FEDERAL PUBLIC SERVICE COMMISSION

COMPETITIVE EXAMINATION FOR RECRUITMENT TO POSTS IN BS-17 UNDER THE FEDERAL GOVERNMENT, 2011

Roll Number

CHEMISTRY, PAPER-I

TIME ALLOWED:	**(PART-I MCQs)**	**30 MINUTES**	**MAXIMUM MARKS: 20**
THREE HOURS	**(PART-II)**	**2 HOURS & 30 MINUTES**	**MAXIMUM MARKS: 80**

NOTE: **(i)** **First** attempt **PART-I (MCQs)** on separate Answer Sheet which shall be taken back after 30 minutes.
(ii) **Use of simple calculator is allowed.**
(iii) **Overwriting/cutting of the options/answers will not be given credit.**

(PART-I MCQs) (COMPULSORY)

Q.1. Select the best option/answer and fill in the **appropriate box** on the **Answer Sheet**. **(1 x 20=20)**

(i) The geometry associated with sp^3d^2 hybridization is:

(a) Octahedral (b) Tetrahedral (c) Trigonal planar (d) Trigonal biplanar

(ii) Which of the following molecules has a dipole movement?

(a) CH_4 (b) CO_2 (c) H_2O (d) CCl_4

(iii) Which of the following represents the shape of NH_3 molecule?

(a) Trigonal planar (b) Angular (c) Trigonal Pyramidal (d) Tetrahedral

(iv) Which of the following is the largest ion?

(a) Li^+ (b) Cs^+ (c) Rb^+ (d) Na^+

(v) Which of the following represent different isotopes of the same element?

1. 12 protons, 11 neutrons, 12 electrons
2. 11 protons, 12 neutrons, 11 electrons
3. 10 protons, 12 neutrons, 12 electrons
4. 11 protons, 12 neutrons, 10 electrons
5. 12 protons, 12 neutrons, 12 electrons

(a) 1 and 5 (b) 2 and 4 (c) 2, 3, 4 and 5 (d) None of these

(vi) Which of the following represents the correct number of particles in $^{79}_{34}Se^{2-}$?

(a) 34 protons, 79 neutrons, 2 electrons (b) 34 protons, 45 neutrons, 32 electrons

(c) 34 protons, 45 neutrons, 2 electrons (d) 34 protons, 45 neutrons, 36 electrons

(vii) Which one of the following is correct equation for the reaction of chlorine with water?

(a) $2Cl + H_2O \rightarrow 2HCl + \frac{1}{2}O_2$ (b) $Cl_2 + 2H_2O \rightarrow 2HCl + H_2O_2$

(c) $Cl_2 + 3H_2O \rightarrow HClO_3 + 5HCl$ (d) $Cl_2 + H_2O \rightarrow HCl + HOCl$

(viii) Faraday's laws of electrolysis are related to the:

(a) Atomic number and speed of the cation (b) Atomic number and speed of the anion

(c) Quantity of electricity and equivalent weight of the electrolyte (d) None of these

(ix) When Pt and Co are electrically connected, which one is corroded:

(a) Pt (b) Co (c) Both of these (d) None of these

(x) For the reaction ($Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$), which of the following statements is correct?

(a) Zn is dissolved and Cu is deposited (b) Cu is reduced and Zn is exidized

(c) Cu is the cathode and Zn the anode (d) All statements are correct

(xi) What is the pH of 0.0001 M NaOH solution?

(a) 4 (b) 10 (c) 5 (d) 14

(xii) What is the pH of 1.0×10^{-3} M HCl solution?

(a) 10 (b) 30 (c) 3 (d) 0.3

(xiii) Which of the following is the correct equilibrium expression for the reaction $[N_2(g) + 3H_2(g) \quad 2NH_3(g)]$?

(a) $[2NH_3][N_2 + 3H_2]$ (b) $[2NH_3] / [N_2][3H_2]$

(c) $[NH_3]^2 / [N_2][H_2]^3$ (d) $[NH_3]^2 / [N_2] + [H_2]^3$

(xiv) Which of the following best describes how a catalyst works?

