**Chemistry: 5. The Air and Oxygen**

***Please remember to photocopy 4 pages onto one sheet by going A3→A4 and using back to back on the photocopier***

**Syllabus**

**OC21** Understand that air is a mixture of gases, and state the composition of air (approximately 78% N2 and 21% O2, with CO2, water vapour and other gases making up the balance)

**OC22** Show that approximately one fifth of the air is oxygen; show that there is CO2 and water vapour in air

**OC23** Demonstrate and describe what happens when (i) a wooden splint and (ii) a piece of magnesium are burned in air

**OC24** Prepare a sample of oxygen by decomposing H2O2 using MnO2 as a catalyst (word equation and chemical equation)

**OC25** Investigate the ability of oxygen to support combustion in a wooden splint and a candle, and state two uses of oxygen

**OC26** Burn carbon and magnesium in oxygen, and test the products using moist litmus paper

 **Student Notes**

*(Students should cover the chapter ‘Acids and Bases’ first as some of the demonstrations here refer to the products of reactions as being either acidic or basic)*

**The Atmosphere**

**Composition of the atmosphere**

**The atmosphere is made up of 78% nitrogen and 21% oxygen**

Carbon dioxide, water vapour and various other gases make up the remainder.

**To show that approximately one fifth of the air is oxygen**



**Demonstration one**

Set up as shown - the water rises approximately one fifth of the height of the graduated cylinder to replace the oxygen used up by the burning candle.

**Demonstration two**

Volume of air before heating = 100cm3

Volume of air after heating the copper = 79cm3

Volume of oxygen present in 100cm3 = 21 cm3

Percentage of air = 21/100 = 21%

**To show that there is carbon dioxide in air**

When air is drawn through limewater by a vacuum pump the limewater turns milky proving there is carbon dioxide in air.

**To show that there is water vapour in air**

Fill a test-tube with ice and water and leave it for a few minutes; a liquid will form on the outside of the test-tube.

Test the liquid using ***anhydrous copper sulphate***: it will turn from white to blue showing that the liquid which condensed was water.

**Preparation of oxygen**

**Hydrogen peroxide → oxygen + water**

 H2O2 → O2 + H2O



Manganese dioxide (MnO2) is added in as a catalyst (to speed up the reaction)

**Procedure**

1. In this case hydrogen peroxide is added to manganese dioxide.
2. Oxygen gas and water are produced. The oxygen gas then bubbles through the water in the trough. The water (which was in the trough) gets pushed out and the oxygen fills the gas jar.
3. Add a little water to the gas jar and test the pH using universal indicator paper.

**Conclusion**:

Oxygen is a colourless, odourless gas.

It has a pH of 7 so it is a neutral

**To investigate the ability of oxygen to support combustion in a wooden splint and a candle**

****Oxygen will relight a glowing splint. This is the characteristic test for oxygen.

**Burning a glowing** **wooden splint in oxygen**

Place a glowing splint (a very small piece of wood) in a gas jar of oxygen.

**Result and Conclusion**

The glowing splint re-ignites showing that oxygen aids combustion.

**Burning carbon in oxygen**

**Procedure**

Heat a piece of carbon over a Bunsen burner until it starts to glow – now quickly put it into a jar of oxygen.

**Result**

The carbon ignites.

**Testing the products**

Add water and test using blue litmus paper.

**Result and Conclusion**

It turns red showing that carbon dioxide is an acidic gas.

**Burning magnesium in oxygen**

**Procedure**

Hold a piece of magnesium ribbon over a Bunsen burner until it ignites – now quickly place it into a jar of oxygen.

**Result**

The magnesium burns with a bright flame.

**Testing the products**

Add water and test using red litmus paper.

**Result and Conclusion**

It turns blue showing that magnesium oxide is a base.

In general non-metal oxides are acidic and metal oxides are basic

**Uses of oxygen**

1. Used in welding to increase combustion
2. Used in medicine to help breathing

**My very bad hydrogen peroxide Joke**

Two scientists walk into a bar and first one says I’ll have a pint of H2O.

The second guy says I’ll have a pint of H2O too.

He drinks it.

And then he dies

**Exam Questions**

1. [2012]
The table gives the % by volume of five gases/ vapours found in our atmosphere.

|  |  |
| --- | --- |
| Formula | % Volume |
| N2 | 78.08 |
| O2 | 20.95 |
| H20 | 0 to 4 |
| Ar | 0.93 |
| CO2 | 0.036 |

1. Which two of these gases/ vapours are produced when a fossil fuel is burned?
2. The amount of water vapour present in the air is the most variable. Suggest a reason for this.
3. [2008 OL][2009 OL][2012 OL]

Name any three gases normally found in clean air.

1. [2012]
Describe an experiment, using a labelled diagram to show the presence of carbon dioxide in air.

