Victorian Certificate of Education

CHEMISTRY 2026 Unit 1

SAC 2 AOS 2 Outcome 2

Reading time: 5 minutes

Writing time: 45 minutes

Directions to students

Student's Name: _____

Teacher: _____

Structure of booklet

Section	Question to be answered	Total marks
Short answer	7	45
	Total	45

Materials

- Students are permitted to bring into the examination room: pencils, highlighters, erasers, sharpeners, rulers, and an approved scientific calculator.

- Students are NOT permitted to bring into the examination room:
white out liquid/tape, phones or electronic devices, including smart watches.

- Students are provided with the following: Question and answer book of 16 pages and VCAA Data booklet.

The task

- Please ensure that you write your name and teacher's name on this booklet. This paper consists of short answer questions and 20 multiple choice questions.

- There are a total of 45 marks available.

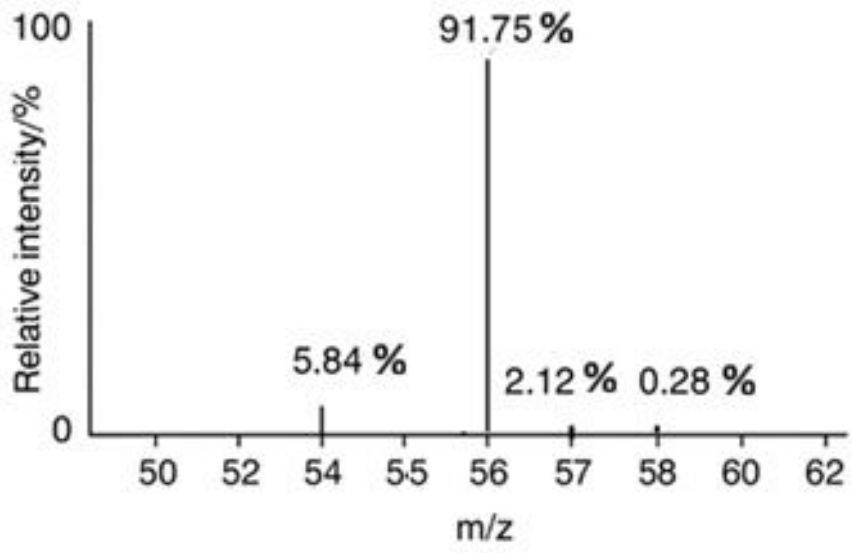
- Be sure to include states with all chemical equations.

- All numerical answers need to be quoted to the correct number of significant figures.

- All working out must be shown in the space provided.

Question 1 (5 marks)

A mass spectrum shows the percentage abundance of each isotope of an element. The mass spectrum of a sample of the element iron is shown below.



a. State two conclusions you can draw from this spectrum. 2 marks

1-----mark for each of any conclusion relevant to the image shown
eg isotope 56 is the most abundant or there are four naturally occurring isotopes of Fe.

b. Use the percentage intensity values on the spectrum to determine the relative atomic mass of iron. 3 marks

- *Fe-54: 5.8%*
- *Fe-56: 91.7%*
- *Fe-57: 2.2%*
- *Fe-58: 0.3%*

=> (54 X 5.8) + (56 X 91.7) + (57 X 21.2) + (58 X 0.28) / 100
= 3.132 + 51.352 + 1.254 + 0.174 = 60
1-----mark for the correct formula
1-----mark for the correct answer

Question 2 (4 marks)

The image below shows part of the label on a 3.00 kg bag of garden lime.

Lime is an ionic compound, calcium hydroxide, $Ca(OH)_2$.

a. Determine the relative formula mass of calcium hydroxide. 1 mark

74.1 g/mol

b. Determine the number of Ca^{2+} ions in 200 grams of lime. 2 marks

1-----mark Moles of lime (= 200 / 74.1 = 2.7)
1----- mark Number of ions of Ca^{2+} = moles × Avogadro's number (6.02 X times 10^{23}) = 1.63 X 10^{24} ions

c. Determine the percentage by mass of oxygen in lime. 1 mark

oxygen = 16 X 2 / 74.1 = 43.2%

d. Determine the mass of hydrogen in a 3.00 kg bag of lime. 1 mark

H = 2 X 1 / 74.1 X 100 = 2.70%
=> 0.0270 X 3000 = 81.0g

Question 3 (5 marks)

Ammonium sulfate is another common fertilizer.

