UNIT 3 CHEMISTRY 2005

WRITTEN EXAMINATION 1

TRIAL EXAMINATION PAPER

Reading Time: 15 minutes
Writing Time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of Book

Section	*Number of Questions*	*Number of Questions to be Answered*	*Number of Marks*	*Suggested Times (minutes)*
A	20	20	20	30
B	7	7	60	60
			Total 80	Total 90

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MULTIPLE CHOICE QUESTIONS - ANSWER SHEET

Please note that the format and requirements of this answer sheet are different to the answer sheet that will be issued in the VCAA examination. Copies of the actual examination answer sheet may be obtained at: **www.vcaa.vic.edu.au**

Choose the correct response or the one which best answers the question by shading the square corresponding to your response in the table below.

Question 1	A	B	C	D
Question 2	A	B	C	D
Question 3	A	B	C	D
Question 4	A	B	C	D
Question 5	A	B	C	D
Question 6	A	B	C	D
Question 7	A	B	C	D
Question 8	A	B	C	D
Question 9	A	B	C	D
Question 10	A	B	C	D
Question 11	A	B	C	D
Question 12	A	B	C	D
Question 13	A	B	C	D
Question 14	A	B	C	D
Question 15	A	B	C	D
Question 16	A	B	C	D
Question 17	A	B	C	D
Question 18	A	B	C	D
Question 19	A	B	C	D
Question 20	A	B	C	D

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 marks will be given if more than one answer is completed for any question.

QUESTION 1
A sample of $CaCl_2$ is placed in the flame of a Bunsen burner. The component of the substance which is responsible for the production of a flame colour is

A Ca^{2+}
B Ca
C Cl^-
D Cl

QUESTION 2
The simplest formula for a compound which contains 51.8% carbon, 9.8% hydrogen and 38.4% chlorine is

A $CHCl$
B C_4H_9Cl
C C_4H_8Cl
D CH_2Cl

QUESTION 3
In a titration, an acid of known concentration is placed in a burette and reacted with a base that has been pipetted into a conical flask.

What should each piece of glassware be rinsed with immediately before the titration?

	Burette	Pipette	Conical Flask
A	Acid	Base	Water
B	Water	Water	Water
C	Acid	Base	Base
D	Water	Water	Base

QUESTION 4
The oxidation number of oxygen in HOF is equal to

A -2
B 0
C 1
D 2

QUESTION 5
Which one of the following reactions is a redox reaction?

A $2CrO_{4(aq)}^{2-} + 2H_{(aq)}^{+} \rightarrow Cr_2O_{7(aq)}^{2-} + H_2O_{(l)}$
B $C_6H_{12}O_{6(aq)} + 6H_2SO_{4(l)} \rightarrow 6C_{(s)} + 6H_3O_{(aq)}^{+} + 6HSO_{4(aq)}^{-}$
C $10HNO_{3(aq)} + I_{2(aq)} \rightarrow 2HIO_{3(aq)} + 10NO_{2(g)} + 4H_2O_{(l)}$
D $2CrO_{4(aq)}^{2-} + 2H_{(aq)}^{+} \rightarrow Cr_2O_{7(aq)}^{2-} + H_2O_{(l)}$

QUESTION 6
A $20.00\ ml$ solution containing Ca^{2+} at a concentration of $20\ ppm$ is to be diluted to a $0.0025\ M$ solution. The volume of water that needs to be added to the $20.00\ ml$ solution is closest to

A $20\ ml$
B $40\ ml$
C $50\ ml$
D $100\ ml$

QUESTION 7
If 10.0 g of $Na_2CO_3.10H_2O$ is heated to remove all water, the mass loss would be

A 0.50 g
B 0.63 g
C 3.70 g
D 6.29 g

The following information refers to Questions 8 and 9.

An aerosol can of deodorant has a volume of $150\ ml$. The contents of the can exert a pressure of $9.0\times10^{5}\ Pa$ at $27^{o}C$.

QUESTION 8
The number of particles present in the can of spray is

A 3.26×10^{25}
B 3.62×10^{23}
C 3.26×10^{22}
D 3.62×10^{20}

QUESTION 9
If the contents of the can are transferred to a $200\ ml$ container, what will be the temperature in ^{o}C if the pressure drops to $6.00\times10^{5}\ Pa$?

