External assessment 2023

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 (54 marks)

- 9 short response questions

Clear zone — margin trimmed off after completion of assessment

Queensland Government | QCAA Queensland Curriculum & Assessment Authority

LUI

School code

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Book of books used

Attach your barcode ID label here

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.

Do not write on this page

This page will not be marked

Do not write outside this box.

Question 1 (2 marks)

Polylactic acid (PLA) and low-density polyethylene (LDPE) are both used to produce plastic wrapping film.

Plastic	Composition	Density (g/cm^3)	Tensile stress (MPa)	Elongation (%)	Degradation rate
PLA	plant-based	1.24	60	6	slow
LDPE	petrochemical-based	0.92	12	148	none

Analyse the data to discuss one advantage and one disadvantage of using PLA rather than LDPE to produce plastic wrapping film.

Advantage: _____

_____

_____

Disadvantage: _____

_____

_____

Question 2 (3 marks)

Compare the structure of α-helix and β-pleated sheets in the secondary structure of proteins.

Similarity: _____

_____

_____

Difference: _____

_____

_____

Significance: _____

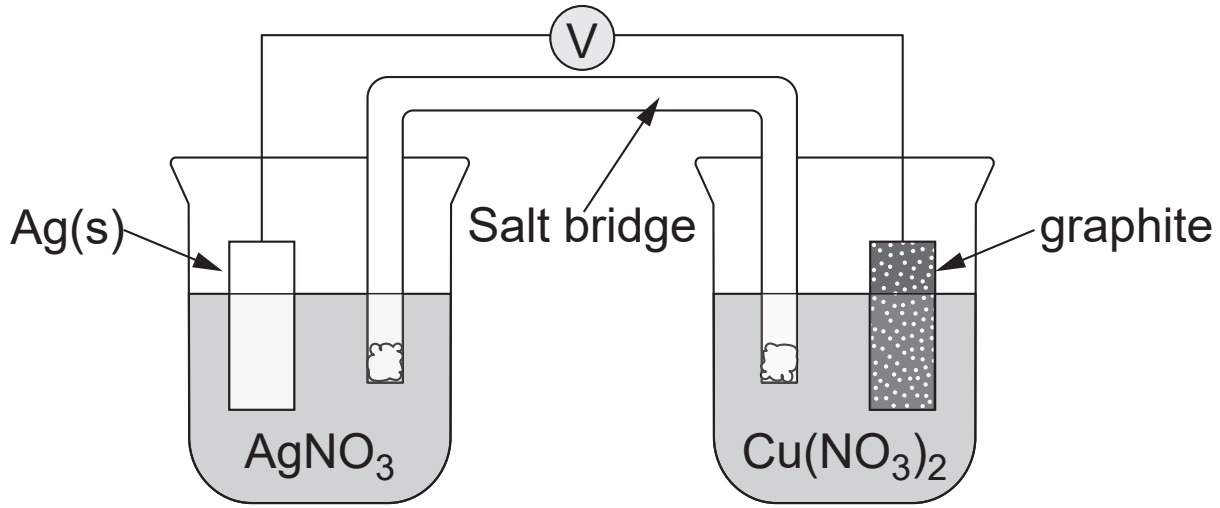
_____

_____

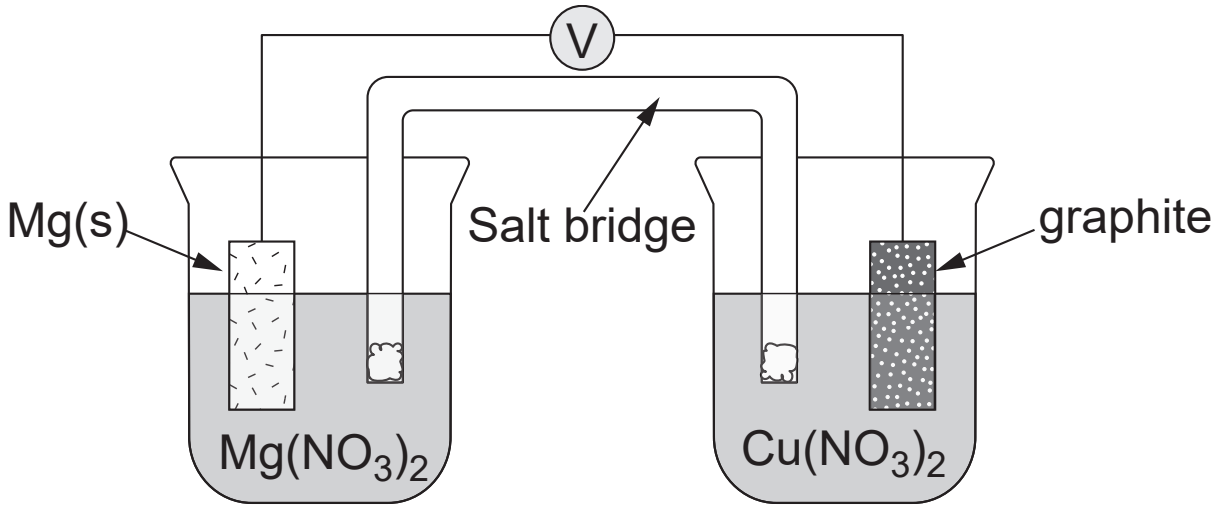
Question 3 (7 marks)

An experiment was conducted at standard state conditions to investigate the potential difference (V) produced by different galvanic cells. The three cells used in the experiment are shown.

