Class	Register Number	Name

南洋女子中學校

NANYANG GIRLS' HIGH SCHOOL

Mid-Year Examination 2018
Secondary Three IP Chemistry

CHEMISTRY **1 hour 30 minutes**

Monday **7 May 2018** **0845 - 1015**

READ THESE INSTRUCTIONS FIRST

Write your class, register number and name in the spaces at the top of this page.
Do not use paper clips, glue or correction fluid.

There are 3 sections in this paper.

Section A
Answer all questions.
For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the one you consider correct and record your choice in the Multiple-Choice Answer Sheet provided.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Section B and C
Answer all questions. The number of marks is given in brackets [ ] at the end of each question or part question.

Candidates are reminded that all quantitative answers should include appropriate units. The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner.

A copy of the Periodic Table is on page **18**.

Section A (20 marks)	
Section B (30 marks)	
Section C (10 marks)	
Total (60 marks)	

Section A

Answer **all** questions.
Choose the answer you consider correct and record your choice in the Multiple-Choice Answer Sheet provided.

1 Which of the following is **not** a factor affecting rate of diffusion?

A concentration gradient
B relative molecular mass
C temperature
D volume

2 Below is a table showing the melting and boiling points of two metals, gallium and mercury. Both metals have been used in thermometers.

metal	melting point/ °C	boiling point/ °C
gallium	29.8	2400.0
mercury	–38.8	356.7

Which of the following describes the movement of their metal atoms at 20.0 °C?

	gallium	mercury
A	vibrate about fixed positions	vibrate about fixed positions
B	vibrate about fixed positions	slide across neighbouring atoms
C	slide across neighbouring atoms	slide across neighbouring atoms
D	slide across neighbouring atoms	move randomly in all directions

3 There are three methods to collect gases:
I upward delivery
II downward delivery
III displacement of water

When magnesium metal is placed in a solution of hydrochloric acid, which method(s) could be used to collect the gas produced?

A I only
B II only
C I and II only
D I and III only

4 Which of the following is the **best** drying agent to obtain a dry sample of ammonia gas?

A concentrated sulfuric acid
B solid calcium oxide
C solid calcium carbonate
D sodium hydroxide

5 50 cm^3 of distilled water was added to 50 cm^3 of 1 mol dm^{-3} of sulfuric acid. Which of the following statements best describes the change in the solution?

A The pH of the solution is halved.
B The solubility of the solution is halved.
C The concentration of hydrogen ions is halved.
D The number of hydrogen ions dissociated from sulfuric acid molecules is halved.

6 The following table gives some information on different pH indicators:

indicator	colour at pH 1	pH at which colour changes	colour at pH 14
congo red	blue	5	red
bromothymol blue	yellow	6	blue
phenophthalein	colourless	10	red

What colour would be observed if 2 drops of each indicator were added to the same sample of distilled water?

A green
B purple
C blue
D orange

7 Tin(II) oxide (SnO) is a blue black solid at room temperature. It is insoluble in water, but dissolves in hydrochloric acid as well as concentrated sodium hydroxide solution.

What type of oxide is tin(II) oxide?

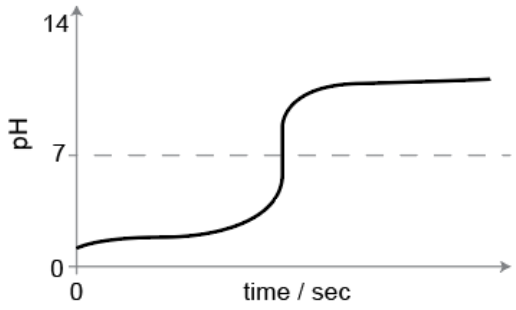
A acidic
B amphoteric
C basic
D neutral

8 5 g of zinc carbonate was added to 50 cm^3 of 1 mol dm^3 sulfuric acid. After some time, effervescence stopped. Why does this occur?

