Student Name: _____

CHEMISTRY

Unit 3 – Written examination 1

2009 Trial Examination

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

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*	*Suggested times (minutes)*
A	20	20	20	25
B	7	7	69	65
			Total 89	90

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, VCAA approved data book and a scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied
- Question and answer book of 15 pages.

Instructions
- Print your name in the space provided on the top of this page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other electronic communication devices into the examination room.

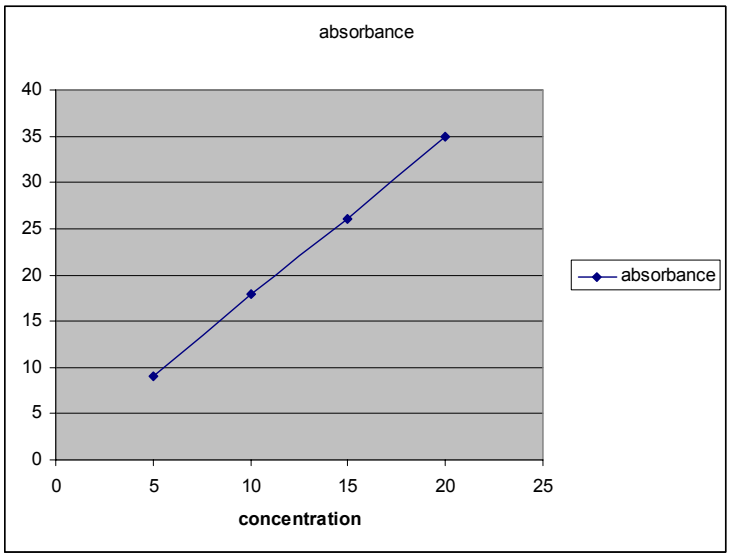
SECTION A- Multiple-choice questions

Instructions for Section A

Answer **all** questions.
Choose the response that is **correct** or **best answers** the question.
A correct answer scores 1, an incorrect answer scores 0.
No mark will be given if more than one answer is completed for any question.
Marks will **not** be deducted for incorrect answers.

Questions 1 and 2 refer to the following information

The level of copper ions in a water supply is studied using atomic absorption. A calibration curve is established where the concentration is in units of $\mu g\ L^{-1}$.



A 1.00 mL sample of water is diluted to 100 mL and tested in the instrument. The absorbance of the sample is recorded as 24.0.

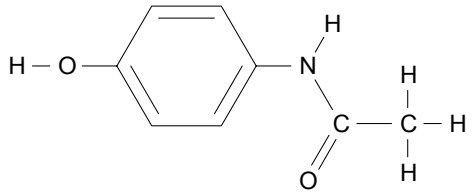
Question 1
The concentration of copper ions, in $\mu g\ L^{-1}$ in the original sample, is closest to
A. 12.5
B. 38.0
C. 1370
D. 1500

Question 2
It is found that the copper ions came from the compound copper chloride, $CuCl_2$. The mass of copper chloride, **in mg**, in the original 1.0 mL sample of water was
A. 0.026
B. 1.25
C. 2.90
D. 3.20

SECTION A – continued

Question 3
A titration is performed to determine the concentration of a methanoic acid solution. Sodium hydroxide is used as the base. A suitable indicator to use for this titration would be
A. phenolphthalein
B. bromothymol blue
C. methyl orange
D. methyl red

Questions 4 and 5 refer to the following information



The molecule above is paracetamol. It is a common analgesic or painkiller. A typical paracetamol packet has 24 tablets, each tablet containing 500 mg of paracetamol.

