Christ Church Grammar School

Year 12 Chemistry
Mid-year Examination 2016

Section One: Multiple Choice **25 marks (25% of paper)**

This section contains 25 questions. Answer all questions on the Multiple–choice Answer Sheet provided. Use blue or black pen only. If you make a mistake, place a cross through that square. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is given for any question.

Suggested working time for this section is 50 minutes.

1.	B
2.	C
3.	C
4.	D
5.	C
6.	D
7.	B
8.	D
9.	C
10.	C
11.	A
12.	C
13.	B
14.	A
15.	D

16.	A
17.	C
18.	A
19.	B
20.	D
21.	B
22.	C
23.	C
24.	B
25.	C

END OF SECTION ONE

Section Two: Short Answer **70 marks (35% of paper)**

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

When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to three significant figures and include appropriate units where applicable.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page
- Continuing an answer. If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested time for working for this section is 60 minutes.

Question 26 **(7 marks)**

Write balanced ionic equations for the following reactions

(i) Solid potassium oxide and methanoic acid

$$K_2O + 2HCOOH \rightarrow 2HCOO^- + 2K^+ + H_2O \checkmark\checkmark$$

(salt allowed)

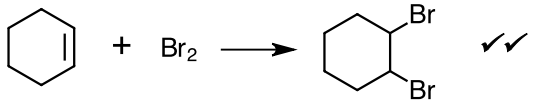
(2 marks)

(i) Glycine and sodium hydroxide solution

$$H_3N^+\text{-}CH_2\text{-}COO^- + OH^- \rightarrow H_2N\text{-}CH_2\text{-}COO^- + H_2O \checkmark\checkmark$$

(2 marks)

(ii) Bromine water is added to cyclohexene



✓✓

(2 marks)

Observation: *orange liquid is rapidly decolourised* ✓

(1 mark)

Question 27 **(1 mark)**

Write an expression for the equilibrium constant, K, for the following reaction

$$Fe_3O_4(s) + 4\,H_2(g) \rightleftharpoons 3\,Fe(s) + 4\,H_2O(g)$$

$$K = \frac{[H_2O]^4}{[H_2]^4} \quad \checkmark$$

Question 28 **(9 marks)**

Consider the following reaction:

$$C_5H_{12} + Br_2 \rightleftharpoons C_5H_{11}Br + HBr \qquad \Delta H = +ve$$

The melting points and boiling points of each of the species in the process are given in the table below:

Species	Melting point (^{0}C)	Boiling point (^{0}C)
C_5H_{12}	-129	36
Br_2	-7.2	58.5
$C_5H_{11}Br$	-95	130
HBr	-87	-67

a) Four identical reaction vessels were set up containing 1 mole of C_5H_{12} and 1 mole of Br_2 at 200°C.

Vessel 1 the mixture was allowed to reach equilibrium
Vessel 2 the temperature was decreased to 50°C and the mixture was allowed to reach equilibrium
Vessel 3 1 mole of xenon gas was added and the mixture was allowed to reach equilibrium
Vessel 4 a catalyst was added and the mixture was allowed to reach equilibrium

Compare the rate of attainment of equilibrium and the mass HBr produced in containers 2, 3 and 4 to that in Container 1 (increase, decrease, remain the same).

	Effect on the rate of attainment of equilibrium	Effect on the mass of HBr(g)
Vessel 2	*Decrease*	*Decrease*
Vessel 3	*No effect*	*No effect*
Vessel 4	*Increase*	*No effect*

(6 marks)

(b) Predict the effect of the following changes on the position of the equilibrium.

Change	Effect on the equilibrium (left, right, no change)
The volume of the container is increased at 100^{O}C	*Left*
HBr is added at constant temperature at 25^{O}C	*Left*
Bromine is added at constant temperature at 25^{O}C	*No change*

(3 marks)

Question 29 **(12 marks)**

Consider the equilibrium:

$$4\ NH_3(g) + 5\ O_2(g) \rightleftharpoons 4\ NO(g) + 6\ H_2O(g) \quad \Delta H = -908\ kJ$$

When the following changes are imposed on the system at equilibrium, describe the change in the equilibrium concentration of NO(g) and the rate of the forward reaction. (Use the terms increase, decrease or no change)

Change	Effect on [NO]	Effect on forward rate of reaction
The volume of the vessel is decreased	*Increase*	*Increase*
The temperature is decreased	*Increase*	*Decrease*
Addition of a suitable catalyst	*No change*	*Increase*
Addition of H_2O at constant volume	*Decrease*	*Increase*

(8 marks)

(b) What conditions of temperature and pressure would be most suitable to optimise the production of NO? Give an explanation for your answer.

Compromised temperature ✓
Maximised yield from lower T - this favours exothermic direction but at the expense of a lower rate – proportion of collisions with E > or = to Ea. ✓

Compromised pressure ✓
Maximised yield from lower P – this favours yield as there are 9 volumes of gas on the products side vs 10 on the reactants ✓. This would again be at the expense of rate – reduced frequency of collisions.

