LUI | | | | | | | | | | | School code | | | | |

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Book of books used

External assessment 2025

Question and response book

Chemistry

Paper 2

Time allowed

- Perusal time — 10 minutes
- Working time — 90 minutes

General instructions

- Answer all questions in this question and response book.
- Write using black or blue pen.
- QCAA-approved calculator permitted.
- QCAA formula and data book provided.
- Planning paper will not be marked.

Section 1 (55 marks)

- 9 short response questions

Clear zone — margin trimmed off after completion of assessment

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Section 1

Instructions

- If you need more space for a response, use the additional pages at the back of this book.
  - On the additional pages, write the question number you are responding to.
  - Cancel any incorrect response by ruling a single diagonal line through your work.
  - Write the page number of your alternative/additional response, i.e. See page …
  - If you do not do this, your original response will be marked.

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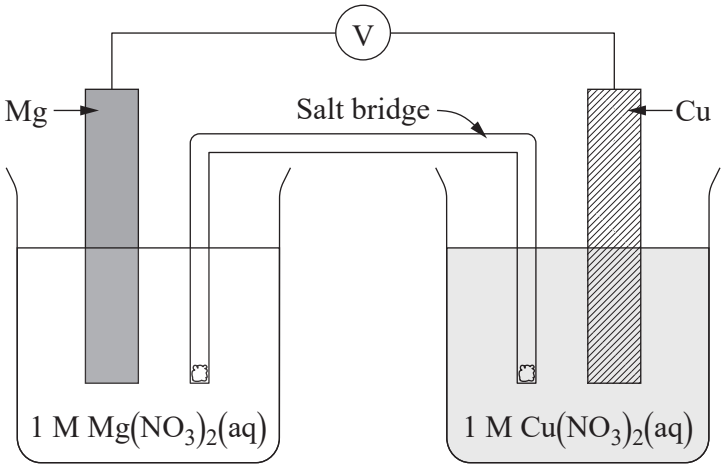
QUESTION 1 (8 marks)

A galvanic cell was constructed using copper and magnesium electrodes.



a) Determine the half-equation occurring in the Mg | $Mg(NO_3)_2$ half-cell. *[1 mark]*

b) Contrast the flow of electrons and the movement of anions in the cell. *[2 marks]*

c) Describe two changes that would be observed as the galvanic cell operates. *[2 marks]*

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d) Predict whether a voltage would be produced if the $Mg(s)$ electrode was replaced with an $Al(s)$ electrode. Explain your reasoning. *[3 marks]*

QUESTION 2 (3 marks)

An organic compound is analysed using mass spectroscopy and infrared spectroscopy.

a) Describe how the mass spectrum could be used to determine if the organic compound is hexanal or hexan-2-one. *[2 marks]*

b) Explain how the infrared spectrum could be used to determine if the organic compound is hexanal or hexanoic acid. *[1 mark]*

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QUESTION 3 (5 marks)

Alizarin yellow R is an acid–base indicator that is yellow in its non-ionised form (HIn) and red in its conjugate base form (In^-).

$$HIn(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + In^-(aq)$$

Yellow Red

The dissociation constant (K_a) for alizarin yellow R is 7.9×10^{-12}.

a) Determine the pK_a. *[1 mark]*

b) Explain the relationship between the pH range of the colour change of alizarin yellow R and its pK_a value. *[3 marks]*

c) Identify a type of titration for which alizarin yellow R would be a suitable indicator. *[1 mark]*

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QUESTION 4 (5 marks)

Hypochlorous acid $(HOCl)$ is a weak acid formed by dissolving chlorine (Cl_2) gas in water. Hydrochloric acid (HCl) is also formed in this process.

$$Cl_2(g) + H_2O(l) \rightarrow HOCl(aq) + HCl(aq)$$

The dissociation constant (K_a) for hypochlorous acid is 2.8×10^{-8}.