A -249
B -6
C 24
D 267

QUESTION 10
The pH of a $10^{-8}M\ \ NaOH$ solution at $25^{o}C$ is closest to

A 6
B 7
C 8
D 10

QUESTION 11
The pH of the solution obtained by mixing 20.00 ml of a 0.10M HCl solution with 18.00 ml of a 0.075M $Ba(OH)_2$ solution is closest to

A 2.0
B 1.74
C 12.26
D 11.96

QUESTION 12

Given the equilibrium $xA_{(aq)} + 2H^{+}_{(aq)} \rightleftharpoons C_{(aq)} + H_2O_{(l)}$, $K = 5M^{-3}$

It follows that the coefficient, x, is equal to

A 1
B 2
C 3
D 4

QUESTION 13

The reaction between copper ions and ammonia is given below.

$$Cu^{2+}_{(aq)} + 4NH_{3(g)} \leftrightarrow Cu(NH_3)^{2+}_{4(aq)}$$

A sample was tested at various times and the concentration fraction (CF) was determined. The results obtained were as follows:

T = 5 minutes CF = 0.58
T = 10 minutes CF = 0.42
T = 15 minutes CF = 0.33 $K_{eq} = 0.30$

These results indicate that

A The system is in equilibrium at 15 minutes
B The rates of the forward and reverse reactions are equal at all times
C The system is approaching equilibrium via a net forward reaction.
D The system is approaching equilibrium via a net back reaction.

QUESTION 14

Consider the reaction that forms an equilibrium involving colourless hydrogen iodide and purple iodine: $H_{2(g)} + I_{2(g)} \Leftrightarrow 2HI_{(g)}$. When an equilibrium mixture of the gases is heated at a constant pressure, the intensity of the purple colour increases. This suggests that the reaction as written is

A Exothermic
B Complete
C Endothermic
D Unaffected

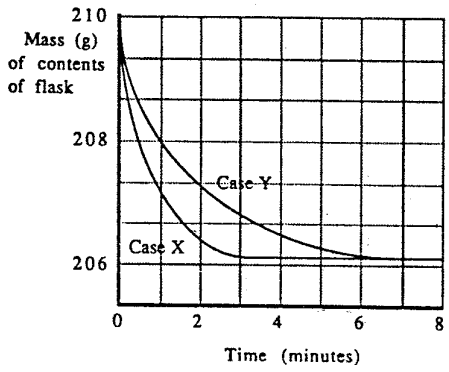
QUESTION 15
Nitrous acid ionises in water according to the following equation.

$$HNO_{2(aq)} + H_2O_{(l)} \Leftrightarrow H_3O^+_{(aq)} + NO^-_{2(aq)}$$

450 ml of water is added to a 50 ml solution of nitrous acid at constant temperature. Which one of the following answers best describes the system once it has returned to equilibrium?

	Concentration $NO^-_{2(aq)}$	Amount $NO^-_{2(aq)}$	Final Reaction Rates as compared to initial equilibrium rates
A	Higher	Higher	Higher
B	Higher	Lower	Lower
C	Lower	Higher	Higher
D	Lower	Higher	Lower

QUESTION 16
The rate of reaction of solid sodium carbonate reacting with nitric acid was studied by measuring the mass of the reaction mixtures at various times. The reactions were performed in an open vessel under identical conditions. In both case X and Y, 10.0g of calcium carbonate crystals were reacted with the same volume of 0.25M nitric acid.

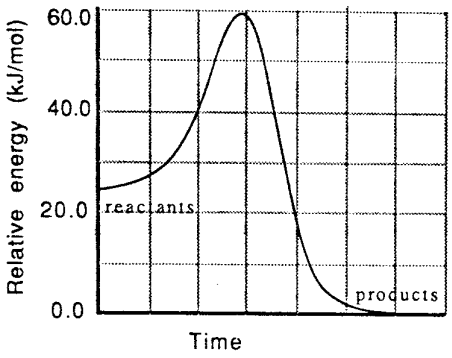


Which of the following statements is FALSE?

