MARKER CODE				

STUDENT ENROLMENT NUMBER (SEN)									

TONGA NATIONAL FORM SEVEN CERTIFICATE

2022

CHEMISTRY

QUESTION AND ANSWER BOOKLET

Time allowed: 3 Hours

INSTRUCTIONS:

1. Write your **Student Enrolment Number (SEN)** on the top right-hand corner of this page.
2. This paper consists of **FIVE SECTIONS** and is out of 82 weighted scores.

SECTION	STRANDS	TOTAL SKILL LEVEL
ONE	ATOMIC STRUCTURE, BONDING, SOLIDS AND RELATED PROPERTIES	16
TWO	KINETIC ENERGY AND NUCLEAR CHEMISTRY	15
THREE	INORGANIC CHEMISTRY	13
FOUR	QUANTITATIVE AND REDOX CHEMISTRY	21
FIVE	ORGANIC CHEMISTRY	17
TOTAL		82

3. Answer ALL QUESTIONS. Write your answers in the spaces provided in this booklet.
4. Use a **BLUE** or **BLACK** ball point pen only for writing. Use a pencil for drawing if required.
5. If you need more space for answers, ask the supervisor for extra paper. Write your **Student Enrolment Number (SEN)** on each additional sheet, number the questions clearly and insert them in the appropriate places in this booklet.

   NOTE: A Periodic Table is provided in page **23**.
6. Check that this booklet contain pages 2-23 in the correct order and that page 22 has been deliberately left blank.

YOU MUST HAND IN THIS BOOKLET TO THE SUPERVISOR BEFORE YOU LEAVE THE EXAMINATION ROOM.

SECTION ONE: ATOMIC STRUCTURE, BONDING, SOLIDS AND RELATED PROPERTIES

1. Name the **shape** of Sulfur tetrafluoride, SF_4.

Skill level 1	
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0	
NR	

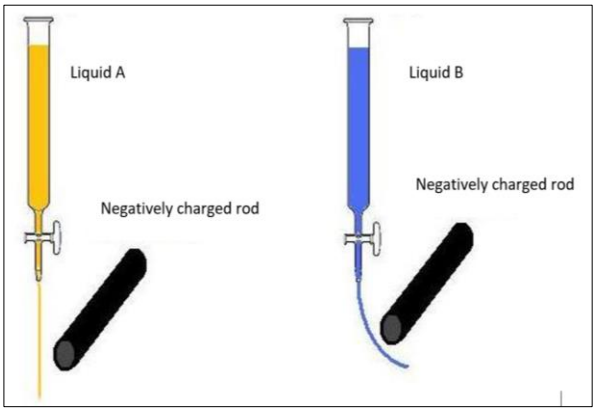
2. Describe how the **ground state** electron configuration in the s, p, d, f notation of copper atom, Cu, differs from that of a zinc atom, Zn.

Skill level 2	
2	
1	
0	
NR	

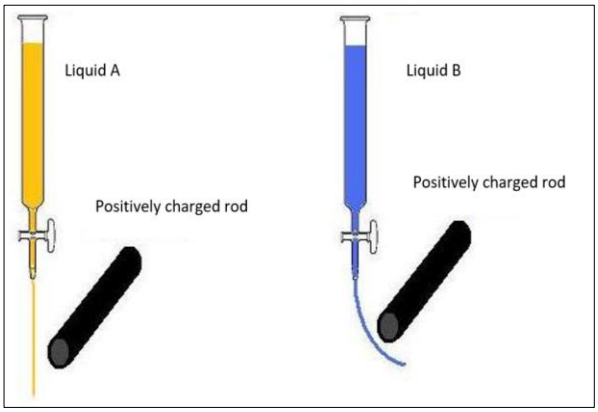
3. A **negatively** charged rod was brought close to jet streams of two different molecular liquids, **A** and **B**. The following is observed in **Figure 1**(a).
Then a **positively** charged rod was brought close to the jet streams of liquids **A** and **B**.
The observed results are shown in **Figure 1**(b).

Figure 1: Reactions of streams of liquid A and liquid B when placed near (a) negatively charged rods and (b) positively charged rod.

a. Negatively charged rod



b. Positively charged rod



Analyse the information and the results in **Figure 1**(a) and 1(b) above to determine the **polarity** of liquids **A** and **B** with justifications.

