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

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Book of books used

External assessment 2022

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 (49 marks)

- 6 short response questions

Clear zone — margin trimmed off after completion of assessment

Queensland Government | QCAA Queensland Curriculum & Assessment Authority

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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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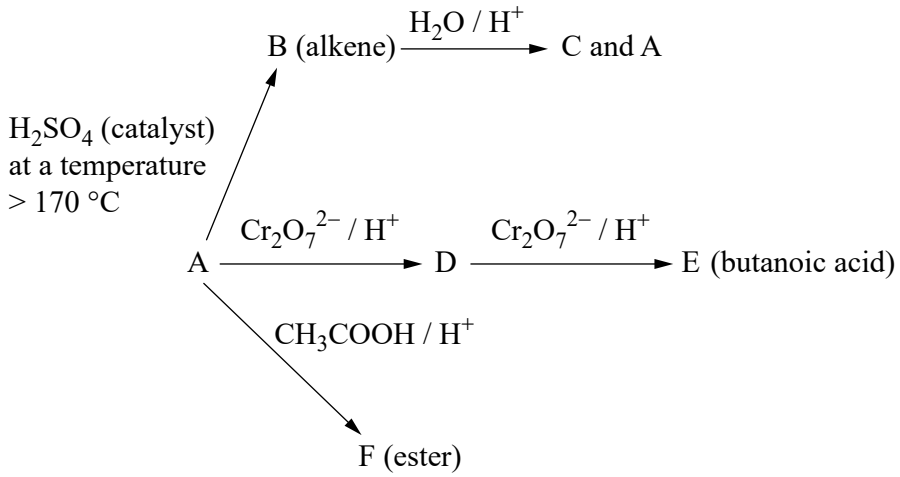
QUESTION 1 (8 marks)

The diagram shows a series of different reactions starting with compound A, which has the empirical formula $C_4H_{10}O$.



a) Identify the class of organic compounds that compound A belongs to. *[1 mark]*

b) Compound C is an isomer of compound A. Deduce the structural formulas and IUPAC names of compounds A and C. *[4 marks]*

i) Compound A

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.

IUPAC name: _____

Do not write outside this box.

ii) Compound C

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 at the back of this question and response book.

IUPAC name: _____

c) Identify whether compounds A and C are structural or geometric isomers. *[1 mark]*

_____

d) Deduce the structural formula and IUPAC name for compound F. *[2 marks]*

Compound F

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.

IUPAC name: _____

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QUESTION 2 (8 marks)

The reaction shows part of the contact process used to produce sulfuric acid.

$$2SO_2(g) + O_2 \overset{V_2O_5}{\rightleftharpoons} 2SO_3(g)$$

The equilibrium constant (K_c) for this reaction at different temperatures is shown.

Temperature (K)	Equilibrium constant, K_c (mol L^{-1})
298	9.77×10^{25}
500	8.61×10^{11}

a) Deduce if the forward reaction is exothermic or endothermic. Explain your reasoning. *[2 marks]*

b) Calculate the equilibrium concentration of SO_3 at 500 K given the equilibrium concentrations.

$[SO_2] = 0.860$ M; $[O_2] = 0.330$ M *[2 marks]*

Concentration = _____ M (to three significant figures)

Do not write outside this box.

c) Apply Le Châtelier's principle to explain whether halving the reaction vessel's volume at 500 K would affect the position of the equilibrium or the value of the equilibrium constant.

[4 marks]

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QUESTION 3 (9 marks)

A 50.0 mL solution of ethanoic acid (CH_3COOH) was titrated with 15.0 mL of 0.10 M sodium hydroxide (NaOH) solution to reach the equivalence point (pK_a ethanoic acid = 4.76).

a) Write a balanced chemical equation to indicate how ethanoic acid acts as a Brønsted-Lowry acid during the titration and identify its conjugate base. *[2 marks]*

b) Determine the K_b of the conjugate base of ethanoic acid. *[1 mark]*

K_b = _____ (to two decimal places)

c) Calculate the concentration of the conjugate base at the equivalence point. Show your working. *[2 marks]*

Concentration = _____ M (to three significant figures)

Do not write outside this box.

d) Calculate the pH at the equivalence point. Show your working. *[4 marks]*

pH = _____ (to one decimal place)

Do not write outside this box.

QUESTION 4 (8 marks)

Bioethanol is a renewable energy source made from biomasses such as starch and cellulosic materials. The two-step process for the conversion of starch and cellulose to bioethanol is shown.

Process	Step 1	Step 2	Conversion to glucose	Production process
Starch	Enzymatic hydrolysis (α–amylase) of starch biomass to form glucose	Fermentation of glucose to form bioethanol (yeast)	Easier	Faster
Cellulose	Acid hydrolysis ($H_2SO_4(aq)$ at 320 °C and 25 MPa) of cellulose biomass to form glucose	Fermentation of glucose to form bioethanol (yeast)	Harder	Slower

a) Identify why it is important to control the temperature during the fermentation process to produce bioethanol. *[2 marks]*

b) Explain why cellulose is harder to convert to glucose than starch. *[3 marks]*

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c) After 48 hours of fermentation, a 15% w/v glucose solution produces 37.5 g L^{-1} of ethanol. Calculate the percentage yield of ethanol. Show your working. *[3 marks]*

Ethanol yield = _____ % (to one decimal place)

Do not write outside this box.

QUESTION 5 (8 marks)

One step in the electrolytic refining of copper uses impure copper anodes and high purity copper cathodes in an electrolyte solution of copper(II) sulfate.

a) Predict whether the concentration of the copper(II) sulfate solution will change during the purification process. Provide appropriate half-equations to support your reasoning. *[4 marks]*

b) If the copper anodes contain silver and zinc impurities, determine whether either metal could be produced as a by-product of the electrolytic refining of copper. Explain your reasoning. *[4 marks]*

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QUESTION 6 (8 marks)

Polypeptides and proteins are formed by condensation reactions of amino acids.

a) Identify the type of bond formed when three amino acids are joined to form a tripeptide and state any other product/s formed. *[2 marks]*

b) Determine the total number of tripeptides that can be formed containing histidine, lysine and glycine and use the three-letter symbols for the amino acids to describe two of the tripeptides formed. *[3 marks]*

c) Explain how the pH of the buffer solution can be used to separate histidine, lysine and glycine through electrophoresis. *[3 marks]*

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END OF PAPER

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ADDITIONAL PAGE FOR STUDENT RESPONSES

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