FEDERAL PUBLIC SERVICE COMMISSION

COMPETITIVE EXAMINATION FOR RECRUITMENT TO POSTS
IN BPS-17 UNDER THE FEDERAL GOVERNMENT, 2001.

CHEMISTRY, PAPER-I

TIME ALLOWED: THREE HOURS MAXIMUM MARKS: 100

NOTE: Attempt **FIVE** questions in all, including question **No.8** which is **COMPULSORY**. All questions carry **EQUAL** marks.

1. (a) What are the Lowry- Bronsted definitions of an acid and a base? Why this concept of acid base is less restrictive than the Arrheniues definition?
   (b) Which is the stronger acid of the following pairs? Give reasons.
   H_2SO_4 or $HClO_3$
   H_3ASO_4 or H_3PO_4
   CH_3OH or CH_3SH
   (c) Formic acid, HCOOH, has pka = 3.7 and picric acid, $C_6H_3N_3O_7$, has pka = 0.3, which is strong acid?
   (d) Boron trichloride, BCl_3, reacts with diethyl ether, $(C_2H_5)_2O$, to form addition compound $Cl_3BO(C_2H_5)_2$. Identify Lewis acid and Lewis base.
   (e) What do you understand by the following?
   (i) Soft base (ii) Hard base (iii) Soft acid (iv) Hard acid
   (f) What is symbiosis?

2. (a) What do you mean by thermodynamics? Discuss its scope and limitations
   (b) What is meant by the following terms?
   (i) Reversible and irreversible process
   (ii) Isothermal and adiabatic process
   (c) State the second law of thermodynamics and explain the condition under which heat can be Converted into work.
   (d) What is Clausius clapeyron equation? Discuss its applications.
   (e) Define and explain the terms, "Work Function" and "Free Energy" as used in Thermodynamics.

3. (a) Aluminum is not found in native form but in combination, why?
   (b) What are the chief minerals of aluminum? Write down the impurities associated with it?
   (c) How aluminum is extracted from its important ore by Hall's and Heroult process? Why chemical reduction is not suitable in this case?
   (d) Write down major applications of aluminum
   (e) What are ultramarines?

4. (a) What are the essentials of crystal field theory (CFT)?
   (b) What is meant by crystal field splitting and crystal field stabilization energy of a Coordination compound?
   (c) What do you understand by 10Dq? Write the units in which it's being expressed. What is Meant by D and q.
   (d) How CFT can explain the violet colour of $[Ti(H_2O)_6]^{+3}$
   (e) Is this d-d electronic transition in $[Ti(H_2O)_6]^{+3}$ allowed or forbidden? Give reasons.
   (f) What is Jahn Teller effect? Show this Jahn Teller effect in the absorption spectra of $[Ti(H_2O)_6]^{+3}$

113

CHEMISTRY, PAPER-I

5. (a) Write down the similarities between carbon and silicon. Why silicon form complexes while carbon does not?
   (b) What is allotropy? Write down the different allotropic forms of carbon.
   (c) What are silicones? Give their important applications.
   (c) Explain the difference in density and electrical conductivity between diamond and graphite.

6. (a) What is meant by corrosion?
   (b) Discuss the mechanism of rusting of iron.
   (c) How rusting process could be controlled?
   (d) Aluminum is more reactive than iron, but corrosion is more serious problem with iron than with aluminum. What is the reason for it?
   (d) The process of rusting is more pronounced in coastal regions. Explain why?

7. Write notes on the following.
   (a) Theories of metallic bonding. (b) Glass industry.
   (c) Water pollution problem in Pakistan.

COMPULSORY QUESTION

8. Write only the correct answer in the answer book. Do not reproduce the question.

   (1) Rutherford's scattering experiment showed that.
   (a) The nuclear charge is proportional to atomic number.
   (b) Electrons are small compared with the atom.
   (c) The nucleus is small as compared with the atom. (d) None of these.

   (2) In photoemission of electron the energies of electron emitted depend on the:
   (a) Intensity. (b) Wavelength.
   (c) Velocity of light. (d) None of these.

   (3) The charge density, due to an electron wave, at a point x at a time t is given by:
   (a) eA^2 (b) $e|\psi|^2$ (c) $e\psi$ (d) None of these.

   (4) De broglie's relation between momentum and wavelength for an electron is:
   (a) $\lambda = h/p$ (b) $p = h\nu$ (c) $p = \lambda/h$ (d) None of these.

   (5) The kinetic energy associated with plane electron wave is given by:
   (a) hk (b) $\frac{1}{2}mk^2$ (c) $h^2k^2 / 8\pi^2 m$ (d) None of these.

   (6) The total energy of the electron is:
   (a) The difference between its kinetic and potential energy.
   (b) The sum of its kinetic and potential energy.
   (c) The product of its kinetic and potential energy.

   (7) If the wavelength of an electron wave is infinite the electron must be stationary:
   (a) True (b) False

   (8) The quantization condition for the electron wave is that:
   (a) The value of φ must not be discontinuous.
   (b) The value of $d\varphi / dx$ must not be discontinuous.
   (c) The value of φ and $d\varphi / dx$ must not be discontinuous.
   (d) None of these.

   (9) The energy differences between adjacent energy levels of the hydrogen atom:
   (a) Decrease with increasing energy. (b) Increase with increasing energy.
   (b) Are independent of energy. (d) None of these.

2

(10) When an electron jumps from an energy level to a lower one, the energy released is usually.
(a) Emitted as heat. (b) Emitted as light.
(c) Emitted as photon. (d) None of these.

(11) The spin quantum number of the electron determines.
(a) The angular momentum about the nucleus.
(b) The total angular momentum of the electron.
(c) The angular momentum of electron about its own center of mass.
(d) None of these.

(12) In the emission spectrum of hydrogen the effect of a magnetic field will be.
(a) To increase the number of spectral lines.
(b) To decrease the number of spectral lines.
(c) To change the wavelength of the spectral lines without increasing their number.
(d) None of these.

(13) Pauli's exclusion principle states that, within one atom.
(a) No more than two electrons can have the same energy.
(b) The spin of electrons interact so as to become parallel if possible.
(c) No two electrons may have the same four quantum numbers.
(d) None of these.

(14) The first series of transition elements in with the 3d shell is gradually filled, begins at atomic number.
(a) 19 (b) 21 (c) 11 (d) None of these.

(15) Graphite is good lubricant because.
(a) Sheet of atom are bonded together covalently.
(b) The atom in sheet is bonded covalently to one another.
(c) The sheets are bonded to one another by Vander Waal's forces.
(d) None of these.

(16) The conductivity of a pure semiconductor is.
(a) Proportional to temperature.
(b) Rise exponentially with temperature.
(c) Decrease exponentially with increasing temperature. (d) None of these.

(17) The charring action of H_2SO_4 is due to its being:
(a) Dehydrating agent (b) An oxidizing agent.
(c) A reducing agent. (d) None of these.

(18) Aqua regia is mixture of:
(a) HCl & H_2SO_4 (b) HCl & HNO_3
(c) HNO_3 & H_2SO_4 (d) None of these.

(19) The addition of a catalyst to a reaction:
(a) Changes the enthalpy (b) Changes the entropy.
(c) Changes the activation energy. (d) None of these.

(20) Of the visible spectrum shorter wavelength is:
(a) Red. (b) Green. (c) Violet. (d) None of these.

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3

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CHEMISTRY, PAPER-II

TIME ALLOWED: THREE HOURS MAXIMUM MARKS: 100

NOTE: Attempt **FIVE** questions in all, including question **No.8** which is **COMPULSORY**. All questions carry **EQUAL** marks.

1. (a) On the basis of molecular orbital theory, explain the formation of molecules of O_2 and HF. Also give molecular orbital diagram and calculate the bond oder. **(08)**
   (b) Give example in each case and explain the phenomena of sp^3, sp^2 and sp hybridization. **(12)**

2. (a) Explain the terms "Molecularity" and "Order of Reaction". **(04)**
   (b) Derive an expression for the rate constant for second order reaction assuming the initial concentration of reactants to be different. **(13)**
   (c) How does the increase in temperature effect equilibrium for an exothermic reaction. **(03)**

3. (a) In the context of catalysis, discuss the following with specific examples:
      (i) Intermediate compound formation theory. **(07)**
      (ii) Adsorption theory. **(07)**
   (b) Explain the terms: **(2 x 3)**
      (i) Catalyst promotion.
      (ii) Auto catalysis.
      (iii) Catalyst poisoning.

