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Student name

CHEMISTRY
Unit 3
Trial Examination

QUESTION AND ANSWER BOOK

Total writing time: 1 hour 30 minutes

Structure of book

Section	Number of questions	Number of marks
A	20	20
B	10	68
	Total	**88**

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape, mobile phones and/or any other unauthorised electronic devices.
- A copy of the official VCAA Data Book (printed or photocopied) can be brought into the trial examination.

Materials supplied

- Question and answer book of 18 pages, with a detachable answer sheet for multiple-choice questions inside the front cover.

Instructions

- Detach the answer sheet for multiple-choice questions during reading time.
- Write your **name** in the space provided above on this page and on the answer sheet for multiple-choice questions.
- All written responses should be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.
- You may keep your copy of the VCAA Data Book.

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2012

CHEMISTRY

Unit 3 Trial Examination

MULTIPLE CHOICE ANSWER SHEET

STUDENT NAME:	

INSTRUCTIONS: **USE PENCIL ONLY**

- Write your name in the space provided above.
- Use a **PENCIL** for **ALL** entries.
- If you make a mistake, **ERASE** it – **DO NOT** cross it out.
- Marks will **NOT** be deducted for incorrect answers.
- **NO MARK** will be given if more than **ONE** answer is completed for any question.
- Mark your answer by **SHADING** the letter of your choice.

	ONE ANSWER PER LINE					ONE ANSWER PER LINE				
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	

SECTION A – Multiple-choice questions

Instructions for Section A

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

Question 1

The Avogadro constant is the same as the number of

A. molecules in 16 g of oxygen gas

B. electrons in 1 g of hydrogen gas

C. atoms in 24 g of carbon

D. ions in 1 L of 1.0 M sodium chloride solution

Question 2

Which of the following is **not** a criterion for choosing a suitable material to use as a primary standard in acid/base volumetric analysis?

A. It should have a relatively high molar mass.

B. It should be anhydrous.

C. It should not react with carbon dioxide.

D. It should have a relatively high solubility in water.

Question 3

The volume delivered by a standard 20 mL pipette is closest to

A. 20 ± 1 mL

B. 20.0 ± 0.1 mL

C. 20.0 ± 0.2 mL

D. 20.00 ± 0.01 mL

Question 4

The acid/base indicator bromophenol blue is a weak acid. Its ionisation can be represented by

$$HIn(aq) \rightleftharpoons H^+(aq) + In^-(aq)$$

Which **one** of the following statements about bromophenol blue is correct?

A. Molecules of the indicator bromophenol blue are always blue.

B. At pH < 3, a solution of bromophenol blue contains more ions, In^-, than molecules, HIn.

C. Bromophenol blue is a suitable indicator to titrate hydrochloric acid with KOH(aq).

D. None of the above.

Question 5

Which of the following analyses is most suited to determination by atomic absorption spectroscopy?

A. the sulfate ion content in bottled water.

B. the magnesium ion content of a sample of mineral spring water.

C. the amount of caffeine in an energy drink.

D. the percentage ethanol in a bottle of red wine.

The next two questions refer to the following information.

Hex-1,6-diene reacts with hydrogen bromide according to the following equation

$$C_6H_{10}(g) + 2HBr(aq) \quad C_6H_{12}Br_2(l)$$

Question 6

This reaction between hex-1,6-diene and hydrogen bromide is referred to as

A. addition

B. substitution

C. condensation

D. bromination

Question 7

The number of structural isomers expected would be

A. 1

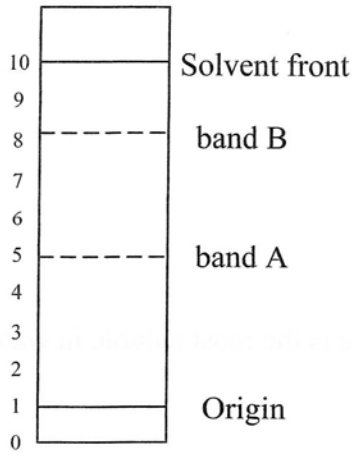
B. 2

C. 3

D. 4

The next two questions refer to the following information.

The diagram below represents a chromatogram of some food colouring.



