



PERTH MODERN SCHOOL
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Year 11 Unit 1 Examination, 2017

Question/Answer Booklet

CHEMISTRY

Student Name: _____

Teacher Name: _____

Time allowed for this paper

Reading time before commencing work: ten minutes
Working time for paper: two and a half hours

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, correction tape/fluid, eraser, ruler, highlighters
Special items: up to three non-programmable calculators approved for use in the ATAR 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.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of examination
Section One: Multiple-choice	20	20	40	40	25.0 %
Section Two: Short answer	9	9	50	55	34.4 %
Section Three: Extended answer	4	4	60	65	40.6 %
				Total	100.0 %

Instructions to candidates

1. 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 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.

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

3. When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to the appropriate number of 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 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. Which one of the following has the same electron configuration as a chloride ion?
 - (a) argon
 - (b) potassium
 - (c) sulfur
 - (d) magnesium

2. Which one of the following statements best describes the similarities and differences between isotopes of an element?
 - (a) Isotopes have the same electron configuration but different atomic number.
 - (b) Isotopes have similar chemical properties but differ in their electron configuration.
 - (c) Isotopes have the same number of protons and neutrons but differ in their electron configuration.
 - (d) Isotopes have similar chemical properties but different physical properties.

3. Which one of the elements listed below is most similar in chemical and physical properties to element number 52?
 - (a) chromium
 - (b) antimony
 - (c) selenium
 - (d) iodine

4. Which one of the following electron configurations would represent a non-metal in Group 15?
 - (a) 2, 8, 3
 - (b) 2, 5
 - (c) 2, 8, 2
 - (d) 2, 7

5. Which one of the following statements about nanomaterials is **false**?
- (a) Nanomaterials are substances that contain particles with specific properties which may differ from those of the equivalent bulk material.
 - (b) Nanomaterials are materials made of nano-particles which range from 1 – 100 nm in size.
 - (c) Fullerene, an allotrope of carbon, can be used to make nanomaterials.
 - (d) Nanomaterials are substances that contain only particles of 1 nm in size.
6. Which one of the following is the correct formula for calcium phosphate?
- (a) CaPO_4
 - (b) $\text{Ca}_3(\text{PO})_4$
 - (c) Ca_2PO_2
 - (d) $\text{Ca}_3(\text{PO}_4)_2$
7. Which one of the elements has 4 valence electrons?
- (a) silicon
 - (b) aluminium
 - (c) lithium
 - (d) sulfur
8. Which of the following is the electronic configuration for the sulfide ion, S^{2-} ?
- (a) $1s^2 2s^2 3s^6 2p^2 3p^6$
 - (b) $1s^2 2s^2 2p^6 3s^2 3p^4$
 - (c) $1s^2 2s^2 2p^6 3s^2 3p^2$
 - (d) $1s^2 2s^2 2p^6 3s^2 3p^6$
9. Which of these is the best explanation as to why covalent molecular substances **cannot** conduct electricity in either the solid or liquid form?
- (a) Their low melting points mean they melt easily when an electrical current is applied.
 - (b) There are no charged particles able to move through their structure.
 - (c) They have very weak intermolecular forces of attraction.
 - (d) The bonding of covalent molecular substances involves sharing electrons.
10. Which one of following is the best explanation as to why ionic substances conduct electricity in both the molten and aqueous form?
- (a) In both the molten and aqueous solution ionic substances have mobile ions.
 - (b) In both the molten and aqueous solution ionic substances have mobile electrons.
 - (c) Ionic bonding is similar to metallic bonding in that when molten and aqueous they both have freely moving electrons.
 - (d) Ionic substances have high melting points and are brittle.

11. Separating pure water from salt water can be done by:

- (a) evaporation.
- (b) distillation.
- (c) decantation.
- (d) filtration.