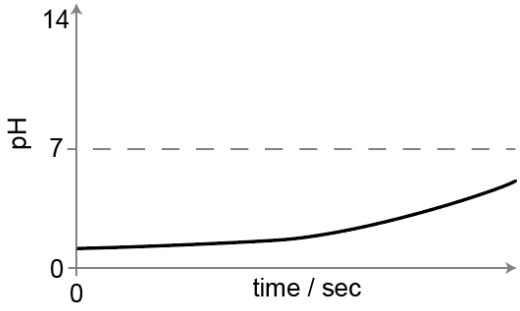
A The H^+ ions was fully used up.
B The gas formed dissolved in water.
C The zinc carbonate was fully used up.
D An insoluble coating was formed around the zinc carbonate powder.

9 In the preparation of aluminium nitrate, excess aluminium metal was added to nitric acid. Which of the following pH graphs best represents this reaction?

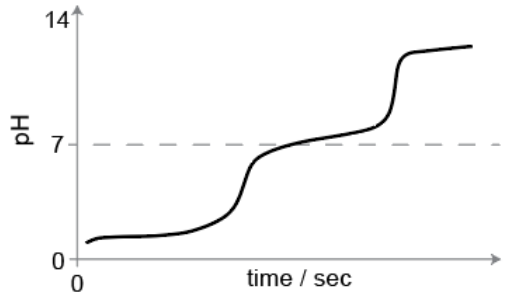
A



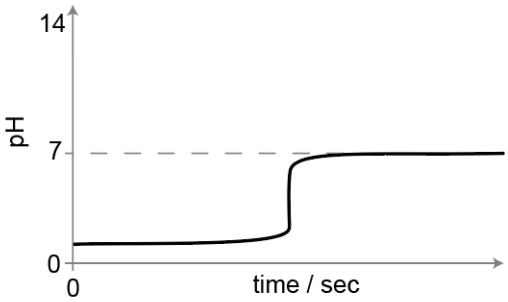
B



C



D



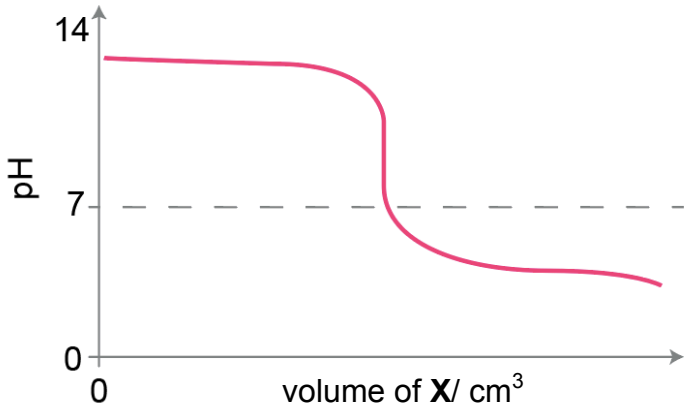
10 Which of the following shows the correct method to prepare lithium nitrate and chromium(III) nitrate?

	lithium nitrate	chromium(III) nitrate
A	titrate LiOH with HNO_3	titrate $Cr(OH)_3$ with HNO_3
B	titrate LiOH with HNO_3	Add Cr_2O_3 in excess to HNO_3
C	add Li metal in excess to HNO_3	Add Cr metal in excess to HNO_3
D	add Li_2O in excess to HNO_3	Add $CrCl_3$ solution to HNO_3

11 Crystallisation separates the solute from the solvent based on which of the following properties?

A difference in densities
B difference in boiling points
C difference in molecular mass
D difference in solubility of the solute at different temperatures

12 Solution **Y** is titrated with solution **X** to obtain the following graph:



Which of the following could be the identity of **X** and **Y**?

	X	Y
A	ethanoic acid	sodium hydroxide
B	hydrochloric acid	aqueous ammonia
C	sodium hydroxide	ethanoic acid
D	aqueous ammonia	hydrochloric acid

13 Potassium cyanide, KCN, is a deadly poison that is famously used in many detective novels and period dramas. Which pair of reagents would you choose to prepare this salt?

