

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	9	63
Total		83

- 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 15 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.

STAV Publishing

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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 sample with the greatest number of C atoms is

- A. 0.10 mol of $\text{C}_6\text{H}_{12}\text{O}_6$
- B. 20 g of C_2H_4
- C. 20 L of CO_2 at 0°C and 1 atm
- D. 1.0×10^{23} molecules of CH_4

Question 2

Genetic information is carried by a nucleic acid in the form of the

- A. relative proportions of the four bases
- B. acid strength of the nucleic acid
- C. hydrogen bonds which hold the helix in place
- D. specific sequences of the four bases

Question 3

How many structural isomers are possible with the molecular formula C_6H_{14} ?

- A. 4
- B. 5
- C. 6
- D. 7

Question 4

Which of the following could undergo oxidation to a carboxylic acid when treated with an appropriate oxidant?

- A. $\text{CH}_3\text{CH}_2\text{CHO}$
- B. $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$
- C. CH_3COOH
- D. $(\text{CH}_3)_3\text{COH}$

Question 5

The **high** resolution ^1H NMR spectrum of $\text{C}_2\text{H}_5\text{Br}$ would show

- A. 2 peaks
- B. 3 peaks
- C. 5 peaks
- D. 7 peaks

Question 6

Which of the following reactions is an example of a substitution reaction?

- A. $\text{C}_3\text{H}_6 + \text{HCl} \rightarrow \text{C}_3\text{H}_7\text{Cl}$
- B. $\text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{COO}^- + \text{H}_3\text{O}^+$
- C. $2 \text{C}_6\text{H}_6 + 15 \text{O}_2 \rightarrow 12 \text{CO}_2 + 6 \text{H}_2\text{O}$
- D. $\text{C}_2\text{H}_5\text{Cl} + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_4\text{Cl}_2 + \text{HCl}$

Question 7

A student wishes to determine the concentration of citric acid in fruit juice. The student titrates 20.00 mL samples of a standard sodium hydroxide solution with diluted fruit juice from a burette. Four experiments were carried out and the following titres were obtained:

19.55 mL, 20.35 mL, 20.30 mL, 20.35 mL.

The discrepancy in the first titration could be due to the student washing the

- A. conical flask with sodium hydroxide solution only.
- B. burette with water only.
- C. pipette with sodium hydroxide solution only.
- D. pipette with water only.

Question 8

How many mole of oxygen gas are required for the complete combustion of 0.5 mole of ethene?

- A. 0.5
- B. 0.75
- C. 1.5
- D. 3.0

Question 9

Which one of the following terms best describes the type of reaction in which a peptide link is formed between amino acids?

- A. hydrolysis
- B. condensation
- C. substitution
- D. addition

Question 10

The compound CH_3CHO (ethanal) is an example of a group of compounds called aldehydes. Which of the following analytical techniques could be used to identify this?

- A. Infrared Spectroscopy
- B. Atomic Absorption
- C. UV–Visible Spectroscopy
- D. Gas Chromatography

Question 11

A polyunsaturated fat is hydrolysed. Glycerol and polyunsaturated acid are formed. Which one of the following is a possible formula for the acid?

- A. $\text{C}_{16}\text{H}_{32}\text{O}_2$
- B. $\text{C}_{18}\text{H}_{36}\text{O}_2$
- C. $\text{C}_{20}\text{H}_{38}\text{O}_2$
- D. $\text{C}_{24}\text{H}_{44}\text{O}_2$

Question 12

The molecule $\text{HOCH}_2\text{CH}_2\text{COOH}$ forms a polyester in which the average polymer molecule contains 500 monomer units. The approximate molar mass of the polymer, in g mol^{-1} , would be

- A. 36 000
- B. 43 000
- C. 45 000
- D. 53 000

Question 13

The number of distinct carbon atoms and hydrogen atoms respectively in the appropriate NMR spectra of hexane would be

- A. 2, 3
- B. 3, 2
- C. 3, 3
- D. 6, 6

Question 14

A 20.00 mL sample of sodium hydroxide solution which had been prepared some months previously was titrated with 0.1150 M hydrochloric acid, using phenolphthalein as indicator. This titration required 24.28 mL. A 20.00 mL sample of freshly prepared sodium hydroxide was titrated with 0.1150 M hydrochloric acid, using methyl orange as indicator. This time the titration required 26.40 mL of acid. Which of the following is the most likely cause of this difference?

