

JEE Main Chemistry Sample Paper - 14

Duration: 1 Hour

Maximum Marks: 100

Instructions

- This paper contains TWO sections: **Section A** (MCQs) and **Section B** (Numerical).
- Section A contains 20 Multiple Choice Questions.
- Section B contains 5 Numerical Value Questions.
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries **-1 mark**.
- No negative marking for unattempted questions.

Section A — Multiple Choice Questions

Q1. The number of stereoisomers possible for the compound $\text{CH}_3\text{-CH=CH-CH(Br)-CH}_3$ is: [JEE Main 2022]

- (A) 2
- (B) 3
- (C) 4
- (D) 6

Q2. Which intermediate is most stable? [JEE Main 2023]

- (A) CH_3^+
- (B) CH_3CH_2^+
- (C) $(\text{CH}_3)_3\text{C}^+$
- (D) $\text{CH}_2=\text{CH-CH}_2^+$

Q3. Major product of chlorination of propane in presence of light is: [JEE Main 2021]

- (A) 1-Chloropropane
- (B) 2-Chloropropane



- (C) Propene
- (D) 1,2-Dichloropropane

Q4. SN1 reaction is favoured by:

[JEE Main 2024]

- (A) Strong nucleophile
- (B) Polar protic solvent
- (C) High steric hindrance
- (D) Both (B) and (C)

Q5. Phenol is more acidic than ethanol due to:

[JEE Main 2020]

- (A) Inductive effect
- (B) Resonance stabilization
- (C) Hyperconjugation
- (D) Steric effect

Q6. Which has maximum reactivity towards nucleophilic addition?

[JEE Main 2023]

- (A) Formaldehyde
- (B) Acetaldehyde
- (C) Acetone
- (D) Benzaldehyde

Q7. Aldol condensation occurs in:

[JEE Main 2022]

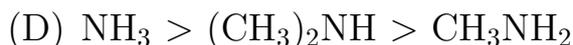
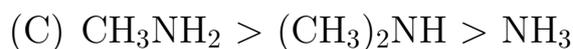
- (A) Only aldehydes without α -H
- (B) Aldehydes and ketones with α -H
- (C) Only ketones
- (D) Only aromatic aldehydes

Q8. Basicity order is:

[JEE Main 2021]

- (A) $\text{NH}_3 > \text{CH}_3\text{NH}_2 > (\text{CH}_3)_2\text{NH}$
- (B) $(\text{CH}_3)_2\text{NH} > \text{CH}_3\text{NH}_2 > \text{NH}_3$





Q9. Zwitter ion is formed by:

[JEE Main 2024]

(A) Glucose

(B) Glycine

(C) Fructose

(D) Urea

Q10. Which has maximum bond angle?

[JEE Main 2020]

(A) NH_3

(B) H_2O

(C) BF_3

(D) CH_4

Q11. Hybridization of Xe in XeF_4 :

[JEE Main 2022]

(A) sp^3

(B) sp^3d

(C) sp^3d^2

(D) sp^3d^3

Q12. Which has highest lone pair-lone pair repulsion?

[JEE Main 2021]

(A) NH_3

(B) H_2O

(C) CH_4

(D) CO_2

Q13. IUPAC name of $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ is:

[JEE Main 2023]

(A) Pentaamminechlorocobalt(III) chloride

(B) Pentaamminechlorocobalt(II) chloride

(C) Pentachlorocobalt(III) ammine



(D) None

Q14. Magnetic moment of $[\text{Fe}(\text{CN})_6]^{4-}$ is:

[JEE Main 2024]

(A) 0 BM

(B) 2 BM

(C) 4 BM

(D) 5 BM

Q15. Highest electronegativity is:

[JEE Main 2020]

(A) F

(B) Cl

(C) O

(D) N

Q16. Lanthanide contraction affects:

[JEE Main 2021]

(A) Atomic size

(B) Basic strength

(C) Density

(D) All

Q17. Unit of rate constant for first order reaction is:

[JEE Main 2022]

(A) s^{-1}

(B) $\text{mol L}^{-1} \text{s}^{-1}$

(C) $\text{L mol}^{-1} \text{s}^{-1}$

(D) $\text{mol}^2 \text{L}^{-2} \text{s}^{-1}$

Q18. EMF increases when:

[JEE Main 2023]

(A) Temperature increases

(B) Concentration difference increases

(C) Pressure decreases

(D) Electrolyte diluted



Q19. Number of moles in 44 g CO₂:

[JEE Main 2020]

- (A) 0.5
- (B) 1
- (C) 2
- (D) 44

Q20. At equilibrium:

[JEE Main 2024]

- (A) $\Delta G = 0$
- (B) $\Delta H = 0$
- (C) $\Delta S = 0$
- (D) None



Section B — Numerical Questions

- Q21.** Number of stereoisomers of tartaric acid: [JEE Main 2022]
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- Q22.** Half-life of a first order reaction is 10 min. Time required for 75% completion (in minutes): [JEE Main 2023]
-
- Q23.** pH of 0.01 M HCl: [JEE Main 2021]
-
- Q24.** Number of unpaired electrons in Fe^{3+} : [JEE Main 2020]
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- Q25.** If $\Delta H = -100 \text{ kJ}$ and $\Delta S = -200 \text{ J K}^{-1}$, the temperature (in K) at which $\Delta G = 0$: [JEE Main 2024]
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Detailed Solutions

Q1.

Solution

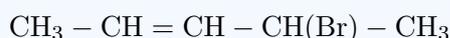
Concept: The number of stereoisomers depends on the presence of geometrical (E/Z) isomerism and optical isomerism due to chiral centers.

Formula:

$$\text{Total stereoisomers} = 2^n \times (\text{geometrical isomerism})$$

where n = number of chiral centers.

Solution: Given compound:



Step 1: Check for geometrical isomerism The double bond (C=C) has different groups on both carbons \rightarrow E/Z isomerism possible \rightarrow 2 isomers.

Step 2: Check for chiral center Carbon bearing Br is attached to four different groups:

-H, -Br, -CH₃, and alkenyl group

Hence, one chiral center \rightarrow 2 optical isomers.

Step 3: Total stereoisomers

$$2 (\text{geometrical}) \times 2 (\text{optical}) = 4$$

No meso form exists because there is only one chiral center.

Hence, total stereoisomers = 4.

Final Answer: (C)

Answer: (C)



Q2.

Solution

Concept: Stability of carbocations depends on hyperconjugation, inductive effect, and resonance stabilization. Resonance stabilization is more effective than hyperconjugation.

Formula:



Solution:

Given intermediates:

- (A) CH_3^+ → methyl carbocation (no stabilization)
 (B) CH_3CH_2^+ → primary carbocation (slightly stabilized by +I effect)
 (C) $(\text{CH}_3)_3\text{C}^+$ → tertiary carbocation (stabilized by hyperconjugation and +I effect)
 (D) $\text{CH}_2=\text{CH}-\text{CH}_2^+$ → allylic carbocation

Step 1: Identify resonance stabilization in option (D)



Positive charge is delocalized over two carbon atoms → strong resonance stabilization.

Step 2: Compare stability Resonance stabilization (allylic) is stronger than hyperconjugation (tertiary carbocation).

Hence,



Therefore, most stable intermediate is option (D).

Final Answer: (D)

Answer: (D)

Q3.

Solution

Concept: Free radical halogenation proceeds via a chain mechanism. Product distribution depends on stability of intermediate radicals ($3^\circ > 2^\circ > 1^\circ$).

Solution:

Propane undergoes chlorination via free radical mechanism.

Step 1: Possible radicals Primary radical: $\text{CH}_3-\text{CH}_2-\text{CH}_2$ Secondary radical: $\text{CH}_3-\dot{\text{C}}\text{H}-\text{CH}_3$

Step 2: Stability comparison Secondary radical is more stable than primary due to hyperconjugation.

Step 3: Major product Chlorine substitutes at secondary carbon.

Hence, major product = 2-chloropropane.

Final Answer: (B)

Answer: (B)



Q4.

Solution

Concept: SN1 reaction proceeds via carbocation intermediate. Stability of carbocation and solvent plays key role.

Solution:

Step 1: SN1 requires stable carbocation → favoured by steric hindrance.

Step 2: Polar protic solvents stabilize carbocation via solvation.

Step 3: Strong nucleophile is not necessary.

Hence, SN1 is favoured by:

Polar protic solvent + high steric hindrance

Final Answer: (D)

Answer: (D)

Q5.

Solution

Concept: Acidity depends on stability of conjugate base.

Solution:

Phenol forms phenoxide ion:



Step 1: Phenoxide ion is resonance stabilized:

Negative charge delocalized over ring

Step 2: Ethoxide ion has no resonance stabilization.

Hence, phenol is more acidic due to resonance stabilization.

Final Answer: (B)

Answer: (B)



Q6.