A potassium hydroxide and sodium cyanide
B potassium nitrate and sodium cyanide
C potassium hydroxide and hydrocyanic acid (HCN)
D potassium nitrate and hydrocyanic acid (HCN)

14 How many atoms are present in 20 cm^3 of ammonia gas at room temperature and pressure?

A $\frac{20}{24\times1000}\times6.02\times10^{23}$

B $\frac{20}{24\times1000}\times4\times6.02\times10^{23}$

C $\frac{20}{6.02\times10^{23}}\times4\times24000$

D $\frac{20}{1000}\times4\times24\times6.02\times10^{23}$

15 A solution of sulfuric acid with a concentration of $2x$ mol dm^{-3} is titrated with potassium hydroxide solution with a concentration of $3x$ mol dm^{-3}. If V cm^3 of sulfuric acid was used, what is the volume of potassium hydroxide solution required?

A $\frac{1}{3}V$ cm^3

B $\frac{2}{3}V$ cm^3

C $\frac{3}{2}V$ cm^3

D $\frac{4}{3}V$ cm^3

16 Phenol red is a pH indicator that can be used in acid-base titrations. It has the molecular formula of $C_{19}H_{14}O_5S$. What is the relative molecular mass of phenol red?

A 168.0

B 184.0

C 322.0

D 354.1

17 0.300 g of magnesium was added to 30.0 cm^3 of 0.5 mol dm^{-3} of hydrochloric acid. It was then filtered and the filtrate crystallised, washed and dried. The mass of anhydrous salt formed were 0.682 g. What is the percentage yield of magnesium chloride formed?

A 47.7%

B 58.0%

C 92.4%

D 95.4%

Refer to the following for question 18 and 19

Nitrogen triiodide, NI_3, is a substance that sublimes at –20 °C and spontaneously decomposes at 0 °C into nitrogen and iodine vapours. It is so explosive that all it takes for it to detonate is the touch of a feather.

$$2NI_3(s) \rightarrow N_2(g) + 3I_2(g)$$

18 0.5 g of nitrogen triiodide was synthesised. How many moles of nitrogen triiodide was formed?

A 381
B 3.47×10^{-3}
C 1.27×10^{-3}
D 3.55×10^{-3}

19 Given that the molar volume of gases at 0 °C is 22.4 dm^3 mol^{-1}, what is the mass of nitrogen triiodide needed to produce 1 dm^3 of gases from the decomposition reaction at 0 °C?

A 8.22 g
B 8.81 g
C 16.4 g
D 17.6 g

20 To prepare aluminium sulfate, Alex added 0.8 g of aluminium metal to excess sulfuric acid. 1000 cm^3 of hydrogen gas was evolved. He then filtered and evaporated the salt solution to dryness. The final crystals that were obtained was 4.75 g. Which of the following statement best explains his percentage yield?

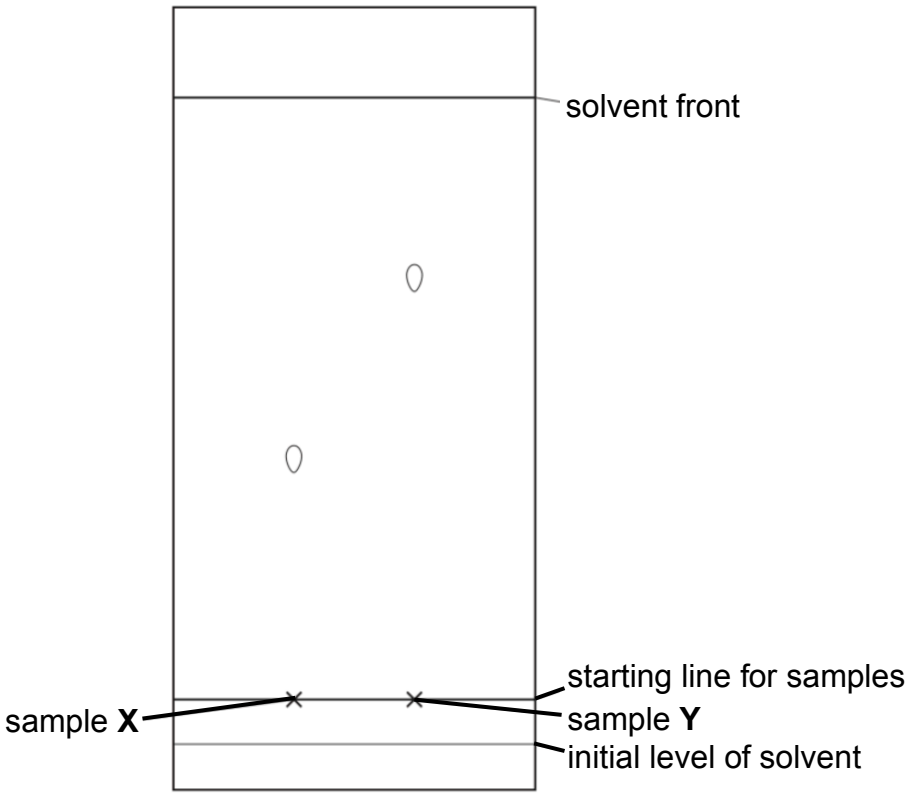
A The crystals had impurities present.
B The aluminium metal was not 100% pure.
C There was water of crystallisation present in the crystals.
D The crystals were not dried properly.