Cell 1



Cell 2



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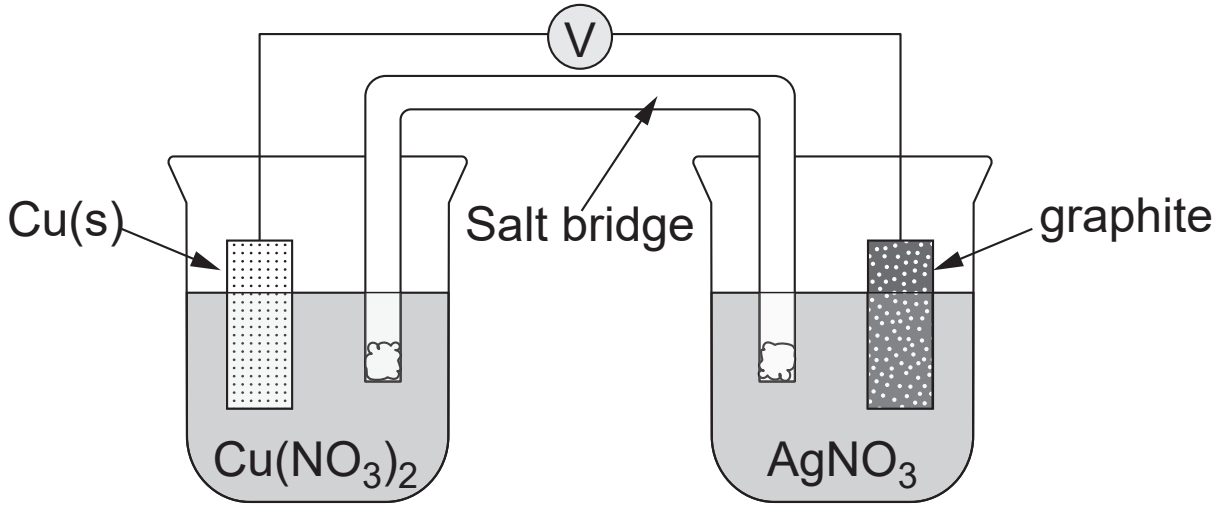
Cell 3



(a) Predict which cell produced the highest voltage. Explain your reasoning. [3 marks]

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(b) Determine the maximum voltage that could be produced by a fourth galvanic cell constructed from any of the components used in the first three cells. Use oxidation and reduction half-equations to justify your answer.
[4 marks]

