



THE COPPERBELT UNIVERSITY
SCHOOL OF MATHEMATICS AND NATURAL SCIENCES

DEPARTMENT OF CHEMISTRY

Test One for 2021/2022

DATE: May 2022

COURSE: GENERAL CHEMISTRY

COURSE CODE: CH 110

TIME ALLOWED: Two (02) HOURS

INSTRUCTIONS TO CANDIDATES:

1. This paper comprises **FOUR** questions
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. Start answering each new question on a new page.

QUESTION 1: INTRODUCTION

[25 MARKS]

- a) Fill each blank space with an appropriate word in the sentences that follow;
Energy is a by-product of many chemical processes.

[5]

When considering nuclear energy, Nuclear fission [i] is a proven large scale energy source but has radioactive waste problems. Chemists [ii] can help to devise better ways of disposing nuclear waste.

Energy production and energy utilization can negatively affect our environment. For example, burning fossil fuels gives off CO₂ [iii] which is a greenhouse gas along with NO [iv] and Sulphur dioxide [v] which result in acid rain. However, new technologies are being introduced to reduce harmful emissions and improve air quality.

- b) Fill in the Table below for units of measurements.

[6]

Table 1: Table of Units of Measurement

	Base Quantity	Name of Unit	Symbol
1	Mass	Kilogram	kg
2	length	Metre	m
3	Time	Second	s
4	Amount of Substance	Mole	mol
5	Temperature	Kelvin	K
6	Electric current	Ampere	A
7	Luminous intensity	Candela	cd

- c) What is the collective term used for the units in question (b)? SI unit of measurement [1]
d) In Table 1, correctly list the three parameters that uniquely identify an isotope in the nuclide symbol A_ZX . [3]

Table 2: Parameters that uniquely describe an isotope

Parameter	Meaning of parameter
A	Mass number
X	Element symbol
Z	Atomic number

- e) For a nuclide, two of its components give the same value. Which are these two? Electrons & Protons [1]
f) A certain isotope X^+ contains 54 electrons and 78 neutrons. Write the nuclide of this isotope. [3]
g) Complete the table below on the three fundamental chemical laws that you learnt in the introductory topic of General Chemistry. [6]

Table 3: List of three Fundamental Chemical Laws

No.	Name of Fundamental Chemical Law	Discoverer of Law
1	Law of Conservation of mass	Antoine Lavoisier
2	Law of definite proportions	Joseph Louis Proust
3	Law of multiple proportions	John Dalton

Pen

132
C₂
54

QUESTION 2: STOICHIOMETRY

[25 MARKS]

- a) Zinc (Zn) is a silvery metal that is used in making brass (with copper) and in plating iron to prevent corrosion. How many moles of Zn are there in 45.9 g of Zn? [2]
- b) Sulfur (S) is a nonmetallic element that is present in coal. When coal is burned, sulfur is converted to sulfur dioxide and eventually to sulfuric acid, which gives rise to the acid rain phenomenon. How many atoms are in 25.1 g of S? [2]
- c) Lithium carbonate (Li_2CO_3) was the first "mood-stabilizing" drug approved by the FDA for the treatment of mania and manic-depressive illness, also known as bipolar disorder. Calculate the percent composition by mass of lithium carbonate. *of each element* [3]
- d) Iron (Fe), the main component of steel, is the most important metal in industrial society. How many Fe atoms are in 95.8 g of Fe? [3]
- e) During excessive physical activity, lactic acid (Molar mass = 90.08 g/mol) forms in muscle tissue and is responsible for muscle soreness. Elemental analysis shows that this compound contains 40.0 mass % C, 6.71 mass % H, and 53.3 mass % O. [10]
- Determine the empirical formula of lactic acid.
 - Determine the molecular formula.
- f) When potassium chromate (K_2CrO_4) is added to a solution containing 0.500 g silver nitrate (AgNO_3), solid silver chromate (Ag_2CrO_4) is formed. Write a balanced chemical equation and find the percent yield if 0.455 g of silver chromate is obtained. [5]

QUESTION 3: REACTIONS IN SOLUTION

[25 MARKS]