(a) It changes the potential energies of the reactants and products.

(b) It decreases the temperature of the reaction which leads to a faster rate.

(c) It lowers the activation energy for the reaction by providing a different reaction mechanism.

(d) It raises the activation energy for the reaction which produces a faster rate.

(xv) Which of the following will not act as Lewis acid;

(a) $AlCl_3$ (b) BF_3 (c) $FeBr_3$ (d) CCl_4

(xvi) Which of the following is the strongest acid?

(a) HF (b) HCl (c) HBr (d) HI

(xvii) Which of the following could be used for cathodic protection:

(a) Al (b) Cd (c) Cu (d) None of these

(xviii) Hybridization of XeF_4 is:

(a) sp^3d (b) sp^2d^2 (c) sp^3d^2 (d) sp^3

(xix) Which of the following will increase the rate of the reaction?

(a) Decreased temperature and increased concentration of reactants

(b) Decreased temperature and decreased concentration of reactants

(c) Increased temperature and decreased concentration of reactants

(d) Increased temperature and increased concentration of reactants

(xx) Silicones are polymeric substances with linkage:

(a) Si – S – Si (b) Si – O – Si (c) $Si(CH_3)_4$ (d) O = Si = O

CHEMISTRY, PAPER-I

PART-II

NOTE:(i) **PART-II** is to be attempted on separate Answer Book.
(ii) **Attempt ONLY FOUR questions from PART-II. All questions carry EQUAL marks.**
(iii) **Periodic Table is attached.**
(iv) **Extra attempt of any question or any part of the attempted question will not be considered.**

Q.2. (a) Explain with suitable examples the difference between electrochemical cell and electrolytic cell? **(07)**

For the cell, Ni(s)/Ni^{+}(aq)//Ag^{+}(aq)/Ag(s), write half cell reactions at each electrode and balanced redox reaction that occurs in the cell.

(b) For the given reaction, $Fe_2O_{3(S)} + 2Al_{(S)} \rightarrow Al_2O_{3(S)} + 2Fe_{(S)}$ the heat of formation of $Fe_2O_{3(S)}$ and $Al_2O_{3(S)}$ are -822.25 and -1669.84 kJ at 298 K, calculate the change in enthalpy. **(03)**

(c) Write comprehensive note on Fuel cells. **(10)**

Q.3. (a) How do buffers resist changes in pH? Write any two applications of buffers in Chemistry? **(05)**

(b) Calculate pH of 0.1 N solution of NaOH. **(02)**

(c) Give a brief account of Debye-Hükel theory of strong electrolytes? **(05)**

(d) What is hydrogen over voltage, how it is related to corrosion rate? **(08)**

Q.4. (a) Explain the terms Gibbs free energy, enthalpy and entropy of a reaction. What is the relationship between these terms? **(08)**

(b) The heat of reaction for the following reaction at 298K is – 92.466 kJ. **(04)**

$$\tfrac{1}{2}H_2(g) + \tfrac{1}{2}Cl_2 \rightarrow HCl(g)$$

Calculate the heat of this reaction at 323 K.

(c) Define heat of combustion. How it is measured experimentally?. **(08)**

Q.5. (a) Explain the terms spontaneous and non-spontaneous reactions with suitable examples. **(05)**

(b) Describe moving boundary method for the determination of transference number. **(10)**

(c) Write a note on concentration cells. **(05)**

Q.6. (a) Describe main features of crystal field theory, How this theory explains colour of coordination complexes? **(10)**

(b) Write the electronic configuration for each of the following: **(04)**

Ni^{2+}, Cu, Mn^{2+}, Cr^{3+}

(c) Write coordination and oxidation numbers for the transition metal atom in each of the following coordination compounds. **(06)**

	$K[Ag(CN)_2]$	$K[CuCl_2]$	$[MnO_4]^-$
Coordination No			
Oxidation No			

Q.7. (a) State the method by which NaOH is manufactured industrially using NaCl as raw material? **(06)**

(b) Describe different allotropic forms of carbon? Discuss structure and chemical properties of each. **(08)**

