

# CHEMISTRY

## UNITS 3 & 4

Student name

Student ID

Letter

### Structure of book

| Section | Number of questions | Number of marks |
|---------|---------------------|-----------------|
| A       | 30                  | 30              |
| B       | 11                  | 90              |
|         | <b>Total</b>        | <b>120</b>      |

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners rulers, and an approved scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape, mobile phones and/or any other unauthorised electronic devices.
- A copy of the official VCAA Data Book (printed or photocopied) can be brought into the trial examination.

### Materials supplied

- Question and answer book of 21 pages, with a detachable answer sheet for multiple-choice questions inside the front cover.

### Instructions

- Detach the answer sheet for multiple-choice questions during reading time.
- Write your name and student ID in the space provided above on this page and on the answer sheet for multiple-choice questions.
- Unless otherwise indicated, the diagrams in this book are not drawn to scale.
- All written responses should be in English.

### At the end of the examination

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

**SECTION A – Multiple-choice questions****Instructions for Section A**

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

Choose the response that is **correct** or that **best answers** the question.

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

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

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

**Question 1**

A 20 mL pipette and a 50 mL burette can be used in chemical analysis. The volume delivered by each of these pieces of equipment is best represented by

|           | <b>pipette</b>  | <b>burette</b>  |
|-----------|-----------------|-----------------|
| <b>A.</b> | 20.0 ± 0.1 mL   | 50.00 ± 0.05 mL |
| <b>B.</b> | 20.00 ± 0.03 mL | 50.0 ± 0.5 mL   |
| <b>C.</b> | 20.0 ± 0.1 mL   | 50.0 ± 0.5 mL   |
| <b>D.</b> | 20.00 ± 0.03 mL | 50.00 ± 0.05 mL |

**Question 2**

The volume, in L, occupied by 0.0200 g of oxygen gas at 27°C and a pressure of 107 kPa is closest to

- A.** 0.466
- B.** 0.0290
- C.** 0.0150
- D.** 0.00200

**Question 3**

One form of incomplete combustion of methane is shown by the following equation:



If 10.0 L of methane fuel was burnt at SLC, what volume, in L, of carbon monoxide would be produced under the same conditions?

- A.** 2.00
- B.** 5.00
- C.** 10.0
- D.** 20.0

# STAV 2022

## CHEMISTRY

### Units 3 & 4 Trial Examination

## MULTIPLE CHOICE ANSWER SHEET

|                          |  |
|--------------------------|--|
| <b>STUDENT<br/>NAME:</b> |  |
|--------------------------|--|

**INSTRUCTIONS:****USE PENCIL ONLY**

- Write your name in the space provided above.
- Use a **PENCIL** for **ALL** entries.
- If you make a mistake, **ERASE** it – **DO NOT** cross it out.
- Marks will **NOT** be deducted for incorrect answers.
- **NO MARK** will be given if more than **ONE** answer is completed for any question.
- Mark your answer by **SHADING** the letter of your choice.

|    | ONE ANSWER PER LINE                                                                                         |    | ONE ANSWER PER LINE                                                                                         |
|----|-------------------------------------------------------------------------------------------------------------|----|-------------------------------------------------------------------------------------------------------------|
| 1  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 16 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 2  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 17 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 3  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 18 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 4  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 19 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 5  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 20 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 6  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 21 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 7  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 22 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 8  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 23 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 9  | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 24 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 10 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 25 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 11 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 26 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 12 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 27 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 13 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 28 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 14 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 29 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |
| 15 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D | 30 | <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D |



**Question 4**

The combustion of methane (natural gas) can be used to produce electricity in a gas-fired power station. In such a power station, the energy available from the methane is used to convert water in a boiler from liquid water to steam.

