STUDENT NAME _____

CHEMISTRY

Written Examination Unit 1

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*
A	20	20	20
B	8	8	70
			Total 90

- 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 into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied
- Question and answer book of 20 pages
- Data Book

Instructions
- Write your **student number (if provided) and student name** in the space provided above on this page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

Circle the correct answer for each question on the answer sheet provided on page 1

Multiple choice answer sheet

1. A B C D
2. A B C D
3. A B C D
4. A B C D
5. A B C D
6. A B C D
7. A B C D
8. A B C D
9. A B C D
10. A B C D
11. A B C D
12. A B C D
13. A B C D
14. A B C D
15. A B C D
16. A B C D
17. A B C D
18. A B C D
19. A B C D
20. A B C D

SECTION A – Multiple-choice questions

Instructions for Section A

- A correct answer scores 1, an incorrect answer scores 0
- A scientific calculator is permitted in this test.
- Circle the correct answer for each question on the answer sheet provided on page 1.
- No marks will be given if more than one answer is selected.

Question 1

Select the correct statement about the structure of atoms.

A. Each element is one mass unit heavier than the previous element.
B. The mass of protons in an atom will equal the mass of the neutrons.
C. Protons and neutrons are held together by strong nuclear forces.
D. The number of neutrons in an atom will equal the number of electrons.

Question 2

Which of the following isotopes contain equal numbers of neutrons?

A. ^{37}Ar and ^{38}K
B. ^{39}Ar and ^{39}K
C. ^{40}Ar and ^{39}K
D. ^{38}Ar and ^{38}K

Question 3

During a chemical reaction, the electron configuration of an element undergoes the following change:

$1s^2 2s^2 2p^6 3s^2 3p^5 \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6$

The above change could occur when

A. a fluorine atom forms a fluoride ion.
B. a chlorine atom forms a chloride ion.
C. an argon atom forms an ion.
D. a sulfur atom forms a sulfide ion.

Question 4

Which of the following has a higher value for argon than chlorine?

A. first ionisation energy
B. electronegativity
C. atomic radius
D. metallic character

Question 5
The following information is known about element X

It does not conduct electricity
It can form a compound Na_2X
Its ion has the same number of electrons as an ion of calcium(Ca^{2+})

Element X is

A. magnesium
B. oxygen
C. chlorine
D. sulfur

Question 6
Which of the following compounds has the correct formula?

A. sodium nitride (NaN_3)
B. aluminium phosphate ($Al_2(PO_4)_3$
C. copper(I) sulfate ($CuSO_4$)
D. iron(II) nitrate $Fe(NO_3)_3$

Question 7
Which bond is the most polar?

A. F - F
B. O – H
C. H - Cl
D. O – Cl

Question 8
Element X forms an ionic compound $X(NO_3)_3$. The compound element X forms with a sulfate ion is likely to be:

A. XSO_4
B. $X_2(SO_4)_3$
C. X_2SO_4
D. X_3SO_4

Question 9
Which of the following will have the highest melting point?

A. pentanol
B. pentane
C. pentanoic acid
D. methane

Question 10

The order of reactivity from highest (left) to lowest (right) is given below for select metals.

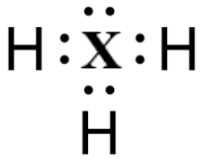
Li > K > Na > Ca > Mg > Zn > Fe > Cu

Which one of the following reactions will occur spontaneously?

A. copper + magnesium chloride solution
B. magnesium + zinc chloride solution
C. magnesium + sodium chloride solution
D. iron + lithium chloride solution

Question 11

The Lewis diagram below shows a compound formed by element X.



The identity of X and the shape of the molecule formed are, respectively

A. sulfur and V-shaped
B. nitrogen and tetrahedral
C. phosphorous and pyramidal
D. carbon and pyramidal

Question 12

Which of the following liquids will be insoluble in water?

A. ethanol
B. propanoic acid
C. hydrochloric acid
D. hexane

Question 13

Nitrogen can form many different oxides. When analysing a sample of one of these oxides it is found that the number of mole of nitrogen is 0.346 and the number of mole of oxygen is 0.863.