(c) Discuss chemistry of Hard and Soft water. **(06)**

Q.8. (a) Write an essay on the Oxides of Nitrogen and Environmental Pollution. **(08)**

(b) Write structure and chemical properties of Interhalogen compounds. **(07)**

(c) With the help of equations, outline the manufacture of glass. **(06)**

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FEDERAL PUBLIC SERVICE COMMISSION

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Roll Number

CHEMISTRY, PAPER-II

TIME ALLOWED:	**(PART-I MCQs)**	**30 MINUTES**	**MAXIMUM MARKS: 20**
THREE HOURS	**(PART-II)**	**2 HOURS & 30 MINUTES**	**MAXIMUM MARKS: 80**

NOTE: **(i)** **First** attempt **PART-I (MCQs)** on separate Answer Sheet which shall be taken back after 30 minutes.
(ii) **Use of simple calculator is allowed.**
(iii) **Overwriting/cutting of the options/answers will not be given credit.**

(PART-I MCQs) (COMPULSORY)

Q.1. Select the best option/answer and fill in the **appropriate box** on the **Answer Sheet**. **(1 x 20=20)**

(i) Carbon atoms in p-xylene are:

(a) sp^2 hybridized (b) sp^3 hybridized (c) Sp hybridized (d) Both (a) and (b)

(ii) Which of the following sugars is found in milk?

(a) Lactose (b) Sucrose (c) Maltose (d) Fructose

(iii) Glucose when heated with Benedict's reagent ($CuSO_4$, NaOH, and tartaric acid) forms a brick red precipitate due to formation of:

(a) Cu_2O (b) $Cu(OH)_2$ (c) Copper tartrate (d) None of these

(iv) Which of the following can not be used as solvent in polarimetry?

(a) Methanol (b) Ethanol (c) 1-butanol (d) 2-butanol

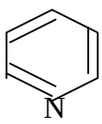
(v) Polarimetry is a technique to analyze:

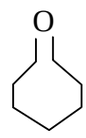
(a) Chiral compounds (b) Unsaturated compounds (c) Polar compounds (d) All of these

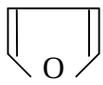
(vi) Which of the following is not an aromatic compound?

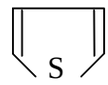
(a) Pyrrole (b) Pyridine (c) Furan (d) Piperidine

(vii) Which of the following is not a heterocyclic compound?

(a) 

(b) 

(c) 

(d) 

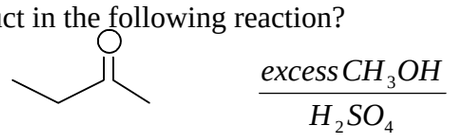
(viii) Which of the following will show optical isomerism?

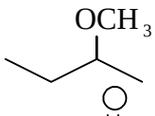
(a) 2,3-dimethylbutane (b) 3,4-dimethylhexane
(c) 3,4-diethylhexane (d) 1,4-dimethylcyclohexane

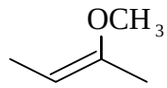
(ix) What type of reaction takes place when a ketone is treated with HCN?

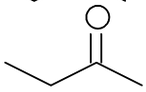
(a) Electrophilic substitution (b) Nucleophilic substitution
(c) Nucleophilic addition (d) Electrophilic addition

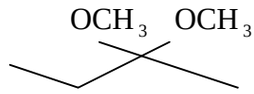
(x) What is the major product in the following reaction?



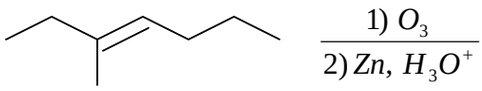
(a) 

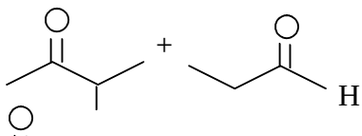
(b) 

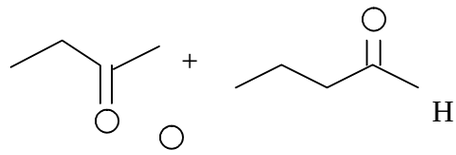
(c) 

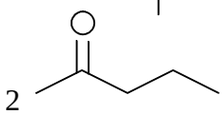
(d) 

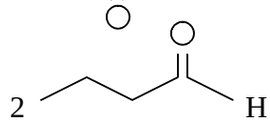
(xi) What are the expected products from the following reactions?



