FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2023
FOR RECRUITMENT TO POSTS IN BS-17
UNDER THE FEDERAL GOVERNMENT

Roll Number

CHEMISTRY, PAPER-I

TIME ALLOWED: THREE HOURS	**PART-I (MCQS)** **MAXIMUM MARKS = 20**
PART-I(MCQS): MAXIMUM 30 MINUTES	**PART-II** **MAXIMUM MARKS = 80**

NOTE: (i) Part-II is to be attempted on the separate **Answer Book.**
(ii) Attempt **ONLY FOUR** questions from **PART-II. ALL** questions carry **EQUAL** marks.
(iii) All the parts (if any) of each Question must be attempted at one place instead of at different places.
(iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.
(v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.
(vi) Extra attempt of any question or any part of the question will not be considered.
(vii) **Use of calculator is allowed.**

PART-II

Q.2. (a) The following reaction occurs via two steps, where the first step is rate-determining step. (12)
Step I $NO_2(g) + NO_2(g) \rightarrow NO(g) + NO_3(g)$
Step II $NO_3(g) + CO(g) \rightarrow NO_2(g) + CO_2(g)$
    i.   Write down the rate equation for the above reaction.
    ii.   Which molecule acts as a catalyst in this reaction? Give a reason.
    iii.   Which molecule is an intermediate in this reaction and justify it.

(b) Describe Arrhenius's equation. (8) **(20)**

Q.3. (a) An explosion is usually considered adiabatic, indicating negligible heat transfer, even though it's rapidly expanding gaseous products are not at the same temperature as the surroundings, and the boundary permits heat transfer. Explain the phenomenon. (10)

(b) Draw a working diagram for a reversible heat engine that operates with two isothermal steps and two constant-pressure steps. How many heat reservoirs are needed to operate this engine? (10) **(20)**

Q.4. (a) Describe Schrodinger Wave Equation for a particle in a three-dimensional box. (10)
(b) Explain photoelectric effect. (8)
(c) What is a wave function? Give Born's interpretation of wave function. (2) **(20)**

Q.5. (b) Describe Nernst's equation. (10)
(b) Describe the significance of pH, pK_a, and pK_b. (6)
(c) What is the relationship between conductance and Kohlrausch's law? (4) **(20)**

Q.6. (a) Describe three methods of mechanical phase separation. (10)
(b) Briefly discuss "The Hard-Soft Acid-Base Principle." (10) **(20)**

Q.7. (a) Compare Valence Bond Theory with Molecular Orbital Theory. (10)
(b) What is the oxidation state? Differentiate between the oxidation state and valency /covalency of an element with suitable examples. (6)
(c) Write the molecular orbital configuration of the followings: (4) **(20)**
$$O_2^+, O_2, O_2^- \text{ and } O_2^{-2}$$

Q.8. Discuss the following in detail. **(5 each)** **(20)**
    i.   Crystal Field Theory
    ii.   Hess's Law
    iii. Electrophoresis Technique
    iv. Freundlich Adsorption Isotherm

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CHEMISTRY, PAPER-II

TIME ALLOWED: THREE HOURS	**PART-I (MCQS) MAXIMUM MARKS = 20**
PART-I(MCQS): MAXIMUM 30 MINUTES	**PART-II MAXIMUM MARKS = 80**

NOTE: (i) **Part-II** is to be attempted on the separate **Answer Book.**
  (ii) Attempt **ONLY FOUR** questions from **PART-II**. **ALL** questions carry **EQUAL** marks.
  (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places.
  (iv) Candidate must write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.
  (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.
  (vi) Extra attempt of any question or any part of the attempted question will not be considered.
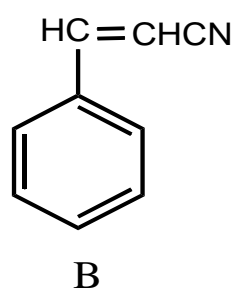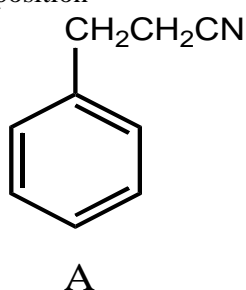 **(vii)** **Use of calculator is allowed.**

PART-II

Q. 2. **(a)** Arrange the following alkenes in order of their relative stability. How will you proceed to determine the order practically? **(5)**
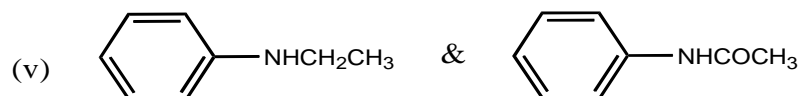
i.	1-hexene
ii.	cis-3-hexene
iii.	trans-3-hexene
(iv)	2-methyl-2-pentene
(v)	2,3-dimethyl-2-butene

(b) Explain why? **(5)**
  (i) Poly substitution is a complicating factor in aromatic alkylation but not in aromatic nitration or halogenation.
  (ii) A undergoes nitration predominantly at the ortho/ para positions but B mainly at meta position

CH_2CH_2CN $HC=CHCN$

A   B

(c) Compare the basicity of: **(5)**
  (i) $(CH_3)_3N$ & $(CCl_3)_3N$
  (ii) $C_6H_5CH_2NH_2$ & $CH_3C_6H_4NH_2$
  (iii) Aniline & Cyclohexyl amine
  (iv) H_2N—⟨⟩—CN & NC—⟨⟩—NH_2
  (v) ⟨⟩—$NHCH_2CH_3$ & ⟨⟩—$NHCOCH_3$

(d) Explain why? **(2.5 each)** **(5)** **(20)**
  (i) Tertiary carbocation is more stable than primary.
  (ii) Ethanol has higher boiling point than diethyl ether.

Q. 3. **(a)** Write the structural formula for more stable conformation of each of the following compounds. **(8)**

  a) *trans*-1-Fluoro-3-methylcyclohexane,
  b) *cis*-1-Iodo-4-methylcyclohexane
  c) *cis*-1-*tert*-Butyl-4-methylcyclohexane,
  d) *cis*-1,3,5-Trimethylcyclohexane