1 Air is a mixture of gases.
The two main gases present are the elements nitrogen and oxygen.

(a) Another element that is present in air is

(1)

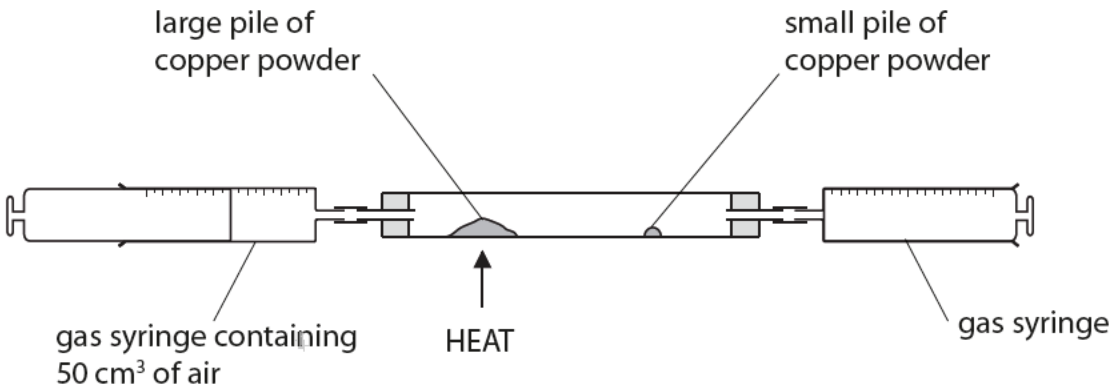
- ☒ **A** argon
- ☒ **B** carbon dioxide
- ☒ **C** hydrogen
- ☒ **D** sulfur dioxide

(b) Give the formula of a compound that is found in unpolluted air.

(1)

.....

(c) This apparatus in the diagram is used to find the percentage of oxygen in air.



The large pile of copper powder is heated, and the air in the syringe is passed several times from one gas syringe to the other.

The large pile of copper powder turns black. The remaining gas is allowed to cool and its volume is measured.

(i) Explain why the large pile of copper turns black.

(2)

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(ii) Why is the gas allowed to cool before its volume is measured?

(1)

.....

.....

(iii) The small pile of copper powder is then heated and the remaining gas is passed several times over the hot copper. The copper does not turn black.

Suggest why the small pile of copper does not turn black.

(1)

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(d) In another experiment, the total volume of air in the apparatus before heating is 150 cm^3. At the end of the experiment the volume of gas remaining is 125 cm^3.

Use this information to calculate the percentage of oxygen in this sample of air.

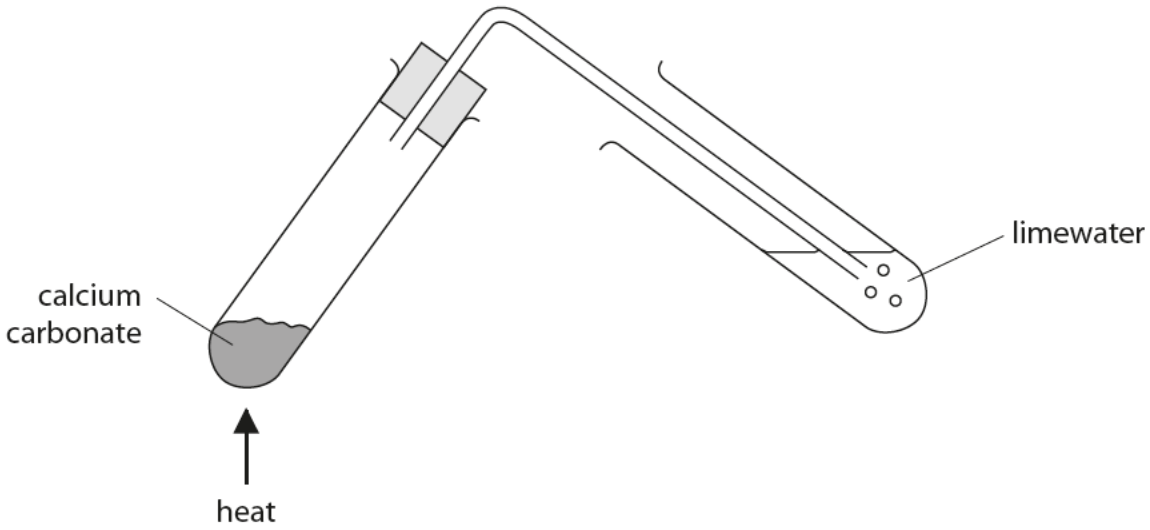
(2)

percentage of oxygen = ...%

(Total for Question 1 = 8 marks)