12. Which two of these species represent an element, and its positive ion?

Species	Number of protons	Number of electrons	Number of neutrons
1	11	11	12
2	12	12	12
3	12	10	13
4	11	11	13

- (a) 1 and 2
- (b) 1 and 3
- (c) 2 and 3
- (d) 2 and 4

13. Which one of these lists of chemical formulas represents **molecular compounds** only?

- (a) CO_2 , HCl , H_2
- (b) CO_2 , NaCl , H_2O
- (c) CH_4 , HCl , H_2O
- (d) C , HCl , CH_2Br_2

14. Which of the following has the molecules in order of **decreasing** bond polarity?

- (a) HCl , HF , CH_4 , H_2
- (b) H_2 , CH_4 , HCl , HF
- (c) CH_4 , H_2 , HCl , HF
- (d) HF , HCl , CH_4 , H_2

15. Which one of these is the **best** description of the crystal structure of vanadium chloride?

- (a) A regular arrangement of positively charged vanadium atoms and negatively charged chlorine atoms in a crystalline lattice with electrostatic forces of attraction between oppositely charged atoms.
- (b) Six vanadium ions surrounded by six chlorine ions in a crystalline lattice with electrostatic forces of attraction between oppositely charged ions.
- (c) A regular arrangement of positively charged vanadium ions and negatively charged chloride ions in a crystalline lattice with electrostatic forces of attraction between oppositely charged ions.
- (d) A three-dimensional structure of vanadium atoms and chlorine atoms with an electrostatic force of attraction between shared electrons and the nuclei of adjacent atoms.

16. Distillation is a separation technique that is useful when separating a mixture of liquids. Which of the following correctly identifies the physical property that enables the substances to be separated?

- (a) Melting point
- (b) Density
- (c) Solubility in water
- (d) Boiling point

17. Which of the following statements is the best description of the trends in the 1st ionisation energy of the elements on the Periodic Table?

- (a) 1st ionisation energy increases across Period 3 and increases down groups of the Periodic Table.
- (b) 1st ionisation energy decreases across Period 3 and decreases down groups of the Periodic Table.
- (c) 1st ionisation energy increases across Period 3 and decreases down groups of the Periodic Table.
- (d) 1st ionisation energy decreases across Period 3 and increases down groups of the Periodic Table.

18. Identify the all the types of bonding present in a solution of copper(II) chloride in ethanol.

- I dispersion forces
- II ion-dipole forces
- III hydrogen bonds
- IV ionic bonds

- (a) II and IV
- (b) I, III and IV
- (c) I, II, and III
- (d) All of the above.

19. Which of the following groups of solutions will produce a coloured precipitate when mixed?

All solutions are 0.1 mol L⁻¹.

- | | | |
|-------------------------|--------------------|-------------------|
| (a) Copper(II) sulfate | Sodium chloride | Barium nitrate |
| (b) Strontium bromide | Iron(III) nitrate | Sodium iodide |
| (c) Potassium hydroxide | Copper(II) sulfate | Calcium bromide |
| (d) Ammonium nitrate | Iron(II) chloride | Potassium sulfate |

20. Substance A is made up two components (O and P). A small sample of substance A was dotted onto chromatography paper, and a chromatogram was developed using an appropriate solvent. The result is shown below.



Compound P is adsorbed

- (a) more strongly onto the stationary phase and has a smaller R_f value than component O.
- (b) more strongly onto the stationary phase and has a larger R_f value than component O.
- (c) less strongly onto the stationary phase and has a smaller R_f value than component O.
- (d) less strongly onto the stationary phase and has a larger R_f value than component O.

End of Section One

Section Two: Short answer**34.4% (55 Marks)**

This section has **9** questions. Answer **all** questions. Write your answers in the spaces provided.

When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to the appropriate number of significant figures and include appropriate units where applicable.

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Suggested working time: 50 minutes.

