



Methodist Ladies' College Semester 1, 2014

Question/Answer Booklet

CHEMISTRY STAGE 2

Student Name _____

Ms Haughton

Mrs Templeton-Knight

Time allowed for this paper

Reading time before commencing work: 10 minutes

Working time for paper Two hours thirty minutes

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer booklet

Multiple-choice Answer Sheet

Chemistry Data Sheet

To be provided by the candidate

Standard items: pens(blue/black preferred), pencils(including coloured), sharpener, eraser, correction tape/fluid, eraser, ruler, highlighters

Special items: non-programmable calculators approved for use in the WACE examinations

Important Note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

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Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of exam
Section One: Multiple-choice	20	20	40	40	25
Section Two: Short answer	12	12	60	70	45
Section Three: Extended answer	3	3	50	50	30
Total					100

Instructions to candidates

1. The rules for the conduct of Western Australian examinations are detailed in the *Year 12 Information Handbook 2014*. Sitting this examination implies that you agree to abide by these rules.
2. Answer the questions according to the following instructions.

Section One: Answer all questions on the separate Multiple-choice Answer Sheet provided. For each question shade the box to indicate your answer. Use only blue or black pen to shade the boxes. If you make a mistake, place a cross through that square then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Sections Two and Three: Write your answers in this Question/Answer Booklet.

3. When calculating numerical answers, show your working out reasoning clearly. Express numerical answers to three significant figures and include appropriate units where applicable.
4. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.
5. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
 - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
 - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Section One: Multiple-choice

25% (40 Marks)

This section has **20** questions. Answer **all** questions on the separate Multiple-choice Answer Sheet Provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square, do not erase or use correction fluid, and shade your new answer. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question

Suggested working time: 40 minutes

1. When a gas is cooled in a sealed, rigid container, the
- (a) pressure increases
 - (b) volume and pressure decrease
 - (c) pressure decreases
 - (d) pressure might increase or decrease depending on the size of the gas particles
2. An ammonia solution that is 8 mol L^{-1} is best described as a:
- (a) concentrated solution of a weak electrolyte
 - (b) concentrated solution of a strong electrolyte
 - (c) dilute solution of a weak electrolyte
 - (d) dilute solution of a strong electrolyte
3. Which one of the following statements about elements in Groups 1 and 2 on the Periodic Table is correct?
- (a) They lose electrons to form negatively charged ions in a sea of electrons
 - (b) They form negative ions because they have few valence electrons
 - (c) They either form positive ions or share their valence electrons in a covalent network structure
 - (d) They commonly form positive ions when reacting with group 17 elements
4. The correct formula of iron(II) sulfite is:
- (a) Fe_2S
 - (b) Fe_2SO_3
 - (c) FeS
 - (d) FeSO_3

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5. Use the table to identify a pair of isotopes.

Element	Number of protons	Number of electrons	Number of neutrons
W	20	21	21
X	19	18	19
Y	19	21	19
Z	20	19	20

- (a) Elements X and W
(b) Elements X and Y
(c) Elements W and Z
(d) Elements Y and W
6. A compound C is formed from elements A and B. Element A has 16 protons in its nucleus and element B has a total of 11 electrons in each of its atoms. Compound C can be described as:
- (a) ionic with the formula A_2B
(b) ionic with the formula B_2A
(c) covalent with the formula A_2B
(d) covalent with the formula B_2A
7. The number of non bonding pairs in a molecule of carbon dioxide is:
- (a) 2
(b) 4
(c) 6
(d) 8
8. A quantity of salt crystals is added to a beaker of water and stirred for a long period of time. The mixture is left to settle. The final result is a clear liquid with salt crystals at the bottom of the beaker. Which of the following would happen if more salt crystals are added to the beaker.
- (a) A supersaturated solution would be produced.
(b) All the extra salt added would dissolve in the water.
(c) The amount of salt at the bottom of the beaker would remain the same.
(d) The concentration of the salt solution would remain constant.

9. Which one of the following will most likely conduct electricity when heated to 600°C?
- (a) diamond (m.p 3550°C)
 - (b) carbon tetrachloride (m.p 23°C)
 - (c) potassium nitrate (m.p. 334°C)
 - (d) magnesium chloride (m.p 714°C)
10. Which one of the following lists classifies all of the substances correctly?