(a) 

(b) 

(c) 

(d) 

(xii) Which of the following will undergo Aldol condensation?

(a) Formaldehyde (b) Acetaldehyde (c) Benzaldehyde (d) All of these

(xiii) Which of the following is the most acidic?

(a) Ethanol (b) Butanol (c) Cyclohexanol (d) Phenol

(xiv) Which of the following is the most basic?

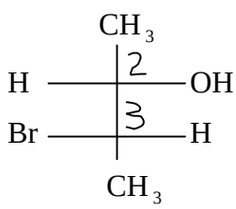
(a) Aniline (b) m-chloroaniline

(c) N,N-dimethylaniline (d) m-nitroaniline

(xv) Which of the following are correctly matched?

	Reagent	**Reaction**
(a)	Na Metal	Witting reaction
(b)	$(C_6H_5)_3P = C(C_2H_5)_2$	Wurtz reaction
(c)	$KOH/NH_2\text{-}NH_2$	Wolff-Kishner reduction
(d)	Se + Δ 250 °C	Birch reduction

(xvi) What is the correct configuration at chiral centers in the following molecule?



(a) 2R, 3R (b) 2R, 3S (c) 2S, 3R (d) 2S, 3S

(xvii) The reaction acetone with phosphonium ylide $[(C_6H_5)_3P = C(CH_3)_2]$ produces:

(a) 2,3-dimethyl-2-butanol (b) 2,3-dimethyl-2-butene

(c) 2-chloro-2,3-dimethylbutane (d) Both (a) and (b)

(xviii) Which of the following reactions are used to prepare amines:

(a) Gabrial synthesis (b) Hofmann reaction (c) Reductive amination (d) All of these

CHEMISTRY, PAPER-II

(xix) The active agent in the nitration of benzene is:

(a) NO_2^- (b) NO_2^+ (c) NO (d) HNO_2

(xx) The most probable intermediate in Favorskii rearrangement is:

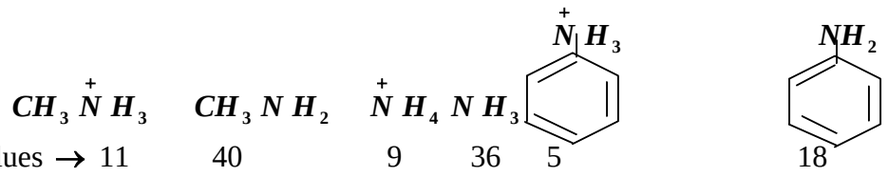
(a) Lactone (b) Lactam (c) Cycloprapanone (d) None of these

PART-II

NOTE:(i) **PART-II** is to be attempted on separate Answer Book.
(ii) **Attempt ONLY FOUR questions from PART-II. All questions carry EQUAL marks.**
(iii) **Extra attempt of any question or any part of the attempted question will not be considered.**

Q.2. (a) Differentiate between Inter-molecular and Intra-molecular hydrogen bonding. Discuss effects of hydrogen bonding on any two properties of organic compounds. Support your answer with suitable examples. **(08)**

(b) Arrange following compounds in decreasing order of their base strength (strongest first). Give a brief explanation in support of your answer: **(03)**



pK_a values → 11 40 9 36 5 18

(c) How would you account for the following: **(06)**

i. Picric acid (2,4,6-trinitrophenol) liberates CO_2 from aqueous soulution of Na_2CO_3 but phenol does not?

ii. Benzene undergo Friedel Craft alkylation in the presence of Lewis acid while pyridine does not?

iii. Benzene is an aromatic compound while cyclooctatraene is nonaromatic?

