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. ($R_H = 1{\cdot}1 \times 10^7\ m^{-1}$)

(b) Calculate the effective nuclear charge for a 3*d* electron of cobalt atom.

(c) Draw the Lewis electron dot structures of the following :

$$ClO_4^-,\ CO_3^{2-},\ CCl_4,\ NO_2^-$$

(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 : 2½×2=5

$$XeF_2,\ IF_5$$

(Continued)

(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, $e = 4 \cdot 8 \times 10^{-10}$ 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. ($h = 6 \cdot 6 \times 10^{-34}$ J-s, $m = 9 \cdot 1 \times 10^{-31}$ kg, $e = 1 \cdot 6 \times 10^{-19}$ 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

$$E\gamma\, d\gamma = \frac{8\pi h\gamma^3}{C^3(e^{h\gamma/kT} - 1)} d\gamma$$ 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 2*s*, 3*p*, 4*p* and 5*d* orbitals. 4

Or

(iii) Prove that an *s*-orbital has no angular dependance. 4

(iv) Write a note on radial probability distribution function. 6

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