Question 8

A. Band A has a larger R_f value than band B and adheres to the stationary phase more strongly.

B. Band A has a smaller R_f value than band B and adheres to the stationary phase more strongly.

C. Band A has a larger R_f value than band B and adheres to the stationary phase less strongly.

D. Band A has a smaller R_f value than band B and adheres to the stationary phase less strongly.

Question 9

The R_f value for band A is approximately

A. 0.44

B. 0.50

C. 0.90

D. 1.0

Question 10

The low resolution proton NMR spectrum of the substance $CH_3CH_2OCH_2CH_3$ would consist of

A. one peak

B. two peaks

C. two triplets and two quartets

D. one triplet and one quartet

Question 11

The number of hydrogen atoms in a molecule of 2,2-dihydroxyoctanoic acid is

A. 16

B. 18

C. 19

D. 21

Question 12

Which of the following substances is the most soluble in water (in mol L^{-1}) at 25°C ?

A. CH_3CH_3

B. CH_3OCH_3

C. CH_3CH_2OH

D. $CH_3CH_2CH_2CH_2OH$

Question 13

ClO_2 is prepared for use in water treatment plants by the reduction of $NaClO_3$ according to the following equation

$$2NaClO_3 + SO_2 + H_2SO_4 \quad 2ClO_2 + 2NaHSO_4$$

When 1 mol of ClO_2 is prepared, the amount of electrons transferred in the reaction is

A. 0.5 mol

B. 1 mol

C. 2 mol

D. 4 mol

Question 14

Consider the molecule $CH_3CH_2CH_2CHClCH_2CH_3$

The systematic name for this molecule is

A. 5-chlorohexane

B. 3-chlorohexane

C. 5-chloroheptane

D. 3-chloroheptane

Question 15

A large polyethene molecule has a relative mass of 2.0×10^4. The number of carbon atoms in this molecule would be closest to

A. 714

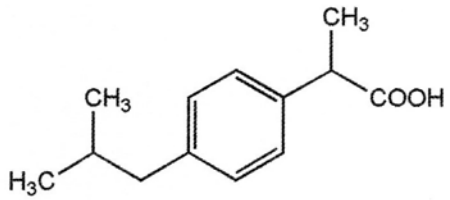
B. 1428

C. 4.3×10^{26}

D. 8.6×10^{26}

Question 16

Ibuprofen is useful as a painkiller. A molecule of Ibuprofen can be represented as shown below.



The molecular formula of Ibuprofen can be represented as

A. $C_{13}H_{17}O_2$

B. $C_{13}H_{18}O_2$

C. $C_{14}H_{17}O_2$

D. $C_{14}H_{13}O_2$

Question 17

The reactions that produce ethanol can be summarised as:

$$CO_2 + H_2O \xrightarrow{A} C_6H_{12}O_6 \xrightarrow{B} CH_3CH_2OH$$

The names of the reactions **A** and **B** are

A. photosynthesis and fermentation

B. respiration and fermentation

C. photosynthesis and oxidation

D. respiration and oxidation

Question 18

The molecule, 3-hydroxypropanoic acid forms a polymer in which the average molecule contains 500 monomer units. The approximate mass of the polymer, in g mol^{-1}, is

A. 22 500

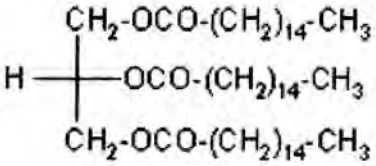
B. 27 000

C. 36 000

D. 45 000

Question 19

Palm oil, obtained from the kernels of palm trees, consists of the triglyceride called tripalmitin or glycerine tripalmitate (shown below).



The glycerine triplamitate can be converted into the biofuel, methyl palmitate. The molecular formula for methyl palmitate would be

A. $C_{17}H_{34}O_2$

B. $C_{18}H_{36}O_2$

C. $C_{51}H_{102}O_6$

D. $C_{54}H_{108}O_6$

Question 20

Information about octane and benzene are provided in the table below.

Substance	Melting point (°C)	Boiling point (°C)	Solubility
octane	-57	126	Soluble in benzene
benzene	5.5	80	Soluble in octane

Which of the following would allow a mixture of the above chemicals to be separated based on the following criteria

- It is easy to perform
- It gives the best yield of benzene

A. Dissolve in water, filter, evaporate water.

B. Fractionally distil and collect distillate.

C. Evaporate, allow the vapour to crystallise, collect crystals.

D. None of the above.

END OF SECTION A

SECTION B – Short answer questions

Instructions for Section B

Answer **all** questions in the spaces provided

To obtain full marks for your responses you should

- Give simplified answers with an appropriate number of significant figures for 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 formulas for individual substances include an indication of state; for example, $H_2(g)$; NaCl(s)

Question 1

Linolenic acid is an essential fatty acid.

a. Explain why linolenic acid is referred to as an unsaturated fatty acid.

_____

_____

_____

1 mark

b. Determine the mass of iodine, I_2, that reacts with 1.00 g of linolenic acid.

_____

_____

_____

_____

_____

3 marks

Total 4 marks

Question 2

Identify the strongest type of intermolecular force in each of the following compounds.

CH_3Cl _____

CH_4 _____

CH_3OH _____

Total 3 marks

Question 3

Fluorescent brighteners are used as an additive to washing powders. It is these agents that cause white clothes to appear blue under ultraviolet lights. Fluorescent brightener 101 is used in the commercial product 'Supa White' and it absorbs ultraviolet light strongly at 240 nm and at 375 nm.

A 0.986 g sample of 'Supa White' was dissolved in 100 mL of distilled water. This was transferred to a 500.0 mL volumetric flask with three rinsings and the solution made up to the calibration line with distilled water.

The absorbances of a series of standard solutions of the fluorescent brightener 101 were measured using a wavelength of 375 nm. A 10.0 mL sample of the diluted solution of 'Supa White' was placed in the sample holder of the instrument and its absorbance was also measured at 375 nm. The results are shown in the table below.

Standard solutions	Concentration (mg L^{-1})	Absorbance
1	7.00	0.85
2	6.00	0.71
3	5.00	0.60
4	4.00	0.48
5	3.00	0.35
'Supa White' solution	unknown	0.68

a. Suggest one reason why a wavelength of 375 nm might be selected in the analysis rather than a wavelength of 240 nm?

