CHUKA UNIVERSITY

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE

OF BACHELOR OF SCIENCE IN BIOCHEMISTRY

CHEM 211: PHYSICAL INORGANIC CHEMISTRY

STREAMS: BSC (BIOCHEM) **TIME: 2 HOURS**

DAY/DATE: MONDAY 02/12/2019 **8.30 A.M. – 10.30 A.M.**

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.

h= 6.626 x 10^{-34} Js C= 2.998 X 10^{8} MS-1 m_e=9.109 x 10^{-31} kg e = 1.609 x 10^{-19} C

QUESTION ONE (30 MARKS)

a) Using a suitable diagram explain the ultraviolet catastrophe (4 marks)

b) Calculate the number of photons emitted by a 100 W yellow lamp in 1.0 s. Take the wavelength of yellow light as 560 nm and assume 100 percent efficiency (4 marks)

c) Explain the wave-particle duality (2 marks)

d) Define and write the mathematical expression of the Heisenberg Uncertainty Principle (3 marks)

e) Give four properties of the acceptable solutions to the Schrödinger wave equation (2 marks)

f) i) Briefly explain the octet rule (2 marks)

ii) Give two exceptions to the octet rule (2 marks)

g) Differentiate between sigma and pi bonds (1 mark)

h) Using the Molecular Orbital theory explain with reasons why the following molecules exist (4 marks)

i) He_2^+ molecule

ii) He_2 molecule

i) Explain briefly two Fajans rules (4 marks)

j) Draw the graphical representation of a particle in a box, with a particle mass m and confined between two walls at x= 0 and x = l (2 marks)

QUESTION TWO (20 MARKS)

a) Discuss two experiments that showed the failures of classical physics (6 marks)

b) i) Define the photoelectric effect (1 mark)

ii) Give three experimental characteristics of the photoelectric effect (3 marks)

c) Estimate the wavelength of electrons that has been accelerated from rest through a potential difference of 40 KV (4 marks)

d) For a standing wave of wavelength λ, whose amplitude at any point along x may be described by a function f(x), it can be shown that

$$\frac{d^2f(x)}{dx^2} = -\frac{4\pi^2}{\lambda_2} f(x)$$

Using this equation and any other equations derive the Schrödinger equation (6 marks)

$$\nabla^2\psi + \frac{8\pi^2 m}{h^2}(E - V)\psi = 0$$

QUESTION THREE (20 MARKS)

a) Write down the three rules to be considered for the Linear Combination of Atomic Orbitals (3 marks)

b) Using the Molecular Orbital theory predict the bond order and the number of unpaired electrons in O_2,O^{2-} and $O2^{2-}$ (9 marks)

c) Write the term symbols from the ground state configuration of i) Na ii) F (4 marks)

d) Using the valence shell electron pair repulsion theory predict the structure of the following: (4 marks)

BF_3 ii) NH_3 iii) H_2O iv) PCl_5

QUESTION FOUR (20 MARKS)

a) Using the valence band theory explain the difference between a conductor, insulator and semiconductor (6 marks)

b) Using the linear combination of molecular orbitals (LCAO) method, discuss using suitable drawings the combination of :

i) S-S combination of orbital

ii) S-P combination of orbitals (6 marks)

c) Explain the following terms briefly

i) Electron affinity

ii) Hunds rule

iii) Pauli exclusion principle (3 marks)

d) i) Define hybridization of atomic orbitals (1 mark)

(ii) Discuss the hybridization of BF_3 molecule (4 marks)
