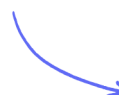


Alternative to Practical Questions

# Air Quality & Climate

Air / Effects of Greenhouse Gases / Reducing the Effects of Environmental Issues / Photosynthesis

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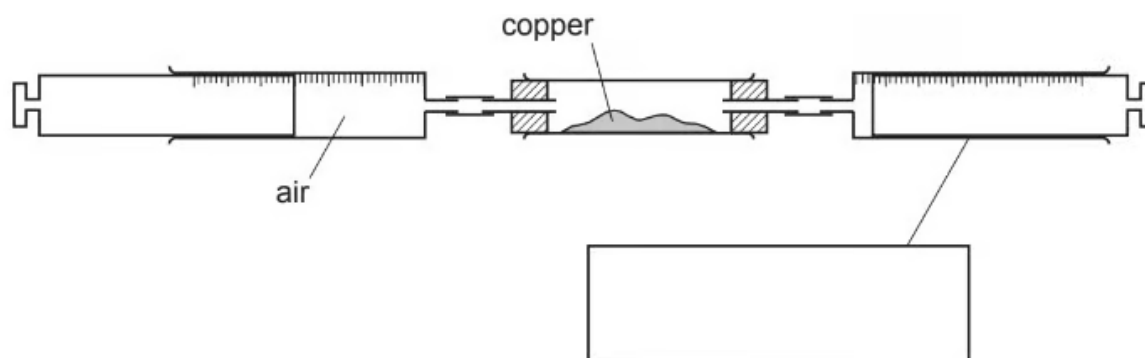


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Total Marks

/6

- 1 (a)** A student investigated the reaction of air with copper.  $100\text{cm}^3$  of air was passed continuously over heated copper using the apparatus below. When the volume remained constant, the apparatus was left to cool and the volume of gas was measured.



a) i) Complete the box to show the apparatus labelled.

[1]

ii) Indicate on the diagram, with an arrow, where heat is applied.

[1]

(2 marks)

(b) b) What should be used to transfer the copper from a bottle to the apparatus?

[1]

(1 mark)

(c) c) The copper changed colour from brown to .....

[1]

**(1 mark)**

**(d)** d) Why was the apparatus left to cool before measuring the final volume of gas?

[2]

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**(2 marks)**

## Theory Questions

# Air Quality & Climate

Air / Effects of Greenhouse Gases / Reducing the Effects of Environmental Issues / Photosynthesis

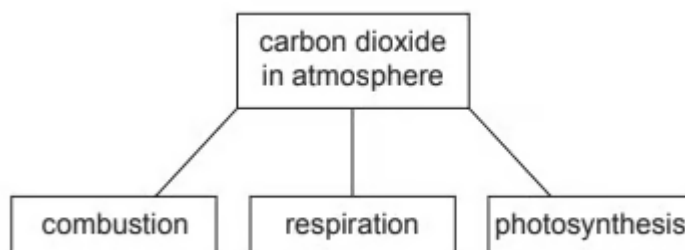
Easy (5 questions)	/28
Medium (8 questions)	/69
Hard (6 questions)	/65
<b>Total Marks</b>	<b>/162</b>

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# Easy Questions

- 1 (a) The diagram shows some of the processes which determine the percentage of carbon dioxide in the atmosphere.



Explain how combustion alters the percentage of carbon dioxide in the atmosphere.

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(3 marks)

- (b) Separate: Chemistry Only

Photosynthesis reduces the percentage of carbon dioxide in the atmosphere.

i)

Complete the word equation for photosynthesis.

carbon dioxide + water → ..... + .....

[2]

ii)

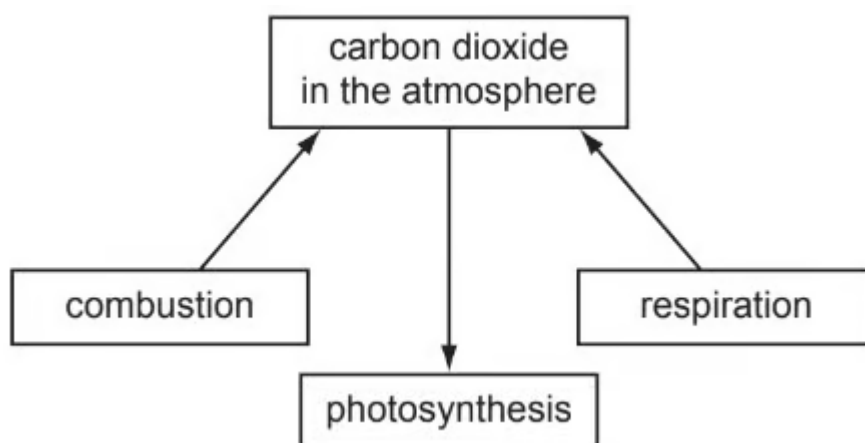
State two essential conditions for the above reaction to occur.

[2]

(4 marks)

## 2 Extended Only

The diagram shows part of the carbon cycle. This includes some of the processes which determine the percentage of carbon dioxide in the atmosphere.



i) Carbon dioxide is one greenhouse gas. Name another one.

[1]

ii) Explain why the combustion of waste crop material should not alter the percentage of carbon dioxide in the atmosphere.

[2]

iii) In 1960 the percentage of carbon dioxide in the atmosphere was 0.032% and in 2008 it was 0.038%. Suggest an explanation for this increase.

[2]

.....

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.....

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.....

(5 marks)

- 3 (a)** Choose from the following list of gases. A gas may be chosen once, more than once or not at all.

<b>sulfur dioxide</b>	<b>hydrogen</b>	<b>methane</b>	<b>carbon monoxide</b>
-----------------------	-----------------	----------------	------------------------

<b>argon</b>	<b>ethene</b>	<b>butane</b>

When burned in oxygen, the only product is water.

.....  
(1 mark)

**(b) Extended Only**

It can polymerise.

.....  
(1 mark)

- (c)** When reacted with oxygen, the only product is carbon dioxide.

.....  
(1 mark)

- (d)** It is produced by the decay of vegetation in the absence of oxygen.

.....  
(1 mark)



**4 (a)** Oxygen and nitrogen are the two main gases in unpolluted air.

State the percentage of each gas.

Gas	% in unpolluted air
nitrogen	
oxygen	

(2 marks)

**(b) Extended Only**

Greenhouse gases can be released into the atmosphere.

Name **two** greenhouse gases.

(2 marks)

**(c) Extended Only**

Increasing amounts of greenhouse gases lead to global climate change.

Give **two** effects of global warming.

(2 marks)

(d) Which strategies will reduce the effects of climate change?

Tick (✓) **two** boxes.

Use of catalytic converters	
Planting trees	
Deforestation	
Reduced livestock farming	
Increased use of landfill	

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(2 marks)

5 (a) The following can all be found in air.

For each question choose a gas. A gas may be chosen once, more than once or not at all.

carbon monoxide	sulfur dioxide	carbon dioxide	nitrogen
-----------------	----------------	----------------	----------

oxides of nitrogen	particulates	argon
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Which gas is toxic and formed from incomplete combustion of methane?

.....  
(1 mark)

(b) **Extended Only**

Which gas is formed in cars and removed using catalytic converters?

.....  
(1 mark)

(c) Which substance increases the risk of cancer?

.....  
(1 mark)

(d) Which **two** gases cause acid rain?

.....  
(1 mark)

# Medium Questions

## 1 Separate: Chemistry and Extended Only

Ozone is a form of oxygen. Ozone is present in the upper atmosphere and it prevents dangerous solar radiation from reaching the Earth's surface. Some of the chemicals that diffuse into the upper atmosphere decompose ozone. Chemicals that have this effect are methane ( $\text{CH}_4$ ), chloromethane ( $\text{CH}_3\text{Cl}$ ) and an oxide of nitrogen ( $\text{NO}_2$ ).

i) Which of these three chemicals diffuses the most slowly? Give a reason for your choice.

[2]

ii) Chloromethane is formed when seaweed decomposes. Name the compounds in the environment from which seaweed might have obtained the following elements:

carbon; .....hydrogen;  
.....chlorine.  
.....

[3]

iii) How can chloromethane be made from methane?

reagent ..... condition  
.....

[2]

iv) The oxides of nitrogen are atmospheric pollutants. Describe how they are formed.

[2]

.....

.....

.....

.....

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**(9 marks)**

**2 (a)** The major gases in unpolluted air are 79% nitrogen and 20% oxygen.

i) Name another gaseous element in unpolluted air.

[1]

ii) Name two compounds in unpolluted air.

[2]

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**(3 marks)**

**(b) Extended Only**

Two common pollutants in air are carbon monoxide and the oxides of nitrogen.

i) Name another pollutant in air.

[1]

ii) Describe how carbon monoxide is formed.

[2]

iii) How are the oxides of nitrogen formed?

[2]

iv) Explain how a catalytic converter reduces the emission of these two gases.

[2]

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(7 marks)

**3 (a)** This question is concerned with the following oxides.

sulfur dioxide  
carbon monoxide  
lithium oxide  
aluminium oxide  
nitrogen dioxide  
strontium oxide

Two of the oxides are responsible for acid rain.

Identify the two oxides and explain their presence in the atmosphere.

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**(5 marks)**

**(b)** Lithium oxide is an ionic compound.

i) Identify another ionic oxide in the list in part a).

[1]

ii) Draw a diagram which shows the formula of lithium oxide, the charges on the ions and the arrangement of the valency electrons around the negative ion.

Use x to represent an electron from an atom of oxygen. Use o to represent an electron from an atom of lithium.

[2]

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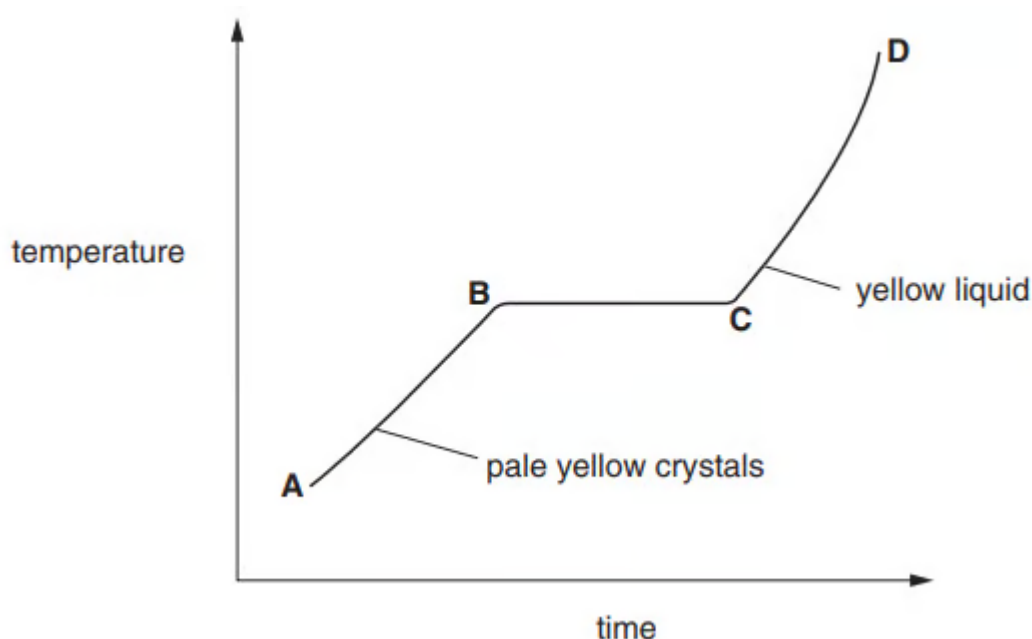


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(3 marks)

#### 4 (a) Extended Only

When nitrogen dioxide is cooled, it forms a yellow liquid and then pale yellow crystals. These crystals are heated and the temperature is measured every minute. The following graph can be drawn.



i) Describe the arrangement and movement of the molecules in the region A-B.

ii) Name the change that occurs in the region B-C

.....

.....

.....

.....

(4 marks)

**(b) Extended Only**

Nitrogen dioxide and other oxides of nitrogen are formed in car engines.

i) Explain how these oxides are formed.

ii) How are they removed from the exhaust gases?

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**(4 marks)**

**(c)** Nitrogen dioxide, oxygen and water react to form dilute nitric acid.

Describe how lead(II) nitrate crystals could be prepared from dilute nitric acid and lead(II) oxide.

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**(3 marks)**

### 5 (a) **Separate: Chemistry and Extended Only**

The reactions in this question are all examples of photochemical reactions.

Explain the phrase *photochemical reaction*.

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**(2 marks)**

### (b) **Separate: Chemistry Only**

Many millions of years ago, the Earth's atmosphere was rich in carbon dioxide and contained negligible amounts of oxygen. After the appearance of green plant-like bacteria, the proportions of these two gases in the atmosphere changed.

i) What are the approximate percentages of these two gases in the atmosphere now?

carbon dioxide = .....

oxygen = .....

[2]

ii) Explain how the green plant-like bacteria changed the composition of the atmosphere.

[4]

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**(6 marks)**

**6 (a)** Minimising air pollution is essential for health and for the environment.

Natural gas is methane.

i) Write the equation for complete combustion of methane.

[2]

ii) Explain why it is dangerous to use a gas fire in a poorly ventilated room.

[2]

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**(4 marks)**

**(b)** Low sulfur fuels are being introduced. Ordinary diesel contains 500 ppm of sulfur but low sulfur diesel contains less than 50 ppm. Why is this an advantage to the environment?

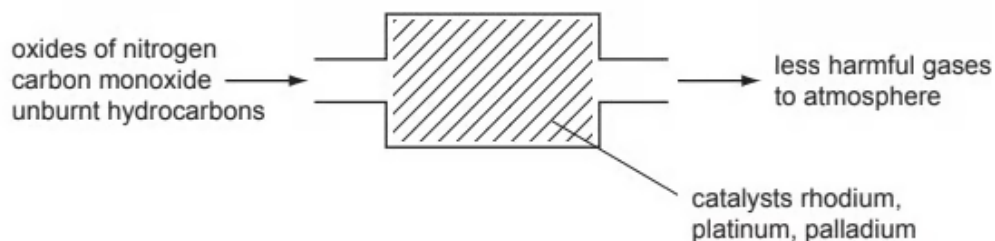
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**(2 marks)**

**(c) Extended Only**

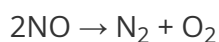
Catalytic converters reduce pollution from motor vehicles, as shown in the following diagram.



i) What type of elements are the metals rhodium, platinum and palladium?

[1]

ii) Rhodium catalyses the decomposition of the oxides of nitrogen.



Two other pollutants are carbon monoxide and unburnt hydrocarbons. How are they made into less harmful substances?

[2]

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(3 marks)

**7 (a)** Coal is a solid fossil fuel.

Name two other fossil fuels.

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**(2 marks)**

**(b)** Two of the elements present in a sample of coal are carbon and sulfur.

A sample of coal was heated in the absence of air and the products included water, ammonia and hydrocarbons.

Name **three** other elements present in this sample of coal.

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**(2 marks)**

**(c)** Sulfur, present in coal, is one major cause of acid rain. Sulfur burns to form sulfur dioxide which reacts with rain water to form sulfuric acid.

i) Describe how the high temperatures in vehicle engines are another cause of acid rain.

[3]

ii) Give two harmful effects of acid rain.

[2]

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**(5 marks)**

- (d)** In 2010, a large coal-burning power station in the UK was converted to burn both coal and wood.

Explain why the combustion of wood rather than coal can reduce the effect of the emissions from this power station on the level of carbon dioxide in the atmosphere.

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**(3 marks)**



**8 (a)** The properties of five alkenes at room temperature are shown in the table.

alkene	number of carbon atoms in a molecule	state at room temperature	density in g / cm <sup>3</sup>	boiling point / °C
ethene	2	gas	0.0012	-104
propene	3	gas	0.0018	-47
butene	4	gas	0.0024	
pentene	5	liquid	0.64	30
hexene	6	liquid	0.67	63

When propene undergoes incomplete combustion, carbon monoxide is formed.

What condition is needed for incomplete combustion?

.....  
(1 mark)

**(b)** Give **one** adverse effect of carbon monoxide on health.

.....  
(1 mark)

# Hard Questions

**1 (a)** Clean dry air contains mainly nitrogen and oxygen.

Name two other gases that are in clean dry air.

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**(2 marks)**

**(b)** Air often contains pollutants. Identify three common gaseous pollutants in air and state how each of these pollutants are produced.

pollutant gas 1 .....

how it is produced .....

pollutant gas 2 .....

how it is produced .....

pollutant gas 3 .....

how it is produced .....

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**(6 marks)**

**2 (a)** Air is a mixture of gases.

The main constituents are the elements oxygen and nitrogen.

i) Name another element in air.

[1]

ii) Give the formula of a compound in unpolluted air.

[1]

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**(2 marks)**

**(b)** Common pollutants present in air are the oxides of nitrogen and sulfur dioxide.

i) How are the oxides of nitrogen formed?

[2]

ii) How is sulfur dioxide formed?

[2]

iii) These oxides are largely responsible for acid rain.

State **two** harmful effects of acid rain.

[2]

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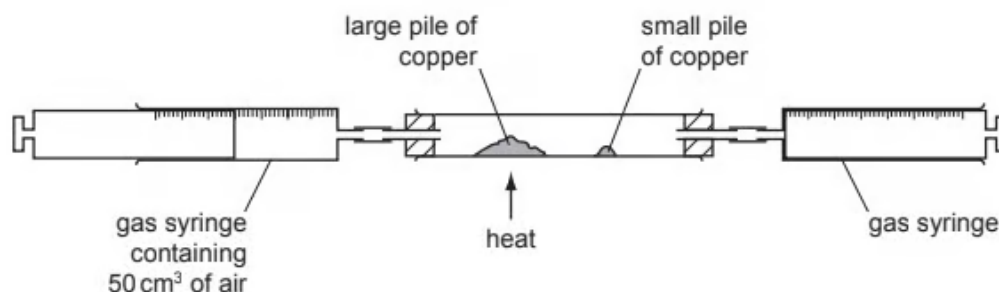
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**(c)** The percentage of oxygen in air can be determined by the following experiment.



The gas syringe contains  $50\text{ cm}^3$  of air. The large pile of copper is heated and the air is passed from one gas syringe to the other over the hot copper. The large pile of copper turns black. The gas is allowed to cool and its volume measured. The small pile of copper is heated and the remaining gas passed over the hot copper. The copper does not turn black. The final volume of gas left in the apparatus is less than  $50\text{ cm}^3$ .

i) Explain why the copper in the large pile turns black.

[2]

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

[1]

iii) Explain why the copper in the small pile did not turn black.

[1]

iv) What is the approximate volume of the gas left in the apparatus?

[1]

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**(5 marks)**

- 3 (a)** Plant growth is improved by the availability of essential elements, such as nitrogen, and by the soil having a suitable pH.

Nitrogen-based fertilisers are made from ammonia. Ammonia is manufactured by the Haber process.

- i) Describe the Haber process giving reaction conditions and a balanced equation. (Do not discuss reaction rate and yield.)

[5]

- ii) Fertilisers contain nitrogen. Name the other two elements essential for plant growth commonly found in fertilisers.

[2]

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**(7 marks)**

- (b)** Crops do not grow well if the soil is too acidic.

- i) One cause of acidity in soil is acid rain. Explain how acid rain is formed.

[3]

- ii) Name two bases which are used to increase the pH of acidic soils.

[2]

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(5 marks)

**4 (a)** Polluted air contains two oxides of carbon and two oxides of nitrogen. A major source of these pollutants is motor vehicles.

i) Describe how carbon dioxide and carbon monoxide are formed in motor vehicle engines.

[3]

ii) State one adverse effect of each of these gases.

[2]

iii) Nitrogen monoxide, NO, is released by motor vehicle exhausts. Explain how nitrogen monoxide is formed in motor vehicle engines.

[2]

iv) When nitrogen monoxide is released into the atmosphere, nitrogen dioxide, NO<sub>2</sub>, is formed. Suggest an explanation why this happens.

[1]

.....

.....

.....

.....

.....

.....

.....

.....

**(8 marks)**

**(b)** Predict the possible adverse effect on the environment when this non-metal oxide, NO<sub>2</sub>, reacts with water and oxygen.



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**(2 marks)**

- (c)** How are the amounts of carbon monoxide and nitrogen monoxide emitted by modern motor vehicles reduced?

Include an equation in your answer.

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**(3 marks)**

- 5 (a)** Three common pollutants in the air are carbon monoxide, the oxides of nitrogen, NO and NO<sub>2</sub> and unburnt hydrocarbons. They are all emitted by motor vehicles.

Describe how the oxides of nitrogen are formed.

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**(2 marks)**

- (b)** Describe how a catalytic converter reduces the emission of these three pollutants.

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**(4 marks)**

**6 (a)** i) Coal is a solid fossil fuel. Name another fossil fuel.

[1]

ii) Explain what is meant by the term *fossil fuel*.

[2]

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**(3 marks)**

**(b)** The burning of fossil fuels is largely responsible for the formation of acid rain. Two of the acids in acid rain are sulfuric acid and nitric acid.

i) Explain how the combustion of coal can form sulfuric acid.

[3]

ii) High temperatures generated by the combustion of fossil fuels can lead to the formation of nitric acid. Explain.

[3]

iii) Nitric acid contains nitrate ions.

Describe a test for nitrate ions.

[2]

iv) Explain how you could determine which one of two samples of acid rain had the higher concentration of hydrogen ions.

[2]

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**(10 marks)**

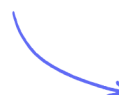
## Multiple Choice Questions

# Water & Water Pollution

Water: Chemical Tests / Substances in Water from Natural Sources / Water Treatment / Fertilisers

Easy (5 questions)	/5
Medium (5 questions)	/5
Hard (5 questions)	/5
<b>Total Marks</b>	<b>/15</b>

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# Easy Questions

- 1 A student added anhydrous copper(II) sulfate to a test tube containing an aqueous solution.

Which row correctly describes the colour change the student observed?

	before addition	after addition
A	white	pink
B	white	blue
C	blue	white
D	pink	blue

(1 mark)

- 2 Which of the following statements regarding the uses of water are correct?

1	Water in industry is used as a solvent and as a coolant.
2	All water used in industry is safe for human consumption.
3	Water in the household may contain dissolved salts.
4	Water in the household is used for sanitation and cooking.

- A.** 1, 3 & 4
- B.** 1, 2 & 4
- C.** 2, 3 & 4
- D.** 1 & 4 only

**(1 mark)**

- 3** During the treatment of ground water, large insoluble particles are allowed to settle to the bottom of a tank.

What is this process called?

- A.** Sedimentation
- B.** Anaerobic digestion
- C.** Screening
- D.** Chlorination

**(1 mark)**

- 4** There are many steps involved when treating water.

Which of the answers below is the incorrect reason for the treatment step being carried out?

	Treatment	Explanation
<b>A</b>	filtration	to remove dissolved solids
<b>B</b>	carbon filtration	to remove tastes and odours
<b>C</b>	sedimentation	to remove mud and sand
<b>B</b>	chlorination	to kill bacteria

(1 mark)

## 5 Separate: Chemistry Only

What essential plant nutrients do fertilisers supply?

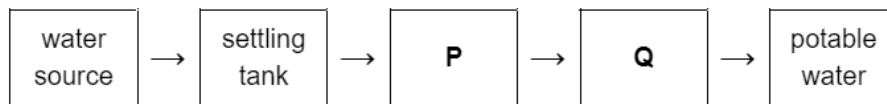
<b>A</b>	phosphorus	calcium	nitrogen
<b>B</b>	iron	nitrogen	magnesium
<b>C</b>	nitrogen	potassium	phosphorus
<b>D</b>	potassium	calcium	nitrogen

(1 mark)



# Medium Questions

- 1 Potable water is produced from a water source near a country spring as shown in the flow diagram.



Which processes occur at P and Q?

	P	Q
A	chlorination	filtration
B	chlorination	distillation
C	filtration	distillation
D	filtration	chlorination

(1 mark)

- 2 Which pair of substances would make an NPK fertiliser?

- A. ammonium phosphate and potassium chloride
- B. calcium phosphate and potassium chloride
- C. ammonium sulfate and potassium nitrate
- D. potassium nitrate and calcium carbonate

(1 mark)

3 Mineral water contains dissolved salts such as magnesium chloride. Which one of the following statements about mineral water is correct?

- A. Mineral water boils at slightly above 100 °C.
- B. Mineral water is pure water.
- C. Mineral water boils at exactly 100 °C.
- D. Another name for mineral water is fizzy water.

(1 mark)

4 Ammonia and sulfuric acid can react in the lab to make ammonium sulfate fertiliser.

What is the formula of the product?

- A.  $\text{NH}_3\text{SO}_4$
- B.  $\text{NH}_4\text{SO}_4$
- C.  $(\text{NH}_4)_2\text{SO}_4$
- D.  $(\text{NH}_3)_2\text{SO}_4$

(1 mark)

5 Which is the correct reason for carrying out each step when treating water?

	Adding carbon	Chlorination	Sedimentation
A	kill microbes	remove salts	remove solids
B	remove salts	remove odours	kill microbes
C	remove odours	kill microbes	remove solids
D	remove odours	remove solids	1. remove salts

(1 mark)

# Hard Questions

- 1 Which row correctly identifies the substance based on the experiment and observations carried out?

	Experiment	Observations	Identity of bold substance
A	<b>Pink crystals</b> are heated	The crystals turn blue and steam is given off	anhydrous cobalt(II) chloride
B	Water is added to a <b>white solid</b>	The white solid turns blue	anhydrous copper(II) sulfate
C	<b>Blue crystals</b> are heated	The crystals turn white and steam is given off	anhydrous cobalt(II) chloride
D	Water is added to a <b>blue solid</b>	The blue solid turns pink	hydrated copper(II) sulfate

(1 mark)

2 Fertilisers provide three essential elements required for plant growth.

Which substances will make a salt that will contain two of these essential elements?

- 1 ammonia and nitric acid
- 2 potassium hydroxide and sulfuric acid
- 3 ammonia and phosphoric acid
- 4 potassium hydroxide and nitric acid

**A.** 1 and 2

**B.** 1 and 3

**C.** 2 and 4

**D.** 3 and 4

**(1 mark)**

### 3 Separate: Chemistry Only

Which substances lead to deoxygenation of water?

- 1  $\text{NH}_4\text{NO}_3$
- 2 Pb
- 3 Mg
- 4  $\text{Ca}_3(\text{PO}_4)_2$

**A.** 2 and 4

**B.** 1 and 2

**C.** 3 and 4

**D.** 1 and 4

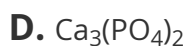
**(1 mark)**

## 4 Separate: Chemistry and Extended Only

Different fertilisers contain the essential elements needed for plant growth in varying quantities.

Which fertiliser compound contains the highest percentage by mass of the essential elements needed for growth?

[Relative atomic masses,  $A_r$ : H = 1; N = 14; O = 16; P = 31; S = 32; K = 39; Ca = 40]



(1 mark)

## 5 Separate: Chemistry Only

Four water samples, **W**, **X**, **Y** and **Z**, were analysed in the laboratory to measure pH, boiling point, and the amount of dissolved solids.

The sources of water were:

- pure water
- tap water
- acidic rain
- sea water

The results are shown in the table below.

Water sample	pH	Boiling point / °C	Mass of dissolved solids in 20 cm <sup>3</sup> of water / g
<b>W</b>	8.2	101.3 - 101.5	0.72
<b>X</b>	4.2	100.2 - 100.3	0.03
<b>Y</b>	7.0	100.0	0.00
<b>Z</b>	6.3	100.5 - 100.6	0.02

Which are the correct identities of water samples **W**, **X**, **Y** and **Z**?

	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>
<b>A</b>	acidic rain	pure water	tap water	sea water
<b>B</b>	pure water	tap water	sea water	acidic rain
<b>C</b>	tap water	sea water	acidic rain	pure water
<b>D</b>	sea water	acidic rain	pure water	tap water

**(1 mark)**

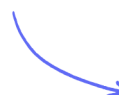
## Theory Questions

# Water & Water Pollution

Water: Chemical Tests / Substances in Water from Natural Sources / Water Treatment / Fertilisers

Easy (5 questions)	/29
Medium (5 questions)	/42
Hard (5 questions)	/55
<b>Total Marks</b>	<b>/126</b>

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# Easy Questions

1 (a) This question is about chemical tests for water.

Complete these sentences about the test for water using the words from the list.

hydrated	green	anhydrous	white
blue	sulfur	yellow	sulfate

Cobalt chloride paper will turn from ..... to pink in the presence of water.

..... copper ..... will turn from ..... to blue in the presence of water.

.....

.....

.....

.....

(4 marks)

(b) Describe how a student could test to see if a sample of water is pure.

.....

.....

.....

.....

(4 marks)



(c) Explain why tap water is not used for chemical reactions.

.....

.....

(2 marks)

**2 (a)** This question is about water:

State **two** industrial uses of water.

---

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**(2 marks)**

**(b)** State **two** uses of water in the home.

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**(2 marks)**

**(c)** Before water is used in industrial processes and in the home it must be purified. Give **two** substances which are found in natural water before purification.

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**(2 marks)**

**(d)** State the term that describes a rock that store water.

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**(1 mark)**

**3 (a)** This question is about the testing and purification of water

Which of these statements describes the correct test for water? Tick **one** box.

Hydrated copper(II) sulfate stays white	
Hydrate copper(II) sulfate turns pink	
Cobalt chloride paper turns pink	
Cobalt chloride paper turns white	

.....  
(1 mark)

**(b)** When water is added to hydrated copper(II) sulfate heat is produced. What type of reaction is this?

.....  
(1 mark)

**(c)** Untreated water contains soluble and insoluble impurities.

Name the **two** processes that remove insoluble impurities during the treatment of water.

.....

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(2 marks)

(d) Complete the following sentence using the words from the list

<b>chlorine</b>	<b>carbon</b>	<b>sand</b>
-----------------	---------------	-------------

In order to remove odours and tastes water is passed through .....

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(1 mark)

**4 (a)** Fertilisers are concentrated forms of plant nutrients

Which of the following ions do plants need for growth?

Tick **one** box.

$\text{Cu}^{2+}$	
$\text{PO}_4^{3-}$	
$\text{SO}_4^{2-}$	
$\text{OH}^-$	

---

**(1 mark)**

- (b)** Potassium nitrate is used as a fertiliser. The potassium ion has the formula  $\text{K}^+$  and the nitrate ion has the formula  $\text{NO}_3^-$ .

Give the formula for potassium nitrate.

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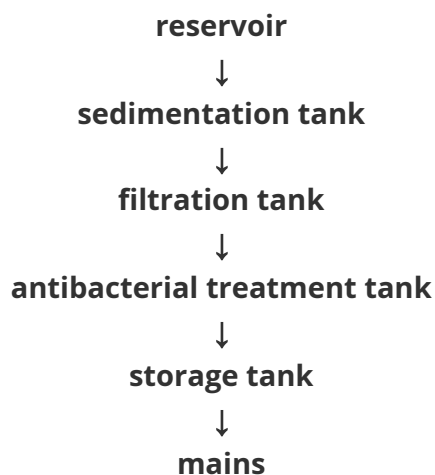
**(1 mark)**

- (c)** What property must fertilisers have in order for plants to take up the ions through their roots.

---

(1 mark)

**5 (a)** The flow chart shows stages in producing drinking water.



At which stage is chlorine added to the water.

.....  
(1 mark)

**(b)** Chlorine is a toxic substance. Suggest why it is safe to be added to drinking water.

.....  
(1 mark)

**(c)** Suggest another use for which chlorinated water is required.

.....  
(1 mark)

**(d)** Describe what happens in the sedimentation tank.

.....  
(1 mark)

# Medium Questions

**1 (a)** This question is about water.

Describe a chemical test which shows the presence of water.

test .....

colour change if water is present .....

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**(3 marks)**

**(b)** How could you show that a sample of water is pure?

---

**(1 mark)**

**(c)** Describe how water is treated before it is supplied to homes and industry.

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**(2 marks)**



**2 (a)** Water is needed for industry and in the home.

i) Rain water is collected in reservoirs. How is it treated before entering the water supply?

[2]

ii) State **two** uses of water in the home.