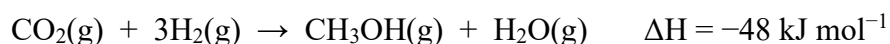


The maximum mass of water, in g, that could be converted from liquid water to steam by the complete oxidation of one mole of methane is

- A. 91.0
- B. 182
- C. 364
- D. 728

**Question 5**

One of the reactions involved in the production of methanol is:

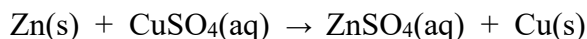


From this information it can be concluded that

- A. when 3.0 g of hydrogen reacts, 48 kJ of energy are released
- B. the reaction of 1.0 mol of carbon dioxide absorbs 48 kJ of energy
- C. the production of 2.0 mol of methanol would release 96 kJ of energy
- D. the formation of 1.0 mol of water releases 24 kJ

**Question 6**

Copper(II) sulfate and zinc react according to the following equation:



When 1.5 g of zinc, an excess, is added to 100 mL of 0.10 M copper(II) sulfate in a calorimeter, the temperature increased by 4.8°C. If the calorimeter constant is 530 J °C<sup>-1</sup>, then the ΔH for the reaction is

- A. +111 kJ mol<sup>-1</sup>
- B. -111 kJ mol<sup>-1</sup>
- C. +254 kJ mol<sup>-1</sup>
- D. -254 kJ mol<sup>-1</sup>

**Question 7**

Biodiesel and petrodiesel are both being used as transport fuels. Which of the following statements could **not** be used as an argument for increasing the use of biodiesel?

- A. The combustion of biodiesel produces less carbon dioxide than petrodiesel.
- B. Biodiesel can be produced from resources including corn, sugar cane and algae.
- C. Petrodiesel is a non-renewable resource.
- D. Biodiesel and petrodiesel produce reasonably similar amounts of energy per gram.

**Question 8**

Ammonium nitrate can be used in cold packs that are often found in first aid kits.

A calorimeter was electrically calibrated using a 100 mL of pure water and was then used to determine the molar heat of solution of ammonium nitrate.

If the water was replaced prior to the determination of the molar heat of solution and, instead of 100 mL, only 90 mL was added to the calorimeter, the molar heat of solution determined would be

- A. lower due to the temperature change being smaller
- B. lower due to the temperature change being greater
- C. higher due to the temperature change being smaller
- D. higher due to the temperature change being greater

**Question 9**

The oxidation number of beryllium in the ion  $\text{Na}_2\text{BeF}_4$  is

- A. -2
- B. 0
- C. +2
- D. +6

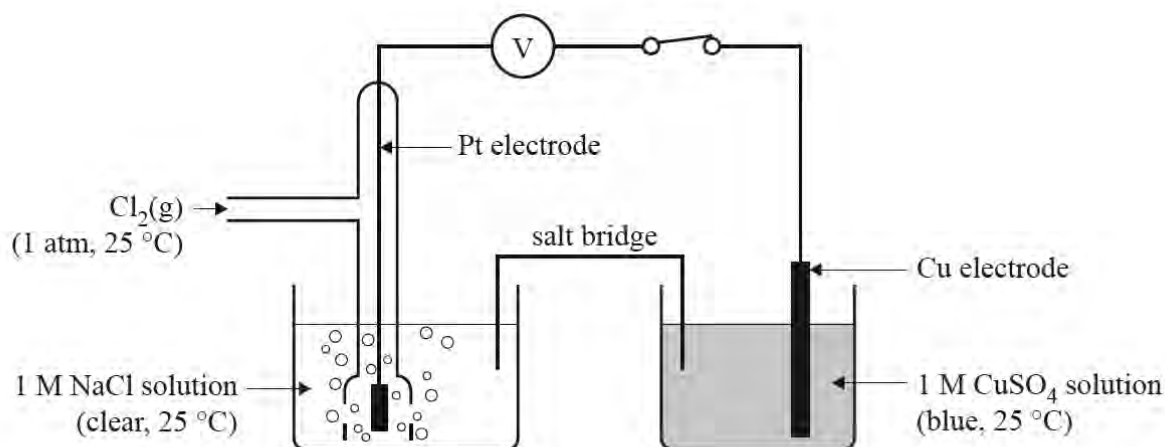
**Question 10**

Which of the following could oxidise  $\text{I}^-$  ions?