Skill level 3	
3	
2	
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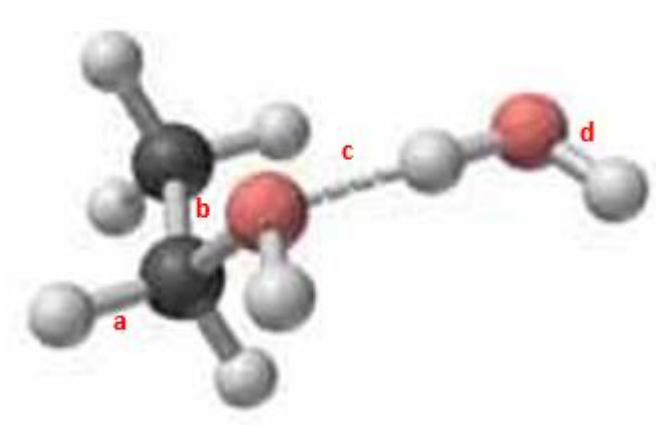
4. Models of a molecule of water and ethanol are shown in **Figure 2** below and they have bonds existing that are labelled as **a**, **b**, **c** and **d**.

   In the models, each coloured sphere represents an atom with:

   red = oxygen atom,
   white = hydrogen atom, and
   black = carbon atom

Figure 2: Ethanol molecules bonding



***Circle* ONE** (1) letter that correctly represents the strongest **covalent bond**.

a **b** **c** **d**

Skill level 1	
1	
0	
NR	

5. Both water, H_2O, and ammonia, NH_3, have **similar molar mass** of 18 $gmol^{-1}$ amd 17 $gmol^{-1}$ respectively but **very different melting points**.

Table 1 shows the melting points and molar mass of water and ammonia

Table 1: Melting points (°C) and molar mass ($gmol^{-1}$) of water, H_2O and ammonia, NH_3

	Water, H_2O	**Ammonia, NH_3**
Molar mass ($gmol^{-1}$)	18	17
Melting point (°C)	0	-77.7

Explain the difference in the **melting point** of water, H_2O, and ammonia, NH_3 even though they have similar molar masses.

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Skill level 3	
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6. Copper sulphate, $CuSO_4$ is easily hydrated. Describe how copper sulphate is **hydrated**. [Use labelled diagram to clarify your description]

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Skill level 2	
2	
1	
0	
NR	

7. Lithium, Li and sodium, Na are elements of the Periodic Table with their physical properties and bonding type given below:

Properties	Lithium, Li	Sodium, Na
Melting point (°C)	181	98
Boiling point (°C)	1342	883
Electrical Conductivity	average	very good
Electronegativity	0.98	0.93
First ionisation energy (kJ/mol)	596	496
Bonding	Metallic	Metallic

Discuss the effect of the atomic structure of lithium, Li and sodium, Na on their bonding and physical properties above.

Skill level 4	
4	
3	
2	
1	
0	
NR	

SECTION TWO: KINETIC ENERGY AND NUCLEAR CHEMISTRY

Part A: Kinetic Chemistry

Ammonia is manufactured from nitrogen, N_2, and hydrogen, H_2, in the Haber Process.

$$N_2\,(g) + 3H_2\,(g) \overset{400°C}{\rightleftharpoons} 2NH_3\,(g) \qquad \Delta H = -92\ kJmol^{-1}$$

The following associated bond energies are given.

N≡N is 944 kJmol-1

H-H is 436 kJmol-1

1. Define **bond energy**.

Skill level 1	
1	
0	
NR	

2. Use the energy data above to calculate the **energy of the N-H bond.**
(You must show all your working.)

Skill level 3	
3	
2	
1	
0	
NR	

3. Describe the **response** made by the equilibrium reaction in the Haber Process above **if** the temperature of the system is increased.
Use Le Chatelier's principle in your description.

Skill level 2	
2	
1	
0	
NR	

4. The **Kinetic Theory of Gases** assumes the following:

- Particles of gases move fast and randomly,
- The distance between the gas particles is much greater than their individual sizes,
- There are no forces of attraction or repulsion between the molecules,
- No loss of kinetic energy of the gas particles at collision.
- When temperature increases, the gas particles moves faster and collide with the wall of the container to cause increase pressure.

The Kinetic Theory is almost true for Helium, He and Neon, Ne but not for carbon dioxide, CO_2, methane, CH_4 and others.

Discuss the **limitations** of the Kinetic Theory under conditions of high pressure, low temperature and high molecular masses.