[2]

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**(4 marks)**

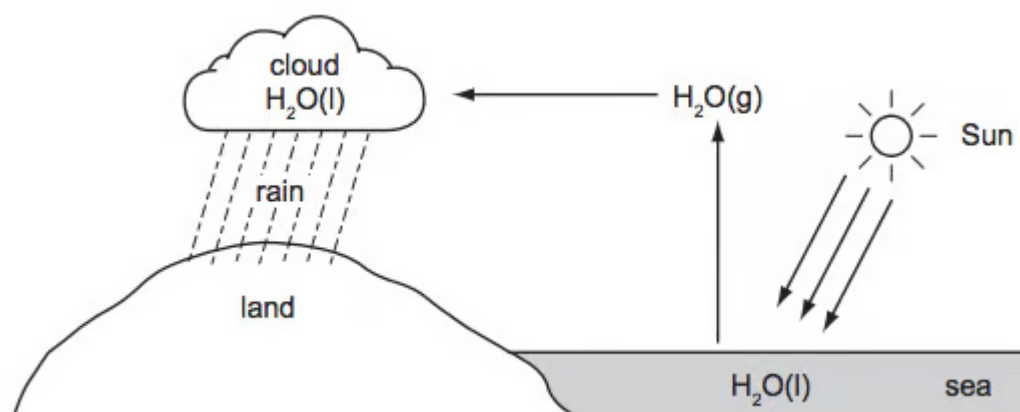
**(b)** In many regions, drinking water is obtained by the distillation of sea-water. Explain how distillation separates the water from sea-water.

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**(2 marks)**

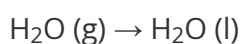
**3 (a)** The diagram below shows part of the Water Cycle.



i) State the name of each of the following changes of state.



name .....



name .....

[2]

ii) Which one of the above changes of state is exothermic? Explain your choice.

[1]

.....

.....

.....

**(3 marks)**

**(b)** The rain drains into rivers and then into reservoirs. Describe how water is treated before it enters the water supply.

.....

---

(2 marks)

(c) **Separate: Chemistry Only**

i) Explain how acid rain is formed.

[4]

ii) Fish live in water which is neutral (neither acidic nor alkaline). Acid rain decreases the pH of water in lakes and rivers. Both of the bases, calcium oxide and calcium carbonate, can neutralise this acid and increase the pH.

Explain why calcium carbonate is a better choice.

[2]

---

(6 marks)

#### 4 (a) **Separate: Chemistry Only**

Plants require three main elements for healthy growth which be provided by fertilisers.

Give the formulae of **three** ions used to make fertilisers which provide the three required elements.

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(3 marks)

- (b) Calcium nitrate is used as a fertiliser to help prevent blossom end rot in tomatoes which causes browning of the bottom of the fruit. It provides both calcium and nitrogen.

Write the formula for calcium nitrate.

---

(1 mark)

#### (c) **Separate: Chemistry and Extended Only**

Using your answer to part (b) calculate the percentage by mass of nitrogen in calcium nitrate.

( $A_r$ : Ca = 40, N = 14, O = 16)

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(2 marks)

#### (d) **Separate: Chemistry Only**

Explain why salts from fertilisers end up in bodies in groundwater.

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(2 marks)

- 5 (a)** Waste water like this needs to be treated before being released into the environment. Waste water may require removal of organic matter and harmful chemicals. The three main steps are sedimentation, filtration and chlorination.

Explain what happens in sedimentation.

(2 marks)

- (b)** Explain why chlorination is required.

(3 marks)

- (c)** **Table 5.1** shows some information about how the treated solid sludge was disposed of from one sewage treatment plant in 2000 and 2020.

**Table 5.1**

**Mass of treated solid sludge in tonnes**

Year	Used as fertiliser	Sent to landfill	Other	Total
2000	56	22	55	132
2020	152	2	39	193

Calculate the percentage of treated solid sludge that was sent to landfill in 2000.

Give your answer to 3 significant figures.

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(3 marks)

- (d) The total mass of treated solid sludge increased from 2000 to 2020 and the proportions of how the sludge was disposed of changed.

Suggest **one** reason for the increase in the total mass of treated solid sludge and **two** reasons for the changes in the proportions of the disposal methods.

Use **Table 5.1** to help you answer.

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(3 marks)

# Hard Questions

1 (a) Fertilisers are used to promote plant growth.

Two fertilisers are ammonium phosphate,  $(\text{NH}_4)_3\text{PO}_4$ , and calcium dihydrogenphosphate,  $\text{Ca}(\text{H}_2\text{PO}_4)_2$ .

Describe a test to distinguish between these two fertilisers.

test .....

result .....

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(3 marks)

## (b) Separate: Chemistry and Extended Only

Many fertilisers are manufactured from ammonia.

Describe how ammonia is made in the Haber process. Give the essential conditions and an equation for the process.

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(4 marks)

## (c) Separate: Chemistry Only

State the essential plant nutrient not supplied by ammonium phosphate.



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(1 mark)

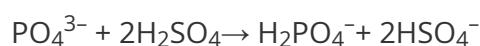
**(d) Separate: Chemistry and Extended Only**

The soluble compound, calcium dihydrogenphosphate is made by heating the insoluble mineral rock phosphate,  $\text{Ca}_3(\text{PO}_4)_2$ , with sulfuric acid.

i) Why would rock phosphate not be effective as a fertiliser?

[1]

ii) The phosphate ion,  $\text{PO}_4^{3-}$ , from the rock phosphate is changed into the dihydrogenphosphate ion,  $\text{H}_2\text{PO}_4^-$ .



What type of reagent is the phosphate ion? Give a reason for your choice.

