

JEE Main 2024 Chemistry Question Paper Jan 27 Shift 1 with Solutions

1. Which of the following has maximum magnetic moment?

- (1) $3d^3$
- (2) $3d^6$
- (3) $3d^7$

Correct Answer: (2) $3d^6$

Solution:

Step 1: Understanding magnetic moment.

Magnetic moment depends on the number of unpaired electrons. Higher the number of unpaired electrons, higher the magnetic moment.

Step 2: Determine unpaired electrons.

For 3d orbitals:

- $3d^3 \rightarrow 3$ unpaired electrons
- $3d^6 \rightarrow 4$ unpaired electrons (Hund's rule)
- $3d^7 \rightarrow 3$ unpaired electrons

Step 3: Conclusion.

Since $3d^6$ has the highest number of unpaired electrons (4), it has maximum magnetic moment.

Quick Tip

Magnetic moment increases with the number of unpaired electrons: $\mu = \sqrt{n(n+1)}$.

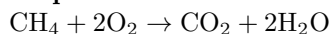
2. Mass of methane required to produce 22 g of CO_2 upon combustion is _____.

- (1) 6 g
- (2) 10 g
- (3) 8 g
- (4) 12 g

Correct Answer: (3) 8 g

Solution:

Step 1: Write the balanced combustion equation.



Step 2: Calculate moles of CO_2 .

$$\text{Moles of } \text{CO}_2 = \frac{22}{44} = 0.5$$

Step 3: Use mole ratio.

From equation: 1 mole $\text{CH}_4 \rightarrow 1$ mole CO_2

So moles of $\text{CH}_4 = 0.5$

Step 4: Calculate mass of CH₄.

$$\text{Mass} = 0.5 \times 16 = 8 \text{ g}$$

Quick Tip

Remember: CO₂ molar mass = 44 g/mol, CH₄ molar mass = 16 g/mol.

3. Assertion: Boron has very high melting point (2453 K).

Reason: Boron has strong crystalline lattice.

- (A) Assertion is true; Reason is true; Reason correctly explains Assertion
- (B) Assertion is true; Reason is true; Reason does not explain Assertion
- (C) Assertion true; Reason false
- (D) Assertion false; Reason true

Correct Answer: (A)

Solution:

Step 1: Check truth of Assertion.

Boron indeed has a very high melting point (2453 K). So the assertion is true.

Step 2: Check truth of Reason.

Boron has a strong 3D crystalline network made of rigid covalent bonds. So the reason is also true.

Step 3: Check explanation.

A strong crystalline lattice directly leads to a very high melting point. Hence the reason correctly explains the assertion.

Quick Tip

If strong covalent bonding or network lattice is present, melting point is always high.

4. Sum of bond order of CO and NO⁺ is:

- (1) 4
- (2) 5
- (3) 6
- (4) 7

Correct Answer: (3) 6

Solution:

Step 1: Bond order of CO.

CO has bond order = 3.

Step 2: Bond order of NO⁺.

NO⁺ is isoelectronic with CO → bond order = 3.

Step 3: Add both.

$$3 + 3 = 6$$

Quick Tip

Isoelectronic species have the same bond order.

5. How many of the following have +4 oxidation state of the central atom?

BaSO₄, SOCl₂, SF₄, H₂SO₃, H₂S₂O₇, SO₃

- (1) 1
- (2) 2
- (3) 3
- (4) 4

Correct Answer: (3) 3

Solution:

Step 1: Find oxidation states.

- BaSO₄: S = +6
- SOCl₂: S = +4
- SF₄: S = +4
- H₂SO₃: S = +4
- H₂S₂O₇: S = +6 (average)
- SO₃: S = +6

Step 2: Count species with +4 oxidation state.

SOCl₂, SF₄, H₂SO₃ → 3 compounds.

Step 3: Conclusion.

Total = 3 compounds.

Quick Tip

Always assign oxygen as -2 and hydrogen as +1 while calculating oxidation states.