The oxide is

A. NO
B. NO_2
C. N_2O_4
D. N_2O_5

Question 14
Which molecule has the same empirical formula as molecular formula?

A. pentane
B. CH_3COOH
C. P_4O_{10}
D. pentene

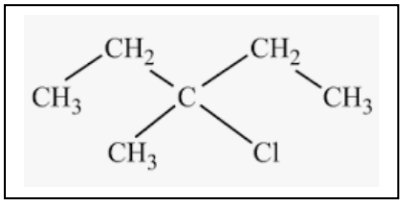
Question 15
The number of atoms in 0.50 mol of $CuSO_4$ is

A. 3
B. 6×10^{23}
C. 1.8×10^{24}
D. 9×10^{23}

Question 16
Which of one of the following statements is most correct when comparing compounds of the same homologous series.

A. They have the same chemical properties
B. All compounds have the same molecular mass
C. All compounds have the same molecular formula
D. Options A and C are both correct.

Question 17



The IUPAC name for the molecule above is

A. 3-chlorobutanoic acid
B. 3-chloro-3-methylpentane
C. 3-ethyl-chlorobutane
D. 3-methyl,3,chloropentane

Question 18
Which of the following is a structural isomer of 2,2-dimethylpropane?

A. 2,3-dimethylbutane
B. 2-methylbutane
C. 2-methylpentane
D. hexane

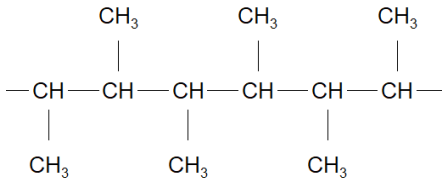
Question 19

An organic molecule has the empirical formula CH_2O. Which is the formula mass of the compound given that 0.33 mol of this substance has a mass of 40.0 grams?

A. CH_2O
B. $C_3H_6O_3$
C. $C_2H_4O_2$
D. $C_4H_8O_4$

Question 20

A segment of a polymer is shown below



The monomer used to form this polymer is

A. propene
B. but-1-ene
C. 2,3-dimethylbutane
D. but-2-ene

END OF MULTIPLE-CHOICE QUESTIONS

SECTION B - Short-answer questions

Instructions for Section B

Questions must be answered in the spaces provided in this book.

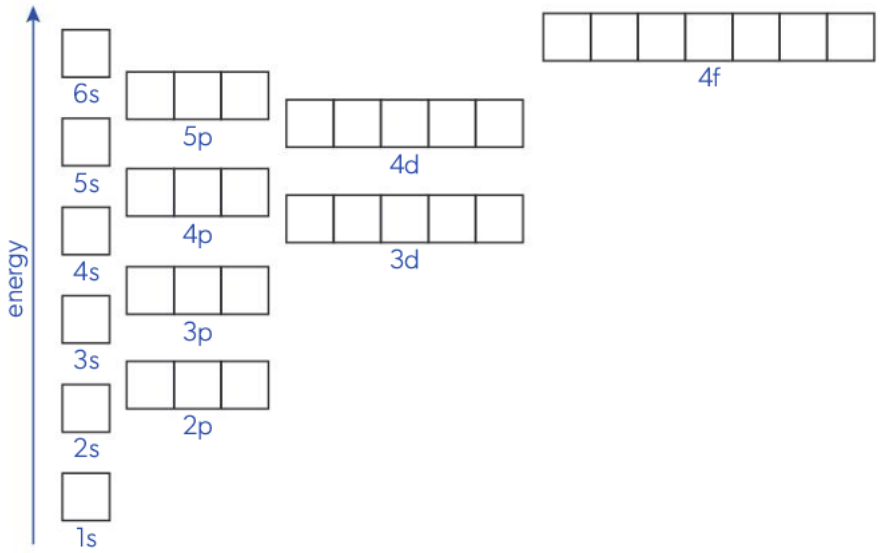
To obtain full marks for your responses you should

- Give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks.
- Show all workings 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 (5 marks)

a. The diagram below can be used to explain many aspects of the arrangement of electrons in atoms.



i. What aspect of electron configurations does each small square represent?