Question 4
The number of mole of paracetamol required to make a packet of paracetamol tablets is
A. 0.0066
B. 0.0795
C. 0.146
D. 79.5

Question 5
A molecule of paracetamol contains
A. a carboxylic acid functional group and an alkanol functional group
B. an alkene functional group and an ester functional group
C. an ester functional group and an alkanol functional group
D. an amide functional group and an alkanol functional group

Question 6
One of the active ingredients in an insect repellent is diethyl toluamide, DEET. The label on a 150 g can of repellent gives the concentration of DEET as 160 g/kg. The mass, in g, of DEET in a can is
A. 24
B. 160
C. 340
D. 24000

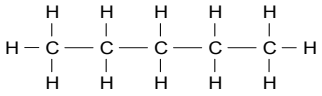
Question 7
A 100 mL solution of sodium hydroxide acid has a pH of 13. What volume of water, in mL, must be added to it to change the pH to 11?
A. 2.0
B. 19
C. 99
D. 9900

Question 8
A laboratory assistant has access to solutions of hydrochloric acid, potassium hydroxide and sulfuric acid. The concentration of the sulfuric acid is 0.4 M. but the concentrations of the other two solutions are not known.

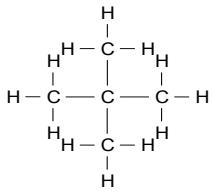
A 10 mL sample of the sulfuric acid neutralises 20 mL of the potassium hydroxide. It takes 8.0 mL of the hydrochloric acid to neutralise the same volume of potassium hydroxide. What is the concentration, in M, of the hydrochloric acid?
A. 0.40
B. 0.80
C. 1.0 M
D. 1.6 M

Questions 9 and 10 refer to the following information

The molecules below are structural isomers. They are difficult to distinguish as their properties are similar



molecule A



molecule B

Question 9

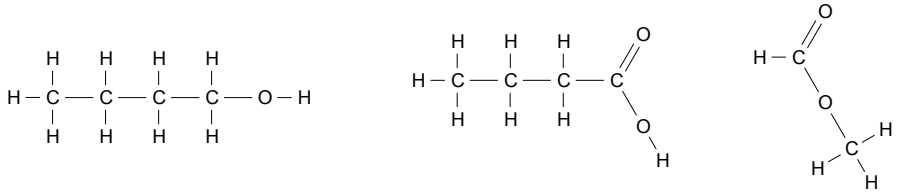
If both molecules are subjected to low resolution NMR, the results will show the following number of peaks:

	molecule A		molecule B	
	^{1}H NMR	^{13}C NMR	^{1}H NMR	^{13}C NMR
A.	1	1	1	1
B.	2	2	2	1
C.	3	3	1	2
D.	5	3	3	3

Question 10
Both molecules are passed though a mass spectrometer. Molecule A
A. will have peaks at 14 and 29 that molecule B will not have
B. will have a peak at 57 that molecule B does not have
C. will have less peaks than molecule B
D. will have a different parent molecular ion mass to that of molecule B

SECTION A – continued

Question 11



The systematic names for the molecules drawn above are, respectively:

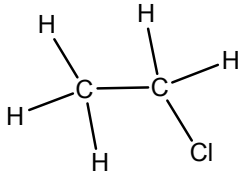
A. butanol, butanoic acid, ethyl methanoate
B. 1–butanol, 1-butanoic acid, methyl methanoate
C. 1-butanol, butanoic acid, methyl methanoate
D. 4-butanol, 1-butanoic acid, methyl methanoate

Question 12

A compound extracted from wheat has a molecular formula of $C_{685}H_{1068}N_{196}O_{211}S_5$

A. No natural compound could have a molecule such as this.
B. The molecule is a carbohydrate. Its role is energy storage.
C. The molecule is an enzyme found in the cells of wheat.
D. The molecule is an essential amino acid that can form disulfide links to neighbouring molecules.

Question 13



The molecule shown could be formed from the reaction of

A. ethene and chlorine gas
B. ethene and hydrochloric acid
C. 1-ethanol and hydrochloric acid
D. ethane and hydrochloric acid

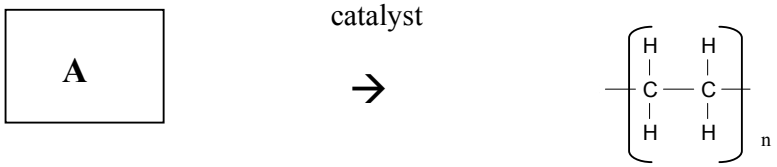
Question 14

Apricot flavouring can be isolated as pentyl propanoate. The artificial synthesis of this compound would require

