

2019

CHEMISTRY

(Major)

Paper : 3.1

(Structure and Bonding)

Full Marks : 60

Time : 3 hours

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

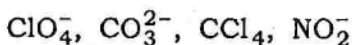
1. Answer the following questions : 1×7=7

- (a) How is average value of a property associated with an operator of a normalized function expressed?
- (b) What is an eigenfunction?
- (c) Write the time independent Schrödinger equation for hydrogen atom.
- (d) What is the average distance of the electron of H atom from its nucleus?
- (e) Calculate the formal charge of P in PH_4^+ ion.

- (f) How does bond multiplicity affect bond length?
- (g) Why is a sigma bond stronger than a pi bond?

2. Answer the following questions : 2×4=8

- (a) Calculate the wavelength for transition of the electron of H atom in 2nd line of Balmer series. ($R_H = 1.1 \times 10^7 \text{ m}^{-1}$)
- (b) Calculate the effective nuclear charge for a 3d electron of cobalt atom.
- (c) Draw the Lewis electron dot structures of the following :



- (d) Give reason why BeF_2 is linear but SF_2 is V-shaped.

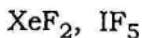
3. Answer any *three* of the following questions :

5×3=15

- (a) What do you mean by bond moment and dipole moment? Give reason why NF_3 is less basic than NH_3 . 1+1+3=5

- (b) Using VSEPR theory, explain the geometry of the following molecules :

$2\frac{1}{2} \times 2 = 5$



- (c) What do you understand by percent ionic character of covalent diatomic molecule? Calculate the percent ionic character of H—F bond. (Dipole moment for HF = 1.92 D, $e = 4.8 \times 10^{-10}$ e.s.u., H—F bond length = 0.92 Å) 2+3=5
- (d) Calculate the de Broglie wavelength of an electron which is accelerated by applying a potential difference of 54 volts. ($h = 6.6 \times 10^{-34}$ J-s, $m = 9.1 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C) 5
- (e) Write a note on aufbau principle. 5
4. Answer the following questions : 10×3=30
- (a) Answer either (i) or (ii) and (iii) :
- (i) What is resonance? What are the essential rules for writing resonating structures? Draw the different resonating structures of CO_3^{2-} ion. 2+5+3=10
- Or
- (ii) Explain Pauling and Mulliken scales of electronegativity. 3+3=6
- (iii) Write the outlines of valence bond approach to bonding in diatomic molecules. 4

(b) Answer either (i) or (ii) and (iii) :

- (i) Show that for a black body radiator the energy density in the region between γ and $\gamma + d\gamma$ is given by

$$E_{\gamma} d\gamma = \frac{8\pi h\gamma^3}{C^3 (e^{h\gamma/kT} - 1)} d\gamma \quad 10$$

Or

- (ii) How was the spinning property of an electron experimentally demonstrated by Stern-Gerlach? Explain. 6
- (iii) From Pauli antisymmetry principle, prove that two electrons having same spin cannot exist in an orbital. 4

(c) Answer either (i) and (ii) or (iii) and (iv) :

- (i) Find the wave function for p_x orbital. 6
- (ii) Draw the radial probability distribution function for 2s, 3p, 4p and 5d orbitals. 4

Or

- (iii) Prove that an s-orbital has no angular dependence. 4
- (iv) Write a note on radial probability distribution function. 6