(4 marks)

Question 30 **(6 marks)**

(a) Write an equation to represent the ionisation of water

$H_2O \rightarrow OH^- + H^+$ *or* $2H_2O \rightarrow OH^- + H_3O^+$

(1 mark)

The following table shows the pH of water at three different temperatures

Temperature (°C)	pH
10	7.27
30	
50	6.63

(b) Given that the value of K_w is 1.47×10^{-14} at 30°C, calculate the pH of water at this temperature and enter your value in the table above

$[H^+] = \sqrt{1.47 \times 10^{-14}} = 1.21 \times 10^{-7}$ ✓

$pH = -\log[6.855 \times 10^{-8}] = 6.91$ ✓

(2 marks)

(c) Considering water at 10°C, would you expect it to be acidic, basic or neutral. Circle your answer below:

acidic basic (neutral)

(1 mark)

(d) Explain your answer to (c)

If a solution is neutral then [H+] and [OH-] are equal✓.
As it is pure water the [ ] of each must be equal. ✓

(2 marks)

Question 31 **(8 marks)**

(a) The following ionic salts were all dissolved separately in equal volumes of water at 25°C. The approximate pH of the solutions formed was measured and recorded as being either neutral ('7'), acidic ('5') or basic ('9'). Complete the table below.

salt dissolved	approximate pH ('5','7' or '9')
potassium nitrate	*7*
ammonium chloride	*5*
sodium phosphate	*9*
potassium hydrogensulfate	*5*

(4 marks)

(b) One further ionic salt, phosphonium ethanoate, PH_4CH_3COO was dissolved in water and was found to have a pH of below 7. Use your knowledge of acid/base chemistry to account for this observation. Use equations to support your answer.

$PH_4^+ + H_2O \rightarrow PH_3 + H_3O^+$ ✓ *equation 1*

$CH_3COO^- + H_2O \rightarrow CH_3COOH + OH^-$ ✓ *equation 2*

Since pH<7, $[H^+]$ must be greater than $[OH^-]$ ✓

And so position of eqm in equation 1 must be further over to the r.h.s. than in equation 2. ✓

(4 marks)

Question 32 **(7 marks)**

Calculate the pH of the solution formed when 43.0mL of 0.200molL^{-1} nitric acid is added to 15.0mL of 0.300molL^{-1} barium hydroxide (at 25°C).

$n(HNO_3) = \frac{43}{1000} \times 0.2 = \quad 8.6 \times 10^{-3}$ mol ✔

$n(Ba(OH)_2) = \frac{15}{1000} \times 0.3 = \quad 4.5 \times 10^{-3}$ mol ✔

Total $n(OH^-) = 2 \times 4.5 \times 10^{-3} = 9 \times 10^{-3}$ mol ✔

n(OH-) left = $9 - 8.6 \times 10^{-3} = 4 \times 10^{-4}$ mol ✔

[OH-] = 4 x10-4/0.058 = 6.897 x 10-3

[H+] = = $\frac{1 \times 10^{-14}}{6.897 \times 10^{-3}} = 1.45 \times 10^{-12}$ ✔

pH = - log $[1.45 \times 10^{-12}] = 11.8$ ✔

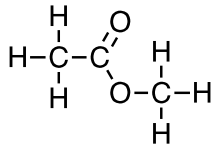
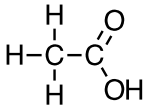
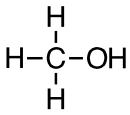
Question 33 **(6 marks)**

A sweet smelling liquid, **A**, has a molecular formula $C_3H_6O_2$. **A** was prepared from reacting liquids **B** and **C** in the presence of concentrated H_2SO_4.

Liquid **B** produces a colourless, odourless gas when added to solid sodium carbonate.

Liquid **B** has a higher molar mass than liquid **C**.

Identify possible structures for liquids **A**, **B** and **C**.

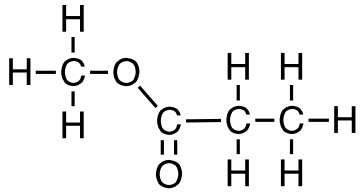
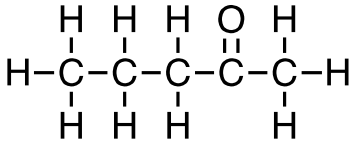
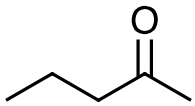
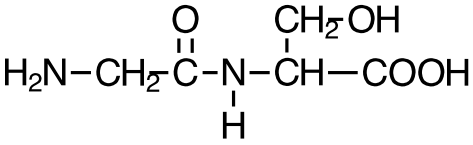
Name of Liquid **A** ***Methyl ethanoate***	Structure of Liquid **A** 
Name of Liquid **B** ***Ethanoic acid***	Structure of Liquid **B** 
Name of Liquid **C** ***methanol***	Structure of Liquid **C** 

(6 marks)

If "Liquid B has a higher molar mass than liquid C" is missed then deduct one mark if all other logic is correct.

