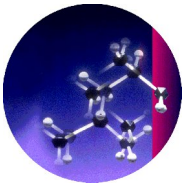

CHEMOLOGY EDUCATION SERVICES

Name:_____

CHEMISTRY - Year 12
UNIT 3 TRIAL EXAM – 2011

Time allowed: 1 hour 30 minutes

QUESTION AND ANSWER BOOKLET

Structure of booklet

Section	Number of questions	Number of questions to be answered
A	20 multiple choice Questions	20 multiple choice Questions
B	7	7

Directions to students

Materials
Question and answer booklet of 21 pages. Answer sheet for multiple choice questions
An approved calculator may be used.
Data Pages may be found at
http://www.vcaa.vic.edu.au/vce/studies/chemistry/chem1_sample_2008.pdf

The Task
Pleasure ensure that you write your name on the multiple choice answer sheet and this answer booklet.
Answer **all** Questions from Section A, which should be answered on the sheet provided.
Answer **all** questions from Section B, which should be answered in this booklet in the spaces provided.
There is a total of 94 marks available. All answers should be written in English.

P O BOX 477 MENTONE 3194
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SECTION A

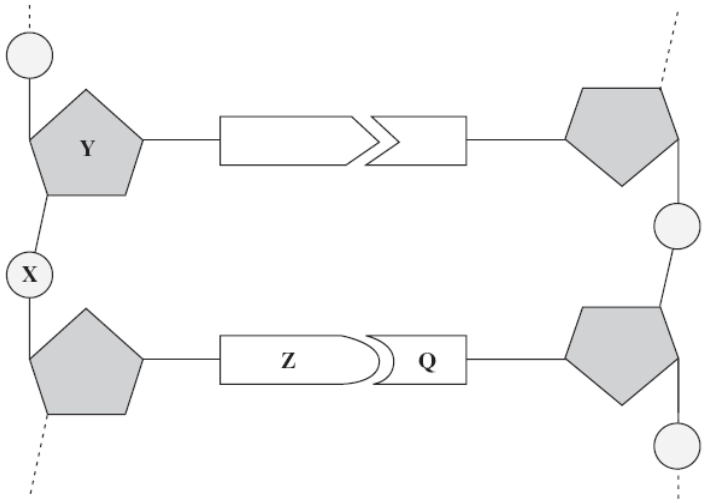
Specific instructions for Section A

Section consists of 20 multiple choice Questions. Section A is worth approximately 22% of the marks available. You should spend about 25 minutes on this section.

Choose the response that is **correct** or **best answers the question,** and mark your choice on the multiple choice answer sheet provided.

No credit will be given for a Question if two or more letters are marked for that Question. Marks will not be deducted for incorrect answers and you should attempt every Question.

Questions 1 & 2 refer to the diagram below which shows two nucleotide pairs of a DNA molecule.



Question 1

From the above Figure 1, it can be seen that X represents _____ and Y represents _____.

A. phosphate; nitrogenous base
B. deoxyribose; pentose
C. phosphate; deoxyribose
D. nitrogenous base; phosphate

Question 2

Which type of bond holds together **Z** and **Q**?

A. peptide
B. covalent
C. hydrogen
D. ionic

Question 3
4.00 mol of a hydrocarbon with an empirical formula of CH_2 has a mass of 280 g. What is the molecular formula of this compound?

A. C_2H_4
B. C_3H_6
C. C_4H_8
D. C_5H_{10}

Question 4
Which gives the correct order of these processes in a mass spectrometer?

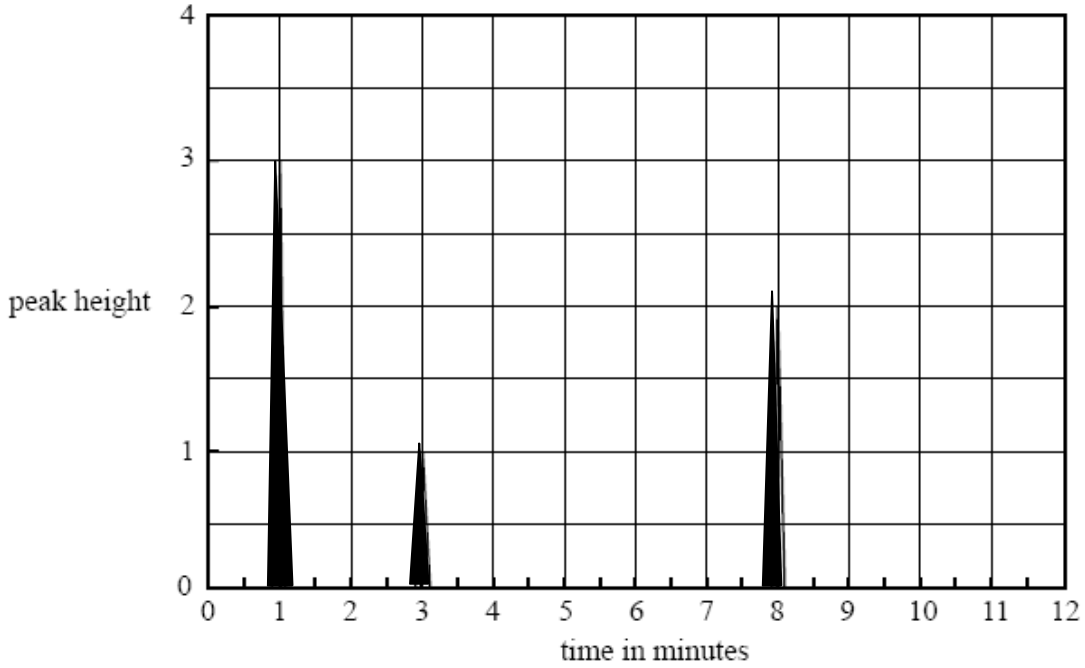
A. ionization deflection acceleration
B. ionization acceleration deflection
C. acceleration ionization deflection
D. deflection acceleration ionization

Question 5
The volume, in mL, of pure water that must be **added** to 100.0 mL of 0.0100 M HNO_3 to produce a diluted solution of pH 4.00 is closest to

A. 100
B. 900
C. 10000
D. 9900

Question 6

A mixture of methanol (CH_3OH), ethanol (C_2H_5OH) and propanol (C_3H_7OH) was analysed in a gas-liquid chromatography column. The following output was obtained.



