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Book

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books used

External assessment 2024

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 (52 marks)

- 8 short response questions



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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 (3 marks)

A 30.00 mL aliquot of aqueous hydrochloric acid (HCl) with a pH of 2.00 was diluted with 2970.00 mL of water to make up a final volume of 3.00 L of aqueous HCl solution.

- a) Determine the concentration of hydrogen ions in the original 30.00 mL aliquot of HCl(aq). *[1 mark]*

- b) Calculate the pH of the final 3.00 L solution of HCl(aq). Show your working. *[2 marks]*

Do not write outside this box.

QUESTION 2 (6 marks)

Phenol red (HIn) is a weak acid that acts as an indicator as shown.



- a) Identify the conjugate base of phenol red. *[1 mark]*

- b) Determine the dissociation constant (K_a) of phenol red. *[1 mark]*

- c) Explain the relationship between the pH range of colour change for phenol red and its pK_a value. *[4 marks]*

Do not write outside this box.

QUESTION 3 (9 marks)

The concentration, pH and dissociation constant (K_a) of aqueous solutions of ethanoic acid and two unknown monoprotic acids, I and II, are shown.

| Acid | Concentration (M) | pH | K_a |
|--------------------------|-------------------|-----|----------------------|
| CH ₃ COOH(aq) | 0.2 | | 1.8×10^{-5} |
| I | 0.2 | 1.9 | 6.6×10^{-4} |
| II | 0.1 | 1.1 | 1.3×10^6 |

- a) Compare the relative strength of an aqueous solution of acid I and CH₃COOH(aq). [3 marks]

Similarity: _____

Difference: _____

Significance: _____

Do not write outside this box.

b) Determine whether an aqueous solution of acid I or acid II would have a higher electrical conductivity. Explain your reasoning.

[3 marks]

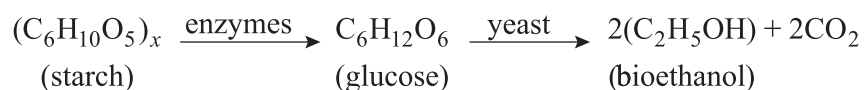
c) Calculate the pH of 0.2 M $\text{CH}_3\text{COOH}(\text{aq})$. Show your working.

[3 marks]

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QUESTION 4 (11 marks)

Bioethanol can be synthesised from plants rich in starch. Amylose and amylopectin in the starch are converted to glucose, which then undergoes fermentation to produce ethanol.



- a) Explain the role of enzymes in converting the amylose and amylopectin in starch to glucose.

[2 marks]

- b) Describe the structure of amylose and amylopectin by completing the table.

[4 marks]

| | Amylose | Amylopectin |
|--------------------|---------|-------------|
| Monomer | | |
| Glycosidic linkage | | |
| Chain structure | | |
| Shape | | |

Note: If you make a mistake in the table, 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) Determine whether the fermentation of glucose to bioethanol is a redox reaction.
Explain your reasoning.

[3 marks]

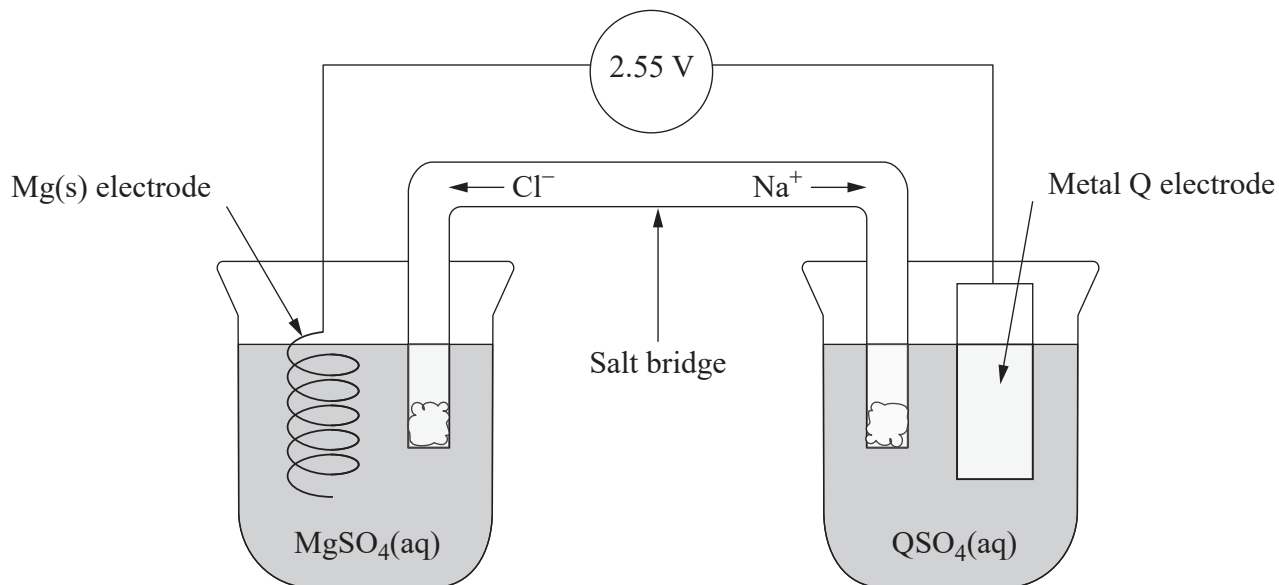
d) Calculate the atom economy for the fermentation of glucose to bioethanol.
Show your working.

