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|-------|-----------------|------|
| Class | Register Number | Name |
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南洋女子中学校  
**NANYANG GIRLS' HIGH SCHOOL**  
**Mid-Year Examination 2015**  
**Secondary Three**

**CHEMISTRY**

Theory Paper

**1 hour 30 minutes**

**0800h-0930h**

**Wednesday**

**13 May 2015**

Additional materials: Writing papers

**READ THESE INSTRUCTIONS FIRST**

**Do not open this booklet until you are told to do so.**

Write your name, register number and class in the spaces at the top of this page.

**Section A (MCQ)**

Write your name, class and register number on the Multiple Choice Answer Sheet provided.

There are **twenty** questions in this paper. 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 **soft pencil** on the answer sheet.

**Section B (Structured)**

Answer **All** questions in the spaces provided on the Question Paper.

**Section C (Free-Response)**

Answer **All** questions. Write your answers on the separate writing paper provided.

**Submit Multiple Choice Answer Sheet, Question Paper and Writing Paper separately.**

The intended number of marks is given in the brackets [ ] at the end of each question or part question. A copy of the Periodic Table is printed on page 13.

| Examiner's Use                 |  |
|--------------------------------|--|
| <b>Section A</b><br>(20 marks) |  |
| <b>Section B</b><br>(30 marks) |  |
| <b>Section C</b><br>(10 marks) |  |
| <b>Total</b><br>(60 marks)     |  |

This document consists of 13 printed pages.

**Setters: CHG, LSC**

**NANYANG GIRLS' HIGH SCHOOL**

**[Turn over]**

**Section A (20 marks)**

**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 soft pencil on the answer sheet.**

- 1 Which of the following salts is prepared using titration?
- A aluminium chloride  
B ammonium nitrate  
C lead(II) sulfate  
D iron(II) chloride
- 2 Which of the following is **NOT** true?
- A Hydrogen chloride gas turns moist blue litmus paper red.  
B Sulfur dioxide gas turns dry blue litmus paper red.  
C An acid only shows its acidic properties in the presence of water.  
D Acid molecules ionize in the presence of water to produce hydrogen ions.
- 3 Which one of the following compounds will **not** increase the pH of an acidic solution?
- A calcium oxide  
B calcium carbonate  
C calcium hydroxide  
D calcium sulfate
- 4 Which of the following is the correct ionic equation for the formation of an insoluble salt?
- A  $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$   
B  $\text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{NaNO}_3(\text{s})$   
C  $2\text{K}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{K}_2\text{SO}_4(\text{s})$   
D  $\text{Pb}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq}) \rightarrow \text{Pb}(\text{NO}_3)_2(\text{s})$
- 5 Which of the following gives **ONLY** a colourless solution when reacted with dilute hydrochloric acid?
- A barium carbonate  
B copper(II) oxide  
C potassium hydroxide  
D zinc metal
- 6 Ant bites are acidic in nature. Which of the following is suitable for treating it?
- A vinegar  
B baking powder  
C sugar  
D orange juice
- 7 Aluminium hydroxide is a base. Why is it used in the manufacture of toothpaste?
- A It helps to whiten teeth.  
B It helps to strengthen teeth.  
C It kills the bacteria in the mouth.  
D It prevents tooth decay by neutralising the acids produced by bacteria in the mouth.

- 8 2 drops of methyl orange are added to 15 cm<sup>3</sup> of dilute nitric acid in a conical flask. 10 cm<sup>3</sup> of aqueous sodium hydroxide of similar concentration are then added gradually to the flask. What change occurs in the mixture in the conical flask?

A Methyl orange changes colour from yellow to red.  
B A gas is formed.  
C The pH value is increased.  
D The concentration of the H<sup>+</sup> ion increases.

- 9 Which of the following pairs of solutions when added together will produce a precipitate?

I Potassium carbonate and silver nitrate  
II Lead(II) nitrate and sodium chloride  
III Sodium carbonate and copper(II) sulfate  
IV Magnesium chloride and barium nitrate

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

- 10 Ian soaked his feet in a pail filled with vinegar. When he stepped onto the marble floor, he observed that there were bubbles of gas around his feet.

What is the identity of the gas produced?