Given that the sensitivity of the detector is the same per mole for all three substances, the mole percentage of methanol in the sample is closest to

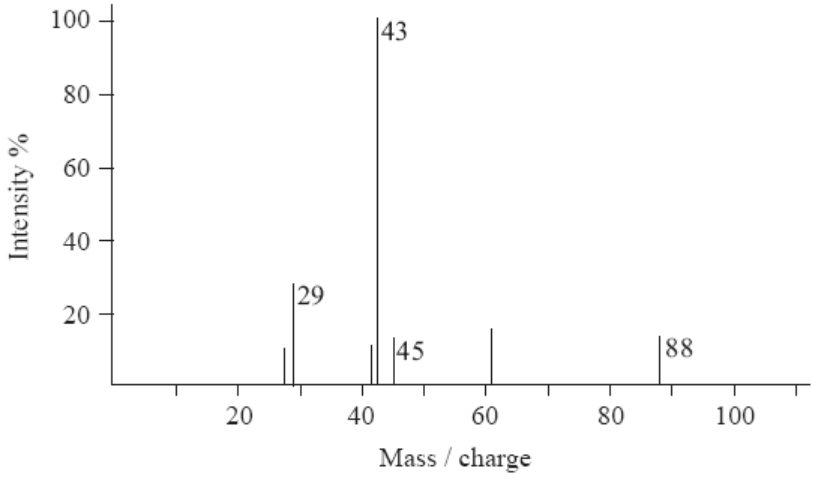
A. 20
B. 30
C. 33
D. 50

Question 7

What volume of carbon dioxide, in L under standard conditions, is formed when 7.00 g of ethene, C_2H_4 undergoes complete combustion?

A. 11.2 L **B.** 22.4 L **C.** 16.8 L **D.** 12.3 L

The mass spectrum of an unknown compound, **X**, of empirical formula C_2H_4O is shown below.

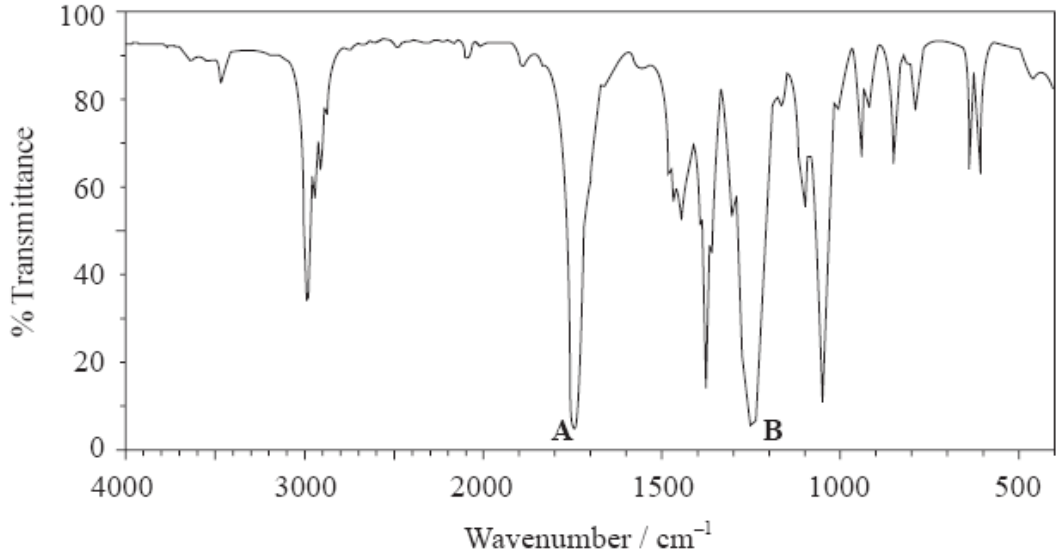


Question 8

The relative molecular mass of **X** from the mass spectrum is

A 29 **B** 45 **C** 88 **D** 61

The IR spectrum of **X** (from question 8) is shown below.