[2 marks]

Do not write outside this box.

QUESTION 5 (8 marks)

The diagram shows a galvanic cell with a cell potential of 2.55 V under standard conditions.



a) Describe the movement of electrons in the galvanic cell.

[3 marks]

Do not write outside this box.

b) Determine the half-equation and standard electrode potential for the half-cell that contains metal Q. Include states in your half-equation.

[2 marks]

c) Identify one limitation associated with standard reduction potentials.

[1 mark]

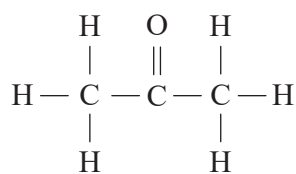
d) Determine whether metal Q is a stronger reducing agent than metallic copper (Cu). Explain your reasoning.

[2 marks]

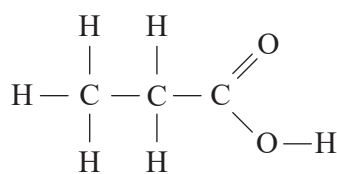
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QUESTION 6 (9 marks)

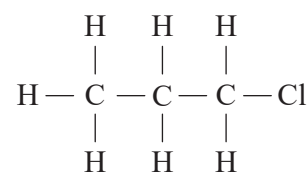
Six molecules were selected to investigate functional groups and the arrangement of atoms.



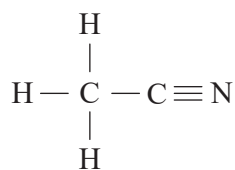
Molecule 1



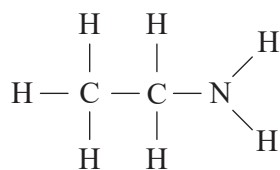
Molecule 2



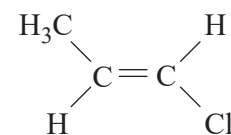
Molecule 3



Molecule 4



Molecule 5



Molecule 6

- a) Identify a molecule that contains a carbonyl functional group.

[1 mark]

- b) Identify a geometric isomer of molecule 6 and apply IUPAC rules to name the geometric isomer.

[1 mark]