	Pure substance	Homogenous mixture	Heterogeneous mixture
(a)	Silver nitrate	Brass	Indian ocean
(b)	Air	Cordial	Sugar solution
(c)	Tap water	Dissolved salt	Carbon dioxide
(d)	Distilled water	Diamond	Iron ore

11. A single use heat pack involves the reaction between finely divided iron and oxygen (from air) to produce iron (III) oxide. This reaction produces 824 kJ of heat per mole of iron (III) oxide produced. Which of the following equations best represents this reaction?

- (a) $2\text{Fe(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{FeO(s)} \quad \Delta H = -824 \text{ kJ}$
- (b) $4\text{Fe(s)} + 3\text{O}_2\text{(g)} \rightarrow 2\text{Fe}_2\text{O}_3\text{(s)} \quad \Delta H = -412 \text{ kJ}$
- (c) $4\text{Fe(s)} + 3\text{O}_2\text{(g)} \rightarrow 2\text{Fe}_2\text{O}_3\text{(s)} \quad \Delta H = -1648 \text{ kJ}$
- (d) $4\text{Fe(s)} + 3\text{O}_2\text{(g)} + 1648 \text{ kJ} \rightarrow 2\text{Fe}_2\text{O}_3\text{(s)}$

12. Which one of the following best describes the bonding in ice?

- (a) Hydrogen ions are electrostatically attracted to oxygen ions
- (b) Two oxygen atoms are covalently bonded to one hydrogen atom within the molecule and weak intermolecular forces hold the molecules together.
- (c) There are weak forces of attraction between the oxygen and hydrogen atoms in the molecules and strong electrostatic forces hold the molecules together.
- (d) The hydrogen and oxygen atoms are held by strong electrostatic attraction of their nuclei to the shared electrons in the covalent bond, whilst weak intermolecular forces hold the molecules together.



13. X is an ionic compound, the table below shows the observations made when the following tests were carried out on solution X.

Test	Observation
1. copper nitrate solution is added	black precipitate is formed
2. sodium chloride solution added	no visible reaction

The possible identity of the anion present in X is?

- (a) sulfide
 - (b) hydroxide
 - (c) silver
 - (d) carbonate
14. Which of the following statements best describes how elements are arranged on the periodic table?
- (a) Elements are arranged in order of increasing mass and in groups according to the number of valence electrons.
 - (b) Elements are arranged in order of increasing atomic number and in groups according to the number of valence electrons.
 - (c) Elements are arranged in order of increasing protons and in groups according to the number of occupied electron shells.
 - (d) Elements are arranged in order of increasing mass number and in periods according to the number of electron shells occupied.
15. Which of the following statements about reaction rate is false?
- (a) Increasing the concentration of reactants increases the rate of reaction
 - (b) As a reaction proceeds the reaction rate slows as the reactant concentration decreases
 - (c) Exothermic reactions proceed at a slower rate if the temperature is increased.
 - (d) Increasing pressure on a gaseous reaction will increase the rate of a reaction.

16. Which of the following lists the 0.5 mol L^{-1} aqueous solutions in the correct order of **decreasing** vapour pressure?
- (a) sucrose, calcium chloride, potassium iodide, ammonium phosphate
(b) ammonium phosphate, calcium chloride, potassium iodide, sucrose
(c) calcium chloride, ammonium phosphate, potassium iodide, sucrose
(d) sucrose, potassium iodide, calcium chloride, ammonium phosphate
17. Which one of the following about the activated complex (transition state) is false?
- (a) The activated complex is unstable and short lived
(b) The activated complex has a higher enthalpy than the reactants and the products
(c) The activated complex always decomposes
(d) The activated complex for the forward and reverse reactions is always different.
18. Which of the following statements about gas particles is true according to the kinetic theory of matter?
- (a) The distance between gas particles depends only on the temperature of the gas.
(b) On average, gas particles lose energy when they collide with one another.
(c) When a gas is heated, the speed of the particles increases.
(d) The temperature of a gas is the sum of the kinetic and potential energy of the gas particles.
19. Which one of the following correctly classifies the substances?