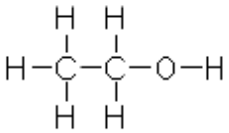
Question 9

The bonds which correspond to the absorptions **A** and **B** and the name of the functional group present in **X**

	Bonds	Functional Group
A	C = O and C – O	Ester
B	C – H and C = O	Carboxylic acid
C	C = O and C – O	Alkanol
D	C = O and C = C	Ester

Question 10

The molecule ethanol is drawn below

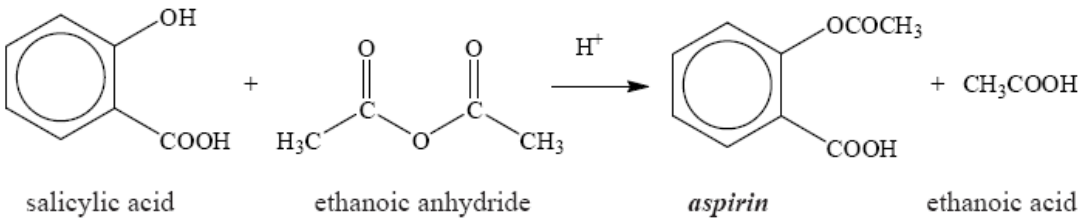


Select the option that correctly lists the number of peaks expected in the ^{1}H NMR and ^{13}C NMR of ethanol

	^{1}H NMR	^{13}C NMR
A.	1	2
B.	1	3
C.	3	2
D.	6	3

Question 11

Aspirin, one of the most widely used drugs in the world, can be prepared according to the equation given below.



The names of the two functional groups in aspirin are

A. a carboxylic acid functional group and an ester functional group
B. an alkene functional group and an alkanol functional group
C. an ester functional group and an alkanol functional group
D. an amide functional group and an alkanol functional group

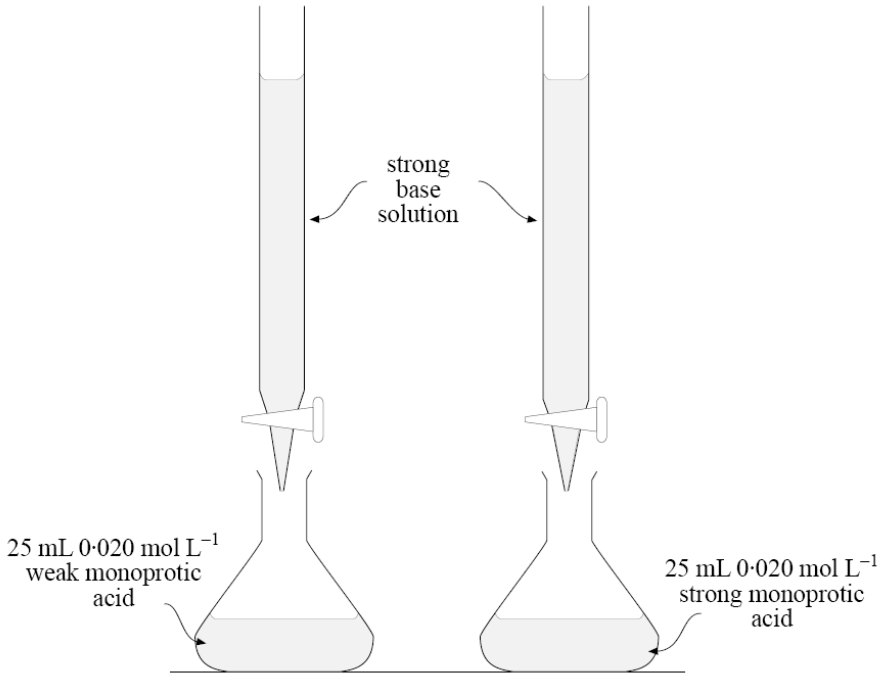
Question 12

Which of the following is not considered a biochemical fuel?

A. ethanol
B. biodiesel
C. vegetable oils
D. natural gas

Question 13

Two titrations are carried out as shown below.



A. The volume of base required to reach the equivalence point will depend upon the particular acid used.
B. The weak acid will require the same amount of base as the strong acid to reach the equivalence point.
C. The weak acid will require less base than the strong acid to reach the equivalence point.
D. The weak acid will require more base than the strong acid to reach the equivalence point.

Question 14

A titration is performed to determine the concentration of an ethanoic acid solution. Potassium hydroxide is used as the base and placed in the burette. A suitable indicator to use for this titration would be

A. phenolphthalein
B. bromothymol blue
C. methyl orange
D. methyl red

Use Figure 1 below to answer questions 15 and 16.

Ethene can be converted into other carbon-containing compounds using the reagents shown in ***Figure 1*** below.

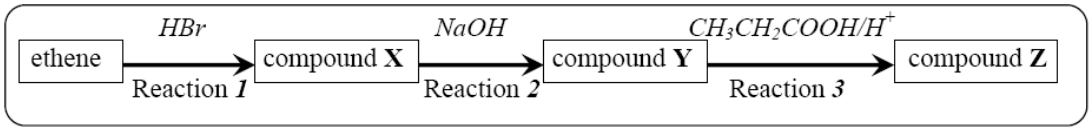


Figure 1: Flowchart of organic reactions

Question 15

Compounds **X**, **Y** and **Z** are, respectively

A. bromoethane, ethanol, propyl ethanoate.
B. bromoethane, ethanol, ethyl propanoate.
C. bromoethene, ethanoic acid, ethyl propanoate.
D. bromoethene, ethene hydroxide, propyl ethanoate.

Question 16

Reaction ***1***, ***2*** and ***3*** can be described as, respectively

A. addition, addition, neutralization.
B. addition, substitution, condensation.
C. substitution, neutralization, oxidation.
D. substitution, substitution, condensation.

Question 17

Which of the following statements about the tertiary structure of proteins is **not** correct?

A. Changing the tertiary structure of an enzyme will always cause a change in its ability to catalyse a specific chemical reaction.
B. The tertiary structure of a protein is determined by interactions between different Z groups (side chains).
C. The three-dimensional structure of a protein is determined by its tertiary structure.
D. Changing the tertiary structure of a protein will always cause a change in its secondary and primary structures.

Question 18
What is the IUPAC name for $HCOOCH_2CH_2CH_3$?

