in the batteries of cars and lorries
phosphoric acid	H_3PO_4	used as a food preservative and flavouring in Coca-Cola
ethanoic acid	CH_3COOH	vinegar is a dilute solution of ethanoic acid

Which chemical element do acids all contain?

……...

(b) Balanced chemical equations showing the changes taking place when an acid dissolves in water are shown below:

$$HCl(g) \rightarrow H^+(aq) + Cl^-(aq)$$

$$HNO_3(l) \rightarrow H^+(aq) + NO_3^-(aq)$$

$$H_2SO_4(l) \rightarrow 2H^+(aq) + SO_4^{2-}(aq)$$

(i) Which particle is *always* formed when an acid dissolves in water?

……

(ii) Based upon your previous answer, define the term *acid*.

……

……

• Interactive animation on balancing chemical equations.

- From the interactive animation…

→ State three things that you have learned about balancing chemical equations:

→ State two interesting facts about balancing chemical equations:

→ State one question that you still have about the balancing chemical equations:

……

……

……

(c) Reaction 1: Acid + Reactive Metal

Some word equations, and their corresponding balanced chemical equations, for reactions between acids and metals are given below. Note: The balanced chemical equation gives the formulae of the chemicals and the state that they are in – (s) for solid, (*l*) for liquid, (g) for gas and (aq) for aqueous. Whole numbers, called *coefficients*, may need to be written in front of some formulae in order to *balance* the chemical equation – *i.e.* ensure that all particles are conserved during the reaction.

hydrochloric acid + magnesium → magnesium chloride + hydrogen gas

$$2HCl(aq) + Mg(s) \rightarrow MgCl_2(aq) + H_2(g)$$

sulfuric acid + zinc → zinc sulfate + hydrogen gas

$$H_2SO_4(aq) + Zn(s) \rightarrow ZnSO_4(aq) + H_2(g)$$

(i) Magnesium chloride and zinc sulfate are both classified as *salts*. Based upon the information provided, write a general word equation that describes the reaction between an acid and a metal.

……

(ii) The word equation for the reaction between nitric acid and calcium is given below. Write the balanced chemical equation for this reaction.

nitric acid + calcium → calcium nitrate + hydrogen

……

(iii) Give the names and formulae of the products that are formed when sulfuric acid reacts with sodium.

……

(d) Reaction 2: Acid + Base

A base is classified as a metal oxide or metal hydroxide. If the base is soluble in water, then it can be further classified as an alkali. Alkalis dissolve in water to produce an aqueous solution of hydroxide ions, OH^-, for example:

sodium hydroxide (solid) → sodium ions (aqueous) + hydroxide ions (aqueous)

$$NaOH(s) \rightarrow Na^+(aq) + OH^-(aq)$$

Some word equations, and their corresponding balanced chemical equations, for reactions between acids and bases are given below.

sulfuric acid + sodium hydroxide → sodium sulfate + water

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

nitric acid + calcium hydroxide → calcium nitrate + water

$$2HNO_3(aq) + Ca(OH)_2(aq) \rightarrow Ca(NO_3)_2(aq) + 2H_2O(l)$$

(i) Sodium sulfate and calcium nitrate are both classified as *salts*. Based upon the information provided, write a general word equation that describes the reaction of any acid with any base.

……

(ii) The word equation for the reaction between hydrochloric acid and copper(II) oxide is given below. Write the balanced chemical equation for this reaction.

hydrochloric acid + copper(II) oxide → copper(II) chloride + water

……

(iii) Give the names and formulae of the products that are formed when nitric acid reacts with magnesium oxide.

……

Note: Neutralisation is described as the process when the hydrogen ions from an acid react with the hydroxide ions from an alkali to form water.

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

(e) Reaction 3: Acid + Metal Carbonate

Metal carbonates are compounds that contain a metal and the carbonate polyatomic ion. Some word equations, and their corresponding balanced chemical equations, for reactions between acids and metal carbonates are given below.

nitric acid + sodium carbonate $\rightarrow$ sodium nitrate + water + carbon dioxide

$$2HNO_3(aq) + Na_2CO_3(aq) \rightarrow 2NaNO_3(aq) + H_2O(l) + CO_2(g)$$

hydrochloric acid + calcium carbonate $\rightarrow$ calcium chloride + water + carbon dioxide

$$2HCl(aq) + CaCO_3(s) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

(i) Sodium nitrate and calcium chloride are both classified as *salts*. Based upon the information provided, write a general word equation that describes the reaction of any acid with any metal carbonate.