2 Some powdered calcium carbonate was heated strongly in a test tube.

The gas given off was bubbled through limewater.



The equation for the reaction taking place in the heated tube is

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

(a) What type of chemical reaction is taking place when calcium carbonate is heated?

(1)

- ☒ **A** dehydration
- ☒ **B** oxidation
- ☒ **C** reduction
- ☒ **D** thermal decomposition

(b) State the appearance of the limewater before and after the gas was bubbled through it.

(2)

appearance before .....

appearance after .....

(c) The Taj Mahal is a famous building in India. It is made out of a form of calcium carbonate called marble.



The appearance of the marble has changed gradually over the years because of the effects of sulfur dioxide in the atmosphere.

Describe how sulfur dioxide has caused this change in appearance.

(3)

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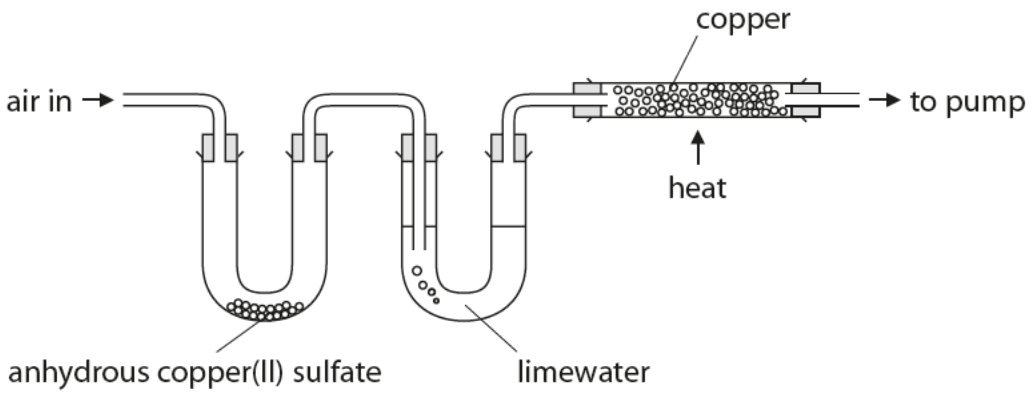
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(Total for Question 2 = 6 marks)

3 A sample of air is passed through the apparatus shown in the diagram.



The anhydrous copper(II) sulfate turns from white to blue.

The limewater turns milky.

The copper turns black.

(a) Name the subst e that turns anhydrous copper(II) sulfate blue.

(1)

(b) Name the substan e that reacts with limewater to make it turn milky.

(1)

(c) Explain y the copper turns black.

(2)

(Total for Question 3 = 4 marks)

4 Air is a mixture of gases.

The table gives the formulae of three gases and their approximate percentage by volume in a sample of dry, unpolluted air.

Gas	Percentage by volume
CO_2	0.04
N_2	78
O_2	21

(a) (i) Give the names of the two main gases in the sample of air.

(1)

..... and .....

(ii) Give the name of the gas that makes up most of the remaining 0.96% of the air.

(1)

.....

(b) State a use for N_2

(1)

.....