Solution

Concept: Reactivity towards nucleophilic addition depends on steric hindrance and +I effect.

Solution:

Step 1: Compare compounds Formaldehyde (no alkyl groups) → least steric hindrance
Acetaldehyde → one alkyl group Acetone → two alkyl groups Benzaldehyde → resonance reduces reactivity

Step 2: Reactivity order



Hence, most reactive = formaldehyde.

Final Answer: (A)

Answer: (A)

Q7.

Solution

Concept: Aldol condensation requires presence of α -hydrogen.

Solution:

Step 1: Aldehydes and ketones having α -H undergo aldol reaction.

Step 2: Compounds without α -H (like benzaldehyde) do not undergo aldol.

Hence, correct condition:

Aldehydes and ketones with α -H

Final Answer: (B)

Answer: (B)

Q8.

Solution

Concept: Basicity of amines depends on +I effect and solvation.

Solution:

Step 1: Alkyl groups increase electron density on N → increase basicity.

Step 2: In aqueous solution:



Secondary amine is most basic due to optimal +I effect and solvation.

Final Answer: (B)

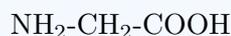
Answer: (B)



Q9.

Solution**Concept:** Zwitter ion contains both positive and negative charges in the same molecule.**Solution:**

Glycine structure:



In aqueous solution:



Hence, glycine exists as zwitter ion.

Final Answer: (B)

Answer: (B)

Q10.

Solution**Concept:** Bond angle depends on hybridization and lone pair repulsion.**Solution:**Step 1: Compare geometries $\text{NH}_3 \rightarrow$ trigonal pyramidal (107°) $\text{H}_2\text{O} \rightarrow$ bent (104.5°) $\text{BF}_3 \rightarrow$ trigonal planar (120°) $\text{CH}_4 \rightarrow$ tetrahedral (109.5°)

Step 2: Maximum bond angle is in trigonal planar geometry.

Hence, BF_3 has maximum bond angle.

Final Answer: (C)

Answer: (C)

Q11.

Solution**Concept:** Hybridization is determined by steric number (bond pairs + lone pairs).**Solution:**For XeF_4 :

Step 1: Xe has 8 valence electrons.

Step 2: Forms 4 bonds with F atoms \rightarrow 4 bond pairs.

Step 3: Remaining electrons form 2 lone pairs.

Total steric number:

$$4 + 2 = 6$$

Hybridization:



Geometry: Octahedral (electron pair), square planar (molecular)

Final Answer: (C)

Answer: (C)

Q12.

Solution**Concept:** Lone pair–lone pair repulsion is strongest among electron pair interactions.**Solution:**Compare: $\text{NH}_3 \rightarrow 1$ lone pair $\text{H}_2\text{O} \rightarrow 2$ lone pairs $\text{CH}_4 \rightarrow 0$ lone pair $\text{CO}_2 \rightarrow 0$ lone pair (on central atom)Maximum lone pair–lone pair repulsion occurs in H_2O .

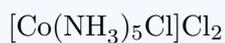
Final Answer: (B)

Answer: (B)

Q13.

Solution**Concept:** Naming of coordination compounds involves identifying ligands and oxidation state.**Solution:**

Given complex:

Step 1: Charge on complex ion = +2 Let oxidation state of Co = x

$$x + 0 \times 5 + (-1) = +2 \Rightarrow x = +3$$

Step 2: Ligands: $\text{NH}_3 \rightarrow$ ammine $\text{Cl}^- \rightarrow$ chloro

Step 3: Name: Pentaamminechlorocobalt(III) chloride

Final Answer: (A)

Answer: (A)

Q14.

Solution**Concept:** Magnetic moment depends on number of unpaired electrons.**Formula:**

$$\mu = \sqrt{n(n+2)} \text{ BM}$$

Solution:In $[\text{Fe}(\text{CN})_6]^{4-}$: $\text{Fe}^{2+} \rightarrow d^6$ CN^- is strong field ligand \rightarrow low spin complex

Electronic configuration:



Number of unpaired electrons = 0

Hence, magnetic moment = 0 BM.

Final Answer: (A)

Answer: (A)

Q15.

Solution**Concept:** Electronegativity increases across a period and decreases down a group.**Solution:**

Among given elements:



Fluorine has highest electronegativity.

Final Answer: (A)

Answer: (A)

Q16.

Solution

Concept: Lanthanide contraction is the gradual decrease in atomic size across lanthanide series.

