

**Student Number**

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## **Exam Choice**

**2008**

### **PRELIMINARY COURSE EXAMINATION**

# **Chemistry**

**Total marks – 75**

#### **General Instructions**

- Reading time – 5 minutes
- Working time – 2 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Approved calculators may be used
- Write your student number in the space provided

This paper has two parts, Part A and Part B

Part A – 15 marks

- Attempt Questions 1-15
- Allow about 30 minutes for this part

Part B – 60 marks

- Attempt Questions 16-27
- Allow about 1 hour and 30 minutes for this part

**Part A – 15 marks**  
**Attempt Questions 1-15**  
**Allow about 30 minutes for this part**

Use the multiple-choice answer sheet.

Select the alternative A,B,C or D that best answers the question. Fill in the response oval completely.

Sample:       $2 + 4 =$       (A) 2      (B) 6      (C) 8      (D) 9


A   ☐      B   ☒      C   ☐      D   ☐

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A   ☒      B   ☒      C   ☐      D   ☐

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.

A   ☒      B   ☒      C   ☐      D   ☐

 **correct**

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1 Which one of the scientists below is credited with the development of the modern Periodic Table?

- (A) Dalton
- (B) Rutherford
- (C) Mendeleev
- (D) Gay-Lussac

2 Which one of the following choices correctly identifies an example of each class of chemical?

	<b>Metallic</b>	<b>Ionic</b>	<b>Covalent Molecular</b>	<b>Covalent Network</b>
(A)	silicon	lithium fluoride	carbon dioxide	silicon dioxide
(B)	uranium	sodium oxide	ammonium chloride	silicon tetrachloride
(C)	iron	silicon dioxide	water	graphite
(D)	tin	ammonium chloride	ammonia	diamond

3 Which of the sets of chemicals below could be produced by a car using natural gas (methane) as fuel?

- (A)  $\text{CO}_2$ , NO,  $\text{SO}_2$
- (B) NO,  $\text{CO}_2$ ,  $\text{C}_8\text{H}_{18}$
- (C)  $\text{SO}_2$ ,  $\text{CO}_2$ , CO
- (D) CO,  $\text{CO}_2$ ,  $\text{H}_2\text{O}$

4 Which of the following sets contains only exothermic reactions?

- (A) photosynthesis, respiration, decomposition of  $\text{AgCl(s)}$
- (B) respiration, combustion, burning  $\text{Mg(s)}$
- (C) combustion, photosynthesis, respiration
- (D) decomposition of  $\text{CuCO}_3\text{(s)}$ , photosynthesis, burning  $\text{Mg(s)}$

- 5 The table below shows some information about the percentage of water and its state in one 'sphere' of earth.

Percentage of 'sphere' composed of water	70%
State of water	liquid

To which one of the following spheres does the information in the above table refer?

- (A) Hydrosphere  
(B) Atmosphere  
(C) Biosphere (living things)  
(D) Lithosphere
- 6 Which one of the following properties most directly affects the reactivity of a metal?
- (A) malleability  
(B) melting point  
(C) first ionisation energy  
(D) electrical conductivity
- 7 Which of the following substances are members of an homologous series?
- (A)  $\text{C}_3\text{H}_8$ ,  $\text{C}_5\text{H}_{12}$ ,  $\text{C}_7\text{H}_{16}$   
(B)  $\text{C}_3\text{H}_8$ ,  $\text{C}_3\text{H}_6$ ,  $\text{C}_3\text{H}_4$   
(C)  $\text{C}_3\text{H}_6$ ,  $\text{C}_4\text{H}_{10}$ ,  $\text{C}_5\text{H}_8$   
(D)  $\text{C}_3\text{H}_4$ ,  $\text{C}_4\text{H}_8$ ,  $\text{C}_5\text{H}_{12}$
- 8 Which one of the following equations is the basis for the formation of fossil fuels?
- (A)  $\text{C}_6\text{H}_{12}\text{O}_6(\text{aq}) + 6\text{O}_2(\text{g}) \rightarrow 6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l})$   
(B)  $6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l}) \rightarrow \text{C}_6\text{H}_{12}\text{O}_6(\text{aq}) + 6\text{O}_2(\text{g})$   
(C)  $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$   
(D)  $\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$

