Rossmoyne Senior High School

ATAR course examination

Question/Answer booklet

Semester 2 2020

CHEMISTRY

Please place your student identification label in this box

WA Student number: In figures

In words | | | | | | | | | | | | |

_____

_____

TIME ALLOWED FOR THIS PAPER
Reading time before commencing work: ten minutes
Working time for the paper: three hours

Number of additional answer booklets used (if applicable) ☐

MATERIALS REQUIRED/RECOMMENDED FOR THIS PAPER

To be provided by the supervisor:
This Question/Answer Booklet
Multiple-choice Answer Sheet
Chemistry Data Booklet

To be provided by the candidate:
Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, eraser, correction tape/fluid, ruler, highlighters

Special items: non-programmable calculators approved for use in the WACE examinations

IMPORTANT NOTE TO CANDIDATES
No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of examination
Section One Multiple-choice	25	25	50	/ 25	/ 25
Section Two Short answer	8	8	60	/ 83	/ 35
Section Three Extended answer	5	5	70	/ 93	/ 40
					/ 100

Instructions to candidates

1. Write your answers in this Question/Answer booklet preferably using a blue/black pen. Do not use erasable or gel pens.

2. Answer the questions according to the following instructions.

   Section One: Answer all questions on the separate Multiple-choice answer sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

   Sections Two and Three: Write your answers in this Question/Answer Booklet.

3. When calculating numerical answers, show your working or reasoning clearly. Your working should be in sufficient detail to allow your answer to be checked readily and for marks to be awarded for reasoning. Express numerical answers to the appropriate number of significant figures and include appropriate units where applicable.

4. You must be careful to confine your answers to the specific questions asked and to follow any instructions that are specific to a particular question.

5. Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

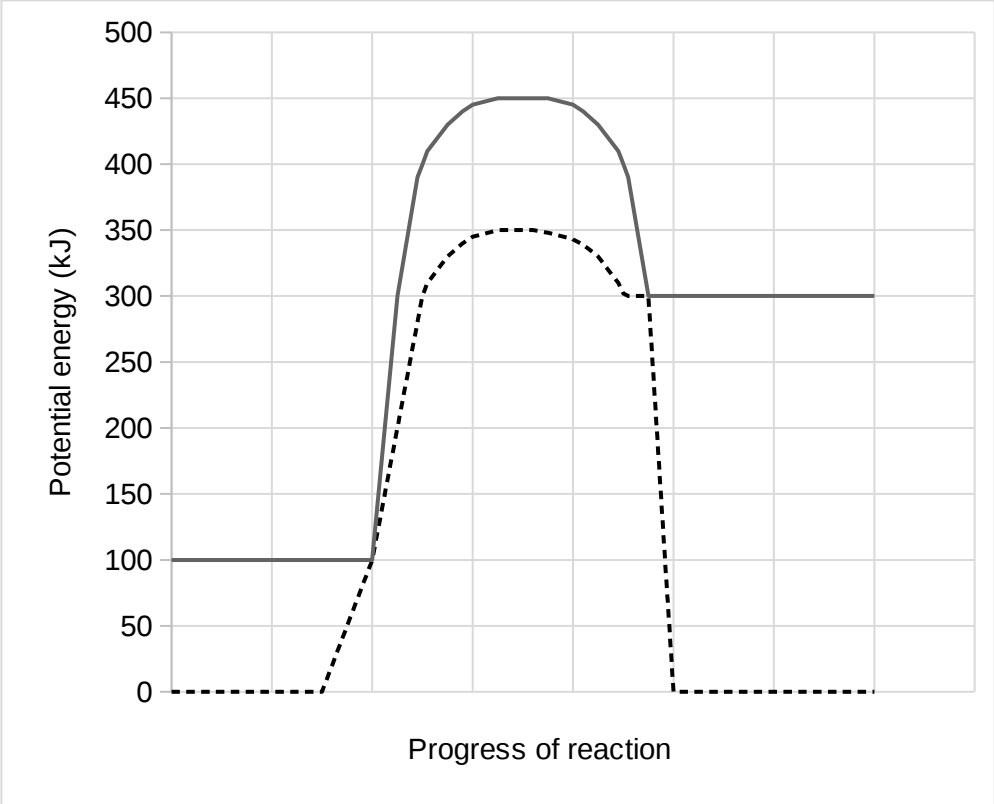
6. The Chemistry Data booklet is not to be handed in with your Question/Answer booklet.

Section One: Multiple-choice **25% (25 marks)**

This section has **25** questions. Answer **all** questions on the separate Multiple-choice Answer Sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 50 minutes.

Questions 1 and 2 refer to the energy profile diagram below.



1. The reaction represented by the **solid** line

   (a) is exothermic.
   (b) has an activation energy of +200 kJ.
   (c) has an enthalpy change of +350 kJ mol^{-1}.
   (d) involves a gain in energy by the system.

2. When compared to the reaction represented by the solid line, which of the following statements is **not** correct regarding the reaction represented by the **dashed** line?

   (a) It would occur at a faster rate.
   (b) It would have a lower enthalpy change.
   (c) It would have a lower activation energy.
   (d) It involves an alternate reaction pathway.

3. Determine the pattern for the oxidation number of **manganese** in the following compounds.

$Mn(s)$, $MnCl_2(aq)$, $MnO_2(s)$, _____

Select the compound that would continue this pattern.

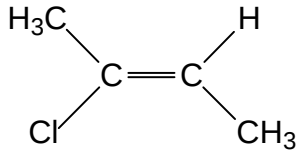
(a) Mn_2O_7

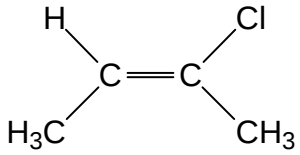
(b) MnF_3

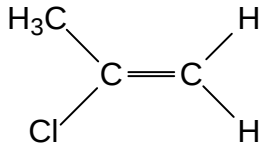
(c) Mn_2O_3

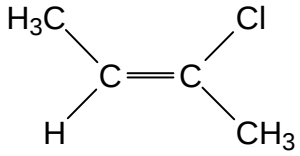
(d) K_2MnO_4

4. Which two molecules are cis/trans isomers of each other?

W 

X 

Y 

Z 

(a) X and Z

(b) X and Y

(c) W and Y

(d) W and Z

5. Which of the following polymers is able to form hydrogen bonds between its chains?

(a) Polyethene

(b) Polytetrafluoroethene

(c) Nylon 6,6

(d) Polyethylene terephthalate

Questions 6, 7 and 8 refer to the data shown in the table below.

Acid	Ka at 25 ºC	Ka at 50 ºC
Hydrofluoric acid (HF)	7.2×10^{-4}	9.1×10^{-4}
Ethanoic acid (CH_3COOH)	1.8×10^{-5}	3.5×10^{-5}

6. Based on the table above which one of the following statements is true?

(a) A solution of CH_3COOH will always have a higher pH than a solution of HF.

(b) A solution of CH_3COOH will always have a lower pH than a solution of HF.

(c) A 0.1 mol L^{-1} solution of CH_3COOH has a higher pH than a 0.1 mol L^{-1} solution of HF.

(d) A 0.1 mol L^{-1} solution of CH_3COOH has a lower pH than a 0.1 mol L^{-1} solution HF.

7. Consider the two conclusions made regarding the data above.

I. Ethanoic acid is a stronger acid than hydrofluoric acid.
II. The ethanoate ion is a stronger base than the fluoride ion.

Which of the statements above is/are correct?

(a) statement I only

(b) statement II only

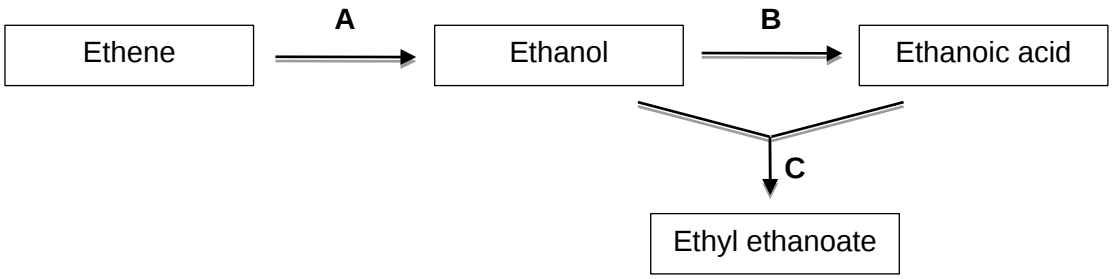
(c) statements I and II

(d) neither statement is true

8. Based on the information in the table, which one of the following conclusions could be made concerning the heating of the acids?