[2]

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(3 marks)

## 2 (a) **Separate: Chemistry Only**

The Atacama desert in Chile has deposits of the salt sodium nitrate.

Very large amounts of this salt were exported to Europe for use as a fertiliser. After the introduction of the Haber process in 1913, this trade rapidly diminished.

i) Explain why the introduction of the Haber process reduced the demand for sodium nitrate.

[2]

ii) Suggest why surface deposits of sodium nitrate only occur in areas with very low rainfall such as desert areas.

[1]

iii) The desert has smaller surface deposits of potassium nitrate. Suggest why potassium nitrate is a better fertiliser than the sodium salt.

[1]

(4 marks)

## (b) Extended Only

The equation for the decomposition of copper(II) nitrate is given below.



Copper(II) nitrate forms a series of hydrates with the formula  $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ .

All these hydrates decompose to form copper(II) oxide.

1 mole of  $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$  forms 1 mole of CuO.

i) What is meant by 1 mole of a substance?

[1]

ii) 7.26 g of a hydrate,  $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ , formed 2.4 g copper(II) oxide.

number of moles of CuO formed = ..... number of moles of  $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$  in  
7.26 g = ..... mass of 1 mole of  $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$  = ..... g mass of 1 mole  
of  $\text{Cu}(\text{NO}_3)_2$  is 188 g the value of x in this hydrate = .....

[4]

(5 marks)

**3 (a)** Groundwater can contain fertilisers washed from fields. An example of a fertiliser that can be found is ammonium nitrate.

i) Write a balanced equation, including state symbols, to show how ammonium nitrate can be made by a student via a neutralisation reaction.

[2]

ii) Describe how the student could perform a chemical test for the presence of nitrate ions.

[2]

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**(4 marks)**

**(b) Separate: Chemistry and Extended Only**

Drinking water extracted from rivers in agricultural areas often contain nitrates. The first legal standard for nitrate in drinking water was set in 1980. The current UK drinking water standard is  $50 \text{ mg / dm}^3$  to safeguard against cases of methaemoglobinaemia or blue baby syndrome.

Calculate the maximum mass in grams of nitrate that would be safe in a  $240 \text{ cm}^3$  glass of water. Give your answer to two significant figures.

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**(3 marks)**

**(c) Separate: Chemistry Only**

An alternative fertiliser is ammonium phosphate.

i) Give the formula for ammonium phosphate.

[1]

ii) Which ion that plants need is missing from this fertiliser?

[1]

.....  
.....  
(2 marks)

**(d) Separate: Chemistry and Extended Only**

Phosphates can be found in reservoirs from which drinking water is obtained. A maximum of  $0.025 \text{ mg / dm}^3$  of phosphate ions is allowed by water companies.

A sample of reservoir water has a concentration of  $0.00014 \text{ mol / dm}^3$ .

Calculate the percentage of the maximum mass allowed of phosphate ions in the sample of reservoir water.

.....  
.....  
.....  
(3 marks)

- 4 (a) Water from reservoirs is treated to make it suitable for drinking. Even though the water has been treated it is not pure. One method to purify water is de-ionisation.

Describe another method which will produce pure water.

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(3 marks)

(b) **Separate: Chemistry Only**

Explain why it is beneficial to drink water that is not deionized.

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(2 marks)

- (c) Chlorine is added to drinking water in order to make it safe to drink. The chlorine kills micro-organisms that can cause illnesses such as cholera and typhoid.

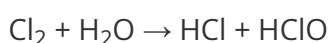
Suggest a concern with adding chlorine to drinking water.

---

(1 mark)

(d) **Separate: Chemistry and Extended Only**

When chlorine is added to water it undergoes a reaction which forms hydrogen chloride and chloric(I) acid. The chloric(I) acid is the compound that kills the bacteria.



In this reaction chlorine is both oxidised and reduced. Explain why.

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(3 marks)

**5 (a)** A scientist finds an unlabelled bottle on a shelf.

She thinks the bottle contains a solution of ammonium sulfate,  $(\text{NH}_4)_2\text{SO}_4$ .

Describe tests the scientist could do to show that the solution is ammonium sulfate.

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**(6 marks)**

**(b)** Ammonium sulfate is often used as a fertiliser.

It is prepared by reacting ammonia ( $\text{NH}_3$ ) with sulfuric acid ( $\text{H}_2\text{SO}_4$ ).

i) Name the type of reaction that occurs between ammonia and sulfuric acid.

[1]

ii) Write a chemical equation for the reaction of ammonia with sulfuric acid.

[1]

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**(2 marks)**



### (c) **Separate: Chemistry and Extended Only**

A common test for water is to use anhydrous copper(II) sulfate. If water is present an exothermic reaction takes place and the solid turns from white to blue and becomes hydrated copper(II) sulfate. This reaction is reversible.

6.25 g of blue hydrated copper(II) sulphate,  $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$  was gently heated in a crucible until the mass remaining was 4.00 g. This is the white anhydrous copper(II) sulphate.

Use this information to calculate a value for  $x$  in  $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$ .

$A_r$ 's Cu = 64, S = 32, O = 16, H = 1

$x = \dots\dots\dots$

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**(3 marks)**

### (d) **Separate: Chemistry Only**

Cobalt(II) chloride paper is used to test for water as well. Hydrated cobalt chloride has the formula  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ .

i) State the colour change when cobalt chloride paper is added to water.

[1]

ii) When hydrated cobalt chloride is heated, water is given off. Write the balanced symbol equation for this reaction.

[2]

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**(3 marks)**