

Total No. of printed pages = 7

3 (Sem 3) CHM M2

2015

CHEMISTRY

(Major)

Paper : 3:2.

(Chemical Bonding)

Full Marks = 60

Time - Three hours

The figures in the margin indicate full marks for the questions:

1. Write short answer : 1×7=7

(a) The shape of XeF_4 molecule is _____.

Fill up the blank.

(b) Which of the following molecules has M-H bonds of two different categories ?

(i) B_2H_6 , M is B

(ii) C_6H_6 , M is C

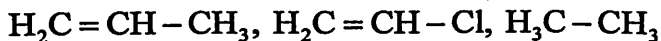
(iii) H_2O , M is O

(iv) BeH_2 , M is Be.

Choose the correct option.

[Turn over

(c) Which of the following species does not exhibit delocalisation of electrons ?



(d) Photons can initiate a good number of chemical reactions. – Give reasons.

(e) 'X' is a sub-division of a crystal that, when stacked together without rotation or reflection, reproduces the crystal. – What is 'X' ?

(f) Mention the type of crystal system found in – Diamond, Graphite.

(g) In a crystal, a plane makes intercepts in the three axes such that $x':y':z' = 2a:b:2c$. What will be the Miller indices of the plane ?

2. Answer *all* questions : 2×4=8

(a) Write the postulates of VSEPR theory.

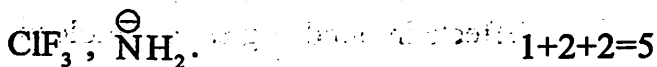
(b) Explain why bond angles in PCl_5 are of two different types.

(c) Write the wave function for a single electron moving in the field of two nuclei A and B. Explain the meaning of the terms involved.

- (d) In a close packed solid composed of spheres of radius r , an octahedral hole is formed. What will be the maximum radius of the sphere that may be accommodated in the said hole ?

3. Answer any *three* questions : $5 \times 3 = 15$

- (a) How is the shape of a molecule explained ? Mention the conditions which impart regular geometry to covalent molecules. Find out the shape of the following entities :-



- (b) Compare the following pairs of molecules with respect to the parameters cited within parenthesis.

(i) CO_2 and H_2O (Hybridisation of central atom).

(ii) $\text{H}_2\text{C} = \text{CH}_2$ and $\text{HC} \equiv \text{CH}$ (C-H bond length).

(iii) NH_3 and $\overset{\oplus}{\text{N}}\text{H}_4$ (shape).

(iv) cis-1, 2 -Dichloroethene and trans-1, 2 -Dichloroethene (Dipole moment).

(v) OF_2 and Cl_2O (Bond angle). $1 \times 5 = 5$

- (c) Justify the following statement giving suitable examples :

'A polyatomic molecule may be non-polar inspite of having polar bonds'.

Explain why dipole moment of NH_3 is higher than that of NF_3 . $3+2=5$

- (d) What are meant by steric effect and electronic effects in bond angles of a molecule ? Which effect will be predominant for $\text{CH}_3\text{-C-CH}_3$ bond angle in $\text{H}_3\text{C} = \text{C}(\text{CH}_3)_2$? $2+3=5$

4. Answer any *three* questions : $5 \times 3 = 15$

- (a) Draw molecular orbital diagram for N_2 molecule. Calculate the bond order.

Explain why NO^+ is more stable than NO but CO^+ is less stable than CO . $3+2=5$

- (b) What is meant by aromaticity ? Discuss the structural features of aromatic compounds.

Draw orbital picture of benzene. $1+3+1=5$

(c) Define –

(i) Resonance

(ii) Delocalised electrons.

State the differences between resonance and delocalisation.

The length of oxygen-oxygen bond in ozone is 128 pm, whereas oxygen-oxygen single and double bond lengths are 141 pm and 120 pm respectively. – Explain. $2+1\frac{1}{2}+1\frac{1}{2}=5$

(d) Describe Band theory of metallic bonding. What is an n-type semiconductor? – Support your answer with suitable diagram. $3+2=5$

5. Answer any *three* questions : $5 \times 3 = 15$

(a) (i) Define Radius ratio. State how radius ratio is helpful in predicting coordination number of ions. $1+2=3$

(ii) What are Perovskites? Draw the structure of Perovskites. $1+1=2$

(b) Define Lattice energy. How is it important to predict the solubility of an ionic crystal in a liquid?

Calculate the enthalpy of formation of NaCl(s) from the following data :

Na(s) is converted to Na(g) and then to Na⁺(g) by supplying 109 kJ mol⁻¹ and 501 kJ mol⁻¹ of energy respectively. Similarly Cl₂(g) is first dissociated to Cl(g) and then converted to Cl⁻(g) when 239 kJ mol⁻¹ of energy is supplied and 355 kJ mol⁻¹ of energy is released respectively. The energy required to dissociate one mole of NaCl(s) into Na⁺(g) and Cl⁻(g) ions is 790.2 kJ mol⁻¹. 1+1+3=5

- (c) What is polarisation of ions ? Mention the causes of polarisation of ions.

Explain the following observations :

- (i) the mp. of NaCl is higher than that of AlCl₃.
- (ii) liquid CaI₂ is obtained at 848 K whereas liquid CaBr₂ is obtained at 1003 K.
- (iii) Ag⁺ and K⁺ have same charge and same size, but there is a difference of 321 K temperature in their melting points.

2+3=5

(d) What is Hydrogen bonding ? Which of the following species will possess intermolecular Hydrogen bonding ?

CH_3OH , NH_3 , HCl , HF , PH_3 , H_2S , H_2O

Explain why p-nitrophenol has higher boiling point than o-nitrophenol. 1+2+2=5