	Non electrolyte	Weak electrolyte	Strong electrolyte
(a)	BaSO ₄	NH ₃	H ₂ SO ₄
(b)	C ₂ H ₅ OH	CH ₃ COOH	CaCl ₂
(c)	NH ₃	AgCl	CuCO ₃
(d)	C ₆ H ₁₂ O ₆	CH ₃ COOH	NH ₃



20. Which of the following is **not** a physical property of sulfur?
- (a) Sulfur is a yellow, crystalline solid
 - (b) Sulfur does not conduct electricity when molten
 - (c) Sulfur undergoes combustion to produce sulfur dioxide gas
 - (d) Sulfur has a melting point of 114 ° C.

End of Section One

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Section Two: Short answer

45% (70 Marks)

This section has twelve (12) questions. Answer all questions. Write your answers in the spaces provided.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
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Suggested working time: 60 minutes

Question 21

(9 marks)

- (a) Complete the table below by adding the name of an **element** from **atomic number 1 to 20** of the Periodic Table for each of the types of bonding and structure described.

(4 marks)

Bonding and structure at room temperature and pressure	Name of Element
metallic solid	calcium
monatomic gas	
covalent network solid	
covalent molecular gas	
covalent molecular solid	

- (b) Why do metallic solids such as calcium conduct electricity?

(2 marks)



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- (c) Covalent bonding is common to both network and molecular solids. Why do covalent network solids have extremely high melting points but covalent molecular solids have low melting points?

(3 marks)

Question 22

(8 marks)

Complete the table below by naming or giving the formula for the following substances.

Name	Formula
aluminium chloride	
ethanoic acid	
	P_2O_5
tin(IV) sulfide	
	CaC_2O_4
potassium dichromate	
	$Fe(NO_3)_3$
	Na_2HPO_4

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Question 23

(9 marks)

Some physical properties of ethanol are shown in the table below.

colour	melting point	boiling point at atmospheric pressure	vapour pressure at 20°C	Mass of 1.00 mL
colourless	-114°C	78°C	5.85 kPa	0.785 g

(a) Complete the following sentences by inserting the words, **less than**, **greater than** or **equal to**.

(3 marks)

(i) At 50°C the vapour pressure of ethanol is _____ 5.85 kPa.

(ii) The boiling point of a solution of copper(II) chloride dissolved in ethanol is _____ 78°C.

(iii) The melting point of a solution of copper(II) chloride dissolved in ethanol is _____ - 114°C.

(b) 25.0 mL of ethanol, C₂H₅OH, is dissolved in water producing 150.0 mL of solution.

(i) What mass of ethanol is dissolved in the water? (1 mark)

(ii) Determine the concentration of the solution in mol L⁻¹. (2 marks)

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- (c) A cocktail was prepared by mixing 50.0 g of 40.0% ethanol by mass gin and 60.0 g of 35.5% ethanol by mass dry martini.

(3 marks)



What amount in moles of ethanol did the drinker consume?

Question 24

(4 marks)

Explain using your knowledge of kinetic theory and the behavior of gases why:

- (a) Carbon dioxide gas will bubble out of soft drinks when the can is opened. (2 marks)

- (b) People perspire on a hot day in order to cool down. (2 marks)

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Question 25

(6 marks)

For the species listed in the table below, draw electron dot diagrams. All valence shell electron pairs should be represented as \cdot or $-$

Name or formula	electron dot diagram
O_2	
SiF_4	
magnesium phosphide	

Question 26

(4 marks)

Consider two 1 litre gas jars at $25^\circ C$ and atmospheric pressure, one containing methane gas, CH_4 , and the other, carbon monoxide gas, CO .

Complete the table below by circling the correct answer when comparing methane gas with carbon monoxide gas.

characteristic	Compared with carbon monoxide (CO) methane (CH_4) has :
a. average Kinetic energy	same higher lower
b. average velocity	same higher lower
c. number of molecules	same higher lower
d. amount in moles	same higher lower



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Question 27**(4 marks)**

Chromium sulfide reacts with hydrochloric acid to produce hydrogen sulfide gas (H_2S) and chromium chloride solution.

