MELBOURNE HIGH SCHOOL

UNIT 3 CHEMISTRY

TRIAL EXAMINATION

2009

QUESTION AND ANSWER BOOKLET

Thursday 28th 2009
Reading time: 15 minutes
Writing time: 90 minutes

Section	*Number of questions*	*Number of questions to be answered*	Number of marks	Suggested time (minutes)
A	20	20	20	23
B	9	9	60	67
		Total	80	90

Materials : * Question and answer booklet consisting of a cover page and 14 pages of questions - pages are numbered 2 to 15
* Answer sheet for multiple-choice questions.

Instructions : * Multiple choice items are to be answered by filling in the appropriate box which corresponds to the answer of your choice in the question booklet.
* Short answer questions are to be answered in the spaces provided.
* All written responses must be in English.
* Chemical equations and half equations must include symbols of state.
* Numerical answers are to be given to appropriate numbers of significant figures.
* A unit must be given in numerical answers that require a unit for complete specification.
***Students must bring in to the examination a clean, stapled copy of the data book.**
* Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, and one scientific calculator.
* **Students are NOT permitted to bring graphics calculators, mobile phones and/or any other electronic communication devices into the examination room, blank sheets of paper, white out liquid/tape**.

Submission : * At the conclusion of the exam, place the Multiple Choice answer sheet inside this booklet.

Section A / 20

Section B / 60

Total / 80

2009 UNIT 3 SECTION A

Specific instructions for Section A

- This section consists of 20 multiple-choice items, which are to be answered by shading the box on the answer sheet that corresponds to your answer in **lead pencil**.
- If you wish to change an answer, erase the original answer completely.
- A correct answer scores 1 mark and an incorrect answer scores 0 marks.
- 1 × 20 = 20 marks, 23 minutes

1 How many electrons are in the molecule C_2H_2?

A. 6
B. 10
C. 14
D. 26

2 Which substance, when dissolved in water to give a 0.1 mol dm^{-3} solution, has the lowest pH

A. HCl
B. NaCl
C. NH_3
D. H_2SO_4

3 Which compound has the highest boiling point?

A. $CH_3CH_2CH_3$
B. CH_3CH_2OH
C. CH_3OCH_3
D. CH_3COH

4 Consider the reaction

$$MnO_{2(s)} + 4HCl_{(aq)} \rightarrow Cl_{2(aq)} + 2H_2O_{(l)} + MnCl_{2(aq)}$$

The atoms whose oxidation numbers change during this reaction are

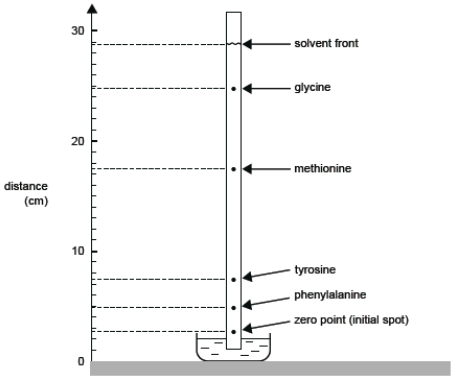
A. Mn
B. Mn and Cl
C. Mn, Cl and O
D. Mn, Cl, O and H

5 What is the correct sequence for the processes occurring in a mass spectrometer?

A. vaporisation, ionisation, acceleration, deflection
B. vaporisation, acceleration, ionisation, deflection
C. ionisation, vaporisation, acceleration, deflection
D. ionisation, vaporisation, deflection, acceleration

The following 2 questions, 6 and 7 relate to the information below.

Chromatography is often used for analysis of the mixture of amino acids that is formed when proteins are broken down. The small protein X is being investigated as it has some pain killing activity. An aqueous solution of protein X is broken down into it's constituent amino acids and the resultant solution of amino acids is subjected to paper chromatography. A strip from such a chromatogram is shown below.



