

2017

CHEMISTRY

(Major)

Paper : 3.1

(Structure and Bonding)

Full Marks : 60

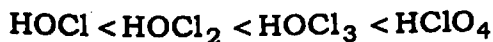
Time : 3 hours

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

1. Answer the following : 1×7=7

- (a) For α -scattering experiment of Rutherford what is the logic of using gold foil as target?
- (b) What will be the expression for potential energy of a system where an electron is brought towards a nucleus of Z number of a proton from infinity to a distance d ?
- (c) If we plot spectral distribution of radiation energy of a blackbody, what happens to the λ_{\max} of the curve with variation in temperature?
- (d) Is it possible to get a perfect blackbody? If requires what will we do?

- (e) Convert 1 D (debye) into SI unit.
- (f) The acidic character of following increases in the order :



Give reason for this behaviour.

- (g) Calculate the Z_{eff} of zinc for the outermost valence shell electron.

2. Answer the following :

2×4=8

- (a) The spectra for valence shell electron of sodium metal is found as a doublet when taken in appropriate energy region. How would you explain it and what is the physical interpretation of it?
- (b) What are the conditions for acceptability of wave functions obtained by solving Schrödinger wave equation?
- (c) In a system, two non-interacting, identical and indistinguishable particles 1 and 2 are represented by wave function ψ_a and ψ_b respectively. Using the concept of probability density, write the expression for possible linear combinations of the system.
- (d) Draw Lewis structure for NO_3^- and calculate formal charge on each atom.

3. Answer any *three* questions : 5×3=15

(a) (i) State and explain Heisenberg's uncertainty principle. 3

(ii) Calculate the uncertainty in the location of an electron moving with a speed of $2.2 \times 10^6 \text{ ms}^{-1}$, if the uncertainty in the momentum measurement is 0.1 percent. 2

(b) Describe Planck's quantum theory. How was his theory successful in explaining Wien's and Rayleigh-Jeans failure of blackbody radiation phenomenon? 3+2=5

(c) Mention two types of hybridization where *d* orbital is involved. Take suitable example to explain formation and shape of such molecules. 1+2+2=5

(d) The photoelectric work function of a metal is 2.0 eV.

(i) Calculate the threshold wavelength. 2

(ii) What will be the velocity of the most energetic electrons when the metal is irradiated with light of wavelength 4000 Å? 3

4. Answer the following : 10×3=30

(a) (i) Name the two series of hydrogen spectrum when transition occurs to $n=4$ and $n=5$ level of energy spectrum. Draw neat diagram, showing at least eight different energy levels for this two series. What was the main reason for not knowing existence of such series before Bohr's theory? 2+2+1=5

(ii) The product of the angular parts of $\Theta\phi$ of hydrogenic wave functions when $n=1$, $l=0$ is $1/\sqrt{4\pi}$. Give a description of the plot of $\Theta\phi$ function against the independent variables θ and ϕ ($\theta \rightarrow 0-\pi$ and $\phi \rightarrow 0-2\pi$) to obtain the shape of the orbital. ($1/\sqrt{4\pi} = 0.282$) 5

(b) (i) The atomic number of an element is 50. Apply the Aufbau principle in totality with name of the rules where necessary to explain its ground state electronic configuration. 5

(ii) (1) State and explain Bent's rule using PF_5 as an example. 1+2=3

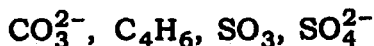
(2) Show with example that bond moments and dipole moments are different concepts. 2

(c) (i) (1) What is Pauling's electronegativity scale? On this scale, the electronegativities of N and O are 3.0 and 3.5 respectively. Why is O more electronegative than N? 1+2=3

(2) Which of the following substances is most ionic? Explain your reasoning. 2

CsCl, NaCl, MgCl₂

(ii) What are meant by resonance and resonance energy? Draw the resonance structure of the following :



Is it possible to isolate these resonance structures? Justify your answer. 2+2+1=5