- A. phenolphthalein is not a suitable indicator for the titration of hydroxide ions with acid.
- B. the sodium hydroxide had absorbed carbon dioxide from the air, forming some sodium carbonate.
- C. the difference shows the normal variation to be expected when two different indicators are used.
- D. more acid is required when methyl orange is used as an indicator, because methyl orange reacts with hydrochloric acid.

Question 15

A sample of E-10 petrol is to be analysed for its ethanol content. Which of the following techniques is the most suitable analytical technique for this analysis?

- A. Gas chromatography
- B. NMR spectrometry
- C. Atomic absorption spectroscopy
- D. UV-visible spectroscopy

Question 16

Which of the following has hydrogen in the lowest oxidation state?

- A. NaH
- B. H₂SO₄
- C. NaHSO₄
- D. H₂O₂

Question 17

Which of the following could oxidise I^- ions?

- A. H^+ ions
- B. Fe^{2+} ions
- C. Cu metal
- D. H_2O_2

Question 18

$\text{NH}_3(\text{aq})$ is titrated with hydrochloric acid solution. At equivalence point, the pH of the solution is

- A. less than 7
- B. greater than 7
- C. 7
- D. unable to be determined without other information

Question 19

A section of a DNA strand contains the following base pairs G-C, A-T, T-A, G-C, C-G. The number of hydrogen bonds needed to be broken to unwind this section of DNA would be

- A. 5
- B. 10
- C. 12
- D. 13

Question 20

The formula for the biofuel, methyl stearate can be represented as

- A. $\text{CH}_3\text{COO}(\text{CH}_2)_{17}\text{CH}_3$
- B. $\text{HCOO}(\text{CH}_2)_{17}\text{CH}_3$
- C. $\text{C}_{17}\text{H}_{33}\text{COOCH}_3$
- D. $\text{C}_{17}\text{H}_{35}\text{COOCH}_3$

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 the formulas for individual substances include an indication of state; for example, $\text{H}_2(\text{g})$; $\text{NaCl}(\text{s})$

Question 1

Salinity in soil is a serious problem across many areas of Victoria and indeed Australia. The sodium chloride in a 50.0 g sample of soil was dissolved in de-ionised water, filtered and then titrated with a solution of 0.4998 M silver nitrate. Using the titration data, the amount of sodium chloride in the soil sample was determined to be 1.58 per cent by mass.

Calculate a numerical value, in mL, of the volume of silver nitrate used in the titration and give your answer to the appropriate number of significant figures.

Total 4 marks

Question 2

Although hydrolysis of esters involves a reversible reaction, adequate precautions will result in a reaction which is sufficiently quantitative to permit determination of molecular mass. In a particular reaction, 0.308 g of an ester is reacted under reflux with 20.00 mL of 1.00 M sodium hydroxide solution. After cooling, phenolphthalein is added and the excess sodium hydroxide is back titrated with 0.513 M hydrochloric acid, 32.2 mL being required.

Assume the compound is saturated and contains only one ester grouping.

- a. Calculate the molar mass of the ester.

4 marks

- b. Determine the molecular formula of the ester.

2 marks

- c. i. Draw the semi-structural formula for **all** possible esters with this molecular formula.

- ii. If a multiplet is seen in the high resolution ^1H NMR spectrum of the ester, select the ester from your response in c. i. that it must be.

