Student Name: _____

CHEMISTRY

Unit 3 – Written examination 1

2008 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	6	6	58	65
			Total 78	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 14 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.

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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.

Question 1
Copper sulfate crystals have a formula $CuSO_4.xH_2O$. 10.0 g of copper sulfate crystals contains 3.61 g of water. The value of x is
A. 2
B. 4
C. 5
D. 10

Questions 2 and 3 refer to the following information

0.1400 g of metal, M reacts with oxygen gas to form 0.1685 g of the oxide, M_2O

Question 2
The metal M is most likely to be
A. lithium
B. sodium
C. potassium
D. calcium

Question 3
The volume of the oxygen gas needed for this reaction will be, at STP,
A. 0.002 L
B. 0.020 L
C. 0.040 L
D. 40.0 L

Question 4
In a 0.45 M solution of $MgCl_2$, what is the concentration of Cl^- ions in g L^{-1}?
A. 16
B. 32
C. 37
D. 43

SECTION A – continued

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Question 5
In which list does the underlined element have the same oxidation number in each compound?
A. $\underline{N}H_3$, $\underline{N}H_4Cl$, $H\underline{N}O_3$
B. $\underline{C}H_4$, $\underline{C}O_2$, $Na_2\underline{C}O_3$
C. $\underline{O}_2$, $H_2\underline{O}$, $C\underline{O}_2$
D. $\underline{Fe}Cl_3$, $\underline{Fe}_2O_3$, $\underline{Fe}N$

Question 6
Ammonium ions can react with sulfur ions in the reaction:
$NH_4^+(aq) + S^{2-}(aq) \rightarrow NH_3(aq) + HS^-(aq)$
This reaction is
A. an acid-base reaction with ammonium ions acting as an acid
B. a precipitation reaction, where HS^- solid forms on the bottom of the container
C. an ionization reaction, where the ammonia is ionised
D. a redox reaction, as the oxidation number of the nitrogen and sulfur atoms changes

Question 7
A 10 mL solution of hydrochloric acid has a pH of 2. What volume of water, in mL, must be added to it to change the pH to 3?
A. 10
B. 90
C. 99
D. 100

Question 8
A 10 mL sample of vinegar, containing ethanoic acid, is made up to the mark with water in a 250 mL volumetric flask. 20 mL aliquots are then titrated against 0.200 M sodium hydroxide, NaOH. The average titre is 15.0 mL. The concentration of the vinegar is, in M,
A. 0.15
B. 1.50
C. 3.75
D. 4.00

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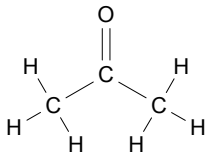
Question 9
The molecule propanone is drawn below

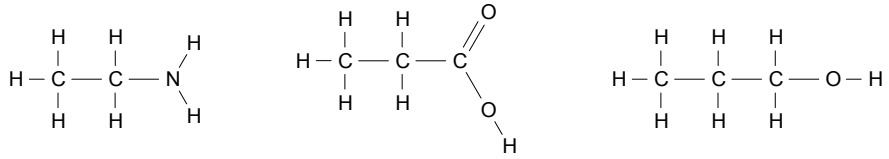


Select the option that correctly lists the number of peaks expected in the ^{1}H NMR and ^{13}C NMR of propanone

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

Question 10
The molecule propanol will exhibit absorption bands that include the following, in cm^{-1},
A. 2700, 1650, 1100
B. 2700, 1700, 800
C. 3400, 2700, 800
D. 3400, 3000, 1100

Question 11



The systematic names for the molecules drawn above are, respectively:
A. aminoethane, propanoic acid, 1-propanol
B. aminoethane, 1-propanoic acid, propanol
C. 1-aminoethane, 1-propanoic acid and 1- propanol
D. aminopropane, propanoic acid and 1-propanol

