

# 2018 VCE Chemistry Trial Examination



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# VICTORIAN CERTIFICATE OF EDUCATION

## Year 2018

STUDENT NUMBER

Letter

|         |  |  |
|---------|--|--|
| Figures |  |  |
| Words   |  |  |

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## CHEMISTRY

### Trial Written Examination

Reading time: 15 minutes

Writing time: 2 hours 30 minutes

### QUESTION AND ANSWER BOOK

#### Structure of book

| <i>Section</i> | <i>Number of questions</i> | <i>Number of questions to be answered</i> | <i>Number of marks</i> |
|----------------|----------------------------|-------------------------------------------|------------------------|
| A              | 30                         | 30                                        | 30                     |
| B              | 12                         | 12                                        | 90                     |
|                |                            |                                           | Total 120              |

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

#### Materials supplied

- Question and answer book of 38 pages.
- A data book
- Answer sheet for multiple-choice questions.

#### Instructions

- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- All written responses must be in English.

#### At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.
- You may keep the data book

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# VCE CHEMISTRY 2018

## Trial Written Examination

### MULTIPLE-CHOICE ANSWER SHEET

Student Name \_\_\_\_\_

Student Number \_\_\_\_\_

Signature \_\_\_\_\_

If your name or number on this sheet is incorrect, notify the Supervisor.

Use a **PENCIL** for **ALL** entries. For each question, shade the box that indicates your answer.

All answers must be completed like **THIS** example.

|   |                                     |   |   |
|---|-------------------------------------|---|---|
| A | <input checked="" type="checkbox"/> | C | D |
|---|-------------------------------------|---|---|

Marks will **NOT** be deducted for incorrect answers.

**NO MARK** will be given if more than **ONE** answer is completed for any question.

If you make a mistake, **ERASE** the incorrect answer. **DO NOT** cross it out.

#### ONE ANSWER PER LINE

#### ONE ANSWER PER LINE

|     |   |   |   |   |     |   |   |   |   |
|-----|---|---|---|---|-----|---|---|---|---|
| 1.  | A | B | C | D | 16. | A | B | C | D |
| 2.  | A | B | C | D | 17. | A | B | C | D |
| 3.  | A | B | C | D | 18. | A | B | C | D |
| 4.  | A | B | C | D | 19. | A | B | C | D |
| 5.  | A | B | C | D | 20. | A | B | C | D |
| 6.  | A | B | C | D | 21. | A | B | C | D |
| 7.  | A | B | C | D | 22. | A | B | C | D |
| 8.  | A | B | C | D | 23. | A | B | C | D |
| 9.  | A | B | C | D | 24. | A | B | C | D |
| 10. | A | B | C | D | 25. | A | B | C | D |
| 11. | A | B | C | D | 26. | A | B | C | D |
| 12. | A | B | C | D | 27. | A | B | C | D |
| 13. | A | B | C | D | 28. | A | B | C | D |
| 14. | A | B | C | D | 29. | A | B | C | D |
| 15. | A | B | C | D | 30. | A | B | C | D |

**SECTION A – Multiple-choice questions**

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** for the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

**Question 1**

In which one of the following sets of chromium-containing compounds do the chromium atoms all have the same oxidation number?

- A.  $\text{Cr}_2\text{O}_3$   $\text{K}_2\text{Cr}_2\text{O}_7$   $\text{Na}_2\text{CrO}_4$
- B.  $\text{CrCl}_2$   $\text{Cr}_2\text{O}_3$   $\text{K}_2\text{Cr}_2\text{O}_7$
- C.  $\text{Na}_2\text{CrO}_4$   $\text{CrO}_3$   $\text{Cr}(\text{NO}_3)_3$
- D.  $\text{Cr}_2\text{O}_3$   $\text{CrCl}_3$   $\text{Cr}(\text{NO}_3)_3$

**Question 2**

Which statement about petrodiesel and biodiesel is correct?

- A. Petrodiesel is produced by distilling crude oil; biodiesel is produced by esterification of fatty acids.
- B. Petrodiesel emits soot (small carbon particles) when burning is incomplete; biodiesel is pollutant-free.
- C. Petrodiesel consists of long-chain hydrocarbons; biodiesel contains benzene and its derivatives.
- D. Petrodiesel has greater viscosity and hence flows more slowly along fuel lines than biodiesel.

**Question 3**

Justyna performs her tests in flasks that are placed in a water bath to keep the flasks and their contents at a constant temperature of 37° C.

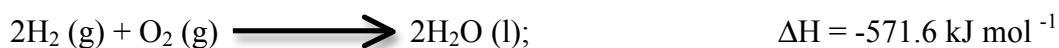
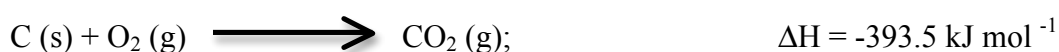
Under these conditions, the temperature at which the experiment is conducted is referred to as the

- A. control.
- B. dependent variable.
- C. independent variable.
- D. controlled variable.

**Question 4**

Which one of the following molecules contains a chiral carbon?

|    | Name               | Semi-structural formula                                            |
|----|--------------------|--------------------------------------------------------------------|
| A. | 2-chlorobutane     | CH <sub>3</sub> CHClCH <sub>2</sub> CH <sub>3</sub>                |
| B. | 2-methylbut-1-ene  | CH <sub>2</sub> C(CH <sub>3</sub> )CH <sub>2</sub> CH <sub>3</sub> |
| C. | Propanoic acid     | CH <sub>3</sub> CH <sub>2</sub> COOH                               |
| D. | 1,2-dichloroethene | ClCHCHCl                                                           |

**Question 5**

From the information supplied, the enthalpy change for the reaction above is

- A. -965.1 kJ mol<sup>-1</sup>
- B. -107.7 kJ mol<sup>-1</sup>
- C. +178.1 kJ mol<sup>-1</sup>
- D. +679.3 kJ mol<sup>-1</sup>

**Question 6**

Which one of the following energy sources provides the highest quantity of energy per gram of fuel?

- A. Coal
- B. Natural gas
- C. Nuclear fission
- D. Biochemical fuels

**Question 7**

Use the information in the table below to answer this question.

| Conjugate redox pair         | $E^\theta$ |
|------------------------------|------------|
| $\text{Ag}^+ / \text{Ag}$    | + 0.80     |
| $\text{Cu}^{2+} / \text{Cu}$ | + 0.34     |
| $\text{F}_2 / \text{F}^-$    | +2.87      |
| $\text{Br}_2 / \text{Br}^-$  | + 1.09     |
| $\text{Zn}^{2+} / \text{Zn}$ | -0.76      |
| $\text{Mg}^{2+} / \text{Mg}$ | -2.37      |

What is the correct order from strongest oxidant to weakest oxidant?

- A.  $\text{Ag}^+$ , Cu,  $\text{Br}_2$ ,  $\text{F}_2$ ,  $\text{Zn}^{2+}$ , Mg
- B.  $\text{Mg}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Ag}^+$ ,  $\text{Br}_2$ ,  $\text{F}_2$
- C.  $\text{F}_2$ ,  $\text{Br}_2$ ,  $\text{Ag}^+$ ,  $\text{Cu}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mg}^{2+}$
- D. Mg, Zn,  $\text{Ag}^+$ ,  $\text{Br}^-$ ,  $\text{F}^-$ , Cu

**Question 8**

Which one of the following best describes the anode in a galvanic cell?