Amino acids are colourless, but the position of an amino acid spot on the strip can be seen by spraying the strip with a solution of ninhydrin, a substance that reacts with the amino acids to produce an intense purple colour

6. The R_f of methione is

A. 17
B. 0.60
C. 0.57
D. 0.07

7 The amino acid which would elute fastest in HPLC (using the same solvent) is

A. glycine
B. methione
C. tyrosine
D. phenylalanine

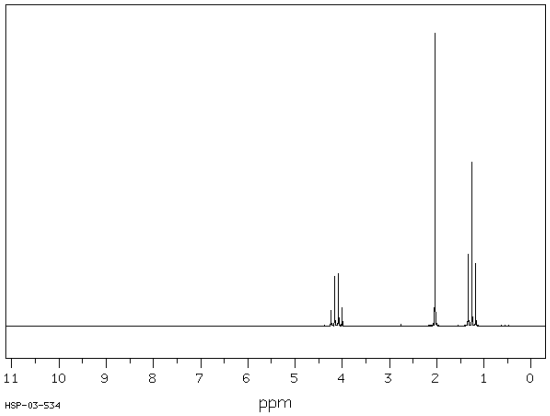
8 Which of the following statements in regard to the IR spectra of important biomolecules is incorrect.

A. Oleic acid shows an absorption at a wavenumber of 1750 cm^{-1}
B. Glycerol shows an absorption at a wavenumber of 3300 cm^{-1}
C. Glycine shows an absorption at a wavenumber of 3200 cm^{-1} and 3500cm^{-1}
D. Steric acid shows an absorption at a wavenumber of 1610 $cm^{-1}$and 1700cm^{-1}

9 1.245 g of impure silver is reacted with concentrated nitric acid, which is diluted to make 200.00 mL of solution. A 20.00 mL aliquot is taken and reacted with excess sodium chloride. The resulting solid is filtered, rinsed and dried, and has a mass of 0.165 g. The purity of the silver is

A. 10%
B. 90%
C. 97%
D. 100 %

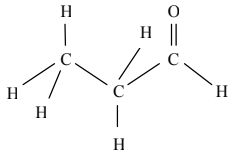
10 This high resolution ^{1}H NMR is from a molecule with the chemical formula $C_4H_8O_2$.



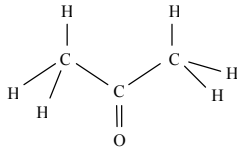
The molecule is

A. $CH_3COOCH_2CH_3$
B. $CH_3CH_2CH_2COOH$
C. $CH_3COCH(OH)CH_3$
D. $CH_3CH_2COOCH_3$

11 Which statement about compounds I and II is not true?



Compound I



Compound II

A. The mass spectrum of both compounds will show a peak at a mass-to-charge ratio of 58.
B. The low resolution ^{1}H NMR spectrum of Compound I has three peaks, and that of Compound II has two peaks.
C. The ^{13}C NMR spectrum of Compound I has three peaks and that of Compound II has two peaks.
D. The fingerprint region of the IR spectra will be different for both compounds.

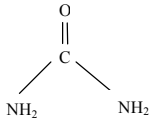
12 1-propyl butanoate is the product of a reaction involving concentrated H_2SO_4 and

A. $CH_3CH_2CH_2OH$ and $CH_3CH_2CH_2COOH$
B. $CH_3CH_2CH_2CH_2OH$ and CH_3CH_2COOH
C. $CH_3CH_2CH_2CH_2OH$ and $CH_3CH_2CH_2COOH$
D. $CH_3CH_2CH_2OH$ and $CH_3CH_2CH_2CH_2COOH$

13 Peptides are formed via the pathway of

A. addition polymerisation between an alkanol and a carboxylic acid.
B. condensation polymerisation between an alkanol and carboxylic acid.
C. addition polymerisation between an alkanol and an amine.
D. condensation polymerisation between a carboxylic acid and an amine.