IUPAC name: _____

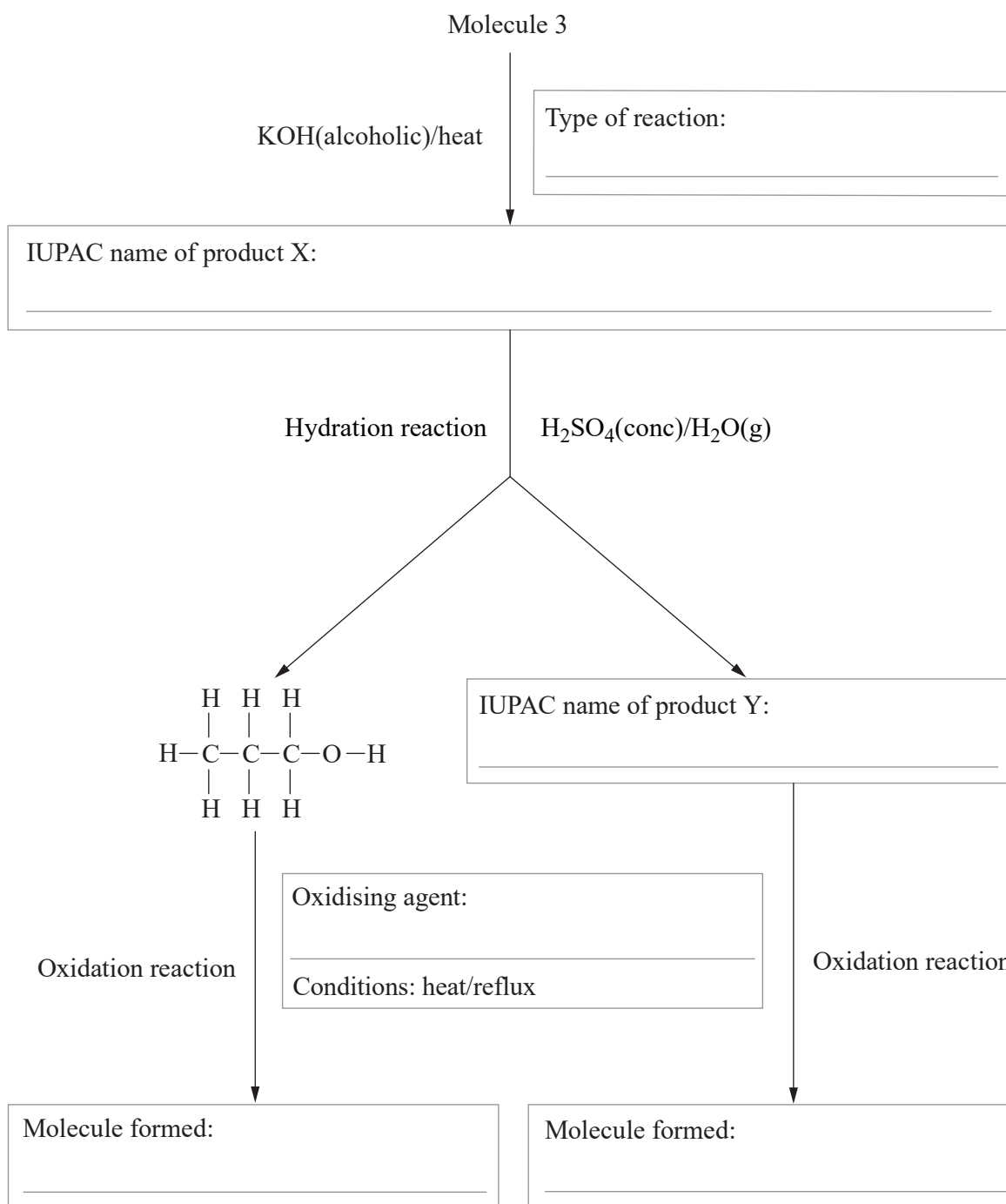
- c) Describe, using a balanced chemical equation, how molecule 4 can be converted to molecule 5. Include all relevant reagents.

[2 marks]

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d) Complete the diagram to explain how molecule 3 can be converted into molecule 1 and molecule 2.

[5 marks]

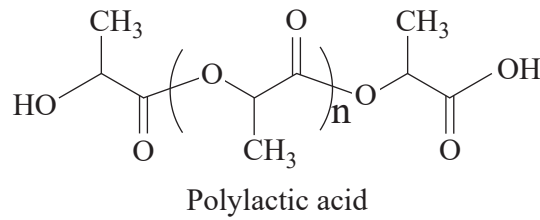


Note: If you make a mistake in the diagram, cancel it by ruling a single diagonal line through your work and use the additional response space at the back of this question and response book.

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QUESTION 7 (4 marks)

Polylactic acid (PLA) is a biodegradable plastic that can be decomposed by microorganisms into carbon dioxide (CO₂), water and biomass.



- a) Explain how the biodegradability of polylactic acid is related to its structure. [2 marks]

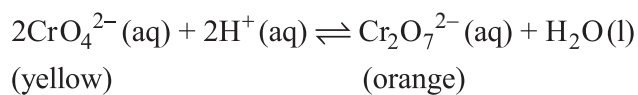
- b) Describe, using a diagram, the structural formula of lactic acid. [2 marks]

Note: If you make a mistake in the diagram, 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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QUESTION 8 (2 marks)

In the aqueous solution of a chromate salt, an equilibrium exists between the yellow chromate (CrO_4^{2-}) ions and the orange dichromate ($\text{Cr}_2\text{O}_7^{2-}$) ions. This equilibrium can be represented by the equation shown.



Explain, at an atomic level, why no colour change occurs once the chromate–dichromate solution has established equilibrium.

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ADDITIONAL PAGE FOR STUDENT RESPONSES

Write the question number you are responding to.