_____

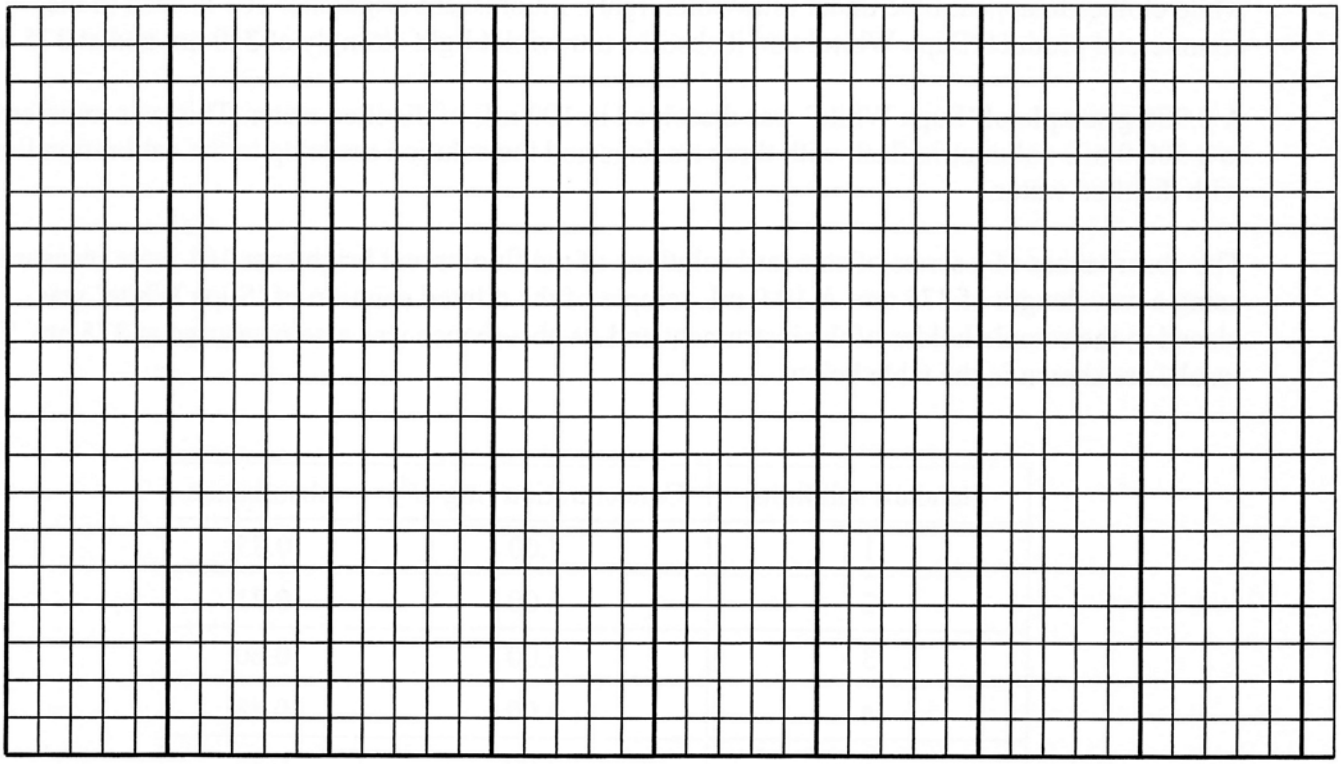
_____

_____

1 mark

Question 3 continues on the next page

b. Use the data to construct a calibration curve of absorbance against concentration on the grid provided below.



3 marks

c. Use the calibration curve to determine the concentration of the optical whitener in the sample.

_____

1 mark

d. The fluorescent brightener 101 has the chemical formula $C_{16}H_{12}O_3$. Calculate the:

i. mass of fluorescent brightener 101 in the 500.0 mL volumetric flask.

_____

ii. number of molecules of fluorescent brightener 101 in the 0.986 g sample.

_____

_____

_____

_____

1 + 3 = 4 marks
Total 9 marks

Question 4

Nucleic acids are natural polymers with extremely large relative molecular masses. The polymer chains are made up of nucleotides. Except for red blood cells, all cells in the human body contain deoxyribonucleic acid.

a. **i.** Name the units that make up a nucleotide.

_____

ii. Briefly explain how these units are linked in forming a DNA strand.

_____

_____

_____

_____

_____

2 + 2 = 4 marks

b. Explain how two DNA strands are linked to form two helices.

_____

_____

_____

_____

_____

2 marks

c. What two main factors allow sections of DNA to be separated in gel electrophoresis? Explain your answer.

_____

_____

_____

_____

_____

2 marks
Total 8 marks

Question 5

a. Consider the amino acid, alanine. Complete the table below to show the **structure** (showing all bonds) of the organic species formed when alanine:

dissolves in water	
reacts with hydrochloric acid	
reacts with methanol in the presence of a small amount of concentrated sulfuric acid.	

3 marks

b. The enzyme pepsin is found in the stomach juice which has a pH of about 2. Would you expect pepsin to be able to function in the small intestine where the pH is about 8? Explain your answer.

2 marks
Total 5 marks

Question 6

An aqueous solution contained both sodium carbonate and sodium hydrogencarbonate. A 25.0 mL sample of the solution was transferred into a conical flask. After the addition of a few drops of phenolphthalein, 0.150 M hydrochloric acid was then added from a burette.

The indicator changed colour when exactly 20.80 mL of the hydrochloric acid had been added to the conical flask. This end-point showed that the reaction in Stage **1** had been completed.

Stage 1 $CO_3^{2-}(aq) + H^+(aq) \quad HCO_3^-(aq)$

A few drops of methyl orange were then added to the conical flask. A further 33.25 mL of the 0.150 M hydrochloric acid were required before this second indicator changed colour.

This end-point showed that the reaction in Stage **2** had been completed.

Stage 2 $HCO_3^-(aq) + H^+(aq) \quad CO_2(aq) + H_2O(l)$

a. Use the data about Stage **1** to calculate the concentration of sodium carbonate in the original solution.

_____

_____

_____

_____

_____

2 marks

b. State why the volume of hydrochloric acid used in Stage **2** is greater than that used in Stage **1**.

_____

_____

1 mark

c. Hence calculate the concentration of sodium hydrogencarbonate in the original solution.