A hydrogen  
B carbon dioxide  
C oxygen  
D ammonia

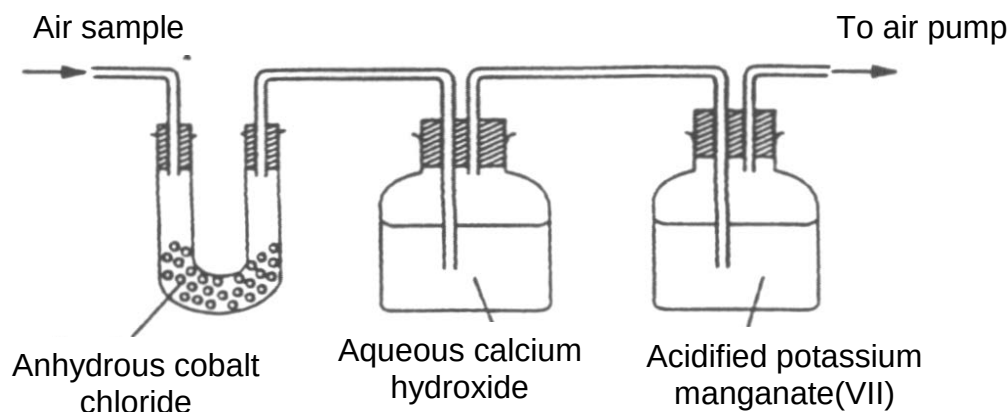
- 11 Which of the following must be **true** of an acidic salt?

A It turns damp blue litmus paper red.  
B It is the only salt formed from a dibasic acid.  
C It contains hydrogen that is replaceable by a metal.  
D It is a salt of a non-metal.

- 12 Which of the following methods listed below **cannot** be used to prepare the respective solid salt?

|   | Method                                                               | Solid salt          |
|---|----------------------------------------------------------------------|---------------------|
| A | Add hydrochloric acid to lead(II) carbonate.                         | lead(II) chloride   |
| B | Add aqueous sodium carbonate to aqueous magnesium nitrate.           | magnesium carbonate |
| C | Add aqueous barium nitrate to sulfuric acid.                         | barium sulfate      |
| D | Add nitric acid to silver carbonate, then add aqueous sodium iodide. | silver iodide       |

- 13** The apparatus below was used to examine an air sample.



It was found that the anhydrous cobalt chloride turned from blue to pink, the acidified aqueous potassium manganate(VII) turned from purple to colourless and a white precipitate was formed in the aqueous calcium hydroxide. What gases were present in the air sample?

- |                                                               |                                                              |
|---------------------------------------------------------------|--------------------------------------------------------------|
| <b>A</b> $\text{H}_2\text{O}$ , $\text{SO}_2$ , $\text{CO}_2$ | <b>C</b> $\text{CO}_2$ , $\text{H}_2\text{O}$ , $\text{H}_2$ |
| <b>B</b> $\text{H}_2\text{O}$ , $\text{SO}_2$ , $\text{NO}$   | <b>D</b> $\text{O}_2$ , $\text{H}_2$ , $\text{NO}_2$         |
- 14** Solution **S** reacts with aqueous sodium hydroxide to form a white precipitate that is insoluble in excess aqueous sodium hydroxide. Identify the cations that are likely to be in solution **S**.
- |                   |  |
|-------------------|--|
| I Lead(II) ion    |  |
| II Calcium ion    |  |
| III Aluminium ion |  |
| IV Iron(II) ion   |  |
- |                  |                            |
|------------------|----------------------------|
| <b>A</b> II only | <b>C</b> II and IV only    |
| <b>B</b> IV only | <b>D</b> I, II, III and IV |
- 15** Aqueous sodium hydroxide and a piece of aluminium foil were added to a colourless solution **X**. The mixture was warmed and a pungent gas which turned moist red litmus blue was evolved. What could **X** be?
- |                            |                        |
|----------------------------|------------------------|
| <b>A</b> Silver nitrate    | <b>C</b> Sodium iodide |
| <b>B</b> Iron(III) nitrate | <b>D</b> Zinc sulfate  |

**16** The following tests were conducted on solution **P** separately. The observations are as tabulated:

| Tests                                                                                    | Observation                                                                                           |
|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| Add excess aqueous sodium hydroxide to 1 cm <sup>3</sup> of solution <b>P</b> gradually. | White precipitate was observed. The white precipitate was soluble in excess aqueous sodium hydroxide. |
| Add excess aqueous ammonia to 1 cm <sup>3</sup> of solution <b>P</b> gradually.          | White precipitate was observed. The white precipitate was insoluble in excess aqueous ammonia.        |

What could solution **P** be?