- (a) Write a balanced equation for the reaction described and give full observations (3 marks)

Equation _____

Observations _____

- (b) An ore containing a mixture of chromium metal and chromium sulfide was treated with excess hydrochloric acid. As well as hydrogen sulfide gas a second gas was produced. Identify that gas. (1 mark)

Question 28**(2 marks)**

A pressure cooker is a cooking device that has a deep pan with a lid to form an airtight seal when closed. Water is added to a pressure cooker and the water is able to reach a temperature of approximately $120\text{ }^\circ\text{C}$.



Water in a normal saucepan will boil at $100\text{ }^\circ\text{C}$. Explain how the water in a pressure cooker is able to boil at $120\text{ }^\circ\text{C}$.

(2 marks)

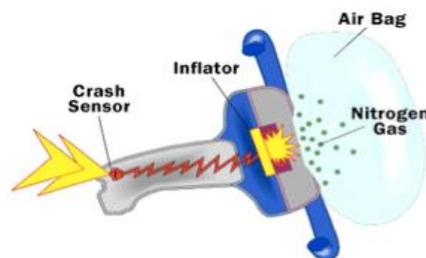
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Question 29

(7 marks)

The air bags in cars inflate when activated by a crash sensor. Nitrogen gas is produced to inflate the bags in a three-step process. In the first step, sodium azide (NaN_3) decomposes according to the equation below.



- (a) 135 g of sodium azide is stored separately in the inflator chamber. The crash sensor causes the sodium azide to decompose and nitrogen gas is blasted into the air bag.

Calculate the volume of nitrogen produced from 135 g of sodium azide at STP

(3 marks)

- (b) In another chamber potassium nitrate is mixed with the sodium metal to produce potassium oxide, sodium oxide and nitrogen gas. Write a balanced equation for this reaction.

(2 marks)

- (c) The nitrogen inflating the bag is not at standard temperature and pressure but usually around 40°C . Would the actual volume of nitrogen gas inflating the bag be greater or less than the answer to (a) above? Explain.

(2 marks)

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Question 30

(3 marks)

Name all the particles that carry the charge when electricity flows in the following substances:

- (a) molten silver _____
- (b) an aqueous solution of copper sulfate _____
- (c) solid copper _____

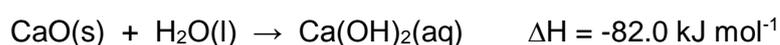
Question 31

(8 marks)

- (a) State whether the following processes are endothermic or exothermic. (5 marks)

Process	Endothermic or exothermic
$4\text{Al(s)} + 3\text{O}_2\text{(g)} \rightarrow 2\text{Al}_2\text{O}_3\text{(s)} + 993 \text{ kJ}$	
Combustion of petrol	
When ammonium nitrate is added to water in a beaker, the beaker feels cold to the touch.	
$2\text{N(g)} \rightarrow \text{N}_2\text{(g)}$	

- (b) The equation for the reaction between calcium oxide, CaO, and water can be represented as:



See next page

Calculate the mass of calcium oxide required to release 287 kJ of energy.

(3 marks)

Question 32**(6 marks)**

Give the chemical formula or name of a species that matches the description in the table below:-

Description	Example (formula or name)
An element that exists as a silver liquid at room temperature	
An ionic compound that consists of only non-metal atoms	
The most reactive element in group 2	
A halogen which is a solid at room temperature	
A yellow solid with a high melting point that is malleable	
A substance that undergoes ionisation when added to water and produces a strong electrolyte	

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End of Section Two

Section Three: Extended answer

30% (50 Marks)

This section contains three (3) questions. You must answer all questions. Write your answers in the spaces provided.

Where questions require an explanation and/or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression.

Final answers to calculations should be expressed to **three (3)** significant figures and include appropriate units.

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Suggested working time: 50 minutes

Question 33

(24 marks)

The Haber process is the industrial manufacture of ammonia from nitrogen and hydrogen.

