



Cambridge (CIE) IGCSE Chemistry



Your notes

The Periodic Table & Trends

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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

(1) (2)

(3) (4) (5) (6) (7) (8)



Your notes

| | | | | | | | | | | | | | | | | | |
|----------------|----------------|----------------|------------------|------------------|--------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | | | | | | | | | | | | | | | | | |
| 1 | 2 | | | | | | | | | | | | | | | | |
| 3 7 Li | 4 9 Be | | | | | | | | | | | | | | | | |
| LITHIUM | BERYLLIUM | | | | | | | | | | | | | | | | |
| 11 23 Na | 12 24 Mg | | | | | | | | | | | | | | | | |
| SODIUM | MAGNESIUM | | | | | | | | | | | | | | | | |
| 19 39 K | 20 40 Ca | 21 45 Sc | 22 48 Ti | 23 51 V | 24 52 Cr | 25 55 Mn | 26 56 Fe | 27 58 Co | 28 59 Ni | 29 64 Cu | 30 65 Zn | 31 31 Ga | 32 70 Ge | 33 73 As | 34 79 Se | 35 80 Br | 36 84 Kr |
| POTASSIUM | CALCIUM | SCANDIUM | TITANIUM | VANADIUM | CHROMIUM | MANGANESE | IRON | COBALT | NICKEL | COPPER | ZINC | GALLIUM | GERMANIUM | SELENIUM | BROMINE | KRYPTON | |
| 37 85 Rb | 38 88 Sr | 39 89 Y | 40 91 Zr | 41 93 Nb | 42 96 Mo | 43 (99) Tc | 44 101 Ru | 45 103 Rh | 46 106 Pd | 47 108 Ag | 48 112 Cd | 49 115 In | 50 119 Sn | 51 122 Sb | 53 128 Te | 53 127 I | 54 131 Xe |
| RUBIDIUM | STRONTIUM | YTTRIUM | ZIRCONIUM | NIOBIUM | NIOBIUM | TECHNETIUM | RUTHENIUM | RHODIUM | PALLADIUM | SILVER | CADMIUM | INDIUM | TIN | ANTIMONY | TELURIUM | IODIN | XENON |
| 133 55 Cs | 137 56 Ba | 139 57 La | 178 72 Hf | 181 73 Ta | 184 74 Tungsten | 75 185 Re | 76 190 Os | 77 192 Ir | 78 195 Pt | 79 197 Au | 80 201 Hg | 81 204 Ti | 82 207 Pb | 83 209 Bi | 84 (210) Po | 85 (210) At | 85 (222) Rn |
| CAESIUM | BARIUM | LANTHANUM | HAFNIUM | TANTALUM | TUNGSTEN | REHNIUM | OSMIUM | IRIDIUM | PLATINUM | GOLD | MERCURY | THALIUM | LEAD | BISMUTH | POLONIUM | ASTATINE | RADON |
| (223) 87 Fr | (226) 88 Ra | (227) 89 Ac | (261) 104 Unq | (262) 105 Unp | (263) 106 Unp | (278) 107 Bh | (276) 108 Bk | (281) 109 Mt | (281) 110 Ds | (286) 111 Rg | (285) 112 Cn | (290) 113 Nh | (289) 114 Fl | (289) 115 Mc | (293) 116 Lv | (294) 117 Ts | (295) 118 Og |
| FRANCIUM | RADIUM | ACTINIUM | UNQUADRINUCLEAR | UNPENTINUCLEAR | UNPENTINUCLEAR | BOHRIUM | HAASSIUM | MEITNERIUM | DIMITRIEVNIUM | OGONTGENIUM | COPERNICIUM | NIKHONIUM | FLEROVYIUM | MOSCOWVIUM | LIVORNIUM | TIENNESENNE | OGANESSIAN |

LANTHANIDE

ACTINIDES

KEY:

The diagram shows a key for identifying elements based on their box color and properties. It includes a yellow box for Helium (He) with its atomic number (2), element symbol (He), name (HELIUM), and relative atomic mass (4). A legend at the top right indicates colors for different states at room temperature: METALS (blue), NON-METALS - SOLID (purple), NON-METALS - GAS (red), LIQUIDS (orange), and METALLOID (green).

| AT ROOM TEMPERATURE | | | | |
|---------------------|--------------------|------------------|---------|-----------|
| METALS | NON-METALS - SOLID | NON-METALS - GAS | LIQUIDS | METALLOID |

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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.



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

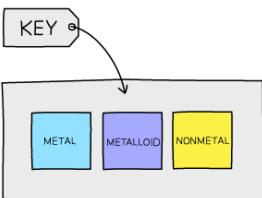
| Property | Metal | Non-metal |
|---------------------------------|---|--|
| Electron arrangement | 1–3 outer shell electrons (more in Periods 5+ 6) | 4–7 electrons in the outer shell |
| Bonding | metallic | covalent |
| Electrical conductivity | good conductors | poor conductors |
| Type of oxide | 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 |



Your notes

| BASIC OXIDES | | | ACIDIC OXIDES | | | | | | | | | | | | | | |
|--------------|------|----|---------------|----|----|----|----|--------|----|----|----|----|----|----|----|----|----|
| 1/I | 2/II | H | | | | | | O/VIII | | | | | | | | | |
| Li | Be | | B | C | N | O | F | He | | | | | | | | | |
| Na | Mg | | Al | Si | P | S | Cl | Ne | | | | | | | | | |
| K | Ca | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn | Ga | Ge | As | Se | Br | Kr |
| Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | Pd | Ag | Cd | In | Sn | Sb | Te | I | Xe |
| Cs | Ba | La | Hf | Ta | W | Re | Os | Ir | Pt | Au | Hg | Tl | Pb | Bi | Po | At | Rn |
| Fr | Ra | Ac | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ce | Pr | Nd | Pm | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu |
| Th | Pa | U | Np | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | Lr |



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

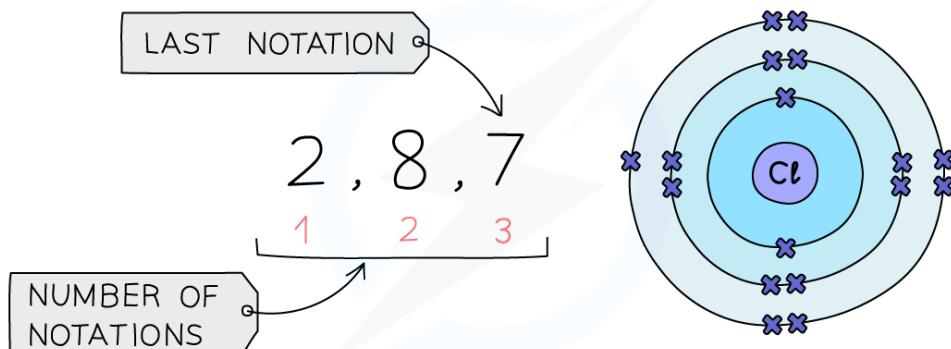
Periodic trends & electronic Configuration

- 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

| | GROUP | | | | | | | | | | | | | | | | | | 0 | |
|---|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|----|
| 1 | 1 | 2 | | | | | | | | | | | | | | | | | | He |
| 2 | Li | Be | | | | | | | | | | | | | | | | | | B |
| 3 | Na | Mg | | | | | | | | | | | | | | | | | | C |
| 4 | K | Ca | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn | Ga | Ge | As | Se | Br | Kr | N | |
| 5 | Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | Pd | Ag | Cd | In | Sn | Sb | Te | I | Xe | O | |
| 6 | Cs | Ba | La | Hf | Ta | W | Re | Os | Ir | Pt | Au | Hg | Tl | Pb | Bi | Po | At | Rn | F | |
| 7 | Fr | Ra | Ac | | | | | | | | | | | | | | | | | Cl |

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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



Your notes

- 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.

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**



Your notes

| Element | Reaction | Observations |
|---------|--|---|
| Li | lithium + water → lithium hydroxide + hydrogen $2\text{Li(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{LiOH(aq)} + \text{H}_2\text{(g)}$ | <ul style="list-style-type: none"> Relatively slow reaction Fizzing Lithium moves on the surface of the water |
| Na | sodium + water → sodium hydroxide + hydrogen $2\text{Na(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{NaOH(aq)} + \text{H}_2\text{(g)}$ | <ul style="list-style-type: none"> More vigorous fizzing Moves rapidly on the surface of the water Dissolves quickly |
| K | potassium + water → potassium hydroxide + hydrogen $2\text{K(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{KOH(aq)} + \text{H}_2\text{(g)}$ | <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> Explodes with sparks |
| Cs | <ul style="list-style-type: none"> Violent explosion due to rapid production of heat and hydrogen |
| Fr | <ul style="list-style-type: none"> Too reactive to predict |



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 to their position in the Group. Then look for general patterns in the data.



Your notes