1 mark

_____

ii. How many orbitals are there in the 4f subshell and how many electrons can be placed there?

Number of orbitals: _____ Number of electrons: _____ 2 marks

iii. Use the squares provided on the diagram to show the electron configuration of nickel and to explain how this diagram informs you of the order of filling. 2 marks

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Question 2 (7 marks)

a. A compound can be formed when oxygen and chlorine react.

i. In the space provided below, draw a Lewis diagram of each atom and use the diagrams to draw a Lewis structure of the likely compound that forms. 2 marks

Chlorine	Oxygen	Compound formed

ii. Show the dipoles on the molecule. 1 mark

iii. Describe the shape of the molecule formed. 1 mark

_____

b. Consider the two molecules oxygen dichloride (OCl_2) with a boiling temperature of 2°C and water (H_2O) which boils at 100°C.

i. Briefly describe the intramolecular bonding found in both compounds. 1 mark

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ii. Oxygen dichloride is a bigger molecule than water and yet it has a much lower boiling temperature. Explain why students would expect OCl_2 to have higher boiling point than H_2O and explain why in reality, H_2O has a greater boiling point than OCl_2. 2 marks

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Question 3 (8 marks)

a. Ammonium hydrogencarbonate is used in foods and in the production of pharmaceuticals

i. Write the chemical formula of ammonium hydrogencarbonate. 1 mark

_____

ii. Determine the percentage composition of chalcopyrite ($CuFeS_2$). Show all working in the space provided below. 2 marks

iii. Calculate the total number of atoms in 100 g of chalcopyrite. Show all working in the space provided below. 2 marks

b. A mining company discovered a deposit of the copper ore, malachite ($Cu_2CO_3(OH)_2$), in a neighbouring mine. Which site, the malachite or the chalcopyrite, is economically viable for extraction of copper? Justify your answer with a calculation. 3 marks

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Question 4 (6 marks)

The diagram below shows a representation of a lithium atom and a nitrogen atom.

a. Which atom has the greater atomic radius? Justify your answer. 2 marks

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b. Lithium and fluorine can react to form a compound.

i. Give the shell electron configurations of lithium and fluorine after the reaction. 1 mark

_____

_____

ii. State the formula and name of this compound. 1 mark

formula: _____ name: _____

iii. Describe the properties of this compound by circling the correct response in the table below. 2 marks

Property	Response
Electrical conductivity	In the solid state In the liquid state In the gas state
Behaviour under high impact	Malleable Brittle Turns to liquid

Question 5 (11 marks)

A student is investigating a set of chemical reactions.
The student's tests and observations are shown below.

Test	Reactants	Observations
1	magnesium and oxygen are heated	magnesium ignites quickly and burns vigorously producing a white powder
2	butane gas (C_4H_{10}) is burnt in excess oxygen at room temperature.	A great deal of heat is formed with the production of carbon dioxide and water.
3	hydrogen gas (H_2) and nitrogen gas (N_2) are mixed and ignited	a strong smell of ammonia (NH_3) gas is noticed after the reaction is complete and is the only product.
4	calcium chloride and sodium nitrate solutions	no reaction
5	calcium chloride and sodium carbonate solutions	a white precipitate forms

a. Write balanced equations for the reactions occurring in tests 1 and 2. States included.