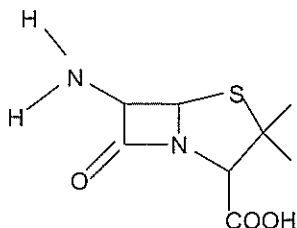
2 marks

Total 8 marks

Question 3

Penicillins are used to treat bacterial infections in animals.

A common form of penicillin has the structural formula shown in the diagram below:



- a. How many carbon atoms is the amino group bonded to?

1 mark

- b. Explain why the arrangement of atoms around the nitrogen atom in this amino group is triangular pyramidal.

1 mark

- c. Penicillin is usually given to animals in the form of its sodium salt. On the diagram above, make the change to the appropriate functional group to represent the salt including any charges.

1 mark

- d. Explain why penicillin is given to animals in the form of its sodium salt rather than in its molecular form.

1 mark

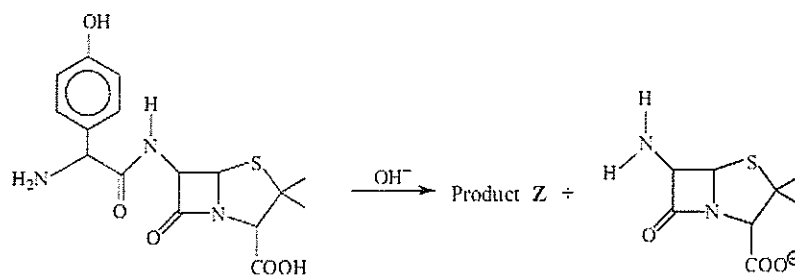
- e. The synthetic penicillin amoxycillin hydrolyses in a solution of sodium hydroxide.
- i. Calculate the mass of sodium hydroxide needed to prepare 1.00 L of solution of concentration 0.00500 M.

2 marks

- ii. Determine the pH of this solution of sodium hydroxide.

1 mark

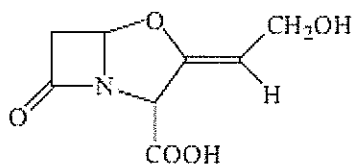
- iii. The alkaline hydrolysis of amoxycillin results in the formation of two products, as shown in the diagram below:



Draw the structural formula of Product Z.

2 marks

- iv. Amoxycillin is sometimes mixed with clavulanic acid. The structural formula of clavulanic acid is shown in the diagram below:



A solution of clavulanic acid is shaken with a solution of bromine. Explain what would happen and why?

2 marks

Total 11 marks

Question 4

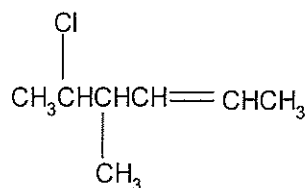
a. Write the semi-structural formula for

i. 2-methylbutanoic acid _____

ii. 3, 4 dichloropentan-2-ol _____

2 marks

b. Write the systematic name for the compound shown below.

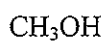
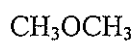
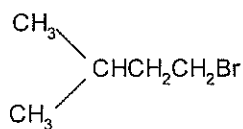
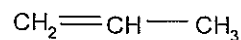


1 mark

Total 3 marks

Question 5

Complete the table below for the following compounds

**A****B****C****D**

Compound	Number of <u>low</u> resolution ^1H signals	Number of ^{13}C signals
A		
B		
C		
D		

Total 4 marks

Question 6

Write an equation for the following processes (reagents should be shown above the arrow). No states are required in this instance.

- a. conversion of chloroethane to ethylamine (ethanamine)

2 marks

- b. conversion of ethene to ethanol

2 marks

- c. conversion of ethanol into ethyl ethanoate

2 marks

Total 6 marks

Question 7

A student was carrying out an investigation in which the method to produce a dry sample of a precipitate was designed, and the percentage yield obtained was determined.