Question 12
The boiling point of hexane is $69^{\circ}C$ and octane is $107^{\circ}C$ A mixture of hexane and octane is heated in a laboratory distillation apparatus. The temperature of the mixture will:
A. rise at a linear rate if the apparatus is kept insulated
B. rise quickly until it reaches $69^{\circ}C$ and then rise more slowly as the hexane is boiling
C. rise quickly until it reaches $69^{\circ}C$ and then rise more quickly as the hexane is boiling
D. rise quickly and then remain at $69^{\circ}C$ until all the hexane evaporates

SECTION A - continued

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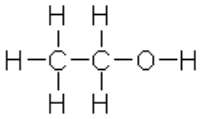
Question 13



The molecule shown could be formed from the reaction of
A. aminoethane and water
B. chloroethane and potassium hydroxide
C. ethene and oxygen
D. ethane and water

Question 14
When methane reacts with chlorine in the presence of *uv* light,
A. an addition reaction occurs to form CH_3Cl
B. a substitution reaction occurs to form CH_3Cl
C. the products are CH_3Cl and HCl only
D. the products include CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4 and HCl

Questions 15 and 16 refer to the following information.

1- propanol is produced in the process outlined below.

Question 15
The name of compound A is
A. propane
B. 1-propane
C. propene
D. chloropropane

Question 16
Compound B is obtained from fractional distillation of the products of the first reaction. The fractional distillation step is required
A. to crack the alkane molecule, forming an alkene molecule
B. to separate 1-chloropropane from propene
C. to separate 1-chloropropane from structural isomers
D. to separate the chloropropene from propene

SECTION A – continued
TURN OVER

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Question 17

The empirical formula of an amino acid is C_3H_7ON . The amino acid will be

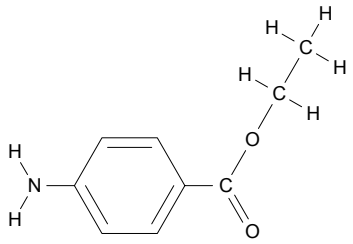
A. valine
B. lysine
C. aspartic acid
D. leucine

Question 18

The base sequence in a particular fragment of DNA is: adenine, adenine, cytosine, thymine, adenine, guanine. The base sequence in the matching strand will be

A. thymine, thymine, adenine, guanine, cytosine, thymine
B. thymine, thymine, guanine, adenine, thymine, cytosine
C. guanine, adenine, thymine, cytosine, adenine, adenine
D. guanine, guanine, adenine, thymine, cytosine, adenine

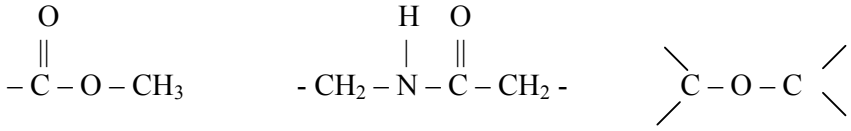
Question 19



The molecule drawn is the local anesthetic, ethyl-aminobenzoate. The functional groups in this molecule are

A. amine and carboxy
B. amine, hydroxy and carboxy
C. amine and ester
D. carboxy and ester

Question 20



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

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

END OF SECTION A

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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 working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working. • make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, $H_2(g)$; NaCl(s)

Question 1

A 20.0 mL sample of acid is delivered to a laboratory for analysis. The identity of the acid, and its concentration, is not known. The 20.0 mL sample is made up to the mark with water in a 250 mL volumetric flask.

25 mL aliquots are then titrated against 0.05 M sodium carbonate, Na_2CO_3 solution. Methyl red is chosen as the indicator and a sharp transition occurs at an average titre of 15.6 mL.

a. Calculate the number of mole of Na_2CO_3

_____

1 mark

b. Complete the table, showing possible concentrations of the acid.

If the acid is:	concentration of diluted acid	concentration of original acid
Monoprotic		
Diprotic		
triprotic		

3 marks

c. Give three reasons why sodium carbonate is a popular choice as a standard base.