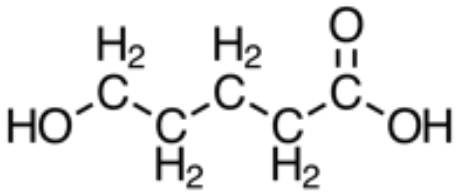
Question 34 **(6 marks)**

Complete the following table, drawing the full structural formula and giving the name of each substance.

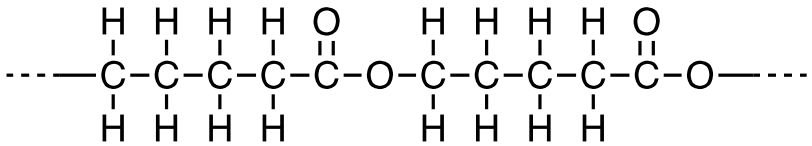
Substance	Full structural formula
An ester that is a structural isomer of ethyl ethanoate	 IUPAC Name: ***methyl propanoate***
An oxidation product of pentan-2-ol	 **or**  IUPAC Name: ***pentan-2-one***
The dipeptide Gly-Ser, as it exists in basic conditions	 No name required.

Question 35 **(4 marks)**

The following molecule (MW = 106.12 $gmol^{-1}$) can be used to produce a polymer when it is heated under acidic conditions.



a) Draw the structure of the polymer, showing two repeating units. (2 marks)

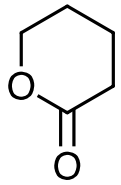


b) What class of polymer is this an example of? (1 mark)

Condensation / polyester

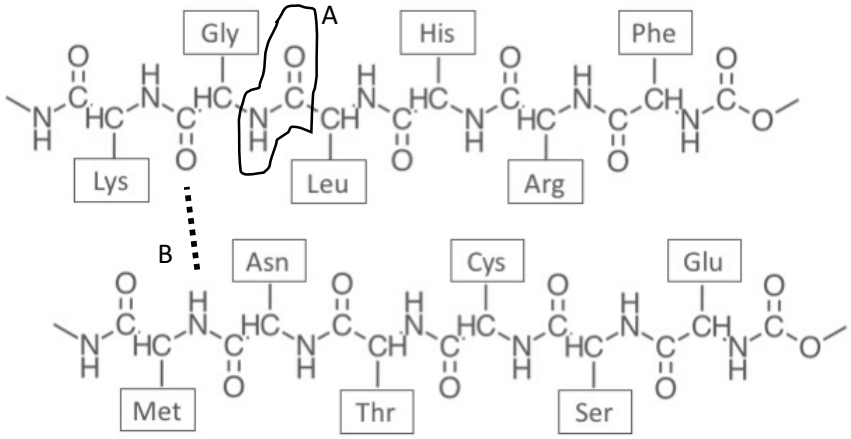
c) Under these reaction conditions, a small amount of a cyclic compound (MW = 88.104 $gmol^{-1}$) was also found to be produced. Draw the structure of this cyclic compound.

(1 mark)



Question 36 **(4 marks)**

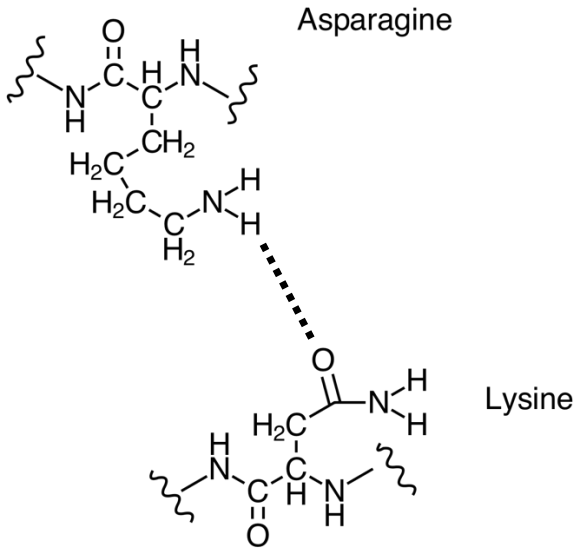
Below is a section of a protein showing 2 parallel strands of the same polypeptide chain.
The side chains of each amino acid are abbreviated, using their 3-letter abbreviation.



a) The primary structure of a protein involves the sequence of amino acids, each joined by amide (peptide) bonds. Circle an amide (peptide) bond in the diagram above – labelling it with the letter A. (1 mark)

b) The secondary structure of a protein includes β-pleated sheets and α-helices. Draw one of the bonds responsible for these secondary structures on the diagram above. Label it with the letter B. (1 mark)

c) Asparagine (Asn) and Lysine (Lys) are two amino acids in close proximity in the protein structure above. Their structures are shown in full below.



i) What type of intermolecular force is responsible for the attraction between these two amino acids?

