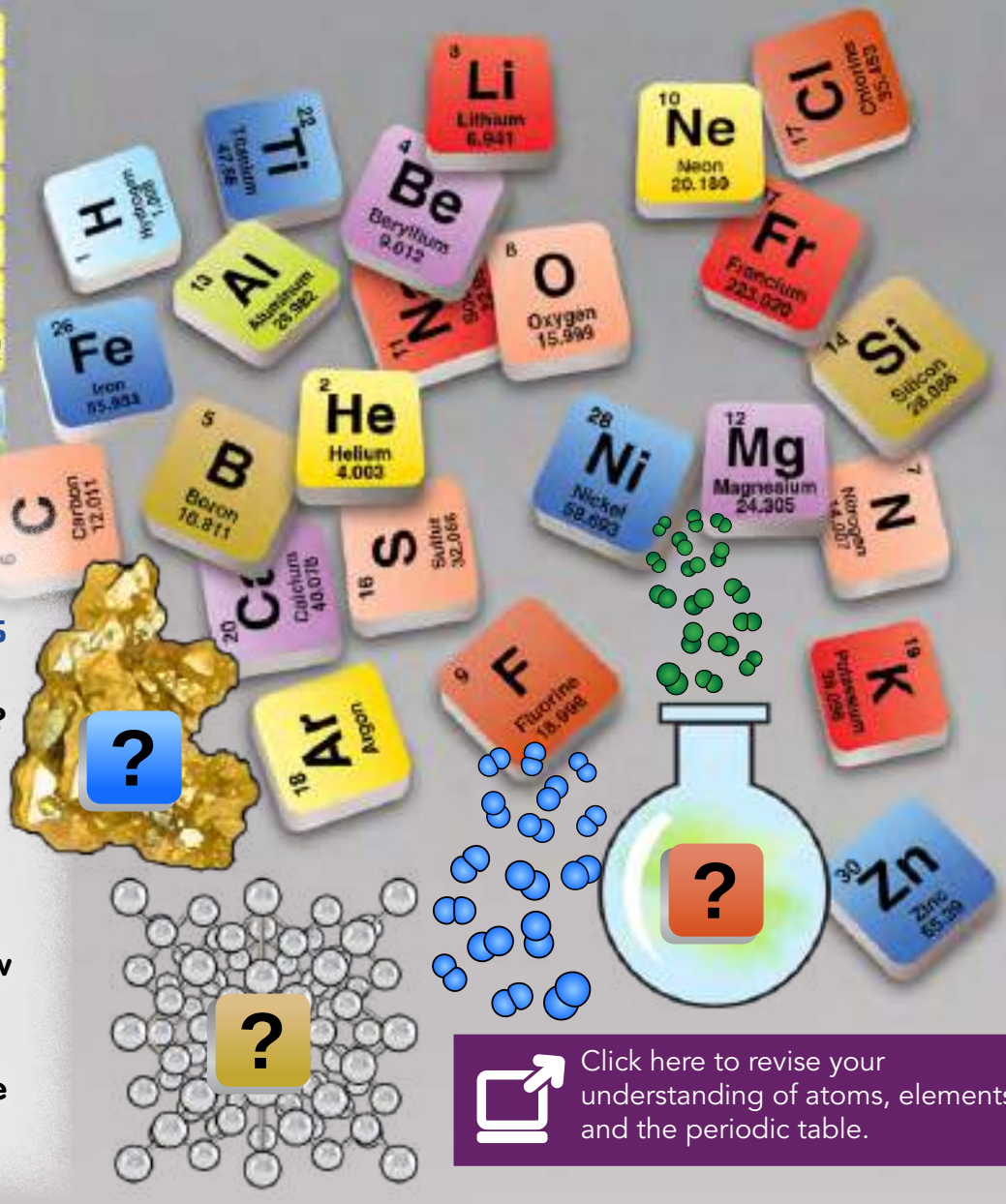
PART 1

Part 1: Periodic rap!

Activity 1.1 Elements and the periodic table

Activity type



ONE OF THE MOST IMPORTANT DISCOVERIES EVER MADE WAS THAT THE WORLD AROUND US IS MADE OF ATOMS. CHEMISTRY IS THE STUDY OF HOW THESE ATOMS INTERACT AND REACT.

What do you remember about the elements and the periodic table?

Elements are the simplest chemical substances. They cannot be broken down into simpler substances. Each element consists of just one type of atom, which carries the same name as the element.

In 1871 Dimitri Mendeleev arranged some 75 known elements into the periodic table. In this table elements with similar properties were grouped together, particularly in the same column. Mendeleev was able to use this reasoning to predict the properties of new elements based on gaps in his table.