A. Butanoic acid
B. Butanal
C. Methyl propanoate
D. Propyl methanoate

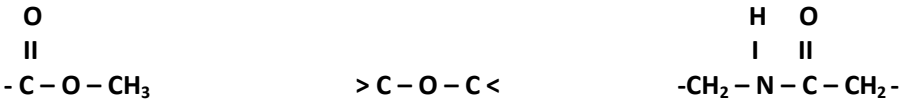
Question 19
In a series of experiments the following observations were made about a colourless liquid.

Experiment	Observation
Liquid was added to potassium dichromate solution.	No visible reaction.
pH of liquid measured.	pH less than 7 recorded
Liquid was added to ethanol and heated with concentrated sulfuric acid.	Fruity smell produced.

Which one of the following substances would produce all of these observations?

A. 2-methyl-2-butanol.
B. Butanoic acid.
C. 1-butanol.
D. Hexene.

Question 20



The linkages drawn above are most likely to be found in, respectively:

A. biodiesel, protein and carbohydrate
B. fatty acid, amino acid and polysaccharide
C. lipid, protein and glucose
D. fatty acid, protein and carbohydrate

END OF SECTION A

SECTION B

Specific Instructions for Section B

Section B consists of 7 short answer questions (question 1 to 9). You must answer all of these questions. The section is worth 74 marks or approximately 79% of the total. You should spend approximately 65 minutes on this section. The marks allocated and suggested time, are at the end of each question. Questions should be answered in the spaces provided in this booklet.

You should

* give simplified answers with the appropriate number of significant figures. Unsimplified answers will not receive full marks.
* Show all working in your answers to numerical problems. No marks can be given unless accompanied by working.
* make sure all chemical equations are balanced and that formulas for individual substances include an indication of state. Eg $H_2(g)$, NaCl (s).

Question 1 (7 marks)

Baking powder causes cakes to rise as a result of the reaction between cream of tartar (potassium hydrogen tartrate, $KHC_4H_4O_6$), and baking soda (sodium hydrogen carbonate, $NaHCO_3$). These substances react according to the equation:

$$KHC_4H_4O_6(s) + NaHCO_3(s) \rightarrow KNaC_4H_4O_6(s) + CO_2(g) + H_2O(l)$$

(a) A sample of self raising flour contains 10.0 g of cream of tartar and 5.00 g of baking soda, what volume of CO_2 (measured at S.T.P.) would be released when the reaction was completed?

(5 marks)

_____

_____

_____

_____

_____

_____

_____

(b) Calculate the remaining mass of the reactant that is in excess after the reaction has finished.

(2 marks)

_____

_____

_____

_____

_____

Question 2 (13 marks)

Two VCE Chemistry students, Taukolo and Kendrick, were set the task of determining the concentration of ethanoic acid in a particular brand of vinegar. An outline of the method they used is given in ***Figure 7*** below.

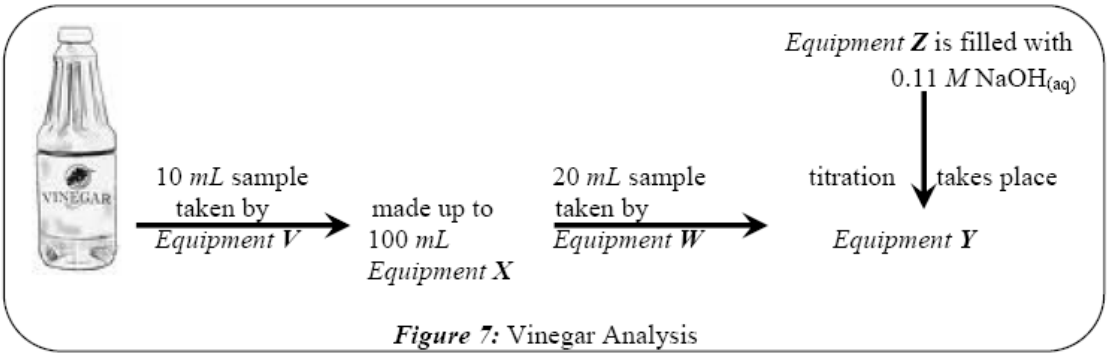


Figure 7: Vinegar Analysis

A few drops of phenolphthalein indicator were added. The diluted vinegar was titrated with the base. One rough and three accurate titrations were carried out.

The four titration figures recorded were 16.10, 15.35, 15.36 and 15.35 *mL*, respectively.

The equation for the reaction is:

$$NaOH(aq) + CH_3COOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$$

a) The *Equipment* ***V, W***, ***X***, ***Y*** and ***Z*** are all rinsed before they are used. Put a tick (√) in the appropriate boxes below to indicate which solution should be used for the **final** rinse of each of these species of glassware. (2 marks)

Glassware used	Rinse with water	Rinse with diluted vinegar solution	Rinse with NaOH solution
Equipment **W**			
Equipment **X**			
Equipment **Y**			
Equipment **Z**			

b) Name: (2 marks)

Equipment ***W*** _____

Equipment ***Z*** _____

c) Explain why the vinegar is diluted before titrating. (1 mark)

_____

d) Explain why titrations are repeated until three concordant results are obtained. (1 mark)

_____

_____

e) State the colour change at the end point. (1 mark)

_____

f) Calculate the concentration (*mol* L^{-1}) of ethanoic acid in the diluted vinegar. (2 marks)

_____

_____

_____

_____

g) Calculate the concentration (*mol* L^{-1}) of ethanoic acid in the original vinegar. (2 marks)