……

(ii) The word equation for the reaction between sulfuric acid and potassium carbonate is given below. Write the balanced chemical equation for this reaction.

sulfuric acid + potassium carbonate $\rightarrow$ potassium sulfate + water + carbon dioxide

……

(iii) Give the names and formulae of the products that are formed when nitric acid reacts with copper(II) carbonate.

……

12. Reactions of Bases: Base + Ammonium Salt

Ammonium salts are compounds that contain the ammonium polyatomic ion combined with another species, such as a chloride ion, nitrate ion or sulfate ion. Some word equations, and their corresponding balanced chemical equations, for reactions between ammonium salts and bases are given below.

ammonium chloride + sodium hydroxide $\rightarrow$ sodium chloride + water + ammonia

$$NH_4Cl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l) + NH_3(g)$$

ammonium nitrate + calcium hydroxide $\rightarrow$ calcium nitrate + water + ammonia

$$2NH_4NO_3(aq) + Ca(OH)_2(aq) \rightarrow Ca(NO_3)_2(aq) + 2H_2O(l) + 2NH_3(g)$$

(a) Sodium chloride and calcium nitrate are both classified as *salts*. Based upon the information provided, write a general word equation that describes the reaction of any ammonium salt with any base.

……..

(b) The word equation for the reaction between ammonium sulfate and sodium hydroxide is given below. Write the balanced chemical equation for this reaction.

ammonium sulfate + sodium hydroxide $\rightarrow$ sodium sulfate + water + ammonia

……..

(c) Give the names and formulae of the products that are formed when ammonium nitrate reacts with potassium hydroxide.

……...

13. Tests for Gases

(a) Hydrogen gas is highly flammable. Based upon this property, suggest how it might be possible to test for the hydrogen gas that is produced when a metal reacts with an acid.

……...

……...

(b) Carbon dioxide gas reacts with aqueous calcium hydroxide, $Ca(OH)_2(aq)$, to form white calcium carbonate, $CaCO_3(s)$, which is insoluble in water. Based upon this property, suggest how it might be possible to test for the carbon dioxide gas that is produced when a metal carbonate reacts with an acid.

……...

……...

(c) Ammonia gas is alkaline. Based upon this property, suggest how it might be possible to test for the ammonia gas that is produced when an ammonium salt reacts with an alkali.

……...

……...

14. pH Scale

We can use the pH scale to measure how acidic or alkaline a solution is. The values of the pH scale range from 0 to 14.

Solutions with pH values less than 7 are *acidic*. The lower the pH value, the more acidic the solution. Solutions with pH values greater than 7 are *alkaline*. The greater the pH value, the more alkaline the solution. Substances which are either very acidic or very alkaline are usually corrosive and can burn our skin.

Solutions with a pH value of exactly 7 are neither acidic nor alkaline. Such solutions are described as being *neutral*. An example of a neutral liquid is pure water. Note that tap water is not neutral because of the minerals that are dissolved in it.

In school laboratories, litmus paper is often used to quickly and simply test whether a solution is either acidic or alkaline.

Type of Solution	**Action On**	
	Red Litmus Paper	**Blue Litmus Paper**
acidic	remains red	turns red
alkaline	turns blue	remains blue
neutral	remains red	remains blue

Universal Indicator is an indicator that provides approximate pH values. It is available to use in the form of paper strips or as a solution. Universal Indicator is made up of a mixture of indicators, hence it is able to a wide range of colours depending on the pH of the solution tested. **Figure 14** shows how Universal Indicator changes colour when exposed to different household substances which have different pH values.