- |    | Polarity | Electrode reaction |
|----|----------|--------------------|
| A. | positive | oxidation          |
| B. | positive | reduction          |
| C. | negative | oxidation          |
| D. | negative | reduction          |

**Question 9**

A reaction that might occur at the **cathode** of a fuel cell using hydrogen and oxygen as reactants is

- A.  $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$
- B.  $\text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g}) + 4\text{e}^- \rightarrow 4\text{OH}^-(\text{aq})$
- C.  $\text{H}_2(\text{g}) \rightarrow 2\text{H}^+(\text{aq}) + 2\text{e}^-$
- D.  $\text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{g}) + 2\text{e}^-$

**Question 10**

The types of bonding present in the tertiary structure of a protein are

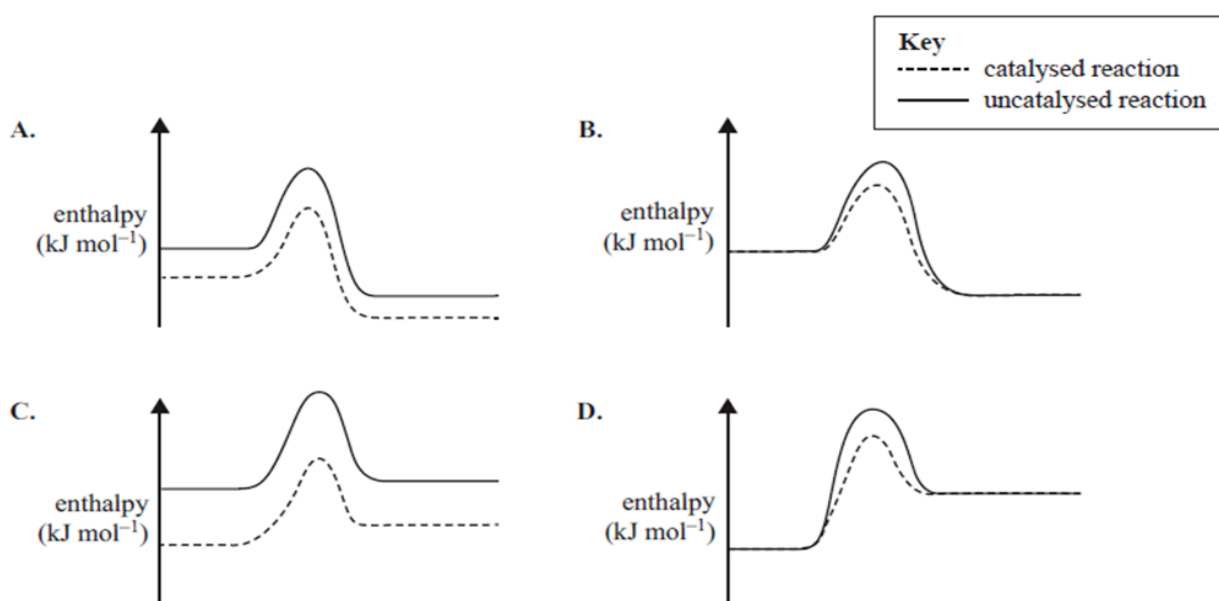
- A. covalent bonding, ionic bonding, hydrogen bonding
- B. covalent bonding, ionic bonding, dispersion forces
- C. covalent bonding, ionic bonding, hydrogen bonding, dispersion forces
- D. ionic bonding, hydrogen bonding, dispersion forces

**Question 11**

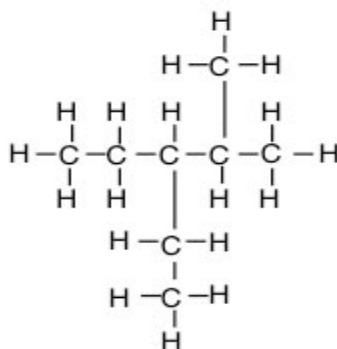
The oxidation of sulfur dioxide to form sulfur trioxide is shown in the equation below. It is an exothermic reaction. The reaction is catalysed by vanadium (V) oxide.



Which one of the following energy profile diagrams correctly represents both the catalysed and the uncatalysed reactions?



Use the following structure to answer Questions 12 and 13



### Question 12

What is the correct IUPAC systematic name for this compound?

- A. 2,3-dimethylheptane
- B. 3,4-dimethylheptane
- C. 4-methyl-5-ethylhexane
- D. 2-methyl-3-ethylpentane

### Question 13

How many structural isomers does this compound have?

- A. 2
- B. 3
- C. 4
- D. more than 4

**Question 14**

To prepare the ester propyl methanoate, the two reagents needed are

- A. propan-1-ol and methanol.
- B. propan-1-ol and methanoic acid.
- C. methanol and propanoic acid.
- D. propanoic acid and methanoic acid.

**Question 15**

What are the three main materials required for the manufacture of a biodiesel fuel?

- A. petrol, an alkanol and an alkali solution
- B. tallow, an alkanol and an acidic solution
- C. a source of natural oil, an ester and an alkali solution
- D. tallow, an alkanol and an alkali solution

**Question 16**

Which one of the following molecules is **not** a primary amide?

- A.  $\text{HCONH}_2$
- B.  $\text{C}_6\text{H}_5\text{CONH}_2$
- C.  $\text{CH}_3\text{CONH}_2$
- D.  $\text{C}_6\text{H}_5\text{CONHCH}_3$

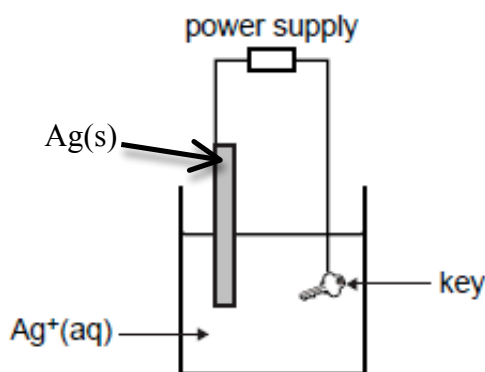
**Question 17**

The technique of proton nuclear magnetic resonance ( $^1\text{H}$  NMR) gives physical, chemical and structural information about a molecule. The principle behind  $^1\text{H}$  NMR is

- A. the absorption of infrared radiation.
- B. the chemical shift, on the resonant frequencies of the nuclei present, as a result of nuclear spin.
- C. carbon-13 nuclear magnetic resonance.
- D. measuring the amount of light that the sample absorbs.

**Question 18**

A student decided to silver-plate a locker key using the apparatus shown.



In this cell, the key is the

- A. cathode and is connected to the positive terminal of the power supply.
- B. cathode and is connected to the negative terminal of the power supply.
- C. anode and is connected to the positive terminal of the power supply.
- D. anode and is connected to the negative terminal of the power supply.

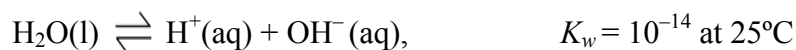
**Question 19**

Ethanoic acid reacts with ethanol to produce ethyl ethanoate and water. The equilibrium constant for this reaction with dioxane as a solvent is 4.0 at a fixed temperature. An equilibrium mixture at this temperature is created with  $[\text{CH}_3\text{COOH}] = [\text{C}_2\text{H}_5\text{OH}] = 0.40 \text{ M}$  and  $[\text{H}_2\text{O}] = 1.50 \text{ M}$  in enough dioxane to make 1.0 L of solution. What is the equilibrium concentration of ethyl ethanoate?

- A. 0.43 M
- B. 0.64 M
- C. 0.96 M
- D. 1.50 M

**Question 20**

For the reaction



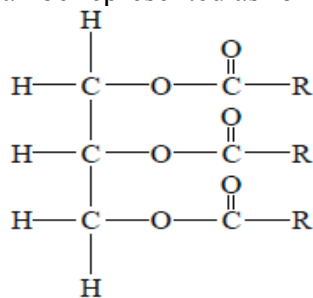
55.9 kJ mol<sup>-1</sup> of heat is evolved when one mole of H<sup>+</sup>(aq) reacts with one mole of OH<sup>-</sup>(aq).