_____

_____

h) Calculate the concentration of ethanoic acid in the original vinegar sample in grams *per* litre. Express this concentration in terms of % (*w/v*). (2 marks)

_____

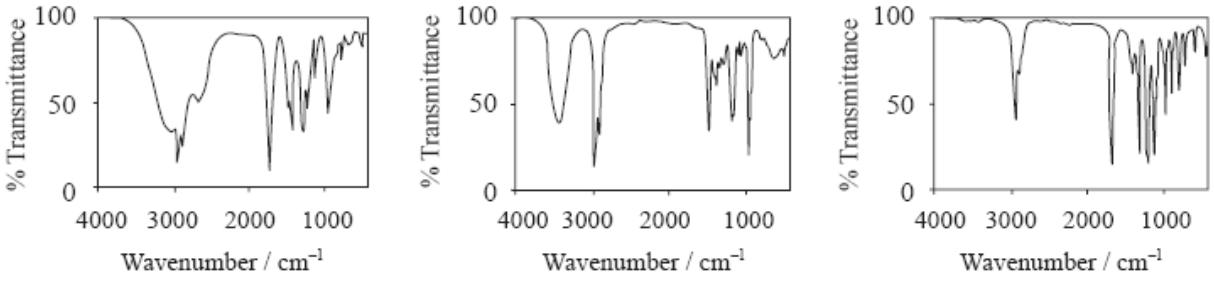
_____

_____

_____

Question 3 (9 marks)

Consider the IR spectra of the following three compounds.
A = $CH_3(CH_2)_3COOH$
B = $CH_3COOC(CH_3)_3$
C = $(CH_3CH_2)_3COH$



a) Determine which IR spectrum corresponds to each compound A, B and C. Explain your reasoning. IR data can be found in Data Booklet. (5 marks)

Compound	Spectrum	Reason
A		
B		
C		

b) Distinguish between the ^{1}H NMR spectra of 1-bromopropane and 2-bromopropane (splitting patterns are not required). (4 marks)

_____

_____

_____

_____

_____

_____

Question 4 (9 marks)

a) Cobalt (Co) is an essential element for most living organisms. There is one Co atom in each molecule of vitamin B12 (molar mass = 1355 g mol^{-1}). Human beings need 0.0015 mg of vitamin B12 per day for good health.

Calculate the mass of Co in 0.0015 mg of vitamin B12. (3 marks)

_____

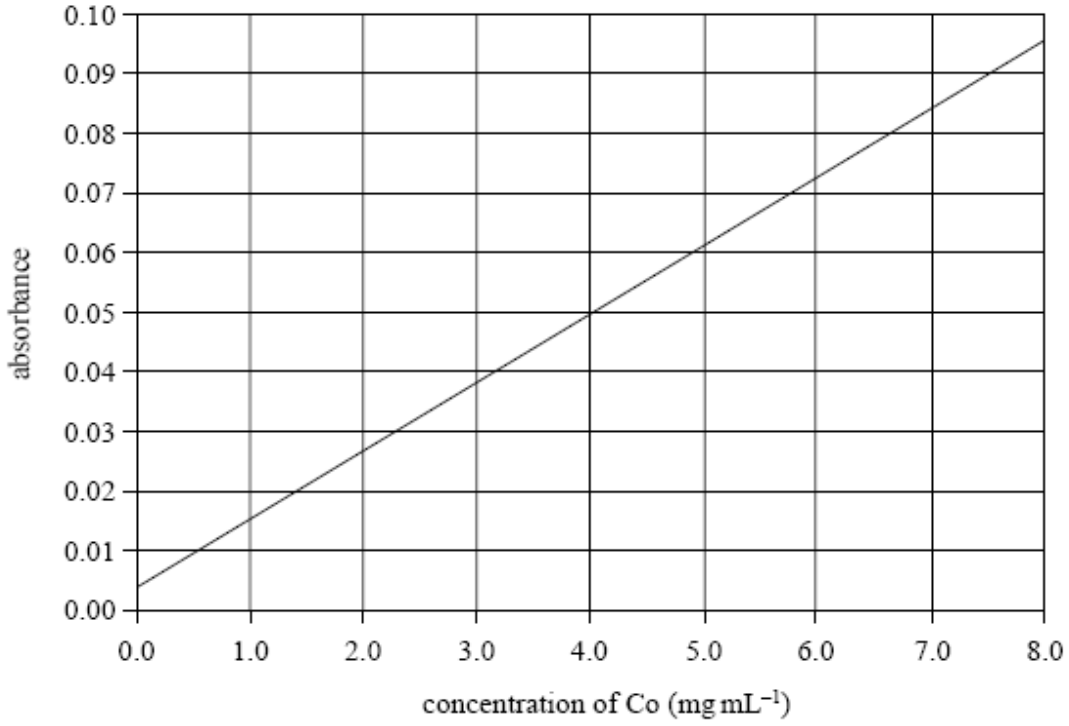
_____

_____

_____

_____

b) Co is obtained from sulfide ores. Atomic absorption spectroscopy (AAS) was used to determine the percentage of Co in an ore. The following calibration graph was drawn using the absorbance of samples with known concentrations of Co:



10.0 g of the ore was crushed, dissolved, and made up to a 100 mL solution. Some of this solution was injected into the flame of the AAS and an absorbance of 0.08 was recorded.