Skill level 4	
4	
3	
2	
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Part B: Nuclear Chemistry

1. An Oxygen-16 nucleus absorbs a neutron to form X. Then X subsequently decays to form a Fluorine-17 nucleus.
Write a **balanced nuclear equation** that shows the decay of X to form the Fluorine-17 nucleus.

[**Hint!** You must identify X first with its atomic and mass number]

Skill level 2	
2	
1	
0	
NR	

2. Explain the differences between fission and fusion reaction.
Use equations and labelled diagrams, where possible, to show the differences.

Skill level 3	
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NR	

SECTION THREE: INORGANIC CHEMISTRY

Part A: Transition Metals

1. Determine the oxidation number of chromium in sodium dichromate.

Skill level 1	
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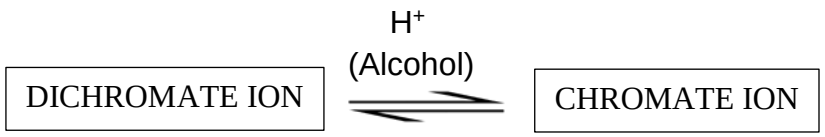
2. Describe the **colour <u>changes</u>** in the equilibrium formed by chromate ions and dichromate ions in acidic condition when alcohol is present.



Skill level 2	
2	
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0	
NR	

Part B: Complex Ions

1. Name the aquo complex ion formed by iron (II) or Fe^{2+}.

Skill level 2	
2	
1	
0	
NR	

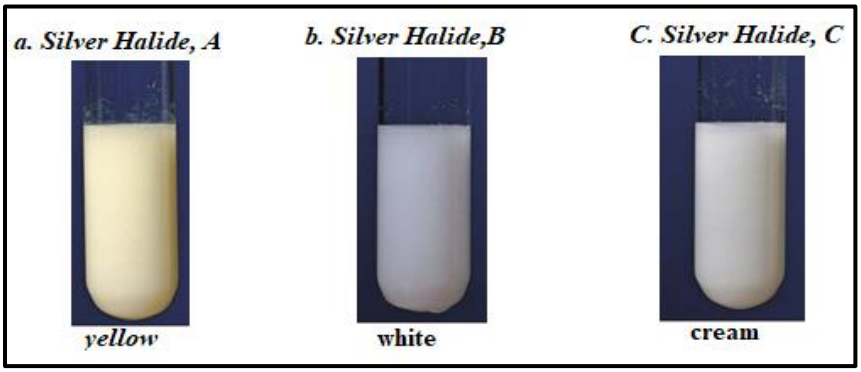
2. Explain why majority of the transition metal ions form coloured complex **compounds**.

Skill level 3	
3	
2	
1	
0	
NR	

Part C: Group 17 Chemistry

1. **Figure 3**(a), (b) and (c) below show solid suspensions or precipitates of different silver halides. They are labelled as Silver halide **A**, **B** and **C** with yellow, white and cream colour respectively.

Figure 3



Describe the **observations** made when each of the silver halide solids, **A**, **B** and **C** is separately mixed with concentrated ammonia solution.

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Skill level 2	
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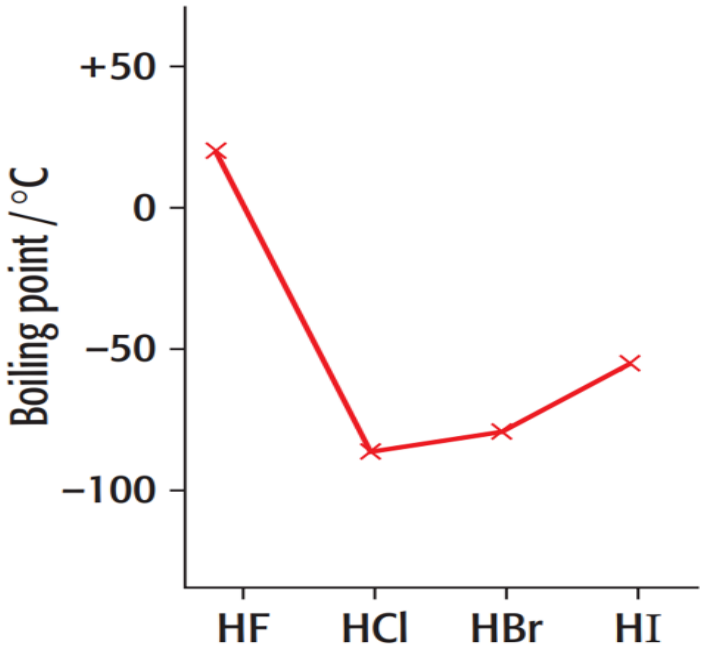
2. **Figure 4** below shows the boiling point in degrees Celsius of hydrogen halides.

