THE UNIVERSITY OF ZAMBIA TG----

SCHOOL OF NATURAL SCIENCES

2022/2023 ACADEMIC YEAR FIRST TERM
TEST 1

CHE1000: Introductory Chemistry
TIME: Two hours DATE:.........................

INSTRUCTIONS TO THE CANDIDATES

1. Indicate your **student ID number** and **TG number** in space provided.
2. The test consists of three **(3)** sections: **A, B** and **C**
3. Section **A** has twenty **(20)** multiple choice questions. Each question carries two **(2)** marks. (Total marks = **40**).
4. Section **B** has ten **(10)** final answer only questions. Each question carries two **(2)** marks. (Total marks = **20**).
5. Section **C** has one **(1)** Lab question carrying **10 marks** and six **(6)** short answer questions carrying five **(5)** marks each. (Total marks = **40**).
6. **ATTEMPT ALL QUESTIONS IN ALL SECTIONS.**
7. **ANSWERS MUST BE GIVEN IN THE PROVIDED SPACES.**
8. **ORGANISE AND PRESENT YOUR WORK CLEARLY AND LOGICALLY WHERE NECESSARY.**

INFORMATION TO THE CANDIDATES:

1. **Periodic table is printed on the last page.**

USEFUL DATA		**Universal Gas Constant R**
Avogadro's constant, N_A	6.022×10^{23} mol^{-1}	8.3145 J mol^{-1} K^{-1}
Molar volume of gas at S.T.P	22.4 dm^3 mol^{-1}	8.3145 k Pa L K^{-1} mol^{-1}
Planks constant, h	6.626×10^{-34} Js	0.083145 L bar mol^{-1} K^{-1}
Rydberg constant, R_H	1.097×10^7 m^{-1}/ 2.179×10^{-18} J	0.08206 L atm mol^{-1} K^{-1}
Speed of light in a vacuum, c	3.00×10^8 ms^{-1}	62.364 L torr mol^{-1} K^{-1}
Mass of an electron	9.11×10^{-31} Kg	62.364 L mmHg mol^{-1} K^{-1}
1 electron volt	1.602×10^{-19} J	
1 Joule, J	1 J = 1 kg. m^2. s^{-2}	
1 Faraday, F	96485 C mol^{-1}	
1 Volt, V	1 J C^{-1}	
Pressure 1 atm = 1.01325×10^5 Pa = 1.01325×10^5 N m^{-2} = 760 torr = 760 mmHg = 1.01325 bar 1 bar = 1.00000×10^5 Pa = 1.00000×10^5 N m^{-2}		**STP:** Temperature 273.15 K Pressure 1.00 atm

SECTION	A	B	C	TOTAL
MARKS				

SECTION A (MULTIPLE CHOICE QUESTIONS)

Answer ALL questions on the answer grid provided. Each question carries 2 marks.

A 1. Which of the following has two (2) significant numbers?

[A] 12.08 **[B]** 0.0018 **[C]** 8.001 **[D]** 20.

A 2. A hydrocarbon with an empirical formula of CH_2, has a molecular weight of 98.2 amu. What is the true molecular formula for the compound?

[A] CH_2 **[B]** C_7H_{14} **[C]** C_8H_2 **[D]** C_3H_6

A 3. Identify which of the following statements is incorrect

[A] One mole of water contains 6.022×10^{23} H_2O molecules.
[B] There are 16.0 g in 1.00 moles of O_2
[C] 12.0 grams of Carbon have the same number of atoms as 14.0 grams of Nitrogen.
[D] 28.0 grams of N_2 have the same number of molecules as 32.0 grams of O_2

A 4. How many moles of $FeCl_3$ are present in 2.4 M of $FeCl_3$ solution in a volume of 1.00 L?

A] 2.92 mol **[B]** 1.82 mol **[C]** 3.92 mol **[D]** 2.4 mol

A 5. If the sample of nitrogen occupies 1.75 L at STP. How many moles of nitrogen are present?

[A] 7.81 **[B]** 7.82×10^2 **[C]** 7.81×10^{-2} **[D]** 781

A 6. Nitrogen gas has occupied a volume of 500ml at a pressure of 0.971atm. What volume will the gas fill at a pressure of 1.50 atm, assuming the temperature remains constant?

[A] 342 mL **[B]** 424 mL **[C]** 324 mL **[D]** 442 mL

A 7. As the volume of a confined gas decreases at constant temperature, the pressure exerted by the gas:

[A] Decreases **[B]** Increases **[C]** Stay the same **[D]** Fluctuates

A 8. At constant pressure and 25 °C, a sample of gas occupies 4.5 L. At what temperature will the gas occupy 9.0 L?

[A] 596 K **[B]** 50 K **[C]** 50 °C **[D]** 596 °C

A 9. A microwave oven emits radiation at a wavelength of 0.500 cm. What is the frequency of this radiation?