Hydrogen bonding

(1 mark)

ii) Draw a dashed line showing this interaction on the diagram above. (1 mark)

END OF SECTION TWO

Section Three: Extended answer **80 marks (40% of paper)**

This section contains **six** questions. You must answer **all** questions. Write your answers in the spaces provided.

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 three significant figures.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
•Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
•Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

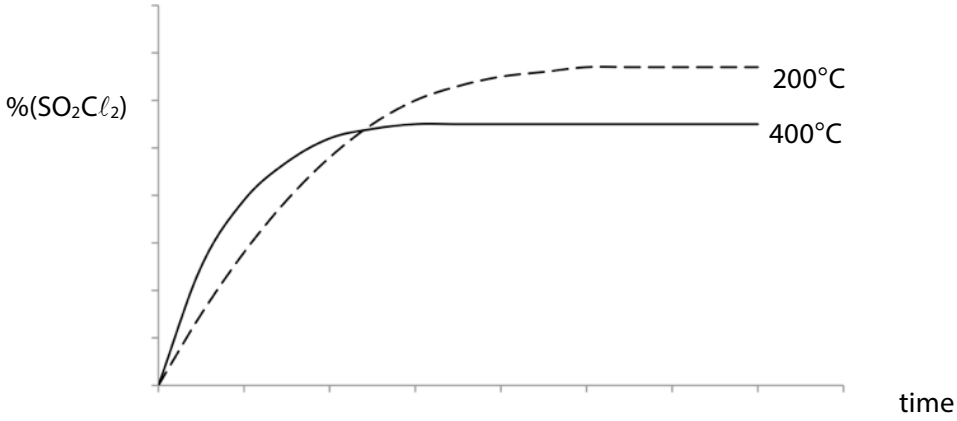
Suggested working time for this section is 70 minutes.

Question 37 **(15 marks)**

Consider the reaction below :

$$SO_2(g) + C\ell_2(g) \rightleftharpoons SO_2C\ell_2(g)$$

The following graph shows the change in percentage of $SO_2C\ell_2$ in the reaction mixture during its preparation at different temperatures:

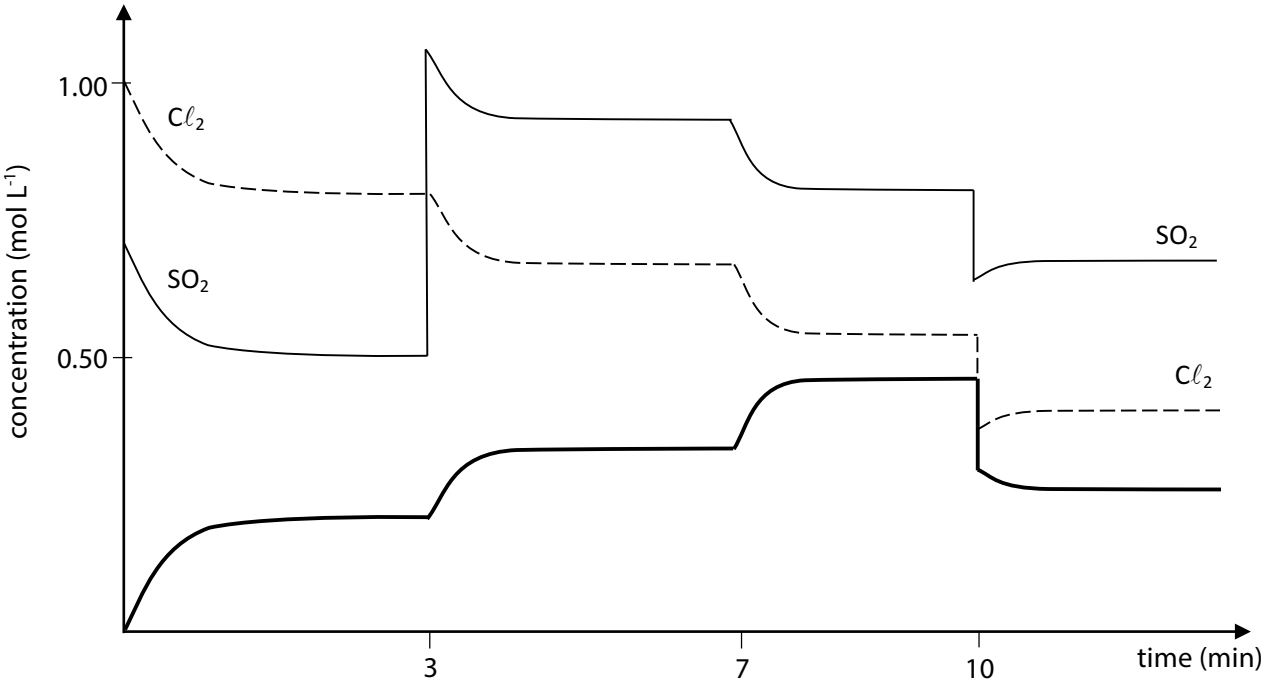


(a) Is the forward reaction endothermic or exothermic? Explain.