(i) Using the calibration graph on page 15, determine the concentration of Co in the solution, in mg mL^{-1}. (1 mark)

_____

(ii) Calculate the mass of Co in the 100 mL of solution. (1 mark)

_____

_____

(iii) Hence calculate the percentage by mass (% w/w) of Co in the 10.0 g of ore. (2 marks)

_____

_____

_____

_____

(iv) Nickel atoms were also present in the 10.0 g sample of ore. Explain why the presence of nickel does not interfere with the determination of Co by AAS. (2 marks)

_____

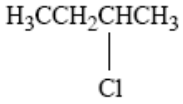
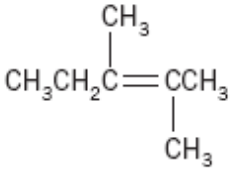
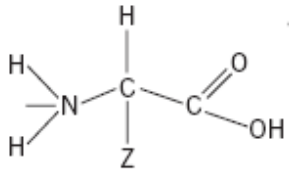
_____

_____

_____

Question 5 (13 marks)

a) Complete the following table:

Name	Semi structural formula	Name of organic compound formed in reaction with concentrated NaOH
		
Name	**Semi structural formula**	**Functional group present after exposure to acidified $KMnO_4$**
3-methyl hexan-1-ol		
Name	**Semi structural formula**	**Semi Structural formula after exposure to HCl and a catalyst.**
		
Structural Formula in high pH	**Structural Formula**	**Structural Formula in low pH**
		

b) Water reacts with propene under certain conditions. Write balanced equations (using structural formulae) illustrating the reaction and name the possible products.

(3 marks)

c) Propene can, under particular conditions, polymerise. Write an equation to illustrate the polymerisation of propene (include at least 3 monomeric units). (2 marks)

Question 6 (7 marks)

An organic compound, A, has an empirical formula C_3H_6O, and a molar mass of between 100 and 125. NMR spectroscopy indicates the presence of four methyl groups.
The compound, A, was reacted with sodium hydroxide. After the reaction the excess sodium hydroxide was neutralised and two products, B and C, were isolated.

B was acidic whereas C was neutral. Neither B nor C could be oxidised.

Both B and C were soluble in water. Both B and C reacted with sodium.

(a) Determine the molecular formula of A. (1 mark)

_____

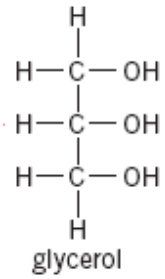
_____

(b) Identify the functional group in A. (1 mark)

_____

(c) Identify (with semi structural formula) B, C and hence A. (3 marks)

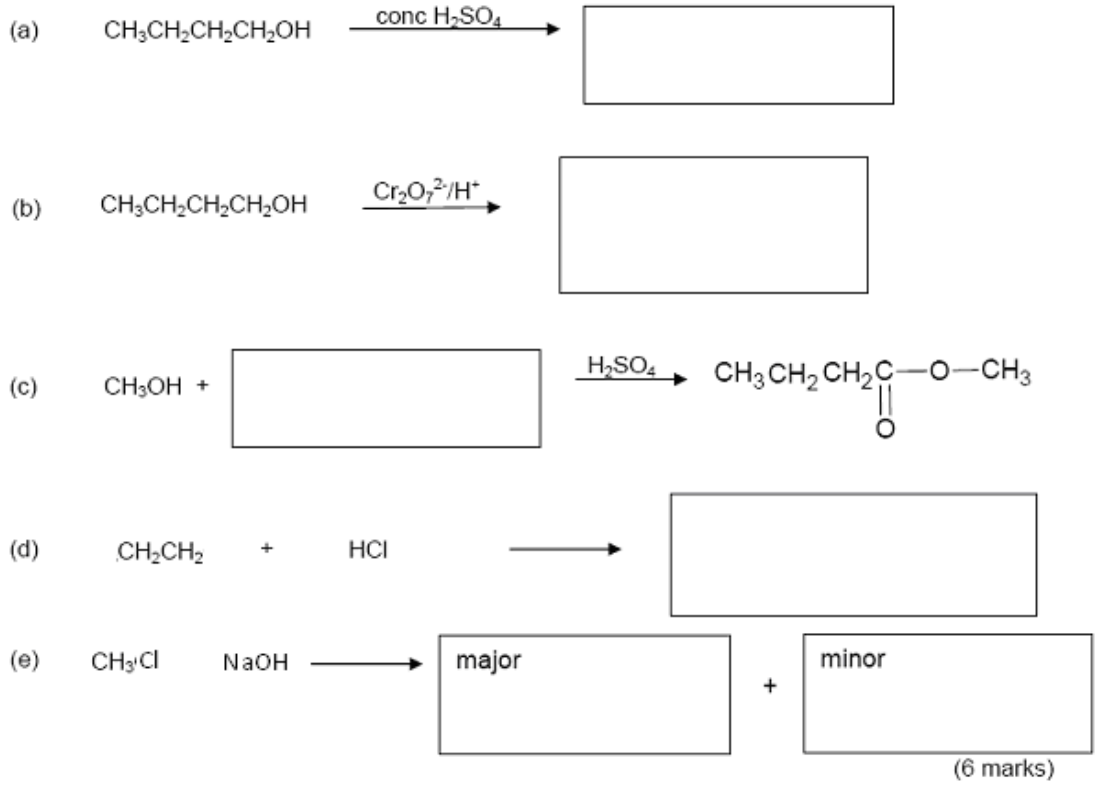
(d) Write balanced equations for the reactions of B with glycerol (shown below), to form a triglyceride. (2 marks)



glycerol

Question 7 (16 marks)

1. Complete each of the reactions below by writing the structural formula of the product or the reactant in each conversion.