Today we know of 90 naturally occurring elements, and many more that are only created in nuclear reactions.

Click here to revise your understanding of atoms, elements and the periodic table.

Activity 1.2 What's in a period?

Activity type

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How do the elements vary as you move across the periodic table? We will investigate period three.

HAVE YOU GOT YOUR LAB COAT AND SAFETY GOGGLES ON? HAIR TIED BACK AND ENCLOSED SHOES?

WHEN YOU HANDLE CHEMICALS YOU NEED TO ASSESS RISKS AND TAKE PRECAUTIONS. REVISE LAB SAFETY WITH YOUR TEACHER AND FAMILIARISE YOURSELF WITH CHEMICAL SAFETY WARNINGS. KEEP AN EYE OUT FOR THIS SIGN AS YOU PROGRESS THROUGH THE UNIT.

REMEMBER LAB SAFETY STARTS WITH YOU!

Part A: Examining the elements

What to use:

Each GROUP will require:

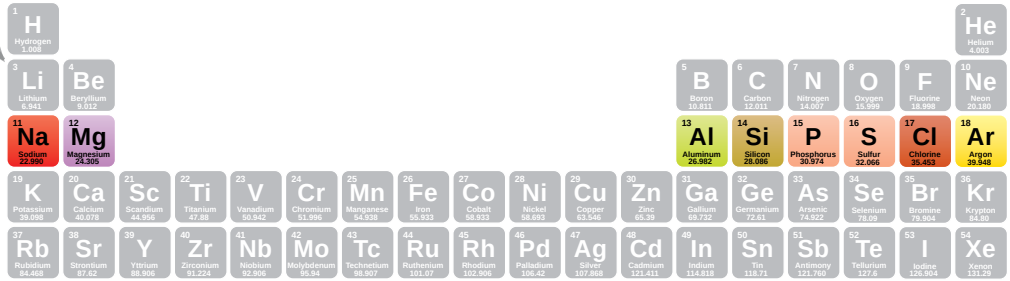
- samples of period three elements e.g. magnesium, aluminium, silicon, sulfur, argon
- data table
- *Science by Doing* ***Notebook***.

Teacher demonstration

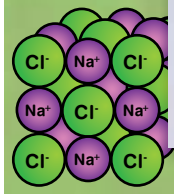
Your teacher will show you samples or refer to the digital images of sodium, phosphorus and chlorine.

Step 1
Draw up a table as shown below.

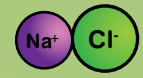
Step 2
Use your observations and the data sheet to complete the table.



Property	Na	Mg	Si	P	S	Cl	Ar
Appearance							
State at room temperature							
Electron configuration							
Type of structure							
Metal/ non-metal							
Hard/soft							
m.p/b.p							



Sodium and chlorine combine to form the ionic compound sodium chloride (NaCl). What else do you know about NaCl?



KEEP GOING

Part B: Oxides of period three elements

What to use:

Each GROUP will require:

- oxides of period three elements
- e.g. sodium oxide, magnesium oxide, aluminium oxide, silicon dioxide
- dropper bottle of universal indicator and colour chart
- 4 medium test tubes
- test-tube rack.

Each STUDENT will require:

- data table.

Teacher demonstration

Your teacher will demonstrate the properties of phosphorus and sulfur oxides in a fume hood as these are too dangerous for you to handle.

What to do:

Step 1
Draw up a table as shown to record your results and observations from the teacher demonstration.

Step 2
Add 2 cm depth of sodium oxide solution to a test tube.

Is the solution cloudy?

Does this make it soluble or insoluble? Save your solution in the test-tube rack.

Step 3
Add half a spatula of magnesium oxide to a test tube together with 2 cm of water. Record whether the oxide is soluble, partly soluble or insoluble.

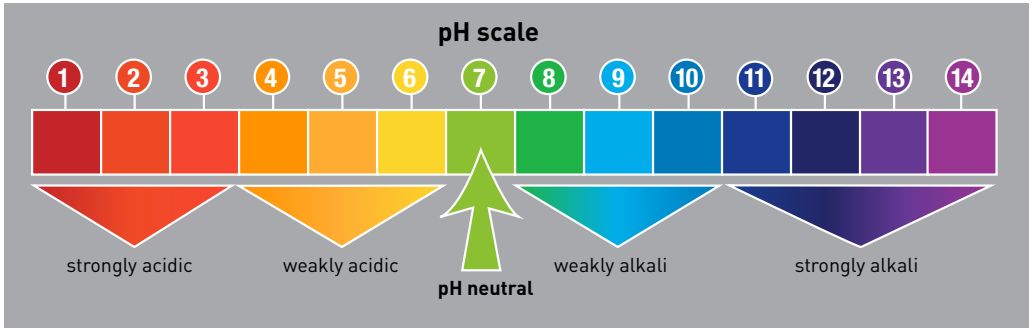
Step 4
Repeat Step 2 with aluminium and silicon oxides.