- A** lead(II) sulfate  
**B** aluminium sulfate  
**C** zinc sulfate  
**D** ammonium sulfate

- 17** Dilute nitric acid was added to compound **Q** to give a gas and a colourless solution **R**. Aqueous ammonia was then added to the solution **R** to give a white precipitate which dissolved in excess aqueous ammonia to form a colourless solution.

What could compound **Q** be?

- A** lead(II) carbonate                      **C** copper(II) carbonate  
**B** zinc carbonate                          **D** calcium carbonate

- 18** Which of the following reagents when added separately to aqueous lead(II) nitrate and aqueous aluminium nitrate will be able to distinguish the two solutions?

- A** hydrochloric acid  
**B** nitric acid  
**C** aqueous sodium hydroxide  
**D** aqueous ammonia

- 19** Which of the following procedures will **NOT** produce a colourless and pungent gas which turns moist red litmus paper blue?

- A** ammonium chloride is warmed with aqueous sodium hydroxide  
**B** sodium chloride is warmed with aqueous barium nitrate  
**C** alkaline solution of potassium nitrate is warmed with aluminium powder  
**D** alkaline solution of magnesium nitrate is warmed with zinc powder

- 20** Which of the following reagents forms a white precipitate when added to a solution containing lead(II) ions?

- |     |                          |
|-----|--------------------------|
| I   | aqueous ammonia          |
| II  | dilute sulfuric acid     |
| III | aqueous sodium chloride  |
| IV  | Aqueous potassium iodide |

- A** I and II only  
**B** I and IV only  
**C** I, II and IV only  
**D** I, II, and III only

**Section B (30 marks)**

**Answer all questions in this section in the spaces provided.**

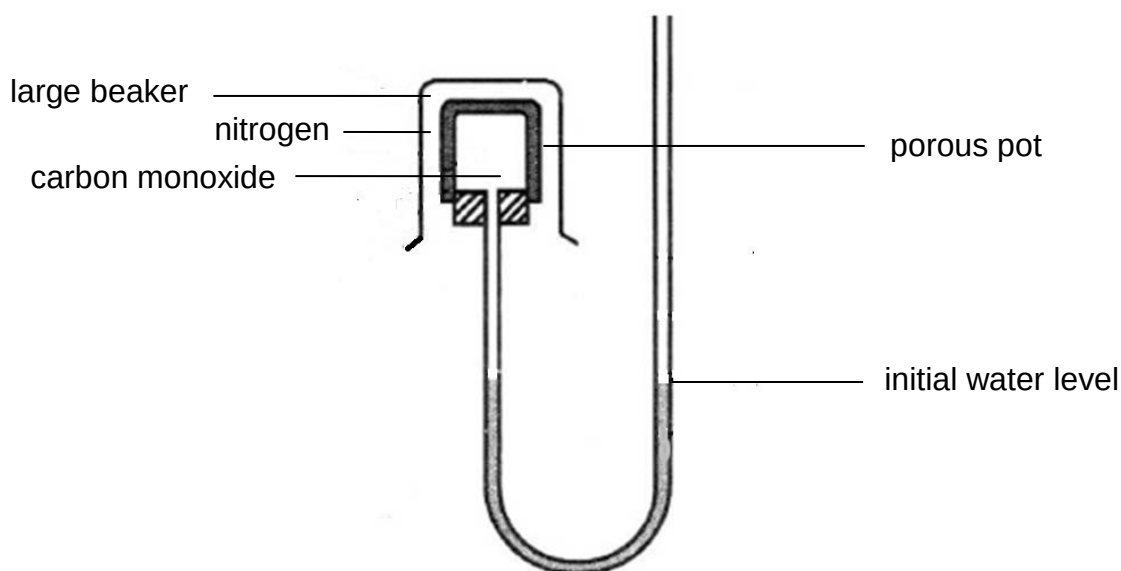
**B1** Water is a colourless liquid that is vital for all known forms of life. It melts at  $0^{\circ}\text{C}$  and boils at  $100^{\circ}\text{C}$ .