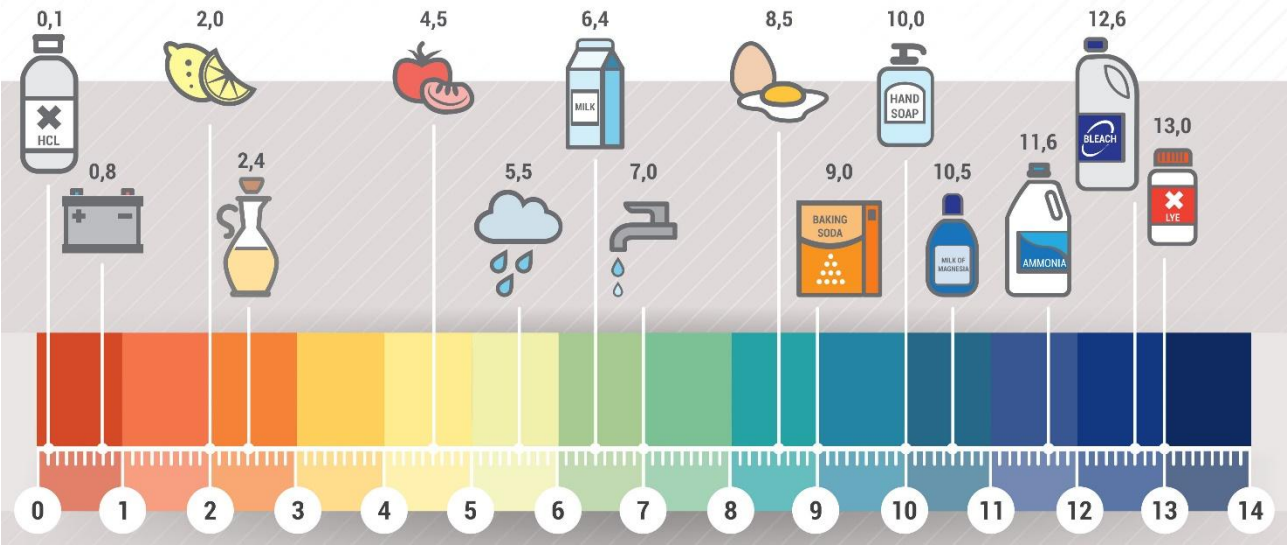


Figure 14. Universal Indicator and the pH values of some common household substances.

• Interactive animation on pH.

- From the interactive animation…

→ State three things that you have learned about pH:
→ State two interesting facts about pH:
→ State one question that you still have about pH:

……

……

……

……

……

Applications of Neutralisation

• Your mouth is full of bacteria which form a film over your teeth called dental plaque. When you consume food and drinks that are high in carbohydrates, particularly food and drinks that are sugary, the bacteria metabolise the carbohydrates to release energy – producing acids at the same time. These acids can break down the enamel of your teeth forming holes or cavities. Toothpaste is typically alkaline (pH between 7 and 10) and therefore neutralises the acid, reducing the incidence of tooth decay.

	• Acid reflux is a condition in which hydrochloric acid from the stomach passes up into the oesophagus. This often causes irritation and discomfort to the individual suffering from the condition. The condition can be treated quite easily by swallowing an *antacid* – a chemical that reacts with the hydrochloric acid and neutralises it. Common antacids that are available from the pharmacy include calcium carbonate, $CaCO_3$, and magnesium hydroxide, $Mg(OH)_2$.
	• Different crops grow well under different conditions of pH. For example, blueberries grow well at a pH of 5.0 – 5.5, rice grows well at a pH of 5.5 – 6.5 and alfalfa grows well at a pH of 6.5 – 7.0. Farmers can adjust the pH of a soil to suite the crop that will be grown in it. Acidic soil can be neutralised (its pH can be increased) by adding calcium carbonate, $CaCO_3$, calcium oxide, CaO, or calcium hydroxide, $Ca(OH)_2$. Alkaline soil can be neutralised (its pH can be decreased) by adding ammonium sulfate, $(NH_4)_2SO_4$.

15. Chemical Changes in Our Everyday Lives

Give examples of chemical changes / chemical reactions that you encounter in your everyday life. What are some examples of chemical changes that you might read about in the news?

……...

……...

……...

……...

……...

……...

16. Conclusions

(a) Write a general / universal statement about chemical interactions.

……...

……...

……...

(b) Write a general / universal statement about the reactions of acids.