- A.  $\text{H}^+$
- B.  $\text{Fe}^{2+}$
- C.  $\text{Cu}^{2+}$
- D.  $\text{Au}^+$

**Use the following information to answer Questions 11 and 12.**

The galvanic cell shown below is set up in a fume cupboard by a Chemistry student. Chlorine gas is continually bubbled through the left half-cell.



### Question 11

When the cell begins to operate

- A. the cell voltage will start at 1.02 V, then slowly drop.
- B. the Cu electrode will have a positive polarity and act as the cathode.
- C. electrons will move out of the Pt electrode and along the wire to the Cu electrode.
- D. electrons will move through the salt bridge towards the  $\text{Cu}^{2+}/\text{Cu}$  half-cell and complete the circuit.

### Question 12

What is the student most likely to observe in the  $\text{Cu}^{2+}/\text{Cu}$  half-cell sometime after the switch is turned on?

- A. bubbles forming over the electrode
- B. the copper electrode looking corroded
- C. the solution looking lighter blue in colour
- D. crystals of copper growing over the electrode

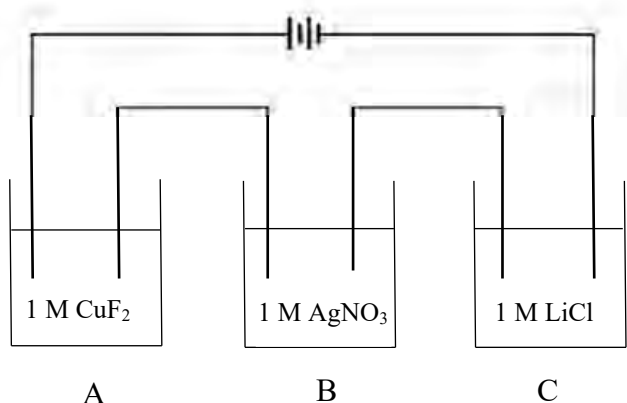
**Question 13**

Electrolysis of 0.10 M  $\text{AgNO}_3(\text{aq})$ , using platinum electrodes, deposited 1.47 g of metallic silver. If the electrolysis was conducted using a steady current of 4.00 A, what time, in seconds, would be required to deposit the 1.47 g of silver, assuming 80.0% efficiency?

- A. 5.5
- B. 263
- C. 329
- D. 411

**Question 14**

A current of 2.5 A is passed through three cells as shown below, A, B and C, connected in series, for 30 minutes. These cells contain solutions as indicated below. Each cell also contains a pair of inert electrodes.



At the completion of the electrolysis, the ratio of the number of moles of non-aqueous products present at the negative electrodes in each cell, i.e. A : B : C will be

- A. 1 : 2 : 0
- B. 2 : 1 : 2
- C. 1 : 2 : 1
- D. 2 : 1 : 0

**Question 15**

A student set up three different electrolytic cells. The substances that were electrolysed were molten  $\text{NaCl}$ , 0.05 M  $\text{NaCl}$  and 5.0 M  $\text{NaCl}$ .

Which of the following statements correctly describes the results of the experiment?

- A. The reactions occurring for the aqueous solutions will produce the same products at the anode and cathode.
- B. The pH at the cathode increased when solutions of  $\text{NaCl}$  are electrolysed
- C. The only means by which different products can be produced for varying concentrations of  $\text{NaCl}$  is to alter the voltage.
- D. Chlorine gas is the major product when molten  $\text{NaCl}$  and 0.05 M  $\text{NaCl}$  are electrolysed.

**Question 16**

In which of the following situations would you expect the rate of reaction between calcium carbonate and nitric acid to be the greatest?

- A. Powdered calcium carbonate and 2 M hydrochloric acid at 40°C.
- B. Powdered calcium carbonate and 0.5 M hydrochloric acid at 40°C.
- C. Powdered calcium carbonate and 2 M hydrochloric acid at 20°C.
- D. Calcium carbonate pieces and 0.5 M hydrochloric acid at 40°C.