**9** Identify the correct statement about aluminium.

- (A) Aluminium is a renewable resource because its ore, bauxite, is formed continuously by natural geological processes.
- (B) Aluminium mining and extraction consumes very little energy, and hence makes only a small contribution to the enhanced greenhouse effect.
- (C) One of the most important reasons for recycling aluminium is that it consumes approximately 20% of the energy required to obtain it from its ore.
- (D) Aluminium production is sufficiently inexpensive that there is no demand for more expensive recycled material.

**10** Which of the following alternatives correctly identifies the molecular shape of water, hydrogen sulfide and ammonia?

	<b>water</b>	<b>hydrogen sulfide</b>	<b>ammonia</b>
(A)	bent	bent	pyramidal
(B)	linear	linear	pyramidal
(C)	pyramidal	bent	trigonal planar
(D)	bent	linear	trigonal planar

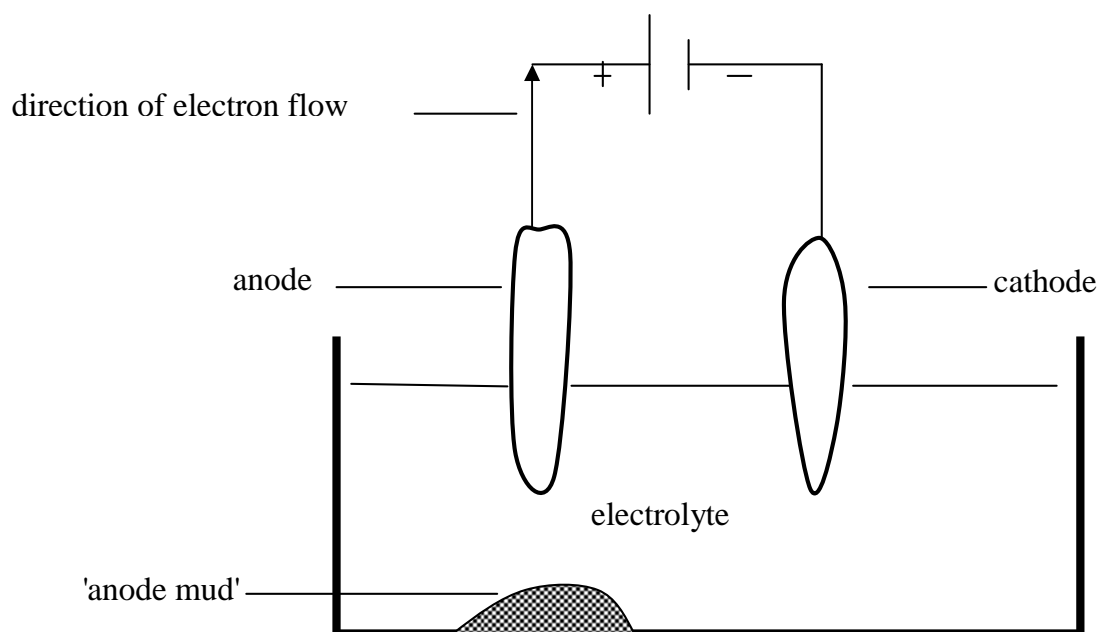
**11** The density of water at 25°C is 1.00 gcm<sup>-3</sup>. The density of ice at 0°C is 0.917 gcm<sup>-3</sup>. What volume change would occur if an ice cube of mass 9.50 g, initially at 0°C, melted to form liquid water with a final temperature of 25°C?