14 Glycine is one of the amino acids that forms proteins. Protein that is not required in the body is broken down in the liver. Unwanted nitrogen is converted to urea and eliminated in the urine.



urea

The maximum mass of urea (relative molecular mass = 60) that could be eliminated as a result of the breakdown of 1.00 g of glycine (relative molecular mass = 75) is, in gram,

A. 0.40
B. 0.80
C. 1.00
D. 1.60

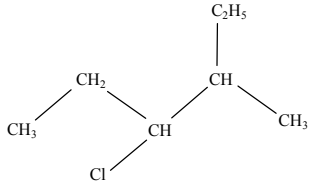
15 A stomach enzyme is heated, and denatured. The bonds which hold an enzyme together include

I dispersion forces
II dipole-dipole bonds
III Hydrogen bonds
IV covalent bonds

When the enzyme is heated from 25 ºC to 90 ºC, bonds affected include

A. I and IV.
B. I and III.
C. I, II, III and IV.
D. II and III only.

16 Name the following molecule



A. 3-chloro-2-ethylpentane
B. 2-ethyl-3-chloropentane
C. 3-methyl-4-chlorohexane
D. 3-chloro-4-methylhexane

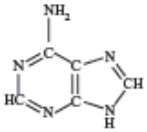
17 How many isomers are there of C_4H_9OH, containing the alcohol functional group?

A. 2
B. 3
C. 4
D. 6

18 Alanine dissolves in water. In an aqueous solution with a pH = 7, alanine is acting as

A. an acid only.
B. a base only.
C. neither an acid nor a base.
D. both an acid or a base.

19 The base shown will bond in the DNA molecule with



A. Adenine
B. Cytosine
C. Guanine
D. Thymine

20 The reagents required to convert ethene to ethanamine are

A. chlorine gas followed by sodium hydroxide
B. hydrochloric acid followed by sulfuric acid
C. chlorine gas followed by ammonia
D. hydrochloric acid followed by ammonia

End of Section A

2008 UNIT 3 SECTION B

Specific instructions for Section B

- **This section consists of 9 short answer questions which are to be answered in the spaces provided.**
- **Numerical answers must be given to the appropriate number of significant figures.**
- **Symbols of state must be included in all equations and half equations.**
- **No credit will be given for an incorrect numerical answer unless it is supported by working.**
- **60 marks, 67 minutes**

1. Anhydrous sodium carbonate can be made into a primary standard solution, and used to standardise a solution of HCl.

a Write the chemical formula for anhydrous sodium carbonate.

_____

b Give 3 reasons why anhydrous sodium carbonate would be chosen as a primary standard.

_____

_____

_____

_____

c From the list in your Data Book, choose an appropriate indicator for the reaction between sodium carbonate and hydrochloric acid.

_____

d If 2.013 g of anhydrous sodium carbonate were made up into a 250.00 mL solution, what is the molar concentration of the primary standard solution?

e Circle the compound/s which could be used as a primary standard to standardise a solution of sodium hydroxide.

sodium borate	anhydrous sodium carbonate	hydrochloric acid
sulfuric acid	hydrated oxalic acid	calcium hydroxide

(1 + 3 + 1 + 2 + 1 = 8 marks)

2. The sodium chloride content of a 330 g can of baked beans was determined as follows. The Cl^- ions in 50.00 g of the baked beans were precipitated as silver chloride. The mass of the precipitate was 1.151 g.

a Write a balanced ionic equation for the formation of the precipitate.

_____

b Calculate the amount, in moles, of the Cl^- ions in the sample of baked beans.

c Calculate the mass of NaCl in the sample of baked beans.

d Calculate the salt content of the baked beans, in terms of % (w/w).

e Suppose instrumental analysis showed that the experimental result was higher than the true result. Suggest two possible sources of experimental uncertainty that could account for the higher result.

