THE COPPERBELT UNIVERSITY
SCHOOL OF MATHEMATICS AND NATURAL SCIENCES

CHEMISTRY DEPARTMENT

Test One for 2018/2019 Academic Year

DATE: 28th FEBRUARY 2019

COURSE: GENERAL CHEMISTRY

COURSE CODE: CH 110

TIME ALLOWED: TWO (02) HOURS

INSTRUCTIONS TO CANDIDATES

1. This paper comprises **FOUR** questions printed on pages 2 to 5.
2. Candidates are expected to attempt **ALL** questions.
3. Each question carries **TWENTY-FIVE** marks.
4. Candidates are reminded to **CLEARLY PRESENT** their answers.
5. All the parts of a question should be answered **IN CONTINUATION**.

QUESTION 1: INTRODUCTION **[25 MARKS]**

(a) Copy Tables 1 and 2 into your answer book and complete the missing information.

(i) Fill in the names of the compounds [3]

Table 1: Compounds and their names

Number	Compound	Name of Compound
1	$CaHPO_4$	
2	S_2Cl_2	
3	N_2O_5	

(ii) Fill in the chemical formulae and the common names of the compounds. [3]

Table 2: Chemical formulae of named compounds and their common names

#	IUPAC Compound Name	Formula	Common Name
1	Dihydrogen dioxide	H_2O_2	hydrogen peroxide
2	Dinitrogen monoxide	N_2O	water
3	Nitrogen trihydride	NH_3	ammonia

(b) Most elements occur in nature as mixtures of isotopes. Calculate the average relative atomic mass of chlorine given that naturally occurring chlorine is 75.78% ^{35}Cl (atomic mass 34.969 amu) and 24.22% ^{37}Cl (atomic mass 36.966 amu). [4]

(c) Copy Table 3 into your answer book and complete the missing isotopic information for which you will get 1 mark for each correctly completed cell. [6]

Table 3: Information on chlorine and iron isotopes

Isotope	Nucleon number	Neutron number	Electron number
^{35}Cl			
^{55}Fe			

(d) What are the commonly used alternative terms for nucleon number and electron number for an element? [2]

(e) The Table 4 below relates to separation of substances. Copy the table into your answer book and complete the missing items for ½ a mark for each correctly filled cell. [3]

Table 4: Separation of matter

S/No	Separation method	Description of method
1		Select components by particle size
2		Select components by density
3	Crystallisation	
4	Extraction	
5		Select components by boiling point
6		Select components by affinity for a 'stationary phase'

(f) Carry out the following mathematical operations, and give each result with the correct number of significant figures.

(i) $1.05 \times 10^{-3} \div 6.135$ [1]

(ii) $21 - 13.8$ [1]

(iii) As part of a lab assignment to determine the value of the gas constant (R), a student measured the pressure (P), volume (V), and temperature (T) for a sample of gas, where

$$R = \frac{PV}{T}$$

The following values were obtained: P = 2.560, T = 275.15, and V = 8.8. (Since gases will be discussed in detail later on in the course, do not be concerned at this time about the units for these quantities.) Calculate R to the correct number of significant figures. [2]

QUESTION 2: ATOMIC STRUCTURE AND PERIODICITY [25 MARKS]

(a) Complete the first column of the table of the series of electromagnetic lines of atomic spectra of a hydrogen atom. [5]

Table 5: Electromagnetic line series of hydrogen atom

Series	n_1	n_2
Lyman	1	2, 3, 4, ...∞
Balmer	2	3, 4, 5 .....∞
~~Bracket~~ Paschen	3	4, 5, 6 .....∞
f - final Bracket	4	5, 6, 7, ...∞
P - final	5	6, 7, 8 .....∞.

(b) One application of the wave-particle duality of matter is electron diffraction, which is used to determine the distances between atoms in crystalline solids. Experimentally, this is done by accelerating a beam of electrons to the point where the wavelength of the electron beam is of the same order of magnitude as the distance between atoms (roughly 0.1 – 0.5 nm). How fast would an electron need to be travelling in order to have a wavelength of 0.1 nm? [6]

(c) What is the energy of a photon of light, with a wavelength of 515 nm? [2]

(d) Use the Rydberg equation to explain the electron transition (or give n_1 and n_2) that leads to the emission of the spectral line mentioned in (c) assuming the emission is of a hydrogen atom. [2]

(e) Copy the table below in your answer book and complete it for ¾ of mark per correctly filled cell. [6]

Table 6: Abbreviated electron configuration and number of unpaired valence elements for given elements.

Element	Electron configuration	Unpaired valence shell electrons
Zn		
V		
Cr		
Mn		

(f) Copy the table below in your answer book and fill in the order in which the elements in (e) are drawn into a magnetic field. Start with the least drawn element as the first one and end with the most drawn element as the last or fourth one. You will get ½ a mark for each correctly filled cell. [2]

Table 7: Order of elements attraction in a magnetic field.

Order being drawn in magnetic field	1	2	3	4
Element				

(g) Mendeleev is one the first scientists to organise elements into the first periodic table. Explain the difference in how his periodic table and the modern periodic table are organised. [2]

QUESTION 3: CHEMICAL EQUILIBRIUM [25 MARKS]

(a) (i) What do you understand by the term "chemical equilibrium"? [1]

(ii) State three factors that affect the chemical equilibrium [3]

(b) A mixture of 0.10 mol of NO, 0.050 mol of H_2 and 0.10 mol of H_2O is placed in a 1.0 L vessel at 300 K. The following equilibrium is established.

$2NO_{(g)} + 2H_{2(g)} \rightleftharpoons N_{2(g)} + 2H_2O_{(g)}$

At equilibrium, the concentration of NO is 0.062M

(i) Calculate the equilibrium concentration of H_2, N_2 and H_2O [9]

(ii) Calculate the equilibrium constant K_C and show its units [3]

(iii) Then, calculate the equilibrium constant, K_c for the reaction below

$N_{2(g)} + 2H_2O_{(g)} \rightleftharpoons 2NO_{(g)} + 2H_{2(g)}$ [3]

(c) (i) State Le chatellier's principle [1]

(ii) For the reaction, $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$, $\Delta H = -93KJ.$

An equilibrium mixture of $PCl_3(g)$, $Cl_2(g)$ and PCl_5 is in a container.

If chlorine gas is added to the container:

What is the effect on the quantity of $PCl_3(g)$ and what is the effect on the equilibrium constant, K_p ? [2]

(iii) If the temperature for the reaction in (ii) above is increased, what is the effect on the quantity of $PCl_3(g)$, *and* PCl_5? and what is effect on the equilibrium constant, K_p? [3]