- (A) An increase in volume of 0.86 mL would occur
- (B) A decrease in volume of 0.86 mL would occur
- (C) An increase in volume of 0.79 mL would occur
- (D) A decrease in volume of 0.79 mL would occur

- 12 Which of the following shows the correct impacts on reaction rate, of changing concentration (C), pressure (P) and particle size (PS)?

	increasing C	increasing P	decreasing PS
(A)	increases rate	decreases rate	decreases rate
(B)	increases rate	increases rate	increases rate
(C)	decreases rate	decreases rate	decreases rate
(D)	decreases rate	increases rate	decreases rate

- 13 The final step in the extraction of copper from its ore is the refining of impure copper by electrolysis, the main features of which are shown below.



Which of the following statements about this process is correct?

- (A) Copper atoms in the impure copper are oxidised at the anode.
- (B) Copper ions are produced at the cathode.
- (C) Electrons in the electrolyte move towards the anode.
- (D) The anode mud will contain more reactive metals such as zinc and magnesium.

- 14 The solubility rules for a range of common compounds are shown below:

Anion present in salt	General Solubility Rule	Main exceptions
Nitrate	All salts soluble	No exceptions
Chloride	Most salts soluble	Lead(II); mercury(II), silver
Sulfate	Most salts soluble	Lead(II); mercury(II), silver, barium
Carbonate	Most salts insoluble	Group I and ammonium cations
Hydroxide	Most salts insoluble	Group I and ammonium cations, barium

Students were given an unknown solution labelled "X". They were told that the solution contained a single ionic compound. They performed the following tests on separate samples of the solution:

Test	Precipitate formed
Add copper(II) sulfate	✓
Add sodium chloride	✗
Add silver nitrate	✓

Which of the compounds below could be the name of chemical "X"?

- (A) sodium sulfate  
(B) barium chloride  
(C) lead(II) nitrate  
(D) silver nitrate
- 15 The specific heat capacity of copper is  $3.9 \times 10^2 \text{ J kg}^{-1} \text{ K}^{-1}$ . A student heated a 125.0 g cube of copper by placing it in hot water. The initial temperature of the copper was  $22.5^\circ\text{C}$ . From measurements of the temperature change in the water, it was found that 2.5 kJ of energy was lost from the water in heating up the copper.

From the information above, the final temperature of the copper would be:

- (A)  $27.6^\circ\text{C}$   
(B)  $28.8^\circ\text{C}$   
(C)  $51.3^\circ\text{C}$   
(D)  $73.8^\circ\text{C}$

## Part B

Attempt questions 16-27

Allow about 1 hour and 30 minutes for this part.

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

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### Question 16 (4 marks)

Marks

Diamond, graphite and fullerenes, three allotropes of carbon, have remarkably different physical properties. Account for the differences in electrical conductivity of each of these allotropes.

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**Question 17** (4 marks)

Explain, using specific examples, how the variety of metals available for human use has increased over time. Include at least one balanced equation in your answer.

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**Question 18** (6 marks)

A chemistry teacher required a mixture of sulfur and iron (2 parts sulfur: 1 part iron) to use in an experiment. She found a sulfur/iron mixture which had been used in a previous year, but there was no information about the ratio of sulfur to iron on the label.

The teacher took a sample of the unknown mixture and followed the procedure below to separate it.

*Procedure*

1. Weigh out a small mass of the mixture.
2. Transfer solid to a clean, dry conical flask.
3. Add 100g of hydrochloric acid-enough to react with all of the iron in the mixture.
4. After all of the iron appears to have dissolved, filter the remaining mixture through fine filter paper.
5. Dry the filter paper and weigh the residue.

**Question 18 continues on page 10.**

Question 18 (continued)

The measurements the teacher took are below.