_____

_____

_____

_____

_____

_____

(1 + 1 + 1 + 1 + 2 = 6 marks)

3. Pyrolusite, an ore of manganese, contains manganese in the form of MnO_2. A sample of pyrolusite from a newly discovered deposit is analysed to determine the degree of purity of the deposit.
To determine the amount of Mn in the pyrolusite sample, 1.25g of dried pyrolusite was heated with 100 mL of 0.150 M oxalic acid ($H_2C_2O_4$). The oxalic acid was in excess, so that all of the MnO_2 reacted according to

$$MnO_{2(s)} + H_2C_2O_{4(aq)} + 2H^+_{(aq)} \rightarrow Mn^{2+}_{(aq)} + 2CO_{2(g)} + 2H_2O_{(l)}$$

20.00 mL of the resulting solution is then titrated with a 0.0510 M solution of the triiodide ion

$$I_3^-{}_{(aq)} + H_2C_2O_{4(aq)} \rightarrow 2CO_{2(g)} + 2H^+_{(aq)} + 3I^-_{(aq)}$$

22.00 mL of the 0.0510 M triiodide solution was needed to react with the remaining oxalic acid.

a What is the oxidation number of the manganese in MnO_2?

_____

b Calculate the amount in mole of oxalic acid remaining in the original 100 mL solution after the pyrolusite had been reacted with the oxalic acid.

c Calculate the amount, in mole, of oxalic acid used to reduce the MnO_2 in the 1.25 g of pyrolusite.

d Calculate the amount in mole of MnO_2 present in the original 1.25 g of pyrolusite and hence the percentage of MnO_2 by mass present in the pyrolusite.

(1 + 3 + 2 + 2 = 8 marks)

4. In order to help prevent tooth decay, Melbourne's public water supplies have fluoride ions added into the "tapwater". The fluoride ions are obtained by the addition of sodium fluoride to the water, and the concentration of fluoride ions is 0.9 mg L^{-1}.

a. Calculate the mass of sodium fluoride in mg that must be present in 1.00 L of water to produce a concentration of fluoride ions of 0.90 mg L^{-1}.

One method of determining the concentration of fluoride ions in water uses a red coloured indicator, Ind, that reacts with fluoride ions in solution to give a colourless product. The reaction can be represented as

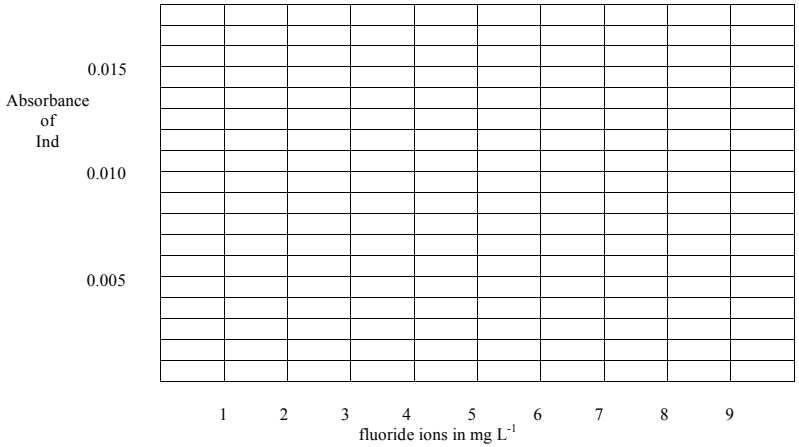
$$\underset{\text{red coloured indicator}}{Ind_{(aq)}} + \underset{\text{colourless}}{F^-_{(aq)}} \rightarrow \underset{\text{colourless}}{FInd^-_{(aq)}}$$

A calibration curve was prepared using five different aqueous solutions of sodium fluoride, each of known concentration. *X* mole of Ind is then added to 25.00 mL of each of five NaF solutions and a NaF solution of unknown concentration. The intensity of the red Ind colour of each of the mixtures is then determined using a UV-visible spectrophotometer.

The measured absorbances are given in the following table.

Fluoride ion concentration in mg L^{-1}	Absorbance of Ind
1.00	0.0130
2.00	0.0110
3.00	0.0090
4.00	0.0070
5.00	0.0050
Unknown NaF sample	0.0100

b. Draw a calibration on the graph provided.



c Find the concentration of the unknown NaF sample, in mg L^{-1}, from your calibration curve.

_____

d Why does the absorbance fall with increasing fluoride ion concentration?

_____

_____

_____

_____

e Find the value of *X*?

