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THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2019/2020 ACADEMIC YEAR
DEFERRED FINAL EXAMINATIONS

CHE1000: INTRODUCTION TO CHEMISTRY

TIME: THREE (3) HOURS

INSTRUCTIONS TO THE CANDIDATES

1. Indicate your **student ID number** and **TG number** on **ALL** your answer booklets.
2. This examination paper consists of two (**2**) sections: **A** and **B**
3. Section **A** has ten **(10)** short answer questions. Questions carry equal marks. (Total marks = **40**).

   ANSWER ALL QUESTIONS IN SECTION A IN THE MAIN ANSWER BOOKLET
4. Section **B** has five **(5)** long answer questions. Questions carry equal marks. (Total marks = **60**).

   ANSWER QUESTION B1 AND ANY THREE QUESTIONS, EACH QUESTION IN A SEPARATE ANSWER BOOKLET.
6. **YOU ARE REMINDED OF THE NEED TO ORGANISE AND PRESENT YOUR WORK CLEARLY AND LOGICALLY.**
7. Please be reminded that it is your responsibility to **ENSURE** that you have Ten (10) printed pages containing questions A1 to A10 and B1 to B5.

ADDITIONAL INFORMATION TO THE CANDIDATES:

Useful data is provided on page 11.
Periodic Table of Elements is on last page.

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SECTION A

ANSWER ALL QUESTIONS IN THIS SECTION IN THE MAIN BOOKLET

Question A1

Balance and write the net ionic equation for the precipitation reaction below

$$K_2S(aq) + Ni(NO_3)_{2(aq)} \rightarrow KNO_{3\,(aq)} + NiS_{(s)}$$

[4 Marks]

Question A2

A gas at constant pressure is heated from 35°C to 80°C, calculate the new volume if the initial volume was 5.6 L

[4 Marks]

Question A3

The De Broglie relationship can be used to determine the wavelength of a baseball weighing 5.0 oz (1 oz = 28.3 g) thrown at a speed of 35 m/s.

a) Write the De Broglie relationship equation.
b) Calculate the wavelength of the baseball

[4 Marks]

Question A4

Bromine Pentafluoride BrF_5 is a good example of inter halogen molecule

a) Draw the Lewis dot structure for BrF_2.
b) What is the formal charge on bromine?

[4 Marks]

Question A5

A CHE 1000 student accidently drops her pure silver earrings in a 1 M acidified solution of KMnO4 prepared by the technicians. Their half reactions are shown below:

Oxidation half: $Ag\,(s) \rightleftharpoons Ag^+\,(aq) + e^-$
Reduction half: $MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightleftharpoons Mn^{2+}(aq) + 4H_2O(l)$

Calculate the $\Delta G°$ of the reaction

[4 Marks]

Question A6

At 40 °C, $H_2O_2(aq)$ will decompose according to the following reaction:

$$2H_2O_2\,(aq) \rightarrow 2H_2O(l) + O_2(g)$$

The following data were collected for the concentration of H_2O_2 at various times.

Time (s)	$[H_2O_2]$ (mol/L)
0	1.000
2.16×10^4	0.500
4.32×10^4	0.250

(a) Calculate the average rate of decomposition of H_2O_2 between 0 and 2.16×10^4 s. Use this rate to calculate the average rate of production of $O_2(g)$ over the same time period.

(b) Between the time period 2.16×10^4s to 4.32×10^4 s, calculate the rate of decomposition of H_2O_2 and average rate of production of O_2.

[4 Marks]

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Question A7

Consider the reaction below and the given heat of formation values:

$$CaF_2\,(s) + H_2SO_4\,(aq) \rightarrow CaSO_4\,(s) + 2\,HF\,(g)$$

$\Delta H°_f$ (kJ/mol)	-1219.6	-909.3	-1434.0	-268.6

Calculate the standard enthalpy change for the reaction.

[4 Marks]

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Question A8

Calculate the molar mass of insulin if 20.0 mg is dissolved in 10.0 mL of solution to give a resulting osmotic pressure of 6.48 torr at 25 °C.

[4 Marks]

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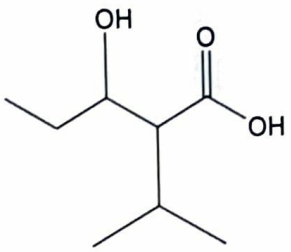
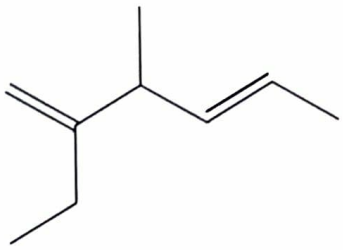
Question A9

Provide the IUPAC name for each of the compounds shown below:

(a)



(b)



[4 Marks]

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Question A10

(a) There are four alkyl bromides with the formula C_4H_9Br. Write their structural formulas and classify each as to whether it is a primary, secondary, or tertiary alkyl bromide.