Mass of empty conical flask = 356.98 g  
 Mass of flask + sulfur/iron mixture = 360.18g  
 Average mass of clean dry filter paper = 1.86 g  
 Mass of dry filter paper + residue = 4.25g

- (a) Should the method the teacher chose to separate the sulfur and the iron be classed as a physical separation? Justify your answer. 2

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- (b) The products of the addition of hydrochloric acid to the iron in the mixture are iron (II) chloride and hydrogen gas. Write a balanced chemical equation for this reaction. 1

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- (c) Use the measurements above to calculate the % of iron in the mixture and use your answer to explain whether the mixture meets the teacher's requirements. 3

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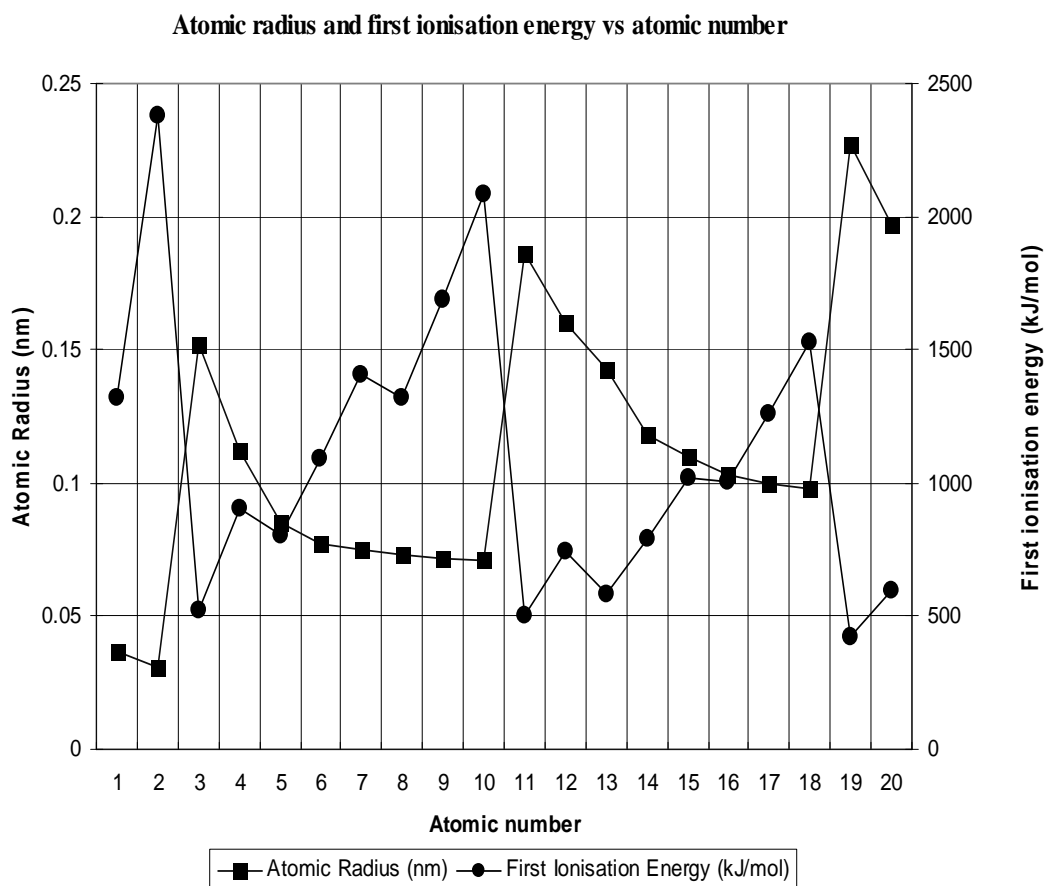
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## Question 19 (5 marks)

The graph below shows the trend in the first ionisation energy and atomic radius of the first 20 elements against their atomic number.



Explain the trends displayed in the graph, using specific examples to illustrate your answer.

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**Question 20** (4 marks)

The particle theory is a simple yet powerful tool for understanding chemical processes. Use the particle theory to explain how the following changes would affect the rate of a chemical reaction.