Question 21**(6 marks)**

- (a) Write the formulae of each of the following compounds. (3 marks)

Name	Formula
lithium carbonate	
chromium(III) bromide	
sulfur trioxide	

- (b) Write the names of each of the following species. (3 marks)

Formula	Name
NH_4^+	
N_2O	
$\text{Fe}(\text{OH})_3$	

Question 22**(9 marks)**

Draw the Lewis structures for the following substances, showing all valence electrons. State whether each substance is polar or non-polar.

Substance	Lewis Structure	Polarity
Hydrogen cyanide HCN		
Oxygen difluoride OF ₂		
Phosphine PH ₃		

Question 23**(6 marks)**

For each of the following combinations, use your understanding of intermolecular forces to predict and explain whether the substances will form a solution.

(a) Methanol, CH_3OH , and water, H_2O .

(3 marks)

(b) Hexane, C_6H_{14} , and decane, $\text{C}_{10}\text{H}_{22}$.

(3 marks)

Question 24**(4 marks)**

Using a labelled diagram, show how ion-dipole forces are formed when sodium chloride dissolves in water.

Question 25**(9 marks)**

A sample of strontium was analysed in order to establish its relative atomic mass.

- (a) What analytical technique was used to produce the data below? (1 mark)

Isotope of strontium	Relative intensity
Strontium-84	0.6782
Strontium-86	11.94
Strontium-87	8.477
Strontium-88	100.0

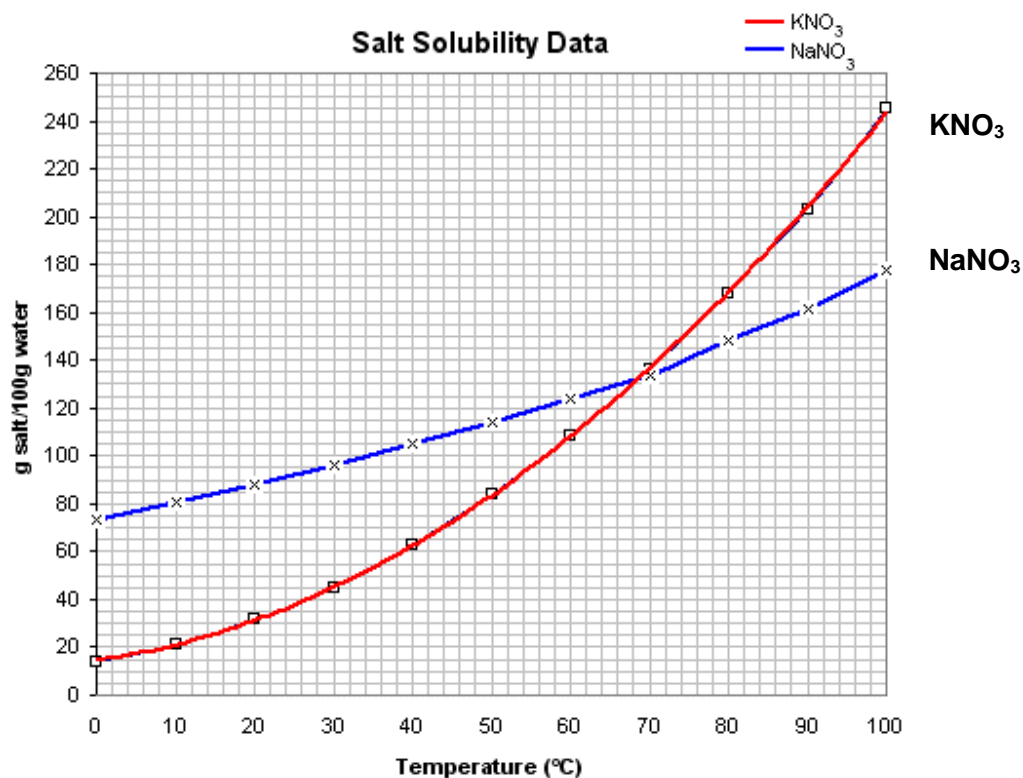
- (b) Use the information in the table above to calculate the approximate percentage abundance of each isotope of strontium. (4 marks)

- (c) Calculate the relative atomic mass of strontium. (2 marks)

- (d) Describe two ways in which the isotopes of strontium are different. (2 marks)

Question 26

(5 marks)



(a) Use the graph above to estimate the solubility of: (2 marks)

(i) Potassium nitrate at 40 °C.

