THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

FIRST SEMESTER EXAMINATION

CH111/ AS111- FOUNDATION CHEMISTRY

MONDAY 06TH JUNE 2022- 8.20 AM

TIME ALLOWED: 3 HOURS

INFORMATION FOR CANDIDATES

1 You have 10 minutes to read through the question paper. You **MUST NOT** begin writing in the answer booklet during this Time.

2 **ANSWER ALL QUESTIONS.**

3 Answers must be written on the Answer Booklet provided, show all working out and Calculations where required.

4 Write your full Name, Student Number, and course code clearly on the Answer Booklet. **Do that Now.**

5 Calculators are permitted in the Examination room. Lecture notes, note books, plain papers and textbooks are **NOT** allowed.

6 Mobile Phones and other electronic devices are not allowed.

7 **DO NOT** over write.

MARKING SCHEME: [100 marks]

1 (a) Briefly explain how a Scientific theory is being developed.

[3 marks]

(b) A 2.2 g of tin (Sn) was reacted with enough nitric acid (HNO_3) to form a hydrated oxide of tin. The final weight of tin oxide was 2.5 g. Determine the empirical formula of the oxide of tin.

[4 marks]

(c) If 10 g of copper metal react with a solution containing 40.0 g of $AgNO_3$, which is the limiting reagent?

[3 marks]

(Total = 10 marks)

2 (a) Describe Rutherford's atomic model and state why a few alpha (α) particles backscattered and the rest penetrated through the gold foil.

[4 marks]

(b) Sodium vapor lamp has a wavelength of 589 nm. What is the frequency of this radiation?

[3 marks]

(c) Consider electrons are ejected from the surface of a metal following irradiation with Ultraviolet light.

(i) What is the relationship (if any) between the Kinetic energy of the ejected electrons and the wavelength of the UV lights?

[3 marks]

(ii) What is the relationship between the intensity of the light and the number of electrons ejected?

[3 marks]

(d) Differentiate between the constructive and destructive interferences and the explain briefly the application of noise cancellation technology in headphones.

[4 marks]

(e) During a photon emission, an electron in a hydrogen atom transition from the energy level n = 7 to n = 5 What is the;

(i) frequency of the emitted photon? [3 marks]

(ii) wavelength in centimetres?

[2 marks]

(Total = 22 marks)

3 (a) Give the orbital designation of this set of quantum numbers: $n = 4, l = 2, m_l = 0, m_s = -1/2$.

(b) Draw the orbital diagram for Ca^{2+}.

(c) Determine the number of 3d electrons in Manganese (Mn) atom by using electronic configuration.

(6 marks)

4 (a) Identify the orbital that has two radial nodes and one angular node.

(b) Draw out the RPD vs radius diagram by using the information above.

(8 marks)

5 (a) Briefly explain what periodic table is, its basis and its significance. [3 marks]

(b) (i) Differentiate between the 2s and 2p electrons of Potassium (K) in terms of penetration and shielding. [3 marks]

(ii) Calculate the Z_{eff} for valence electron of K. [2 marks]

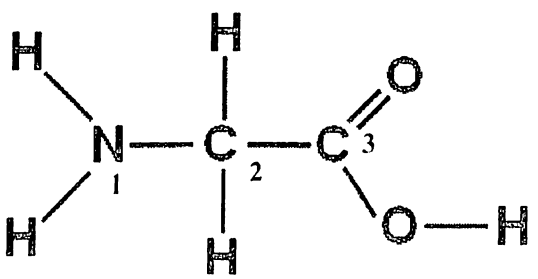
(c) Arrange the following elements in increasing order of first ionization energy: Sr, Cs, S, F, As. [3 marks]

(d) Define electronegativity and give its trend on the Periodic Table. [3 marks]

(Total = 14 marks)

6 (a) In a laboratory conductivity experiment, it was found out that hydrochloric acid (HCl) conducts better than acetic acid (CH3COOH). Explain why. [5 marks]

(b) Structure of glycine is given below:



(i) Determine the formal charge of each central atom labelled 1, 2, & 3 on the structure. [4.5 marks]

(ii) Calculate the formal charge of each atom bonded to the central atom (1, 2, & 3).