_____

2 marks

d. What can you deduce from the fact that methyl red provided a sharp colour transition during the titration?

_____

_____

2 marks

SECTION B - Question 1 – continued
TURN OVER

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e. If the acid is monoprotic, what should its pH be?

_____

1 mark

f. Would atomic absorption spectrometry be useful for identifying the acid? Explain your answer.

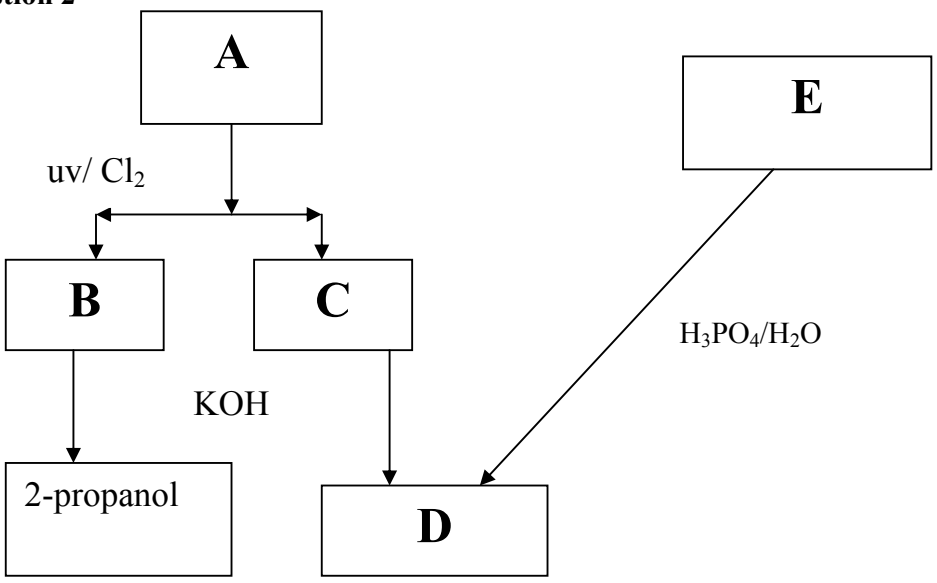
_____

_____

1 mark

Total 10 marks

Question 2



a.

i. Draw structural diagrams of the molecules A to E

A B

_____ _____

C D

_____ _____

E

_____

SECTION B - Question 2 – continued

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ii. Name each molecule A to E, using the lines provided above

iii. Name the type of reaction that is responsible for

A → B _____

E → D _____

5 + 2 + 2 = 9 marks

b.

i. Name an instrument 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

c. The reaction of E to D could produce another product.
Name this product. _____

1 mark
Total 13 marks

Question 3
A mass spectrometer can be used to help identify a substance or to help deduce the structure of a substance.

a.

i. What form must the sample be in when it is enters the evacuated tube used?

_____

ii. How is each substance changed to enable it to be accelerated?

_____

iii. What two factors dictate the degree to which a particles path is curved?

_____

1 + 1 + 1 = 3 marks

SECTION B - Question 3 – continued
TURN OVER

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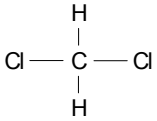
b.

Dichloromethane has the structure shown.
Give two reasons why this molecule has several different peaks on a mass spectrum.



_____

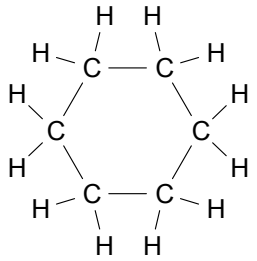
_____

2 marks

c.

i. Draw a structural diagram of 1-hexene.

ii. Cyclohexane has the structure drawn



How will the parent molecular ion for cyclohexane compare to that of 1-hexene?

_____

iii. Name one peak likely to be present on a 1-hexene mass spectrum that will not be present in cyclohexane.