Step 5
Add three drops of universal indicator to each test tube. Use the colour chart to determine the pH.

Discussion:

1. Examine your result tables. What trend do you notice?
2. Write an overall conclusion to describe the changes in elements as you move across the periodic table.
3. Discuss your ideas with other groups. Do they have the same conclusions?

Oxide	Na	Mg	Al	Si	P	S
Formula of oxide						
State at room temperature						
Colour						
Solubility						
pH						
Acid/base						



Click here to find out more about the periodic table.

Activity 1.3 Periodic patterns

Activity type

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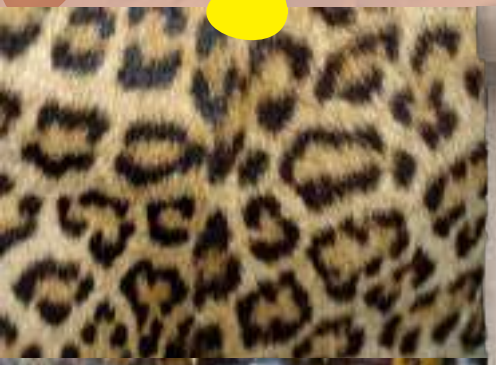
Trends and patterns are everywhere in nature. Does the periodic table have its own patterns?



I will call these groups triads.

triad

Ca

Sr

Ba

The first person to notice patterns in the elements was the German scientist Johann Döbereiner. He proposed his law of triads in 1817. Each of Döbereiner's triads was a group of three elements. The appearance and reactions of the elements in a triad were similar to each other.

Why did Döbereiner choose the name triad?

Investigating a triad

What to do:

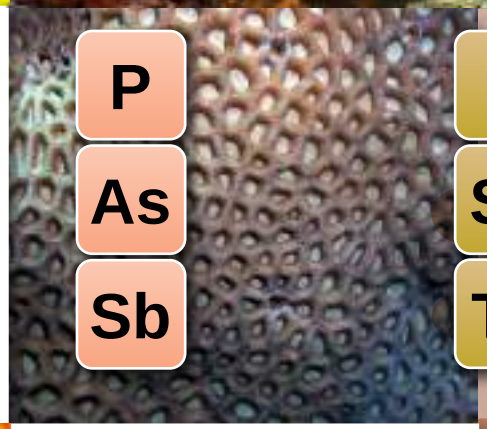
Step 1

Choose a triad from this page.

Find the elements in your triad in the periodic table. Add the atomic mass of the first and third element together and divide by two.

What do you notice about the answer?

Check if this works for another triad.



P

As

Sb

S

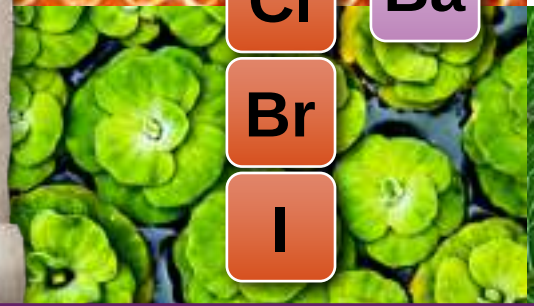
Se

Te

Ca

Sr

Ba



Cl

Br

I

Step 2

Look up your triad's elements in the interactive periodic table.

Make a list of their similarities in appearance and properties.

What patterns can you see in this triad?

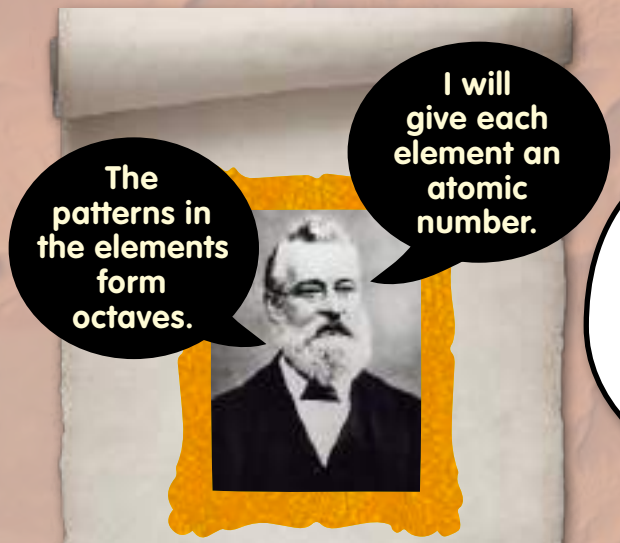
Li

Na

K

KEEP GOING

Do elements come in groups of six, eight or a baker's dozen?