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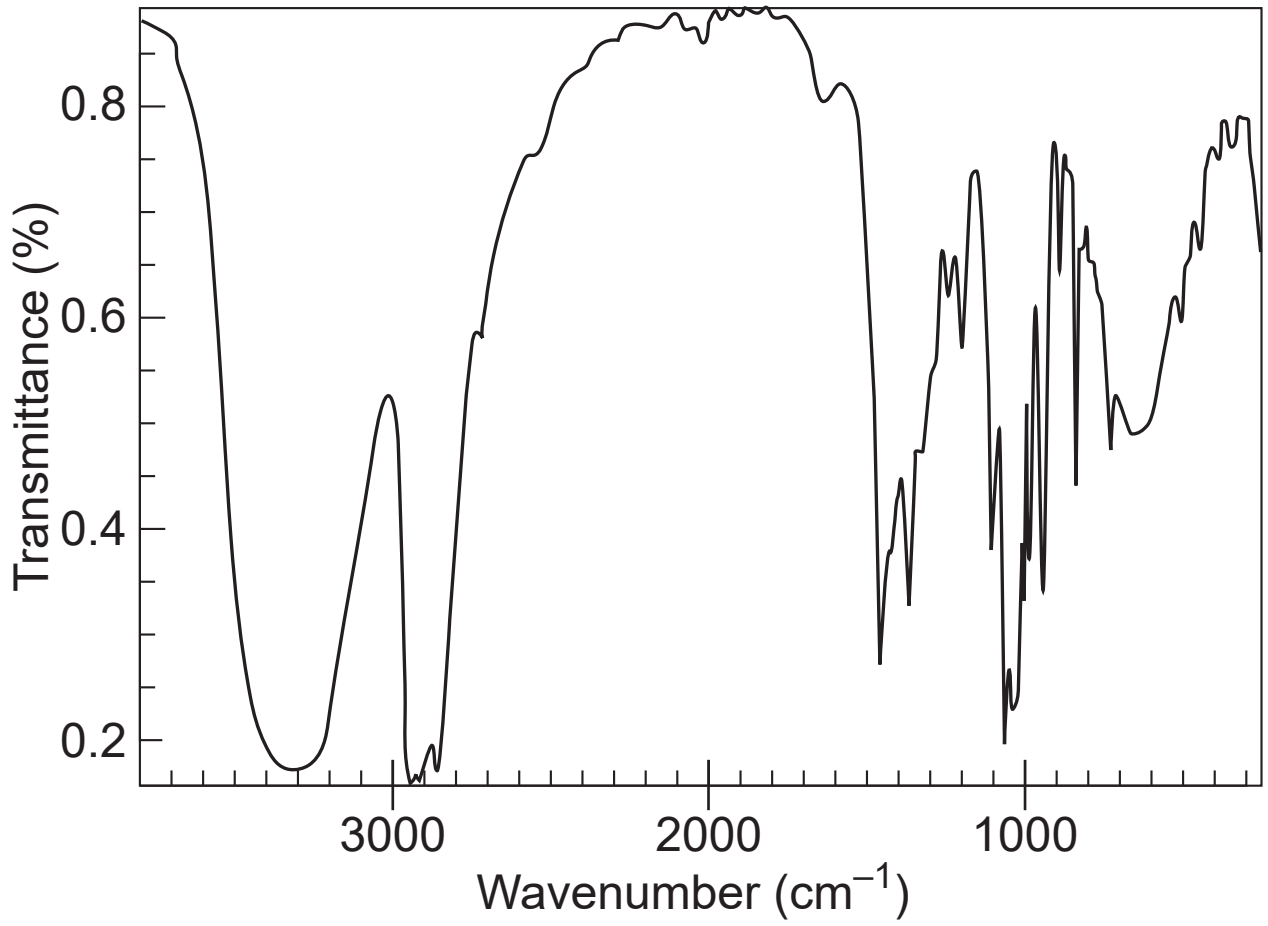
Question 4 (8 marks)

Compound C has the molecular formula $C_4H_{10}O$ and is either an alcohol, an aldehyde or a carboxylic acid.

Compound C infrared spectrum



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(a) Deduce the class of compound C. Explain your reasoning. [4 marks]

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(b) Deduce the structural formula and IUPAC name of two isomers of compound C. [2 marks]

Isomer 1:

IUPAC name: _____

Isomer 2:

IUPAC name: _____

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

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(c) Distinguish between structural and geometric isomers.
[2 marks]

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Question 5 (13 marks)

The table gives the properties of four monoprotic acids.

Acid	Concentration (mol L^{-1})	$[H^+]$ (mol L^{-1})	pH	K_a
1	0.200	7.90×10^{-5}		
2	0.100	4.20×10^{-3}	2.34	1.80×10^{-4}
$CH_3COOH(aq)$	0.100			1.78×10^{-5}
HCl(aq)	0.010	1.00×10^{-2}	2.00	>1

(a) Determine the relative strength of acids 1 and 2 by contrasting their K_a values. [3 marks]

(b) Write a balanced chemical equation for the dissociation of ethanoic acid (CH_3COOH) in water. [2 marks]

(c) Identify whether the conjugate base of ethanoic acid ($CH_3COOH(aq)$) is amphiprotic. Explain your reasoning. [2 marks]

(d) Calculate the pH of the aqueous solution of ethanoic acid (CH_3COOH). Show your working. [3 marks]

(e) Determine the volume of water that would need to be added to 100.0 mL of HCl(aq) to change the pH from 2.00 to 3.00. Explain your reasoning. [3 marks]