**(a)** State one difference between boiling and evaporation of water. [1]

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**(b)** Sketch the corresponding temperature versus time graph when ice at  $-20^{\circ}\text{C}$  is heated until  $120^{\circ}\text{C}$ . [1]

**(c)** Explain why the water level remains the same when the apparatus below was left to stand for 15 minutes. [2]



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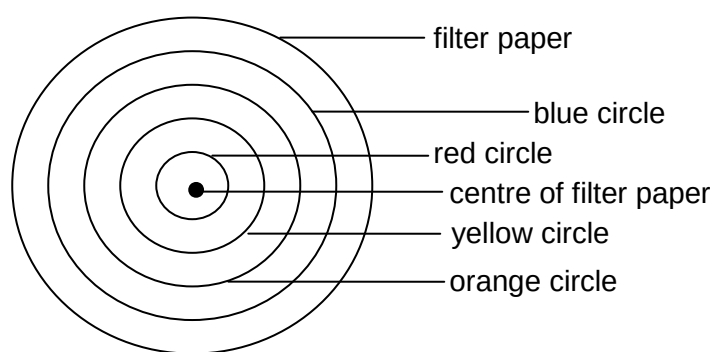
- (d) When  $50\text{ cm}^3$  of ethanol is mixed with  $50\text{ cm}^3$  of water, the total volume is found to be less than  $100\text{ cm}^3$ . Explain why. [1]

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**Total [5]**

- B2** The colouring in a fizzy drink was extracted by a solvent. Two drops of the drink were placed at the centre of a circular filter paper and allowed to dry. Drops of pure solvent were slowly added to the centre of the filter paper. After some time, four coloured circles were seen, as shown in the diagram below.



- (a) (i) What is the name of the separation technique shown above? [1]

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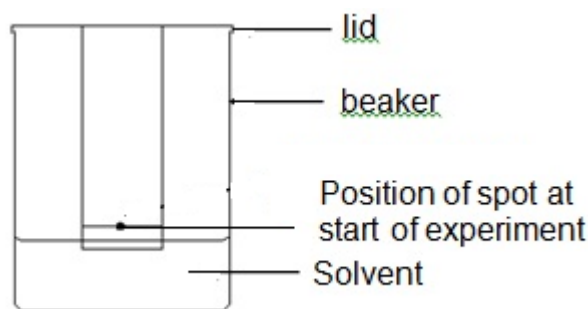
- (ii) How many different dyes are there in the fizzy drink? [1]

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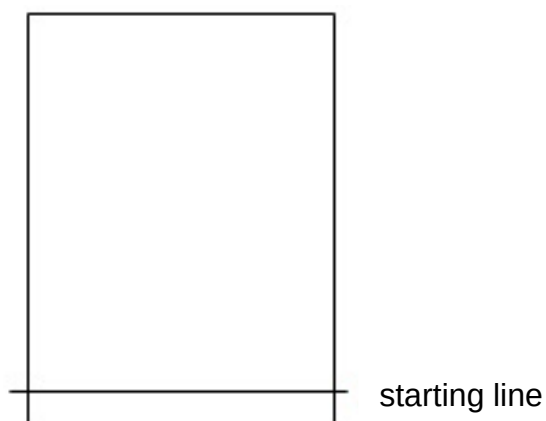
- (iii) Which dye is the most soluble in the solvent used? [1]

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- (b) An alternative set of apparatus for this experiment is shown below. In this case, a strip of rectangular filter paper is used and the filter paper is dipped into a solvent. [2]

