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

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Attach your
barcode ID label here

Book of books used

External assessment

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 (60 marks)

- 5 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 (12 marks)

When zinc metal was placed into a blue solution of copper(II) nitrate, the solution became colourless and a red-brown deposit of copper formed on the bottom of the beaker.

a) Identify if the reaction that occurred can be classified as a redox reaction.
Explain your reasoning. *[3 marks]*

b) When the copper deposited in the reaction was collected and reacted with concentrated nitric acid, copper(II) nitrate solution and nitrogen dioxide gas formed.

$$Cu(s) + 4HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l) \qquad E^\circ = +0.46\,V$$

i) Determine the reduction half-equation for this reaction. *[2 marks]*

ii) Determine the standard reduction potential, E°, for the reduction half-equation. *[1 mark]*

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c) Apply your understanding of standard reduction potentials to explain why:

i) copper can dissolve in concentrated nitric acid, but does not dissolve in concentrated hydrochloric acid. *[3 marks]*

ii) NO_2 is the gaseous product, rather than H_2, when copper dissolves in nitric acid. *[3 marks]*

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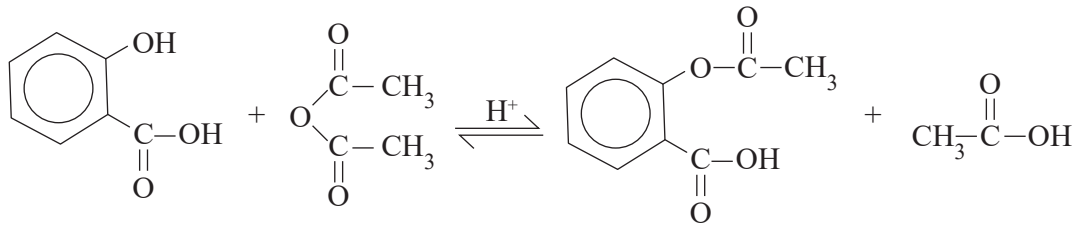
QUESTION 2 (12 marks)

Salicylic acid reacts with ethanoic anhydride in an aqueous solution to produce acetylsalicylic acid, as shown in the equation. Acetylsalicylic acid is commonly known as aspirin.



salicylic acid	ethanoic anhydride	acetylsalicylic acid	ethanoic acid
($C_7H_6O_3$)	($C_4H_6O_3$)	($C_9H_8O_4$)	($C_2H_4O_2$)

a) Identify the type of chemical reaction used to produce aspirin. *[1 mark]*

b) Write the equilibrium expression, K_c, for the reaction. *[1 mark]*

c) At 20 °C, the equilibrium constant (K_c) for the reaction is 2×10^{-3}. Determine whether the concentration of the reactants or products is greater at equilibrium at this temperature. *[2 marks]*

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d) Calculate the minimum mass of salicylic acid required to produce 500.0 mg of aspirin if the yield of aspirin is 45.0%. Show your working. *[4 marks]*

Mass = _____ mg (to three significant figures)

e) When the reaction is heated to 40 °C and equilibrium is re-established, the concentration of acetylsalicylic acid and ethanoic acid increases. Apply Le Châtelier's principle to predict if the forward reaction is exothermic or endothermic. Explain your reasoning. *[4 marks]*

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QUESTION 3 (9 marks)

Ethanol can be produced by the fermentation of glucose or the hydration of ethene.

a) Describe the production of ethanol by fermentation of glucose by writing a balanced equation and indicating if a catalyst is required. *[3 marks]*

b) Calculate the atom economy for the production of ethanol by fermentation of glucose. *[2 marks]*

Atom economy = _____ %

c) In terms of atom economy, determine which process for the production of ethanol (i.e. hydration of ethene or fermentation of glucose) is greener. *[2 marks]*

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d) Identify two principles of green chemistry, other than atom economy, that make the production of ethanol by fermentation greener than by hydration. *[2 marks]*

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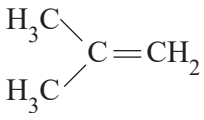
QUESTION 4 (10 marks)

Consider the organic molecule shown.



a) Identify the molecule as saturated or unsaturated. *[1 mark]*

b) Apply IUPAC rules to name this molecule. *[1 mark]*

c) Write an equation to show the products formed by the hydration of this molecule. *[2 marks]*

d) Predict which is the major product formed in c). *[1 mark]*

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e) Identify a physical property and experimental technique that could be used to separate products formed by hydration in c). Explain your reasoning. *[5 marks]*

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QUESTION 5 (17 marks)

Compound A reacts with water to produce compound B and hydroxide ions.

$$\underset{\text{A}}{CH_3CH_2NH_2(aq)} + H_2O(l) \rightleftharpoons \underset{\text{B}}{C_2H_5NH_3^+(aq)} + OH^-(aq)$$

a) Apply IUPAC rules to name compound A. *[1 mark]*

b) Identify the Brønsted-Lowry acids in the equation. *[2 marks]*

c) A small amount of hydrochloric acid is added to the equilibrium mixture. Predict the effect of this on the concentration of compound A in the mixture. Explain your reasoning. *[3 marks]*

d) Calculate the pH of a 2.0 M solution of compound A. State any assumptions. Show your working. ($K_b = 5.6 \times 10^{-4}$) *[6 marks]*

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pH = _____ (to one decimal place)

e) Describe, using a balanced chemical equation, how Compound A could be made from bromomethane. Include relevant conditions and reagents in your response. *[5 marks]*

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ADDITIONAL PAGE FOR STUDENT RESPONSES

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