[4 Marks]

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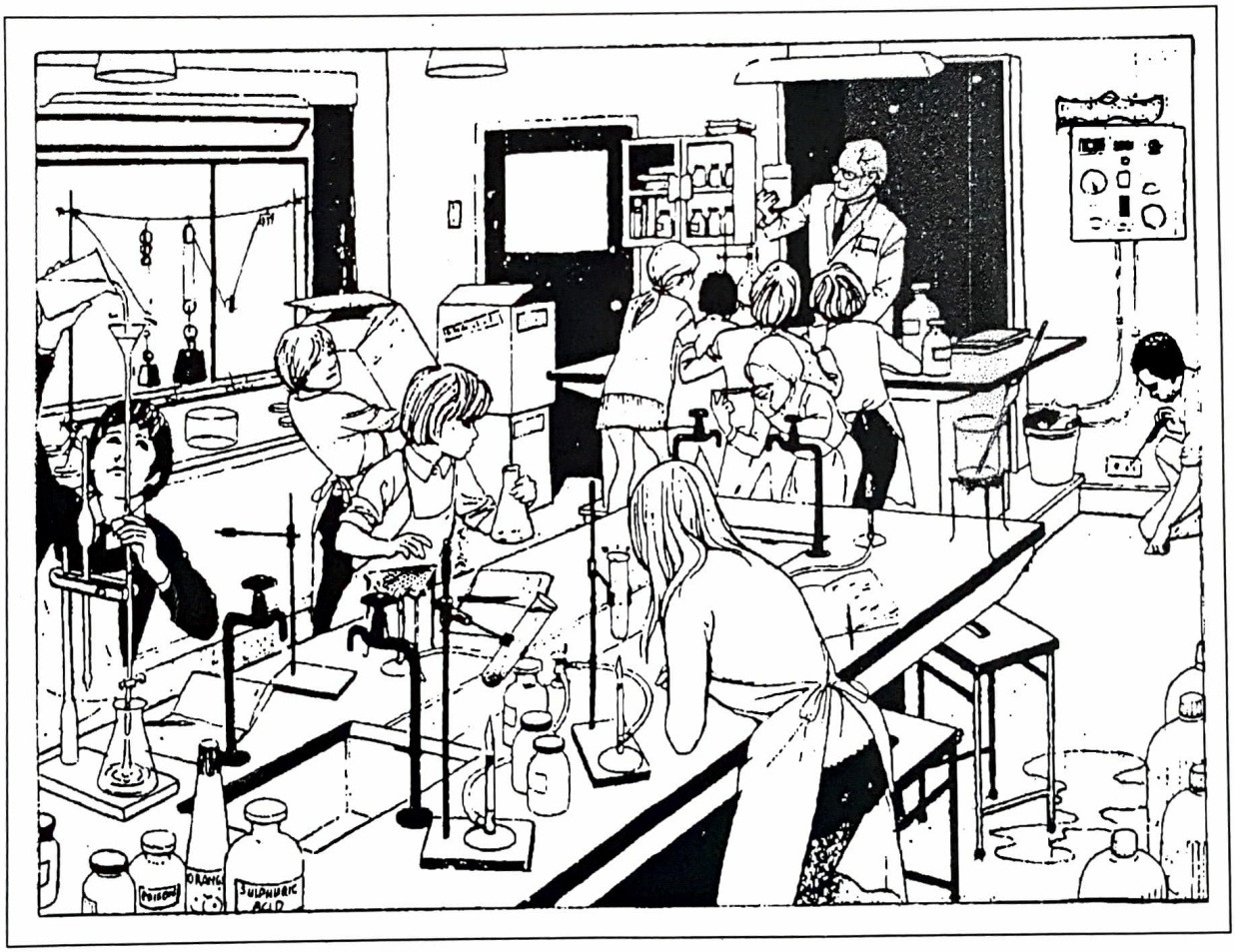
SECTION B

ANSWER QUESTION B1 AND ANY THREE QUESTIONS

EACH IN A SEPARATE BOOKLET

Question B1

The laboratory can be but is not necessarily a dangerous place. When intelligent precautions and a proper understanding of techniques are employed, the laboratory is no more dangerous than any other classroom. In CHE1000 experiment 1, students were introduced to laboratory safety, common laboratory apparatus and techniques. The Figure below shows a class in action in a chemistry lab session.



(a) Write down six (6) dangerous or wrong situations depicted in the picture above?

[3 Marks]

(b) Why should water never be added to a concentrated acid?

[2 Marks]

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(c) Chemicals should never be smelt by putting the container directly to your nose.

(i) In less than three (3) lines, describe how you would smell chemicals in the laboratory.

[2 Marks]

(ii) In less than three (3), explain why chemicals should never be smelt by putting the container directly to your nose?