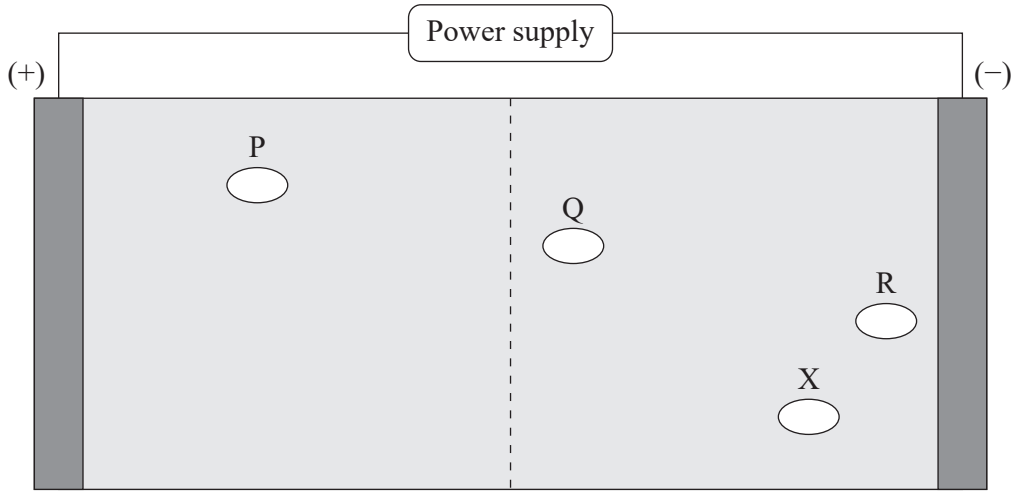
a) Describe the dissociation of $HOCl(aq)$ and $HCl(aq)$ using balanced chemical equations. *[2 marks]*

b) Calculate the pH of a 2.50 M aqueous solution of HOCl. Show your working. *[3 marks]*

Do not write outside this box.

QUESTION 5 (6 marks)

A section of a protein was hydrolysed and then underwent electrophoresis in a buffer of pH 5. The amino acids present in the electrophoresis gel shown were arginine (Arg), cysteine (Cys), glutamic acid (Glu) and an unknown amino acid, X.



a) Determine the amino acids represented by spots P, Q and R. Explain your reasoning. *[4 marks]*

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b) Identify the amino acid represented by spot X. Explain your reasoning. *[2 marks]*

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QUESTION 6 (10 marks)

The table shows the boiling points and molar masses of several organic compounds.

Compound	Class	Name	Molar mass ($g\ mol^{-1}$)	Boiling point (°C)
$CH_3CH_2CH_2CH_2CH_3$	alkane	pentane	72	−1
$CHO_2CH_2CH_3$	ester		74	32
$CH_3CH_2CH_2CHO$	aldehyde	butanal	72	49
$CH_3CH_2CH_2CH_2OH$	alcohol		74	97
CH_3CH_2COOH	carboxylic acid		74	118

a) Predict whether hexane has a higher boiling point than pentane.
Explain your reasoning. *[2 marks]*

b) Explain why butanal has a higher boiling point than pentane. *[3 marks]*

c) Identify the two organic compounds from the table that are highly soluble in water.
Explain your reasoning. *[2 marks]*

Do not write outside this box.

d) Identify the alcohol as primary, secondary or tertiary. Explain your reasoning. *[2 marks]*

e) Apply IUPAC rules to name the ester. *[1 mark]*

QUESTION 7 (4 marks)

Contrast the operation of a hydrogen fuel cell under acidic conditions and a hydrogen fuel cell under alkaline conditions by completing the table.

Contrast	**Hydrogen fuel cell**	
	Acidic conditions	**Alkaline conditions**
Electrolyte used		
Movement of ions		

Note: If you make a mistake, cancel it by ruling a single diagonal line through your work and use the additional response space at the back of this book.

