

BOWEN UNIVERSITY, IWO, OSUN STATE
COLLEGE OF AGRICULTURE, ENGINEERING AND SCIENCE
INDUSTRIAL CHEMISTRY PROGRAMME
2022/2023 SESSION B.SC. DEGREE FIRST SEMESTER EXAMINATION

Course Code: CHM 219

Course Title: Structure and bonding of molecule

Date: Monday, 13/02/2023

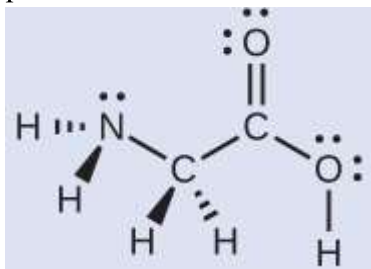
Course Credit: 2

Time Allowed: 2 hrs

INSTRUCTIONS: (a) Answer each main question on a fresh page in your booklet
(b) Answer ALL questions in SECTION A and ONE question each from SECTIONS B & C

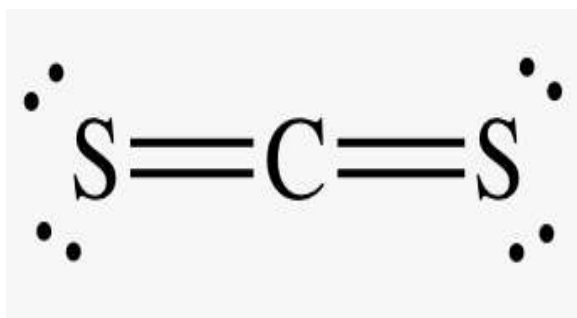
SECTION A (30 marks)

1. Electrons in a molecule occupy _____ orbital.
2. _____ theory assumes that electrons occupy atomic orbitals of individual atoms within a molecule, and that the electrons of one atom are attracted to the nucleus of another atom.
3. The three p orbitals are oriented _____ to each other.
4. The degeneracy of p orbital remains _____ in presence of external field.
5. The electron density in the area between two bonding atoms _____ as a result of overlapping, thereby increases the stability of the resulting molecule.
6. The electrons in the valence shell of a central atom form either _____ pairs or lone pairs of electrons.
7. VSEPR theory predicts the _____ of electron pairs around each central atom and, usually, the correct arrangement of atoms in a molecule.
8. The order of _____ determines the amount of space occupied by different regions of electrons.
9. In trigonal bipyramidal electron-pair geometry, lone pairs always occupy _____ positions.



10. In the figure above, the electron pair geometries of the carbonyl carbon is _____.
11. Electrons in a molecule occupy molecular orbitals rather than atomic orbitals. True/False?
12. The pattern in which the atomic orbitals overlap in sigma and pi bonds differ. True/False?
13. In VBT, when two atoms get closer than the optimal distance, the _____ between the two nuclei becomes predominant.
14. A sigma bond can also be formed through the overlap of two p orbitals. True/False?

15. The energy level of s orbital decreases as we move away from the nucleus. True/False?
16. Group I elements are also known as _____ metals.
17. Group I metals possess a _____ crystal structure.
18. Group I elements react with non-metals to form _____ compounds.
19. The chlorides of group I elements dissolved in water to form a _____ solution.
20. The nitrates of groups I and II elements decomposed to give metal oxide, _____ and oxygen.
21. Group II metal oxides become more _____ as you go down the group.
22. The boron family has oxidation states of +3 and +1 in which the +3 oxidation states are favourable except for thallium which prefers +1 oxidation state due to its stability. This tendency is known as _____.
23. The _____ state of compounds of tin and lead are regarded as ionic.
24. Crystal structure of β -tin is _____.
25. The oxides of germanium, tin and lead are _____ in nature.
26. _____ is used as a photon detector in various infrared detectors.
27. AlCl_3 and BCl_3 are widely used as catalyst because they act as _____ acids.
28. The expected simplest boron hydride, BH_3 , exists in its dimer as _____.
29. The structure of the elements in group IV change from _____ in carbon and silicon to giant metallic lattices in tin and lead.
30. The structure below represents a _____



SECTION B

Question 1

- (a) Define degenerate orbitals and give examples. **3 marks**
- (b) Calculate the degeneracy of the level of the hydrogen atom having energy $-\text{RH} / 16$. **5 marks**
- (c) Identify the quantum numbers in $4d^5$ electron. **5 marks**
- (d) What are the assigned designations for the seven f-orbitals? **7marks**

Question 2

- (a) Differentiate between electron pair geometries and molecular structures. **4 marks**
- (b) Copy and complete the following table. **16 marks**

Ions	Lewis structure	Molecular Structure	Bond angle	Molecular name
CO_3^{2-}				
ICl_2^+				
H_3O^+				
ICl_4^-				

SECTION C

Question 3

(a) Comment briefly on the general periodic trend of groups I and II in relation to

- (i) first ionization energy (ii) atomic radius

3 marks

(b) Discuss briefly, with equations where necessary, the effect of heat and the solubility in water of the carbonates and hydrogencarbonates of group I and group II elements.

7 marks

(c) Boron and aluminium belong to group III elements, and when they react with chlorine separately, they form the chloride of the elements.

- (i) Write the reactions for the formation of each compounds

3 marks

- (ii) Describe the structure and bonding of each compounds

7 marks

Question 4

(a) Briefly discuss the structure and bonding of the following compounds of group 14 elements:

- (i) CO

2^{1/2} marks

- (ii) CO₂

2^{1/2} marks

- (iii) SiO₂

2^{1/2} marks

- (iv) SiH₄

2^{1/2} marks

(b) Enumerate the main groups /representative elements of the periodic table.

4 marks

(c) Give one example of the element and write their respective corresponding electronic configuration in each of the following classifications:

- (i) Pnictogens

1^{1/2} marks

- (ii) alkaline-earth metals

1^{1/2} marks

- (iii) chalcogens

1^{1/2} marks

- (iv) halogens

1^{1/2} marks