Reacting elements with oxygen

Many elements react with oxygen on heating. These reactions and the properties of their products illustrate the periodic nature of the elements. The same procedure can be used to make samples of chlorides using chlorine gas (see experiment: *Reacting elements with chlorine*).

Introduction

Many elements react with oxygen. The ease with which the reaction takes place, the vigour of the reaction and the properties of the compounds made provide excellent evidence to help understanding about the periodic nature of the elements in the Periodic Table and about many chemical principles. The difference in reactivity between reactions in air and in oxygen can be related to the relative concentrations.

Lesson organisation

Students frequently say ‘Do it again.’ and ‘Use a bigger bit.’ when they see a spectacular demonstration. Both chemically and pedagogically it is much better for them to see a number of graded demonstrations rather than the same one again on a bigger scale. The reactions are spectacular and lend themselves well to a series of demonstrations which illustrate the periodic nature of the elements.

Apparatus and chemicals

- Fume cupboard
- Gas preparation apparatus:
- Side-arm flask 250 cm^3
- Tap funnel and bung to fit flask
- Connecting tubing
- Reaction tubes, one for each reaction (see experiment 14 for how to make a reaction tube)
- 1-hole bung and delivery tube to fit
- Clamp stand
- Boss head
- Clamp
- Hydrogen peroxide solution 15 cm^3 20 vol per experiment (**Skin and eye irritant,** Refer to SSERC or CLEAPSS Hazcard) (see note 1)
- Manganese(IV) oxide granular 5g (**Harmful if swallowed or inhaled**, Refer to SSERC or CLEAPSS Hazcard)

The other elements

(Refer to SSERC or CLEAPSS hazard information for detailed safety considerations)

Lithium (**Highly flammable, corrosive,** see Technical notes 3 and 4)

Sodium (**Highly flammable, corrosive**)

Potassium (**Highly flammable, corrosive**)

Magnesium (**Highly flammable,** see Technical note 5)

Calcium (**Highly flammable**)

Aluminium foil (**Low hazard**)

Carbon (**Low hazard**)

Phosphorous Red (**Highly flammable**)

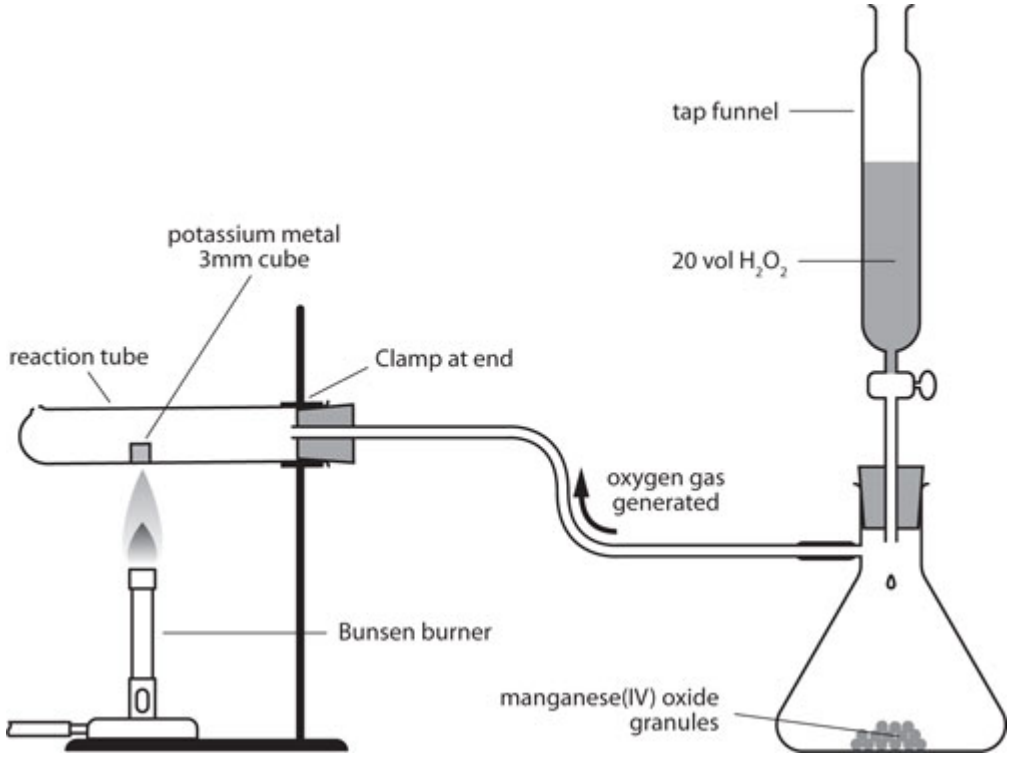
Sulfur (**Low Hazard**)

Technical notes

1 It is recommended that these experiments are done by the demonstrator before demonstrating to pupils, in order to gain experience, if they have not done it before.
2 A steady evolution of oxygen gas can be obtained by dripping 20 vol hydrogen peroxide solution onto manganese(IV) oxide. If granules are used the rate of reaction is more controlled.

The other elements

3 Group 1 metals are stored under oil, this can be removed using paper tissue.
4 Cut pieces of Group 1 metals into cubes no bigger than 3mm.
5 For the other elements 0.1g is sufficient to see a spectacular reaction.



Procedure

HEALTH & SAFETY: Wear eye protection at all times.

a The apparatus is assembled in a fume cupboard, according to the diagram.
b A reaction tube is clamped horizontally close to the bung end.
c The tubes are used to connect the gas generator to the delivery tube in the bung.
d A piece of the element is placed near the bottom of the test tube.
e The bung is pushed gently into the reaction tube.
f Start the oxygen gas generation by running hydrogen peroxide onto the catalyst. Use 20 cm^3 hydrogen peroxide solution to flush the system of air for 60 seconds.
g Heat the solid element using a Bunsen burner with a blue flame.
h Add more hydrogen peroxide slowly
i Remove the Bunsen burner when the element catches fire

Teaching notes

The synthesis reactions of these binary compounds (two elements) will catch the attention of students because they are spectacular. Done in a series of reactions, students begin to appreciate ‘periodicity’ and other important aspects of chemistry.

Group 1 and 2 – Students see the increase in reactivity going down the group (inferred from the heating time required). They will see the reaction start when the metal begins to melt. Melting allows fresh metal to flow out from under the oxide coating which inevitably forms on the surface of metals.

Students understand why metals start to react vigorously with gases when they melt. They will not appreciate that most combustion reactions do not involve solids. The temperature of reaction and the melting points of elements can be related to their structure and bonding. Carbon and silicon burn in the solid state, unlike the other elements.

The melting points, reaction with water and pH of the solutions of these compounds are all logical developments of this topic.

For a comparison of these reactions with the reactions of chlorine and the properties of chlorides see experiment: *Reacting elements with chlorine*.

References

This experiment was written by Mike Thompson on behalf of the RSC

Credits

Health & safety checked January 2018

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