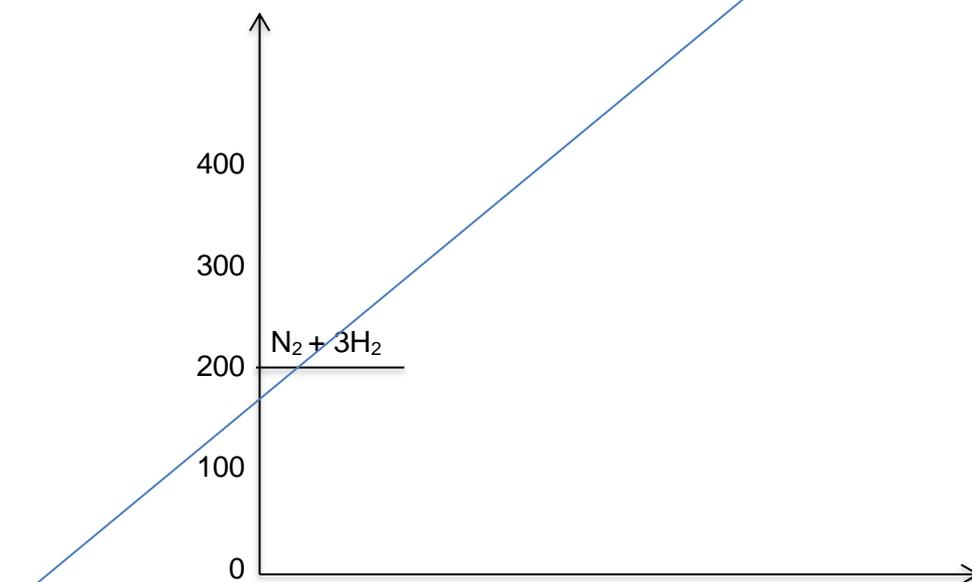


The reaction does not occur readily. It requires a high temperature and pressure as well as a catalyst. The activation energy is 120 kJ.

(a) Complete the energy profile diagram for this reaction. Label:

- both axis
- activation energy
- enthalpy change
- transition state.

(5 marks)



See next page

(b) Rewrite the equation for the reaction including the energy term as part of the equation. (1 mark)

(c) If 6.00×10^3 kL of nitrogen reacts completely. What maximum volume of ammonia, measured at the same temperature and pressure could be produced. (1 mark)

(d) Using relevant theories, explain fully how the conditions used for this industrial process, high temperature, catalyst and high pressure, result in a very good rate of reaction. Diagrams/graphs may assist your explanation. (9 marks)

High temperature

High pressure

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Catalyst

- (e) Ammonia is used to manufacture the fertilizer ammonium nitrate, NH_4NO_3 . Calculate the percentage by mass of nitrogen in ammonium nitrate. (2 marks)

- (f) Plants also use phosphorous to promote growth and health. 50.0 g of ammonium phosphate, $(\text{NH}_4)_3\text{PO}_4$, was mixed with 75.0 g of ammonium nitrate. This mixture was dissolved in enough water to make 875 mL of solution.

- (i) This solution can be described as a homogenous mixture. Explain the term homogenous. (1 mark)

- (ii) Calculate the concentration of ammonium ions in the solution. (5 marks)

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Question 34

(12 marks)

The labels have fallen from 4 bottles known to contain the following white solids:

sodium sulfate, sodium chloride, sodium carbonate and calcium phosphate.

You have available:

- Distilled water
- Barium hydroxide solution
- Nitric acid
- Sodium hydroxide solution

Describe how you could carry out a series of simple tests that would allow you to identify each of the white solids and correctly label the bottles. You may not have to use all the chemicals provided. Describe the distinguishing observations for each test and give ionic equations for any chemical reactions occurring. **3 Tests** should be sufficient.

Test	Distinguishing Observations	Substance/s identified	Relevant equation (if necessary)

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Question 35

(14 marks)