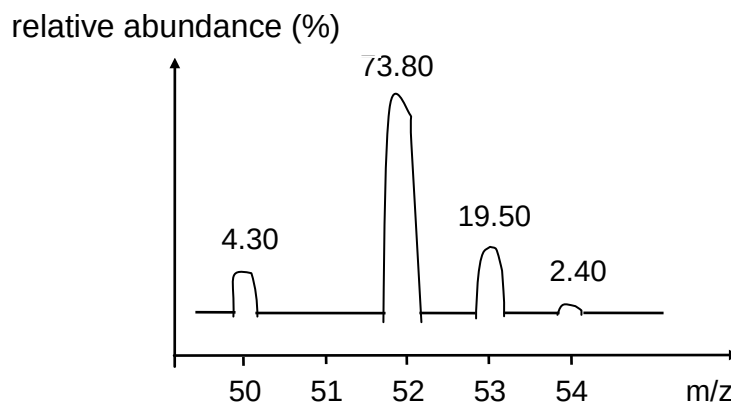


In the space below, draw and label the results you would expect if the set-up was left until the solvent reached near the top of the filter paper.



**Total [5]**

- B3** A gaseous sample of X was injected into a mass spectrometer and the results are shown in the mass spectrum below.



- (a) Define the term 'isotopes'. [1]

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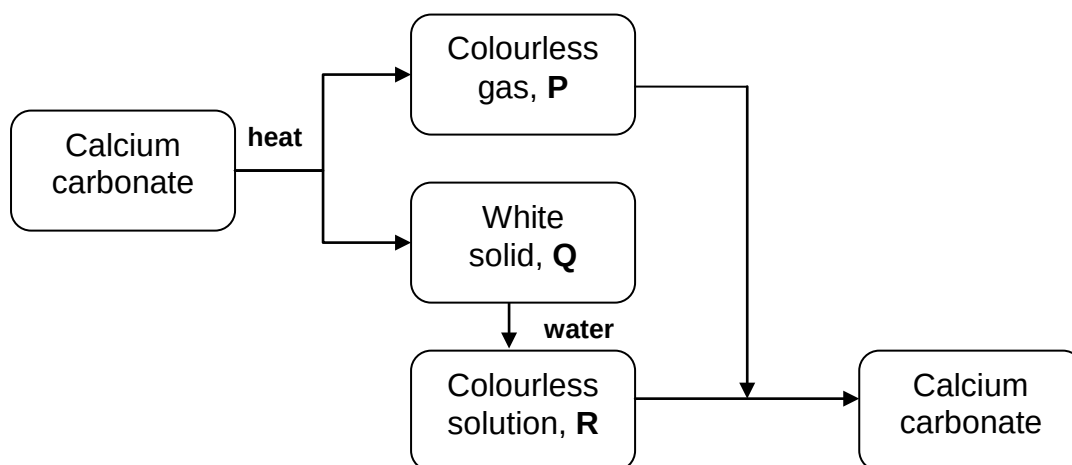
- (b) State the number of isotopes shown in the mass spectrum. [1]

- (c) Using the mass spectrum, calculate the relative atomic mass of **X** and identify element **X**. [2]

- (d) Explain why the relative atomic mass of **X** is not an integer. [1]

Total [5]

**B4** Compounds **P** to **R** are involved in chemical reactions as shown below.



- (a) Identify compounds **P**, **Q** and **R**. [3]

**P**: \_\_\_\_\_

**Q**: \_\_\_\_\_

**R**: \_\_\_\_\_

- (b) Describe a method to confirm the identity of gas **P**. [1]

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- (c) In agriculture, soil that is too acidic can be treated with the base **Q**. This is known as 'liming' the soil. Plants require nitrogen to grow and one important source of nitrogen is from ammonium salts. A farmer decided to fertilise and lime his soil by adding both **Q** and an ammonium salt simultaneously. Suggest why he is wasting both his time and money? [2]

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- (d) Describe briefly the steps you have to take in order to prepare a pure, dry sample of calcium carbonate using base **Q** as a starting reagent. [3]

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- (e) Gas **P** dissolves in water to form a dibasic acid.