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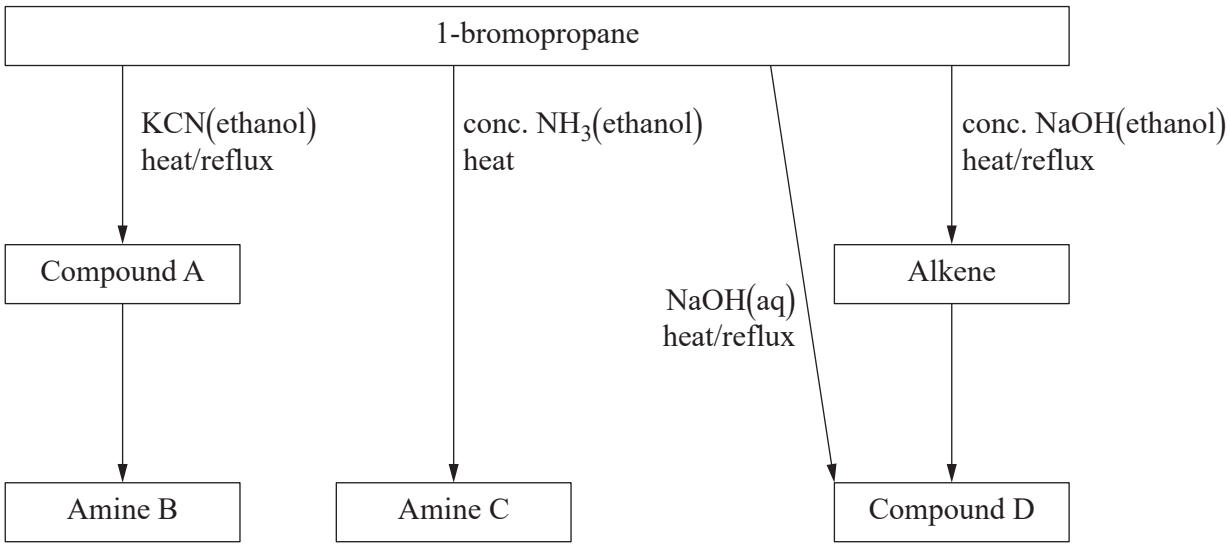
QUESTION 8 (9 marks)

Haloalkanes are useful intermediates for making other organic compounds.



a) Determine the structural formulas and IUPAC names for compounds A and D. *[4 marks]*

Compound A

IUPAC name: _____

Do not write outside this box.

Compound D

IUPAC name: _____

Note: If you make a mistake, cancel it by ruling a single diagonal line through your work and use the additional response space at the back of this book.

b) Determine the IUPAC name of the alkene formed from 1-bromopropane. *[1 mark]*

c) Identify the type of reaction that occurs to convert the alkene to compound D. *[1 mark]*

d) Write a balanced chemical equation to show how compound A can form amine B. Include reagents and conditions. *[2 marks]*

e) Identify how amine B differs from amine C. *[1 mark]*

Do not write outside this box.

QUESTION 9 (5 marks)

Yellow chromate ions (CrO_4^{-}) are in equilibrium with orange dichromate ions $(Cr_2O_7^{2-})$ in an aqueous solution.

$$2CrO_4^{-}(aq) + 2H^{+}(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(l)$$

Yellow Orange

Two experiments were conducted to investigate the effect of pH on the position of equilibrium.

	$[CrO_4^{-}]$ (mol L^{-1})	$[H^{+}]$ (mol L^{-1})	$[Cr_2O_7^{2-}]$ (mol L^{-1})	K_c at 25 °C
Experiment 1		1.0×10^{-4}		4.2×10^{14}
Experiment 2	1.2×10^{-3}		6.0×10^{-2}	4.2×10^{14}

a) Deduce the colour of the solution at equilibrium for experiment 1.
Explain your reasoning. *[2 marks]*

b) Calculate the pH of the solution at equilibrium for experiment 2. Show your working. *[3 marks]*

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ADDITIONAL PAGE FOR STUDENT RESPONSES

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ADDITIONAL RESPONSE SPACE FOR QUESTION 7

If you want this response to be marked, rule a single diagonal line through your previous response.

Contrast	Hydrogen fuel cell	
	Acidic conditions	Alkaline conditions
Electrolyte used		
Movement of ions		

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Data and information provided in this paper may have been developed or adjusted for exam purposes and should not be taken as factual.