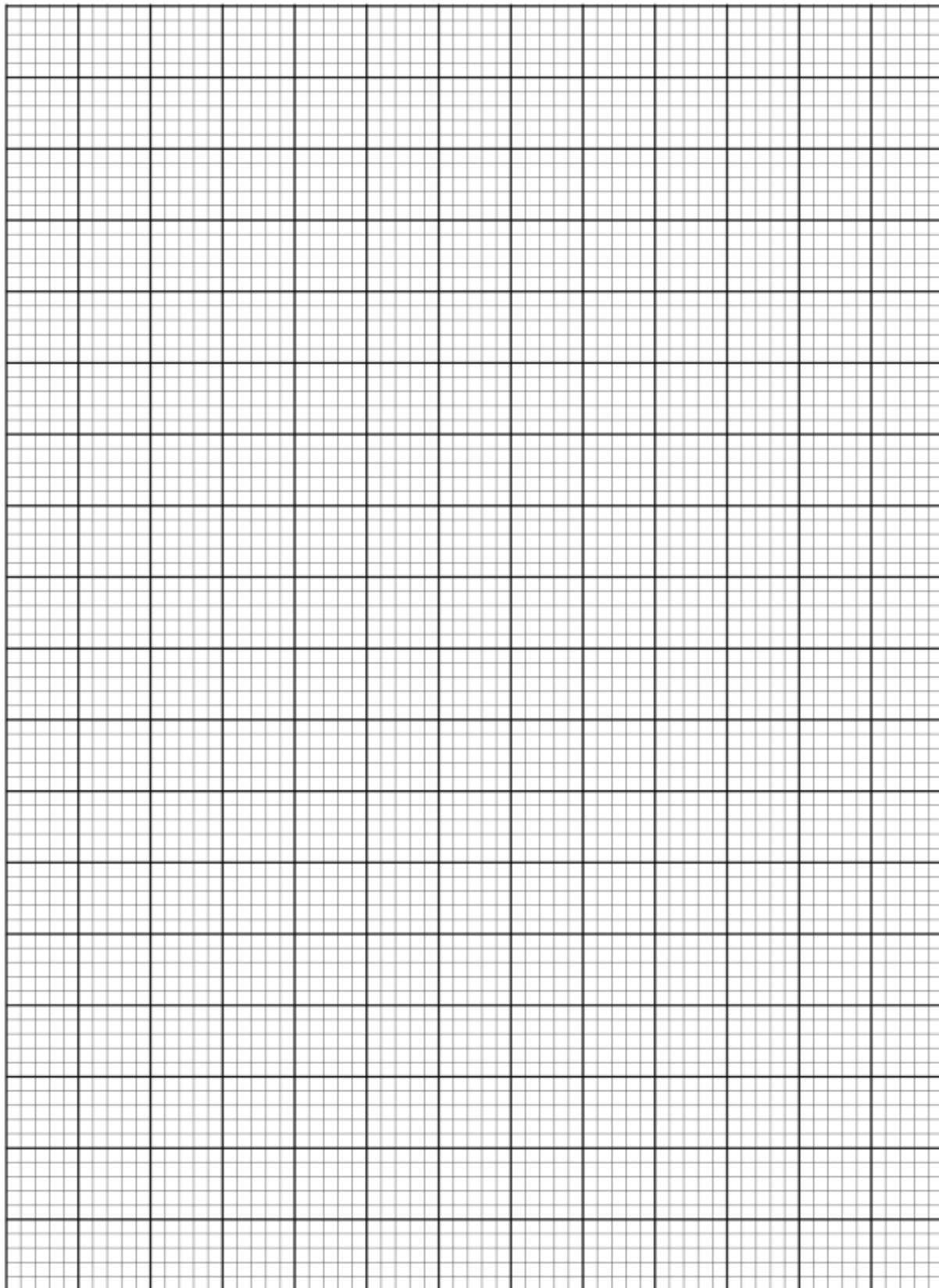
The data in the table below describes the solubility of ammonium nitrate, NH_4NO_3 , and potassium chlorate, KClO_3 in water.

Salts	Solubility at different temperatures (g of salt in 100 g of water)					
	10°C	25°C	40°C	50°C	55°C	60°C
NH_4NO_3	15	24	35	47	59	75
KClO_3	3	5	9	18	25	36

- (a) Plot the data on the graph paper opposite (your graph should take up most of the space available). **Page 27 has an additional piece of graph paper if required.**
Label the axis fully and clearly indicate which salt is represented by each curve. (5 marks)
- (b) At 30°C what would be the concentration of a saturated solution of ammonium nitrate in g L^{-1} ? (Assume that 1.00 mL of water has a mass of 1.00g) (2 marks)
- (c) 70 g of potassium chlorate was dissolved in 200 g of water at 100°C. This solution was cooled to 15°C.
What mass of potassium chlorate would recrystallise from the solution. (2 marks)
- (d) Calculate the mass of solute in 47 g of a saturated solution of ammonium nitrate at 40°C. (3 marks)

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- (e) Both salts in this question are described as strong electrolytes. Silver chloride is also described as a strong electrolyte yet even at 100°C its solubility is only slightly greater than 1.2 g AgCl per 100g of water. Explain.

