

**NATIONAL OPEN UNVERSITY OF NIGERIA**

PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA

**FACULTY OF SCIENCES**

**DEPARTMENT OF PURE & APPLIED SCIENCES**

 **2019\_1 EXAMINATION QUESTIONS**

**CHM 307 ATOMIC AND MOLECULAR STRUCTURE AND SYMMETRY (3 UNITS)**

**INSTRUCTIONS: ANSWER QUESTION 1 AND ANY FOUR QUESTIONS**

**TIME ALLOWED 2 ½ HOURS**

**QUESTION 1**

(ii) State the Pauli’s exclusion principle **(3 marks)**

(ii) Write short note on the following:

1. principles of quantum number **(2 marks)**
2. magnetic quantum number. **(2 marks)**

(iii) Write short note on the effect of vibration on rotation spectroscopy. **(2 marks)**

(b)

(i) Write short notes on the following:

 1. spin-spin coupling. **(2 marks)**

 1. orbit-orbit coupling. **(2 marks)**

 3. JJ coupling. **(2 marks)**

(ii) Discuss two postulates of quantum mechanics. **(4 marks)**

(iii) What is a center atom? **(3 marks)**

**QUESTION2**

1. Use the VSEPR theory to deduce the bond angle of the following:
2. H-C-C bond angle**=.(1 mark)**
3. H-C=C bond angle=. (**1 mark)**
4. C=C=C bond angle=. **(1 mark)**
5. H-N-C bond angle=. **(1 mark)**
6. C-O-H bond angle=. **(1 mark)**

(ii) Calculate wave length of 100 ev electron. **(5 marks)**

(iii) Draw the diagram of energy levels (molecular orbital) in a hydrogen molecule. **(2 marks)**

**QUESTION 3**

1. An electron travels with the speed of 3x106 m s-1.What is the minimum uncertainty in its momentum if we assume that its position is measured within 10 % of its atomic radius. Do the same calculation for a 0.03kg ball travelling at a speed of 25 m s-1. Assume that the uncertainty in position of the ball is equal to the wavelength light of 600 nm. **(6 marks)**
2. Give the Schrodinga wave equation for 3 dimentional (3D) box**. (1 mark)**

(ii) What are the requirements and principles of rotational spectrum? **(5 marks)**

**QUESTION 4**

1. Using the algebra vector, discuss the vector analogy of a resonance**. (4 marks)**

(ii) highlight on the applications of valence bond theory. **(3 marks)**

1. Mention four classes of molecules base on their rotational behavior. **(4 marks)**

(ii) Write an expression for orthogonal wave function. **(1 mark)**

**QUESTION 5**

1. Give comparative details of valence bond theory and molecular orbital theory**. (4 marks)**

(ii) Describe the properties of molecular orbitals. **(2 marks)**

1. Write short note on heat capacity. **(2 mark)**

(ii) Derive an expression for following thermodynamics variables:

1. Heat capacity at constant volume Cv **(2 marks)**
2. Heat capacity at constant volume Cp. **(2 marks)**

**QUESTION 6**

1. Write short note on resonance energy of benzene. **(3 marks)**

(ii) Give the resonance structures of the following:

1. Ozone. **(1 mark)**
2. Alkyl cation. **(1 mark)**
3. Give the equation for dimensionless heat capacity of a material and what do those materials stand for? **(4 marks)**

(ii) What is molecular orbital? **(3 marks)**