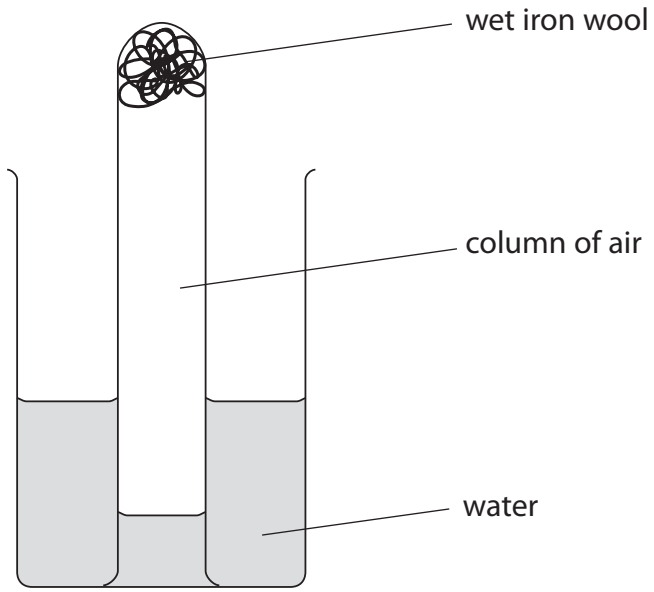
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(c) Give the name of a gas present in **polluted** air that causes acid rain.

(1)

.....

(d) A student used this apparatus to find the percentage by volume of oxygen in a sample of air.



She used this method.

- place some wet iron wool in the bottom of a test tube
- invert the test tube in a beaker containing water
- measure the height of the column of air in the test tube
- leave the test test for one week
- measure the new height of the column of air

The table shows her results.

Initial height of column of air in mm	80
Final height of column of air in mm	63

(i) Some of the iron turned into rust.

Write a word equation for this reaction.

(2)

.....

(ii) Use the student's results to calculate the percentage of oxygen in this sample of air.

(2)

Percentage of oxygen .....

(e) The student left the apparatus for another week and measured the height of the column of air again.

From this measurement, how could she tell whether all of the oxygen in the test tube had been used up in the first week?

(1)

.....

.....

(Total for Question 4 = 9 marks)

5 Titanium is a metal that can be extracted from its ore in a three-stage process.

stage 1 titanium ore is converted into titanium dioxide, TiO_2

stage 2 titanium dioxide is then converted into titanium chloride, $TiCl_4$

stage 3 titanium chloride is converted into titanium, Ti

(a) A titanium ore contains the composition by mass

Fe = 36.8% Ti = 31.6% O = 31.6%

Show by calculation that the empirical formula of this ore is $FeTiO_3$

(3)

(b) The equation for the conversion of titanium dioxide into titanium chloride is

$$TiO_2 + 2Cl_2 + C \rightarrow TiCl_4 + CO_2$$

Explain which element has been oxidised in this reaction.

(2)

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.....

.....

(c) In stage 3

- titanium chloride vapour is passed through molten magnesium in an atmosphere of argon
- the products are allowed to cool to form a solid mixture of titanium and magnesium chloride
- this mixture is crushed into a powder and then added to water to dissolve the magnesium chloride

(i) Write a chemical equation for the reaction between titanium chloride and magnesium.

(2)

.....

(ii) Suggest why this reaction cannot be successfully carried out in an atmosphere of air.

(1)

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.....

(iii) Suggest why the mixture is crushed into a powder before it is added to water.

(1)

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(d) (i) Describe the bonding in titanium metal.

(2)

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(ii) Explain why titanium conducts electricity.

(1)

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(Total for Question 5 = 12 marks)

6 The table shows the percentage composition of the mixture of gases in the exhaust fumes of a car.

Name of gas	Percentage of the gas in the exhaust fumes
carbon dioxide	14.0
carbon monoxide	2.0
hydrocarbons	0.3
nitrogen oxides	0.2
sulfur dioxide	trace amounts
water vapour	12.0
gas Z	71.5

(a) Identify gas Z.

(1)

.....

(b) The carbon dioxide is produced from the combustion of hydrocarbons such as octane.

Complete the word equation for the complete combustion of octane.

(1)

octane + ... → carbon dioxide + ...

(c) How is the carbon monoxide in the exhaust fumes produced?

(1)

.....

.....

(d) (i) Write a chemical equation to show how nitrogen dioxide (NO_2) is produced in a car engine.

(1)

.....

(ii) State one problem caused by nitrogen dioxide in the atmosphere.

(1)

.....

(Total for Question 6 = 5 marks)