

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

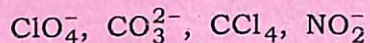
- (a) How is average value of a property associated with an operator of a normalized function expressed?
- (b) What is an eigenfunction?
- (c) Write the time independent Schrödinger equation for hydrogen atom.
- (d) What is the average distance of the electron of H atom from its nucleus?
- (e) Calculate the formal charge of P in  $\text{PH}_4^+$  ion.

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

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

- (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 :



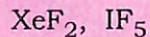
- (d) Give reason why  $\text{BeF}_2$  is linear but  $\text{SF}_2$  is V-shaped.

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

$5 \times 3 = 15$

- (a) What do you mean by bond moment and dipole moment? Give reason why  $\text{NF}_3$  is less basic than  $\text{NH}_3$ .  $1 + 1 + 3 = 5$
- (b) Using VSEPR theory, explain the geometry of the following molecules :

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



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( Continued )

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- (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,  $e = 4.8 \times 10^{-10} \text{ e.s.u.}$ , 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. ( $h = 6.6 \times 10^{-34} \text{ J-s}$ ,  $m = 9.1 \times 10^{-31} \text{ kg}$ ,  $e = 1.6 \times 10^{-19} \text{ C}$ ) 5
- (e) Write a note on aufbau principle. 5

4. Answer the following questions :  $10 \times 3 = 30$

(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  $\text{CO}_3^{2-}$  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

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( Turn Over )

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

- (i) Show that for a black body radiator the energy density in the region between  $\gamma$  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

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