Rewarding Learning

Centre Number

71

Candidate Number

General Certificate of Secondary Education
2013

Science: Chemistry

Unit C2

Higher Tier

[GCH22]

MV18

THURSDAY 20 JUNE, AFTERNOON

TIME

1 hour 45 minutes, plus your additional time allowance.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Complete in blue or black ink only.
Answer **all** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is **115**.
Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.
Quality of written communication will be assessed in question **5(a)**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

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(Questions start overleaf)

1 Fireworks contain the three ingredients shown in the box below.

colouring agent
fuel
oxidiser

(a) Magnesium is often used in fireworks as the colouring agent.

(i) What is the colour of the flame observed when magnesium burns? [1]

_____

(ii) Write a balanced symbol equation for magnesium burning in air. [3]

_____

(b) Carbon in the form of charcoal is often used as the fuel in fireworks.

(i) What is observed when a sample of carbon burns? [2]

_____

_____

_____

(ii) Name the product formed when carbon burns in a limited supply of oxygen. [1]

_____

(c) Oxidisers provide the oxygen needed to allow the firework to burn effectively. A common oxidiser is potassium nitrate, which thermally decomposes to produce potassium oxide, nitrogen and oxygen.

Write a balanced symbol equation for this reaction. [3]

_____

(d) Sparklers are hand held fireworks which contain a fuel, an oxidiser and iron powder. Often the iron powder is mixed with linseed oil to prevent it rusting.

(i) What conditions are required for iron to rust? [2]

_____

_____

_____

(ii) What is the chemical name for rust? [2]

_____

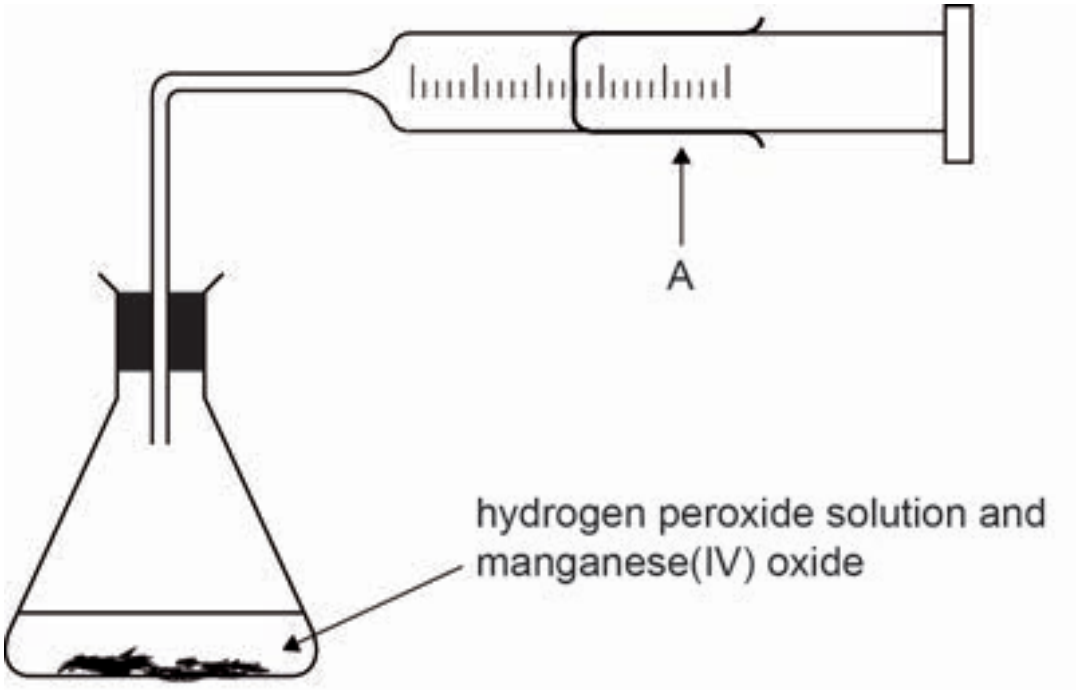
(e) In industry, iron is manufactured in the Blast Furnace.