Solution:

Effects of lanthanide contraction:

- Decrease in atomic size
- Increase in density
- Affect basic strength

Hence, it affects all listed properties.

Final Answer: (D)

Answer: (D)

Q17.

Solution

Concept: Unit of rate constant depends on order of reaction.

Solution:

For first order reaction:

$$\text{Rate} = k[A]$$

$$k = \frac{\text{Rate}}{[A]}$$

Units:

$$\frac{\text{mol L}^{-1}\text{s}^{-1}}{\text{mol L}^{-1}} = \text{s}^{-1}$$

Final Answer: (A)

Answer: (A)



Q18.

Solution**Concept:** EMF of a cell depends on concentration via Nernst equation.**Formula:**

$$E = E^\circ - \frac{0.059}{n} \log Q$$

Solution:Step 1: EMF increases when reaction quotient Q decreases.Step 2: Increasing concentration difference decreases Q .

Hence, EMF increases.

Final Answer: (B)

Answer: (B)

Q19.

Solution**Concept:** Number of moles = $\frac{\text{given mass}}{\text{molar mass}}$ **Solution:**Molar mass of CO_2 :

$$12 + 16 \times 2 = 44 \text{ g/mol}$$

Number of moles:

$$\frac{44}{44} = 1$$

Final Answer: (B)

Answer: (B)

Q20.

Solution**Concept:** At equilibrium, Gibbs free energy change becomes zero.**Formula:**

$$\Delta G = \Delta G^\circ + RT \ln K$$

At equilibrium:

$$\Delta G = 0$$

Solution:

System reaches equilibrium when no net change occurs and free energy is minimum.

Hence,

$$\Delta G = 0$$

Final Answer: (A)

Answer: (A)

Q21.

Solution

Concept: Number of stereoisomers depends on number of chiral centers and presence of meso form.

Formula:

$$\text{Maximum stereoisomers} = 2^n$$

Solution:

Tartaric acid has two chiral centers.

Step 1: Maximum stereoisomers:

$$2^2 = 4$$

Step 2: Due to internal plane of symmetry, one meso form exists.

Hence, total stereoisomers:

$$4 - 1 = 3$$

Final Answer: 3

Answer: (3)

Q22.

Solution

Concept: For first order reaction, relation between half-life and time is logarithmic.

Formula:

$$t = \frac{2.303}{k} \log \frac{a}{a-x}$$

Solution:

Given:

$$t_{1/2} = 10 \text{ min}$$

For first order reaction:

$$t_{1/2} = \frac{0.693}{k} \Rightarrow k = \frac{0.693}{10}$$

For 75% completion:

$$\frac{a}{a-x} = \frac{1}{0.25} = 4$$

$$t = \frac{2.303}{k} \log 4$$

$$t = \frac{2.303}{0.0693} \times 0.602 \approx 20 \text{ min}$$

Final Answer: 20

Answer: (20)



Q23.

Solution**Concept:** Strong acids completely ionize in water.**Formula:**

$$\text{pH} = -\log[\text{H}^+]$$

Solution:

HCl is a strong acid:

$$[\text{H}^+] = 0.01 = 10^{-2}$$

$$\text{pH} = -\log(10^{-2}) = 2$$

Final Answer: 2

Answer: (2)

Q24.

Solution**Concept:** Number of unpaired electrons depends on electronic configuration.**Solution:**

Fe: Atomic number = 26

Fe³⁺:

Remove 3 electrons:



Step 1: Distribute electrons:



Final Answer: 5

Answer: (5)

Q25.

Solution**Concept:** At equilibrium, Gibbs free energy change is zero.**Formula:**

$$\Delta G = \Delta H - T\Delta S$$

At equilibrium:

$$\Delta G = 0$$

Solution:

Given:

$$\Delta H = -100 \text{ kJ} = -100000 \text{ J}$$

$$\Delta S = -200 \text{ J/K}$$

Using:

$$0 = \Delta H - T\Delta S$$

$$T = \frac{\Delta H}{\Delta S}$$

$$T = \frac{-100000}{-200} = 500 \text{ K}$$

Final Answer: 500

Answer: (500)

Answer Key — Section A

Q	Answer								
1	C	2	D	3	B	4	D	5	B
6	A	7	B	8	B	9	B	10	C
11	C	12	B	13	A	14	A	15	A
16	D	17	A	18	B	19	B	20	A

Answer Key — Section B

Q	Answer	Q	Answer	Q	Answer
21	3	22	20	23	2
24	5	25	500		