A. sulfuric acid, 1-pentanol, 1-propanol and dichromate ions
B. sulfuric acid, 2-propanol, 1-pentanol and dichromate ions
C. sulfuric acid, pentanoic acid and 1-propanol
D. sulfuric acid, 1-pentanol and pentanoic acid

SECTION A – continued
TURN OVER

Question 15



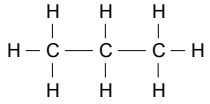
Pick the alternative that correctly describes the reaction above

	name of A	**type of reaction**	**name of product**
A.	ethane	addition	polyethane
B.	ethene	addition polymerisation	polyethene
C.	ethene	addition polymerisation	polyester
D.	ethene	addition	ethane

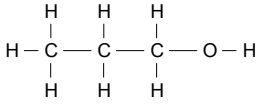
Question 16

Which one of the following molecules will show an absorption band in the infrared spectrum at around 1700 cm^{-1}

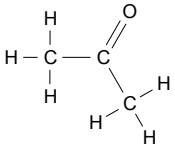
A.



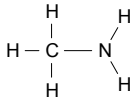
B.



C.

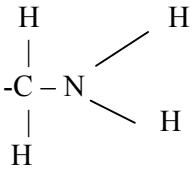
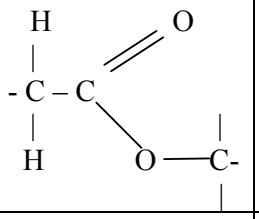
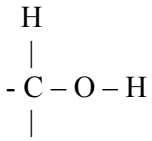
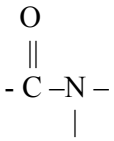


D.



Question 17

Pick the alternative that names the functional groups correctly.

				
A.	amine	ester	alkanol	amide
B.	amide	ester	alcohol	amine
C.	amine	carboxylic acid	alkanol	amide
D.	amine	carboxylic acid	alkanol	nylon

SECTION A – continued

Question 18
The base sequence in a particular strand of DNA is shown below

- G – G – C – A – A – T – G – A –

The sequence of bases that will pair with this strand is
A. – C – C – G – T – T – A – C – T -
B. – T – T – A – C – C – G – T – C -
C. – A – G – T – A – A – C – G – G -
D. – C – C – G – A – A – T – C – A -

Question 19
Linolenic acid is a fatty acid with the molecular formula $C_{18}H_{32}O_2$
Linolenic acid will have
A. one carbon to carbon double bond, a non polar segment and a polar segment
B. two carbon to carbon double bonds and no significant dipoles
C. all single bonds between carbon atoms and a double bond to an oxygen atom.
D. two carbon to carbon double bonds, one carbon to oxygen double bond and a long non polar segment

Question 20
Inulin is a polysaccharide molecules used in plants for energy storage. The monomer in inulin is fructose. Fructose has 6 carbon atoms and an empirical formula of CH_2O. A typical inulin molecule contains around 2200 monomers. The mass of this typical molecule would be, in *amu*,
A. 32000
B. 66000
C. 396419
D. 356418

END OF SECTION A
TURN OVER

SECTION B – Short-answer questions

Instructions for Section B

Questions must be answered in the spaces provided in this book.
To obtain full marks for your responses you should

- Give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks.
- Show all workings in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, $H_2(g)$; NaCl(s)

Question 1

The table below lists six different analysis tasks to be performed.
Below the table, six different techniques are listed.

Select an appropriate analysis technique from the list provided for each required task. Use the spaces provided in the table to write in the technique you have chosen and the justification for your choice.
Each technique can only be used once.