English chemist John Newlands first recognised that the elements followed a pattern, with their properties repeated at regular intervals, as atomic mass increased.

His 1864 periodic table was not accepted by his peers, who ridiculed his idea of octaves. Can you think why?

Newlands' arranged elements in octaves

H	F	Cl	Co/ Ni	Br	Pd	I	Pt/ Ir
Li	Na	K	Cu	Rb	Ag	Cs	Tl
G	Mg	Ca	Zn	Sr	Cd	Ba/ V	Pb
Bo	Al	Cr	Y	Ce/ La	U	Ta	Th
C	Si	Ti	in	Zn	Sn	W	Hg
N	P	Mn	As	Di/ Mo	Sb	Nb	Bi
O	S	Fe	Se	Ro/ Ru	Te	Au	Os

LAW OF OCTAVES

Today we can see obvious problems with Newlands' table of the elements.

The first row, for example, groups elements with similar chemical properties.

Which elements are these?

How do the other elements in the first row differ?

At this time, when many new elements were being discovered, Newlands failed to leave room in his table for them.

These mistakes might have resulted from his attempt to link the periodicity of the elements with patterns in music. He saw a repeating pattern every eighth element, of elements with similar chemical properties.

Can you see any similar elements separated in this way?

KEEP GOING

Is the periodic table now complete?

Are there elements yet to be discovered?

Each vertical group is a family of elements with similar properties.

The elements will be arranged in order of increasing atomic weight.

I will leave spaces for elements yet to be discovered.

Dmitri Mendeleev was a Russian chemist who in 1869 laid the basis of the modern periodic table. His success was due to the fact that he left spaces where there was no element yet discovered that fitted into the pattern.

Can you find my triads in Mendeleev's periodic table?

Mendeleev predicted the existence of an element between silicon and tin, with an atomic mass of 72. When germanium was discovered in 1886, it had the properties Mendeleev had predicted for the missing element.

WHICH OF THE ELEMENTS I-6 IS GERMANIUM?

MAKING PREDICTIONS

Use the modern periodic table to identify the other numbered missing elements below.

H 1.01																	He
Li 6.94	Be 9.01	B 10.8	C 12.0	N 14.0	O 16.0	F 19.0											
G 23.0	Mg 24.3	Al 27.0	Si 28.1	P 31.0	S 32.1	Cl 35.5											
K 39.1	Ca 40.1	2	Ti 47.9	V 50.9	Cr 52.0	Mn 54.9	Fe 56.9	Co 56.9	Ni 56.7								
Cu 63.5	Zn 65.4		1	As 74.9	Se 79.0	Br 79.9											
Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.9	Mo 95.9	4	Ru 101	Rh 103	Pd 106								
Ag 108	Cd 112	In 115	Sn 119	Sb 122	Te 126	I 127											
Ce 133	Ba 137	La 139	6	Nb 151	W 164	3	Os 194	Ir 192	Pt 195								
Au 197	Hg 201	Ti 204	Pb 207	Bi 209	5												
			Th 232		U 238												

Element 2 has a mass of about 70.

Element 4 has a mass of 98.

Element 1 is a transition metal.

Element 3 has an atomic mass of 210 and is In the halogen family.

Element 6 is a transition metal.

Element 5 has a mass of 209.

Click here to find out more about developments in the periodic table.

Activity 1.4 Formulae and equations

Activity type

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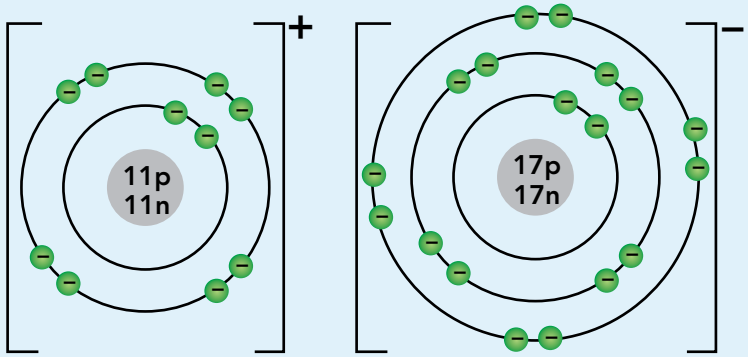
IONIC OR COVALENT

Do you recall the differences between ionic and covalent bonds?
Can you think of some well known examples for each, like salt and methane gas?

IONIC INVOLVES GIVING AND TAKING.

Ionic comes from the word ion and involves giving or taking of electrons.

What kind of elements combine using ionic bonding?