Section B

Answer **all** questions.
Write your answers in the spaces provided.

B1 Enzymes are biological catalysts and used in research laboratories and in industries.

Enzymes called proteases can break down proteins by water to amino acids. The amino acids can be separated and identified by chromatography. The diagram below shows a typical chromatogram.



(a) Given that the amino acids have the following R_f values:

amino acid	glutamic acid	glycine	alanine	leucine
R_f values	0.4	0.5	0.7	0.9

Identify the two amino acids on the chromatogram. **[2]**

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(b) A locating agent is used on the chromatogram. Explain why the chromatogram must be exposed to the locating agent. **[1]**

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(c) Suggest another method to identify the amino acids on the chromatogram other than measuring R_f values. **[1]**

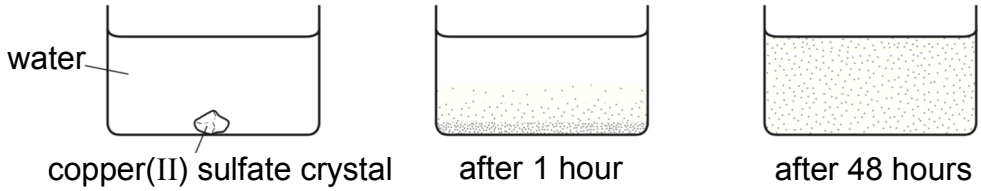
.....

.....

Total **[4]**

B2 A student placed a crystal of copper(II) sulfate in a beaker of water.

After one hour, the crystal had completely disappeared and a dense blue colour was observed in the water at the bottom of the beaker. After 48 hours, the blue colour had spread throughout the water.



Using the kinetic particle theory, explain the observations. **[2]**

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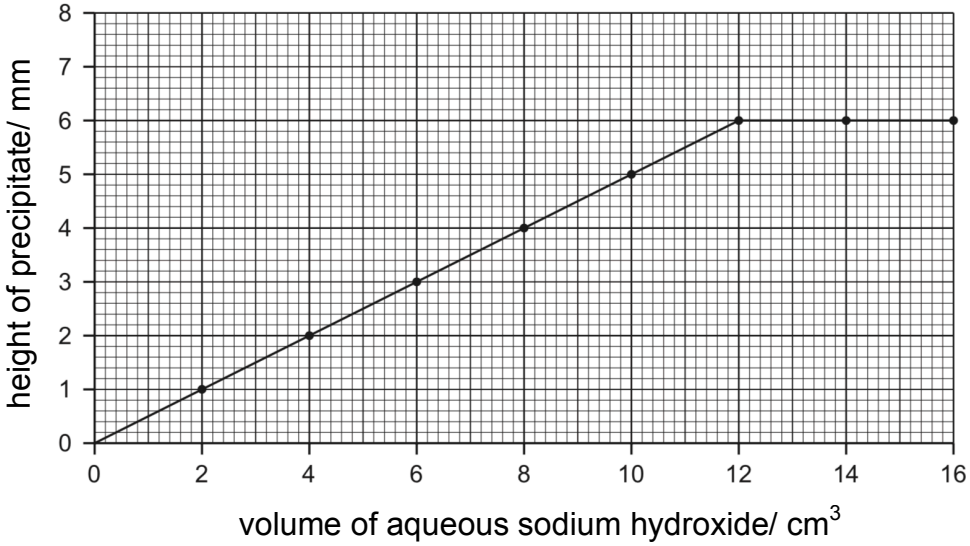
Total **[2]**

B3 2.0 cm^3 portions of aqueous sodium hydroxide were added to 4.0 cm^3 aqueous cobalt(III) nitrate. Both solutions had a concentration of 1.00 mol dm^{-3}.