……...

……...

……...

(c) Write a general / universal statement about the importance of chemical changes.

……...

……...

……...

• Links to videos on page 8.

1. Combining Chemicals Together:

https://youtu.be/ziAt0exwO-k

2. Cooking an Egg:

https://youtu.be/f1OhLkHe-5A

3. Thermal Decomposition:

https://youtu.be/eqjnheMIYps

4. Rusting:

https://youtu.be/H0H2m8IPjVE

5. Combustion:

https://youtu.be/s56QeVER_gw

6. Cellular Respiration:

https://youtu.be/9fIKyrBe8m4

7. Photosynthesis:

https://youtu.be/TYZjESECfts

8. X-Ray Films:

https://youtu.be/0-ZfAmY2Epo

9. Electrolysis:

https://youtu.be/8mx_6C47GG0

10. Electroplating:

https://youtu.be/9x9JEe2VtZY

Self-checklist on Chemical Changes

	Aspect of chemical changes:	Yes, I understand	No, I need more help
1.	I understand that change is inevitable. Change can have positive consequences or negative consequences. Change can be reversible or irreversible.	☐	☐
2.	I know that changes can be either *chemical* or *physical*. In general, chemical changes are extremely difficult / impossible to reverse, while physical changes are much easier to reverse.	☐	☐
3.	I can give examples of chemical and physical changes in my everyday life, and I understand why these changes are important.	☐	☐
4.	I understand that the products of a chemical change / reaction have different properties to the starting materials that were used. This is because bonds break and new bonds form, causing the atoms to rearrange themselves.	☐	☐

	Aspect of chemical changes:	Yes, I understand	No, I need more help
5.	I understand that Scientists classify things based upon their similarities and differences, and that classification allows Scientists to organise their understanding of the natural world.	☐	☐
6.	I know that chemical changes / reactions can be classified in different ways, *e.g.* combustion, oxidation and thermal decomposition.	☐	☐
7.	I know that chemical changes / reactions can be caused by a variety of different conditions, *e.g.* heat, light, mixing and electricity.	☐	☐
8.	I know that compounds can be represented by chemical formulae. Chemical formulae can be derived from the symbols of the chemical elements and their valencies.	☐	☐
9.	I know how to determine the valency of an element from its position in the Periodic Table. I can recall the valencies of simple polyatomic ions (*e.g.* SO_4^{2-} = 2). I can use this information to write the chemical formulae of compounds.	☐	☐
10.	I know the change that takes place during a chemical reaction can be represented by writing a chemical equation. Formulae of the starting materials are written on the left-hand-side and the formulae of the products are written on the right-hand-side. An arrow $\rightarrow$ written between the formulae of the reactants and products shows that a change is taking place.	☐	☐
11.	I know that mass must be conserved and hence chemical equations must be *balanced* by writing whole number coefficients in front of the formulae.	☐	☐
12.	I know the three essential reactions of acids and bases: acid + metal $\rightarrow$ salt + hydrogen acid + base $\rightarrow$ salt + water acid + carbonate $\rightarrow$ salt + water + carbon dioxide I can write balanced chemical equations to describe these important reactions.	☐	☐
13.	I know the pH scale tells me how acidic or alkaline a chemical is (below 7 is acidic, 7 is neutral, above 7 is alkaline). I know that it is important to measure and adjust the pH of certain systems so that they work properly (*e.g.* adjusting the pH of soil so that the plants grow well).	☐	☐

- Scan the QR code below to view the soft copy of these notes.

http://www.nygh.sg/lower_secondary_science/sec_two_science/sec_two_chemistry/chemical_change_qu.pdf

- Scan the QR code below to view the answers to these notes.

http://www.nygh.sg/lower_secondary_science/sec_two_science/sec_two_chemistry/chemical_change_ans.pdf

Periodic Table of the Chemical Elements (2017)

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1.0										2 He helium 4.0
3 Li lithium 6.9	4 Be beryllium 9.0		Key atomic number atomic symbol name relative atomic mass									5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium –	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57–71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium –	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0
actinoids	89 Ac actinium –	90 Th thorium 232.0	91 Pa protactinium 231.0	92 U uranium 238.0	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –