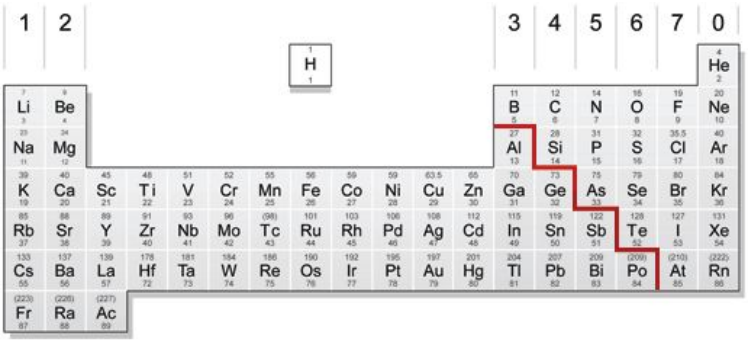
WJEC England GCSE Chemistry

Topic 4: The periodic table and properties of elements

Notes

(Content in bold is for Higher Tier only)



Reactions of elements

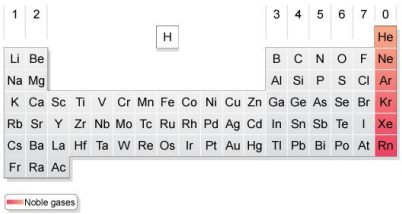
- Elements react in order to gain a stable arrangement of electrons in its outer shell – identical to that of a noble gas, with 8 electrons in its outer shell
- this means that the way elements react is related to the arrangement of electrons in their atoms, since group 1 elements will react by losing 1 electron whereas group 7 elements will react by gaining an electron
- atomic number=number of protons=number of electrons (for an atom with a neutral charge), so the amount of ions an element loses when reacting is linked to its atomic number

Group 1 – Alkali metals

- As you go down the group, melting and boiling points decrease
- They have characteristic properties due to the single electron in their outer shell.
- reaction with group 7 elements: transfer one electron from outer shell to outer shell of group 7 element. Form a metal halide e.g. NaCl
- reaction with oxygen: forms a metal oxide. Vigorous reaction- lithium burns with a red flame, sodium with a yellow-orange flame, and potassium burns with a lilac flame.
- reaction with water: react vigorously with water to create a metal hydroxide (an alkaline solution) and hydrogen gas.
- The reactivity of the elements increases going down the group:
    - outer electron becomes further from the nucleus
    - less attraction between outer electron and nucleus
    - outer electron is lost more easily

Group 0 – Noble gases

- They have 8 electrons in their outer shell (except helium, which has 2).
- They are unreactive and do not easily form molecules, because they have a stable arrangement of electrons.
- The boiling points of the noble gases increase with increasing relative atomic mass (going down the group).



Group 7 – The halogens

- as you go down the group, molecular mass and intermolecular forces increase, leading to an increase in melting point

reactions:

- Similar reactions due to their seven electrons in their outer shell.
- Non-metals and consist of molecules made of pairs of atoms.
- They react with group 1 metals to form a metal halide in which the halide ion carries a -1 charge.
- React with iron wool – useful experiment to see the trend in reactivity of halogens

displacement reactions:

- A more reactive halogen can displace a less reactive in an aqueous solution of its salt.
- E.g. Chlorine will displace bromine if we bubble the gas through a solution of potassium bromide:

  Chlorine + Potassium Bromide → Potassium Chloride + Bromine
- chlorine will displace bromine and iodine
- bromine will displace iodine but not chlorine
- iodine can replace neither chlorine or iodine

reactivity:

- This happens because as you go down the group, the reactivity of halogens decreases.
- The halogens react by gaining an electron in their outer shell, as you go down the group:
  - outer shell becomes further from the nucleus
  - electron shielding increases
  - attraction decreases between nucleus and outer electrons
  - electrons are gained less easily
  - halogens become less reactive

Tests

- Test for…chloride ions, Cl-, bromide ions, Br-, iodide ions, I-, using dilute nitric acid and silver nitrate solution
  - First add dilute nitric acid, followed by silver nitrate solution
  - Chloride gives a white precipitate
  - Bromide gives a cream precipitate
  - Iodine gives a yellow precipitate

Flame tests

- Flame tests can be used to identify metal ions.

Lithium	Red
Sodium	Orange
Potassium	Lilac
Calcium	Yellow-red
Copper (II)	Green-blue
Barium	Pale green

- However, if a sample containing a mixture of ions is used some flame colours can be masked

Advantages of instrumental methods of analysis

- Elements and compounds can be detected and identified using instrumental methods
    - These are accurate, sensitive and rapid

Tests for gases

Test for hydrogen:

- Use a burning splint held at the open end of a test tube of the gas
    - Creates a 'squeaky pop' sound

Test for oxygen:

- Uses a glowing splint inserted into a test tube of the gas
    - Splint relights in oxygen

Test for chlorine:

- Uses litmus paper
    - When damp litmus paper is put into chlorine gas the litmus paper is bleached and turns white

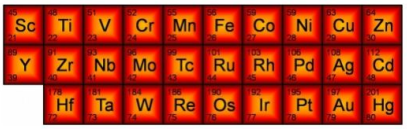
Metals and non-metals

- Metals = elements that react to form positive ions.
    - Majority of elements are metals.
    - Found to the left and towards the bottom of the periodic table.
    - Lose electrons when they react, to empty their outer shell, leaving them with a full shell of electrons under that.
    - metals are typically: shiny, good electrical conductors, highly dense and have high melting points
- Non-metals = elements that do not form positive ions.
    - Found towards the right and top of the periodic table.

- Gain electrons when they react – to gain a full outer shell
- non metals are generally: dull, poor conductors, low in density and have low melting points

Transition metals

Compared to group 1, the transition elements:



- Are harder and stronger
- Have higher melting points (except for mercury) and higher densities
- Much less reactive and don't react as vigorously with oxygen or water

Typical properties

- They have ions with many different charges
- Form coloured compounds
- Are useful as catalysts.

examples:

- titanium: forms ions with charges +2 +3 +4 +5, titanium dioxide used as a catalyst for producing white pigment
- vanadium: +2 +3 +4 +5, vanadium oxide is the catalyst for the contact process
- iron: +2 +3 +4 +5 +6, iron is used as the catalyst for the haber process
- copper: +1 +2 +3

(the highlighted colours indicate the colour of compounds containing these ions)

Practical Assessments

NB: what you should be prepared to do, using the above study materials…

- SP4 Identification of unknown substances using flame tests and chemical tests for ions and gases