At 80°C, the  $K_w$  and pH for pure water are

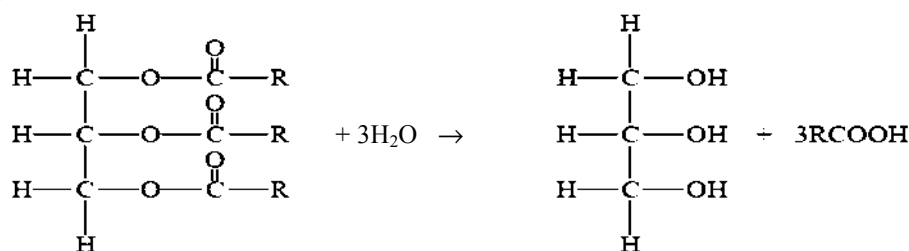
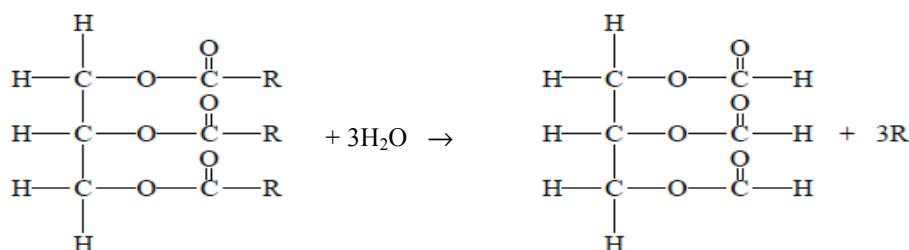
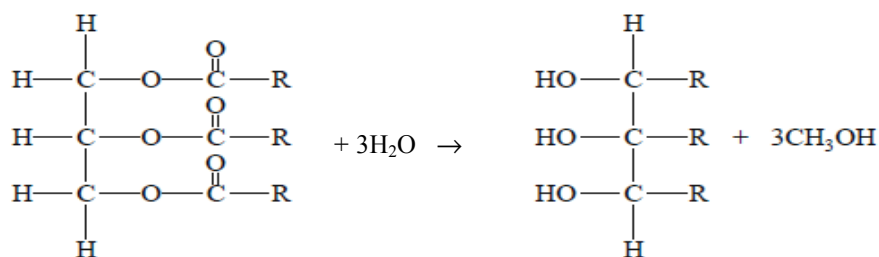
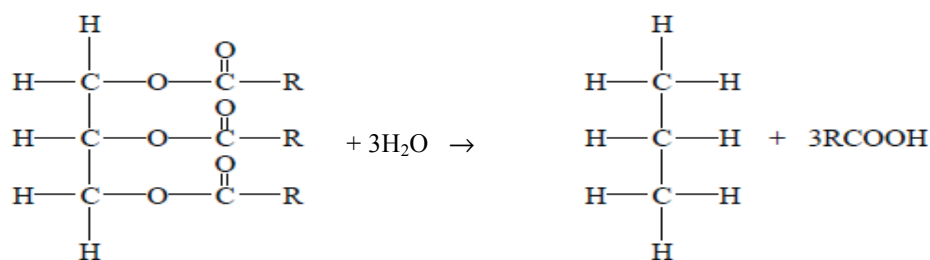
|    | $K_w$                   | pH             |
|----|-------------------------|----------------|
| A. | greater than $10^{-14}$ | less than 7    |
| B. | greater than $10^{-14}$ | greater than 7 |
| C. | less than $10^{-14}$    | less than 7    |
| D. | less than $10^{-14}$    | greater than 7 |

**Question 21**

The general formula of a triglyceride can be represented as follows.



Which one of the following equations represents the hydrolysis of a triglyceride?

**A.****B.****C.****D.**

**Question 22**

When but-1-ene undergoes an addition reaction with chlorine gas,  $\text{Cl}_2$ , the molecular formula of the product is  $\text{C}_4\text{H}_8\text{Cl}_2$ . The semi-structural formula of this product is

- A.  $\text{CH}_3\text{CHClCH}_2\text{ClCH}_3$   
 B.  $\text{CH}_3\text{CCl}_2\text{CH}_2\text{CH}_3$   
 C.  $\text{CH}_2\text{ClCHClCH}_2\text{CH}_3$   
 D.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHCl}_2$

**Question 23**

Four half cells are constructed as follows.

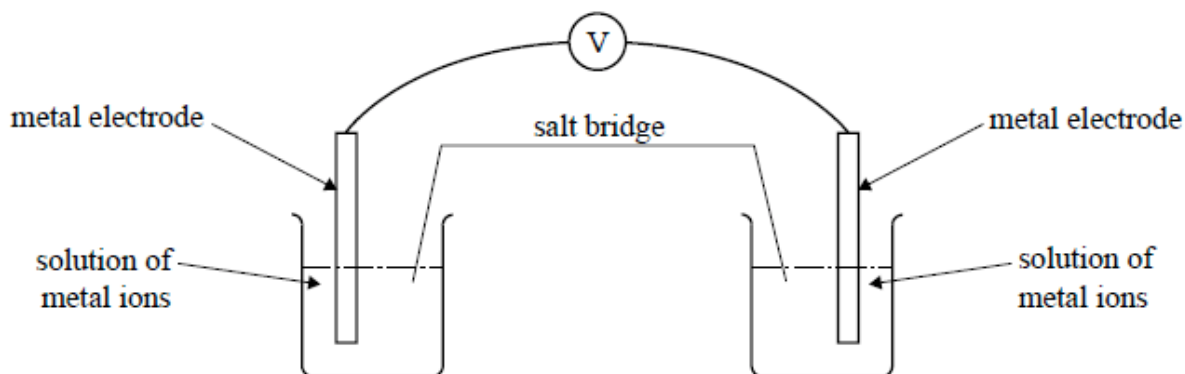
Half cell I: an electrode of metal P in a 1.0 M solution of  $\text{P}^+(\text{aq})$  ions

Half cell II: an electrode of metal Q in a 1.0 M solution of  $\text{Q}^+(\text{aq})$  ions

Half cell III: an electrode of metal R in a 1.0 M solution of  $\text{R}^+(\text{aq})$  ions

Half cell IV: an electrode of  $\text{Cu(s)}$  metal in a 1.0 M solution of  $\text{Cu}^{2+}(\text{aq})$  ions

The half cells are connected in pairs, as shown below, to form a series of galvanic cells.



For each cell, the polarity of the electrodes and the voltage generated are recorded.

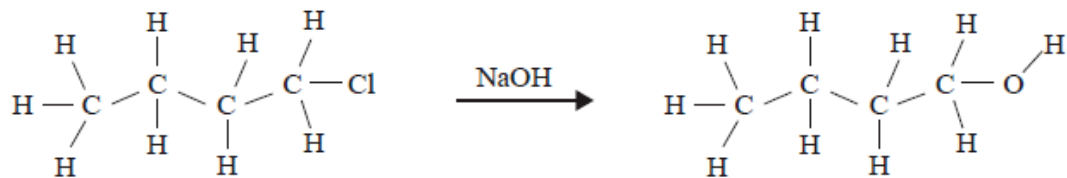
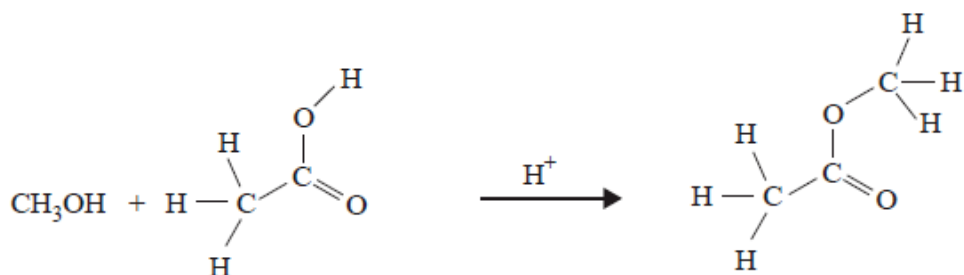
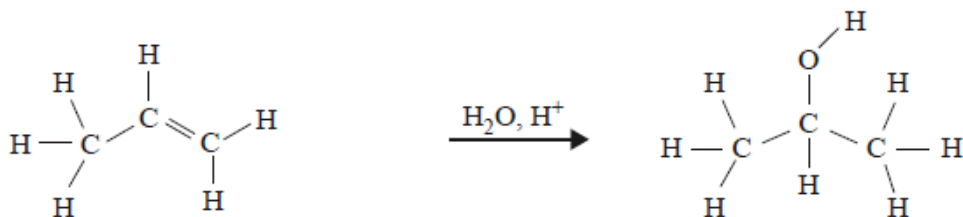
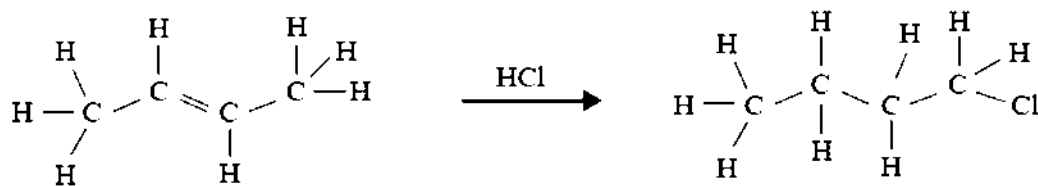
| Half cells used | Positive electrode | Negative electrode | Voltage (V) |
|-----------------|--------------------|--------------------|-------------|
| I and IV        | P                  | Cu                 | 0.46        |
| II and IV       | Cu                 | Q                  | 0.57        |
| III and IV      | Cu                 | R                  | 1.10        |
| II and III      | Q                  | R                  | 0.53        |

Which one of the following lists the metals in order of increasing strength as reductants?

