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Paper Code : BS-CH-101

PUID : 01034 (To be mentioned in the main answer script)

CHEMISTRY-I

Time Allotted : 3 Hours | *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) Energy required to remove an electron from outermost shell of an isolated gaseous atom is called

   a) potential energy b) kinetic energy

   c) electron affinity d) ionization energy.

   ii) At inversion temperature Joule-Thomson coefficient is

   a) zero b) positive

   c) negative d) none of these.

iii) If uncertainty in position and momentum are equal, the uncertainty in velocity is

a) $\sqrt{h/\pi}$ b) $\frac{1}{2m}\sqrt{h/\pi}$

c) $\sqrt{h/2\pi}$ d) none of these.

iv) For transition metal octahedral complexes, the choice betwcen high spin and low spin electronic configurations arises only for

a) d^1 to d^3 complexes

b) d^4 to d^7 complexes

c) d^8 to d^9 complexes

d) d^1, d^2 and d^8 complexes.

v) Which one of the following correctly represents the formation of bonding molecular orbital from the atomic orbitals having wave functions ψ_A and ψ_B?

a) $\psi_A \times \psi_B$ b) ψ_A / ψ_B

c) $\psi_A + \psi_B$ d) $\psi_A - \psi_B$.

vi) IR spectra detects

a) functional group

b) unsaturation

c) number of protons

d) nature of nuclei.

vii) What is the fingerprint region range in IR ?

a) 4000 – 400 cm^{-1} b) 4000 – 1600 cm^{-1}

c) 1600 – 400 cm^{-1} d) No range.

viii) During the motion, if the centre of gravity of molecule changes, the molecule possesses

a) Electronic energy b) rotational energy

c) Translational energy d) Vibrational energy.

ix) The strength of van der Waals forces depends upon

a) size of the molecule

b) molecular structure

c) number of electrons present in the molecule

d) all of these.

x) In which of the following reactions is $\Delta H = \Delta U$?

a) $H_2 (g) + I_2 (g) \rightarrow 2HI (g)$

b) $KI (aq) + I_2 (s) \rightarrow KI_3 (aq)$

c) $6NaOH (aq) + 3Cl_2 (g) \rightarrow 5NaCl (aq) + NaClO_3 (aq) + 3H_2O (l)$

d) $N_2O_4 (g) \rightarrow 2NO_2 (g)$.

xi) Water at 4°C, under pressure of 1 atm, $(C_p - C_v)$ is

a) positive b) negative

c) zero d) R.

xii) In which of the following processes does the entropy decrease ?

a) The dissolving of NaCl in water

b) The evaporation of water

c) The conversion of $CO_2 (g)$ into dry ice

d) When one dozen marbles are taken out of a small bag and dropped on the ground.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Explain the following reactions with a suitable example :

   a) Wolff-Kishner reduction

   b) Cannizzaro reaction. 3 + 2

3. a) State the reason for the presence of only one electron in the 4s subshell of chromium ?

   b) Which of the following has larger size and why ?

   i) Mg^{2+} ii) N^{3-}. 2 + 3

4. a) Give molecular orbital energy level diagram of CO. Write its electronic configuration, magnetic behaviour and bond order.

   b) Discuss types and conditions for hydrogen bonding. 3 + 2

5. a) For a reaction both ΔH and ΔS are positive. Under what conditions will the reaction be spontaneous ?

   b) What will be the conjugate acids for the following Bronsted bases ?

   NH_3, HCO_3^-, CH_3COO^-, $H_2PO_2^-$. 1 + 4

6. Why violet coloured $[Ti (H_2O)_6] Cl_3$ becomes colourless when heated ?

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Phenol on treatment with Br_2 in CS_2 at low temperature gives two isomeric monobromophenols *X* and *Y*. But phenol on treatment with bromine water gives a white precipitate *Z*. Identify the products *X*, *Y* and *Z* with chemical reactions. 6

b) What do you mea by enantiomer and diastereomer ? Differentiate them with examples. 4

c) Give one example of each of Friedel-Crafts' alkylation and acylation reaction. 2

d) Predict the major product(s) of the following reactions and explain their formation : 2

i) $H_3C - CH = CH_2 \xrightarrow[HBr]{(Ph - CO - O)_2}$

ii) $H_3C - CH = CH_2 \xrightarrow{HBr}$.

e) Write down the criteria for aromaticity. 1

8. a) Calculate the force constant for the bond in HCl from the fact that the fundamental vibration frequency is $8{\cdot}667 \times 10^{13}\ s^{-1}$.

b) Calculate the energy of one photon of light of wavelength 2450 Å. Will it be able to dissociate a bond in diatomic molecule which absorbs this photon and has a bond energy equal to 95 kcal per mole ?

c) "All adiabatic reversible expansions lead to a fall of temperature." — Comment or justify. 4 + (3 + 3) + 5

9. a) What is screening constant ? Calculate the effective nuclear charge (Z_{eff}) of one 4*s* electron of the following :

   Cu (Z = 29) and K (Z = 19).

   b) Determine the bond order of each member of the following groups, and determine which member of each group is predicted by the molecular orbital model to have the strongest bond :

   i) H_2, H_2^+, H_2^-

   ii) O_2, O_2^{2+}, O_2^{2-}.

   c) *p*-block elements form acidic, basic and amphoteric oxides. Explain each property by giving two examples and also write the reactions of these oxides with water. 5 + 4 + 6

10. a) What is the necessary and sufficient condition to exhibit optical activity ?

   b) Draw all the stereo-isomers for the following :

   $CH_3CH(OH) - CH(Cl)COOH$

   c) Arrange the different conformations of *n*-butane in terms of their stability. 5 + 5 + 5

11. a) Nitration is also in absence of H_2SO_4 yet H_2SO_4 has no effect on benzene under the conditions employed. Show the mechanism of nitration of benzene.

   b) What is the condition of spontaneity in terms of entropy ? The condition of spontaneity :

   $$\Delta G_{x,y} < 0 \; ; \; \Delta A_{p,r} < 0,$$

   where *G* is the Gibbs free energy and *A* is the Helmholtz free energy. Identify *x*, *y*, *p* and *r*.

c) State whether the following properties are extensive or intensive properties :

Pressure, Concentration, Entropy, Viscosity, Temperature. 4 + (2 + 4) + 5

12. a) pH of a solution of a strong acid is 5. What will be the pH of the solution obtained after diluting the given solution 100 times ?

b) Write the Nernst equation for the cell reaction in the Daniel cell. How will the E_{cell} effected when the concentration of Zn^{2+} is increased ?

c) Draw and explain the energy level diagrams for conductor, semiconductor and insulator.

d) Explain enantiomers and diastereoisomers with examples.

e) Write the principle and application of NMR and MRI. 3 + 3 + 3 + 2 + 4