_____

_____

_____

_____

_____

4 marks

Total 7 marks

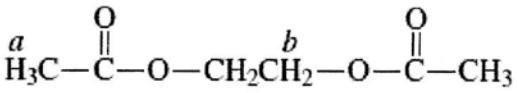
Question 7

Compounds **A, B, C and D** are some of the isomers of $C_6H_{10}O_4$.

a. Isomer **A** is a propyl ester which also contains a carboxylic acid group.
Draw the structure of **A,** showing all bonds.

1 mark

b. Isomer **B** is the diester shown below. Some of the protons have been labelled.



i. Deduce the number of peaks in the proton N.M.R. spectrum of **B.** _____

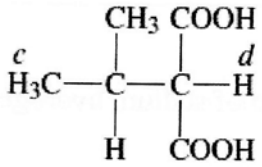
ii. Predict the ppm range of the peaks produced by the protons labelled *a* and *b*.

_____

_____

1 + 2 = 3 marks

c. Isomer **C** is the dicarboxylic acid shown below. Some of the protons have been labelled.



The protons labelled *c* and *d* each produce a peak in the proton N.M.R. spectrum.

Name the splitting pattern affect on:

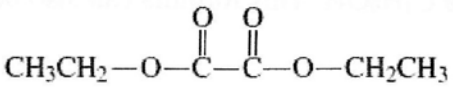
i. the protons labelled c. _____

ii. the proton labelled *d.* _____

1 + 1 = 2 marks

Question 7 continues on the next page

d. Isomer **D** is shown below.



The mass spectrum of Isomer **D** contains major peaks at $m/z = 45$ and $m/z = 29$.

i. Write the semi–structural formula and charge of the fragment which causes the peak at $m/z = 45$.

_____

ii. Draw the formula and charge of the fragment which causes the peak at $m/z = 29$.

_____

1 + 1 = 2 marks
Total 8 marks

Question 8

Butan-1-ol has the chemical formula C_4H_9OH. This formula can also be used for other isomeric alcohols.

a. In the space provided below, draw the structural formulae **and** name these isomeric alcohols.

6 marks

b. Write a balanced equation for the reaction of butan-1-ol with ethanoic acid.

_____

1 mark

c. Name the organic product obtained.

_____

1 mark

d. Liquid butan-1-ol can also be used as a fuel. Write a balanced equation for its **complete** combustion.

_____

1 mark

Question 8 continues on the next page

e. Under reflux conditions in the presence of an acidified solution of potassium dichromate, butan-1-ol reacts to form an acidic product.

i. Draw the structural formula, showing all bonds, of the acidic product.

ii. Name the acidic product. _____

iii. The presence of the acidic product can be confirmed by distilling and collecting the product then testing it with solid sodium carbonate.

Describe what would be expected to be observed on mixing the acidic product with the solid sodium carbonate and write a chemical equation for the reaction.

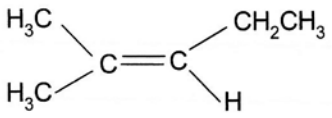
Observation: _____

Chemical equation: _____

1 + 1 + 3 = 5 marks
Total 14 marks

Question 9

An alkene has the structure as shown



a. Give the systematic name of the alkene.

_____

1 mark

b. The alkene is reacted with HBr(g).

i. Name the type of reaction occurring: _____

ii. Draw the structure of any possible product(s).

1 + 2 = 3 marks
Total 4 marks

Question 10

A student wishes to determine the percentage purity of a sample of barium chloride, $BaCl_2$. He expects that the purity of the sample will be about 85%. The student plans to weigh a sample of the solid, dissolve it in de-ionised water in a 250.0 mL volumetric flask and then take 20.00 mL samples of this solution for analysis. The student plans to precipitate the barium ions as barium phosphate, $Ba_3(PO_4)_2$.

$$3Ba^{2+}(aq) + 2PO_4^{3-}(aq) \rightarrow Ba_3(PO_4)_2(s)$$

With the equipment at his disposal, the student cannot collect more than 1.5 g of barium phosphate. What is the **maximum** mass of sample that the student should dissolve in the volumetric flask in order to ensure that he can collect all the precipitate?

6 marks

END OF EXAMINATION