Task	Method chosen	Justification
Identification of amino acids present in a health bar		
Concentration of a solution of lithium hydroxide		
Distinguish between two isomers of butane		
Concentration of lead ions in waste water		
Chloride ion concentration in mineral water		
Empirical formula of a hydrocarbon molecule		

Techniques available

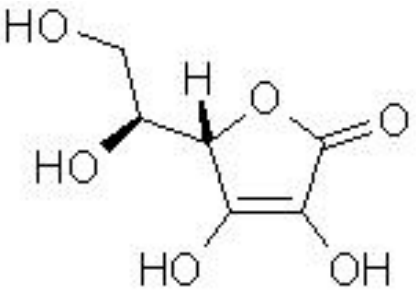
Acid/base titration	TLC	Mass spectrometry
NMR	Precipitation	Atomic absorption spectrometry

Total 12 marks

SECTION B – continued

Question 2

Vitamin C is better known to scientists as ascorbic acid. Its concentration in a food item or fruit juice can be determined by several different methods. One of the methods is a redox titration, using iodine as an oxidant.



The half equation for the reaction of ascorbic acid is

$C_6H_4O_2(OH)_4(aq) \rightarrow C_6H_4O_2(OH)_2(aq) + 2H^+(aq) + 2e^-$

a. Write the half equation for the reaction of iodine.

_____

1 mark

b. Write a balanced overall equation for this titration.

_____

1 mark

The endpoint of the titration can be determined using starch as an indicator. Starch will be blue in the presence of iodine.

c. **i.** If you are performing this titration, explain how you would know when to stop adding from the burette.

_____

_____

ii. Why is starch not listed in your chemistry data book amongst the indicators?

_____

2 + 1 = 3 marks

20.00 mL samples of 0.104 M iodine solution are added to flasks and titrated against an ascorbic acid solution. The average titre is 18.56 mL.

d. Calculate the concentration of the ascorbic acid solution.

_____

_____

2 marks

SECTION B – continued
TURN OVER

e. Iodine solution is not suitable as a primary standard. What does this mean?

_____

1 mark

f. Name two functional groups present in ascorbic acid and give the infrared frequency these functional groups would absorb at.

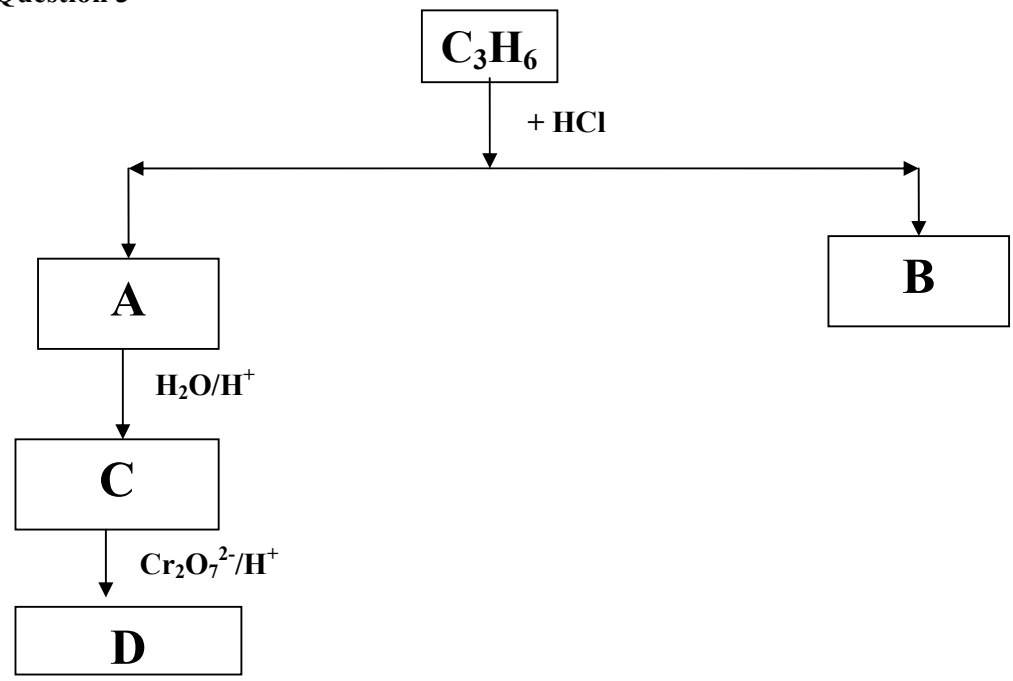
functional group	frequency
_____	_____
_____	_____

2 marks

g. What is the empirical formula of ascorbic acid? _____ 1 mark

Total 11 marks

Question 3



The molecule C_3H_6 can form two isomers when it reacts with hydrochloric acid.

a. Draw structural diagrams, and name, each of the molecules A to D. Use the spaces provided.

A B

_____ _____

SECTION B – continued

C D

_____ _____

4 marks

b. Name the type of reaction that is responsible for

$C_3H_6 \rightarrow A$ _____

$A \rightarrow C$ _____

$C \rightarrow D$ _____

3 marks

c. **i**. Name an instrument other than mass spectrometry that could be used to distinguish molecule B from C.

_____

ii. For the instrument you have chosen, explain how the print-out will differ for each molecule.

_____

_____

_____

1 + 2 = 3 marks

d. Molecule C is passed through a mass spectrometer.

i. What is the mass of the parent molecular ion?

_____

ii. Suggest two peaks that this molecule might have and explain what fragmentation has led to their formation.

_____ _____

_____ _____

SECTION B – continued
TURN OVER

iii. When molecule A is passed through a mass spectrometer, it has several peaks that are about two different in mass value. Explain what causes this.

_____

1 + 2 + 1 = 4 marks

e. Explain why molecule B cannot form an equivalent product to molecule D.

_____

1 mark

Total 15 marks

Question 4

An organic molecule contains the elements carbon, hydrogen and oxygen. A 4.111 g sample of the molecule contains 2.667 g of carbon and 0.555 g of hydrogen.

a. Determine the empirical formula of this molecule.

_____

_____

_____

3 marks

b. The mass spectrum of this molecule shows the parent molecular ion has a mass of 74. What is the molecular formula?

_____ 1 mark

c. Draw two possible structures for this molecule.

2 marks

d. An infrared spectrum of this molecule shows a very broad absorbance band at 3400 cm^{-1} and no band at 1700 cm^{-1}. What conclusion might you draw from this information?