- A. R, Q, Cu, P  
 B. Cu, P, Q, R  
 C. P, Cu, R, Q  
 D. P, Cu, Q, R

**Question 24**

Which one of the following organic reactions does **not** result in the product shown on the right-hand side of the reaction?

**A.****B.****C.****D.**

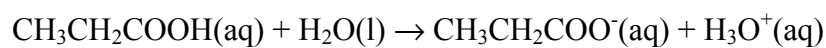
**Question 25**

In the low resolution  $^1\text{H}$  NMR spectrum for ethyl ethanoate, the number of spectral lines is

- A. 1
- B. 2
- C. 3
- D. 4

**Question 26**

Consider the following hydrolysis reaction.



If a 0.184 M solution has a pH of 2.80, the acidity constant of propanoic acid is

- A.  $1.37 \times 10^{-5}$
- B.  $10^{-2.8}$
- C.  $1 \times 10^{-9}$
- D. 2.8

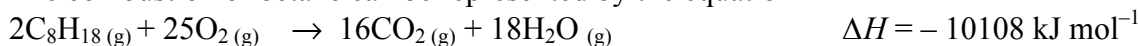
**Question 27**

Tristearin is a saturated fat found in beef. The heat of combustion of tristearin,  $(\text{CH}_3(\text{CH}_2)_{16}\text{COO})_3\text{C}_3\text{H}_5$ , is  $38 \text{ kJ g}^{-1}$ . The amount of energy released by the combustion of 1 mole is

- A. 890 MJ.
- B. 33.8 MJ.
- C. 3.38 MJ.
- D. 46.5 MJ.

**Question 28**

The combustion of octane can be represented by the equation



The energy produced by the complete oxidation of 45 kg of octane is

- A.  $2.0 \times 10^3 \text{ kJ}$ .
- B.  $4.0 \times 10^3 \text{ kJ}$ .
- C.  $2.0 \times 10^6 \text{ kJ}$ .
- D.  $4.0 \times 10^6 \text{ kJ}$ .

**Question 29**

Choose the clause that correctly completes the following sentence.

The dissolving of potassium nitrate in water is an endothermic process in which

\_\_\_\_\_.

- A. the temperature of the solution increases as the potassium nitrate dissolves.
- B. the molar heat of solution of potassium nitrate is positive.
- C. the molar heat of solution of potassium nitrate is negative.
- D.  $\Delta H$  is negative for dissolving potassium nitrate.

**Question 30**

The general formula for a saturated fatty acid is

- A.  $C_nH_{2n}O_2$
- B.  $C_nH_{2n-1}COOH$
- C.  $C_nH_{2n}COOH$
- D.  $C_nH_{2n+2}COOH$

**END OF SECTION A**

**Instructions for Section B**

Answer all questions in the spaces provided.

To obtain full marks for your responses you should

- give simplified answers with an appropriate number of significant figures for all numerical questions; unsimplified answers will not be given full marks.
- show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure all chemical equations are balanced and that the formulas for individual substances include an indication of state; for example,  $\text{H}_2(\text{g})$ ;  $\text{NaCl}(\text{s})$

**Question 1 (8 marks)**

a. Draw a diagram of each level of a protein structure. Briefly describe each structure.

i. Primary structure:



1 mark

ii. Secondary structure:



1 mark

**Question 1 (continued)**

iii. Tertiary structure:



1 mark

iv. Quaternary structure:



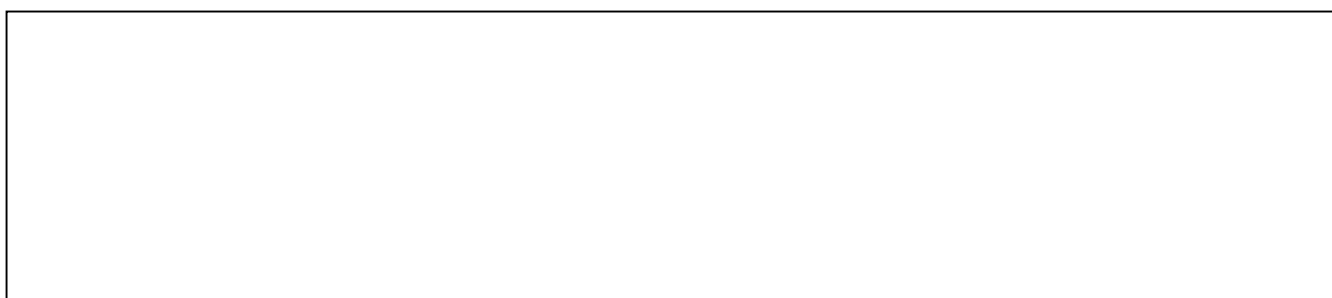
1 mark

b. What kind of a reaction is responsible for the formation of a polypeptide?

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1 mark

c. Use structural formulae to show the reaction between alanine and glycine to form a dipeptide.



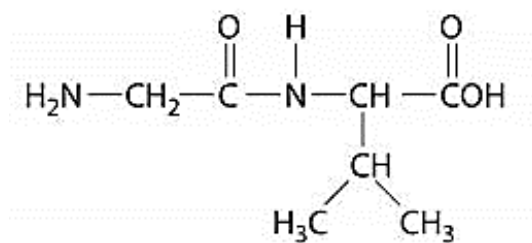
1 mark

**Question 1 (continued)**

- d. Circle the peptide bond in the product of the reaction in c.

1 mark

- e. What is the name of the following polypeptide?



1 mark

**Question 2 (13 marks)**

You have learned in the course of year twelve chemistry that amino acids differ by the nature of their side chains (Z group).

- a. What is a Zwitterion group?

1 mark

- b. Give an example of each of the following amino acids:

|      |                                             |  |
|------|---------------------------------------------|--|
| i.   | An amino acid with a polar side chain       |  |
| ii.  | An amino acid with a non-polar side chain   |  |
| iii. | An amino acid that has an acidic side chain |  |
| iv.  | A cyclic amino acid                         |  |
| v.   | An amino acid with a basic side chain       |  |

3 marks

- c. What is the difference between an omega-3 fatty acid and an omega-6 fatty acid?

1 mark

**Question 2 (continued)**

**d.** Describe the bonding between carbon atoms in the hydrocarbon tails of the following fatty acids.

**i.** Saturated fatty acids

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1 mark

**ii.** Monounsaturated fatty acids

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1 mark

**iii.** Polyunsaturated fatty acids

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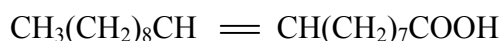
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1 mark

**e.** This is the structure of oleic acid.



**i.** Explain how a triglyceride will be made from oleic acid. Will the triglyceride that forms from oleic acid be a saturated or unsaturated fatty acid? Justify your answer.

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2 marks

**Question 2 e. (continued)**

- ii. Draw a diagram to show the formation of a triglyceride.



2 marks

- iii. Name and circle the functional groups in the triglyceride molecule above.