Exothermic ✓
Yield decrease with T increase ✓
LCP states with an increase in temperature favours the endothermic reaction ✓

(3 marks)

In a particular experiment the reactants were mixed in a 1 L container and the mixture was allowed to come to equilibrium. Changes were made to the system at 3, 7 and 10 minutes. The concentrations of the reactants are plotted against time in the graph below:



(b)Plot the concentration of $SO_2C\ell_2$ on the axes. (4 marks)

(c) What different events happened at the 3 minute, 7 minute and 10 minute marks? Give an explanation for the effect of the change on the system.

Time	What change occurred	Explanation of the change on the system
3 minutes	*SO_2 gas is added*	*$[SO_2]$ increased so forward rate increases due to more collisions* *As forward rate increases $[Cl_2]$ and $[SO_2]$ decreases*
7 minutes	*Temperature is decreased*	*As $[Cl_2]$ and $[SO_2]$ decreases* *As the reaction is exothermic LCP states the exothermic reaction will be favoured*
10 minutes	*Volume is increased*	*[ ] of both reactants decreases* *The equilibrium shifts left to the side with more moles to counteract the decrease*

(9 marks)

Question 38 **(13 marks)**

Oxalic acid (HOOCCOOH) is a weak, diprotic acid that can be used as a primary standard in acid/base titrations.

In a particular experiment, 4.78g of oxalic acid was dissolved in water and made up to 500mL in a volumetric flask.

(a) Calculate the concentration of the oxalic acid solution.

n(Oxalic) $= \frac{4.78}{90.036} = 0.0531 \text{ mol}$ **[oxalic] = 0.0531/ 0.5 = 0.10618 = 0.106 molL^{-1}**

(2 marks)

'Lye' is a solid that consists of potassium hydroxide contaminated with some impurities. A 2.27g pellet of lye was dissolved in water and made up to 250mL.

20mL aliquots (samples) of this solution were titrated against the oxalic acid prepared earlier.

The colours of two indicators are shown below, along with the pH range at which they change colour.

Indicator	pH change range	Colour at low pH	Colour at high pH
Methyl orange	4-6	red	yellow
Phenolphthalein	8-10	colourless	pink

(b)(i) Which indicator would you choose for this titration? Circle your chosen answer

Methyl orange **Phenolphthalein**

(ii) What colour change would you expect to see at the end point for your chosen indicator?

Colour changes from __ ***pink*** _____ to _____ ***colourless*** _____

(3 marks)

The table of results used in the titration is shown below. Complete the table and calculate the average titre

	1	2	3	4
Final reading (mL)	14.95	29.25	43.65	15.15
Initial reading (mL)	0.00	14.95	29.25	0.80
Titre (mL)	***14.95***	***14.3***	***14.4***	***14.35***

The average titre is _____***14.35***_____ mL

(1 mark)

(c) Use this average titre and the concentration of oxalic acid from (a) to calculate the percentage purity of potassium hydroxide in the lye. You may assume that the impurities in the lye have no acidic or basic properties

$n(oxalic) = \frac{14.35}{1000} \times 0.106 = 1.52 \times 10^{-3}$ *mol*✓

2 x n(OH^-) = n(oxalic)

n(OH-) in 20 mL = 2 x 1.52 x 10^{-3} = 0.0305 mol✓

n(OH-) in 250 mL = 0.0305 x 250/20 = 0.0381 mol✓

m(OH-) = 0.0381 x 56.108 = 2.137 g✓

% purity = 2.137/2.27 x 100 = 94.152 = 94.2✓

(5 marks)

(d) If the burette had been rinsed with distilled water before filling it with the oxalic acid, what effect would would this have had on the calculated purity of the lye?

Decreased **Unchanged** **(Increased)**

Question 39 **(15 marks)**

Most of Australia's copper deposits are in the form of the mineral chalcopyrite ($CuFeS_2$). Copper is extracted from this ore by roasting the powdered mineral in air. The chemical reactions for the roasting process are shown below.

Reaction 1 $2CuFeS_2(s) + 4O_2(g) \rightarrow Cu_2S(s) + 2FeO(s) + 3SO_2(g)$

Reaction 2 $Cu_2S(s) + O_2(g) \rightarrow 2Cu(l) + SO_2(g)$

A particular ore body contains 13.6% chalcopyrite by mass. In order to extract the copper it is first crushed and the mineral component, chalcopyrite is then roasted according to the chemical reactions above.

(a) What mass of ore is required to produce 1 tonne of Cu metal?