- (a) The addition of a catalyst to the reaction mixture. 2

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- (b) An increase in temperature. 2

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**Question 21** (4 marks)

A student wants to verify part of the metal reactivity series using 3 metals, X, Y and Z. She finds that metal X reacts with dilute HCl to produce  $H_2$  (g) and a compound of formula  $XCl_2$ , whereas Y and Z do not react with dilute HCl.

- (a) Write two half equations to represent the electron transfer reactions which occur when X reacts with dilute HCl. 2

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- (b) Outline a method for determining the relative reactivity of Y and Z (you may use other appropriate chemicals). 2

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**Question 22** (7 marks)

A chemistry student is required to produce 25.0 mL of 0.01M sodium carbonate solution.

She was provided with the following forms of sodium carbonate:

- A bottle containing 200.0 mL of 0.05M sodium carbonate solution.
- A container of solid sodium carbonate.

Describe TWO methods the student could use to produce the required solution, each using a different starting form of sodium carbonate provided.

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Include calculations, the necessary equipment and the procedure to be followed in your answer.

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**Question 23** (6 marks)

The following table shows the boiling point of some alkanes in common, everyday usage.

alkane	boiling point (°C)
methane	-161.5
propane	-42.1
butane	-0.5
octane	125.7

(a) Draw the structure of butane.

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(b) Explain the trend shown by the data in the table.

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(c) Compare the safe storage requirements of butane and octane.

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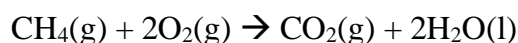
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**Question 24** (6 marks)

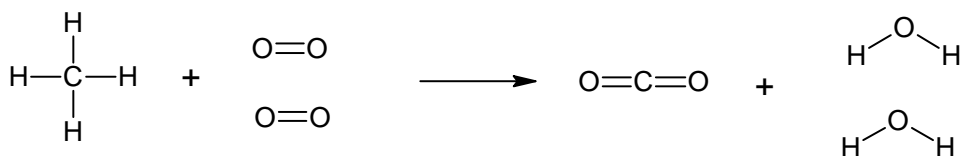
The following table shows various bond energies (the energy required or produced when the bond is broken or formed).

bond	energy (kJ/mol)
C-H	414
C-C	346
C-O	358
C=O	804
O=O	498
O-O	144
O-H	463
H-H	436

Consider the combustion of one mole of methane:



This equation can also be shown as:



(a) Calculate the total energy required to break the bonds in the reactants.

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(b) Calculate the total energy released when the products are formed.

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**Question 24 continues on page 16.**

**Marks**

Question 24 (continued)

- (c) Using your answer to (a) and (b) on the previous page, calculate  $\Delta H$  for this reaction.

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- (d) Draw a labelled energy profile diagram for the reaction. Scales on your axes are not required.