**Question 17**

A chemical reaction has an equilibrium constant,  $K_c$ , of  $1.12 \times 10^{-6}$ . It can be deduced from the constant that

- A. the forward reaction will have a faster rate than the back reaction.
- B. equilibrium will be established very slowly.
- C. equilibrium will be established very quickly.
- D. there is minimal conversion of reactants into products.

**Question 18**

The formulae of two organic compounds are shown below

| Compound A                                                  | Compound B                                                                    |
|-------------------------------------------------------------|-------------------------------------------------------------------------------|
| $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$ | $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_2\text{OH})\text{CH}_3$ |

The two compounds shown above are correctly named as

|    | Compound A      | Compound B                |
|----|-----------------|---------------------------|
| A. | 2-methylpentane | 2-methylpentan-1-ol       |
| B. | 2-methylpentane | 1-hydroxy-2-methylpentane |
| C. | hexane          | 2-hexanol                 |
| D. | 2-methylhexane  | 1-hexanol                 |

**Question 19**

When 2-iodopropane is warmed with aqueous potassium hydroxide, the major organic product is

- A.  $\text{CH}_3\text{COCH}_3$
- B.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{I}$
- C.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- D.  $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$

**Question 20**

How many structural isomers are possible with the molecular formula  $C_6H_{14}$ ?

- A. 4
- B. 5
- C. 6
- D. 7

**Question 21**

Which one of the following semi-structural formulae has a chiral carbon?

- A.  $(CH_3)_2CHCH_2OH$
- B.  $(CH_3)_3COH$
- C.  $CH_3CH_2CH_2CH_2OH$
- D.  $CH_3CH_2CH(OH)CH_3$

**Question 22**

Which of the following lists contains only carbohydrates?

- A. glucose, glycerol, glycogen, starch
- B. fructose, glycerol, starch, cellulose
- C. glucose, glycogen, starch, cellulose
- D. fructose, glucose, glycerol, glycogen

**Question 23**

The molecule  $HOCH_2CH_2COOH$  forms a polyester in which the average polymer molecule contains 500 monomer units. The approximate molar mass of the polymer, in  $g\ mol^{-1}$ , would be

- A. 36 000
- B. 43 000
- C. 44 000
- D. 53 000

**Question 24**

Which one of the following does **not** correctly describe a reaction of glucose?

- A. Glucose reacts with oxygen exothermically to produce carbon dioxide and water.
- B. Glucose molecules react exothermically to produce cellulose and water.
- C. Glucose reacts exothermically to produce carbon dioxide and ethanol.
- D. Glucose molecules react endothermically to produce starch and water.

**Question 25**

A polyunsaturated fat is hydrolysed. Glycerol and a polyunsaturated acid are formed. Which one of the following is a possible formula for the acid?

- A.  $C_{16}H_{32}O_2$
- B.  $C_{18}H_{36}O_2$
- C.  $C_{20}H_{38}O_2$
- D.  $C_{24}H_{44}O_2$

**Question 26**

The **high** resolution  $^1H$  NMR spectrum of  $C_2H_5Br$  would show

- A. 2 peaks
- B. 3 peaks
- C. 5 peaks
- D. 7 peaks

**Question 27**

The number of different carbon environments and different hydrogen environments respectively in the appropriate NMR spectra of hexane would be

- A. 2, 3
- B. 3, 2
- C. 3, 3
- D. 6, 6

**Question 28**

Below are listed some properties of a compound and its constituent atoms.

- I. the reactivity of the compound
- II. the electronegativities of the atoms
- III. the masses of the atoms
- IV. the strength of the covalent bonds

The factors that affect the wavenumber of an absorption band are

- A. I and II
- B. II and III
- C. III and IV
- D. II, III and IV

**Question 29**

A mixture of paracetamol and caffeine was dissolved in ethanol and passed through a HPLC column. The peak for the paracetamol was recorded after exactly three minutes while the peak for the caffeine was recorded after 320 seconds had elapsed. Compared to the caffeine, paracetamol is adsorbed

- A. more strongly onto the stationary phase and has a larger retention time.
- B. less strongly onto the stationary phase and has a smaller retention time.
- C. more strongly onto the stationary phase and has a smaller retention time.
- D. less strongly onto the stationary phase and has a larger retention time.