6. PbCrO₄ + NaOH (hot excess) → ?

Product is:

- (1) dianionic ; CN = 4
- (2) tetra-anionic ; CN = 6
- (3) dianionic ; CN = 6
- (4) tetra-anionic ; CN = 4

Correct Answer: (4) tetra-anionic ; CN = 4

Solution:

Step 1: Understand the reaction.

PbCrO_4 reacts with excess hot NaOH to form a soluble chromate complex. Lead(II) precipitate dissolves in strong base, producing a tetra-anionic chromate species.

Step 2: Coordination concept.

Chromate ion (CrO_4^{2-}) has coordination number 4 because chromium is surrounded by four oxygen atoms in a tetrahedral structure.

Step 3: Conclusion.

Thus, the product formed is a tetra-anion with $\text{CN} = 4$.

Quick Tip

Chromate (CrO_4^{2-}) is always tetrahedral with coordination number 4.

7. For negative deviation from Raoult's law:

- (1) BP increases ; VP increases
- (2) BP decreases ; VP increases
- (3) BP decreases ; VP decreases
- (4) BP increases ; VP decreases

Correct Answer: (4) BP increases ; VP decreases

Solution:

Step 1: Understanding negative deviation.

Negative deviation occurs when intermolecular forces between different components (A–B) are stronger than between like components (A–A and B–B).

Step 2: Effect on vapour pressure.

Stronger interactions lower vapour pressure because fewer molecules escape into vapour phase.

Step 3: Effect on boiling point.

Lower vapour pressure means the solution requires more heating to boil $\rightarrow$ boiling point increases.

Step 4: Conclusion.

Therefore, in negative deviation: BP increases and VP decreases.

Quick Tip

Stronger intermolecular attraction $\rightarrow$ low vapour pressure $\rightarrow$ high boiling point.

8. $\text{NaCl} + \text{H}_2\text{SO}_4 + \text{K}_2\text{Cr}_2\text{O}_7 \rightarrow$ Products

The reaction gives red fumes (A) which on hydrolysis with aqueous NaOH gives yellow solution (B). Compounds (A) and (B) are:

- (1) CrO_2Cl_2 , Na_2CrO_4
- (2) CrCl_3 , NaCrO_2
- (3) CrO_3 , $\text{Na}_2\text{Cr}_2\text{O}_7$
- (4) CrCl_2 , $\text{Na}_2\text{Cr}_2\text{O}_7$

Correct Answer: (1) CrO_2Cl_2 , Na_2CrO_4

Solution:

Step 1: Identify compound (A).

$\text{K}_2\text{Cr}_2\text{O}_7 + \text{NaCl} + \text{H}_2\text{SO}_4$ produces a red volatile compound CrO_2Cl_2 (chromyl chloride).

Step 2: Hydrolysis of (A).



This gives yellow sodium chromate (B).

Step 3: Conclusion.

Thus, (A) = CrO_2Cl_2 , (B) = Na_2CrO_4 .

Quick Tip

Red fumes in dichromate + chloride + acid test always indicate chromyl chloride formation.

9. Order of spin-only magnetic moment for:

FeF_6^{3-} (P), $[\text{V}(\text{H}_2\text{O})_6]^{2+}$ (Q), $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ (R)

- (1) $\text{P} < \text{R} > \text{Q}$
- (2) $\text{P} > \text{Q} > \text{R}$
- (3) $\text{R} > \text{Q} > \text{P}$
- (4) $\text{Q} > \text{P} > \text{R}$

Correct Answer: (1) $\text{P} > \text{R} > \text{Q}$

Solution:

Step 1: Determine unpaired electrons.

P: $[\text{FeF}_6]^{3-} \rightarrow \text{Fe}^{3+} \rightarrow 3d^5 \rightarrow 5$ unpaired electrons (weak field), $\mu = \sqrt{35}$

Q: $[\text{V}(\text{H}_2\text{O})_6]^{2+} \rightarrow \text{V}^{2+} \rightarrow 3d^3 \rightarrow 3$ unpaired electrons, $\mu = \sqrt{15}$

R: $[\text{Fe}(\text{H}_2\text{O})_6]^{2+} \rightarrow \text{Fe}^{2+} \rightarrow 3d^6 \rightarrow 4$ unpaired electrons (weak field), $\mu = \sqrt{24}$

Step 2: Compare values.

$$\sqrt{35} > \sqrt{24} > \sqrt{15}$$

Step 3: Conclusion.

