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3 (Sem–1/CBCS) CHE HC 1

2020

(Held in 2021)

CHEMISTRY

(Honours)

Paper : CHE–HC–1016

(Inorganic Chemistry–I)

Full Marks : 60

Time : Three hours

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

1. Choose the correct answer from the following : 1×7=7

   (a) The number of unpaired electrons present in the ground state electronic configuration of chromium is —

   (i) 4

   (ii) 5

   (iii) 3

   (iv) 6.

Contd.

(b) Arrange the following in the increasing order of the bond energy :

(i) $O_2 < Cl_2 < N_2 < O_2^+$

(ii) $Cl_2 < O_2^+ < O_2 < N_2$

(iii) $N_2 < O_2 < Cl_2 < O_2^+$

(iv) $Cl_2 < N_2 < O_2^+ < O_2$

(c) Predict the shape of the molecule/ion of ClF_3 and I_3^- :

(i) ClF_3 : Planar triangular,
I_3^- : pyramidal

(ii) ClF_3 : Planar triangular,
I_3^- : linear

(iii) ClF_3 : *T*-shaped, I_3^- : *V*-shaped

(iv) ClF_3 : *T*-shaped, I_3^- : linear.

(d) The four quantum numbers of the unpaired electron of fluorine atom is —

(i) $n = 2, l = 1, m = -1, s = +\frac{1}{2}$

(ii) $n = 2, l = 2, m = -1, s = +\frac{1}{2}$

(iii) $n = 2, l = 1, m = -1, s = 1$

(iv) $n = 2, l = 1, m = -2, s = +\frac{1}{2}$

(e) Which of the following is used as redox indicator during the quantitative analysis of iron by $K_2Cr_2O_7$?

(i) Phenolphthalein

(ii) Methylene blue

(iii) Diphenylamine

(iv) Acid orange.

(f) Effective nuclear charge (Z_{eff}) experienced by an $4d$ electron of Fe atom is —

(i) 3.75

(ii) 6.25

(iii) 5.60

(iv) 7.30.

(g) Radius of Na^+ and Cl^- are 95 pm and $181pm$ respectively. Coordination number of Na^+ ion is —

(i) 4

(ii) 6

(iii) 12

(iv) 8.

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

(a) Wave function must obey certain mathematical conditions to become acceptable. Mention those conditions which are required for a well-behaved function.

(b) State and explain Heisenberg's Uncertainty principle.

(c) Can a nickel rod be used to stir a solution of copper sulphate ? Give reason.

(Given that $E^0_{Ni^{2+}/Ni} = -0.25V$, $E^0_{Cu^{2+}/Cu} = +0.34V$)

(d) 'Electronegativity is not a property of isolated atom rather a property of an atom in molecule' — Explain the statement.

3. Answer the following questions : ***(any three)*** 5×3=15

(a) What is hydrogen bonding ? What are the different types of hydrogen bond which exist in molecules ? "Ice floats on water" — Explain the statement with the help of hydrogen bonding concept. 1+2+2=5

(b) Quantitative analysis of Fe^{2+} ion can be done by volumetric method using redox reactions. Mention the two types of redox reactions that are mostly used for this purpose. Give the detail redox reactions involved during these two processes. 2+3=5

(c) Draw the Molecular orbital diagram of N_2 molecule. With the help of the Molecular orbital diagram, assign magnetic behaviour to the following molecule/ions :

$N_2, N^{2+}, N_2^-, N_2^{2+}$ 3+2=5

(d) (i) Define resonance and resonance energy of molecule. 2

(ii) Explain the following observation in the light of Fajans' rule :

Silver halide	Solubility product (K_{sp})
AgF	soluble
AgCl	2×10^{-10}
AgBr	5×10^{-13}
AgI	8×10^{-17}

3

(e) Write briefly about the band theory of metallic bonding. With the help of this theory, define semiconductor and insulators. 2+3=5

4. Answer the following questions : 10×3=30

[Answer ***either*** *(a)* ***or*** *(b)*, ***either*** *(c)* ***or*** *(d)* and ***either*** *(e)* ***or*** *(f)*]

Either

(a) (i) Define lattice energy. Deduce the Born-Landé equation for calculation of lattice energy. 2+4=6

(ii) Explain the use of hydration energy and lattice energy to describe the solubility of alkali halides in water. 4

Or

(b) (i) Van der Waals' radius of *Cl* is more than that of its covalent radius. Explain. 2

(ii) Explain why the absolute size of an atom or ion cannot be defined in an exact manner. 2

(iii) In between Fe^{2+} and Fe^{3+}, select the most electronegative one and give reason. 1

(iv) What is ionization enthalpy ? What are the factors affecting ionization energy ? Define successive ionization energy. 1+2+2=5

Either

(c) (i) Define normalized and orthogonal wave function. Normalize the function $\psi = x^2$ over the interval $0 \leq x \leq k$ (k is a constant). 2+2+3=7

(ii) State Pauli's Exclusion Principle and give its application for arrangement of electron in an orbital. 1+2=3

Or

(d) (i) Explain radial and angular wave function of hydrogen atom. Give the significance of radial and angular distribution function of hydrogen atom. 2+3=5

(ii) What are contour boundary and probability diagrams of atomic orbital ? Explain why *s* orbital is spherical in shape. 3+2=5

Either

(e) (i) Define electron gain enthalpy. Describe various factors on which the electron gain enthalpy of an atom depends. Suggest the trend of the electron gain enthalpy value of halogen atoms. 2+3+2=7

(ii) Explain the shape of the following molecules with the help of hybridization concept.

NH_3, SF_4, $SnCl_2$ 3

Or

(f) Write notes on :

(i) Radius ratio rule and its limitations 3

(ii) Quantum numbers and its significance 4

(iii) Valence bond theory. 3