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ADDITIONAL PAGE FOR STUDENT RESPONSES

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ADDITIONAL RESPONSE SPACE FOR QUESTION 4b)

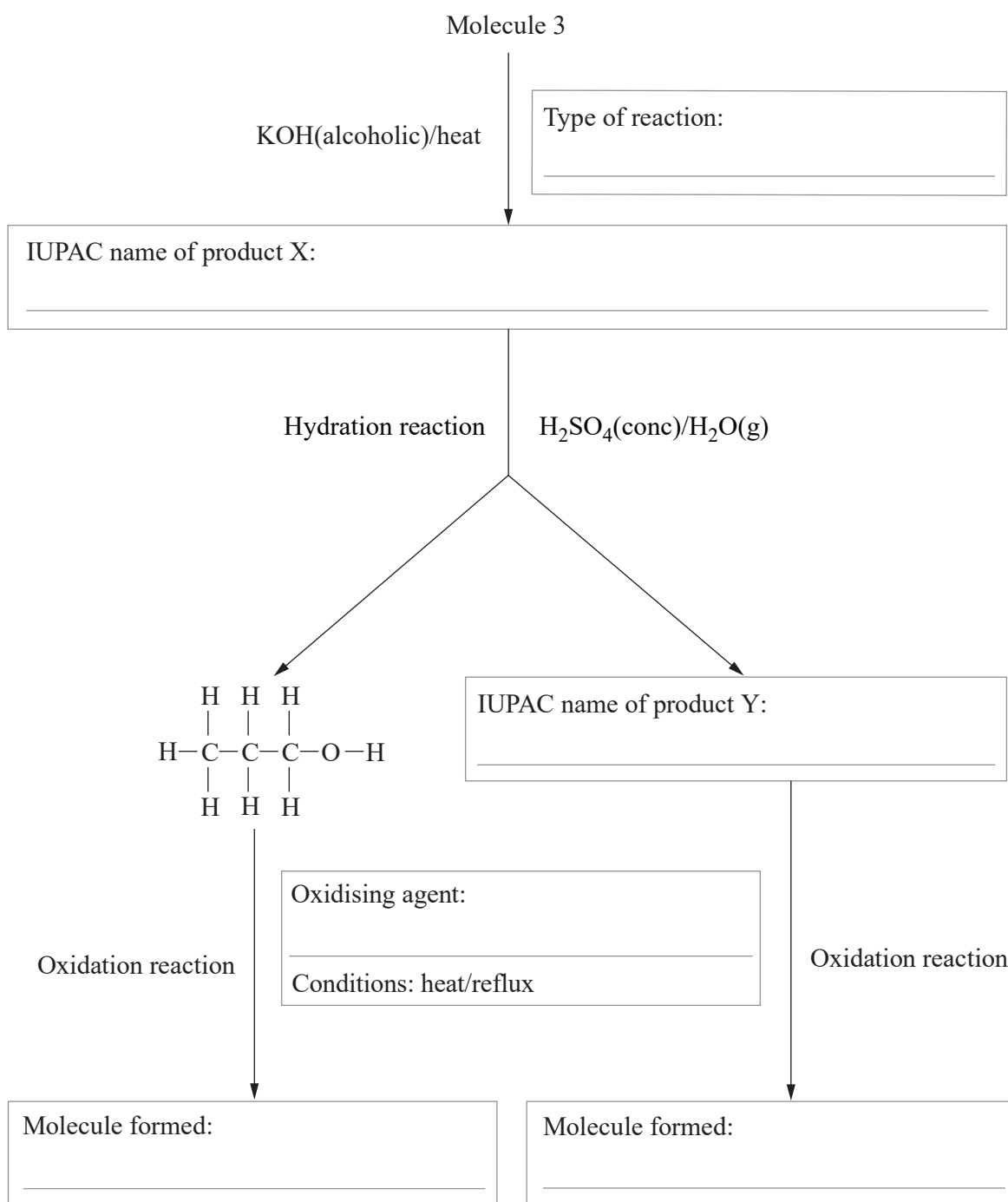
If you want this table to be marked, draw a single diagonal line through your original response.

| | Amylose | Amylopectin |
|---------------------------|----------------|--------------------|
| Monomer | | |
| Glycosidic linkage | | |
| Chain structure | | |
| Shape | | |

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ADDITIONAL RESPONSE SPACE FOR QUESTION 6d)

If you want this diagram to be marked, draw a single diagonal line through your original response.



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