After each addition, the mixture was stirred, centrifuged and the height of the precipitate was measured. The results are shown on the following graph.



(a) Write the ionic equation of the reaction between aqueous sodium hydroxide and aqueous cobalt(III) nitrate. **[1]**

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(b) On the same grid of the graph above, sketch the graph that would have been obtained if 4.0 cm^3 of 1.00 mol dm^{-3} cobalt(II) nitrate had been used instead of cobalt(III) nitrate. **[2]**

(c) The experiment is repeated with aluminium nitrate and aqueous sodium hydroxide of the same concentration and volume.

Given that aluminium nitrate forms a precipitate that dissolves in excess aqueous sodium hydroxide to form a colourless solution, describe the shape of the graph obtained. **[2]**

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Total [5]

B4 Iron(II) sulfate is one of the cheapest industrial chemicals and is used to make inks and pigments of iron(III) oxide and prussian blue. Two experiments using iron(II) sulfate were conducted.

(a) Experiment 1:
Iron(II) sulfate crystallises as a green hydrated salt $FeSO_4 \cdot xH_2O$.
To determine the extent of hydration, 4.16 g of the hydrated crystals were heated carefully until the mass of the anhydrous iron(II) sulfate remains constant at 2.28 g.

(i) Calculate the number of moles in 2.28 g of anhydrous iron(II) sulfate. **[1]**

(ii) Calculate the number of moles of water lost. **[2]**

(iii) Calculate the number of moles of water of crystallisation in one mole of the hydrated salt. **[1]**

(b) Experiment 2:
A nail containing iron reacted completely with dilute sulfuric acid to produce a solution of iron(II) sulfate. The solution was made up to 250 cm^3 in a volumetric flask.

In a titration, 25.0 cm^3 of the iron(II) sulfate solution required 29.50 cm^3 of 0.0200 mol dm^{-3} acidified potassium dichromate(VI), $K_2Cr_2O_7$ for complete reaction.

The reaction between acidified potassium dichromate(VI) and iron(II) sulfate is as follows:

$$Cr_2O_7^{2-}(aq) + 6Fe^{2+}(aq) + 14H^+(aq) \rightarrow 2Cr^{3+}(aq) + 6Fe^{3+}(aq) + 7H_2O(l)$$

(i) Calculate the number of moles of potassium dichromate(VI) used in the titration. **[1]**

(ii) Calculate the number of moles of iron(II) sulfate from the solution in the volumetric flask. **[2]**

(iii) Given that the mass of the nail is 2.00 g, calculate the percentage by mass of iron in the nail. **[1]**

Total [8]

B5 Rancid butter contains a carboxylic acid that has the following composition by mass. Carboxylic acids are weak organic acids and form salts with alkalis.

carbon 62.1%; hydrogen: 10.3%; oxygen: 27.6%

(a) (i) Determine the empirical formula of the carboxylic acid in the rancid butter. **[2]**

(ii) A sample of 0.30 g of the pure carboxylic acid requires 25.90 cm^3 of 0.100 mol dm^{-3} of potassium hydroxide for complete neutralisation in the presence of phenolphthalein.

Given that the carboxylic acid is a monobasic acid, determine the molecular formula of the carboxylic acid. **[3]**

(b) Write the ionic equation for the reaction of the carboxylic acid with potassium hydroxide. **[1]**

……..

(c) Given the following information,

indicator	colour at pH of 1	pH at which colour changes	colour at pH of 14
phenolphthalein	colourless	8.2 – 10.0	pink
methyl orange	red	3.1 – 4.4	yellow

Suggest why methyl orange is **not** a suitable indicator. **[1]**

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Total [7]

B6 Photochromic sunglasses contain small amounts of the salt silver chloride.