_____

iv. Which molecule would have the most peaks on ^{1}H NMR? Explain your answer.

_____

_____

v. Name one infrared absorption peak 1-hexene will have that cyclohexane does not.

_____

1 + 1 + 1 + 2 + 1 = 6 marks
Total 11 marks

SECTION B - continued

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Question 4

The composition of sand varies considerably with the location. One of the components is usually shells, which are mainly calcium carbonate, $CaCO_3$ A student tests a nearby beach sand for its calcium carbonate content. He weighs a 2.000 g sample carefully, washes it and adds an excess of hydrochloric acid to it.

a.

i. Write a balanced equation for the reaction between calcium carbonate and hydrochloric acid.

_____

ii. What form is the calcium now present as? _____

1 + 1 = 2 marks

After the reaction is complete, he filters the mixture to remove any solids that have not reacted. He then uses an evaporating basin to boil the water away from the filtrate. The mass of white solid at the bottom is measured as 0.976 g

b.

i. Calculate the number of mole of white solid.

_____

_____

ii. What is the number of mole of calcium carbonate that was present in the sand?

_____

iii. Calculate the percentage calcium carbonate by mass in the sand.

_____

_____

2 + 1 + 2 = 5 marks

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c. Explain the impact on the final result of each of the following

i. Some filtrate bubbled out of the evaporating basin during heating

_____

ii. Not enough hydrochloric acid was added at the start – it was actually the limiting reagent

_____

iii. The white solid was weighed before drying completely.

_____

1 + 1 + 1 = 3 marks

Total 10 marks

Question 5

The monounsaturated fatty acid, oleic acid, has an empirical formula, $C_9H_{17}O$. It has nine carbon atoms joined by single covalent bonds.

a.

i. Draw a semi-structural diagram of oleic acid.

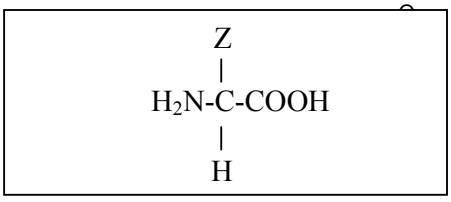
ii. Oleic acid can react with methanol to form a biodiesel molecule. Draw a semi-structural diagram of this biodiesel molecule.

iii. Write a balance equation for the combustion of this biodiesel molecule

_____

1 + 1 + 1 = 3 marks

b. α-Amino acids have a general formula shown below, where the Z- group varies.
Depending upon the nature of the Z- group, the interactions between the neighbouring parts of a protein chain may vary.



i. Draw the alternative form (i.e. Zwitterion) that this molecule can take.

SECTION B – Question 5 – continued

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ii. Draw a Z- group that will likely result in disulfide links between parts of the protein chain

iii. Draw a Z- group that will likely have to rely upon dispersion forces to be attracted to neighbouring sections.

iv. Explain, using an example, how some chain sections can be attracted to others due to ionic interactions.

_____

_____

1 + 1 + 1 + 1 = 4 marks
Total 7 marks

Question 6
CRP stands C-reactive protein. The concentrations in the blood of CRP rise when inflammation is present. It is a sensitive indicator of infection.

a.

i. What is the term given to the detection of illness through the monitoring of CRP concentration?

_____

ii. When testing for levels of CRP, technicians have to ensure the temperature of the sample does not exceed 45 ^{0}C. Give a reason for this.

_____

_____

iii. Pathology labs keep a database of mass spectra of chemicals like CRP. Why do they do this?

_____

1 + 1 + 1 = 3 marks

SECTION B – Question 6 – continued
TURN OVER

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b.

i. What are the components of a nucleotide?

_____

ii. Are all nucleotides the same? Explain your answer.

_____

_____

iii. What type of reaction occurs to join nucleotide molecules together?

_____

1 + 2 + 1 = 4 marks
Total 7 marks

END OF QUESTION AND ANSWER BOOK

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