Thus, $\text{P} > \text{R} > \text{Q}$.

Quick Tip

Magnetic moment increases with number of unpaired electrons: $\mu = \sqrt{n(n+1)}$.

10. Electronic configuration of Nd ($Z = 60$) is:

- (1) $[\text{Xe}] 4f^4 6s^2$
- (2) $[\text{Xe}] 4f^6 6s^2$

- (3) $[\text{Xe}] 4f^3 6s^2$
 (4) $[\text{Xe}] 4f^5 6s^2$

Correct Answer: (1) $[\text{Xe}] 4f^4 6s^2$

Solution:

Step 1: Locate Nd in periodic table.

Nd (Neodymium) belongs to lanthanides, starting from Ce ($Z=58$).

Step 2: Fill electrons in 4f subshell.

Lanthanides progressively fill the 4f orbitals. Nd has 4 electrons in 4f.

Step 3: Conclusion.

Thus, configuration = $[\text{Xe}] 4f^4 6s^2$.

Quick Tip

Lanthanides fill the 4f subshell from Ce (58) to Lu (71).

11. Statement-1: $(\text{NH}_4)_2\text{CO}_3$ is basic.

Statement-2: The acidic nature of salt of a weak acid (WA) and weak base (WB) depends on K_a of WA and K_b of WB.

- (A) $S_1 \rightarrow \text{T}$; $S_2 \rightarrow \text{T}$
 (B) $S_1 \rightarrow \text{T}$; $S_2 \rightarrow \text{F}$
 (C) $S_1 \rightarrow \text{F}$; $S_2 \rightarrow \text{T}$
 (D) $S_1 \rightarrow \text{F}$; $S_2 \rightarrow \text{F}$

Correct Answer: (A) $S_1 \rightarrow \text{True}$; $S_2 \rightarrow \text{True}$

Solution:

Step 1: Check Statement-1.

$(\text{NH}_4)_2\text{CO}_3$ contains NH_4^+ (weak acid) and CO_3^{2-} (strong base conjugate), giving an overall basic salt. Hence S_1 is true.

Step 2: Check Statement-2.

For salts of weak acid and weak base, pH depends on relative strengths (K_a vs K_b). Hence S_2 is true.

Step 3: Conclusion.

Both statements are true.

Quick Tip

Weak acid + weak base $\rightarrow$ pH depends on K_a and K_b .

12. Number of electrons present in all the completely filled subshells having $n = 4$ and $s = +\frac{1}{2}$.

- (1) 8
 (2) 12

- (3) 16
(4) 20

Correct Answer: (3) 16

Solution:

Step 1: Identify all subshells for $n = 4$.

For $n = 4$, the subshells are: 4s, 4p, 4d, 4f.

Step 2: Count electrons with spin $+\frac{1}{2}$.

In completely filled subshells:

- 4s: 2 electrons $\rightarrow$ 1 with spin $+\frac{1}{2}$
- 4p: 6 electrons $\rightarrow$ 3 with spin $+\frac{1}{2}$
- 4d: 10 electrons $\rightarrow$ 5 with spin $+\frac{1}{2}$
- 4f: 14 electrons $\rightarrow$ 7 with spin $+\frac{1}{2}$

Step 3: Add them.

$$1 + 3 + 5 + 7 = 16$$

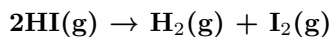
Step 4: Conclusion.

Total electrons with spin $+\frac{1}{2} = 16$.

Quick Tip

In filled subshells, half the electrons have spin $+\frac{1}{2}$ and the other half have spin $-\frac{1}{2}$.

13. Consider the following data for the reaction:



	Experiment-1	Experiment-2
[HI] (mol/L)	0.005	0.01
Rate (mol L ⁻¹ s ⁻¹)	7.5×10^{-4}	3×10^{-3}

Find the order of reaction.

- (1) 1
(2) 2
(3) 3
(4) 4

Correct Answer: (2) 2

Solution:

Step 1: Use rate law.

$$\text{Rate} = k[\text{HI}]^x$$

Step 2: Take ratio of Experiment-2 to Experiment-1.

$$\frac{3 \times 10^{-3}}{7.5 \times 10^{-4}} = \left(\frac{0.01}{0.005} \right)^x$$

Step 3: Simplify.

Left side: 4

Right side: 2^x because $\frac{0.01}{0.005} = 2$.

$$4 = 2^x \Rightarrow x = 2$$

Step 4: Conclusion.

The reaction is second order.

Quick Tip

Rate ratio method is simplest when concentration doubles or triples between experiments.

14. If 3 moles of an ideal gas at 300 K expand isothermally from 30 dm³ to 45 dm³ against constant pressure of 80 kPa, the amount of heat transferred is ___ joule.

- (1) 800 J
- (2) 900 J
- (3) 1200 J
- (4) 1500 J

Correct Answer: (3) 1200 J

Solution:**Step 1: Identify process.**

Isothermal irreversible expansion $\rightarrow \Delta E = 0$.

Step 2: Use first law.

$$\Delta E = q + W = 0 \Rightarrow q = -W$$

Step 3: Work done against constant pressure.

$$W = -P(V_2 - V_1)$$

Step 4: Convert units.

$$45 - 30 = 15 \text{ dm}^3 = 15 \times 10^{-3} \text{ m}^3$$

$$\text{Pressure} = 80 \text{ kPa} = 80 \times 10^3 \text{ Pa}.$$

$$q = 80 \times 10^3 \times 15 \times 10^{-3} = 1200 \text{ J}$$

Step 5: Conclusion.

Heat absorbed = 1200 J.

Quick Tip

For isothermal irreversible expansion: $q = P_{\text{ext}}(V_2 - V_1)$.

15. The mass of silver ($\text{Ag} = 108 \text{ g/mol}$) displaced by a quantity of electricity that displaces 5600 mL of O_2 at STP will be:

- (1) 54 g
- (2) 81 g
- (3) 108 g
- (4) 216 g

Correct Answer: (3) 108 g

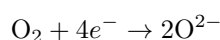
Solution:

Step 1: Convert volume of O_2 to moles.

At STP: $22.4 \text{ L} = 1 \text{ mol}$.

$$\text{Moles of } \text{O}_2 = \frac{5600 \text{ mL}}{22400 \text{ mL}} = 0.25 \text{ mol}$$

Step 2: Write half-reaction for O_2 .

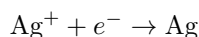


Thus, 1 mole of O_2 requires 4 moles of electrons.

So moles of electrons used:

$$0.25 \times 4 = 1 \text{ mol electrons}$$

Step 3: Use Ag deposition equation.



1 mol electron deposits 1 mol $\text{Ag} = 108 \text{ g}$.

Step 4: Conclusion.

Mass of Ag deposited = 108 g.

Quick Tip

Relate moles of electrons from one half-cell to the metal deposited in another using Faraday's law.

16. Which of the following has oxidation state +4?

- (1) $\text{H}_2\text{S}_2\text{O}_7$
- (2) H_2SO_3

Correct Answer: (2) H_2SO_3

Solution:

Step 1: Write oxidation state equation for sulphur in H_2SO_3 .

$\text{H} = +1$, $\text{O} = -2$.

$$2(+1) + x + 3(-2) = 0$$

Step 2: Solve for x.

$$2 + x - 6 = 0$$

$$x = +4$$

Step 3: Conclusion.

Sulphur in H_2SO_3 is in oxidation state +4.

Quick Tip

In oxyacids, oxidation state of the central atom is found using:
 $\text{H} = +1$, $\text{O} = -2$, and overall charge = 0.