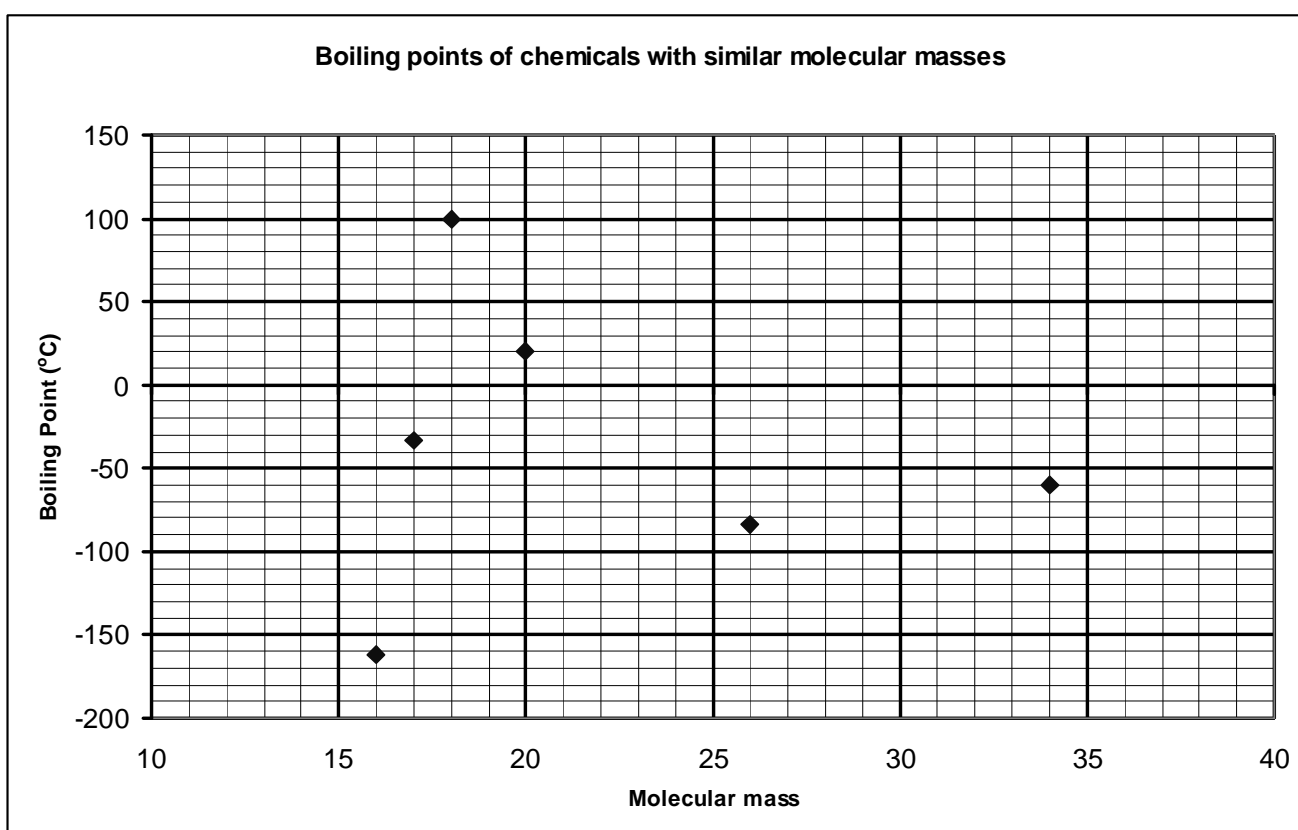
**3**



**Question 25** (6 marks)

The figure below shows the boiling points of a number of substances of similar molecular mass (in a range 16-34 amu).

The substances shown include ammonia, ethyne, hydrogen fluoride, hydrogen sulfide, methane, nitrogen and water.



(a) Use the graph to estimate the boiling point of ethyne.

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**Question 25 continues on page 18.**

Question 25 (continued)

- (b) Account for the higher boiling points of the substances with molecular mass 17, 18 and 20. 3

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- (c) When analysing the effect of molecular shape and polarity on the boiling point of molecules, why should the molecular mass of the molecules be similar? 2

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**Question 26 (4 marks)**

A student transferred 1.35 g of  $\text{Cu}(\text{NO}_3)_2(\text{s})$  and 1.35 g of  $\text{Na}_2\text{CO}_3(\text{s})$  to separate beakers, and dissolved each in 100 mL of water. The student then mixed the two solutions, producing a blue precipitate.

- (a) Write a balanced chemical equation for this reaction. 1

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- (b) Calculate the mass of  $\text{CuCO}_3$  that could be formed in this reaction. 3

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**Question 27** (4 marks)

During your Preliminary course you measured the heat of solution of some solids.

- (a) Describe a method you could use to measure the heat of solution of sodium hydroxide. **3**

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- (b) Identify one reason why your experimental result would differ from the theoretical (literature) value. **1**

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