(a) The ionisation of the acids is an endothermic process and the pH of the solutions will decrease.
(b) The ionisation of the acids is an exothermic process and the pH of the solutions will decrease.
(c) The ionisation of the acids is an endothermic process and the pH of the solutions will increase.
(d) The ionisation of the acids is an exothermic process and the pH of the solutions will increase.

Questions 9 and 10 refer to the chemical synthesis reaction sequence shown below.



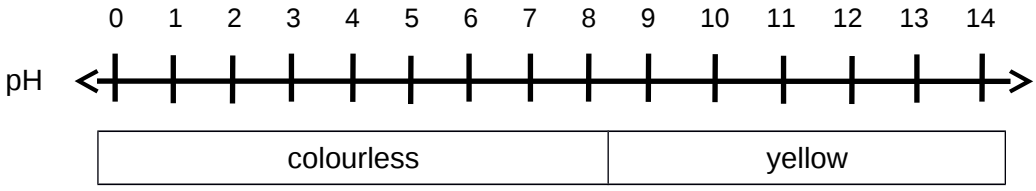
9. Name the processes occurring at A, B and C.

	A	B	C
(a)	hydration	oxidation	esterification
(b)	oxidation	addition	esterification
(c)	addition	hydration	hydrolysis
(d)	hydrogenation	oxidation	dehydration

10. Which catalyst needs to be added at A, B and C for the reactions to proceed as indicated?

(a) H_2SO_4
(b) H_2O
(c) NaOH
(d) H_2O_2

11. The indicator M-Nitrophenol is used for an acid-base titration.



Select the option below that lists the appropriate solution in each flask and the corresponding colour change that would be observed.

	Burette	Conical flask	Colour change
(a)	KOH(aq)	CH_3COOH(aq)	colourless to yellow
(b)	HCl(aq)	NH_3(aq)	yellow to colourless
(c)	HF(aq)	NaOH(aq)	colourless to yellow
(d)	$Ba(OH)_2$(aq)	HNO_3(aq)	yellow to colourless

Questions 12 and 13 relate to the Haber process.

The Haber process can be represented by the chemical equation below.

$$N_2(g) + 3\,H_2(g) \rightleftharpoons 2\,NH_3(g) + 92\ kJ$$

12. Periodically, the ammonia is removed from the reaction chamber. What **immediate** effect would this have on the rate of reaction?

(a) The forward reaction rate would increase.
(b) The reverse reaction rate would increase.
(c) The forward reaction rate would decrease.
(d) The reverse reaction rate would decrease.

13. Which of the following conditions will maximise **both** the rate of formation and equilibrium yield of ammonia?

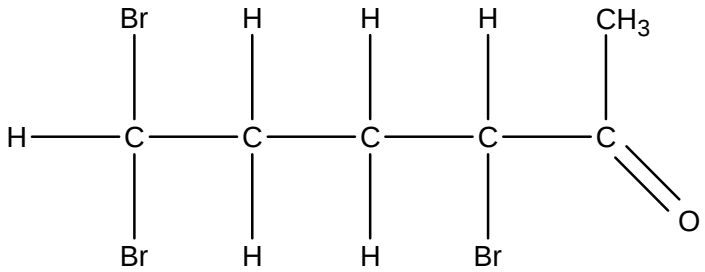
(i) An increased concentration of reactants
(ii) An increased pressure caused by a decrease in volume
(iii) An increased temperature
(iv) Addition of a catalyst

(a) (i) and (ii) only
(b) (ii) and (iii) only
(c) (i) and (iv) only
(d) all of (i), (ii), (iii) and (iv)

14. During the process of electrorefining impure (blister) copper, several different metal impurities are removed. Which statement is **incorrect** regarding the various metal impurities found in blister copper?

(a) Ag would be found in the anode slime.
(b) Zn would be oxidised to $Zn^{2+}(aq)$.
(c) Ni would be found in the anode slime.
(d) Fe would be oxidised to $Fe^{2+}(aq)$.

15. Select the correct IUPAC name for the molecule shown below.

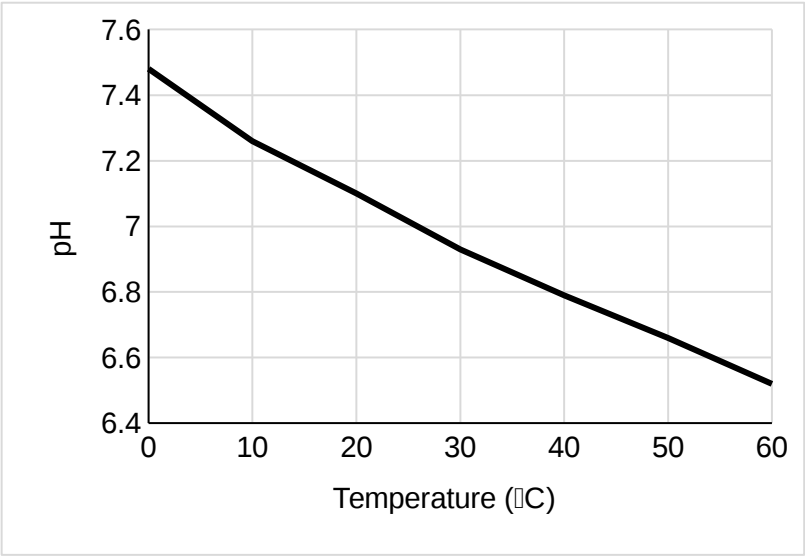


(a) 2,5,5-tribromo-1-methylpentanal.
(b) 1,1,4-tribromohexan-5-one.
(c) 3,6,6-tribromohexan-2-al.
(d) 3,6,6-tribromohexan-2-one.

16. A chemist carried out an experiment to investigate the auto-ionisation of water.

$$H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$$

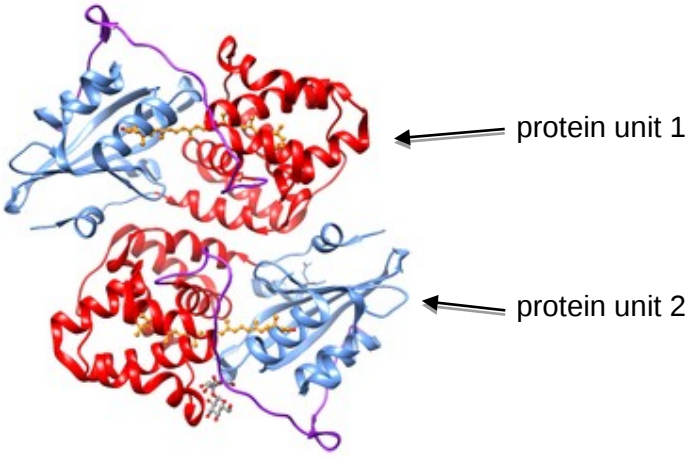
The data collected by the chemist is shown in the graph below.



Which of the following hypotheses is **not** directly related to the data collected in this experiment?

(a) An increase in water temperature will favour the forward reaction.
(b) An increase in water temperature will increase the forward reaction rate.
(c) The auto-ionisation of water is exothermic.
(d) The concentration of $H_3O^+(aq)$ in water is temperature-dependant.

17. The following diagram has been taken from the Protein Data Bank (PDB). It shows the structure of the 'orange carotenoid protein' which is a dimer consisting of two proteins.



This type of 'ribbon structure' provides **least** information about the

(a) primary structure of the protein.
(b) secondary structure of the protein.
(c) tertiary structure of the protein.
(d) protein-protein interactions.