(ii) Sodium nitrate at 85 °C.

(b) If a solution of potassium nitrate is described as 5.5 g L⁻¹, calculate the concentration in mol L⁻¹. (1 mark)

(c) Explain the difference between the terms saturated and unsaturated, with reference to the data for a solution of sodium nitrate at 30 °C. (2 marks)

Question 27**(5 marks)**

Consider the information about some pure substances.

Substance	Melting point (°C)	Boiling point (°C)	Electrical conductivity in solid state	Electrical conductivity in liquid state	Solubility in water
1	1535	2750	good	good	insoluble
2	800	1410	non	good	soluble
3	-259	-253	non	non	insoluble
4	1710	2590	non	non	insoluble
5	50	265	non	non	insoluble

(a) Which **one** of the substances above is most likely a **gas** at room temperature?

(1 mark)

(b) Which **one** of the substances above is most likely to be a **covalent molecular solid**?

(1 mark)

(c) Which **one** of the substances above is most likely to be a **metal**?

(1 mark)

(d) Which **one** of the substances above is most likely a **covalent network** substance?

(1 mark)

(e) Which **one** of the substances above is most likely an **ionic** substance?

(1 mark)

Question 28

(6 marks)

Write ionic equations **including state symbols** the following equations, and describe the observations you would expect to see for each reaction.

(a) Barium nitrate solution is mixed with iron(II) sulfate solution.

Ionic Equation: (2 marks)

Observations: (1 mark)

(b) Lead(II) nitrate solution is mixed with magnesium iodide solution.

Ionic Equation: (2 marks)

Observations: (1 mark)

Section Three: Extended answer**40.6% (65 Marks)**

This section contains **4** 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. Lists or dot points are unlikely to gain full marks.

Final answers to calculations should be expressed to the appropriate number of significant figures.

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Suggested working time: 70 minutes.

Question 30**(18 marks)**

Diamond and graphite are two allotropes of carbon with distinctly different covalent network structures and physical properties. Compare them in terms of the following points.

- (a) Compare the covalent network structures of both diamond and graphite, using a diagram if you wish. (4 marks)

(b) Electrical conductivity.

(i) Explain why diamond does not conduct electricity. (2 marks)

(ii) Explain why graphite does conduct electricity. (2 marks)

(c) Hardness of the solid.

(i) Explain why diamond is so hard. (2 marks)

(ii) Explain why graphite is soft. (2 marks)

(d) One emerging use of carbon is in nanomaterials. How is the structure of carbon nanomaterials different from either structure in part (a)? (3 marks)

(e) Briefly describe one advantage of using titanium dioxide nanomaterial in sunscreens. (1 mark)

(f) List two possible health and safety concerns associated with the use of nanomaterials, such as titanium dioxide in sunscreen. (2 marks)