(a) Explain why a poor yield of silver chloride is obtained when silver oxide is reacted with hydrochloric acid. **[2]**

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(b) Write two balanced chemical equations to show how pure silver chloride is prepared from silver oxide. **[2]**

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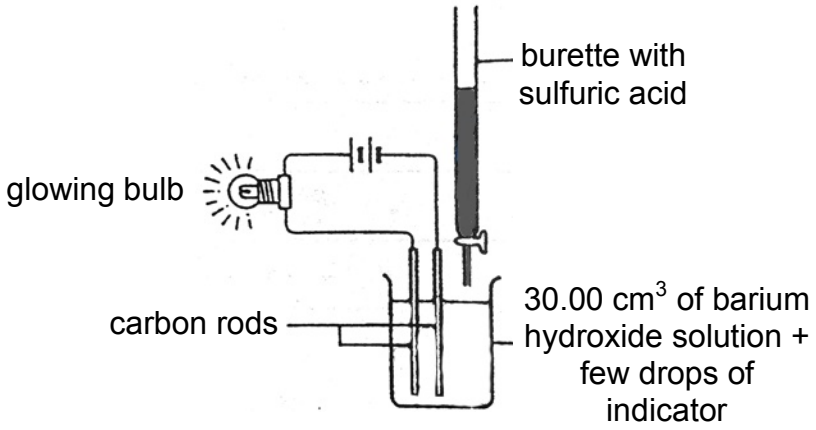
Total [4]

Section C

Answer **all** questions.
Write your answers in the spaces provided.

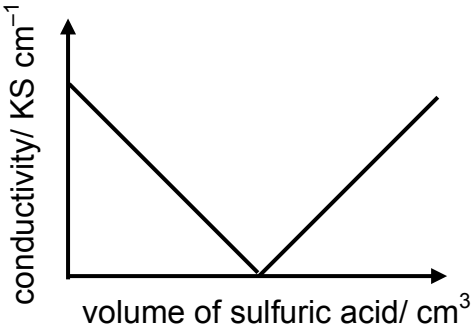
C1 The experiment illustrated in the diagram below was carried out using an indicator. 0.100 mol dm^{-3} sulfuric acid was added from the burette into the beaker.



As the acid was added, a white precipitate appeared in the beaker. When exactly 15.00 cm^3 of the acid had been added, the bulb went out. When more acid was added, the bulb glowed brightly again.

The brightness of the bulb is an indication of the conductivity of the solution in the beaker which varies with the concentration of ions in the solution.

The diagram below shows the changes in conductivity as sulfuric acid was added to the beaker.



(a) Give the formula of the ions/ molecules present in the beaker of solution after adding 15.00 cm^3 of the acid from the burette. **[1]**

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(b) Write a balanced chemical equation, including state symbols, for the formation of the white precipitate. **[2]**

.....

(c) Explain why the light bulb stopped glowing when 15.00 cm^3 of the acid has been added into the beaker. **[2]**

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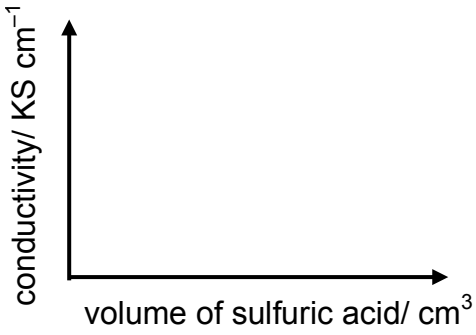
(d) Calculate the number of moles in 15.00 cm^3 of sulfuric acid added. **[1]**

(e) Calculate the concentration, in mol dm^{-3}, of aqueous barium hydroxide used in the reaction. **[2]**

(f) Given that the solubility of barium hydroxide at 25 ^oC is 0.240 g dm^{-3}, calculate the concentration, in mol dm^{-3}, of a saturated aqueous solution. **[1]**

(g) The experiment was repeated by using aqueous sodium hydroxide instead of aqueous barium hydroxide.

Sketch the graph of conductivity against volume of sulfuric acid added. **[1]**



Total [10]

End of paper

The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1.0										2 He helium 4.0
3 Li lithium 6.9	4 Be beryllium 9.0		Key atomic number atomic symbol name relative atomic mass									5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium –	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57–71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium –	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0
actinoids	89 Ac actinium –	90 Th thorium 232.0	91 Pa protactinium 231.0	92 U uranium 238.0	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –