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3 (Sem-1/CBCS) CHE HC 1

2023

CHEMISTRY

(Honours Core)

Paper : CHE-HC-1016

(Inorganic Chemistry-I)

Full Marks : 60

Time : Three hours

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

1. Answer **all** questions from the following :
1×7=7

(a) An electron is present in the valence shell of Lithium. Write all possible values of n , l , m and s .

(b) Arrange the following in decreasing order of their ionic character

HF , HI , HCl , HBr

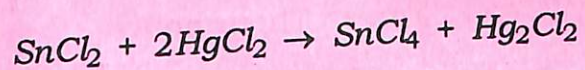
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(c) Choose the correct answer :

Geometry of ClF_3 is

- (i) Tetrahedral
- (ii) Pyramidal
- (iii) Trigonal planar
- (iv) T-shaped

(d) In the reaction



predict the oxidising and reducing agent.

(e) Which of the following molecules are polar?



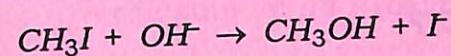
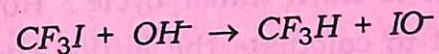
(f) Name the region of electromagnetic spectrum in which Lyman series lie.

(g) Name *two* defects in stoichiometric compounds.

2. Answer **all** questions from the following :

2×4=8

(a) Explain the following reactions in the light of group electronegativity.



(b) What do you mean by well-behaved function?

(c) With the help of VSEPR theory predict the shape of the following molecules



(d) State Heisenberg's uncertainty principle and give the mathematical form of the principle.

3. Answer **any three** questions from the following :

5×3=15

(a) Define electron affinity. Explain the factors on which it depends. Why N has negative electron affinity?

1+3+1=5

(b) Explain disproportionation reaction?
Will Cu^{2+} undergo disproportionation in an aqueous solution? Discuss. 2+3=5

(c) What is Born-Haber cycle? How is it used to calculate the lattice energy of NaCl ? 1+4=5

(d) (i) The dipole moment of HF molecule is 1.91D . Calculate the per cent ionic character in HF . (Bond length of $\text{HF} = 0.92\text{\AA}$) 3

(ii) Explain why NaCl is water soluble but NaI is not. 2

(e) What is polarisation in ionic compounds? Which of the following will exhibit the greater polarising power? Give reason. 2+3=5

(i) K^+ or Ag^+

(ii) K^+ or Li^+

(iii) Ti^{2+} or Ti^{4+}

4. Answer **any three** questions from the following : 10×3=30

(a) (i) What do you mean by de-Broglie wavelength? 1

(ii) Describe the experimental verification of de-Broglie equation. 4

(iii) What are the significance of Heisenberg's Uncertainty Principle? 2

(iv) Calculate the uncertainty in the position of an electron moving with a velocity of 300 ms^{-1} along with an accuracy of 0.001%. 3

(b) (i) Discuss the physical significance of each quantum numbers. $1^{1/2} \times 4 = 6$

(ii) 's-orbital has spherical shape'. Explain the comment on the basis of Angular wave function. 3

(iii) How many quantum numbers are obtained from Schrödinger equation? 1

(c) (i) What do you understand by the terms Bonding and Antibonding molecular orbital? Draw the electron charge density diagram for each. $2+2=4$

(ii) Write the MO electron configuration for the NO^- ion. What is the bond order? Will the bond length be shorter or longer than in NO ? Will the unpaired electrons be concentrated more on the N or O ? Explain. $2+1+1+2=6$

(d) (i) Define atomic and ionic radii. How do atomic radii vary in groups and periods? $2+4=6$

(ii) What are isoelectronic ions? How effective nuclear charge affects the Na^+ , Mg^{2+} , Al^{3+} , F^- , O^{2-} ? Arrange them in increasing order of size. $1+2+1=4$

(e) (i) What do you mean by equivalent hybrid orbital? Give example. $1+1=2$

(ii) What shapes are associated with the molecules involving sp^2 and sp^3d^2 hybridisation? 1

