

CHUKA



UNIVERSITY

## UNIVERSITY EXAMINATIONS

**EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE IN  
CHEM 211: PHYSICAL INORGANIC CHEMISTRY**

STREAMS:

TIME: 2 HOURS

**DAY/DATE: TUESDAY 30/03/2021****8.30 A.M – 10.30 A.M**

## INSTRUCTIONS:

Answer **QUESTION ONE** and any **OTHER TWO** questions.

**QUESTION ONE (30 MARKS)**

- a) Briefly discuss the two basic principles of classical mechanics (3marks)
- b) Explain the following terms i) Black body (2mks) ii) Quantization of energy (2marks)
- c) Calculate the number of photons emitted by a 200 W yellow lamp in 2.0 seconds. Take the wavelength of yellow light as 560 nm and assume 100 percent efficiency ( $h = 6.626 \times 10^{-34}$  JS,  $C = 2.998 \times 10^8$  ms<sup>-1</sup>) (4marks)
- d) Give three properties of the acceptable solutions to the Schrödinger wave equation (3marks)
- e) Define the Heisenberg Uncertainty Principle and give its mathematical expression (3marks)
- f) Draw the particle in a dimensional box and comment on the potential energy (4marks)
- g) i) Define the octet rule (1 mark)  
ii) Briefly discuss two exceptions to the octet rule (4marks)
- h) i) Define hybridization (1mark)  
ii) Draw the hybridization of boron trifluoride (BF<sub>3</sub>) molecule and predict its shape of the molecule (4marks)

**QUESTION 2 (20 MARKS)**

- a) Discuss the photoelectric effect and give three experimental characteristics of the photoelectric effect. (4marks)
- b) For a standing wave, such as a vibrating string of wavelength ( $\lambda$ ), 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 the equation above, derive the Schrödinger wave equation (5marks)

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

- c) Briefly discuss the Valence Shell Electron Pair Repulsion Theory (VSEPR) (4marks)
- d) Using a suitable diagram differentiate between sigma and pi bonds (2marks)
- e) Using the molecular orbital theory draw the atomic and molecular orbitals of  $\text{He}_2^+$  molecule and comment on whether it exists (5marks)

**QUESTION 3 (20 MARKS)**

- a) Explain the Born interpretation of the square of the wave function  $\psi^2$  (2marks)
- b) Show that  $e^{ax}$  is an eigen function of the operator  $d/dx$  and find the corresponding eigen value. (3marks)
- c) Briefly discuss three Fajans rules (6marks)
- d) Explain three rules for linear combination of atomic orbitals (3marks)
- e) Using the molecular orbital theory, draw the energy level diagram of the atomic and molecular orbitals for  $\text{O}_2^-$  ion and calculate the bond order (6marks)

**QUESTION 4 (20 MARKS)**

- a) Using diagrams, differentiate between conductors, insulators and semiconductors using the Band Gap Theory (6marks)
- b) Briefly explain the following terms (5marks)
- i) Electron affinity
  - ii) Aufbau principle
  - iii) Hunds rule
  - iv) Node
  - v) Zero point energy
- c) I) Write the Rayleigh-Jeans law and define the terms (2marks)
- ii) Explain why the Rayleigh-Jeans law failed in explaining black body radiation (3marks)
- d) Explain the concept of wave function duality (2marks)
- e) Write the term symbol arising from the ground-state configurations of Na (2marks)
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