Q.3. (a) Discuss how a catalyst changes the rate and path of the reaction? **(06)**

(b) Reaction of 1, 3-butadiene with HBr gives two products, draw reaction coordinate diagram to illustrate thermodynamic and kinetic products of the reaction. **(07)**

(c) For the following reaction: **(07)**

$CH_3(CH_2)_3Br + OH^- \rightarrow CH_3(CH_2)_3OH + Br^-$

Discuss rate law and various factors that affect the rate of reaction.

Q.4. (a) Starting from benzene how would you prepare the following compounds: **(06)**
Benzoic acid, 4-Bromonitobenzene, Maleic anhydride

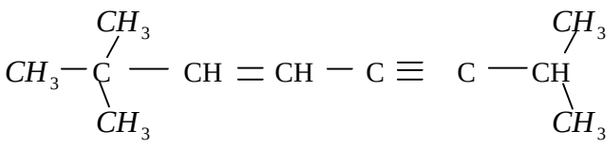
(b) Show reaction of C_2H_5MgBr with each of the following: **(06)**

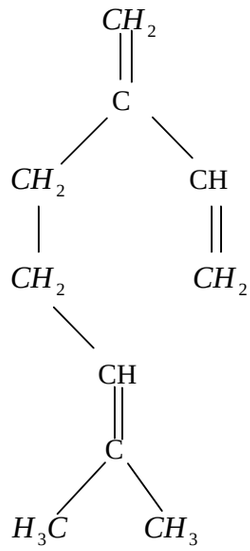
i. CH_3CHO followed by hydrolysis

ii. $CH_3C \equiv C—H$ followed by reaction with $CH_3—I$

iii. $CH_3COOC_2H_5$ followed by hydrolysis.

(c) Assign hybridization at each carbon in the following compound: **(04)**





(d) Suggest two methods to prepare aromatic amines. **(04)**

Q.5. (a) Discuss stereoisomerism in compounds having 2-similar asymmetric carbon atoms. **(06)**

(b) Draw Fisher projection formulae for the following compounds: **(08)**

i. R and S 2 - bromopentane
ii. R and S 3 - chloro-1-pentene
iii. R and S 3 - chloro-3-methyloctane
iv. R and S 2 - pentanol

(c) What do you understand by the terms Z and E isomer? Illustrate your answer by quoting suitable examples. **(06)**

Q.6. (a) Illustrate giving suitable examples the difference between Homogenous and Heterogeneous catalysis. **(06)**

(b) Outline synthesis of azo dye starting with phenol and a suitable aromatic amine. **(04)**

(c) Write notes on the following: **(05+ 05 = 10)**

i. Octane number ii. Catalytic cracking

Q.7. Write structure of product(s) obtained from each of the following reactions: **(2 x 10 =20)**

i. $CH_3CH_2COOH + CH_3CH_2OH + H_2SO_4 \rightarrow$

ii. $C_6H_5COCH_3 + LiAlH_4 \rightarrow$

iii. $C_6H_5COOH + SOCl_2 \rightarrow$

iv. $(CH_3)_3CBr + NaOH(aq) \rightarrow$

v. $C_6H_5NH_2 + NaNO_2 + HCl\ (conc) \rightarrow$

vi. $CH_3CH_2COCH_3 \xrightarrow[2)\ H_3O^+]{1)\ C_2H_5MgBr}$

vii) $C_6H_5NO_2 + Sn/HCl \rightarrow$

viii) $C_6H_6 + Na/NH_3 \rightarrow$

ix) $CH_3CH = CH_2 + HBr \rightarrow$

x) $CH_3COCH_3 + NH_2OH \rightarrow$

Q.8. (a) Write main steps in the formation of following polymers: **(03 + 03 = 06)**

i. Nylon 6,6 and Polyester via Condensation Polymerization.
ii. Polyethlene via Free Radical Polymerization.

(b) What are alkaloids, describe chemical properties and structure of any two alkaloids. **(07)**

(c) Differentiate between oil, fat and wax. Draw structure of triglyceride containing oleic acid $[CH_3(CH_2)_7CH = CH(CH_2)_7COOH]$ as fatty acid and write reaction triglyceride with H_2/Ni followed by NaOH(aq). **(06)**

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