Its chemical formula is $(NH_4)_2SO_4$ and its molar mass is 132 g mol^{-1}.

a. Determine the percentage composition of $(NH_4)_2SO_4$ 2 marks

1----mark for each pair correct
Nitrogen = 28 divided by 132 times 100 = 21.2%
Hydrogen = 8 divided by 132 times 100 = 6.06%
Sulfur = 32 divided by 132 times 100 = 24.2%
Oxygen = 64 divided by 132 times 100 = 48.5%

b. In a 500 g sample of ammonium sulfate,

i. determine the mass of sulfate ions 1 mark

Mass of sulfate ions = 48.5% of 500 = 242.5 grams

ii. number of mole of ions present

1 mark

Moles of ammonium sulfate = 500 divided by 132 = 3.79 moles
Number of ions per mole = 3 (2 ammonium and 1 sulfate)
Total moles of ions = 3.79 times 3 = 11.37 moles

iii. determine the mass, in grams, of sulphur 1 mark

Mass of sulfur = 24.2% of 500 = 121 grams

Question 4 (8 marks)

The mass of carbon in a 4.80 g sample of a hydrocarbon is found to be 4.11 g.

a. Determine the mass of hydrogen in the sample. 1 mark

4.80 - 4.11 = 0.69 grams

b. Determine the empirical formula of the compound. 2 marks

1-----mark for accurately calculating the mol
=> Moles of carbon = 4.11 divided by 12 = 0.3425 moles
Moles of hydrogen = 0.69 divided by 1 = 0.69 moles
1-----mark for correctly obtaining the simplest ratio
C: 0.3425 / 0.3425 = 1
H: 0.69 / 0.3425 = 2
Empirical formula: CH_2

c. The molar mass of the compound is 56 g mol^{-1}.

Determine the molecular formula of the compound.
Molar mass of empirical formula CH_2 = 12 + 2 = 14
Molecular formula mass = 56
Number of empirical units in molecular formula = 56 / 14 = 4
Molecular formula = C_4H_8

d. Draw and name two structures with the molecular formula determined in part c. 4 marks

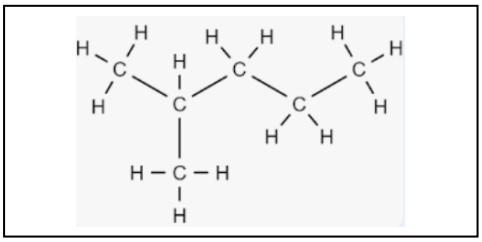
1----mark for but-1-ene name and 1-----mark for but-2-ene name
1-----mark each for correct structure.

_____ _____

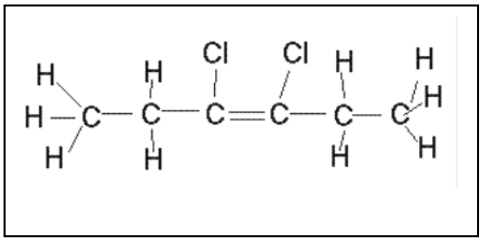
Question 5 (6 marks)