Questions 18 and 19 refer to the information in the table below.

	Boiling point	Solubility in water at 20 ˚C
Butan-1-ol	118 ˚C	7.7 g / 100 mL
Octan-1-ol	195 ˚C	0.1 g / 100 mL

18. The boiling point of octan-1-ol is higher than butan-1-ol because octan-1-ol has

(a) stronger dispersion forces.
(b) stronger dipole-dipole forces.
(c) stronger hydrogen bonds.
(d) stronger ion-dipole forces.

19. The aqueous solubility of butan-1-ol is greater than octan-1-ol because butan-1-ol has

(a) more significant dispersion forces.
(b) more significant dipole-dipole forces.
(c) more significant hydrogen bonds.
(d) more significant ion-dipole forces.

Question 20 and 21 refer to the information below

Biodiesel is normally produced from vegetable oils, animal fats and waste cooking oils through a transesterification process. At present, biodiesel is mainly produced using alkaline catalysts such as NaOH and KOH. An alternative method to produce biodiesel has been developed using lipase instead of the alkaline catalysts.

20. A list of **potential** benefits of using lipase instead of NaOH as a catalyst is written below.

I. reduction in unwanted saponification
II. improved quality of glycerol by-products requiring less purification
III. faster rate of reaction

Which one of the following lists the **true benefits** of using lipase instead of NaOH solution?

(a) I only
(b) I and II only
(c) I and III only
(d) II and III

21. Which one of the following statements is **NOT** true of lipase?

(a) Lipase is a protein.
(b) Lipase has high reusability.
(c) Lipase reduces the need for high operating temperatures.
(d) Lipase functions best between 70 and 80 ^{o}C.

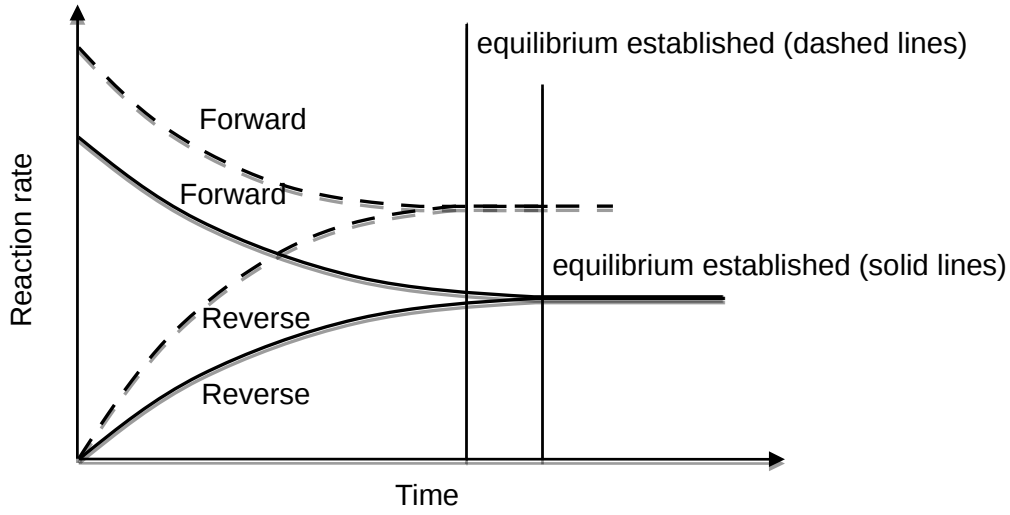
22. Soaps are less effective than detergents in hard water, because the soap ion

(a) does not contain a charged group.
(b) only contains a short non-polar region.
(c) neutralises hard water.
(d) precipitates $Ca^{2+}(aq)$ ions in hard water.

23. Consider the following gaseous equilibrium system;

$$2\ NO_2(g) \rightleftharpoons N_2O_4(g)$$

The **solid** lines on the following graph represent the establishment of equilibrium under a particular set of conditions for this system.



Which of the following changes to this system would **not** result in the establishment of a new equilibrium as indicated by the **dashed** lines?

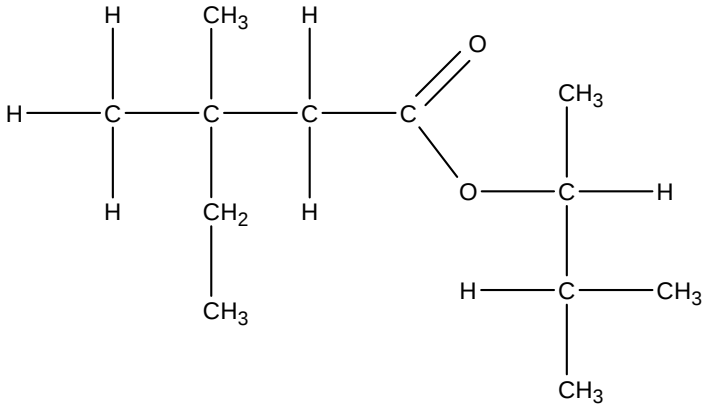
(a) An increase in the temperature of the system.
(b) A decrease in the volume of the system.
(c) The addition of helium gas to the system.
(d) The addition of an appropriate catalyst.

24. The wet corrosion of iron (Fe) occurs in the presence of oxygen gas (O_2) and water (H_2O). The iron reacts to become iron(II) ions, $Fe^{2+}(aq)$, whilst the water and oxygen gas form hydroxide ions, $OH^-(aq)$. The iron(II) ions and hydroxide ions then precipitate to form iron(II) hydroxide, $Fe(OH)_2(s)$. Over time, this precipitate forms iron(III) hydroxide, $Fe(OH)_3(s)$ which then dehydrates to form iron(III) oxide, $Fe_2O_3(s)$, which is commonly called rust.

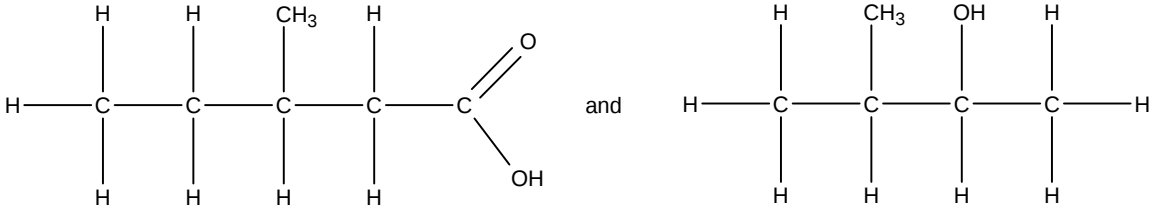
Which of the following statements is **not** correct, regarding the corrosion process described?

(a) The oxidation number of O_2 is decreased.
(b) The solid Fe loses electrons.
(c) The H_2O acts as the oxidising agent.
(d) The precipitation of $Fe(OH)_2$ is not a redox process.

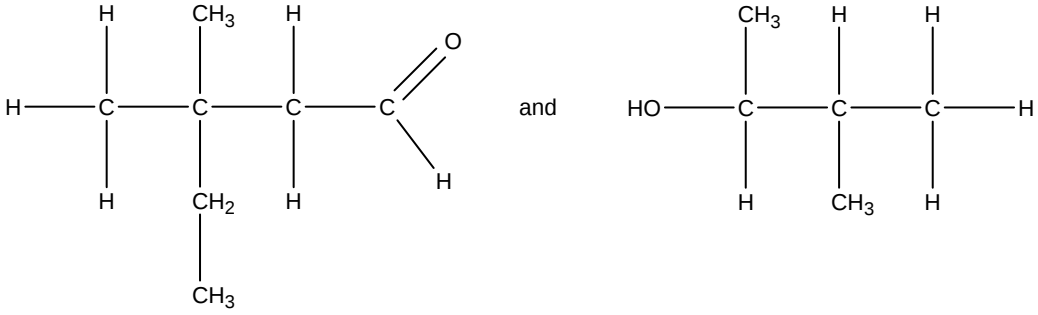
25. Which pair of substances could react, in the presence of an appropriate catalyst, to form the compound below?