1 mark

**Question 3 (6 marks)**

CO<sub>2</sub> is added to 1.00 L of pure water at 25°C in a pressurised bottle. The pressure of CO<sub>2</sub> above the water was raised to 3.00 atm and the gaseous CO<sub>2</sub> came to equilibrium with the CO<sub>2</sub> dissolved in the water. At equilibrium, the mass of CO<sub>2</sub> dissolved in the water was 5.00 g.

The equilibrium constant for this reaction, in atm M<sup>-1</sup>, can be written as

$$K = \frac{p(\text{CO}_2, g)}{[\text{CO}_2(aq)]}$$

Where,  $p(\text{CO}_2)$  represents the pressure of CO<sub>2</sub>.

- a. Calculate the value of this equilibrium constant at 25°C.

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2 marks

**Question 3 (continued)**

- b. 500 mL of this aqueous solution of CO<sub>2</sub> is heated to 30°C and then opened to the atmosphere so that all the CO<sub>2</sub> in the aqueous solution goes into the gas phase. Calculate, in litre, the volume of CO<sub>2</sub> that would be evolved at 1.00 atm pressure and 30°C.

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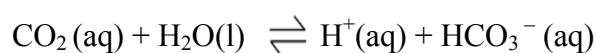
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2 marks

- c. Dissolved CO<sub>2</sub> acts as a weak acid in water according to the following equation,



and the acidity constant of CO<sub>2</sub> in water at 25°C is given by

$$K_a = \frac{[\text{H}^+][\text{HCO}_3^-]}{[\text{CO}_2]} = 4.5 \times 10^{-7} \text{ M}$$

Some CO<sub>2</sub> is added to a solution of NaHCO<sub>3</sub> at 25°C. In the solution, the concentration of the hydrogen carbonate ions (HCO<sub>3</sub><sup>-</sup>) is 0.050 M and the CO<sub>2</sub> concentration is 0.0020 M.

Calculate the pH of the solution.

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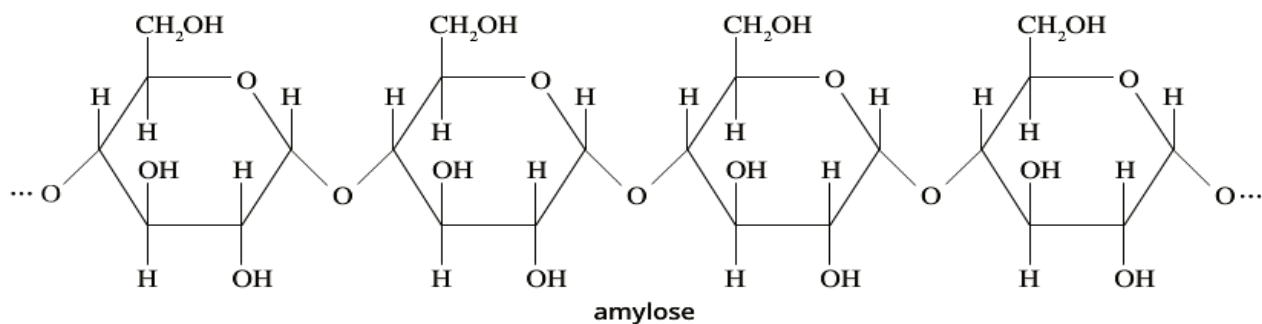
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2 marks

**Question 4 (5 marks)**

Below is part of the starch known as amylose.

- a. Circle and label the glycosidic link in the structure.



1 mark

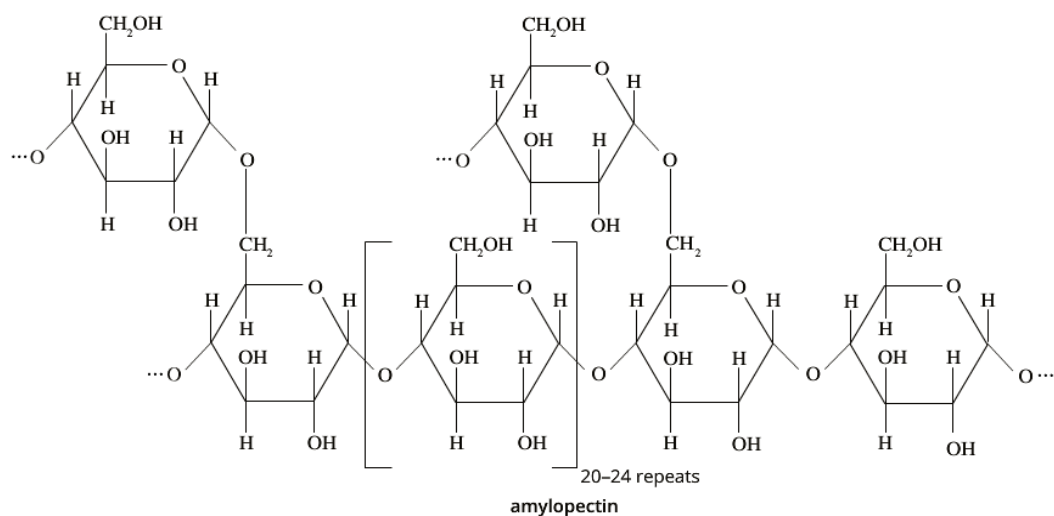
- b. Amylose is a straight chain polymer. Draw the structure of monomer that forms amylose.



1 mark

**Question 4 (continued)**

Amylopectin is a branched polymer with branches located alongside the chain of glucose units.



- c. Explain why amylose and amylopectin have different solubilities in water.

1 mark

- d. Although starch, glycogen and cellulose are all carbohydrates that contain glucose monomers, the human digestive system can digest only glycogen and starch and not cellulose. Explain.

1 mark

**Question 4 (continued)**

- e. Explain what causes lactose intolerance in some people.

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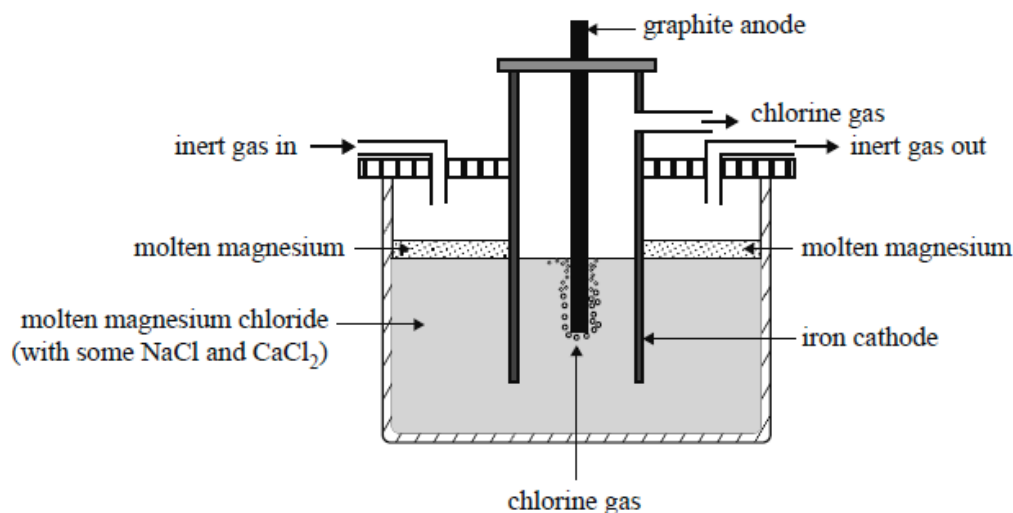
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1 mark

**Question 5 (6 marks)**

Magnesium is used in the production of magnesium-aluminium alloys. It is produced by the electrolysis of molten magnesium chloride. A schematic diagram of the electrolytic cell is shown below.



- a. Write a balanced half-equation for the reaction occurring at each of

- i. the cathode:

- ii. the anode:

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2 marks

**Question 5 (continued)**

- b.** In this cell, NaCl and CaCl<sub>2</sub> are used to lower the melting point of MgCl<sub>2</sub>. Explain why NaCl and CaCl<sub>2</sub> can be used to lower the melting point of MgCl<sub>2</sub> but ZnCl<sub>2</sub> cannot be used?

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2 marks

- c.** Explain what would happen if the graphite anode were replaced with an iron anode? Write the half-equation for the half-cell reaction. Explain your answer.

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2 marks

**Question 6 (7 marks)**

Consider the following reaction:  $\text{CO}_{(g)} + 2\text{H}_{2(g)} \rightleftharpoons \text{CH}_3\text{OH}_{(g)}$   $\Delta H = -103 \text{ kJ mol}^{-1}$

- a. Write the equilibrium expression for the above reaction.

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1 mark

- b. What pressure condition would be required to obtain a high equilibrium yield of methanol?  
Explain your answer.

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1 mark

- c. Would temperature condition would be required to obtain a high equilibrium yield of methanol?  
Explain your answer.

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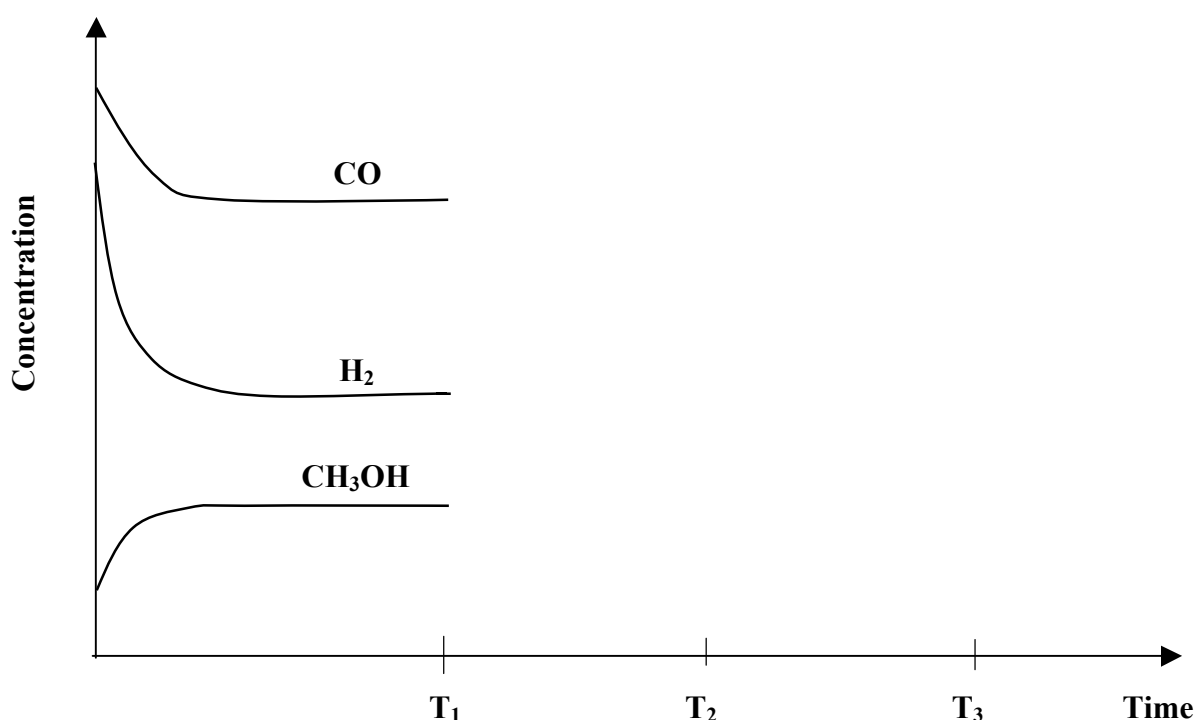
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1 mark

**Question 6 (continued)**

- d. Complete the graph below to show what would happen if the **temperature** of the system was increased at  $T_1$ .  
1 mark
- e. Complete the graph below to show what would happen if the **pressure** of the system was increased at  $T_2$ .  
1 mark
- f. Would the graph from  $T_1$  to  $T_3$  have looked **exactly** the same if a catalyst had been added at  $T_1$ ? Give a reason for your answer  
1 mark



- g. Calculate the equilibrium constant  $K$  at  $T_1$ , given the concentration of species were:

$$[\text{CO}] = 0.5 \text{ M}, [\text{H}_2] = 0.3 \text{ M}, [\text{CH}_3\text{OH}] = 0.2 \text{ M}$$

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1 mark

**Question 7 (12 marks)**

Some alkenes exist as *cis-trans* isomers.

- a. What is meant by a *cis-trans* isomer?

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2 marks

- b. Draw the *cis-trans* isomers for each compound.

- i. 1,2-dichloroethene

2 marks

- ii. 1,2-dimethylcyclopropane

2 marks

**Question 7 (continued)**

- c. Which of the following compounds exist as *cis-trans* isomers? Write **YES** or **NO** and name each compound.

i.  $\text{CH}_2 = \text{CBrCH}_3$  \_\_\_\_\_

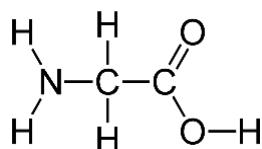
ii.  $\text{CH}_3\text{CH} = \text{CHCH}_2\text{CH}_3$  \_\_\_\_\_

iii.  $\text{CHCl} = \text{CHBr}$  \_\_\_\_\_

3 × 1 = 3 marks

d.

- i. Draw a section of the polymer formed from this monomer.



1 mark

- ii. Draw the structure of the dipeptide formed from the amino acids glycine and valine.

1 mark

- iii. What type of polymerisation reaction are i and ii?

\_\_\_\_\_

1 mark

**Question 8 (10 marks)**

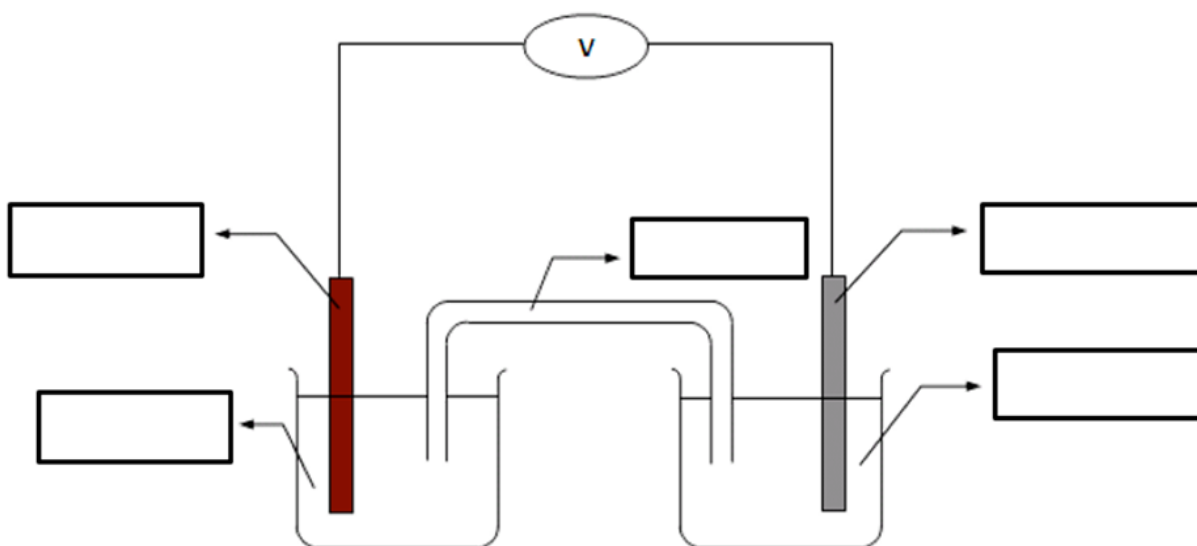
The following is a simple diagram of a galvanic cell.

Use the following chemicals to design your galvanic cell.



a. On the diagram of galvanic cell below, label the following:

- i. The anode and the cathode and the charges on each
- ii. The reduction half-cell side and the oxidation half-cell side
- iii. Direction of electron flow
- iv. The salt bridge electrolyte
- v. The direction of movement of ions in the salt bridge
- vi. The electrolytes formed in each of the two half-cells



Overall galvanic cell equation: \_\_\_\_\_

$(6 \times \frac{1}{2} = 3 \text{ marks})$

b. Write the half-equations for the oxidation reaction and the reduction reaction underneath each corresponding half of the cell.

$(2 \times 1 = 2 \text{ marks})$

c. Write the net cell equation for the reaction underneath the cell

1 mark

**Question 8 (continued)**

d. The reductant in this galvanic cell is \_\_\_\_\_

1 mark

e. The oxidant in this galvanic cell is \_\_\_\_\_

1 mark

f. Explain the purpose of having a salt bridge in galvanic cell.

1 mark

g. Calculate the theoretical voltage of the cell.

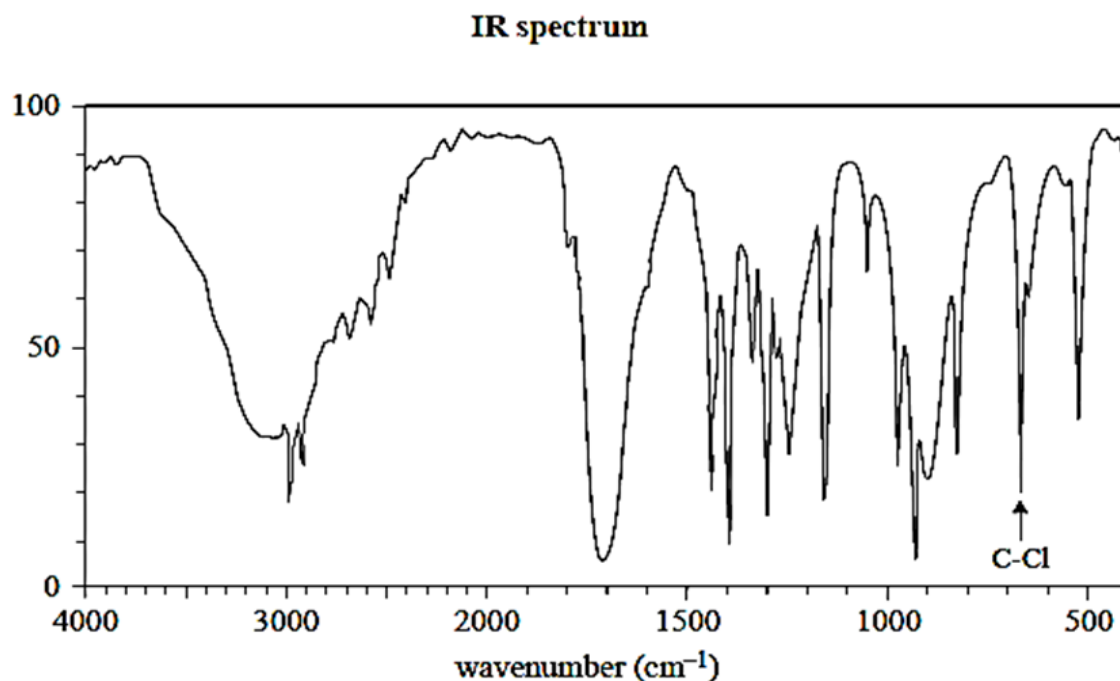
1 mark

**Question 9 (7 marks)**

A small organic molecule has the molecular formula  $C_xH_yO_2Cl$ .

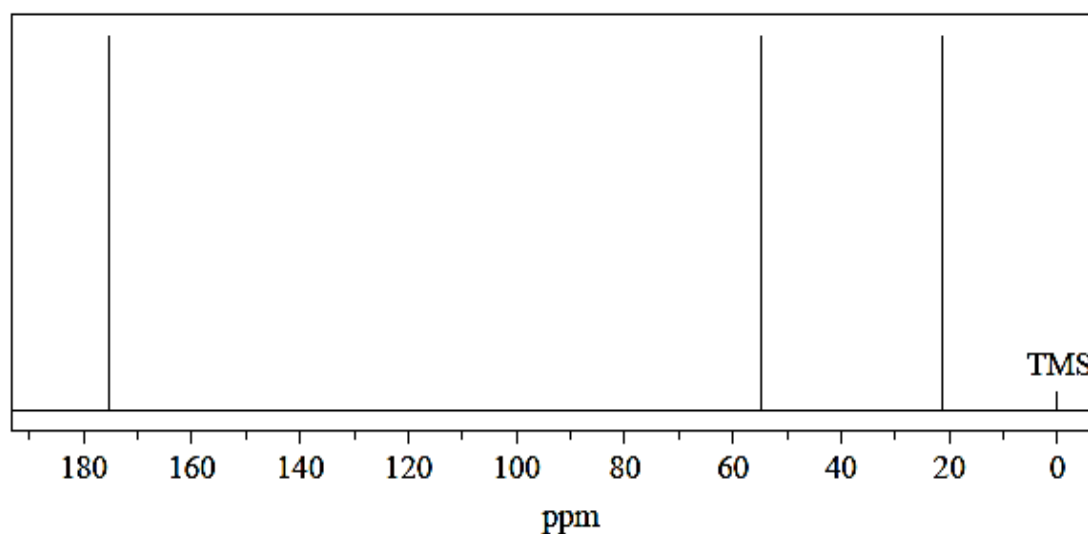
The pH of the molecule is 4.5.

The IR spectrum,  $^{13}C$  NMR,  $^1H$  NMR data and mass spectrum for this molecule are shown below.



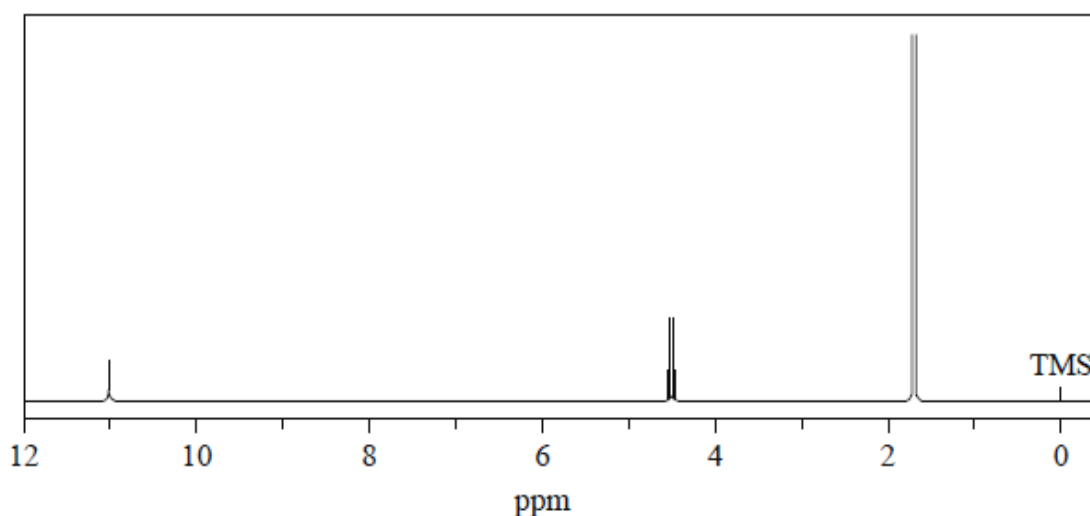
*Data: National Institute of Advanced Industrial Science and Technology*

**$^{13}C$  NMR Spectrum**



*Data: National Institute of Advanced Industrial Science and Technology*

## Question 9 (continued)

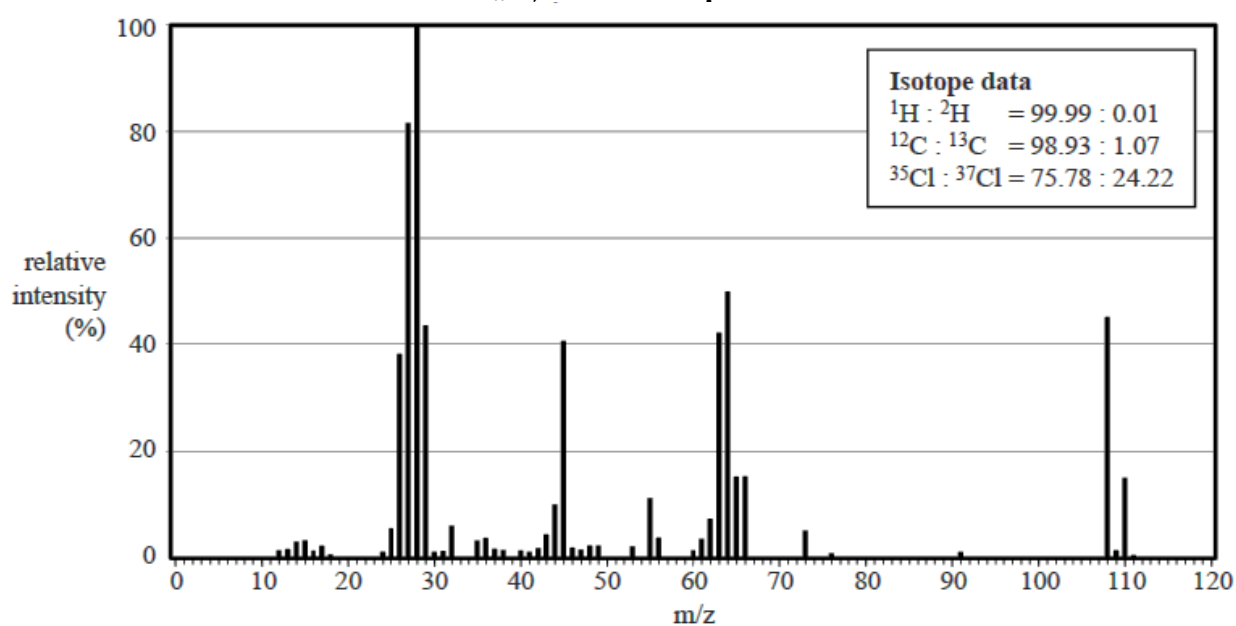
 $^1\text{H}$  NMR spectrum

Data: National Institute of Advanced Industrial Science and Technology

 $^1\text{H}$  NMR data

| Chemical shift (ppm) | Peak splitting    | Relative peak area |
|----------------------|-------------------|--------------------|
| 1.7                  | Doublet (2 peaks) | 3                  |
| 4.5                  | Quartet (4 peaks) | 1                  |
| 11.2                 | Singlet (1 peak)  | 1                  |

Data: National Institute of Advanced Industrial Science and Technology

 $\text{C}_x\text{H}_y\text{O}_2\text{Cl}$  mass spectrum

Data: National Institute of Advanced Industrial Science and Technology

**Question 9 (continued)**

- a. On the infrared spectrum, label the peaks that correspond to the presence of two functional groups in this compound.

2 marks

- b. What does the splitting pattern in the  $^1\text{H}$  NMR spectrum tell you about the structure of this compound?

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1 mark

- c. Use the data provided to determine the values of  $x$  and  $y$  in  $\text{C}_x\text{H}_y\text{O}_2\text{Cl}$ .

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 $x =$  \_\_\_\_\_  $y =$  \_\_\_\_\_

2 marks

- d. Draw the structural formula of this compound.

1 mark

**Question 9 (continued)**

- e. The mass spectrum is showing two molecular ion peaks at  $m/z = 108$  and  $110$ .  
What is the reason for this?

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1 mark

**Question 10 (6 marks)**

When ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ) undergoes complete combustion, it produces carbon dioxide and water.

- a. Write the balanced chemical equation for this reaction.

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1 mark

- b. Calculate the mass of carbon dioxide formed when 2.00 kg of ethanol undergoes combustion.

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1 mark

- c. Calculate the volume of carbon dioxide that would form from the combustion of 2.00 kg of ethanol at SLC?

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1 mark

**Question 10 (continued)**

- d. Calculate the mass of ethanol in 70.0 L.  
(the density of ethanol is  $0.785 \text{ g mL}^{-1}$ )

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1 mark

- e. Calculate the mass of  $\text{CO}_2$  formed in this reaction when 3.00 kJ of energy is released.

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1 mark

- f. Calculate the energy in MJ obtained from the combustion of 50.0 L of ethanol.  
(the density of ethanol is  $0.785 \text{ g mL}^{-1}$ )

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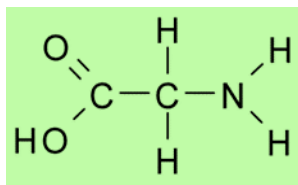
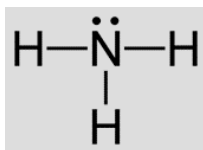
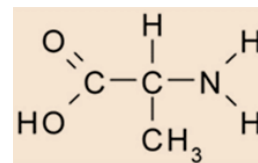
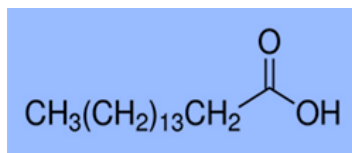
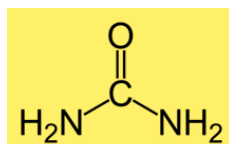
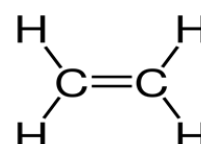
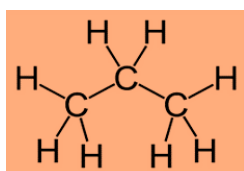
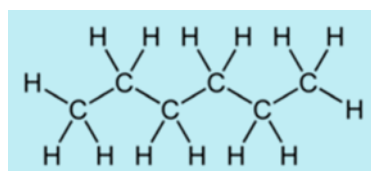
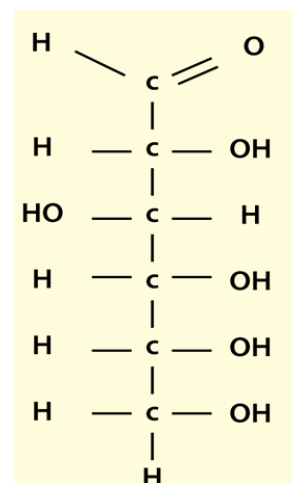
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1 mark

**Question 11 (5 marks)**

Use the below molecules (A- H) to answer the following questions.

**A****B****C****D****E****F****G****H****I**

- a. Which two molecules can interact to form a dipeptide?

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1 mark

- b. Which molecule is the end product of the breakdown of protein in the human body?

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1 mark

**Question 11 (continued)**

- c. Which molecule can polymerise to form starch?

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1 mark

- d. Which molecule can be formed as a result of the hydrolysis of a triglyceride?

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1 mark

- e. Which two saturated hydrocarbons will burn in excess oxygen to produce  $\text{CO}_2$  and  $\text{H}_2\text{O}$ ?

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1 mark**Question 12 (5 marks)**

Petrodiesel and biodiesel have different properties. Both forms of diesel have higher densities than petrol and so the energy released per litre of diesel fuel is higher than per litre of petrol.

*Use the table below to answer these questions.*

| property                              | petrodiesel | biodiesel |
|---------------------------------------|-------------|-----------|
| density ( $\text{kg L}^{-1}$ )        | 0.84        | 0.87      |
| viscosity (cSt)                       | 2.5         | 4.9       |
| energy density ( $\text{kJ L}^{-1}$ ) | 40          | 36        |
| energy content ( $\text{kJ g}^{-1}$ ) | 48          | 41        |
| cloud point ( $^{\circ}\text{C}$ )    | -15 to 5    | -3 to 12  |

- a. Explain why biodiesel has a higher viscosity than petrodiesel by describing the chemical structures of the two molecules.

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2 marks

**Question 12 (continued)**

- b. Biodiesel cannot be stored for as long as petrodiesel. Explain.

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1 mark

- c. A substance that can absorb and store water easily is said to be hygroscopic. Explain why biodiesel has a higher hygroscopic tendency than petrodiesel.

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1 mark

- d. In very cold climates, biodiesel can lose its ability to flow and it can also solidify completely. Explain the reason for this and compare this feature with that of petrodiesel.

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1 mark

**End of question and answer book for the 2018 Kilbaha VCE Chemistry Trial Examination**

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