1. _____ 2 marks

2. _____ 2 marks

b. A further test shows calcium reacts more vigorously in water than magnesium. Using the relative position of each metal in the periodic table, discuss the nature of metal reactivity. In your response refer to what determines metal reactivity and whether the relative reactivity can be predicted. 3 marks

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c. Write an overall equation and a partial ionic equation for reaction 5 in the table.
2 marks

overall equation : _____

net ionic equation: _____

d. Explain how you can predict whether a reaction will occur in the final two tests.
In your response, refer to the student results. 2 marks

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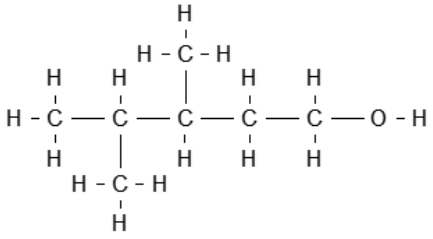
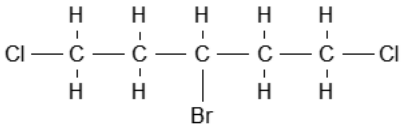
Question 6 (8 marks)

a. In the boxes below, draw structural diagrams of

i. hex-3-ene **ii**. pentanoic acid 2 marks

b. Write the systematic name of 2 marks

i. 

ii. 

_____ _____

c. Draw and name a branched structural isomer of but-2-ene. 2 marks

d. Both ethanol and ethanoic acid are polar molecules with the dominant intermolecular force being that of hydrogen bonding, but the boiling point of ethanoic acid is significantly higher than ethanol. Explain why. 2 marks

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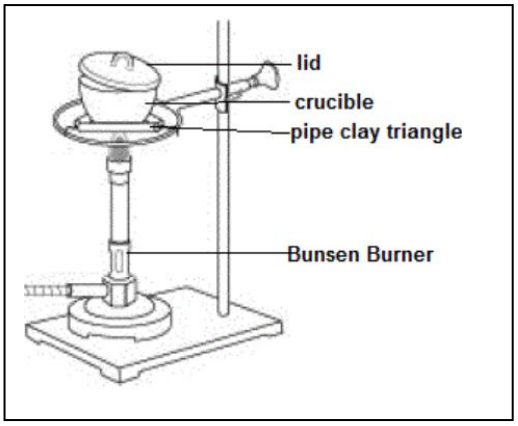
Question 7 (13 marks)

A student performed an experiment to calculate the empirical formula of magnesium oxide. The experimental setup is shown on the right.



Results and calculations

Item weighed	Mass (g)
Crucible + lid	24.836
Crucible + lid + Mg (before heating)	25.112
Crucible + lid + product (after heating)	25.250

a. Calculate the empirical formula from the data obtained by the student given in the table above. 4 marks

b. Before the experiment, the student predicted that the empirical formula of magnesium oxide would be MgO.

i. What chemical knowledge did the student use to make their prediction that the empirical formula of magnesium oxide would be MgO. 1 mark

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_____

_____

ii. How did the student derived empirical formula of magnesium oxide differ from their expected empirical formula? Clearly explain a possible error that may have occurred to justify the student's final outcome. 3 marks

c. Explain why the experimental setup shows the crucible lid slightly open during heating. 1 mark

d. A student suggested that the lid be kept completely open at all times during heating.

i. Describe how this would impact the final calculation of the empirical formula by circling the possible outcome from the list below. 1 mark

MgO, MgO_2, Mg_2O

ii. Justify your answer to question i. above. 2 marks

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e. The method required the student to repeat the steps, heating , cooling and weighing, several times before recording the final mass. Explain why. 1 mark