A Case X used powdered crystals, Case Y used large crystals
B The reaction in Case X took place in the presence of a catalyst
C The rate of reaction in Case X is greater
D The equilibrium constants for the two reactions differ

QUESTION 17
The enthalpy change and activation energy in kJ/mol for the reverse reaction of the system described below are

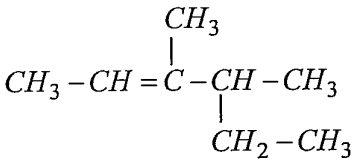
A $\Delta H = -25\ kJ/mol, \quad E_A = 35\ kJ/mol$
B $\Delta H = -25\ kJ/mol, \quad E_A = 60\ kJ/mol$
C $\Delta H = 25\ kJ/mol, \quad E_A = 35\ kJ/mol$
D $\Delta H = 25\ kJ/mol, \quad E_A = 60\ kJ/mol$



QUESTION 18
The group in which all the compounds are members of the same homologous series is

A $C_2H_6, \quad C_2H_4, \quad C_2H_2$
B $CH_3CH_2CH_2OH, \quad CH_3CH_2CH_2CH_2OH, \quad CH_3CH_2CH_2CH_2CH_2OH$
C $CH_3CH_2CH_3, \quad CH_3CH_2OH, \quad HCOOH$
D $CH_3CH_2OCH_2CH_3, \quad CH_3CH_2CH_2CH_2OH, \quad C_4H_9OH$

QUESTION 19
The systematic name for the molecule below is



A 2-ethyl-3-methyl-3-pentene
B octene
C 3,4-dimethyl-2-hexene
D 3-methyl-4-ethyl-2-pentene

QUESTION 20
Which one of the following statements regarding atomic absorption spectroscopy and UV-Visible spectroscopy is incorrect?

A Electrons are excited to higher energy levels via electromagnetic energy.
B The amount of light absorbed is directly proportional to the concentration of the species being assayed
C Both instruments have a monochromator
D The area under each peak can be used as a quantitative tool

SECTION B – SHORT ANSWER QUESTIONS

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 to all numerical questions; unsimplified answers will not be give 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, $H_{2(g)}$; $NaCl_{(s)}$.

QUESTION 1
Quality control officers in industries and laboratories are required to choose appropriate techniques for qualitative and quantitative analyses.

a. (i) State the type of error that affects the **precision** of results obtained from analytical techniques.

_____

1 mark

(ii) State the type of error that affects the **accuracy** of results obtained from analytical techniques.

_____

1 mark

b. During the course of this year, students have been exposed to a variety of analytical techniques that are used in quality control processes, including:

A Atomic absorption spectroscopy.
B Gas liquid chromatography.
C High Pressure Liquid Chromatography.
D UV - Visible spectroscopy.
E Colorimetry.

Five different substances are placed into separate test tubes, and each tube is subjected to **one** of the above techniques i.e. Technique A is applied to one tube only, technique B is applied to one tube only etc.

Which of the above techniques, A, B, C, D or E would be most suitable to measure the concentration of

(i) A sugar solution?

_____

1 mark

(ii) A solution containing sulfate ions?

_____

1 mark

(iii) A solution containing sodium ions?

_____

1 mark

Which of the remaining techniques, A, B, C, D or E would be most suitable to separate the components of

(iv) Proteins in blood?

_____

1 mark

(v) Perfume?

_____

1 mark

Total 7 marks

QUESTION 2

Liquid refuse from chromium processing plants contains chromium as $CrO_{4(aq)}^{2-}$, which must be removed before the liquid is discharged to the drains.

The liquid is first treated to reduce $CrO_{4(aq)}^{2-}$ to $Cr_{(aq)}^{3+}$.

a. Write a balanced ionic equation to represent this process.

_____

_____

1 mark

$Cr_{(aq)}^{3+}$ is then precipitated by the addition of sodium hydroxide, and is removed by settling before the liquid is discarded.

b. Write a balanced ionic equation to represent the precipitation process.

_____

1 mark

A small scale experiment was performed to determine the amount of chromium in the liquid refuse from one particular plant.

A $20.00\ ml$ aliquot of liquid refuse was reacted with $20.00\ ml$ of sodium hydroxide of unknown concentration, to produce $0.563\ g$ of precipitate.

c. (i) Determine the mass of chromium in the $20.00\ ml$ aliquot of liquid refuse.

_____

_____

_____

_____

2 marks

(ii) Determine the concentration of chromium in the liquid refuse in g / L.

_____

_____

1 mark

(iii) State two assumptions that were required in order to calculate the mass and concentration of chromium in the liquid refuse.

_____

_____

1 mark

The excess sodium hydroxide in the resulting solution was titrated with 0.100 M hydrochloric acid, using phenolphthalein as the indicator. The end point was reached when $21.36\ ml$ of acid had been delivered from the burette.

$$2NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$$

d. (i) State why a strong acid such as $H_2SO_{4(aq)}$ was employed in the titration process.

_____

_____

1 mark

(ii) Calculate the amount, in mole, of acid delivered during the titration.

_____

_____

1 mark

(iii) Calculate the amount, in mole, of $NaOH$ that reacted during the titration.

_____

_____

1 mark

(iv) Hence calculate the concentration of $NaOH$ that was added to the $20.00\ ml$ aliquot of liquid refuse

_____

_____

_____

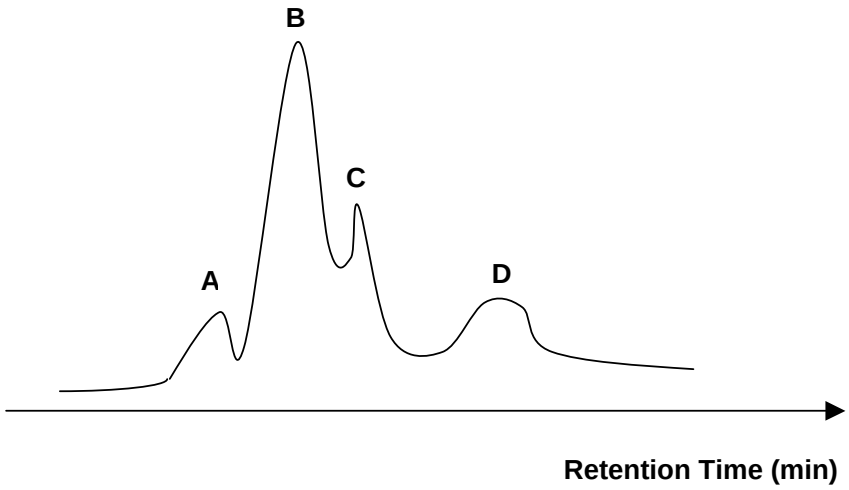
_____

_____

2 marks

Total 11 marks

QUESTION 3
A mixture containing low molecular weight alcohols and carboxylic acids were separated using chromatography on a polar stationary phase. The chromatogram obtained is illustrated below.



A sample containing a mixture of ethanol, ethanoic acid, propanol and propanoic acid was injected into the top of the column and vapourised.

a. (i) Explain why it is important to vapourise the sample upon entry into the column.

_____

_____

_____

1 mark

(ii) Give an example of an appropriate mobile phase for this column.

_____

1 mark

(iii) Explain how the sample components interact with the stationary phase as they pass through the column.

_____

_____

_____

1 mark

Peaks A and B represent the alcohols whereas peaks C and D represent the carboxylic acids in the mixture.

b. (i) Explain, in terms of bonding and structure, why the carboxylic acids display longer retention times as compared to the given alcohols.

_____

_____

_____

1 mark

(ii) Identify the nature of the alcohol at peak B.

_____

1 mark

(iii) Identify the nature of the carboxylic acid at Peak D.

_____

1 mark

Once the components leave the column, they pass into a detector, and a chromatogram is produced. There are a variety of detectors available that will not destroy the sample as the components emerge from the column. The components may then be recovered and used in other analytical procedures.

The most common detector used in gas liquid chromatography is the Flame Ionisation Detector.

c. Explain how the Flame Ionisation Detector is used to obtain the peaks in a chromatogram.

_____

_____

_____

_____

_____

2 marks

Total 8 marks

QUESTION 4

H_2SO_4 is one of the most important chemicals produced in industry, as there are very few consumer goods that do not require the acid at some stage in their production.

As an example, the production of peroxymonosulfuric acid (H_2SO_5) is formed by mixing concentrated hydrogen peroxide and concentrated sulfuric acid.

$$H_2O_{2(l)} + H_2SO_{4(l)} \leftrightharpoons H_2SO_{5(l)} + H_2O_{(l)}$$

a. Write an expression for the equilibrium constant for this reaction.