A redox reaction which occurs in the Blast Furnace is given below:

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

Explain fully, in terms of change in oxygen content, why this reaction is described as a redox reaction. [5]

2 **(a)** The rate of decomposition of a solution of hydrogen peroxide using manganese(IV) oxide (manganese dioxide) can be measured using the apparatus shown below. The manganese(IV) oxide is a catalyst for the reaction.



(i) Name the piece of apparatus labelled A. [1]

_____

(ii) What is meant by the term catalyst? [3]

_____

_____

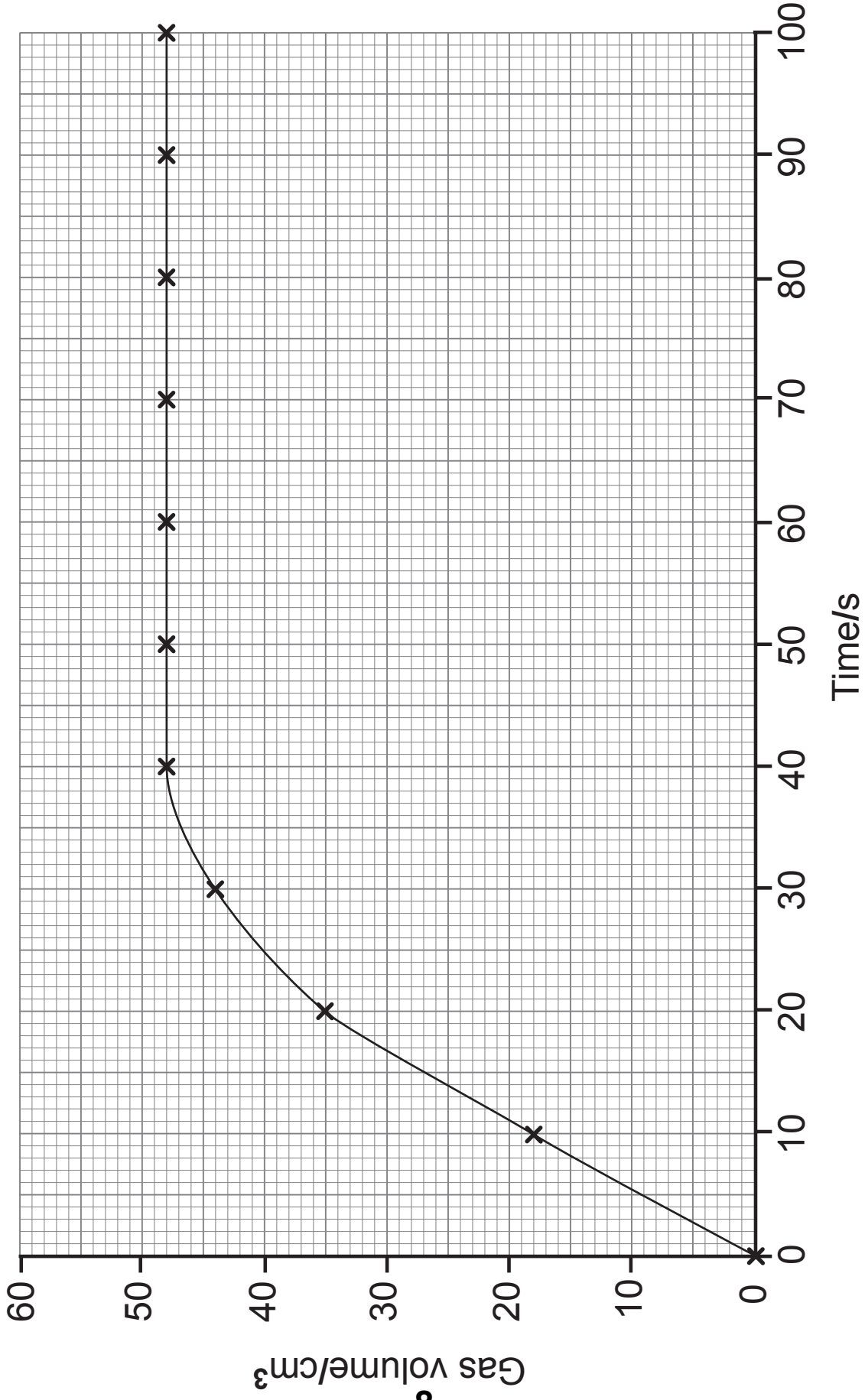
_____

_____

(iii) Write a balanced symbol equation for the decomposition of hydrogen peroxide. [3]

_____

(b) The graph below shows data obtained at 25 °C using 25.0 cm^3 of 0.16 mol/dm^3 hydrogen peroxide solution with 1.0 g of solid powdered manganese(IV) oxide.



(i) Apart from the apparatus shown in the diagram in part **(a)**, name one other piece of equipment which would be required to collect the results used to draw the graph. [1]

_____

(ii) What was the total volume of gas collected? [1]

_____

(iii) The reaction was repeated at 40 °C with all other factors being kept the same. Sketch the graph you would expect to obtain on the axes on page 8. [3]

(c) The table below shows the time taken for the decomposition of hydrogen peroxide solution to be completed. 25.0 cm^3 of 0.16 mol/dm^3 hydrogen peroxide solution was used with 1.0 g of different powdered metal oxides as catalysts.

Metal oxide	**Time for decomposition to be completed/s**	**Rate of decomposition/s^{-1}** $\textbf{rate} = \left(\frac{1}{\textbf{time}}\right)$
Manganese(IV) oxide		
Copper(II) oxide	127	0.00787
Zinc oxide	360	0.00277

(i) Using the graph at 25 °C in part **(b)**, complete the table above. [2]

(ii) State which of the metal oxides in the table is the **least** effective catalyst and explain your answer. [2]

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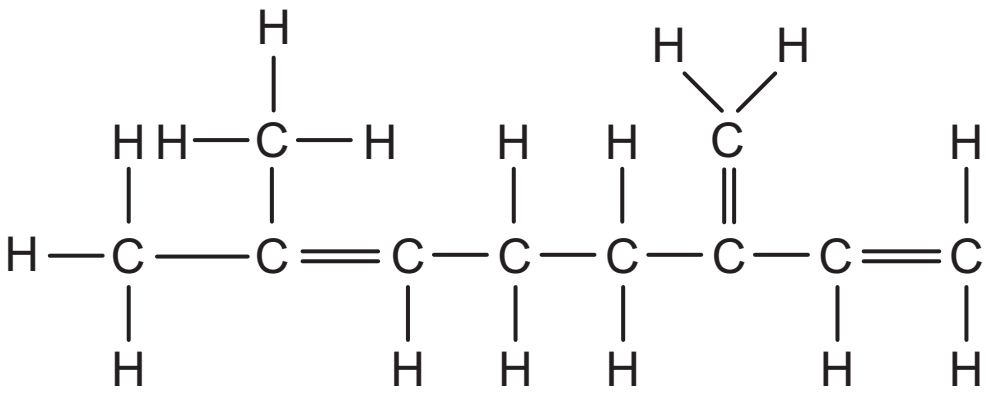
(Questions continue overleaf)

3 Perfume is a mixture of essential oils dissolved in a solvent. One of the essential oils used in making perfume is called myrcene.

(a) The structural formula of a molecule of myrcene is shown below.



(i) Explain why a molecule of myrcene can be classified as a hydrocarbon. [1]

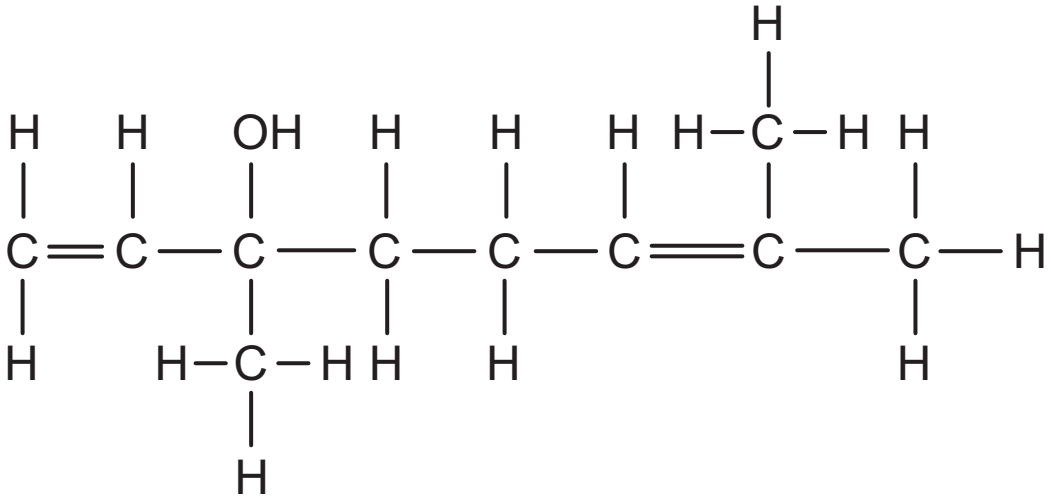
_____

_____

(ii) Identify the functional group present in myrcene. [1]

_____

(b) Linalool is another essential oil used in perfume making. It gives a sweet, lavender-like smell. The structural formula of linalool is shown below.



(i) On the structure of linalool shown above, draw a circle around the **alcohol** functional group. [1]

(ii) Like all alcohols, linalool ($C_{10}H_{17}OH$) undergoes complete combustion in excess air. Complete and balance the symbol equation below for this reaction. [2]

$C_{10}H_{17}OH$ + $O_2 \longrightarrow$

(iii) When linalool is warmed with acidified potassium dichromate solution it is oxidised in the same way as ethanol. State the colour change which is observed in this reaction. [2]

from _____ to _____

(c) Ethanol is an alcohol which is often used as a solvent in perfumes.

(i) Write the general formula for alcohols. [1]

_____

(ii) Draw the structural formula of ethanol. [1]

(iii) Ethene can be used to manufacture the ethanol used in perfumes.
Complete the table below to give information about ethene. [3]

Name	**Molecular formula**	**Structural formula**	**State at room temperature and pressure**
Ethene			

(d) Ethanoic acid is a carboxylic acid which can be used to make other solvents. These solvents are also used in perfumes.

(i) Draw the structural formula of ethanoic acid. [1]

(ii) State two observations you would make when magnesium reacts with ethanoic acid. [2]

_____

_____

_____

_____

(iii) Write a balanced symbol equation for the reaction of magnesium with ethanoic acid. [3]

_____

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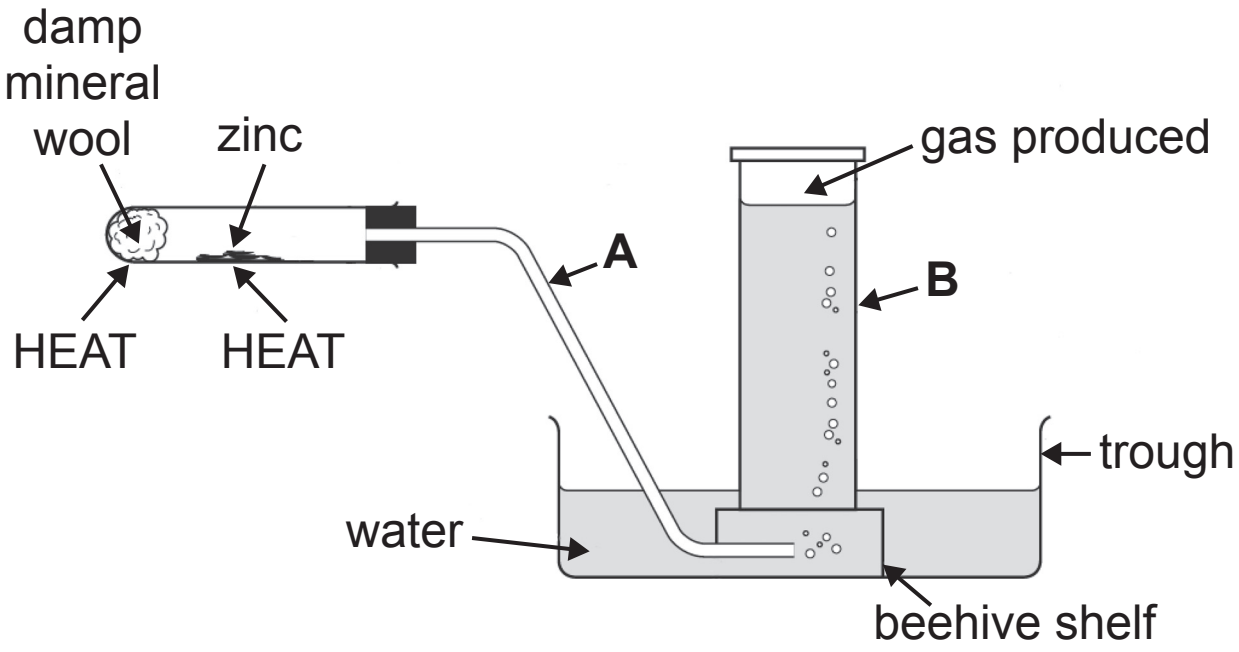
(Questions continue overleaf)

4 Metals may be placed in a reactivity series by observing their reactions with air, water, steam and dilute acid.

(a) The apparatus below may be used to react zinc metal with steam.



(i) What labels should be placed at **A** and **B** on the diagram? [2]

A _____

B _____

(ii) Explain why the damp mineral wool is heated. [1]

_____

(iii) Name the gas produced in this experiment. [1]

_____

(iv) Name a metal which does not react when heated with steam. [1]

_____

(b) X is an unknown metal. The table below gives details of some reactions of the three metals X, sodium and zinc.

Metal	**Reaction when heated in oxygen**	**Reaction with cold water**	**Reaction with dilute hydrochloric acid**
X	Black coating forms on metal without burning	No reaction	No reaction
Sodium	Burns very vigorously with a yellow flame		Dangerous reaction not carried out in school laboratory
Zinc	Burns forming a yellow solid which changes to white on cooling	No reaction	Reacts steadily

(i) Suggest the name of metal X. [1]

_____

(ii) Describe what you would observe when sodium reacts with cold water. [3]

_____

_____

_____

_____

_____

_____

_____

(iii) Write a balanced symbol equation for the reaction of sodium with water. [3]

_____

(c) Aluminium is a metal which is extracted from its ore (bauxite) by electrolysis.

(i) What is meant by the term electrolysis? [2]

(ii) What is the name of the **purified** bauxite which is used in the production of aluminium by electrolysis? [1]

(iii) Write a half equation to represent the production of aluminium during this electrolysis process. [3]

(iv) At what temperature is this electrolysis carried out? [1]

(v) Explain why the carbon anodes need to be replaced periodically during this electrolysis. [3]

5 Alkaline batteries contain one particular metal hydroxide. The metal hydroxide can be represented as MOH.

3.92 g of this solid metal hydroxide were dissolved in 1000 cm^3 of deionised water in a volumetric flask. 25.0 cm^3 of this solution were placed in a conical flask using a pipette.

(a) Describe in detail how you would prepare and use a pipette to transfer 25.0 cm^3 of the MOH solution into a conical flask, ensuring accuracy and safety. [6]

In this question you will be assessed on using your written communication skills including the use of specialist scientific terms.

(b) 25.0 cm^3 of the MOH solution were titrated with hydrochloric acid of concentration 0.125 mol/dm^3 using phenolphthalein indicator. The results are shown in the table below.

	Initial burette volume/cm^3	**Final burette volume/cm^3**	**Titre/cm^3**
Rough titration	0.0	14.9	14.9
First accurate titration	14.9	28.9	14.0
Second accurate titration	28.9	42.9	14.0

(i) Calculate the average titre. [2]

_____ cm^3

(ii) State the colour change at the end-point. [2]

From _____ to _____

(iii) Calculate the number of moles of hydrochloric acid used in the titration. [2]

_____

The balanced symbol equation for the reaction is:

$MOH + HCl \rightarrow MCl + H_2O$

(iv) Calculate the number of moles of MOH present in 25.0 cm^3 of the solution in the conical flask. [1]

(v) Calculate the number of moles of MOH present in 1000 cm^3 of the solution. [2]

(vi) Using the fact that 3.92 g of MOH were dissolved in 1000 cm^3 and the answer to question **(b)(v)** on page 28, determine the relative formula mass of MOH. [2]

(vii) Determine the relative atomic mass of M using your answer to question **(b)(vi)**. [2]
(Relative atomic masses: H = 1; O = 16)

(viii) Identify the metal, M. [1]

6 (a) An investigation was carried out to compare the hardness of water samples from three towns A, B and C.

25 cm^3 of each water sample were placed into three separate conical flasks and labelled A, B and C.
A sample of deionised water was also tested.

Soap solution was added, 1 cm^3 at a time, to each conical flask with shaking until a lasting lather formed.
The total volume of soap solution added to each flask was recorded.

The experiment was repeated with fresh samples of A, B and C which had been boiled and allowed to cool, before adding the soap solution.

The results are shown in the table below.

Water sample	**Volume of soap solution required to form a lather**	
	before boiling (cm^3)	**after boiling (cm^3)**
Deionised water	2	2
A	6	6
B	8	2
C	11	7

(i) Which of the three water samples (A, B or C) is the hardest water? [1]

_____

(ii) Which of the three water samples (A, B or C) contains **only** temporary hardness? [1]

_____

(iii) Which of the three water samples (A, B or C) contains both temporary and permanent hardness? [1]

_____

(b) Permanent hardness may be removed from water by the addition of washing soda. Explain, in terms of ions, how washing soda can soften hard water. [3]

(c) State two disadvantages of hard water. [2]

1. _____

2. _____

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(Questions continue overleaf)

7 Nitrogenous fertilisers contain ammonium compounds such as ammonium nitrate which is produced when ammonia reacts with nitric acid.

(a) (i) Write a balanced symbol equation for the reaction of ammonia with nitric acid. [2]

_____

(ii) Describe how you would carry out a chemical test for the presence of ammonia gas, stating the observations you would make for a positive test. [4]

_____

_____

_____

_____

_____

_____

_____

(iii) State one disadvantage of using nitrogenous fertilisers. [1]

_____

(b) In industry ammonia gas is produced by the Haber process which involves a reversible reaction between the gases nitrogen and hydrogen.