Figure 4: Boiling points of Hydrogen halides



Account for the anomaly in the trend of the boiling points of hydrogen halides shown in **Figure 4**.

Skill level 3	
3	
2	
1	
0	
NR	

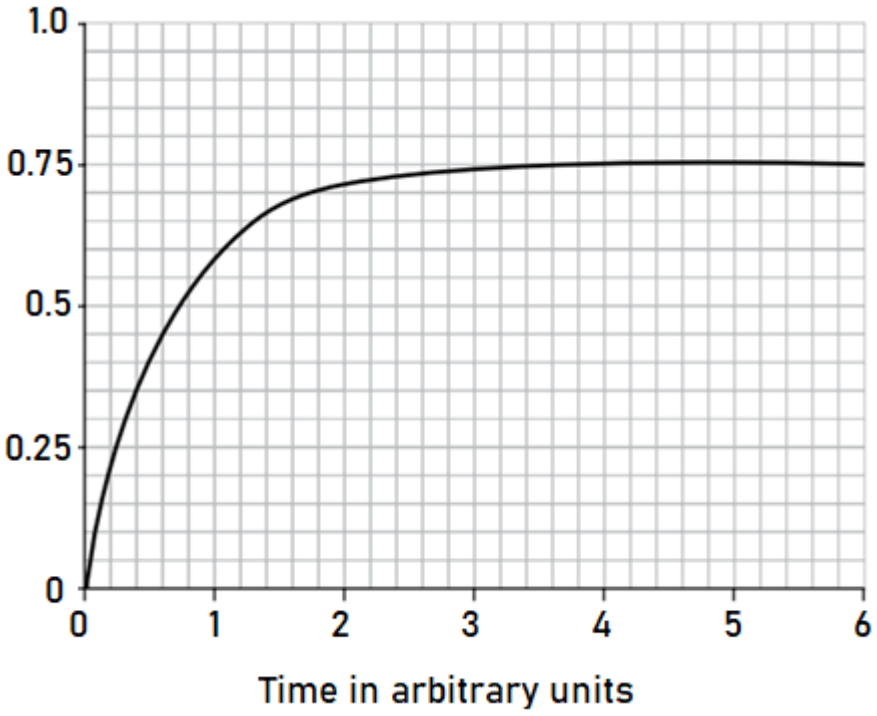
SECTION FOUR: QUANTITATIVE AND REDOX CHEMISTRY

Part A: Equilibrium Chemistry

A 1.0 L container has initial amounts of 1 mole of Hydrogen gas, $H_{2\,(g)}$, and 1 mole of Iodine gas, $I_{2\,(g)}$ placed in it and was subjected to a temperature of 700 K.
Over time, they formed Hydrogen iodide gas, $HI_{\,(g)}$ as shown in the graph below:

$$H_{2(g)} + I_{2(g)} \Leftrightarrow 2HI_{(g)} \qquad \Delta H = -ve$$

Graph 1: Concentration of Hydrogen iodide gas, $HI_{(g)}$ in $molL^{-1}$ formed over time from 1 mole of Iodine, I_2 and 1 mole of Hydrogen, H_2



1. Define an equilibrium reaction.

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Skill level 1	
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2. Write the expression for the equilibrium constant, K_c, of the reaction between hydrogen and iodine.

Skill level 2	
2	
1	
0	
NR	

3. Use the information from Graph 1 and further calculations to determine the concentration at equilibrium of the Hydrogen iodide, HI gas, Hydrogen, H_2 and Iodine gas, I_2 respectively, given Kc is 9 at 700K.

Skill level 3	
3	
2	
1	
0	
NR	

4. IF the container is slightly heated, describe a possible observation made in the closed container of the equilibrium mixture.

Skill level 2	
2	
1	
0	
NR	

Part B: Solubility

40.0 mL of 0.650 moL^{-1} magnesium nitrate solution is mixed with 100 mL of 2.50 $molL^{-1}$ sodium hydroxide solution. K_s $(Mg(OH)_2)$ = $5.61x10^{-12}$.

