

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  $\text{XeF}_4$  molecule is square planar  
Fill up the blank.

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

(i)  $\text{B}_2\text{H}_6$  , M is B

(ii)  $\text{C}_6\text{H}_6$  , M is C

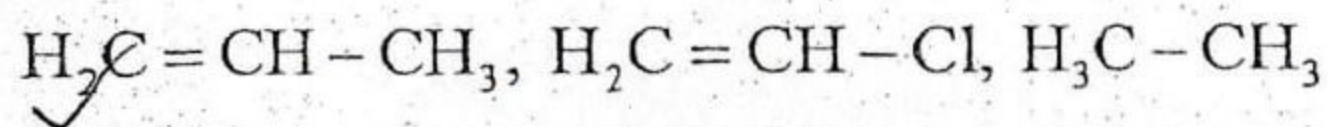
(iii)  $\text{H}_2\text{O}$  , M is O

(iv)  $\text{BeH}_2$  , M is Be

Choose the correct option.

[Turn over

(g) 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.

*Octahedral CCP hexagonal*

(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 :

(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.

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*2, 1, 2*

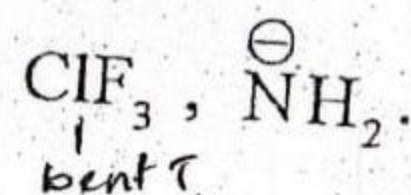
*1/2, 1, 1/2*

(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? VSEPR. Mention the conditions which impart regular geometry to covalent molecules. Find out the shape of the following entities -



$1+2+2=5$

(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)  $H_2C=CH_2$  and  $HC \equiv CH$  (C-H bond length).

(iii)  $NH_3$  and  $NH_4^+$  (shape).

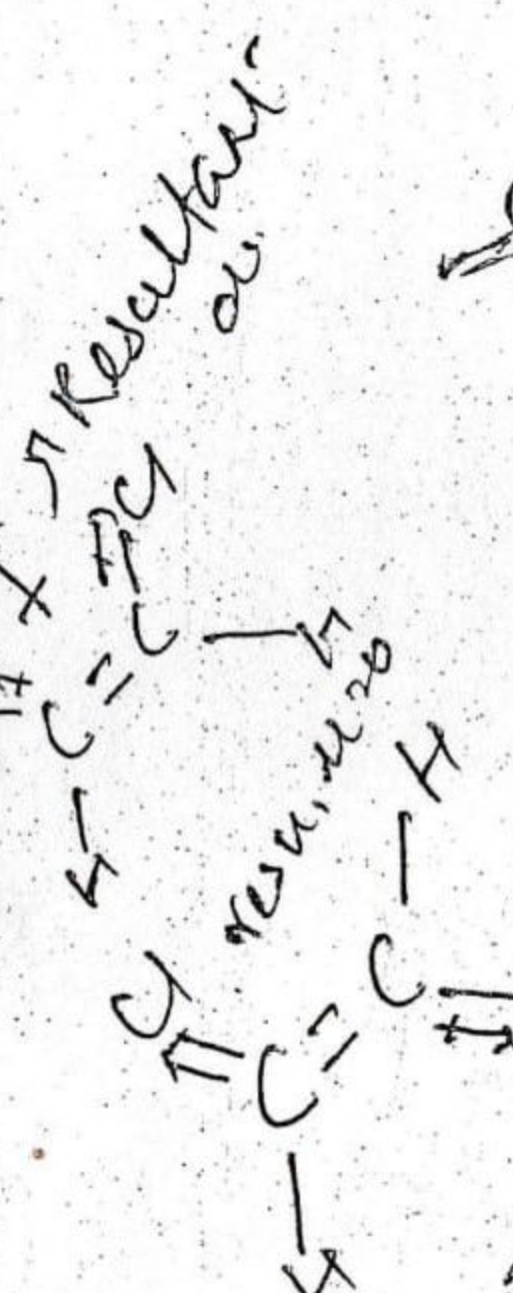
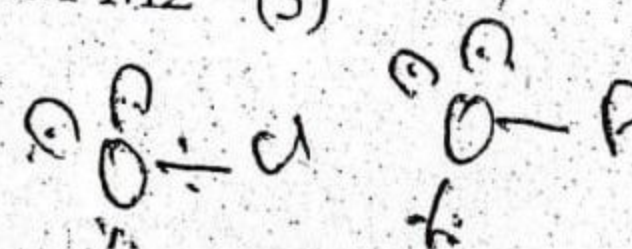
(iv) cis-1, 2-Dichloroethene and trans-1, 2-Dichloroethene (Dipole moment).

(v)  $OF_2$  and  $Cl_2O$  (Bond angle).

$1 \times 5 = 5$

19A/3 (Sem 3) CHM M2 (3)

[Turn over



(c) Justify the following statement giving suitable examples :

N.B.  $\text{BF}_3$   
'A polyatomic molecule may be non-polar inspite of having polar bonds'.

Explain why dipole moment of  $\text{NH}_3$  is higher than that of  $\text{NF}_3$ .  $3+2=5$

(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  $\text{H}_3\text{C} \equiv \text{C}(\text{CH}_3)_2$ ?  $2+3=5$

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

(a) Draw molecular orbital diagram for  $\text{N}_2$  molecule. Calculate the bond order.

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

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

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

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(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?

19A/3 (Sem 3) CHM M2 (5)

[Turn over

High dielectric const. less force

$$F = \frac{q_1 q_2}{4\pi \epsilon_0 r^2}$$
$$F \propto \frac{1}{r^2}$$

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

Na(s) is converted to Na(g) and then to Na<sup>+</sup>(g) by supplying 109 kJ mol<sup>-1</sup> and 501 kJ mol<sup>-1</sup> of energy respectively. Similarly Cl<sub>2</sub>(g) is first dissociated to Cl(g) and then converted to Cl<sup>-</sup>(g) when 239 kJ mol<sup>-1</sup> of energy is supplied and 355 kJ mol<sup>-1</sup> of energy is released respectively. The energy required to dissociate one mole of NaCl(s) into Na<sup>+</sup>(g) and Cl<sup>-</sup>(g) ions is 790.2 kJ mol<sup>-1</sup>. 1+1+3=5

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

Explain the following observations :

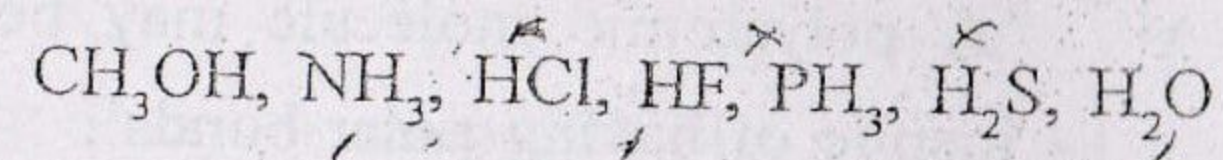
(i) the mp. of NaCl is higher than that of AlCl<sub>3</sub>.

(ii) liquid CaI<sub>2</sub> is obtained at 848 K whereas liquid CaBr<sub>2</sub> is obtained at 1003 K.

(iii) Ag<sup>+</sup> and K<sup>+</sup> 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?



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

~~ΔH<sub>f</sub> = 790.2~~

ΔH<sub>1</sub> = 109 kJ

I = 501 kJ

ΔH<sub>d</sub> = 790.2

~~ΔH<sub>2</sub> = 239 kJ~~

U = 355 kJ

ΔH<sub>f</sub> = 109 + 501 + 1/2 (790.2) - 239 - 355