(6 marks)

2. Name of the type of reaction in (a) above. (1 mark)

_____

3. Explain why reaction 1(d) is classified as an **addition** reaction. (1 mark)

_____

_____

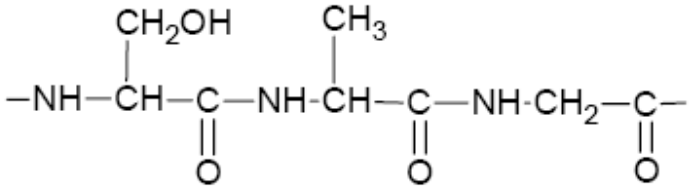
4. Choose the reaction above (a – e) that is an **oxidation** reaction. _____
(1 mark)

5 Chose the reaction above (a – e) that is a **substitution** reaction. _____
(1 mark)

6. Draw structural formulae for the following molecules. (4 marks)
(a) propyl butanoate

(b) 4-fluoro-2-methyl-pentan-3-ol

7. Proteins are polymers made up of repeating units of amino acids. The section of polymer below is made of the three amino acids that are found in silk.

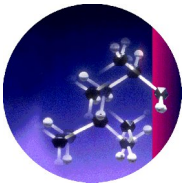


(a) Name the functional group that links the amino acids. (1 mark)

_____

(b) Draw the structure of ONE of the amino acids monomers. (1 mark)

END OF EXAM



CHEMOLOGY EDUCATION SERVICES

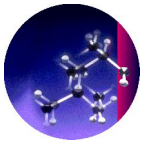
Name:_____

CHEMISTRY EXAM 1

MULTIPLE CHOICE ANSWER SHEET

Shade the box ■ after the letter corresponding to your answer.

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



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SUGGESTED SOLUTIONS TO 2011 CHEMISTRY TRIAL EXAM 1

Section A

1 C		**11 A**	
2 C		**12 D**	Biochemical fuels are derived from plant materials, such as grains, sugarcane,vegetable wastes and oils. Natural gas is not derived from plant materials. Vegetable oils can be used as fuels.
3 D	M = m/n = 280/4 = 70 M_r of empircal formula unit = 14 Number of E/F units in Molecular mass = 70/14 = 5 5 x CH_2 = C_5H_{10}	**13 B**	In both acid solutions there is the same amount of mole of each acid. (n = 0.02 x 25/1000 = 0.005mol)
4 B		**14 A**	
5 D	C_1 = 0.01 M V_1 = 100ml C_2 = 10^{-4} M (pH = 4) V_2 = ? C_1 x V_1 = C_2 x V_2 0.01 x 100 = 10^{-4} x V_2 V_2 = 10 000 ml Volume to be **added** 10 000 – 100 = 9900ml	**15 B**	
6 D	The total peak height is 6 units. Methanol is the smallest molecular mass, so it will have shortest retention time. (the first peak). %methanol = 3 / 6 x 100 = 50%	**16 B**	
7 A	n(ethene) = 7/28 = 0.25 mol n(CO_2) = 2 x n(ethene) = 0.5 mol V(CO_2) at STP = 0.5 x 22.4 = 11.2 L	**17 D**	The primary structure of a protein is the sequence of amino acids. This will not change with the coiling of the protein chains.
8 C	2 X C_2H_4O will give the $C_4H_8O_2^+$ fragment	**18 D**	The alcohol part is named first.
9 A	The molecular formula is $C_4H_8O_2$ use the data table and corresponding wavelengths.	**19 B**	
10 C	There are three different hydrogen environments for the H atom. One on each carbon and one on the oxygen. The are two different carbon environments.	**20 A**	The linkages in order are ester (found in lipids), ether (found in disaccharides and polysaccarides), peptide (or amide) found in proteins.

Section B

Question 1

a) n($KHC_4H_4O_6$) = 10.0/188.1 = 0.0532 mol ❶
n($NaHCO_3$) = 5.0/84 = 0.0595 mol ❶
As they react in a 1:1 ratio, ($KHC_4H_4O_6$) is the limiting reagent. ❶

n($KHC_4H_4O_6$) = n(CO_2) ❶
V(CO_2) = n x 22.4 L = 0.0532 mol x 22.4 = **1.19 L** ❶

(b n($NaHCO_3$) left over = 0.0595 – 0.0532 = 0.00630 mol ❶

m($NaHCO_3$) left over = 0.00630 mol x 84 = **0.529 g** ❶

Question 2

a) ❶❶

Glassware used	Rinse with water	Rinse with diluted vinegar solution	Rinse with NaOH solution
Equipment **W**		√	
Equipment **X**	√		
Equipment **Y**	√		
Equipment **Z**			√

b) Equipment W: Pipette Equipment Z: Burette ❶❶

c) Too large a titre would be required. ❶

d) Improve accuracy; minimise errors. ❶

e) Colourless → Pink ❶

f) Average titre = [15.35 + 15.36 + 15.35]/3 = 15.35 ml ❶

n(NaOH) = 0.11 x 15.35/1000 = 1.69 x 10^{-3} mol = n(ethanoic acid) ❶

$[\text{ethanoic acid}]_{\text{diluted}}$ = 1.69 x 10^{-3} mol / 0.02 = **0.084 M** ❶

g) $C_1 \times V_1 = C_2 \times V_2$

0.084 x 100 = C_2 x 10

C_2 = [ethanoic acid] = **0.84 M** ❶

h) 0.84 mol / L x M_r (ethanoic acid)

0.84 x 60 = **50.4 g / L** ❶
% ethanoic acid = $\frac{50.4}{1000}$ x 100 = 5.04% (w/v) ❶

Question 3

a) A is spectrum I

Only spectrum with a broad peak in the range 2500 – 3300 cm^{-1} corresponding to the carboxylic acid functional group / -OH in carboxylic acid / H – bonding in carboxylic acid (so must be a carboxylic acid.