- (i) Define the term 'dibasic acid'. [1]

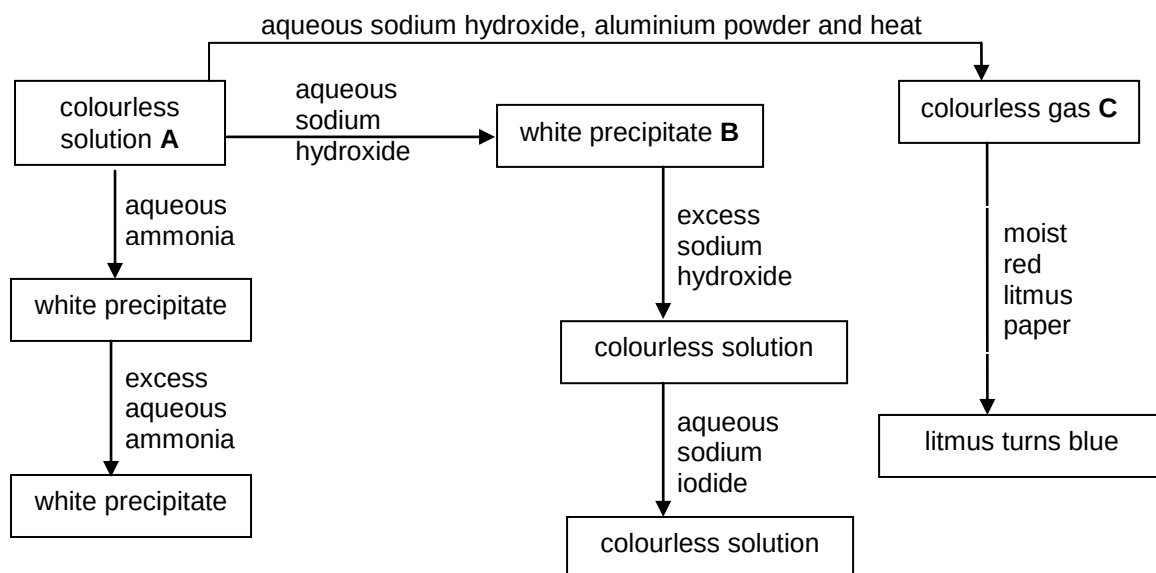
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- (ii) Write the formulae of the two salts formed when the dibasic acid formed by **P** reacts with potassium hydroxide. [2]

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**Total [12]**

**B5** Study the flow chart given and answer the questions that follow.



(a) Identify the colourless solution **A**. [1]

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(b) Write the ionic equation for the formation of **B**. [1]

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(c) Why is there a need to use **moist** litmus paper for testing gas **C**? [1]

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**Total [3]**

**Section C (10 marks)**

**Answer all questions in this section.**

**Write your answers on the separate writing paper provided.**

**C1** Instructions for preparing hydrated copper(II) nitrate are given below.

Step 1: Add one spatula of solid **X** to 50 cm<sup>3</sup> of dilute nitric acid.

Step 2: When it has reacted, add further amounts of **X** until no more effervescence occurs.

Step 3: Filter the mixture.

Step 4: Heat the filtrate until it is saturated.

Step 5: Allow the saturated solution to cool.

Step 6: Filter off the crystals.

Step 7: Dry the crystals between sheets of filter paper.