$n(Cu) = (CuFeS_2) = \frac{1\times10^6}{63.55} = 15735.64123 mol$

$M(CuFeS_2) = 183.54$

$m(CuFeS_2) = 15735.64123 \times 183.54 = 2888119.591$ g of chalcopyrite

m(ore) = 288119.591 x 100/13.6 = 21236173.47 = 21.2 tonnes of ore

(4 marks)

Generally, these industries have an on-site sulphuric acid plant where the by-product of the copper extraction (SO_2) is reacted with oxygen to from sulfur trioxide (SO_3). The sulfur trioxide is then reacted with water to produce sulphuric acid.

(b) Write balanced chemical equations for the reactions of sulfur dioxide with oxygen and subsequently the reaction of the product with water.

$2SO_2 + O_2 \rightarrow 2SO_3$

$SO_3 + H_2O \rightarrow H_2SO_4$

(2 marks)

(c) Determine the volume of sulphur dioxide produced during reactions 1 and 2 that would result from the treatment of one tonne of chalcopyrite ore. The gas is released at atmospheric conditions of 101kPa and 27°C and the process has a 100% yield.

$n(CuFeS_2) = 1 \times 10^6/183.54 \times 0.136 = 740.98$ mol

from equation 1

$n(SO_2) = \frac{3}{2} x\ 740.93 = 1111.4$ mol

from equation 2

$n(SO_2) = \frac{1}{2} x\ 740.923 = 370.47$mol

Total $n(SO_2) = = 1111.4 + 370.47 = 1481.89$ mol

$V = \frac{1481.89\times8.314\times300.15}{101} = 36613 = 36600$ L (3 s.f.)

(6 marks)

(d) Determine the mass of sulphuric acid produced per tonne of chalcopyrite ore if the reaction of sulphur dioxide with oxygen is 93% efficient. Assume the reaction of the product with water gives a 100% yield.

Total $n(SO_2) = 1481.89$ mol

$n(SO_3) = 1481.89 \times 93/100 = 1378.16$

$n(SO_3) = n(H_2SO_4) = 1378.16$ mol

$m(H_2SO_4) = 1378.16 \times 98.086 = 135177.97$ g = 135 kg

(3 marks)

Question 40 **(9 marks)**

One of the more common buffer solutions is that formed between benzoic acid and sodium benzoate.

$$C_6H_5COOH \rightleftharpoons C_6H_5COO^- + H^+$$

In order to prepare such a buffer, the chemist performed the following steps

1. He measured 100.0mL of 1.00molL-1 benzoic acid into a beaker
2. To this solution, he added 144g of sodium benzoate and stirred until it had all dissolved
3. He made the solution up to exactly 500mL in a volumetric flask
4. He measured the pH of this buffer solution and it was found to be 5.2.

(a) Calculate the concentration of benzoic acid in the buffer solution

$n(C_6H_5COOH) = 100/1000 \times 1 = 0.1$ mol

$[C_6H_5COOH] = 0.1/0.5 = 0.2$ molL^{-1}

(2 marks)

(b) Calculate the concentration of benzoate ions in the buffer solution

$n(C_6H_5COO^-) = 144/144.09 = 1.00$ mol

$[C_6H_5COO^-] = 1.000/0.5 = 2.00$ molL^{-1}

(2 marks)

(c) Calculate the concentration of hydrogen ions ions in the buffer solution

$[H^+] = 10^{-5.2} = 6.31 \times 10^{-6}$ molL^{-1}

(1 mark)

(d) He tested his buffer solution by adding five drops of concentrated (10.0molL^{-1}) sodium hydroxide solution. He was pleased that the pH only changed by a very small amount. Explain how this buffer minimised the change in pH, using equations as necessary.

Addition of OH- causes the following reaction to occur:

$C_6H_5COOH + OH^- \rightarrow C_6H_5COO^- + H_2O$

According to LCP, the position of equilibrium shifts to partially offset any imposed change. As the [H+] will not have changed significantly, the pH will only change by a very small amount.

(2 marks)

(e) He also tested the buffer by adding adding five drops of concentrated ($10.0 mol L^{-1}$) hydrochloric acid and found that the change in pH was even less. Explain why the change in pH was less than when he added the sodium hydroxide solution.

As there is a higher concentration of the benzoate ion, there is more present to undergo the following reaction:

$$C_6H_5COO^- + H^+ \rightarrow C_6H_5COOH$$

Buffering capacity for the addition of acid is greater than for the addition of base.

(2 marks)

Question 41 **(17 marks)**

An organic compound X is known to contain carbon, hydrogen, nitrogen and oxygen. When burnt in excess oxygen, a 2.45 g sample of X produced 1.35 g of water and 3.66 g of carbon dioxide.