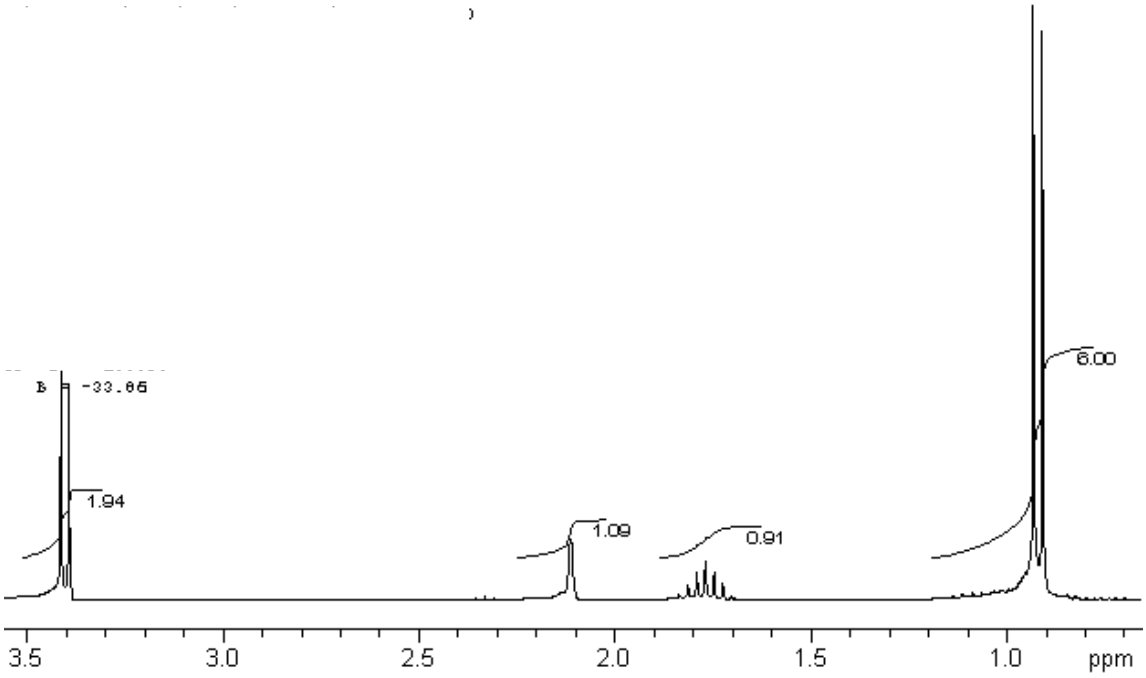
_____

1 mark

e. The ^{1}H NMR spectrum of this molecule is shown on the following page. Note the area under the right peak.
Draw and name the molecule under investigation.

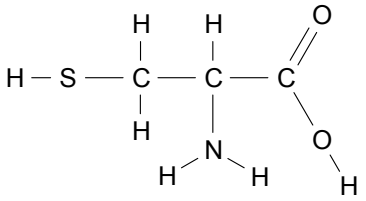
2 marks

SECTION B – continued



Total 9 marks

Question 5



a. Circle two functional groups on the molecule shown. Write the names of the two functional groups that you have circled next to the circles you made.

2 marks

b. Name this molecule _____ 1 mark

c. Draw the structure of this molecule if it is in a solution of pH 3.

1 mark

d. Draw the products formed when this molecule bonds to itself.

2 marks

SECTION B – continued
TURN OVER

e. **i**. When this molecule is spotted onto a TLC plate, with isobutanol as a solvent, its R_f value is known to be 0.43. On one such plate, the molecule moves 3.8 cm. How far should the solvent have moved?

_____

1 mark

ii. For this particular chromatogram, name the stationary phase and the mobile phase.

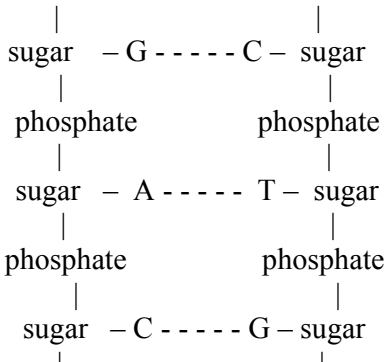
stationary phase: _____ mobile phase: _____

2 marks

Total 9 marks

Question 6

The diagram shown is a simple representation of a DNA molecule.



a. **i**. DNA is a condensation polymer made from four monomers known as nucleotides.

Circle on the diagram a nucleotide.

ii. Explain why there are 4 possible nucleotides.

_____

iii. Name the three components of a nucleotide.

_____

1 + 1 + 1 = 3 marks

b. **i**. What type of bonding is responsible for the secondary structure of DNA?

_____

ii. Explain why the mole amounts of thymine and adenine are equal in DNA.

_____

1 + 1 = 2 marks

c. Forensic scientists collect DNA samples and try and match them to various suspects. In DNA profiling the DNA molecule is split into fragments. These fragments are duplicated in process referred to as PCR. The fragments are then subjected to gel electrophoresis.

SECTION B – continued

i. What does PCR stand for? _____

ii. Which electrode do the DNA fragments move towards and why?

_____

iii. Why do the fragments move at different speeds?

_____

iv. Will the pattern of fragments for a girl match those of her mother? Explain your answer.

_____

1 + 1 + 1 + 1 = 4 marks
Total 9 marks

Question 7

Barium chloride, $BaCl_2$ is found dissolved in water from underground springs in New Zealand. The chloride ions can be precipitated through the addition of silver nitrate, $AgNO_3$ solution.

500.0 mL of water that contains 260 mg L^{-1} of barium ions is placed in a beaker. 25.0 mL of 0.10 M silver nitrate is added to the mineral water.

a. Write a balanced equation for the reaction between barium chloride and silver nitrate.

_____

1 mark

b. Determine which reactant is in excess. Assume that barium chloride is the only source of chloride ions.

_____

_____

_____

3 marks
Total 4 marks

END OF QUESTION AND ANSWER BOOK