- a) A redox reaction is defined as a reaction in which oxidation and reduction take place simultaneously. Identify the following changes as either oxidation or reduction: [6]
- BiO_3^- to Bi^{3+}
 - N_2O_4 to N_2O
 - SO_2 to SO_3
- b) Identify the oxidizing and reducing agents in each of the following reactions [4]
- $\text{I}_2\text{O}_5 + 5\text{CO} \rightarrow 5\text{CO}_2 + \text{I}_2$
 - $2\text{Fe}^{2+} + \text{H}_2\text{O}_2 + 2\text{H}^+ \rightarrow 2\text{Fe}^{3+} + 2\text{H}_2\text{O}$
- c) One litre of solution is prepared by dissolving 125.6 g of NaF in it. If you took 180.0 mL of that solution and diluted it to 500 mL determine the molarity of the resulting solution [5]
- d) Sodium chloride, NaCl, reacts with lead (II) nitrate, $\text{Pb}(\text{NO}_3)_2$, to form lead (II) chloride, (PbCl_2) and sodium nitrate, NaNO_3 . For this reaction write [10]
- Balanced molecular Equation,
 - Complete Ionic Equation
 - Net Ionic Equation:

Assume all reactions occur in aqueous solution. Include states of matter in your equations

QUESTION 4: GASES

[25 MARKS]

- a) State each of the following gas laws:
- (i) Avogadro's law [1]
 - (ii) Charles' law [1]
 - (iii) Boyle's law [1]
 - (iv) Graham's law on diffusion of gases [2]
- b) Given that one mole of a gas at 450 K has a density of 1.41 gdm^{-3} at 1520 mm Hg. What is the density of the gas at rtp? [3]
- c) Determine the molar mass of a gas whose density is 1.50 gdm^{-3} at a temperature of 25°C and pressure of 760 torr. [3]
- d) Three gases were added to the same container of volume 20 litres to give a total pressure of 150 kPa at 25°C . If the mixture contained 8.0 g of O_2 , 8.0g of CO_2 and an unknown mass of N_2 .
- (i) Define the term partial pressure [2]
 - (ii) Calculate the partial pressure of each gas [3] ✓
 - (iii) Calculate the mole fraction of each gas [3] ✓
 - (iv) Determine the mass of N_2 in the container [3] ✓
- e) Give any three postulates of the kinetic theory of gases [3]

TABLE OF FUNDAMENTAL CONSTANTS

<u>Quantity</u>	<u>symbol</u>	<u>Value</u>	<u>Power of ten</u>	<u>Units</u>
Speed of light	C	2.9979	10^8	m s^{-1}
Elementary charge	E	1.602	10^{-19}	C
Faraday's constant	$F = N_{\text{A}}e$	9.6485	10^4	C mol^{-1}
Boltzmann's constant	K	1.380 65	10^{-23}	J K^{-1}
Gas constant	$R = N_{\text{A}}k$	8.314 47		$\text{J K}^{-1} \text{mol}^{-1}$
		8.314 47	10^{-2}	$\text{L bar K}^{-1} \text{mol}^{-1}$
		8.205 74	10^{-2}	$\text{L atm K}^{-1} \text{mol}^{-1}$
		6.236 37	10	$\text{L Torr K}^{-1} \text{mol}^{-1}$
Planck's constant	H	6.626 08	10^{-34}	J s
Avogadro's constant	N_{A}	6.022 14	10^{23}	mol^{-1}
Atomic mass unit	m_{u}	1.660 54	10^{-27}	Kg
Mass				
Electron	m_{e}	9.109 38	10^{-31}	Kg
Proton	m_{p}	1.672 62	10^{-27}	Kg
Neutron	m_{n}	1.674 93	10^{-27}	kg
Rydberg constant	R_{H}	1.097 37	10^7	m^{-1}
1 atm = 760 mmHg = 760 Torr = $1.01325 \times 10^5 \text{ Nm}^{-2}$ = $1.01325 \times 10^5 \text{ Pa}$ = 1.01325 bar				

The Periodic Table

1	2											3	4	5	6	7	0
1 H 1.01		<div>Atomic Number</div> <div>Element</div> <div>Atomic Mass</div>															2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.55	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98.91	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.34	57 † La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.21	77 Ir 192.22	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.98	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 ‡ Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (281)	111 Rg (272)	112 Cn (285)	113 Nh (284)	114 Fl (289)	115 Mc (288)	116 Lv (291)	117 Ts (Unknown)	118 Og (294)

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)