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

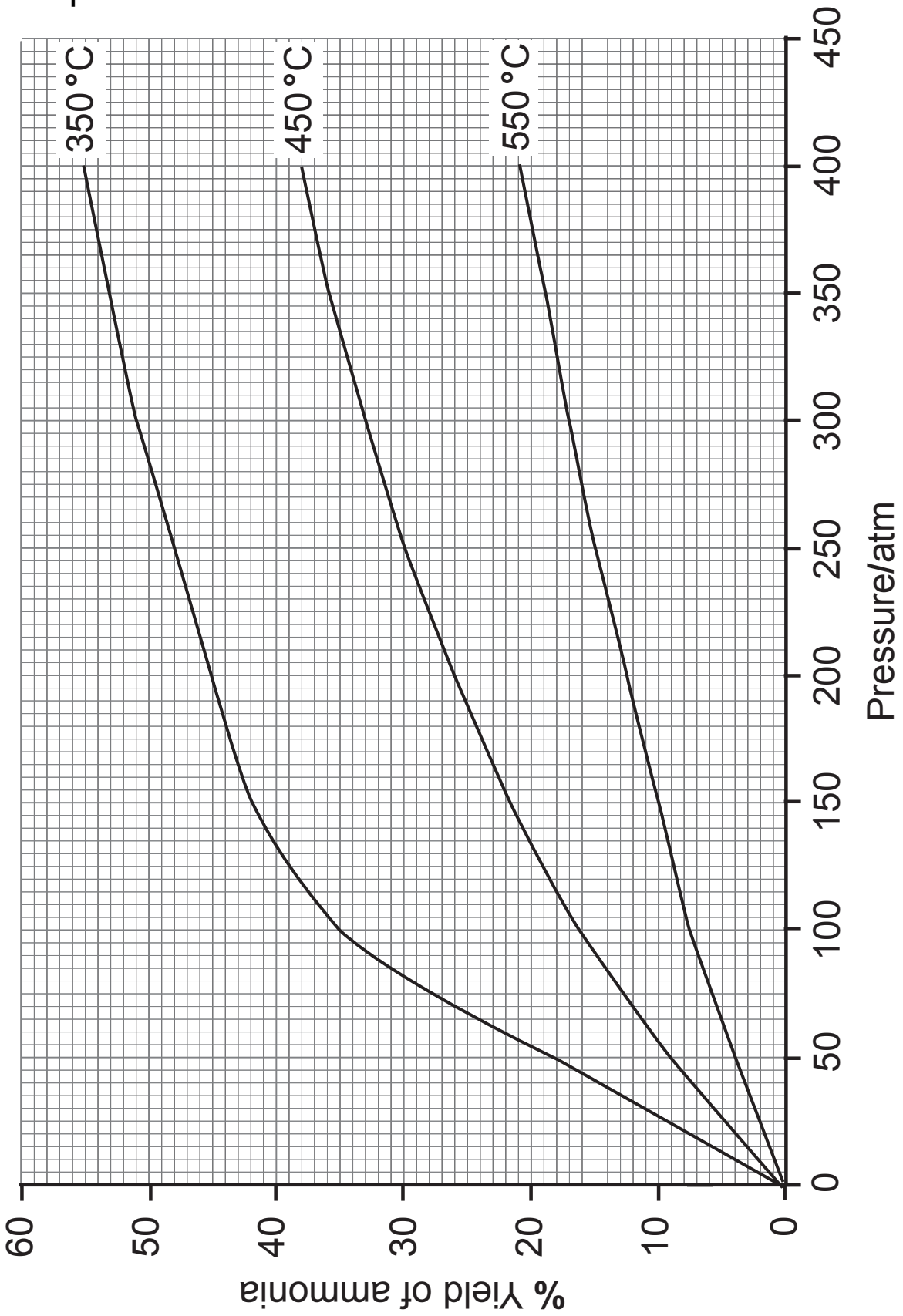
(i) Explain what you understand by the term reversible reaction. [1]

_____

(ii) Name the catalyst used in the Haber process. [1]

_____

(c) The percentage yield of ammonia produced in the Haber Process is affected by both the temperature and the pressure. The graph below shows how the percentage yield of ammonia changes with temperature and pressure.



Use the graph to answer the following questions.

(i) State the effect of increasing temperature on the yield of ammonia at constant pressure. [1]

(ii) 450 °C and 250 atm are commonly used conditions for the Haber Process. What is the percentage yield of ammonia using these conditions? [1]

(iii) Suggest why industry uses 450 °C and 250 atm when it is possible to obtain a higher yield of ammonia using a lower temperature and a higher pressure. [1]

THIS IS THE END OF THE QUESTION PAPER

SOURCES

Pg7, Q2a, Hydrogen Peroxide Experiment, Source: © CCEA
Pg12, Q3, Bottle of Perfume, Source: © iStockphoto / Thinkstock
Pg18, Q4a, Zinc metal apparatus diagram, Source: © Barking Dog Art
Pg24, Q5, Alkaline Battery, Source: © iStockphoto / Thinkstock

For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
QWC	
Total Marks	

Examiner Number