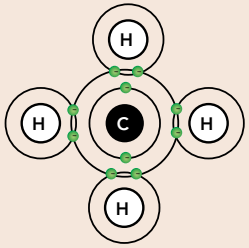


sodium ion
Na^+ [2, 8]$^+$

chloride ion
Cl^- [2, 8, 8]$^-$

What kind of elements usually share electrons?

Why?



How many electrons are shared in this methane molecule?

What do you remember about these types of chemical structures and the formulae of elements and compounds?

What is the difference between carbon monoxide and carbon dioxide?

KEEP GOING

RULES

WHAT IS VALENCY?

How do you use this to work out formulae?

Positive ions (cations)		Negative ions (anions)	
Name	Formula	Name	Formula
Hydrogen	H^+	Chloride	Cl^-
Sodium	Na^+	Bromide	Br^-
Potassium	K^+	Fluoride	F^-
Lithium	Li^+	Iodide	I^-
Ammonium	NH_4^+	Hydroxide	OH^-
Barium	Ba^{2+}	Nitrate	NO_3^-
Calcium	Ca^{2+}	Oxide	O^{2-}
Copper(II)	Cu^{2+}	Sulfide	S^{2-}
Magnesium	Mg^{2+}	Sulfate	SO_4^{2-}
Zinc(II)	Zn^{2+}	Carbonate	CO_3^{2-}
Lead(II)	Pb^{2+}	Hydrogen-carbonate	HCO_3^-
Iron(II)	Fe^{2+}		
Iron(III)	Fe^{3+}		
Aluminium	Al^{3+}		

What is the cross-over method?

Step 1

Place the valency at the top of the element.

Al^{3+} O^{2-}

Step 2

Cross over each valency number as subscripts.

Al^{3+} O^{2-}

2 3

Step 3

Remove the valencies at the top to write the final formula.

