ELIZADE UNIVERSITY, ILARA – MOKIN, ONDO STATE, NIGERIA
DEPARTMENT: PHYSICAL AND CHEMICAL SCIENCES
FIRST SEMESTER EXAMINATIONS: 2020/2021 ACADEMIC SESSION
COURSE CODE: CHM 205 COURSE TITLE: STRUCTURE AND BONDING
HOD's SIGNATURE

TABLE OF CONSTANTS:

Speed of light c, 2.997 x10^{8}m/s — *Elementary charge e, 1.602 x10^{-19}C*
Faraday constant F, 96500C/mol — *Boltzmann constant k, 1.38 x10^{-23}J/K*
Gas constant R, 8.314JK^{-1}mol^{-1} — *Gas constant R, 8.314 x 10^{-2} L.bar K^{-1}mol^{-1}*
Planck's constant h, 6.626 x 10^{-34} Js — *Avogadro's constant N_a, 6.0228 x10^{23}mol^{-1}*
Mass of proton, 1.672 x10^{-27}kg — Mass of neutron, 1.674 x10^{-27}kg
Mass of electron, 9.109 x10^{-31}kg — Atomic mass unit u, 1.661 x10^{-27}kg

DURATION: 2HOURS
INSTRUCTIONS:

1. ***SECTION A: ATTEMPT TWO QUESTIONS***
2. ***SECTION B: ATTEMPT TWO QUESTIONS***

SECTION A

1.

a. Explain why the N – O bond length decreases for the following species in the order NO_2^- > NO_2 > NO_2^+. Arrange these species in order of increasing bond strength and bond energy. Justify your answer.

b. Discuss the principle and application of X – ray diffraction method for determining bond length and bond angles of molecules

2.

c. Draw the structures and state at least two applications of the following compounds

- **i.** Hexachlorophosphazene $(Cl_2PN)_3$
- **ii.** Trisodium trimetaphosphate $(Na_3P_3O_9)$
- **iii.** Borazine $(H_3N_3B_3)$
- **iv.** Dichlorine heptoxide (Cl_2O_7)

d. Define the following terms:

- **i.** Bond order
- **ii.** Bond energy
- **iii.** Van der Waal's radius
- **iv.** Covalent radius

e. State the importance of the van der Waal's radius and the covalent radius?

3.

a. Determine the formal charge on the following molecules

- **i.** NH_4+
- **ii.** PCl_5
- **iii.** $BeCl_2$
- **iv.** BF_4-

b. Complete and balance these chemical equations. State the conditions for the reactions where necessary

i. $B_2O_3 + H_3N \rightarrow$

ii. $HClO_4 + P_4O_{10} \rightarrow$

c. Using the valence bond theory and/ or valence shell electron repulsion theory predict the geometry of the following molecules:

i. XeF_4

ii. PCl_3

iii. SF_4

(Atomic numbers of elements: Xe = 54, F = 9, P = 15, S = 16, Cl = 17)

SECTION B

4.

a. State the postulates of Bohr's theory of the hydrogen atom. **[4 marks]**

b. Derive an expression for the energy of electron in an orbit. **[6 marks]**

c. What is the wavelength of the 5^{th} transition in Balmer series of the hydrogen spectrum ($R=109737\ cm^{-1}$). **[4 marks]**

d. The wavelength of the line in Balmer series that is associated with drop of the electron from an nth orbit is 3.00×10^{-3} cm, calculate the nth value ($R=109737\ cm^{-1}$). **[6 marks]**

5.

a. Derive the Schrodinger's wave equation. **[6 marks]**

b. Calculate the wavelength of an α-particle having mass 6.6×10^{-30} g moving with a speed of 10^5 cm sec^{-1} ($h = 6.6 \times 10^{-34}$ kg m^2 sec) **[5 marks]**

c. What is the de Broglie wavelength of a person with a mass of 50 kg jogging at 5 m/s? **[4 marks]**

d. Calculate the kinetic energy of an electron emitted from a surface a surface of potassium metal (h= h = 6.6×10^{27} erg sec and wave function = 3.62×10^{-34} erg) by light of wavelength 5.5×10^{-8} cm. (c= 3×10^{10} cm sec^{-1}) **[5 marks]**

6.

a. Briefly explain these terms:

i. Pauli Exclusion Principle **[2 marks]**

ii. Wave-Particle Duality **[2 marks]**

iii. Aufbau Principle **[2 marks]**

iv. The Uncertainty Principle **[2 marks]**

v. Molecular Orbital Theory **[2 marks]**

b. Using the VSEPR theory, predict the shapes of the following compounds: SCl_4, H_2O, NH_3, CH_4 and HCHO **[2 marks each]**