

### 3 (Sem-3) CHM M 1

2016

CHEMISTRY

( Major )

Paper : 3.1

Full Marks : 60

Time : 3 hours

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

1. Answer the following :

1×7=7

- (a) If the energy of electron of H-atom in the first orbit is  $-13.6$  eV/atom, what will be the energy of the electron in the fourth orbit?
- (b) In the experimental support from Davisson and Germer for wave nature of electron, what was the source of electron?
- (c) Write one of the postulates of quantum mechanics.
- (d) Examine whether the following is an eigenfunction or not for the operator  $\frac{d^2}{dx^2}$  :

$$y = \sin \frac{2\pi^2}{a} \theta$$

[a is constant]

- (e) Give the Lewis dot picture for  $\text{SO}_2$  and  $\text{SO}_3$ .
- (f) A molecule with formula  $\text{AB}_3$  has zero dipole moment but non-zero bond moment. Draw the structure.
- (g) Halogens can form compounds among themselves. Suggest the basis for such structure.
2. (a) Give the quantum numbers for the valence electrons of outermost shell for the element with atomic number 56. 2
- (b) Define formal charge. Calculate the formal charge of middle N-atom in the two resonance structures of  $\text{N}_2\text{O}$  molecule : 2
- $$\text{N}\equiv\text{N}\rightarrow\text{O} \quad \text{N}=\text{N}=\text{O}$$
- (c) Give one logical explanation to differentiate between micro- and macro-particles. 2
- (d) The atomic number of an element is 44. What will be its expected ground-state valence shell electronic configuration? 2
3. (a) Why does actual nuclear charge of an element different from the theoretical nuclear charge? What is screening constant? Find out the effective nuclear charge of 1s and one 2p electron of nitrogen atom.  $2+1+2=5$

( 3 )

Or

Write Slater's rules for calculating screening constant. Explain the rules with appropriate examples. 5

(b) Give the Pauling definition of electronegativity. Write his equation for the calculation of electronegativity with the meaning of the terms. How does electronegativity influence hybridization?  $1+2+2=5$

(c) What are the different rules followed to draw resonance structures of a molecule? Explain with example. Is there any method to isolate resonance structure of a molecule? Justify.  $4+1=5$

4. (a) Write Schrödinger wave equation for hydrogen atom in polar coordinates. Explain the terms in it. How can this equation be solved? What are radial wave function and angular wave function? Draw plots for the radial and angular functions (one example each).

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

Or

(i) Give the expression for radial wave function of 1s atomic orbital of H-atom. 2

- (ii) Establish that the radial probability density around the nucleus of a shell of thickness  $dr$  is given by the expression  $\rho dV = R_{n,l}^2 4\pi r^2 dr$ , where  $\rho$  is the probability density. 3
- (iii) Draw radial probability distribution curve for 3s, 3p and 3d atomic orbital for H-atom and explain the nature of the curves. 5
- (b) (i) What is the difference between electromagnetic and matter wave? Find an expression of matter wave in respect of momentum. What is the significance of it?  $2+2+1=5$
- (ii) How was Bohr successful in explaining the hydrogen-atom spectrum? Elaborate it. Which series of hydrogen-line spectra was discovered before Bohr's theory?  $4+1=5$
- (c) (i) Show in detail that when electron exchange concept is introduced to Heitler-London theory, it gives a much improved result. 5
- (ii) What are bond moment and dipole moment? Explain with examples that dipole moment is useful in identifying the shape of molecules and geometrical isomers.  $2+3=5$

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