Al_2O_3

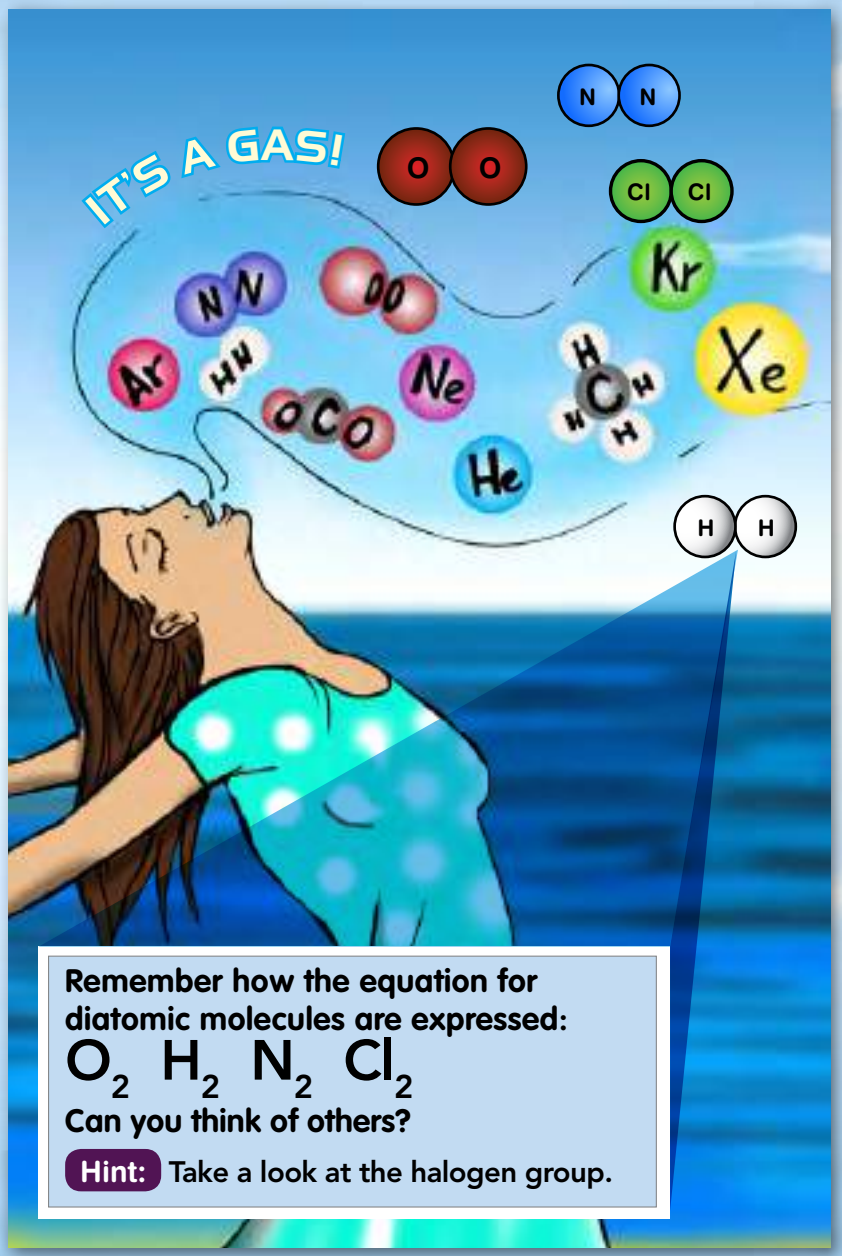
Al^{3+} O^{2-}

2 3

Al_2O_3

Why does this quick approach to formulae writing work?

Hint: Draw the ions for oxygen and aluminium. How many will you need of each to form a stable compound?



Remember how the equation for diatomic molecules are expressed:

O_2 H_2 N_2 Cl_2

Can you think of others?

Hint: Take a look at the halogen group.

KEEP GOING

Writing formulae and equations

What to do:

- Click here to access ***Activity Sheet 1.4***.
- Read the rules below and work through the activity sheet. Practice writing balanced equations.

RULES

WRITING CHEMICAL EQUATIONS

1. Write a word equation for the reaction:

   magnesium + oxygen ⟶ magnesium oxide

2. Write the formula for each substance using the rules for covalent or ionic substances:

   $Mg + O_2 \longrightarrow MgO$

3. Balance the equation by putting numbers in front of formulae so that the number of atoms of each element is the same on reactant and product sides.

   Do this in the following order:
   (i) balance metal atoms
   (ii) balance non-metal atoms
   (iii) balance hydrogen atoms
   (iv) balance oxygen atoms
   (iiv) add subscripts for states (s), (l), (g), (aq) or (ppt).

   Magnesium is already balanced, but there are two oxygen atoms on the reactant side and only one on the product side.

   The balanced equation is: $2Mg_{(s)} + O_{2(g)} \longrightarrow 2MgO_{(s)}$

The most accurate way to represent what is happening in a chemical reaction is to write a balanced chemical equation.

STATE SUBSCRIPTS

To complete a chemical reaction, you add a subscript to indicate what state the final substance is in;

solid (s), liquid (l), gas (g), aqueous (aq) or precipitate (ppt).

Example

Follow the steps to see another example:

Sodium hydroxide reacts with sulfuric acid to form aqueous sodium sulfate and water.

Sodium hydroxide + sulfuric acid ⟶ sodium sulfate and water:

$$Na(OH)_2 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O$$

(i) Balancing Na atoms: $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O$

(ii) Balancing S atoms: one on each side so already balanced.

(iii) Balancing H atoms: $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$

(iv) Balancing O atoms: 6 on each side so balanced.

(v) Adding subscripts: $2NaOH_{(aq)} + H_2SO_{4(aq)} \longrightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$

Click here to complete the ***Notebook*** tasks.

Activity 1.5 Who's in your group?

Activity type

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More than 2000 years ago, the Greek philosopher Aristotle, recognised that many elements were similar. However it was Döbereiner who formally grouped elements into triads based on their properties. Today, the periodic table's vertical groups include elements with common characteristics.

alkali metal | alkaline earth metal | halogen | noble gas

Can you name some elements that belong to these groups?

For each group, how would the structure of member elements be similar?

How would they differ?

NOBLE GASES

The most recently discovered group includes the noble gases, group 8. They are colourless gases occurring naturally in the atmosphere.

What do they all have in common?

Research their individual properties and uses. In a group, use the interactive periodic table and other resources to record two interesting facts for each in a table.

2	He	Helium	4.003	
10	Ne	Neon	20.180	
18	Ar	Argon	39.948	
36	Kr	Krypton	84.80	
54	Xe	Xenon	131.29	
86	Rn	Radon	222.018	

Atomic mass increases

Density decreases

KEEP GOING

Part A: Investigating the alkali metals

Teacher demonstration

Your teacher will carry out some reactions that illustrate properties of the alkali metals.

Can you number or name the main groups in the periodic table?

Click here to learn more about periodic table groups.

STUDENT INVESTIGATIONS

For these practical activities, carefully follow the ***e-Notebook*** instructions provided by your teacher.

Part B: Alkaline Earth Metals

What to use:

Each GROUP will require:

- samples of magnesium and calcium
- sealed and secure containers of chlorine, bromine and iodine (if available). **Do not open the jars!**
- 5 test tubes with stoppers
- 10 mL measuring cylinder
- dropper bottles solutions of:
  - phenolphthalein
  - universal indicator plus colour chart
  - dilute hydrochloric acid
  - sodium sulfate
  - sodium hydroxide.
  - sodium carbonate
  - sodium chloride
  - sodium sulfate
  - calcium chloride
  - barium chloride
  - magnesium chloride
- spotting tile (or plastic sheet)
- spatula
- emery paper
- solid magnesium oxide, calcium hydroxide and barium hydroxide.