4. Using CH_3MgI as one of the starting material, how would you prepare: $(8 \times 2\frac{1}{2})$
   (i) Acetone
   (ii) 1-Butane
   (iii) Dimethyl Ether
   (iv) Ethyl alcohol
   (v) 2-Butyne
   (vi) Tertiary butyl alcohol.
   (vii) Acetic Acid
   (viii) Isopropyl alcohol.

5. (a) Why benzene undergoes electrophilic substitution reaction whereas alkenes undergo addition reactions? **(10)**

4

(b) How will you synthesize the following compounds from benzene?
- (i) Malice Anhydride
- (ii) Acetophenone.
- (iii) Chlorobenzene.
- (iv) Glyoxal.
- (v) Benzene Hexachloride.

6. (a) Give an account of replacement reactions of diazonium compounds. **(12)**
   (b) How will you prepare the following:
   - (i) Congo red. **(02)**
   - (ii) Bismark Brown. **(03)**
   - (iii) Malachite green. **(03)**

7. (a) Why some organic compounds can be polymerized easily, a few require stronger conditions for polymerization, while the others do not polymerize at all. **(10)**
   (b) What are the pre-requisites for a good fermentation process. **(07)**
   (c) Explain the following and give two examples in each case: **(03)**
   - (i) Thermoplastic.
   - (ii) Thermosetting plastic.

COMPULSORY QUESTION

8. (A) Write only the True or False in the Answer Book. Do not reproduce the statements:
   - (1) pk_a value for a stronger acid shall be comparatively high.
   - (2) Chloroacetic acid is weaker than acetic acid.
   - (3) An electron pair donor is an acid.
   - (4) Oxygen is diamagnetic compound as it possesses two odd electrons in its bonding orbitals.
   - (5) A tertiary carbonium ion is less stable than the secondary as well as primary carbonium ions.
   - (6) Nitrogen dioxide possesses an odd electron.
   - (7) Resonance decreases the stability of a molecule and increases its reactivity.
   - (8) Ionic Bonds are directional.
   - (9) CS_2 is a polar compound like H_2O.
   - (10) In addition Polymerization, the molecular weight of the polymer is not an integral multiple of the molecular weight of the monomers.

   (B) Write only the correct answer in the Answer Book. Do not reproduce the question.
   - (11) The PH of 0.1M solution approaches one for:
     (a) HCL (b) CH_3COOH
     (c) H_2SO_4 (d) $HCLO_4$ (e) None of these.

5

(12) Primary alkyl halides undergo substitution by:
(a) SN_2 (b) SN_1
(c) both SN_1 and SN_2 (d) None of these.

(13) Compared to C – Cl bond is alkyl halides the C – Cl bond in vinyl chloride is:
(a) Stronger (b) weaker (c) None of these.

(14) Homolytic fission of C – C bond forms:
(a) Carbonium ion (b) Free radical
(c) carbonion (d) None of these.

(15) Aluminium Chloride:
(a) possesses high m. point.
(b) Sublimes on heating.
(c) Possesses low m. point
(d) None of these.

(16) Addition of an inhibitor in reaction system:
(a) Increases E_a (b) Decreases E_a
(d) Has no effect on energy of activation.
(c) None of these.

(17) A double bond possesses:
(a) Two sigma bonds (b) two pi-bonds
(c) one pi and one Sigma bond (d) None of these.

(18) The normality of 0.5M solution of H_2SO_4 is:
(a) 2.0 (b) 1.0
(c) 0.5 (d) None of these.

(19) A sp^3d^2 hybrid has:
(a) Square planner structure
(b) Linear structure
(c) Octahedral structure
(d) Tetra hedral structure
(e) None of these.

(20) The co-ordination sites available in EDTA for co-ordinate bond formation are:
(a) 2 (b) 6
(c) 4 (d) None of these.

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6