[2 Marks]

(d) It is not advisable to use a ground glass stopper for a reagent bottle containing sodium hydroxide solution. The stopper may become stuck after some days, due to a reaction between sodium hydroxide and carbon dioxide dissolved from the atmosphere.

(i) Write the equation for the dissolution of CO_2 in water to produce carbonic acid.

[2 Marks]

(ii) Write the equation for the reaction of carbonic acid with hydroxide to produce hydrogen carbonate (also called bicarbonate) and water.

[2 Marks]

(iii) Write the equation for the reaction of bicarbonate and hydroxide to produce carbonate and water.

[2 Marks]

[Total: 15 Marks]

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Question B2

a) Calculate the maximum Kinetic Energy (in joules) and velocity (3 significant figures) of an electron ejected from zinc by a 275nm photon. The threshold energy or work function for Zn = 4.31eV. **[3 Marks]**

b)

(i) How would you expect the first ionization energy to change as you go across a period in the periodic table? **[2 Marks]**

(ii) State any two factors that influence the ease of removing an electron from an element. **[2 Marks]**

c) Louis de Broglie discovered that electrons had a **dual nature.** Based on this discovery, what does it mean when we state that electrons have a dual nature? **[2 Marks]**

d) A molecule of H_2O can react with a hydrogen ion, H^+, ion to form a hydronium ion, H_3O^+, ion.

(i) Draw and name the shape of the H_3O^+ ion. Include any lone pairs of electrons. **[5 Marks]**

(ii) Suggest a value for the bond angle in the H_3O^+ ion. **[1 Mark]**

[Total: 15 Marks]

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Question B3

The following battery operates at 25 °C and 1 atmosphere. Assume the solutions are 1.0 L each and current flows at zero resistance.

$$Zn \mid Zn^{2+}(0.10\ M) \parallel Cu^{2+}\ (2.5\ M) \mid Cu$$

The mass of each solid electrode is 200 g.

a) Express the battery as a diagram clearly labelling all parts **[6 marks]**

b) Calculate the cell potential when the circuit is closed **[3 marks]**

c) If a current of 10.0 A passed through the circuit for 10 hours, calculate

(i) The cell potential **[3 marks]**
(ii) The mass of each electrode **[3 marks]**

[Total: 15 Marks]

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Question B4

(a) Consider the following reaction:

$$SiH_4(g) + 2Cl_2(g) \rightleftharpoons 2SiCl_4(g) + 2H_2(g)$$

(i) Write the equilibrium expression (K) for this gas-phase reaction.

[2 Marks]

(ii) Predict the shift in the equilibrium position that will occur for the above reaction when the volume of the reaction is increased. Explain your answer.

[2 Marks]

(b) At 327 °C, the equilibrium concentrations are $[CH_3OH] = 0.15\ M$, $[CO] = 0.24\ M$, $[H_2] = 1.1\ M$. Calculate K_p at this temperature. **[5 Marks]**

$$CH_3OH(g) \rightleftharpoons CO(g) + 2H_2(g)$$

(c) An antacid purchased at a local drug store has a pOH of 2.3. Calculate the pH, $[H^+]$, and $[OH^-]$ of this solution. Is the antacid acidic or basic? **[4 Marks]**

(d) The solubility of CaC_2O_4 is 4.8×10^{-5} mol/L. Calculate the K_{sp} value for the solid.

[3 Marks]

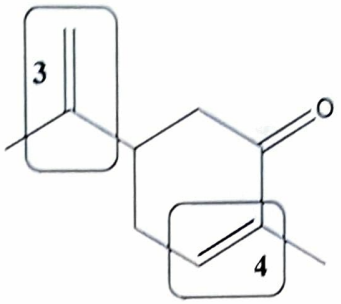
(e) At 40 °C the value of $Kw = 2.92 \times 10^{-14}$. Calculate $[H^+]$ and $[OH^-]$ in pure water at 40 °C.

[4 Marks]

[Total: 15 Marks]

Question B5

(a) Consider the structure of Carvone, a molecule responsible for the odour of spearmint, given below:



Carvone

(i) Write the molecular formula of carvone. **[3 Marks]**

(ii) Which of the two alkenes **3** or **4**, enclosed in the box, is a geometrical isomer? Briefly explain your choice. **[3 Marks]**

(iii)State whether the alkene your chose in part (ii) is E/Z? **[1 Mark]**

(b) Draw a fully labelled molecular orbital diagram for allene ($H_2C=C=CH_2$), showing the orbital overlaps and types of bonds formed. **[6 Marks]**

(c) Write the line formulae corresponding to following IUPAC names.

(i) Methyl 3-aminohexanoate

(ii) 4-Chloro-2-ethylpentan-1-ol

[2 Marks]

[Total: 15 Marks]

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