Each STUDENT will require:

- ***Activity 1.5 e-Notebook***
- safety glasses.

SOME OF THESE CHEMICALS ARE DANGEROUS. HAVE YOU DONE A RISK ASSESSMENT?

Part C: Halogens

What to use:

Each PAIR will require:

- samples of chlorine, bromine and iodine. **Do not open the jars!**
- dropper bottles of:
  - universal indicator
  - sodium chloride
  - sodium bromide
  - sodium iodide
  - silver nitrate
- spotting tile (or plastic sheet).

Discussion:

1. Complete all questions to Parts A, B and C in the ***e-Notebook***.
2. Use the interactive periodic table to view the short videos of the reactions of other alkali metals. What is the trend in reactivity going down the table?
3. Is it similar to the trend in the alkaline earth metals?
4. Write an equation to represent the reaction between potassium and water.
5. Which is the most reactive halogen? Look at the videos of these elements if you are not sure.
6. Write an overall conclusion summarising the patterns in the periodic table.

Activity 1.6 Is the chemistry right?

Activity type

DOWNLOAD e-NOTEBOOK

When you understand the periodic table's patterns, you can predict reactions between chemicals.

Let's revise some common reactions you learnt in Chemical Reactions.

COMBUSTION
DECOMPOSITION
PRECIPITATION
NEUTRALISATION
ACID + CARBONATE
ACID + METAL

What gas is produced when an acid reacts with a metal?

How can we neutralise an acidic solution?

What compounds produce the most colourful precipitates?

What gas can we make from an acid and a carbonate?

KEEP GOING

Recognising reaction types

What to use:

Each PAIR will require:

- dropper bottles of solutions:
  - cobalt chloride
  - sodium carbonate
  - hydrochloric acid
  - sodium hydroxide
  - litmus solution
  - copper carbonate powder
  - magnesium ribbon
  - limewater
- 6 medium test tubes
- test-tube rack
- stopper with delivery tube
- wooden splint
- test-tube holder
- Emery paper (to clean magnesium if needed)
- Bunsen burner and bench mat.

What to do:

Carry out the following reactions, recording observations in your ***Notebook***.

Test 1
Place 1 cm depth of cobalt chloride solution into a test tube. Add an equal amount of sodium carbonate solution.

Test 2
Light the propane (C_3H_8) gas of a Bunsen burner. Turn the collar to produce a blue flame.

Test 3
Place 1 tsp of copper carbonate powder into a test tube. Fit a stopper with delivery tube. Half fill a second test tube with limewater.

Using a test-tube holder, heat the copper carbonate in the Bunsen flame. When you observe a colour change, remove from the heat and place the delivery tube into the limewater to collect bubbles of gas.

Test 4
Place 2 cm depth of sodium hydroxide into a test tube. Add 2 drops of litmus solution.

Add hydrochloric acid one drop at a time, shaking gently before observing any colour change.

Test 5
Place a small piece of magnesium in a test tube. Add hydrochloric acid to cover the metal. Capture the gas produced using an inverted test tube. Test the gas produced with a lit splint.