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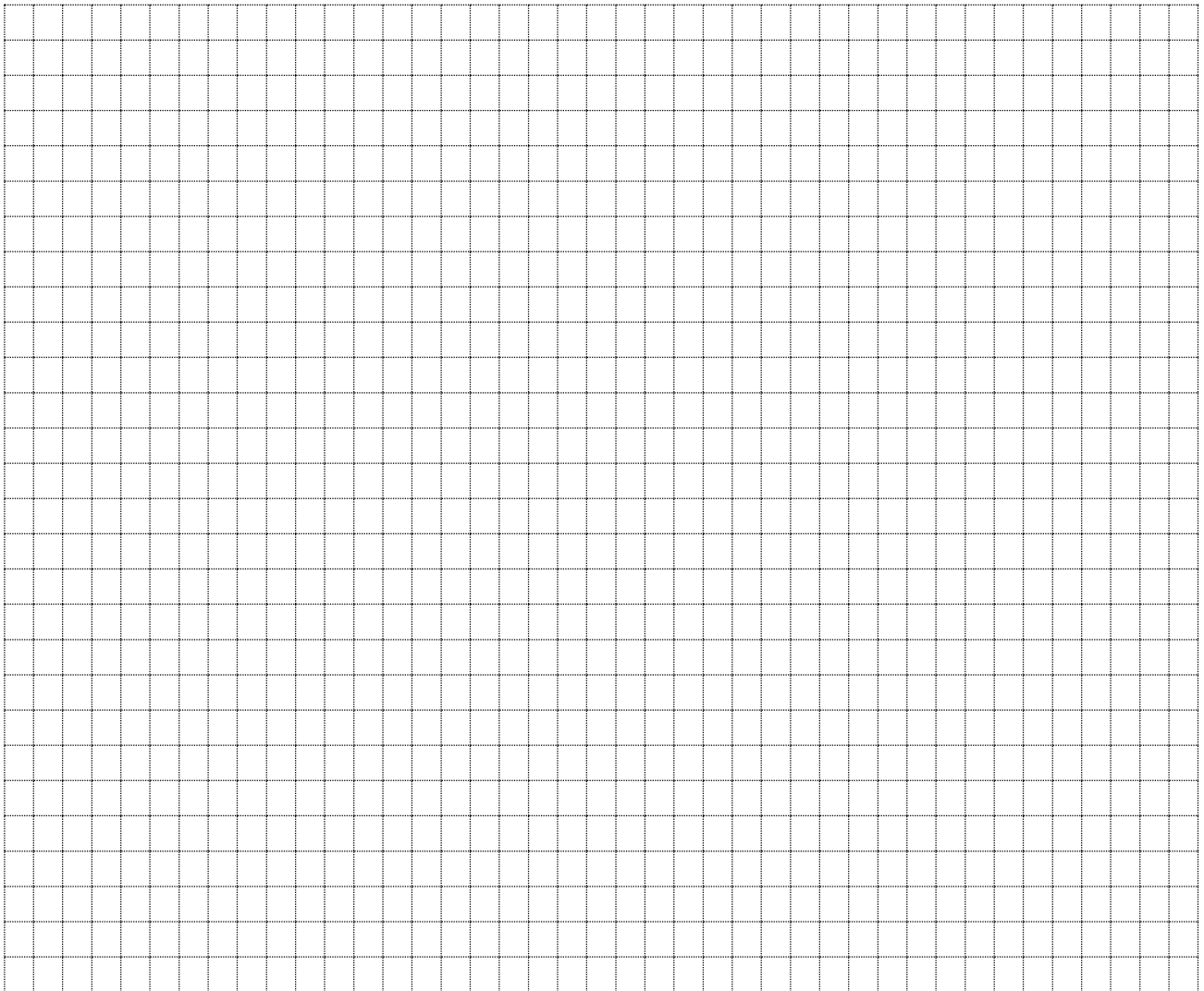
Question 31**(17 marks)**

- (a) What was Niels Bohr's contribution to the understanding of atomic structure? (2 marks)

- (b) How does his contribution contribute to our understanding of analytical techniques such as Flame tests? (3 marks)

- (c) A drinking water sample was thought to be contaminated with lead(II) ions. The absorbance readings, on an Atomic Absorption Spectrometer, of some **known** samples of lead(II) ions are shown below. Draw a **graph** showing the relationship between lead(II) ion concentration and the absorbance level. (5 marks)

Concentration of lead(II) ions (mg L ⁻¹)	Absorbance
0.0010	10
0.0030	35
0.0070	70
0.010	95
0.013	125
0.016	160
0.020	195