1. Define solubility product, K_s.

Skill level 1	
1	
0	
NR	

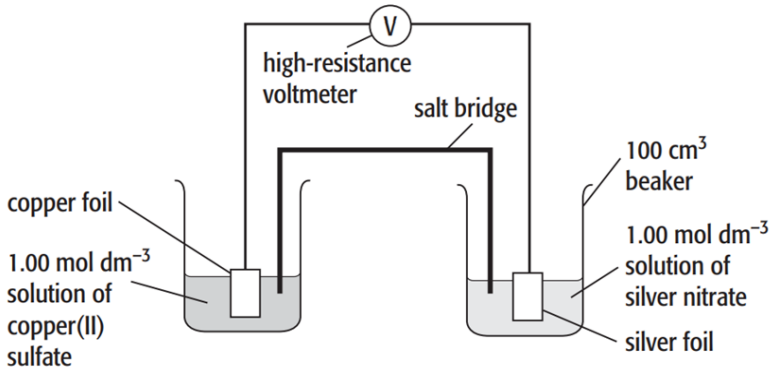
2. Predict whether a precipitate will form when mixing these two solutions.

Skill level 3	
3	
2	
1	
0	
NR	

Part C: Redox Chemistry

Study and use data from **Figure 5** below and the given information to answer the following questions.

Figure 5: Electrochemical cell of two half cells, Cu/Cu^{2+} and Zn/Zn^{2+} at standard conditions.



The standard electrode potential for the half-cells in **Figure 5** above are:

i. $E^0_{(Ag/Ag+)}$ is +0.80V,
ii. $E^0_{(Cu/Cu2+)}$ is +0.34V,

1. Give the polarity of the electrodes in the electrochemical cell in **Figure 5** supported with reasons.

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Skill level 2	
2	
1	
0	
NR	

2. Use the standard electrode potentials of the half-cells to calculate the expected reading in the high resistance voltmeter in **Figure 5** above.
Include in your answer the appropriate unit.

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Skill level 3	
3	
2	
1	
0	
NR	

3. Discuss all the changes and movements of species that occur in both half-cells of the electrochemical system in **Figure 5**.

[Changes involve the half-reactions AND relevant Species and their movement to consider and include the following:

Saltbridge's positive and negative ions,
Copper and sulphate ions,
Silver and nitrate ions,
Copper foil and the aluminium foil,
Electrons and current]

Skill level 4	
4	
3	
2	
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SECTION FIVE: ORGANIC CHEMISTRY

Part A: Organic Compounds

A compound, $CH_3CH_2CH=CHCH_2CH_2OH$ can have different spatial arrangements of atoms.

1. Use the IUPAC rules to name the compound, $CH_3CH_2CH=CHCH_2CH_2OH$.

_____

_____

_____

Skill level 1	
1	
0	
NR	

2. The compound in (1.) has cis and trans isomers.
Draw the structures of the cis and trans isomers of the compound in the spaces provided below.

Cis	**Trans**

Skill level 2	
2	
1	
0	
NR	

Part B: Organic reactions

1. Describe how Tollen's reagent is able to distinguish between an aldehyde and a ketone.

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Skill level 2	
2	
1	
0	
NR	

2. Account for the differences in the reactivity of aldehyde and ketone with the Tollen's reagent.

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Skill level 3	
3	
2	
1	
0	
NR	

3. Write a balanced equation for the reaction of ethanol, CH_3CH_2OH, with acidified potassium permanganate solution, $KMnO_4/H^+$.

   [Must show intermediate and final products.]

Skill level 2	
2	
1	
0	
NR	

Part C: Polymers

1. Glycine or **amino ethanoic acid** and alanine or **2-aminopropanoic acid** are two important amino acids.

   i. Differentiate between the structure of glycine and alanine.

Skill level 3	
3	
2	
1	
0	
NR	

   ii. A protein is developed from glycine represented by letter **G**, and alanine, represented by letter **A**, in the following order: **G-A-A-G**

   Discuss how the properties of the glycine and alanine are integrated into the protein structure **G-A-A-G**

   Consider in your answer the following:

   - *Identify the type of polymerization in the formation of the protein and justify,*
   - *Draw and label the resulting protein molecule of G-A-A-G,*
   - *Compare and contrast the structure of the individual amino acids with the protein,*
   - *Explain how the physical and chemical properties of the individual amino acids, may differ from the protein.*

Skill level 4	
4	
3	
2	
1	
0	
NR	

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PERIODIC TABLE