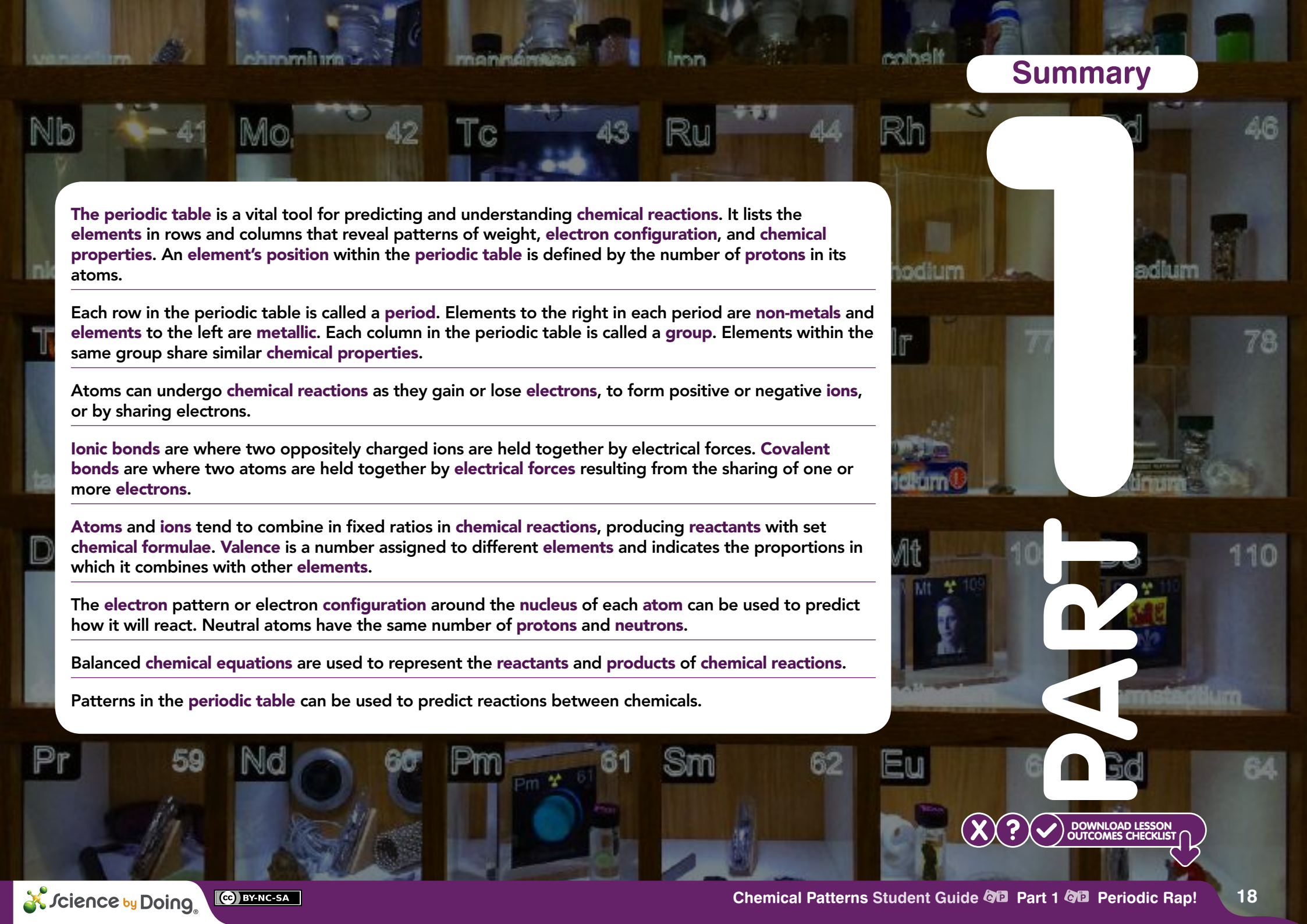
Test 6
Place 2 cm depth of hydrochloric acid to a test tube. Add an equal amount of sodium carbonate solution. Use a balloon to capture the gas produced by this reaction.

Discussion:

Answer the following questions and write an equation to represent each reaction.

1. What type of reaction occurred in Test 1? Explain.
2. What type of reaction is happening when the propane (C_3H_8) gas in a Bunsen is alight?
3. In Test 3, copper(II) oxide and water are products. What gas is produced? How do you know?
4. What process is happening when hydrochloric acid is added to sodium hydroxide in Test 4? How can you tell?
5. What gas is produced in test 5?
6. What did you observe in Test 6? What gas is produced in addition to sodium chloride and water?

Click here to check your understanding of reaction types.



Summary

The periodic table is a vital tool for predicting and understanding **chemical reactions**. It lists the **elements** in rows and columns that reveal patterns of weight, **electron configuration**, and **chemical properties**. An **element's position** within the **periodic table** is defined by the number of **protons** in its atoms.

Each row in the periodic table is called a **period**. Elements to the right in each period are **non-metals** and **elements** to the left are **metallic**. Each column in the periodic table is called a **group**. Elements within the same group share similar **chemical properties**.

Atoms can undergo **chemical reactions** as they gain or lose **electrons**, to form positive or negative **ions**, or by sharing electrons.

Ionic bonds are where two oppositely charged ions are held together by electrical forces. **Covalent bonds** are where two atoms are held together by **electrical forces** resulting from the sharing of one or more **electrons**.

Atoms and **ions** tend to combine in fixed ratios in **chemical reactions**, producing **reactants** with set **chemical formulae**. **Valence** is a number assigned to different **elements** and indicates the proportions in which it combines with other **elements**.

The **electron** pattern or electron **configuration** around the **nucleus** of each **atom** can be used to predict how it will react. Neutral atoms have the same number of **protons** and **neutrons**.

Balanced **chemical equations** are used to represent the **reactants** and **products** of **chemical reactions**.

Patterns in the **periodic table** can be used to predict reactions between chemicals.

PART 1

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