A second sample of X, of mass 1.60 g, was treated to convert all of the nitrogen present to N_2 gas. At 25 °C and 105 kPa, the N_2 produced had a volume of 128 mL.

a) Calculate the empirical formula of compound X. (10 marks)

$m(C) = \frac{12.01}{44.01} \times 3.66 = 0.9988\ g$ $\%\ C = \frac{0.9988}{2.45} \times 100 = 40.77\%$

$m(H) = \frac{2.016}{18.016} \times 1.35 = 0.1511\ g$ $\%H = \frac{0.1511}{2.45} \times 100 = 6.17\%$

$n = \frac{PV}{RT} = \frac{105 \times 0.128}{8.314 \times 298.15} = \frac{13.44}{2478.8191} = 5.42 \times 10^{-3}\ mol$

$m = 5.42 \times 10^{-3} \times 28.02 = 0.152\ g$

$\%N = \frac{0.152}{1.60} \times 100 = 9.5\%$

$\%O = 100 - 40.77 - 6.17 - 9.50 = 43.56\%$

	C	H	N	O
% or mass in 100g	40.77 ÷ 12.01	6.17÷1.008	9.50÷14.01	43.56÷16.00
n	3.3947÷0.6781	6.1210÷0.6781	0.6781÷0.6781	2.7225÷0.6781
ratio	5	9	1	4

$C_5H_9NO_4$

b) A second 1.98 g sample of compound X was found to occupy 0.231 L at 40° C and 150 kPa. Determine the molecular formula of compound X.

E.F. = 147.132

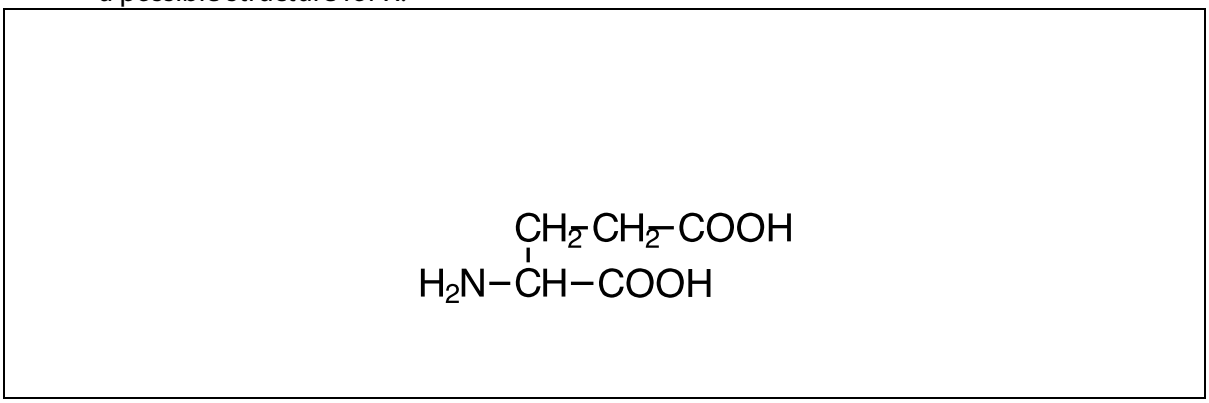
M = 1.98 x 8.314 x 313.15 ÷ 150 x 0.231 = 148.77

$$\frac{MF}{EF} = \frac{148.77}{147.132} \approx 1$$

MF = EF *MF = $C_5H_9NO_4$*

(3 marks)

c) X is known to be an alpha amino acid containing 2 acidic hydrogen atoms per molecule. Draw a possible structure for X.



(2 marks)

d) Determine the volume of 0.12 molL^{-1} NaOH needed to neutralise a solution containing 12 g of compound X.

n(X) = $\frac{12}{147.132} = 0.0816$ *mol*

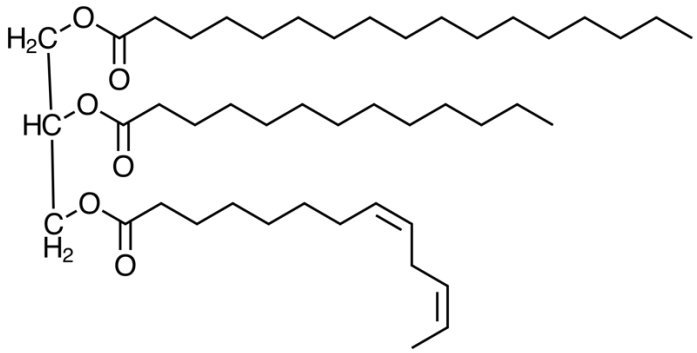
n(H+) = 2 x 0.0816 = 0.163 mol

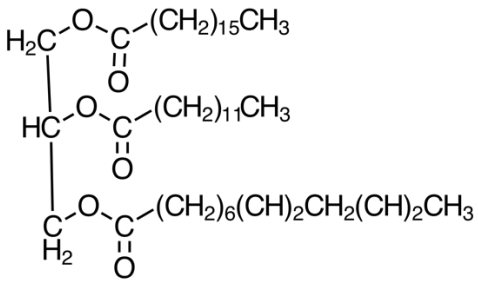
V = $\frac{0.163}{0.12} =$ *1.36 L*

(2 marks)

Question 42 **(11 marks)**

Fatty acids are stored in the human body in the form of triglycerides. One such triglyceride is shown below, using two different notations.