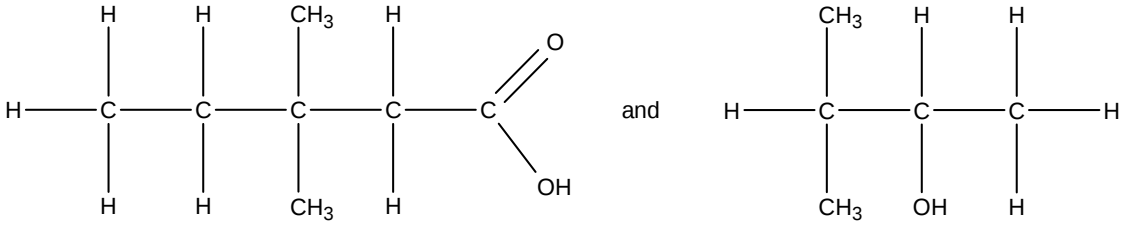
(a)



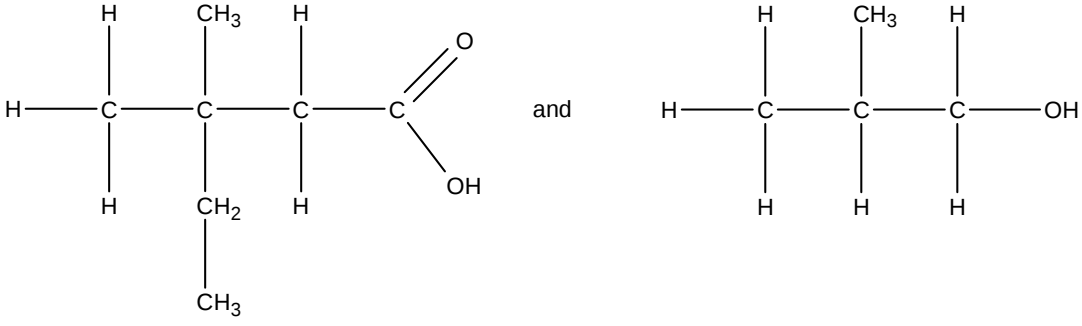
(b)



(c)



(d)



End of Section One

Section Two: Short answer **35% (83 marks)**

This section has **8** questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 60 minutes.

Question 26 **(12 marks)**

Consider 0.05 mol L^{-1} solutions of sodium hydrogencarbonate, potassium hydrogensulfate and lithium phosphate. The table below lists these salts, along with K_c values for the corresponding hydrolysis reactions.

0.05 mol L^{-1} solution	Hydrolysis equation	K_c of hydrolysis reaction
$NaHCO_3(aq)$		2.4×10^{-8}
$KHSO_4(aq)$		1.2×10^{-2}
$Li_3PO_4(aq)$		2.3×10^{-2}

(a) Complete the table above, by writing the hydrolysis equation that would take place in each solution. (3 marks)

(b) Rank these solutions in order from lowest to highest pH. (3 marks)

Lowest pH		Highest pH

The pH of a lithium carbonate solution, $Li_2CO_3(aq)$, was tested with a pH meter and determined to be 10.3.

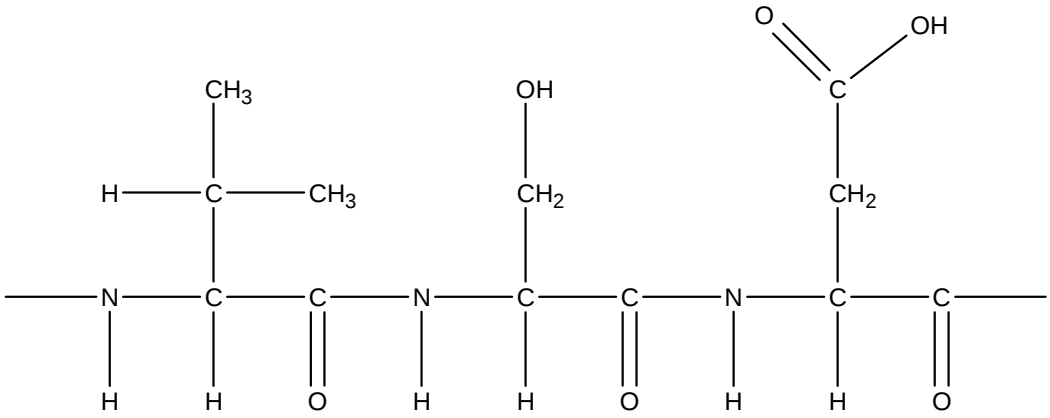
A chemistry student had 8.50 mL of 0.0500 mol L^{-1} barium hydroxide solution, $Ba(OH)_2(aq)$. They wanted to dilute the barium hydroxide so that it would have the same pH as the lithium carbonate solution.

(c) Calculate the volume of water the student would need to add to the barium hydroxide solution, to produce the same pH as the lithium carbonate. (6 marks)

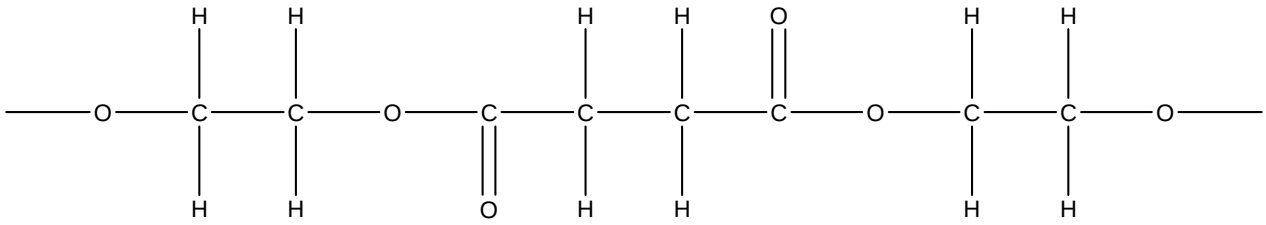
Question 27 **(9 marks)**

Consider the three (3) different polymer fragments shown below.

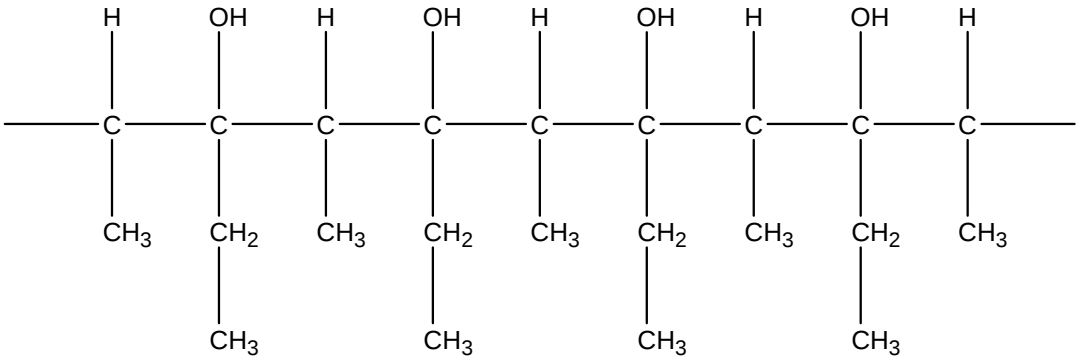
A



B



C



(a) Classify the polymers as having been formed by addition or condensation polymerisation by writing the letters A, B and C in the appropriate column in the table. (3 marks)

Addition polymerisation	Condensation polymerisation

(b) Draw the monomer(s) used to form each of these polymers. (6 marks)

A	
B	
C	

Question 28 **(7 marks)**

Ethanol is a flammable liquid that can be used as a fuel for cars. One method for producing ethanol is by first producing ethene. Ethene is obtained by the cracking of long hydrocarbon chains found in crude oil. Ethene is then converted to ethanol.