_____

_____

1 mark

b. During the production of peroxymonosulfuric acid, the initial mole ratio of $H_2SO_4 : H_2O_2 : H_2O$ used is 2.5:1.0:1.8. When a mixture of this mole ratio containing 2.5 mole of H_2SO_4 is used, it is found that at equilibrium, 0.7 mole of H_2SO_5 is produced. If the volume of the mixture is $1\ dm^3$, calculate the equilibrium constant for the formation of peroxymonosulfuric acid.

_____

_____

_____

_____

_____

_____

_____

_____

3 marks

c. One equilibrium has been established, H_2SO_5 is removed from the reaction mixture keeping temperature and volume constant. Circle the correct responses for each of the below statements.

(i) Equilibrium is re-established via

A net forward reaction A net back reaction.

(ii) While equilibrium is being re-established, the rate of the forward reaction

Increases Decreases Remains constant

(iii) Once equilibrium has been re-established, the amount of H_2SO_5 will be

Higher Lower The same

as the previous equilibrium amount of H_2SO_5.

(iv) Once equilibrium has been re-established, the forward and back reaction rates will be

Higher Lower The same

as the previous equilibrium reaction rates.

4 marks

d. One of the main reasons why H_2SO_4 is so widely employed in industrial processes is because the acid has the ability to react in several different ways. Write balanced equations to show the action of sulfuric acid

(i) as an oxidising agent

_____

_____

1 mark

(ii) as a dehydrating agent

_____

_____

1 mark

(iii) as an acid in aqueous solutions.

_____

_____

1 mark

11 marks

QUESTION 5

Carboxylic acids are weak acids, reacting with water to form a weakly acidic solution. Two common examples of carboxylic acids include methanoic acid and propanoic acid.

The K_a of methanoic acid at 25^oC is $1.6 \times 10^{-4} M$.

$$HCOOH_{(aq)} \Leftrightarrow H^+{}_{(aq)} + HCOO^-{}_{(aq)}$$

a. (i) Find the pH of a solution containing $0.50\ M$ $HCOOH$ at 25^oC.

_____

_____

_____

_____

_____

_____

_____

_____

2 marks

(ii) Find the percentage ionisation of $HCOOH$ at 25^oC.

_____

_____

_____

1 mark

b. The methanoic acid solution is diluted 100 fold by the addition of water at $25^{o}C$.

(i) Find the percentage ionisation of $HCOOH$ in the diluted solution.

_____

_____

_____

1 mark

(ii) Explain why the percentage ionisation of $HCOOH$ changed when the dilution was performed.

_____

_____

_____

1 mark

c. A student was asked to provide a definition for a strong acid in an examination. The answer provided was as follows:

"A strong acid is an acidic species which displays a high degree of ionisation in water".

Explain why the student's answer is incorrect. In your answer, provide a better definition of a strong acid.

