

Fireworks Experiment

Key Stage 4

Scheme of work unit: C3 – Periodic Table
Reactivity and uses of the different elements in each of the Periodic Table groups.

Intended Learning: Investigate reactivity's and properties of the Group 1, Alkali Metals.

Introduction notes:

- The alkali metals are a series of elements comprising Group 1 of the Periodic Table: lithium (Li), sodium (Na), potassium (K), rubidium (Rb), cesium (Cs) and francium (Fr).
- The alkali metals are highly reactive, soft, low-density metals that react readily with halogens to form ionic salts, and with water to form strongly alkaline hydroxides.
- These elements all have one electron in their outermost shell, so the energetically preferred state of achieving a filled electron shell is to lose one electron to form a singly charged positive ion.
- Alkali metals react vigorously with water, and these reactions become increasingly violent as you move down the group.
- Reaction with water is:
Alkali metal + water → alkali metal hydroxide + hydrogen gas.
- The alkali metals show a number of trends when moving down the group, e.g. decreasing electronegativity, increasing reactivity, and decreasing melting and boiling point.
- As you go down Group 1, the metal becomes easier to ionise, so the energy of emission is subsequently less. This is why we see different colours, when the different metals burn.

Facts:

Lithium:

- Used as a scavenger in the iron and steel industry to remove dissolved gases, such as O₂ and N₂.
- Alloyed with aluminium, it is used in the construction of aircraft.
- Used in some type of batteries.

Sodium:

- Used as a reducing agent for organic compounds.
- Alloyed with potassium, provides a highly conductive heat transfer medium in nuclear reactors.
- Used in the manufacture of synthetic rubber.

Potassium:

- Component of fertilisers.
- Essential for plants
- A radioactive isotope of potassium means that coffee and bananas are radioactive!!

Resources:

- Lithium salt (e.g. lithium chloride)
- Potassium salt (e.g. potassium chloride)
- Sodium salt (e.g. sodium chloride)
- Methanol
- Matches
- Suitable flameproof dish

Practical notes:

- Reactivity video of the Group 1 metals with water is available on the website.
- Make sure the solutions are saturated with the metal salt.
- Care must be taken when attempting to ignite the methanol.
- The metal salts are skin irritants, and harmful if swallowed.
- All residues are water soluble.

Further Work:

- Investigate other metals such as the Alkali Earth Metals and the transition metals. Look at reactivity's, properties and colours they emit when burned.

Answers:

1. As the Group is descended, the outermost electron becomes more and more shielded by the other electrons in the electron shells. This makes it increasingly easier for the metal to lose this one electron, to achieve the desired full electron shell configuration. Hence we see an increase in the reactivity.
2. As you go down Group 1, the metal becomes easier to ionise, so the energy of emission is subsequently less. This is why we see different colours, when the different metals burn.
3. Reaction with water is:
Alkali metal + water \rightarrow alkali metal hydroxide + hydrogen gas.
4. Lithium: $1s^2 2s^1$; sodium: $1s^2 2s^2 2p^6 3s^1$; potassium: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$; rubidium: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^6 5s^1$
5. The alkali metals show a number of trends when moving down the group, e.g. Decreasing electronegativity, increasing reactivity, and decreasing melting and boiling point.