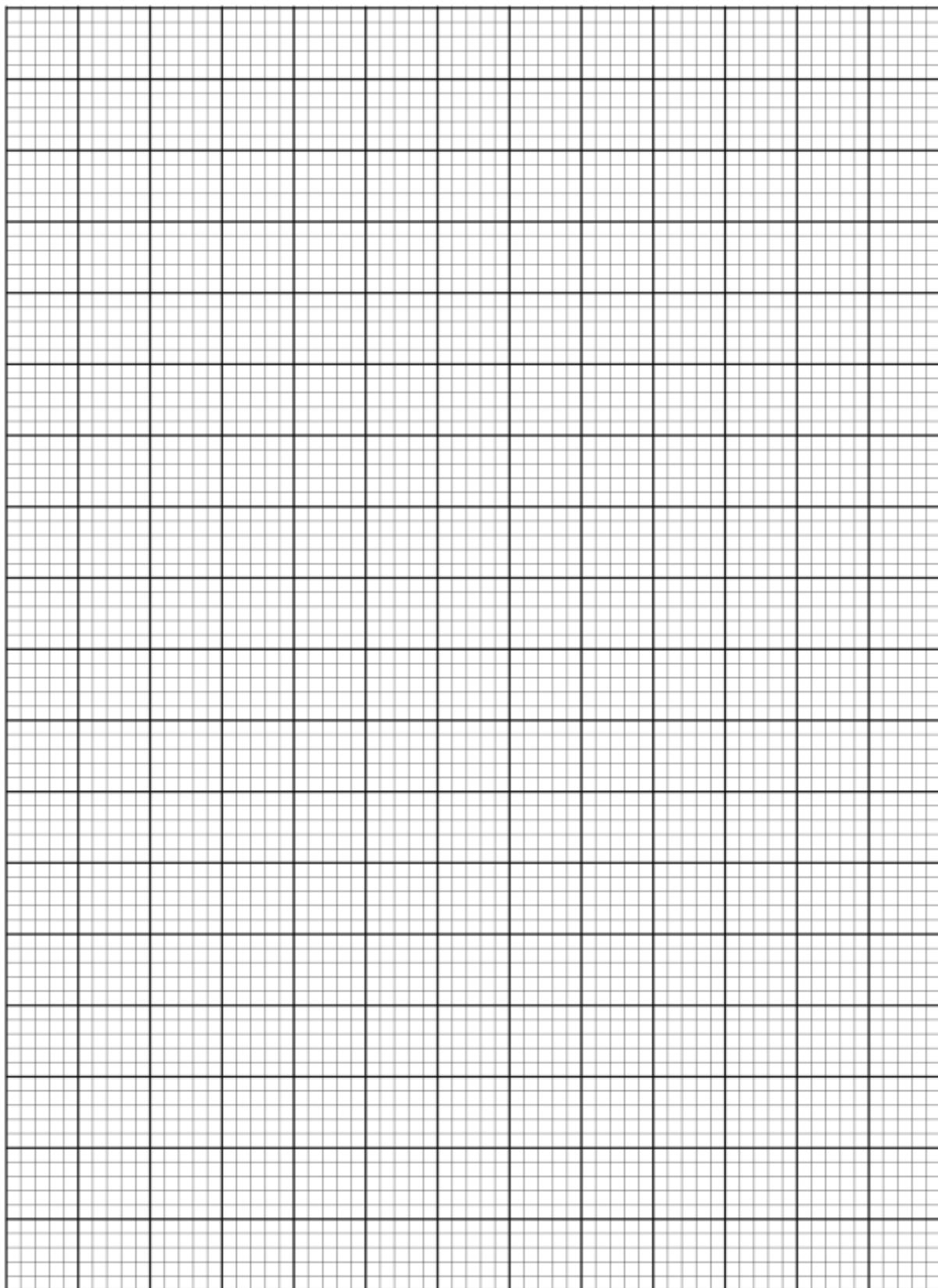
(2 marks)

END OF QUESTIONS

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