(iii) Explain Bent's rule. 3

(iv) What is radial node? Draw radial wave function of 2s and 3p orbitals. Predict the number of radial nodes for each. $1+2+1=4$

(f) Write about the following :

(i) Band theory 5

(ii) Hydrogen Bond 3

(iii) Normality of a solution 2

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3 (Sem-1/CBCS) CHE HC 2

2023

CHEMISTRY

(Honours Core)

Paper : CHE-HC-1026

(Physical Chemistry-I)

Full Marks : 60

Time : Three hours

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

1. Answer the following as directed : $1 \times 7 = 7$
- (a) Write *one* postulate of kinetic molecular theory of gas.
 - (b) Define most probable velocity of a gas.
 - (c) Explain the term coefficient of viscosity.
 - (d) What is compressibility factor?
 - (e) Define critical temperature.
 - (f) Write the significance of van der Waals constant 'a' and 'b'.
 - (g) How surface tension of liquid varies with temperature?

Contd.

2. Answer the following questions : $2 \times 4 = 8$

(a) Why real gases deviate from ideal behaviour?

(b) Prove that $P_c V_c = \frac{3}{8} RT_c$.

(c) Define mean free path. Does it depend upon the velocity of the molecule?

(d) Explain qualitatively the structure of liquid water.

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

(a) Derive the expression for critical constants in terms of van der Waals constants.

(b) Using the expression for Maxwell distribution of speed. Show that the average kinetic energy of a gas molecule is given by $\frac{3}{2} KT$.

(c) The compressibility factor for hydrogen gas is always greater than 1. Explain. Calculate the root mean square velocity of sulphur dioxide molecule at $427^\circ C$. $2+3=5$

(d) Discuss the impurity defect in crystal with the help of a suitable example. Write *two* points to distinguish between Frenkel defect and Schottky defect. $2+3=5$

(e) Define co-efficient of viscosity.

Write the theory of determination of co-efficient of viscosity of a liquid by Ostwald viscometer method. $2+3=5$

4. Answer **any three** of the following questions : $10 \times 3 = 30$

(a) Define surface tension of a liquid.

What are its units?

How surface tension of a liquid is determined?

What is the effect of temperature on the surface tension of a liquid?

$2+1+5+2=10$

(b) (i) Derive Henderson equation for acid and basic buffer solution. 5

(ii) Calculate the change in pH when 0.05 cm^3 of $1M \text{ NaOH}$ solution is added to one litre of buffer solution containing $0.1M$ acetic acid and $0.1M$ sodium acetate at $300K$.

Given that K_a for acetic acid at $300K$ is 2.0×10^{-5} . 5

(c) Define Collision diameter.

Obtain an expression for bimolecular collision frequency of a pure gas.

Explain how collision diameter of a gas can be calculated from measurement of co-efficient of viscosity of the gas.

$1+5+4=10$

(d) (i) What is meant by ionic product of water? Show that $\text{pH} = \frac{1}{2} \text{p}K_w$ for pure water. If $K_w = 4.0 \times 10^{-14}$ for pure water at 317K, calculate p^{OH} .

$$1+2+2=5$$

(ii) Discuss the buffer action of an aqueous solution of ammonium acetate and a mixture of acetic acid and sodium acetate in water.

5

(e) Define Mean free path of a gas molecule. Does it depend upon the velocity of the molecule? Calculate the Mean free path of O_2 molecule at 25°C and a pressure of 10^{-3}mm Hg , given that the collision diameter is 361pm . Express the effect of temperature and pressure on Mean free path.

$$2+1+4+3=10$$

(f) Define Buffer capacity. Express in Mathematical form. If 0.001 mole of acid is added to 500ml of buffer solution, its pH decreases by 0.01 unit. Calculate the buffer capacity of the buffer solution. How do you know that buffer index is always positive? Write two applications of Buffers in Chemistry and Biology.

$$2+1+3+2+2=10$$