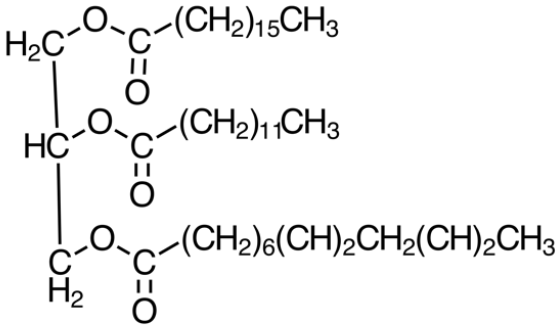




a) Write an equation to represent the hydrolysis of the triglyceride above in acidic conditions. Use the boxes provided to draw the reactants and products respectively.

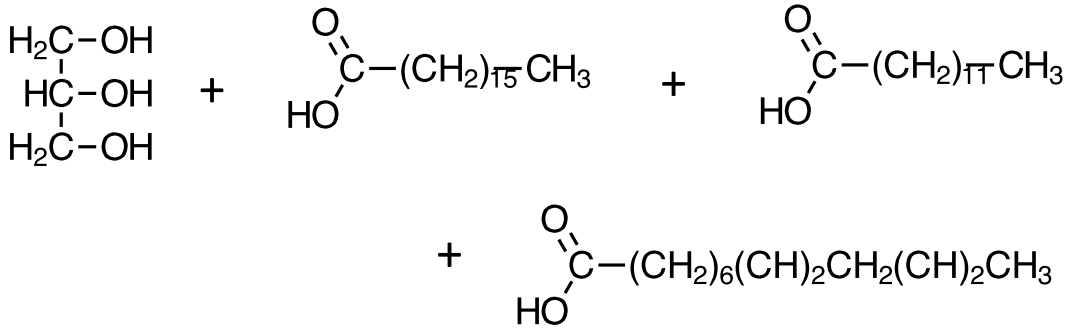
(5 marks)

Reactants

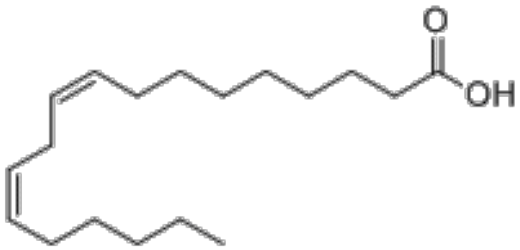
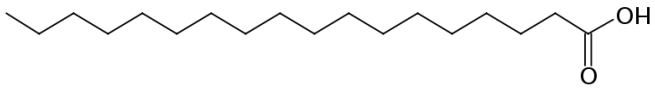
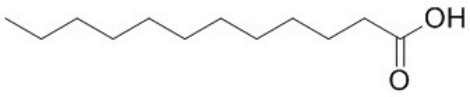


H_3O^+ (or H^+, H_2O)

Products



b) Three of the common fatty acids found in mammals are linoleic acid, stearic acid and lauric acid

	Structure	MW	Melting point (°C)
Linoleic acid $C_{18}H_{32}O_2$		280.45 $gmol^{-1}$	-5 °C
Stearic acid $C_{18}H_{36}O_2$		284.47 $gmol^{-1}$	69 °C
Lauric acid $C_{12}H_{24}O_2$		200.32 $gmol^{-1}$	43 °C

i) Explain why stearic acid has a higher melting point than lauric acid.

Intermolecular forces present are H-bonds and dispersion. ✓
As mass is high for both molecules dispersion forces are significant.

The strength of dispersion forces is proportional to the number of electrons present in linear molecules. ✓

As there are more electrons present in stearic acid, the strength of the dispersion forces present between molecules is higher than the strength of forces present in lauric acid. ✓

More energy required to break intermolecular forces in stearic, therefore higher melting point.

(3 marks)

ii) Hibernating animals possess enzymes called *desaturases* that convert saturated fatty acids into unsaturated fatty acids during winter. This lowers the melting point of the fats and prevents them from freezing. Explain why unsaturated linoleic acid has a lower melting point than stearic acid, which is saturated.

Dispersion forces are the most significant intermolecular force.

As MW for each molecule is similar, dispersion forces should be similar.

Stearic acid is linear whereas linoleic acid is a bulkier molecule.

Strength of dispersion forces is weaker in linoleic acid as molecules are not able to get as close to each other as those in stearic acid. Strength of instantaneous dipoles are governed by number of electrons present and distance between molecules.

(3 marks)

END OF EXAMINATION