[A] $1.67 \times 10^{-11}\ s^{-1}$ **[B]** $1.67 \times 10^{-7}\ s^{-1}$ **[C]** $6.00 \times 10^{-10}\ s^{-1}$ **[D]** $2.00\ s^{-1}$

A 10. Which is the electronic configuration for the S^{2-} ion?

[A] $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$ **[B]** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$
[C] $1s^2\ 2s^2\ 2p^6\ 3p^6$ **[D]** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

A 11. Red, green, yellow and orange are part of visible light in electromagnetic spectrum. Which of the following is the correct order of increasing wavelength.

[A] green, yellow, orange and red　　**[B]** red, orange, yellow and green

[C] orange, red, yellow and green　　**[D]** yellow, green , orange and red

A 12. Decrease in force of attraction between valence electrons and the nucleus by inner electrons is called:

[A] dopler effect　　**[B]** shielding effect　　**[C]** photoelectric effect　　**[D]** none of the above

A 13. Which of the following substances has a net dipole moment?

[A] Water　　**[B]** Methane　　**[C]** Carbon dioxide　　**[D]** Nitrogen

A 14. Based on the electronegativity of atoms (N is 3.0, Br is 2.8, Cl is 2.9, H is 2.1 and Si is 1.8). Which of these bonds N-N, Cl-Br and H-Si is/are non-polar?

[A] N-N　　**[B]** Cl-Br　　**[C]** Only H-Si　　**[D]** All of above

A 15. Which of the following molecules have trigonal planar geometry?

[A] BF_3　　**[B]** NH_3　　**[C]** PCl_3　　**[D]** IF_3

A 16. A set of Lewis structures that describes the delocalization of electrons in a polyatomic ion or molecule is called:

[A] A dipole　　**[B]** A lone pair　　**[C]** Resonance　　**[D]** Electron affinity

A 17. What is the direction of flow of electrons in an electrolytic cell?

[A] Anode to cathode externally　　**[B]** Anode to cathode internally
[C] Cathode to anode externally　　**[D]** Cathode to the anode in the solution

A 18. What is the oxidation state of carbon in C_2H_6?

[A] 3　　**[B]** -2　　**[C]** -3　　**[D]** 4

A 19. What is the standard cell potential for the cell:

$$Zn / Zn^{2+} (1M) \| Cu^{2+} (1M) / Cu$$

$$E^\circ \text{ for } Zn / Zn^{2+} (1M) = -0.76\ V \ \&\ Cu^{2+} / Cu = +0.34\ V$$

[A] -1.10 V　　**[B]** $+0.42$ V　　**[C]** -0.42 V　　**[D]** $+1.10$ V

A 20. An electrolytic cell that is comprised of two half cells with the same electrodes but different concentrations is:

[A] A galvanic cell　　**[B]** A concentration cell
[C] Based on Nernst equation cell　　**[D]** Electrochemical cell

[TOTAL: 40 MARKS]

SECTION B (SHORT FINAL ANSWER QUESTIONS)

Answer ALL questions. Each question carries 2 marks.

B 1. A group N student synthesized a greenish yellow gaseous compound of chlorine and oxygen and discovered that its density is 7.50 g/L at 36 °C and 2.88 atm. Find the molecular mass of the compound.

Ans:____

B 2. What mass of sodium azide is required to pump an airbag to 65.0 L at STP?

$2NaN_3 (s) \rightarrow 2 Na (s) + 3 N_2 (g)$

Ans:____

B 3. Iridium has a relative atomic mass of 192.22 and consists of Ir-191 and Ir-193 isotopes. Calculate the percentage composition of a naturally occurring sample of iridium.

Ans:____

B 4. Assign the correct oxidation number of Mn in MnO_2

Ans:____

B 5. What is the formal charge of carbon in [:C≡N:]?

Ans:____

B 6. Name the shape of the molecule PH_3.

Ans:____

B 7. Which one of these bonds (C-O, C-Br, C-F) is most polar?

Ans:____

B 8. What is the concentration of an electrolyte in a galvanic cell operating under standards conditions?

Ans:____

B 9. Calculate the galvanic cell potential constructed from the two half reactions:

$Ag^+(aq) + e^- \rightarrow Ag(s)$ +0.80V

$Mg^{2+} + 2e^- \rightarrow Mg(s)$ -2.37V

Ans:____

B 10. An electrochemical cell that converts chemical energy of spontaneous redox reactions into electrical energy is:

Ans:____

SECTION B TOTAL MARKS = 20 MARKS

SECTION C (SHORT ANSWER QUESTIONS)

Answer ALL questions. Each question carries 5 marks.

C 1. An organic acid H_2Y of concentration 0.110 mol/dm^3 and volume 25.0 cm^3 was used to titrate with NaOH solution of concentration 0.235 mol/dm^3 using phenolphthalein indicator.