(a) Write a balanced chemical equation to show the production of ethanol from ethene. (3 marks)

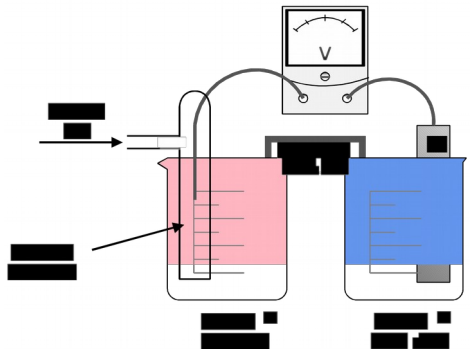
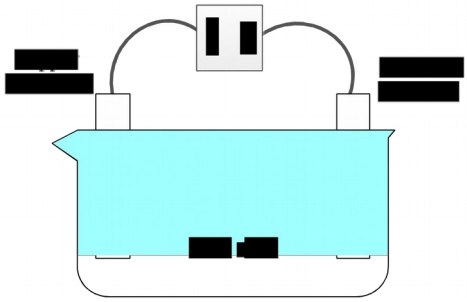
(b) Another method for producing ethanol is from the fermentation of sugar from sugar cane. The method is described below.

- Sugar cane plants are grown as a crop on farmland.
- Sugar cane plants are crushed and soaked in water to produce a sugar solution.
- The sugar solution is separated from the plant material.
- Yeast is added to the sugar solution and fermented.
- The yeast is separated from the solution of water and ethanol.
- Ethanol is separated from water by fractional distillation.

Describe the advantages of producing ethanol by fermentation compared with ethanol production using crude oil. You answer must include environmental advantages, in terms of sustainability, local resources, economics and environmental impacts. (4 marks)

Question 29 **(13 marks)**

Consider the two systems below operating at standard conditions.

System A	System B
	

(a) Contrast the **function** of these two systems by listing three key differences between system A and B (3 marks)

1 _____

2 _____

3 _____

(b) Label the anode in each system on the diagrams above. (2 marks)

(c) Write the anode half equation for each system (2 marks)

System A	
System B	

(d) State three observations what would be made as ‘System B’ operates. (3 marks)

1 _____

2 _____

3 _____

(e) Explain why silver nitrate solution would not be suitable for the salt bridge in ‘System A’. (3 marks)

_____

_____

_____

Question 30 **(9 marks)**

Telluric acid has the formula H_6TeO_6. In solid form, it is found as white crystals. These crystals dissolve in water to produce hydronium ions, $H_3O^+(aq)$. The K_a values for telluric acid at 18 ˚C are given below.

$K_{a1} = 2.09 \times 10^{-8}$ $K_{a2} = 1.00 \times 10^{-11}$

(a) Classify telluric acid as strong or weak (circle your choice). Justify your answer. (2 marks)

strong OR weak

(b) Classify telluric acid as monoprotic or polyprotic (circle your choice). Justify your answer. (2 marks)

monoprotic OR polyprotic

(c) Label and link the conjugate acid-base pairs in the following equation. (2 marks)

$$H_6TeO_6(aq) + HPO_4^{2-}(aq) \rightleftharpoons H_2PO_4^-(aq) + H_5TeO_6^-(aq)$$

Telluric acid can be produced by the oxidation of solid tellurium dioxide, $TeO_2(s)$, by hydrogen peroxide solution. In this reaction, hydrogen peroxide forms water.

(d) Write the oxidation and reduction half-equations and the overall redox equation for this reaction, assuming acidic conditions. (3 marks)

Oxidation half-equation	
Reduction half-equation	
Overall redox equation	

Question 31 **(8 marks)**

(a) Give the IUPAC names for isomers of $C_3H_6O_2$ matching each description below. (2 marks)

	IUPAC Name
A sweet or fruity smelling liquid	
A weak electrolyte with a pH below 7	

(b) Give the IUPAC names for isomers of $C_5H_{12}O$ matching each description below. (2 marks)

	IUPAC Name
A primary alcohol	
A tertiary alcohol	

(c) Draw full structural diagrams for isomers of $C_2H_2F_2$ matching each description below. Include **all** bonds and **all** atoms. (2 marks)

The *cis* geometric isomer	The *trans* geometric isomer

(d) Draw full structural diagrams for isomers of C_4H_8O matching each description below. Include **all** bonds and **all** atoms. (2 marks)

A compound that can be oxidised by acidified $KMnO_4$ solution	A compound that cannot be oxidised by acidified $KMnO_4$ solution

Question 32 **(18 marks)**

Consider the following system in a closed 1.00 L container at equilibrium.

$$4\ HC\ell(g) + O_2(g) \rightleftharpoons 2\ C\ell_2(g) + 2\ H_2O(g) \qquad \Delta H = -300\ kJ\ mol^{-1}$$

(a) Compare and contrast the terms ‘open system’ and ‘closed system.’ (2 marks)

(b) Explain the meaning of the term *dynamic equilibrium*. (2 marks)

(c) Apply collision theory to the forward and reverse reactions to explain the effect on the yield of the reaction above by removing oxygen gas from the closed system. (4 marks)

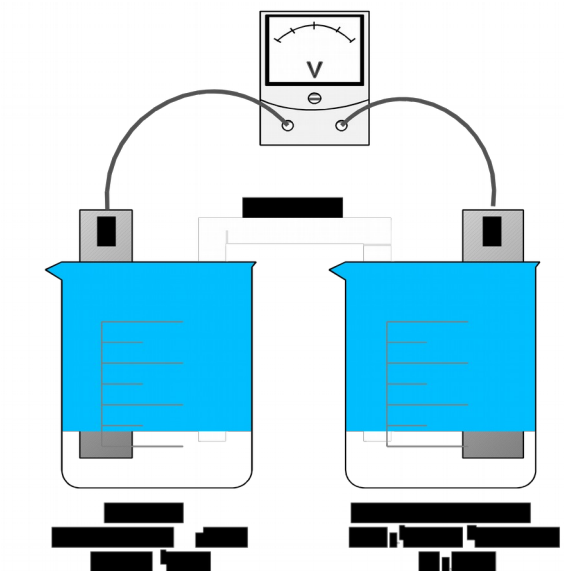
(d) The system above has an equilibrium constant value much greater than 1. Based on this information, describe the appearance of the system above at equilibrium. (2 marks)

(e) Complete the table below by circling the correct option, describing the equilibrium after sufficient time has elapsed from the imposed change. (8 marks)

Imposed change	**Effect on appearance of the system**	**Effect on rate of the forward reaction**
Decreasing the volume of the vessel	Appears more greenish yellow Appears less greenish yellow No observable change	Faster Slower No Effect
Addition of a catalyst	Appears more greenish yellow Appears less greenish yellow No observable change	Faster Slower No Effect
Increasing the temperature of the system	Appears more greenish yellow Appears less greenish yellow No observable change	Faster Slower No Effect
Removing water vapour	Appears more greenish yellow Appears less greenish yellow No observable change	Faster Slower No Effect

Question 33 **(7 marks)**

Consider the galvanic cell below using platinum electrodes **X** and **Y.**



Upon analysis, it is found that as the cell above discharges the bromate ion (BrO_3^-) is converted to bromine (Br_2) in the half cell connected to electrode Y.

(a) In the spaces below write the equations for the reactions occurring at the anode and the cathode. (3 marks)

Anode reaction	
Cathode reaction	

(b) Combine these two equations to provide the overall redox equation. (2 marks)

(c) When the cell above discharges (at standard conditions) 0.43 volts are generated. Use this information to calculate the standard reduction potential for the half cell connected to electrode Y. (2 marks)

End of Section Two

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Section Three: Extended answer **40% (93 marks)**

This section contains **five (5)** questions. You must answer **all** questions. Write your answers in the spaces provided below.

Where questions require an explanation and/or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression. Lists or dot points are unlikely to gain full marks.

Final answers to calculations should be expressed to the appropriate number of significant figures.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 70 minutes.

Question 34 **(20 marks)**

The following reversible reaction between chromate (CrO_4^{2-}) and dichromate ($Cr_2O_7^{2-}$) was set up in a beaker and allowed to establish equilibrium. The initial colour of the equilibrium system was a light orange. The equilibrium can be represented by the following equation;

$$\underset{\textit{yellow}}{2\ CrO_4^{2-}(aq)} + 2\ H^+(aq) \rightleftharpoons \underset{\textit{orange}}{Cr_2O_7^{2-}(aq)} + H_2O(l)$$

This equilibrium system is ‘pH dependent’.