B is Spectrum III

Peak is in the range 1700 – 1750 cm^{-1} corresponding to the carbonyl / C=O group; but no peak for O-H/ no peak at 2500 – 3300 cm^{-1} or 3200 – 3600 cm^{-1}

C is Spectrum II
Peak is in the range 3200 – 3600 cm^{-1} corresponding to alcohol functional group/OH / the only one without a peak at 1700 – 1750 cm^{-1} corresponding to an alcohol. ❶❶

b) 2- bromopropane will show two separate absorptions/peaks; in the ration 6:1.
1-bromopropane will show three separate absorptions/peaks; in the ration 3:2:2. ❶❶

Question 4
a) n(Vit B12) = 1.5 x 10^{-6} / 1355 = 1.11 x 10^{-9} mol = n(Co) ❶

m(Co) = 1.11 x 10^{-9} mol x 58.9 = **6.54 x 10^{-8} g** ❶

b) i) 6.6 – 6.7 mg ml^{-1} ❶

ii) 6.6 x 100 = 660 mg / 100ml ❶

iii) 660 mg (0.66g) in 10.0 g of the ore ❶

%Co = [0.66/ 10.0] x 100 = 6.6% (w/v) ❶

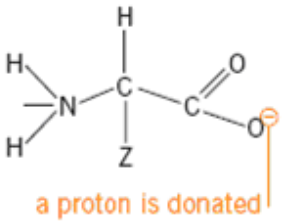
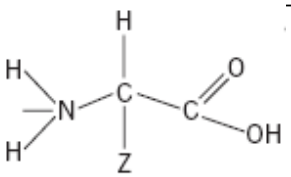
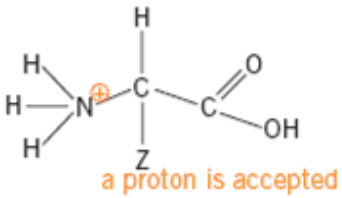
iv) A hollow cathode lamp made of Co is chosen to emit wavelengths of light that only Co atoms will absorb. Other atoms such as Ni will not absorb this wavelength. ❶❶

Question 5

Name	Semi structural formula	Name of organic compound formed in reaction with concentrated NaOH
2-chlorobutane	$H_3CCH_2CHCH_3$ (Cl)	**2-butanol**

Name	Semi structural formula	Functional group present after exposure to acidified $KMnO_4$
3-methyl hexan-1-ol	$CH_2(OH) –CH_2CH(CH_3) –CH_2-CH_2 -CH_3$	O || - C -OH

Name	Semi structural formula	Semi Structural formula after exposure to HCl and a catalyst.
2,3-dimethyl pent-2-ene	$CH_3CH_2C(CH_3)=CCH_3$ (CH_3)	$CH_3CH_2C(H)(Cl)-CCH_3$ (CH_3)

Structural Formula in high pH	Structural Formula	Structural Formula in low pH
		

b) $CH_2 = CH - CH_3 + H_2O \rightarrow CH_2(OH) - CH_2 - CH_3$ ❶❶ **Propanol** ❶

c) $CH_2 = C(CH_3) - CH_3 \rightarrow - CH_2 - CH(CH_3) - CH_2 - CH(CH_3) - CH_2 - CH(CH_3) -$ ❶❶

Question 6

a) $C_6H_{12}O_2$ ❶ The molar mass of the compound must be whole number multiples of the empirical formula Mr (C_3H_6O) = 58 x 2 = 116 (this is between 100 and 125)

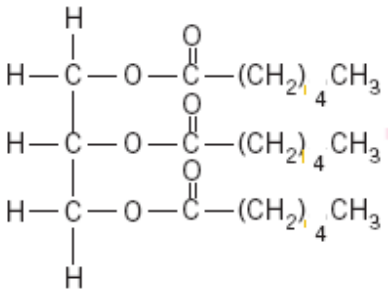
b) Carboxylic acid ❶

c) **Compound A** $CH_3 - (CH_2)_4 - COOH$ ❶

Compound B $CH_3 - (CH_2)_4 - COO^- Na^+$ ❶

Compound C H_2O ❶

d)



❶❶

Question 7

1. a) $CH_3 - CH_2 - CH = CH_2$ ❶

b) $CH_3CH_2CH_2COOH$ ❶

c) $CH_3CH_2CH_2COOH$ ❶

d) $CH_3 CH_2 Cl$ ❶

e) CH_3OH (Major) ❶ + NaCl (Minor) ❶

2. Dehydration ❶

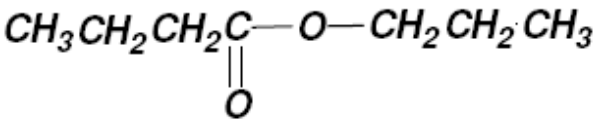
3. Atoms add into the molecule at either end of the double bond. ❶

4. Reaction (b) ❶

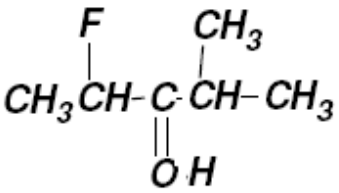
5. Reaction (e) ❶

6. a) ❶❶

propyl butanoate



b) 4 – fluro-2-methyl-pentan-3-ol ❶❶



7. a) amide (or accept peptide) ❶

b) ❶