The equation for the reaction is: $H_2Y\ (aq) + 2NaOH\ (aq) \rightarrow Na_2Y\ (aq) + 2H_2O\ (l)$

(i) State the colour change for the phenolphthalein indicator [1]

From----------------------to--------------------

(ii) State why we discard the first titre value when calculating the mean titre? [1]

Ans:

(iii) Calculate the number of moles of acid in 25.0 cm^3 of 0.110 mol/dm^3 solution. [2]

Ans:

(iv) Given that the mean titre was 23.40 cm^3, calculate the number of moles of NaOH [2]

Ans:

(v) Calculate the number of moles NaOH that reacts with 1 mol of the organic acid. [2]

Ans:

(vi) Describe two things you would do when using a burette to ensure that the **titre values are as accurate** as possible. [2]

C 2. Calculate the root-mean square velocity of helium gas at 25 °C. [5]

Ans:

C 3. An excited hydrogen atom emits light with a wavelength of 397.2 nm to reach the energy level for which n =2. In which principal quantum level did the electron begin? **[5]**

Ans

C 4. A 1.50 g sample of hydrocarbon undergoes complete combustion to produce 4.40 g of CO_2 and 2.70 g of H_2O. What is the empirical formula of this compound? [5]

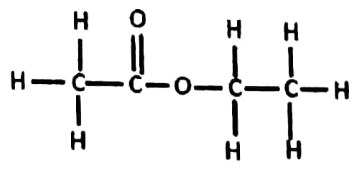
Ans:

C 5. Draw Lewis structures for:

a. SF_4 [2]

b. NO_3^- [3]

C 6. Ethyl acetate, $C_4H_8O_2$, is shown below.



a. **What is the hybridization at each of the carbon atoms in this molecule?** [4]

Ans:

C1:______ C2:______ C3:______ C4:______

b. How many σ are there in the molecule? [1]

Ans:

C 7. A voltaic cell consists of gold and nickel half cells as shown below

$Au^{3+}(aq) + 3e^- \rightarrow Au(s)$ $E^o = +1.50$ V
$Ni^+(aq) + 2e^- \rightarrow Ni(s)$ $E^o = -0.257$ V

a. Write the line notation [1]
Ans:

b. Write the balanced cell reactions [2]
Ans:

c. Calculate the standard cell potential [2]
Ans:

[TOTAL: 40 MARKS]

END OF TEST

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
hydrogen 1 **H** 1.00794																	helium 2 **He** 4.002602
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.012182							**key**	element name atomic number **symbol** atomic mass			boron 5 **B** 10.811	carbon 6 **C** 12.0107	nitrogen 7 **N** 14.00674	oxygen 8 **O** 15.9994	fluorine 9 **F** 18.9984	neon 10 **Ne** 20.1797
sodium 11 **Na** 22.98977	magnesium 12 **Mg** 24.3050											aluminium 13 **Al** 26.981538	silicon 14 **Si** 28.0855	phosphorus 15 **P** 30.97376	sulphur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.984
potassium 19 **K** 39.0983	calcium 20 **Ca** 40.078	scandium 21 **Sc** 44.95591	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.9415	chromium 24 **Cr** 51.9961	manganese 25 **Mn** 54.93805	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.9332	nickel 28 **Ni** 58.6934	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.409	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.64	arsenic 33 **As** 74.9216	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.798
rubidium 37 **Rb** 85.4678	strontium 38 **Sr** 87.62	yttrium 39 **Y** 88.90585	zirconium 40 **Zr** 91.225	niobium 41 **Nb** 92.90638	molybdenum 42 **Mo** 95.94	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.9055	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.8682	cadmium 48 **Cd** 112.411	indium 49 **In** 114.818	tin 50 **Sn** 118.710	antimony 51 **Sb** 121.760	tellurium 52 **Te** 127.60	iodine 53 **I** 126.9045	xenon 54 **Xe** 131.293
caesium 55 **Cs** 132.90545	barium 56 **Ba** 137.327	lutetium 71 **Lu** 174.967	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.9479	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.207	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.217	platinum 78 **Pt** 195.078	gold 79 **Au** 196.96655	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.3833	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.980	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [261]	dubnium 105 **Db** [262]	seaborgium 106 **Sg** [266]	bohrium 107 **Bh** [264]	hassium 108 **Hs** [269]	meitnerium 109 **Mt** [268]	darmstadtium 110 **Ds** [271]	roentgenium 111 **Rg** [272]	ununbium 112 **Uub** [285]		ununquadium 114 **Uuq** [289]				

lanthanum 57 **La** 138.9055	cerium 58 **Ce** 140.116	praseodymium 59 **Pr** 140.90765	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.964	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.9253	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.930	erbium 68 **Er** 167.259	thulium 69 **Tm** 168.934	ytterbium 70 **Yb** 173.04
actinium 89 **Ac** [227]	thorium 90 **Th** 232.038	protactinium 91 **Pa** 231.0359	uranium 92 **U** 238.0289	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]