Note: A spare grid is provided at the end of the examination if required

- (d) The suspect drinking water sample was then tested on the same Atomic Absorption Spectrometer and the absorbance measured at 105. Find the concentration of lead(II) ions, and use this to determine if the water is safe to drink. Briefly show your reasoning on the graph itself or in the space below.
(The maximum acceptable level of lead in drinking water has been established by the National Health and Medical Research Centre at 0.01 mg L^{-1}) (2 marks)

Source: <https://www.nhmrc.gov.au/guidelines-publications/eh52>

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Question 32**(12 marks)**

The structure of the Periodic Table is based on the atomic number of the elements.

Refer to the properties of the elements in Period 2 to answer the following questions.

Element	Atomic radius (pm)	Electronegativity
Li	167	1.0
Be	112	1.6
B	87	2.0
C	67	2.6
N	56	3.0
O	48	3.4
F	42	4.0
Ne	38	-

(a) Describe and explain the trend in atomic radius across Period 2.

(3 marks)

(b) Describe and explain the trend in electronegativity across Period 2.

(3 marks)

Sodium and chlorine are reactive elements with distinctly different physical and chemical properties. The chemically stable compound formed from these two elements has completely different properties to either element. The reactivity or stability of these three substances is related to their valence electrons.

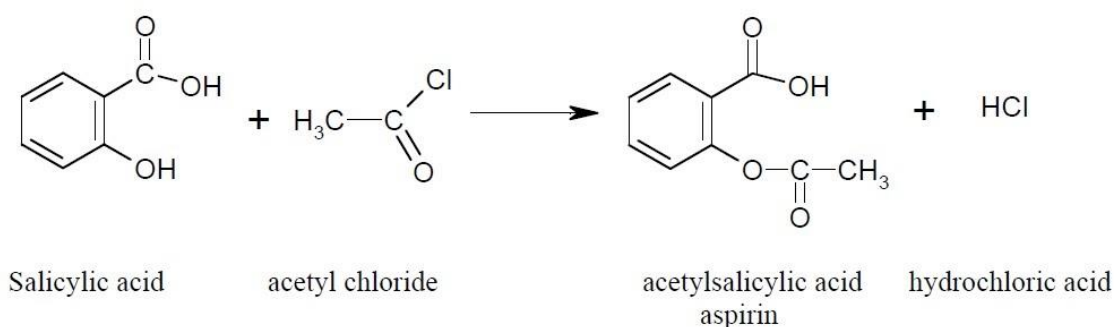
- (c) Explain these statements, **in terms of their position on the periodic table**, by completing the following table. (6 marks)

Statement	Explanation	Marks
Sodium readily forms ions		2
Chlorine readily forms ions		2
The chemically stable compound formed from these elements has completely different properties to either element		2

Question 33**(8 marks)**

Chromatography can be used as an analytical technique to establish the presence and measure the proportions of analytes in a mixture. Thin layer chromatography is particularly useful in the laboratory to establish whether a substance is pure or not. A thin-layer chromatography (TLC) plate is composed of a thin layer of silica, which is highly polar, spread over a plastic or glass slide.

In the preparation of the medicine aspirin, two highly polar substances react to form the aspirin molecule, which is less polar than either of the reagents. As the reagents are toxic, it is important to be sure that the reaction is complete, and any remaining reagents have been removed.



After the preparation of a batch of aspirin, a student carried out thin-layer chromatography with a small sample of their aspirin. The chromatogram was run using the solvent 1,2-dibromoethane, $C_2H_4Br_2$, a very slightly polar liquid. Once the process had finished, the plate was developed with ninhydrin spray to make all substances clearly visible.

- (a) Using a diagram, describe what you would expect to see on the chromatogram if the student's aspirin mixture was contaminated with both reagents. You should indicate the relative positions of the substances aspirin, salicylic acid and acyl chloride on the plate.

(3 marks)