a. Draw the structural formulas of the following: 3 marks

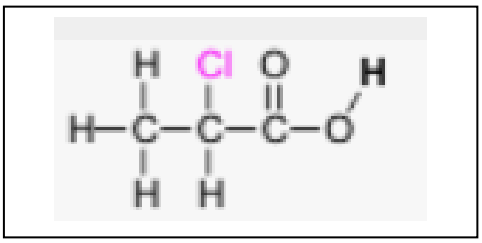
i. 2-methylpentane



ii. 3,4-dichlorohex-3-ene



iii. 2-chloropropanoic acid

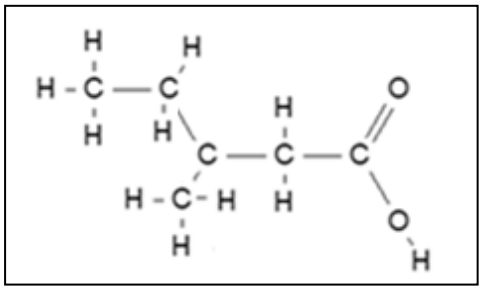


b. Write the semi-structural formula of 3,3-dichlorobutan-1-ol. 1 mark

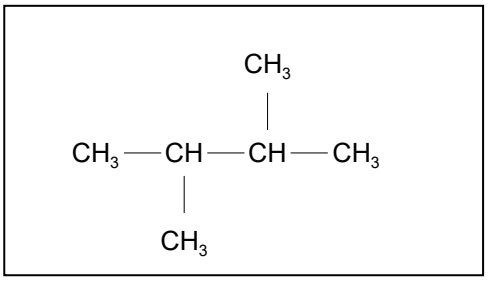
_____ $CH_2(OH)CH_2CCl_2CH_3$ _____

c. Write the systematic name of the following: 2 marks

i.



ii.



__*3-methylpentanoic acid*___ _____*1,3-dimethylbutane*_____

Question 6 (6 marks)

a. Hydrocarbons can be classified as saturated or unsaturated compounds. Give an example of a saturated compound and an unsaturated compound and use your examples to explain what the term saturated means. 2 marks

1-----mark - Must mention carbon-carbon bonds. Saturated compound example: ethane, which has only single bonds between carbon atoms. Unsaturated compound example: ethene, which contains a double carbon-to-carbon bonds.
1-----mark - Saturated means that all carbon-carbon bonds are single bonds, fully "saturated" with hydrogen atoms.

b. Some carbon compounds are members of a homologous series. Use carboxylic acids as an example to explain what a homologous series is. 2 marks

1-----mark A homologous series is a group of compounds with the same functional group which gives each member specific chemical properties. The carboxylic functional group gives each molecule acidic properties.
1-----mark but differing by a CH_2 unit.
..

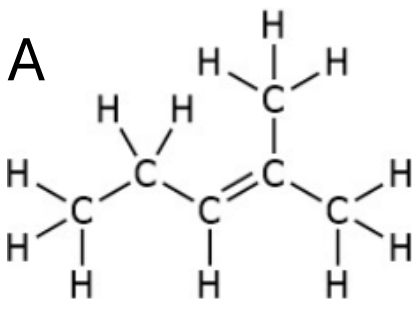
c. Rank the following organic molecules in order of boiling point: propan-1-ol, propanoic acid and 1-chloropropane. Justify your answer.

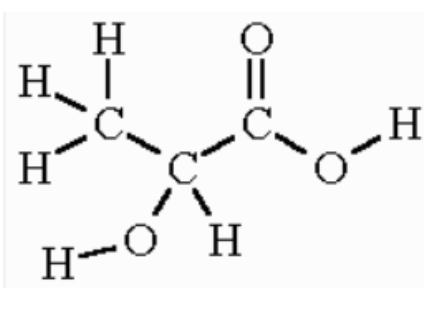
3 marks

1-----mark Ranking by boiling point from high to low:
propanoic acid > propan-1-ol > 1-chloropropane
1-----mark Justify the order -Propanoic acid has strong hydrogen bonding (carboxylic acid group) on two sites, propan-1-ol also has hydrogen bonding but less than acid, and 1-chloropropane has weaker dipole interactions only.
1-----mark Less energy is needed to break the intermolecular forces of 1-chloropropane than of propanoic acid or propan-1-ol

7. Consider the following molecules. These molecules act as monomers for polymerisation reactions. (9 marks)

A





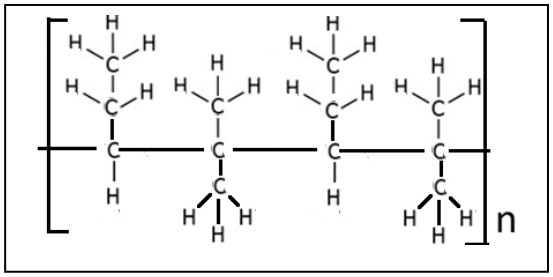
a. What type of reaction takes place to form a polymer from molecule A?