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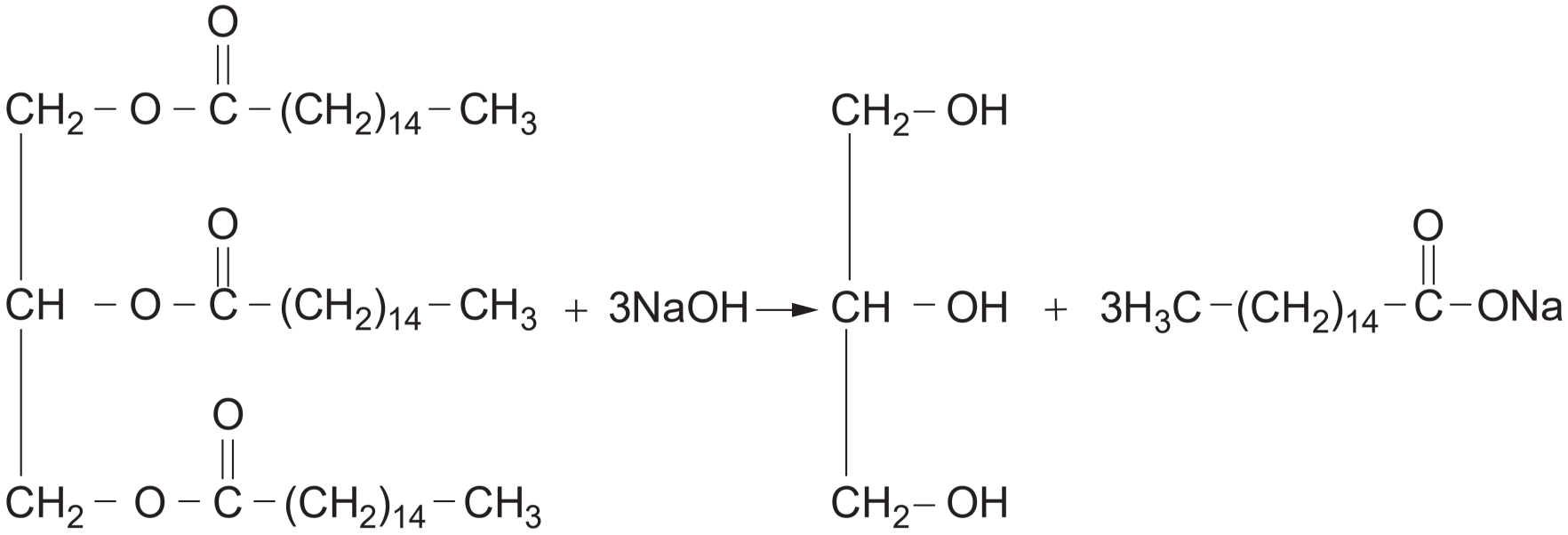
Question 6 (6 marks)

The reaction shows the base hydrolysis (saponification) of a triglyceride to produce glycerol and a soap.



Triglyceride **Glycerol** **Soap**

(a) Identify which compound in the reaction is an ester. [1 mark]

(b) Contrast the structure of saturated and unsaturated fatty acids. [1 mark]

(c) Explain how the cleaning action of soap is related to its structure. [4 marks]

Question 7 (4 marks)

When heated in a sealed container, solid mercury(II) oxide (HgO) decomposed to form metallic mercury (Hg) and oxygen gas (O_2).

$$2HgO(s) \rightleftharpoons 2Hg(l) + O_2(g)$$

Orange Silver Colourless

(a) Identify whether the reaction occurs in an open or closed system. [1 mark]

(b) Explain why the colour of the system does not change once equilibrium is established. [3 marks]

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Question 8 (7 marks)

Two experiments were conducted to investigate the effect of temperature on the equilibrium formed during the decomposition of hydrogen iodide (HI).

$2HI(g) \rightleftharpoons H_2(g) + I_2(g) \qquad \Delta H = +53.6 \text{ kJ mol}^{-1}$

Experiment	Initial concentration (mol L^{-1})			Equilibrium concentration (mol L^{-1})			K_c
	[HI]	[H_2]	[I_2]	[HI]	[H_2]	[I_2]	
1	0.08	0.00	0.00		0.01		2.78×10^{-2}
2	0.00	0.06	0.06	0.06	0.03	0.03	

(a) Determine the concentration of HI(g) and $I_2(g)$ at equilibrium for experiment 1. [2 marks]

[HI]: _____

[I_2]: _____

(b) Calculate the equilibrium constant (K_c) for experiment 2. Show your working. [2 marks]

(c) Determine which experiment was conducted at a higher temperature. Explain your reasoning. [3 marks]

Question 9 (4 marks)

Aspirin ($C_9H_8O_4$) can be produced from a reaction between salicylic acid ($C_7H_6O_3$) and acetic anhydride ($C_4H_6O_3$) with ethanoic acid being a minor product.

$$C_7H_6O_3(s) + C_4H_6O_3(aq) \rightarrow C_9H_8O_4(s) + C_2H_4O_2(aq)$$

Calculate the mass of salicylic acid required to produce 8.25 g of aspirin if the percentage yield of the reaction is 60%. Show your working.

End of paper

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Additional page for student responses

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References

Question 4

Minor adaptation from Coblentz Society, Inc., 2-Butanol 2018, in NIST Chemistry WebBook, NIST Standard Reference Database Number 69, Nist.gov, National Institute of Standards and Technology, U.S. Secretary of Commerce https://webbook.nist.gov/cgi/cbook.cgi?ID=C78922&Type=IR-SPEC&Index=1