[4.5 marks]

(iii) Determine the geometry of each central atom labelled 1, 2, & 3 above.

[6 marks]

(Total = 20 marks)

7 (a) Explain how pressure is being exerted by gas molecules. [3 marks]

(b) A sample of CO_2 gas has a volume of 0.575L at 752 torr and 22.22 °C. What is the mass of CO_2 in this sample? [6 marks]

(c) An empty 49.0 L methane (CH_4) storage tank has an empty mass of 55.85 kg and, when filled, has a mass of 62.07 kg.

(i) Calculate the pressure of CH_4 in the tank at 21°C using both the ideal gas equation and the van der Waals equation. Given the van der Waals: a = 2.253 L^2.atm.mol^{-2}, b = 0.04278 L. mol^{-1}. [8 marks]

(ii) What is the percentage correction achieved by using the more realistic van der Waals equation?

[3 marks]

(Total = 20 marks)

Data Sheet and Periodic Table

1												13	14	15	16	17	18
1 H 1.0	2																2 He 4.0
3 Li 6.9	4 Be 9.0				6 C 12.0	Atomic number Symbol Name Atomic mass						5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0	10 Ne 20.2
11 Na 23.0	12 Mg 24.3	3	4	5	6	7	8	9	10	11	12	13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Ha (262)	106 Sg (263)	107 Uns (262)	108 Uno (265)	109 Une (266)									

- $c = 2.9979 \times 10^{8}$ m/s
- $h = 6.6261 \times 10^{-34}$ Js
- $N_A = 6.022 \times 10^{23}$ mol^{-1}
- $m_e = 9.1094 \times 10^{-31}$ kg
- $a_o = 5.292 \times 10^{-11}$m
- 1amu $= 1.66 \times 10^{-27}$ kg
- $R_H = 2.1799 \times 10^{-18}$ J
- $\Re = R_H/h = 3.2898 \times 10^{15}$ Hz

$$E_n = -\frac{Z^2 R_H}{n^2}$$

$$E_n = -\frac{Z_{eff}^2 R_H}{n^2}$$

for $n_f < n_i$, $v = \frac{Z^2 R_H}{h}\left(\frac{1}{nf^2} - \frac{1}{ni^2}\right)$

For $n_f > n_i$ ..... $v = \frac{Z^2 R_H}{h}\left(\frac{1}{ni^2} - \frac{1}{nf^2}\right)$

- $1W = 1\ J\ s^{-1}$
- $1J = 1\ kgm^2s^{-2}$
- $1ev = 1.6022 \times 10^{-19}$ J
- $E = h\nu = hc/\lambda$
- $C = \nu\lambda$
- $KE = (1/2)mv^2$
- $p = mv$
- $\lambda = h/p$

$$Z_{eff} = Z\text{-}S$$

$$E_i = I.E + K.E$$

- FC =VE- LE -1/2BE
- SN= = BONDED ATOM + = OF LONE PAIR
- VSEPR GENERAL NOMENCLATURE: AXE where A= CENTRAL ATOM, X= = OR BONDED ATOMS, E= = OF LONE PAIR

Charles's Law: $V_1/T_1 = V_2/T_2$

Boyle's Law: $P_1V_1 = P_2V_2$

Avogadro's Law: $V_1/n_1 = V_2/n_2$

Ideal Gas Law: $PV = nRT$

Van der Waals: $P = \frac{nRT}{V - nb} - \frac{n^2a}{V^2}$

Values of gas Constant (R)

- 0.082 atm. L mol^{-1} K^{-1}
- 8.314 kPa.L mol^{-1} K^{-1}
- 8.314 Jmol^{-1}K^{-1}
- 62.4L. mmHg mol^{-1}K^{-1}

Units of Pressure

- 1Torr=1mmHg
- 1atm=760mmHg
- 1atm=760Torr
- 1atm=101.325 Pa
- 760torr =101 325Pa