_____*Addition polymerisation* _____ 1 mark

b. What type of reaction takes place to form a polymer from molecule B?

_____*Condensation polymerisation*_____1 mark

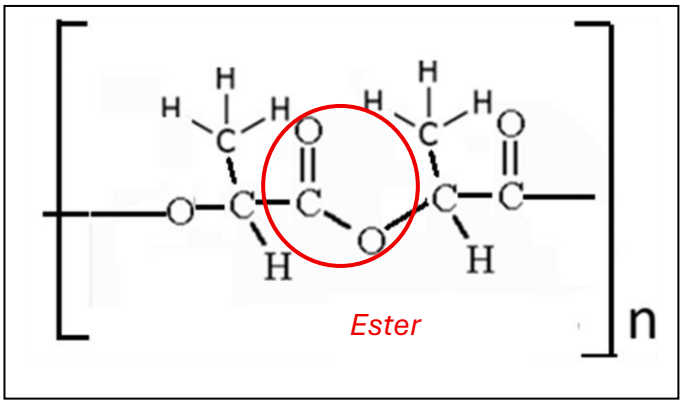
c. Draw a repeating section of the polymer formed by two molecules of monomer A in the box below 2 marks



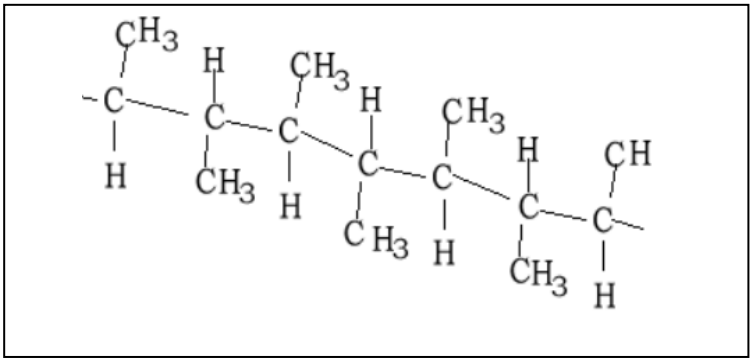
1-----mark clearly showing that bonding between the two monomers has occurred across the C-to-C double bond.
1-----mark for indicating, with appropriate brackets, the repeating unit

d. Draw a section of the polymer formed by two molecules of monomer B in the box below and clearly label and name the functional group that links the two monomers 2 marks

1-----mark for clearly showing how the monomers are linked via the carboxyl and hydroxyl functional groups.
1-----mark for clearly labelling the ester function group

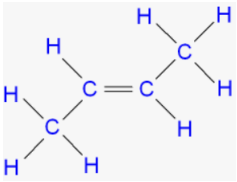


e. Consider the small section of a polymer shown below.



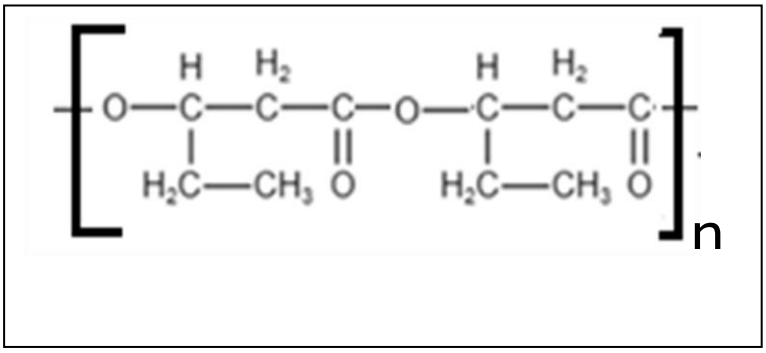
Draw the structural formula, in the box below, of the monomer that formed this polymer. 1 mark

But-2-ene



1-----mark for correct structural formula

f. Consider the small section of a polymer shown below.



Name the monomer and write its semi-structural formula in the box below
. 2 marks

1-----mark *3-hydroxypentanoic acid*

1-----mark *$CH_3CH_2CH(OH)CH_2COOH$*