(a) Complete the following table, by writing the colour this equilibrium system would appear at both a low and a high pH. (2 marks)

Colour at low pH	Colour at high pH

The equilibrium mixture was then divided equally into 2 smaller beakers. The separate beakers, Beaker 1 and Beaker 2, were treated as described below.

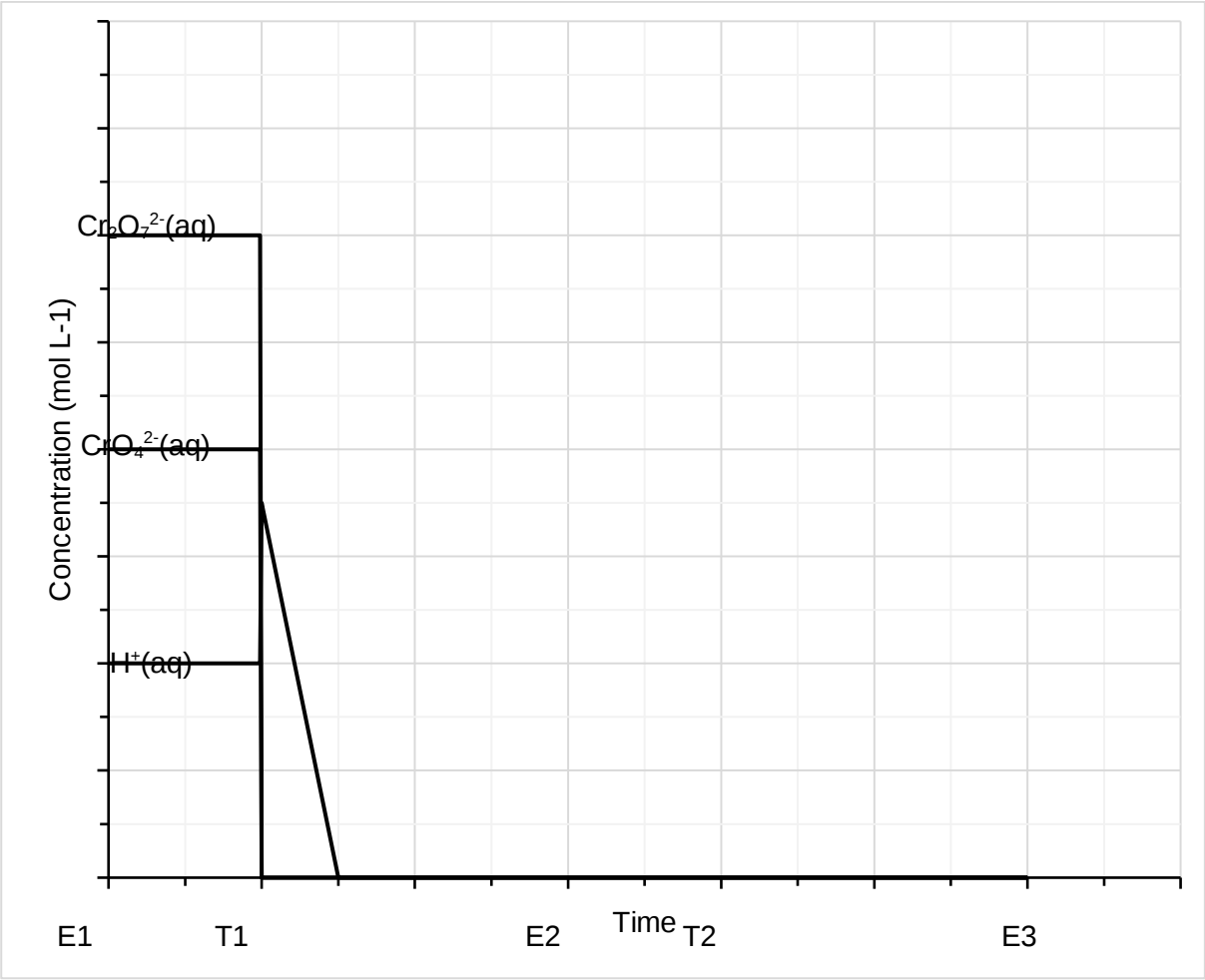
Beaker 1

- Firstly, 10 drops of 2 mol L^{-1} HCl(aq) were added at Time T1, and equilibrium was re-established at Time E2.
- Next, 10 drops of 2 mol L^{-1} NaOH(aq) were added at Time T2, and equilibrium was once again re-established at Time E3.

You may assume the increase in volume due to the added HCl(aq) and NaOH(aq) are negligible.

The following graph represents the equilibrium in Beaker 1.

$$2\ CrO_4^{2-}(aq) + 2\ H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(l)$$



(b) Plot the concentration for each of the ions shown on the graph, from Time T1 to Time E3. (8 marks)

(c) Why isn't a curve for water concentration plotted on the graph? (1 mark)

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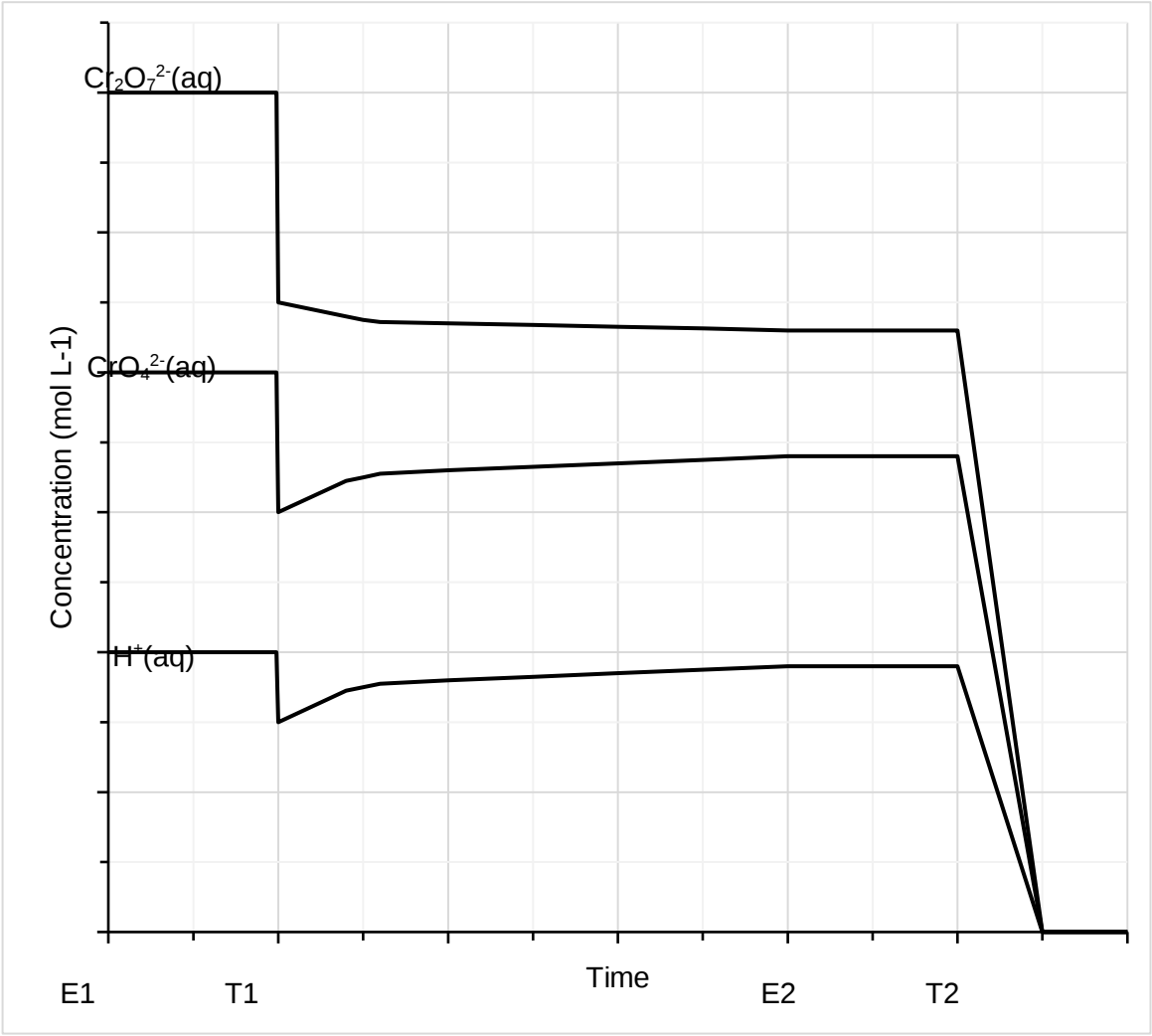
Question 34 (continued)