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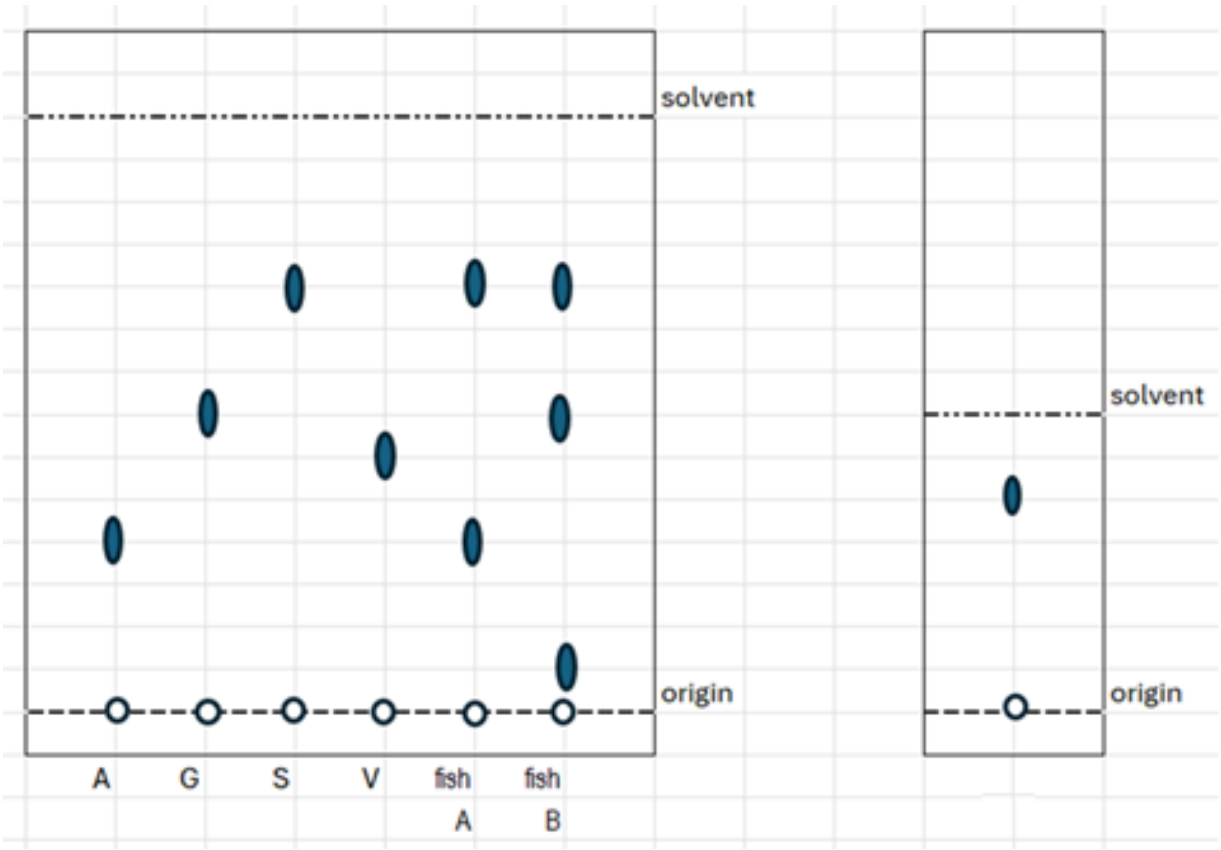
Question 8 (8 marks)

Fish are considered a rich source of amino acids, the building blocks required for the body to produce proteins. The thin layer chromatograms below show an analysis of two fish samples for four particular amino acids. The solvent used is ethanol.

Student A: chromatogram 1 Student B: chromatogram 2



A = alanine G = glycine S = serine V = valine

a. What conclusions can you draw from chromatogram 1 about:

i. Fish A 1 mark

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_____

_____

ii. Fish B 1 mark

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b. With reference to the 2026 data booklet, explain why alanine and glycine produce different spots on the chromatogram.

2 marks

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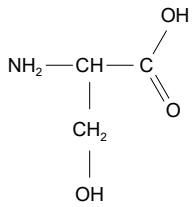
c. The structure of serine is shown below.



Will you expect serine to be more soluble in a polar or non-polar solvent? Justify your answer. 2 marks.

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d. Student B ran a different chromatogram under exactly the same conditions as student A. Identify the amino acid that student B analysed. Justify your answer with a calculations.

2 marks

Question 9 (4 marks)

Analysis of an unknown molecular compound was found to contain only carbon, hydrogen, sulfur, and oxygen. Analysis of the compound shows it has the following percentage composition by mass:

- Carbon = 40.0%
- Hydrogen = 6.7%
- Sulfur = 26.7%
- Oxygen = 26.6%

a. Find the empirical formula for this compound. 2 marks

b. Given that 4.800 grams of this substance contains 1.204×10^{22} molecules, find the molecular formula.

2 marks

End of assessment task