_____

_____

_____

_____

_____

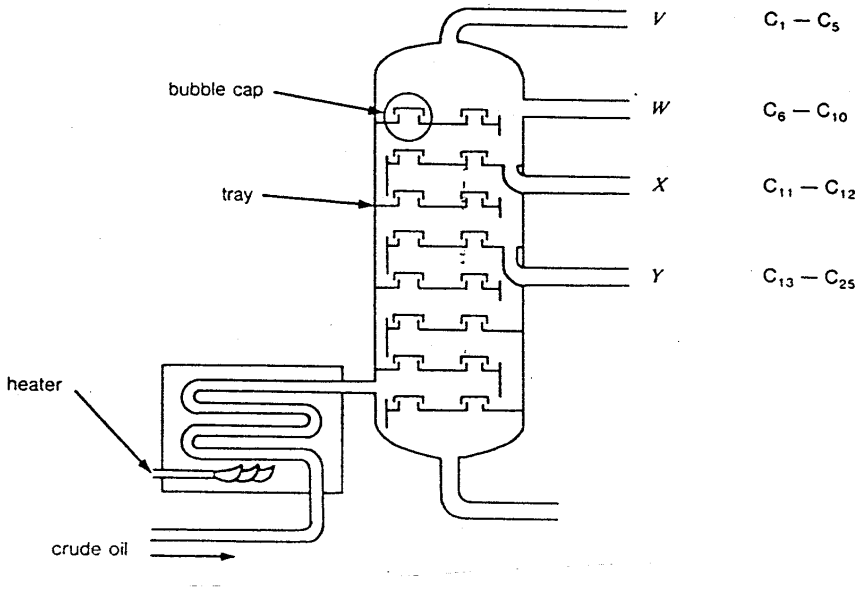
_____

2 marks

Total 7 marks

QUESTION 6

The crude oil component of petroleum is separated into various fractions via a process known as **fractionation**. This procedure is carried out in a fractionating tower, as illustrated below.



a. Crude oil consists of a large number of different compounds. Explain how fractional distillation is used to produce useful compounds from crude oil.

_____

_____

_____

_____

_____

3 marks

The distillation process is insufficient to meet consumer demands for the lighter hydrocarbon fractions. Greater quantities of the lighter fractions are therefore produced via a process referred to as **cracking**.

b. Give an equation for the production of ethene from hexane from a cracking process.

_____

1 mark

The production of ethene from larger hydrocarbons are endothermic processes.

c. (i) State the conditions of temperature and pressure which would result in the greatest yield of ethene in cracking processes.

_____

_____

1 mark

(ii) State one reason why cracking of ethene is often employed using catalysts rather than at higher temperatures?

_____

_____

1 mark

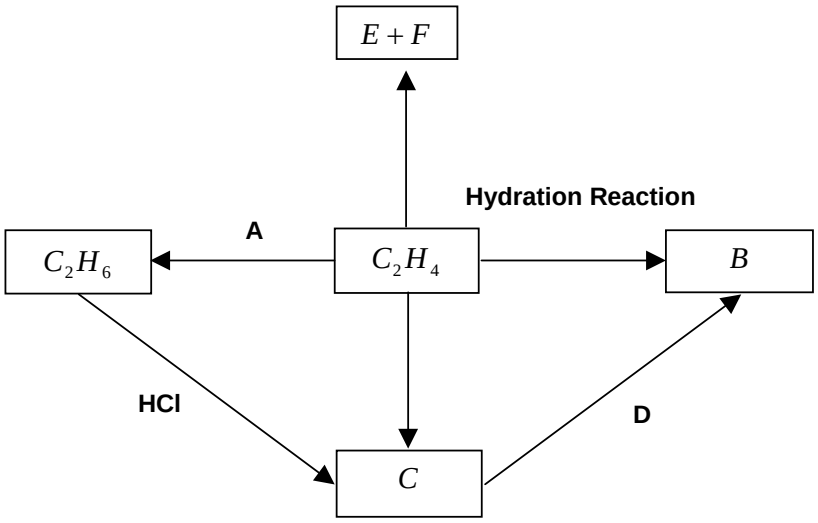
(iii) State two properties of ethene.

_____

_____

1 mark

d. Some common reactions involving ethene are illustrated below.



(i) State the formulae of molecules A and D.

_____

_____

1 mark

(ii) Give the semi-systematic formula of molecule B and the catalyst employed in the hydration of ethene.

_____

_____

1 mark

(iii) When ethene is reacted with insufficient oxygen, molecules E and F are produced. Write a balanced chemical equation to represent this process.

_____

1 mark

Total 10 marks

QUESTION 7

Propanoic acid is a naturally occurring carboxylic acid with chemical formula CH_3CH_2COOH . In the pure state, propanoic acid is a colourless, corrosive liquid with a sharp unpleasant odour.

a. Draw the structural formula of propanoic acid.

1 mark

b. Using an appropriate equation, illustrate how propanoic acid can be produced in a laboratory via an oxidation reaction. In your answer, state the name of any catalyst that is required for this reaction.

1 mark

c. (i) One of the isomers of propanoic acid is a common ester prepared in the laboratory. Draw the structural formula of this ester and state its systematic name.

Structure:

Systematic Name: _____

2 marks

(ii) Using an appropriate alcohol and carboxylic acid, give the chemical equation showing the formation of this ester. State the name of any catalyst used.

1 mark

(iii) Circle a functional group in one organic reactant and one organic product in your equation above.

1 mark

Total 6 marks

END OF PAPER

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