Beaker 2

The following graph represents the equilibrium in Beaker 2.

$$2\ CrO_4^{2-}(aq) + 2\ H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(l)$$

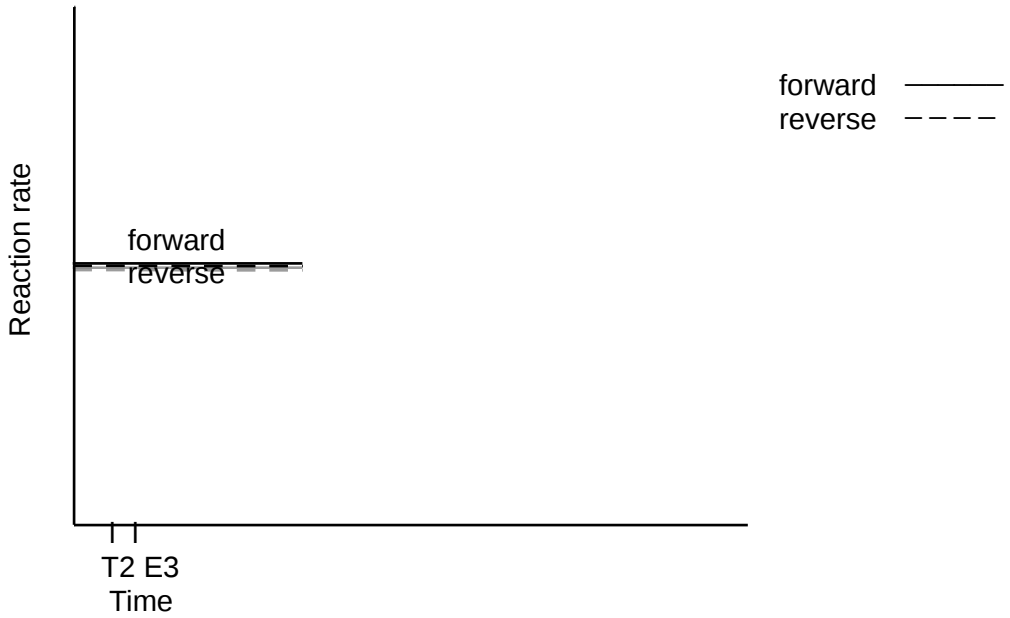


(d) State the change imposed at Time T1. Justify the subsequent equilibrium shift using Le Chatelier's Principle. (3 marks)

At Time T2, Beaker 2 was placed into an ice bath. Over several minutes, the equilibrium became a more yellow colour.

(e) Explain what information this provides about the heat of reaction (ΔH) for this equilibrium system. (3 marks)

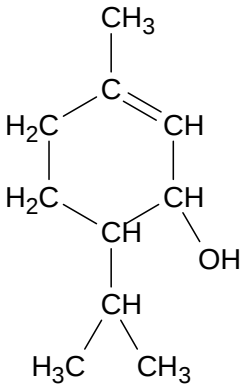
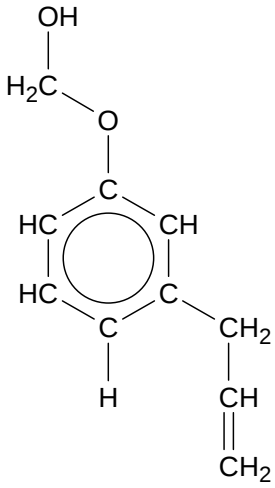
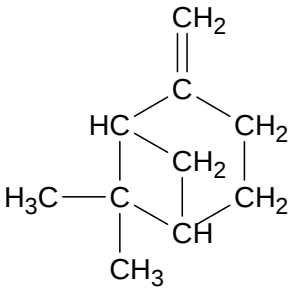
(f) Complete the reaction rate graph below, for both the forward and reverse reaction rates, from Time T2 until the re-establishment of equilibrium at Time E3. (3 marks)



Question 35 **(16 marks)**

In traditional Aboriginal culture, native plants have been used for many generations to treat or heal those who are sick or injured. Research is now being carried out on many of the various plants that were used by Aboriginal peoples and has found that they often contain well known anti-bacterial or anti-inflammatory compounds.

The table below gives information on three (3) compounds that have been identified in native Australian plants which were used by Aboriginal peoples to treat various medical conditions.

Name of compound	Terpinenol	Eugenol	Pinene
Extracted from	Tea tree oil	Australian lemongrass	Eucalyptus oil
Aboriginal medicinal use	treating wounds and throat ailments	treating headaches, colds and muscle pain	treating body pain, fever and chills
Structure			

A chemist was given a pure sample of each of these 3 compounds for analysis. However, the samples were not labelled.

(a) Explain why the addition of bromine water to each of these samples would **not** be a useful distinguishing test. (2 marks)

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The compound ‘pinene’ could quickly be distinguished from the other two compounds by adding a few drops of acidified sodium dichromate solution to each.

(b) Justify how this test would allow for the identification of pinene, including relevant observations in your answer. (Note that equations are **not** required.) (3 marks)

The chemist then used combustion analysis to distinguish ‘terpinenol’ and ‘eugenol’. A 7.58 g sample of one of the compounds was taken for analysis. Upon combustion, 20.33 g of carbon dioxide and 4.99 g of water vapour was produced.

(c) Determine the empirical formula of this sample and identify which compound was being analysed. (9 marks)

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Question 35 (continued)

The chemist then carried out two further chemical tests with the compound identified by combustion analysis in part (c).

(d) Draw structural diagrams for the resulting organic compound formed when the substance identified in (c) reacts
(i) with bromine water
(ii) with acidified sodium dichromate. (2 marks)

	bromine water, $Br_2(aq)$	chemical test described in part (b)
Organic product formed		

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Question 36 **(15 marks)**

A beaker contained 135 mL of 0.273 mol L^{-1} hydrochloric acid, HCl(aq). A group of chemistry students were given some 0.198 mol L^{-1} ammonia solution, $NH_3(aq)$, and asked to neutralise the acid.

They measured 344 mL of the ammonia solution and poured it into the beaker containing the hydrochloric acid. The equation for the reaction that took place is given below.

$$HCl(aq) + NH_3(aq) \rightarrow NH_4Cl(aq)$$

(a) Determine, by calculation, whether all the hydrochloric acid was neutralised upon addition of the ammonia. (4 marks)

(b) Calculate the final concentration, in mol L^{-1}, of any excess reagent present. (3 marks)

(c) Calculate the final concentration, in mol L^{-1}, of ammonium chloride product. (2 marks)

One of the chemistry students in the group, proposed that the final mixture in the beaker would act as a buffer solution.

(d) Was this student correct? Justify your answer using relevant chemical theory. Include a brief description of how the student's hypothesis could be tested experimentally. (6 marks)

Question 37 **(21 marks)**

A student was asked to determine the percentage purity of a sample of salicylic acid ($C_7H_6O_3$). The method used by the student is described below.

- 1.500 g of portion of the impure salicylic acid being analysed was placed in a weighing bottle.
- The contents were tipped into a beaker and approximately 100 mL of distilled water was added.
- Salicylic acid does not dissolve well in cold water so the beaker and its contents were heated gently until all the solid had dissolved.
- The solution was poured into a 250.0 mL volumetric flask and made up to the mark with distilled water.
- 25 mL samples of the solution were then titrated against a standard solution of sodium hydroxide with a concentration of 0.0776 mol L^{-1} and the following results were obtained.