**(a)** Identify solid **X**. [1]

**(b)** Identify the steps which serve the following purposes respectively:

**(i)** To enable crystallisation to take place as solubility of salts decreases with temperature [1]

**(ii)** To use up all the nitric acid [1]

**(iii)** To remove unreacted solid **X** [1]

**(c)** Write the chemical equation for the reaction between solid **X** and dilute nitric acid. [1]

**(d)** Copper(II) nitrate can be converted into copper(II) chloride through two chemical reactions, **I** and **II**.

**I** Changing copper(II) nitrate to copper(II) hydroxide

**II** Converting copper(II) hydroxide to copper(II) chloride

**(i)** State the chemical formula of a reagent that can be used in reaction **I**. [1]

**(ii)** Write the ionic equation for the formation of copper(II) hydroxide in reaction **I**. [2]

**(iii)** Write the chemical equation for reaction **II**. [1]

**(iv)** State the type of reaction in **II**. [1]

**Total [10]**

**End of paper**

## The Periodic Table of the Elements

| Group                                               |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|-----------------------------------------------------|-----------------------------|------------------------------|-----------------------------|-----------------------------|------------------------------|-------------------------------|------------------------------|----------------------------|------------------------------|---------------------------|----------------------------|-----------------------------|-----------------------------|-----------------------------|------------------------------|------------------------------|---------------------------|
| I                                                   | II                          | 1<br>H<br>hydrogen<br>1      |                             |                             |                              |                               |                              |                            |                              |                           |                            | III                         | IV                          | V                           | VI                           | VII                          | 0                         |
| 7<br>Li<br>lithium<br>3                             | 9<br>Be<br>beryllium<br>4   |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            | 11<br>B<br>boron<br>5       | 12<br>C<br>carbon<br>6      | 14<br>N<br>nitrogen<br>7    | 16<br>O<br>oxygen<br>8       | 19<br>F<br>fluorine<br>9     | 20<br>Ne<br>neon<br>10    |
| 23<br>Na<br>sodium<br>11                            | 24<br>Mg<br>magnesium<br>12 |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            | 27<br>Al<br>aluminium<br>13 | 28<br>Si<br>silicon<br>14   | 31<br>P<br>phosphorus<br>15 | 32<br>S<br>sulfur<br>16      | 35.5<br>Cl<br>chlorine<br>17 | 40<br>Ar<br>argon<br>18   |
| 39<br>K<br>potassium<br>19                          | 40<br>Ca<br>calcium<br>20   | 45<br>Sc<br>scandium<br>21   | 48<br>Ti<br>titanium<br>22  | 51<br>V<br>vanadium<br>23   | 52<br>Cr<br>chromium<br>24   | 55<br>Mn<br>manganese<br>25   | 56<br>Fe<br>iron<br>26       | 59<br>Co<br>cobalt<br>27   | 59<br>Ni<br>nickel<br>28     | 64<br>Cu<br>copper<br>29  | 65<br>Zn<br>zinc<br>30     | 70<br>Ga<br>gallium<br>31   | 73<br>Ge<br>germanium<br>32 | 75<br>As<br>arsenic<br>33   | 79<br>Se<br>selenium<br>34   | 80<br>Br<br>bromine<br>35    | 84<br>Kr<br>krypton<br>36 |
| 85<br>Rb<br>rubidium<br>37                          | 88<br>Sr<br>strontium<br>38 | 89<br>Y<br>yttrium<br>39     | 91<br>Zr<br>zirconium<br>40 | 93<br>Nb<br>niobium<br>41   | 96<br>Mo<br>molybdenum<br>42 | 101<br>Tc<br>technetium<br>43 | 101<br>Ru<br>ruthenium<br>44 | 103<br>Rh<br>rhodium<br>45 | 106<br>Pd<br>palladium<br>46 | 108<br>Ag<br>silver<br>47 | 112<br>Cd<br>cadmium<br>48 | 115<br>In<br>indium<br>49   | 119<br>Sn<br>tin<br>50      | 122<br>Sb<br>antimony<br>51 | 128<br>Te<br>tellurium<br>52 | 127<br>I<br>iodine<br>53     | 131<br>Xe<br>xenon<br>54  |
| 133<br>Cs<br>caesium<br>55                          | 137<br>Ba<br>barium<br>56   | 139<br>La<br>lanthanum<br>57 | 178<br>Hf<br>hafnium<br>72  | 181<br>Ta<br>tantalum<br>73 | 184<br>W<br>tungsten<br>74   | 186<br>Re<br>rhenium<br>75    | 190<br>Os<br>osmium<br>76    | 192<br>Ir<br>iridium<br>77 | 195<br>Pt<br>platinum<br>78  | 197<br>Au<br>gold<br>79   | 201<br>Hg<br>mercury<br>80 | 204<br>Tl<br>thallium<br>81 | 207<br>Pb<br>lead<br>82     | 209<br>Bi<br>bismuth<br>83  | 210<br>Po<br>polonium<br>84  | 210<br>At<br>astatine<br>85  | 210<br>Rn<br>radon<br>86  |
| 87<br>Fr<br>francium                                | 88<br>Ra<br>radium          | 89<br>Ac<br>actinium         |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
| *58-71 Lanthanoid series<br>†90-103 Actinoid series |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
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|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                                                     |                             |                              |                             |                             |                              |                               |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and