**Question 30**

A student wishes to determine the concentration of citric acid in fruit juice. The student titrates 20.00 mL samples of a standard sodium hydroxide solution with diluted fruit juice from a burette. Four experiments were carried out and the following titres were obtained:

19.55 mL, 20.35 mL, 20.30 mL, 20.35 mL

The discrepancy in the first titration could be due to the student washing the

- A. conical flask with sodium hydroxide solution only.
- B. burette with water only.
- C. pipette with sodium hydroxide solution only.
- D. pipette with water only.

**END OF SECTION A**

**SECTION B – Short answer questions (90 marks)****Instructions for Section B**

Answer **all** questions in the spaces provided.

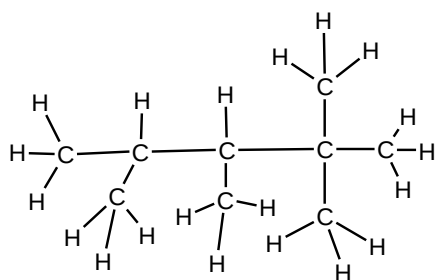
To obtain full marks for your responses you should

- 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 chemical equations are balanced and that the formulas for individual substances include an indication of state; for example,  $\text{H}_2(\text{g})$ ;  $\text{NaCl}(\text{s})$

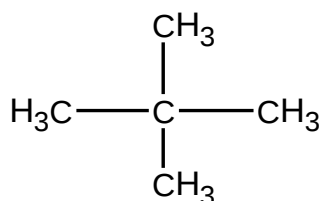
**Question 1**

Name the following compounds:

a. i.

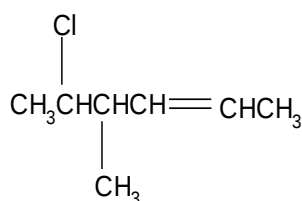


ii.



2 + 2 = 4 marks

b. Write the systematic name for the compound shown below:



2 marks

c. Draw the skeletal structure of methyl propanoate.

2 marks

Total 8 marks

**Question 2**

- a.** Write a balanced equation for the complete combustion of butane under SLC.

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2 marks

- b.** Calculate the energy released by the combustion of 0.450 mol of butane.

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2 marks

- c.** Calculate the volume of carbon dioxide, measured at SLC, produced for every 100 kJ of energy released.

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2 marks

- d.** Calculate the energy released when 2.50 g of water is produced.

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2 marks  
Total 8 marks

**Question 3**

Two students are calibrating a calorimeter consisting of 200 g of water in a well-insulated container incorporating a heating coil, stirrer and thermometer.

- a. The students first use electrical calibration by passing a current of 0.862 A, at 5.73 V, for 10.0 minutes through the calorimeter's heating coil. If their calculated value for the calibration factor (calorimeter constant) was  $750 \text{ J K}^{-1}$ , what temperature change did they observe?

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4 marks

- b. The students decide that this calibration factor was almost certainly the result of some error and dismissed it. What was the justification for this decision?

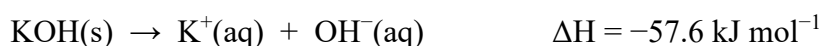
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1 mark

- c. To recalibrate the calorimeter they add 6.73 g of potassium hydroxide to the water in the calorimeter, which dissolves according to the thermochemical equation below:



The temperature rose from  $21.35^{\circ}\text{C}$  to  $29.16^{\circ}\text{C}$ .  
Calculate the new calibration factor based on this data.

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3 marks

Total 8 marks

**Question 4**

a. Consider the equilibrium:  $\text{P(aq)} + 2\text{Q(aq)} \rightleftharpoons \text{R(aq)} + \text{S(aq)}$

1.00 mol of P and 1.00 mol of Q are mixed. Once equilibrium is established, 0.600 mol of P is present. How many moles of Q, R and S are present at equilibrium?

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4 marks

b. If the volume of the flask was 2.00 L, what is the equilibrium constant at the same temperature?

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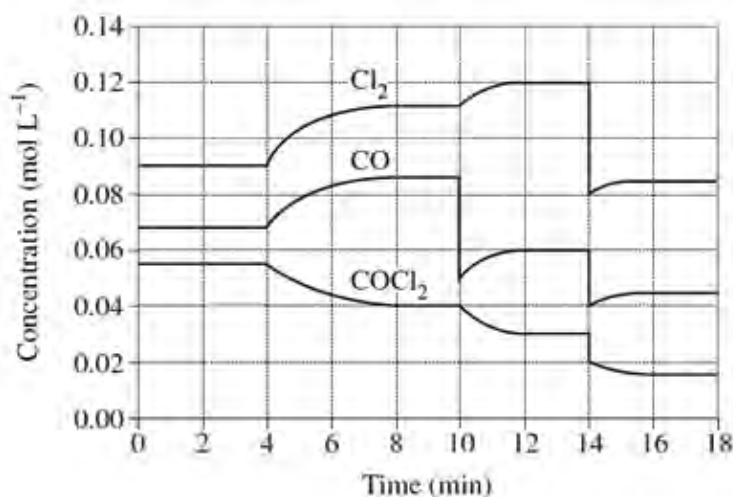
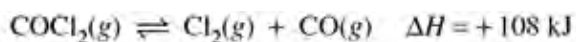
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5 marks

Total 9 marks

**Question 5**

In the following equilibrium system there have been changes to the system at 4, 10 and 14 minutes.



For each of the changes at 4, 10 and 14 minutes:

- i. state the imposed change      ii. use Le Chatelier's Principle to explain the changes that occur in the system

a. 4 minutes:

i. \_\_\_\_\_

ii. \_\_\_\_\_

\_\_\_\_\_

1 + 2 = 3 marks

b. 10 minutes:

i. \_\_\_\_\_

ii. \_\_\_\_\_

\_\_\_\_\_

1 + 2 = 3 marks

c. 14 minutes:

i. \_\_\_\_\_

ii. \_\_\_\_\_

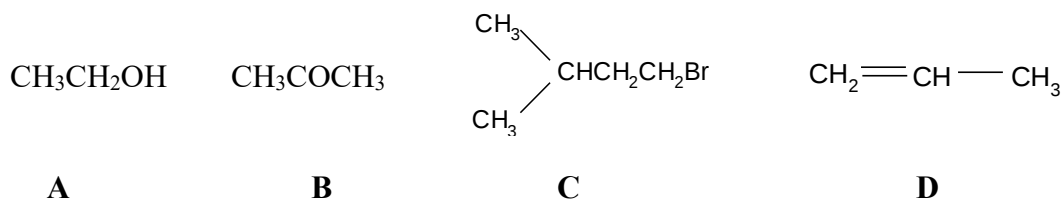
\_\_\_\_\_

1 + 2 = 3 marks

Total 9 marks

**Question 6**

Complete the table below for the following compounds:



| compound | number of <u>low</u> resolution $^1\text{H}$ signals | number of $^{13}\text{C}$ signals |
|----------|------------------------------------------------------|-----------------------------------|
| <b>A</b> |                                                      |                                   |
| <b>B</b> |                                                      |                                   |
| <b>C</b> |                                                      |                                   |
| <b>D</b> |                                                      |                                   |

Total 4 marks

**Question 7**

Write a balanced equation using semi-structural formulae for organic compounds in the following processes (catalysts should be shown above the arrow). No states are required in this instance.

- a.** conversion of chloroethane to ethanamine

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2 marks

- b.** conversion of ethene to ethanol

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2 marks

- c.** conversion of propan-1-ol into propyl methanoate

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3 marks  
Total 7 marks

**Question 8**

A polypeptide was found to have the sequence of amino acids as shown below:



- a. Write an equation using semi-structural formulae for the reaction of Ala with a dilute solution of hydrochloric acid. No states are required.

2 marks

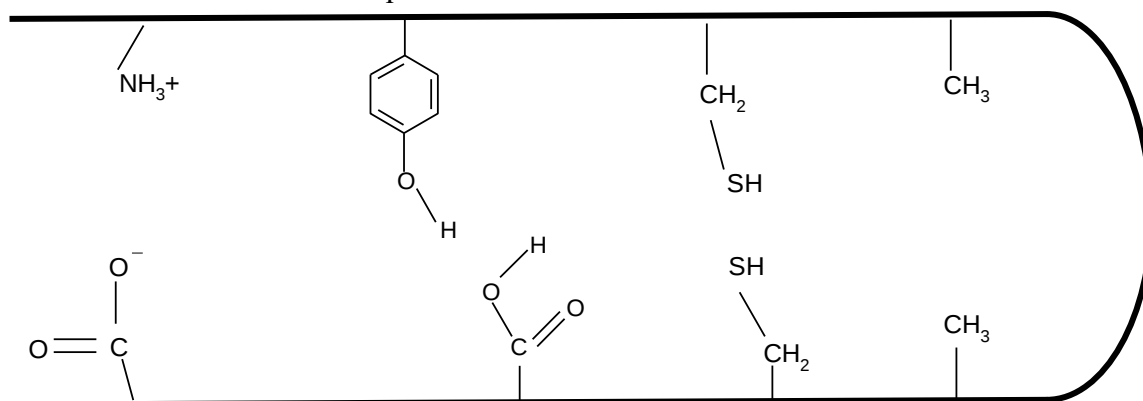
- b. When phenylalanine (Phe) is added to Ala, two dipeptides can be formed. Draw the semi-structural formulae of **both** dipeptides.

2 marks

- c. Name the substance formed in addition to the dipeptides in the reaction described in part b.

1 mark

- d. Proteins formed in the body have a much longer amino acid sequence. The diagram below shows a section of one such sequence.



- i. Name all the bonding types (other than the covalent bonds shown) which could be involved in holding this protein together in this section.

- ii. On the diagram, make any required alterations to show how covalent bonding could be used to hold some parts of the tertiary structure together.

**Question 8 is continued on the next page**

- iii.** When this protein is heated to around 70°C, its structure changes. Describe what happens during heating to the:

secondary structure of the protein

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primary structure of the protein

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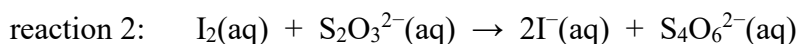
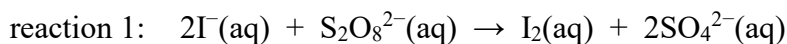
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2 + 1 + 2 = 5 marks  
Total 10 marks

**Question 9**

In chemistry, a number of reactions are collectively referred to as ‘clock’ reactions. These reactions produce a sudden colour change after a period of time.

One of the better known examples of such reactions is that between iodide ions and persulfate ions ( $\text{S}_2\text{O}_8^{2-}$ ) in the presence of thiosulfate ions ( $\text{S}_2\text{O}_3^{2-}$ ) and starch solution. The following two reactions are involved:



The iodine produced in reaction 1 is immediately removed by reaction 2. However,  $\text{S}_2\text{O}_3^{2-}(\text{aq})$  ions are also consumed and are eventually all used up. After this time, iodine builds up and is detected by the starch present which forms an intensely dark blue complex. This occurs at iodine concentrations as low as  $1.0 \times 10^{-5} \text{ M}$ , making starch an excellent indicator for this reaction.

If the amount of  $\text{S}_2\text{O}_3^{2-}(\text{aq})$  is kept constant, the appearance of the dark blue colour may be used to measure the rate of reaction 1.

In one such experiment using 0.20 M KI(aq), 0.20 M  $\text{Na}_2\text{S}_2\text{O}_8(\text{aq})$  and 0.10 M  $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$  at room temperature, the following results were obtained:

| trial number | volume of $\text{I}^-(\text{aq})$ (mL) | volume of $\text{S}_2\text{O}_8^{2-}(\text{aq})$ (mL) | volume of $\text{S}_2\text{O}_3^{2-}(\text{aq})$ (mL) | volume of water (mL) | volume of starch solution (mL) | time for blue colour to appear (s) |
|--------------|----------------------------------------|-------------------------------------------------------|-------------------------------------------------------|----------------------|--------------------------------|------------------------------------|
| 1            | 20                                     | 20                                                    | 20                                                    | 40                   | 10                             | 220                                |
| 2            | 20                                     | 40                                                    | 20                                                    | 20                   | 10                             | 150                                |
| 3            | 40                                     | 20                                                    | 20                                                    | 20                   | 10                             | 142                                |

- a. Explain how these results show that increasing  $\text{S}_2\text{O}_8^{2-}(\text{aq})$  concentration produces a faster rate in reaction 1.

**Compare 2 appropriate trials from the table above as part of your explanation.**

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2 marks

- b. Use the results in the table above to explain how the rate of reaction is affected by the concentration of iodide ions.

**Compare 2 appropriate trials to support your explanation.**

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2 marks

Question 9 is continued on the next page

- c. The experiment is repeated using solutions that were stored in a refrigerator for 24 hours. These solutions were used immediately after being removed from the refrigerator. How would the reaction times in the table be affected? Explain your response.

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2 marks

- d. What is the purpose of two different amounts of water used in the trials?

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1 mark

- e. Explain why the amount of  $\text{S}_2\text{O}_3^{2-}(\text{aq})$  is kept constant in each trial?

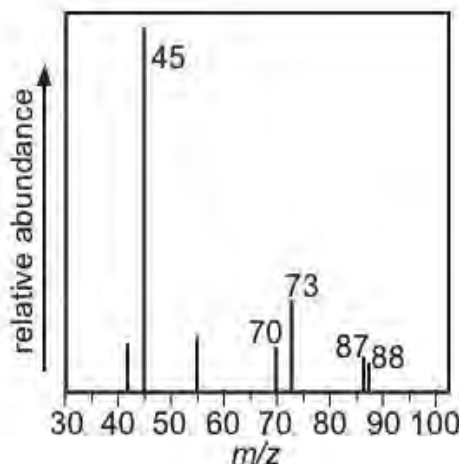
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1 mark  
Total 8 marks

**Question 10**

The simplified mass spectrum of pentan-2-ol is shown below:



- a. Draw the structural formula of pentan-2-ol.

1 mark

- b. Is there a chiral carbon in this molecule? Explain your answer.

2 marks

- c. i. Draw the skeletal structure of an isomer of pentan-2-ol which would be a secondary alcohol.

- ii. Does this molecule have a chiral carbon atom? Explain your answer.

1 + 2 = 3 marks

- d. Identify the likely semi-structural formula for the **ions** producing peaks at the following mass numbers:

- i. 88 \_\_\_\_\_  
ii. 73 \_\_\_\_\_  
iii. 45 \_\_\_\_\_

1 + 1 + 1 = 3 marks

Total 9 marks

**Question 11**

An aqueous solution of 1.0 M cobalt(II) bromide is electrolysed using inert electrodes.

- a. Sketch the cell showing:
- i. the direction of current flow in the external circuit.
  - ii. the cathode and anode and their polarity

1 + 2 = 3 marks

- b. Write half equations for the expected reactions at each electrode.

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2 marks

- c. Write the overall equation for the reaction.

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1 mark

- d. Determine the voltage that should be applied to affect the electrolysis under standard conditions.

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1 mark

- e. Explain how the products of the electrolysis would differ if a copper anode was used.

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3 marks  
Total 10 marks

**END OF TRIAL EXAMINATION**