****

1. [2012]
Give a test to show that the droplets formed on the outside of a glass containing a cold drink are water.
2. [2006]

The composition of air can be investigated in different ways.

Two experiments are shown in the diagram.

In Experiment A the air was pushed repeatedly over the heated copper powder and only 79 cm3 of gas remained at the end of the experiment.

1. Why is it necessary to let the apparatus cool down before measuring the volume of the remaining gas?
2. Why did the volume of gas decrease and then remain steady?
3. What is the remaining gas mainly composed of?
4. Experiment B is less accurate than Experiment A.

Give a reason why this is so.



1. [2006 OL]
2. What happens when a “glowing splint” (very hot piece of wood) is placed in a gas jar of oxygen?
3. Give one property of oxygen that this demonstrates.
4. [2012]
5. What substance is formed when carbon is burned in oxygen?
6. Give the effect of this substance on moist litmus paper.
7. [2008][2010 OL][2008 OL]

The diagram shows magnesium being burned in oxygen to form magnesium oxide (MgO).

1. What colour was the flame?
2. Pieces of moist blue and red litmus paper were mixed with the product of the combustion.

What result was seen?

1. What conclusion can be made from the result of the litmus test?
2. [2011]
The apparatus shown in the diagram was used to strongly heat 2.4 g of magnesium in a crucible.
The lid of the crucible was lifted a little during the heating.
A white powder, with a mass of 4.0 g, was produced.
3. Why was there an increase in mass?
4. Where did the extra mass come from?
5. Give the name or formula of the white powder.

**Preparation of oxygen**



1. [2009] [2006] [2010 OL] [2006 OL][2011 OL]

In 1774 Joseph Priestley, an English chemist, discovered oxygen.

Oxygen can be prepared by using the chemicals indicated in the diagram.

1. Name liquid A.
2. Name solid B.
3. What is a catalyst?
4. Which one of the two chemicals used was the catalyst?
5. Give two uses for oxygen gas.
6. [2011]

Name a catalyst that you have used in the school laboratory and give a reaction that it catalyses.

**Exam Solutions**

1. CO2, H2O
2. Temperature changes/ weather/ evaporation/ rain/ snow/ transpiration/ plants/ respiration/ combustion/ photosynthesis/ specified location…
3. Carbon dioxide, oxygen, nitrogen, water vapour, helium, ozone
4. ****

See diagram

Draw air through a solution of lime water

Result: lime water goes milky

1. Use **a*nhydrous*** (white) copper sulphate – it turns blue*Or* Blue cobalt chloride paper turns pink
2. Because gases expand on heating which would result in an incorrect reading.
3. Only the oxygen in the air gets removed (used up).
4. Nitrogen
5. A: The gas syringe measures the volume more accurately.

B: A graduated cylinder is not as accurate as gas syringe.

1.
2. Re-ignites / lights
3. Oxygen supports combustion / substances burn in oxygen
4. Carbon dioxide/ CO2
5. Blue turns red
6. White
7. Blue stayed blue and red turned blue
8. The product is a base (alkali).
9. Oxygen in the air combined chemically (reacted) with the magnesium to form a compound.
10. The air / oxygen
11. Magnesium oxide/ MgO
12. Hydrogen peroxide (H2O2)
13. Manganese dioxide (MnO2)
14. It is a chemical which speeds up (or slows down) a chemical reaction
15. Manganese dioxide (MnO2)
16. Respiration, combustion
17. Manganese dioxide MnO2 - decomposition of hydrogen peroxide (H2O2)/ preparation of O2

**Other Test Questions**

1. What are the four main components of air?
2. What is the approximate percentage of oxygen in air?
3. What is the approximate percentage of nitrogen in air?
4. How would you demonstrate the percentage of air in oxygen?
5. (i) Draw the diagram of apparatus used to prepare oxygen

(ii Give the word equation for this reaction.

1. Give the chemical equation for this reaction.
2. How would you test for the products of burning carbon and magnesium in oxygen, using moist litmus paper.
3. A sample of carbon (charcoal) was burnt in oxygen.
4. What colour was the carbon?
5. What is the name of the compound formed?
6. What result was achieved when the compound formed was tested with universal indicator paper?
7. What conclusion can be made about the compound from the result achieved?
8. Complete the word equation showing the products formed when a hydrocarbon is burned in oxygen:

Hydrocarbon + oxygen +

1. Three gas jars contain oxygen, hydrogen and carbon dioxide gas.
2. How would you identify which one contains oxygen gas?
3. How would you identify which one contains hydrogen gas?
4. How would you identify which one contains carbon dioxide gas?
5. Which of these gases could be used in fire extinguishers?
6. When iron is exposed to both water and oxygen, it rusts.
7. Draw a diagram to show what would happen when you place steel wool in a test tube and invert it in a basin of water.
8. What can be concluded from this experiment?