Cambridge (CIE) IGCSE Chemistry

Your notes

The Periodic Table & Trends

Contents

Your notes

The Periodic table

- There are over 100 chemical elements which have been isolated and identified
  - Each element has one proton **more** than the element preceding it
  - This is done so that elements end up in columns with other elements which have similar properties
  - Elements are arranged on the periodic table in order of **increasing atomic number**
  - The table is arranged in vertical columns called **groups** and in rows called **periods**

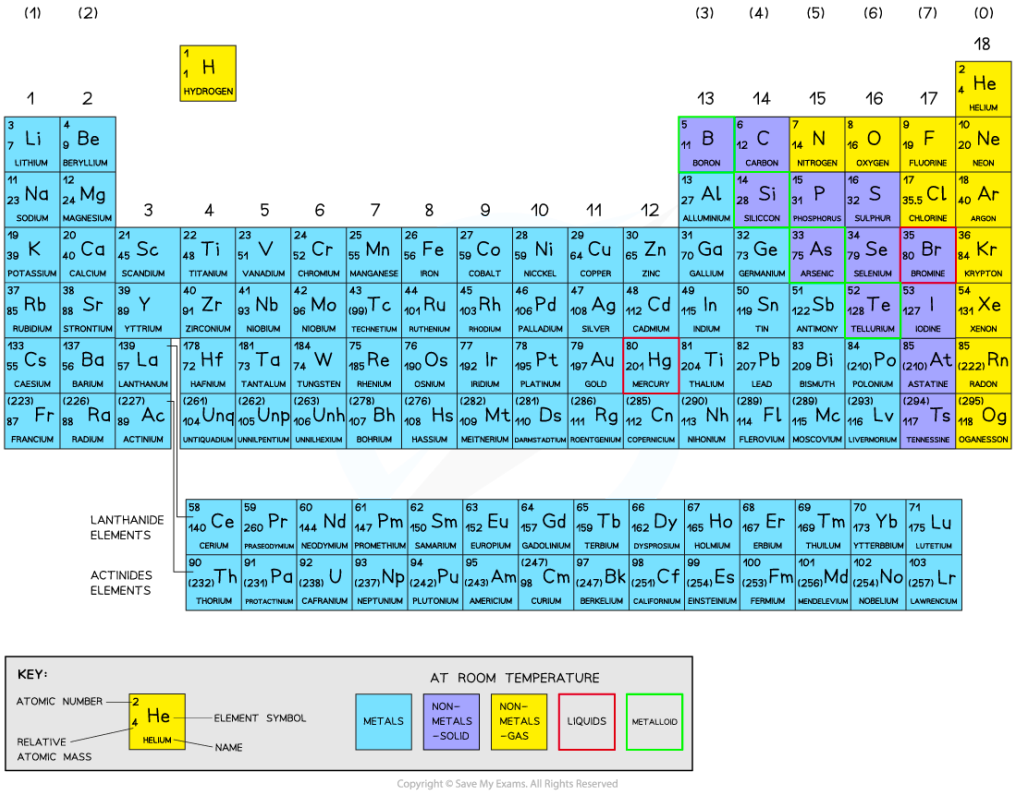
The period number

- Periods are the horizontal rows that show the number of shells of electrons an atom has and are numbered from 1 - 7
- Elements in Period 2 have two electron shells, elements in Period 3 have three electron shells

The group number

- Groups are the vertical columns that show how many outer electrons each atom has
- They are numbered from 1–7 with a final group called Group 0 (instead of Group 8)
- Group 4 elements have atoms with 4 electrons in the outermost shell, Group 6 elements have atoms with 6 electrons in the outermost shell and so on
- The group number can help determine the charge that metal and non-metal ions form
- For metals, the group number corresponds to the number of electrons it will lose to achieve a full outer shell and the charge of the metal ion
  - Sodium is in **Group 1,** it will lose 1 electron and form an ion with a **1+ charge**
  - Magnesium is in **Group** 2, it will lose 2 electrons and form an ion with a **2+ charge**
- For non-metals in Group 7 and 6, they will gain 1 and 2 electrons respectively to gain a full outer shell
  - E.g. non-metals in **Group 7** gain 1 electron to form ions with a **1– charge**
  - Non-metals in **Group 6** gain 2 electrons to form ions with a **2– charge**

The Periodic Table



All elements are arranged in the order of increasing atomic number from left to right

Examiner Tips and Tricks

The group number is always labelled on the periodic table but the period number isn't.

Don't forget that hydrogen and helium are in Period 1.

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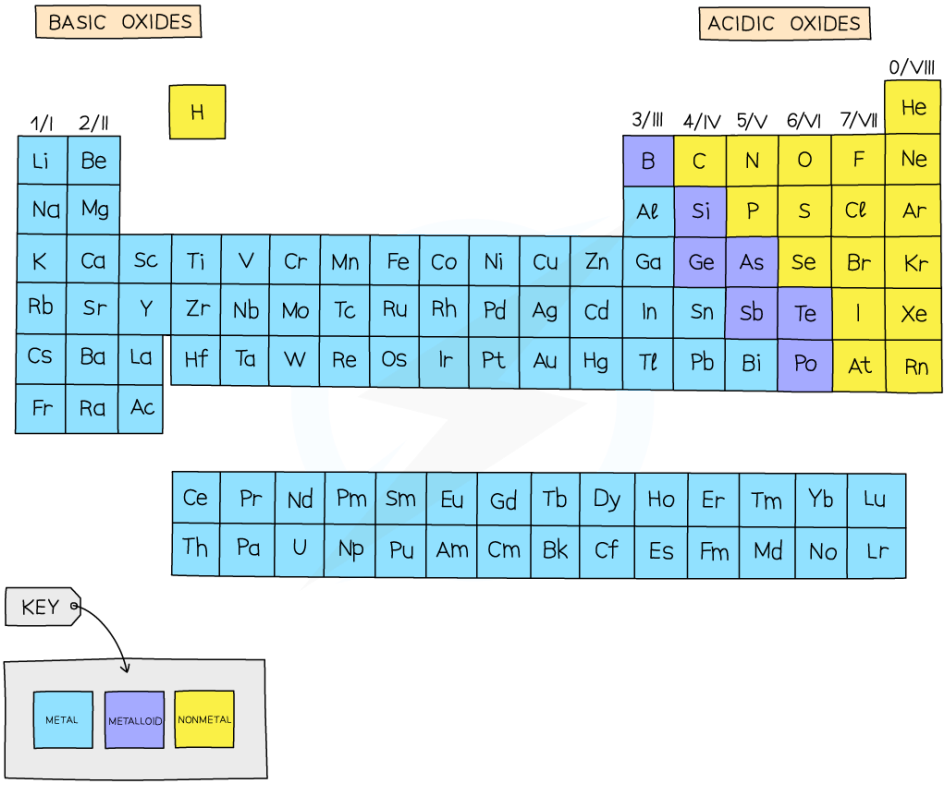
The metallic character of elements

- The metallic character of the elements **decreases** as you move across a period on the Periodic Table, from **left to right**, and it **increases** as you move down a Group
- This trend occurs due to atoms more **readily accepting** electrons to fill their outer shells rather than losing them to have the previous, already full, electron shell as their outer shell
- Metals occur on the **left-hand** side of the Periodic Table and non-metals on the **right-hand** side
- Between the metals and the non-metals lie the elements which display some properties of **both**
- These elements are referred to as **metalloids** or semi-metals

Properties of metals and non-metals

Property	Metal	Non-metal
Electron arrangement	1–3 outer shell electrons (more in Periods 5+ 6)	4–7 electrons in the outer shell
Bonding	metallic	covalent
Electrical conductivity	good conductors	poor conductors
Type of oxide	basic oxide	acidic oxides
Reaction with acids	many react with acids	do not react with acids
Physical characteristics	malleable high melting and boiling point	brittle low melting and boiling point



A zig-zag line in this diagram separates the metals on the left, from the non-metals on the right

Periodic trends & electronic Configuration

- The **electronic configuration** is the arrangement of electrons into shells for an atom
  - E.g. the electronic configuration of carbon is 2,4
- There is a link between the electronic configuration of the elements and their position on the Periodic Table
- The number of notations in the electronic configuration will show the number of occupied shells of electrons the atom has, showing the **period**
- The last notation shows the number of outer electrons the atom has, showing the **group** number

Example: Electronic configuration of **chlorine**:

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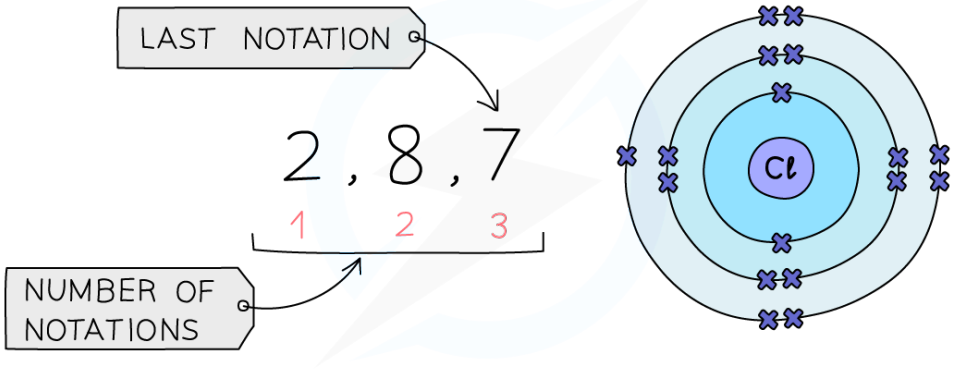
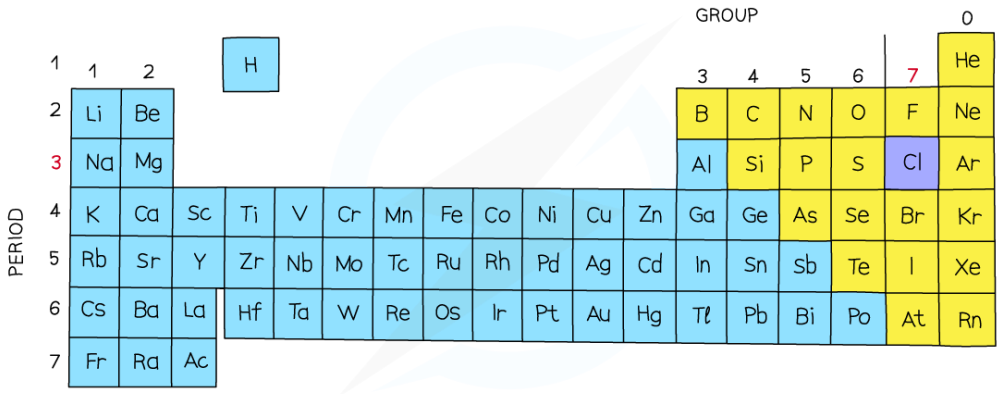


The electronic configuration of chlorine as it should be written

Period: The red numbers at the bottom show the number of notations which is 3, showing that a chlorine atom has 3 shells of electrons.

Group: The final notation, which is 7 in the example, shows that a chlorine atom has 7 outer electrons and is in Group VII



The position of chlorine on the Periodic Table

- Elements in the same group in the Periodic Table have **similar chemical properties**
- When atoms collide and react, it is the **outermost electrons** that interact
- The similarity in their chemical properties stems from having the **same number** of electrons in their outer shell
- For example, both lithium and sodium are in Group 1 and can react with elements in Group 7 to form an ionic compound by reacting in a similar manner

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- As you look down a group, a full shell of electrons is added to each subsequent element
  - Lithium's electronic configuration: 2,1
  - Sodium's electronic configuration: 2,8,1
  - Potassium's electronic configuration: 2,8,8,1

Examiner Tips and Tricks

Electronic configurations can be shown with the numbers separated by commas or by full stops. In this course commas are used, but you will often see full stops used elsewhere. Both are accepted.

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Predicting properties

- Because there are **patterns** in the way the elements are arranged on the Periodic Table, there are also **patterns** and **trends** in the chemical behaviour of the elements and their physical properties
- These trends in properties occur down groups and across the periods of the Periodic Table
- As a result, we can use the Periodic Table to predict properties such as:
  - boiling point
  - melting point
  - density
  - reactivity
- Some common properties / trends in properties include:
  - Group 1 elements react very quickly with water
  - Noble gases are unreactive
  - Transition elements are denser than Group 1 elements
  - Reactivity decreases going down Group 7
  - Melting point decreases going down Group 1
- In this way the Periodic Table can be used to **predict** how a particular element will behave

Identifying Trends

Extended tier only

- Using given information about elements, we can identify trends in properties
- An example of when this might be used is to determine the trend in reactivity of Group 1 metals

- The table below shows the reactions of the first three elements in Group 1 with water

Observations of lithium, sodium, and potassium with water

Element	Reaction	Observations
Li	lithium + water → lithium hydroxide + hydrogen $2Li(s) + 2H_2O(l) \rightarrow 2LiOH(aq) + H_2(g)$	▪ Relatively slow reaction ▪ Fizzing ▪ Lithium moves on the surface of the water
Na	sodium + water → sodium hydroxide + hydrogen $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$	▪ More vigorous fizzing ▪ Moves rapidly on the surface of the water ▪ Dissolves quickly
K	potassium + water → potassium hydroxide + hydrogen $2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$	▪ Reacts more vigorously than sodium ▪ Burns with a lilac flame ▪ Moves very rapidly on the surface ▪ Dissolves very quickly

- The observations show that reactivity of the Group 1 metals increases as you go down the group
- Using this information we can predict the trend going further down Group 1 for the elements rubidium, caesium and francium
- As the reactivity of alkali metals increases down the group, rubidium, caesium and francium will react more vigorously with air and water than lithium, sodium and potassium
- Lithium will be the **least** reactive metal in the group at the top, and francium will be the **most** reactive at the bottom
- Francium is rare and radioactive so is difficult to confirm predictions

Element	Observations
Rb	▪ Explodes with sparks
Cs	▪ Violent explosion due to rapid production of heat and hydrogen
Fr	▪ Too reactive to predict

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Examiner Tips and Tricks

For the extended course you may be asked to identify other trends in chemical or physical properties of Group 1 metals, given appropriate data.

Firstly, ensure that the metals and associated data are written in either descending or ascending order according the their position in the Group. Then look for general patterns in the data.

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