The student mixed 10.0 mL of 0.0900 M Na_2SO_4 with 15.0 mL of 0.0800 M $\text{Pb}(\text{NO}_3)_2$. The precipitate was collected by vacuum filtration and allowed to dry to constant mass. The precipitate was then weighed and found to have a mass of 0.268 g.

- a. Write a balanced chemical equation for the reaction

2 marks

- b. Determine which reactant was in excess. Show your reasoning.

2 marks

- c. Calculate the theoretical mass of precipitate that the student should have obtained.

2 marks

- d. Calculate the percentage yield obtained.

1 mark

- e. State a possible reason why only this percentage was obtained.

1 mark

Total 8 marks

Question 8

An organic compound containing only carbon, hydrogen and oxygen was analysed.

- a. When completely burnt in oxygen, 1.80 g of the compound produced 3.60 g of carbon dioxide and 1.472 g of water. Determine the empirical formula of the hydrocarbon.

4 marks

- b. A separate 2.279 g sample of the hydrocarbon when vaporised in a 1.00 L vessel at 100° C exerted a pressure of 80.3 kPa. Determine the molecular formula of the compound.

2 marks

- c. Name a substance that could have been dissolved in water to absorb the carbon dioxide.

1 mark

Total 7 marks

Question 9

A polypeptide is found to have the sequence of amino acids shown below

Tyr-Ala-Ala-Phe-Leu

- a. Draw the structural formula (showing all bonds) of the species formed when alanine (Ala) reacts with a dilute solution of hydrochloric acid.

2 marks

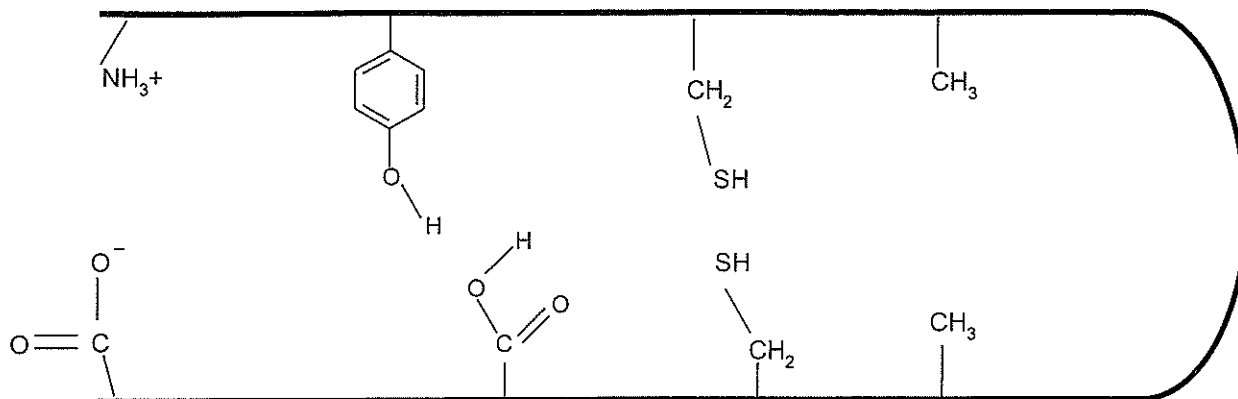
- b. When phenylalanine (Phe) is added to Ala two dipeptides can be formed. Draw the semi-structural formulae of **both** of these dipeptides.

2 marks

- c. Name the substance formed in addition to the dipeptide in the reaction described in part b.

1 mark

- d. Proteins formed in the body have a much longer amino acid sequence. The diagram below shows a section of one such protein.



- i. Name all the bonding types (other than covalent) which are involved in holding this protein together.
- _____
- _____
- ii. On the diagram, make any required alterations to show how covalent bonding could be used to hold some parts of the protein together.
- iii. When this protein is heated above 70°C, its structure changes. Describe what happens during heating to the:
- secondary structure of the protein
- _____
- _____
- primary structure of the protein
- _____
- _____

7 marks

Total 12 marks

END OF EXAMINATION