(1 + 1 + 1 + 1 + 2 = 6 marks)

5. Complete the table.

Region of the Electromagnetic Spectrum	Analysis Instrument which utilises this region of the electromagnetic spectrum	Qualitative or Quantitative Analysis	An element or compound which can be analysed for using the Instrument listed in this region of the electromagnetic spectrum
Ultra-Violet Radiation			
Radio Waves			
Visible Light			

(2 + 2 + 2 = 6 marks)

6. Butanoic acid , $CH_3CH_2CH_2COOH$, is a weak acid. It is used as a food preservative, and as a precursor for chemical synthesis.

a Write the equation for the reaction when water is added to butanoic acid.

_____

b How many peaks would be expected in the ^{13}C NMR spectra of butanoic acid

_____

c Describe the number of peaks, and their multiplicities, seen in the high resolution ^{1}H NMR of butanoic acid.

_____

_____

_____

_____

(1 + 1 + 1 = 3 marks)

7. A representation of a section of polymer chain is

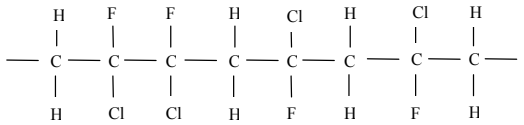
-O-CH_2-CH_2-O-CO-CH_2-CO-O-CH_2-CH_2-O-CO-CH_2-CO-O-

a Give the structure of the two different monomers needed to make this polymer.

b What is the formula of the other small molecule formed when the monomers combine to form the polymer.

_____

c A representation of a different polymer chain is



Give the structure of the monomer from which this polymer is made.

(2 + 1 + 1 = 4 marks)

8. Experiments were carried out on several different reactions of butane. The following series of different possible reactions of butane were observed under a variety of conditions.

$CH_3CH_2CH_2CH_3 \rightarrow A + B$
$CH_3CH_2CH_2CH_3 \rightarrow C + B$
$CH_3CH_2CH_2CH_3 \rightarrow D + E$

Molecules A, B, C, D, and E were further investigated and the following three items of information were obtained.

$A + Cl_2 \rightarrow CH_3CHClCHClCH_3$

C has the same molecular formula as A but has a different structure

$D + H_2O \rightarrow CH_3CH_2OH$

a On the basis of this information, give the semi-structural formulas of each of the following molecules.

Molecule A	Molecule B
Molecule C	Molecule D
Molecule E	

b Write the equation for the reaction between Molecule E and Cl_2.

_____

(5 + 1 = 6 marks)

9. The following is an extract from "The Age Epicure", Tuesday May 12, 2009.

Low-Lactose Milk

Marketed to people who are lactose intolerant and who don't produce enough of the beta galactosidase, the biological compound which breaks down lactose in milk. If lactose passes through to the lower intestines undigested, it ferments, creating wind, small amounts of alcohol and irritation. Low-lactose milks such as 'Zymil' have been treated with a compound that breaks the lactose into glucose and galactose. Low-lactose milks taste remarkably different – they tend to be overtly sweet with a "chemical" aftertaste.

a How is the carbohydrate lactose classified?

_____

b What is the molar mass of lactose?

_____

c Draw the structure of one of the monosaccharides present in 'Zymil', and name it.

_____

d Name the chemical link in the lactose molecule.

_____

e What type of molecule is beta galactosidase and what is its function?

_____

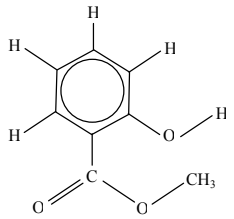
_____

_____

_____

(1 + 1 + 2 + 1 + 2 = 7 marks)

10. Methyl 2-hydroxybenzoate is also known as oil of wintergreen. The structure of this molecule is shown below.



a What is the empirical formula of the molecule.

_____

b Name 2 of the functional groups in this molecule.

_____

c Draw 2 of the precursor molecules which could be used to synthesis methyl 2-hydroxybenzoate (show all bonds).

d Name the synthesis reaction.

_____

(1 + 2 + 2 + 1 = 6 marks)

END OF EXAM