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**	**Trial 5**
Initial reading	0.55 mL	13.05 mL	24.65 mL	0.85 mL	12.55 mL
Final reading	13.05 mL	24.65 mL	37.85 mL	12.55 mL	24.10 mL
Volume added					

(a) Complete the table above and calculate the average titre for the experiment. Show clearly how you calculated the average titre. (3 marks)

(b) Salicylic acid ($C_7H_6O_3$) is a weak monoprotic acid. Given this information use the results above to calculate the percentage by mass of the 1.500 g portion of the impure salicylic acid being analysed. (7 marks)

(c) Explain how the calculated percentage composition of salicylic acid would be affected (above or below the true value) if the pipette used to collect each of the 25.00 mL samples of dilute acid solution were rinsed with water before each use. (4 marks)

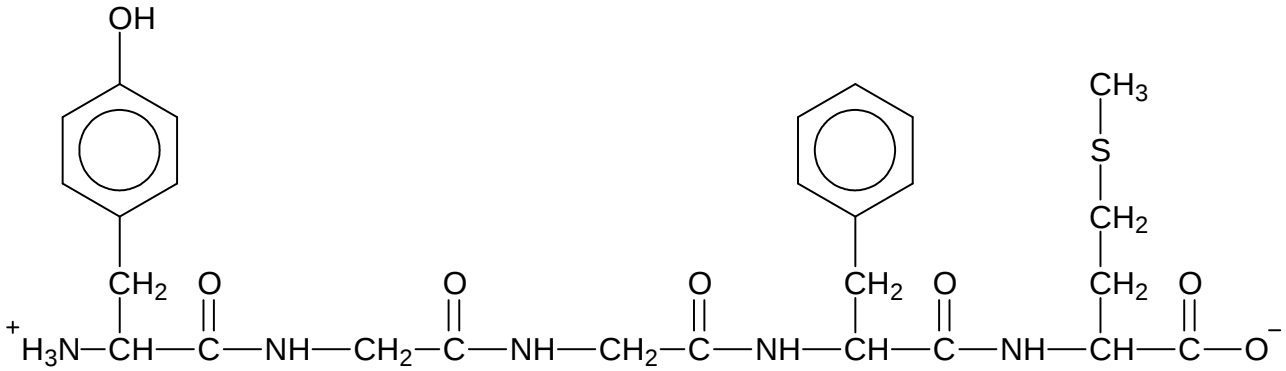
Question 37 (continued)

(d) This titration (between the weak monoprotic salicylic acid ($C_7H_6O_3$) and the strong base., sodium hydroxide) was carried out using phenolphthalein as an indicator since it changes colour at a pH greater than 7. Using chemical equations to justify your answer, show that this indicator was the correct choice. (4 marks)

(e) Salicylic acid can be used to make a home remedy to remove warts from skin. Calculate the amount of the impure salicylic acid that would need to be dissolved in 1.00 L of distilled water to produce a 'home remedy solution' with a salicylic acid concentration of 17 mg per 100 mL. (If you could not work out part (b) use 85.0%) (3 marks)

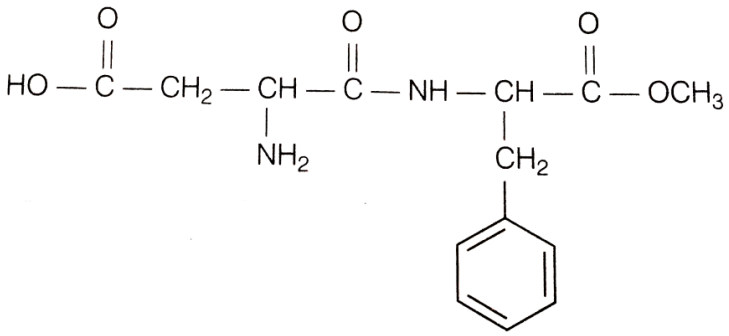
Question 38 **(21 marks)**

The combination of several amino acids can produce small polypeptide molecules. Below is a representation of a pentapeptide.



(a) In the space provided write the primary structure of the pentapeptide above using the abbreviated (three–letter) codes for each amino acid. (3 marks)

(b) Below is the structure of an artificial sweetener known as aspartame. It is used in foods and beverages as a sugar substitute. It is a methyl ester of a simple dipeptide. When it is heated under acidic conditions, two amino acids are produced.



(i) One of the amino acids produced is phenylalanine, name the other amino acid. (1 mark)

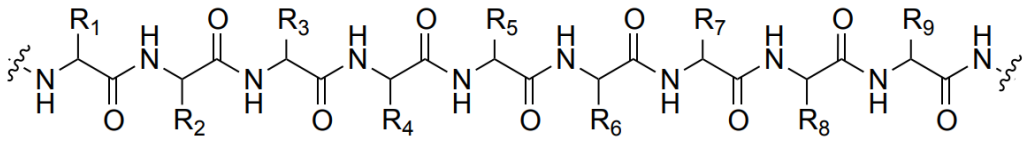
(ii) Draw the structure of the amino acid phenylalanine as it would predominantly exist when in acidic solution. (1 mark)

(c) Consider the structures and common names of two amino acids proline and alanine.

(i) Draw the structure of the zwitterion of proline in the box below. (2 marks)

(ii) Draw the structure of the tripeptide formed when a proline molecule bonds to two alanine molecules, one on each side. (2 marks)

(d) Describe, using diagrams to assist your answer, how the polypeptide chain shown below would form an alpha helix given that the interaction that stabilises the structure is between amino acid 5 (the one with the R5 side chain) and amino acid 1 (the one with the R1 side chain). (4 marks)

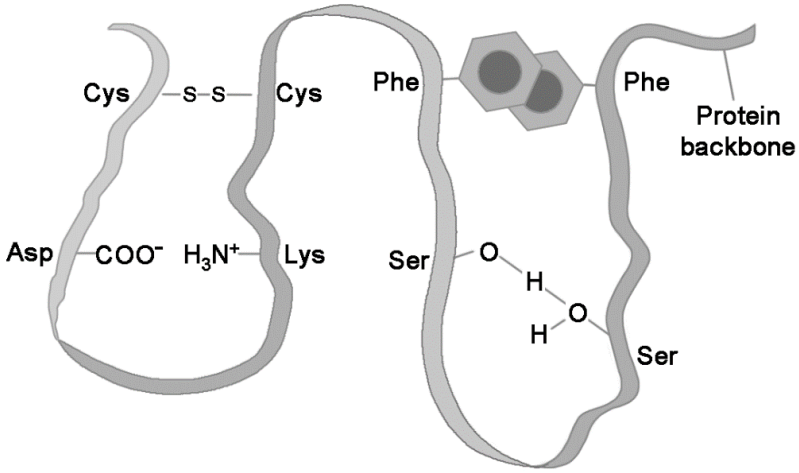


Question 38 (continued)

(e) Any given protein is characterised by a unique primary structure and tertiary structure. Explain how these are related. (2 marks)

(f) Consider a large protein molecule composed of only the following amino acids (Cysteine, Methionine, Valine and Threonine) combined repeatedly and in random orders. List three types of interactions (bonds or other forces) that would contribute to the tertiary structure of this protein. (3 marks)

(g) Consider the protein representation below. Using the diagram to assist your answer, explain clearly how reducing the pH can result in denaturing the protein. (3 marks)



End of questions

Spare answer page

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Acknowledgements

Q 17 Orange carotenoid protein
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Marking Guide

Section		Questions	Marks	Your Mark	Section Total	Section as % of Exam (4SF)
1		1-25	50		/50	
2	TW	26	12		/83	
	TW	27	9			
	MD	28	7			
	MD	29	13			
	MD	30	9			
	TF	31	8			
	BL	32	18			
	BL	33	7			
3	TF	34	20		/95	
	TF	35	16			
	BL	36	15			
	JV	37	21			

	JV	38	21			