17. Which halogen does not show variable oxidation states?

- (1) F_2
- (2) Cl_2
- (3) Br_2
- (4) I_2

Correct Answer: (1) F_2

Solution:**Step 1: General behaviour of halogens.**

Cl, Br and I show multiple oxidation states such as -1 , $+1$, $+3$, $+5$, $+7$.

Step 2: Behaviour of fluorine.

Fluorine is the most electronegative element and can only gain electrons.
Therefore, it shows oxidation state -1 only.

Step 3: Conclusion.

Fluorine does not show variable oxidation states.

Quick Tip

Fluorine is always -1 in all its compounds because it is the strongest oxidizing agent.

18. Statement-1: The 4f and 5f series are written separately in the periodic table to preserve the principle of classification.

Statement-2: s-block elements are found on earth in pure form.

- (A) $\text{S}_1 \rightarrow \text{T}$; $\text{S}_2 \rightarrow \text{T}$
- (B) $\text{S}_1 \rightarrow \text{T}$; $\text{S}_2 \rightarrow \text{F}$
- (C) $\text{S}_1 \rightarrow \text{F}$; $\text{S}_2 \rightarrow \text{T}$
- (D) $\text{S}_1 \rightarrow \text{F}$; $\text{S}_2 \rightarrow \text{F}$

Correct Answer: (B) $\text{S}_1 \rightarrow \text{True}$; $\text{S}_2 \rightarrow \text{False}$

Solution:**Step 1: Check Statement-1.**

Lanthanides (4f) and actinides (5f) are placed separately because including them in the main body would make the table extremely wide. Hence Statement-1 is true.

Step 2: Check Statement-2.

s-block elements like alkali and alkaline earth metals are highly reactive and occur in nature only as compounds, not in pure form. Hence Statement-2 is false.

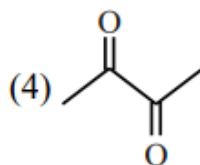
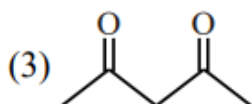
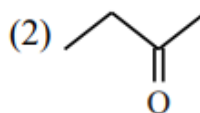
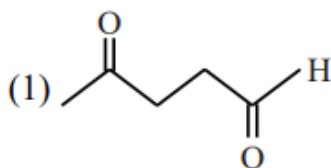
Step 3: Conclusion.

S₁ is true and S₂ is false.

Quick Tip

Alkali metals react vigorously with air and water, so they never occur free in nature.

19. Which of the following compounds is most acidic?



Correct Answer: (3)

Solution:**Step 1: Identify stabilizing effects.**

Acidity increases if the conjugate base is resonance-stabilized or has electron-withdrawing groups.

Step 2: Analyse structure (3).

The compound in option (3) contains two carbonyl groups adjacent to the acidic hydrogen. This allows strong resonance stabilization of the conjugate base.

Step 3: Compare with others.

Other structures have either one carbonyl group or less stabilization. Thus, (3) is most acidic.

Step 4: Conclusion.

Compound (3) is the most acidic due to maximum resonance stabilization.

Quick Tip

More carbonyl groups near a hydrogen → more acidic due to resonance stabilization of conjugate base.

20. Which of the following is the strongest Brønsted base?



Correct Answer: (3) Pyrrolidine

Solution:

Step 1: Understand Brønsted base strength.

A strong Brønsted base readily accepts protons. Basicity increases when the lone pair on nitrogen is more available.

Step 2: Compare compounds.

- Aniline: Lone pair delocalized into the aromatic ring → weak base.
- Pyrrole: Lone pair participates in aromaticity → very weak base.
- Pyridine: Lone pair is on sp^2 N → moderately basic.
- Pyrrolidine: Lone pair is on sp^3 N → highly available → strongest base.

Step 3: Conclusion.

Pyrrolidine (sp^3 -hybridized nitrogen) is the strongest Brønsted base.

Quick Tip

Basicity order: sp^3 N > sp^2 N > sp N > aromatic N (delocalized).

21. The correct statement regarding stereochemistry of S_N1 and S_N2 reactions is:

- (1) S_N1 – Racemisation ; S_N2 – Retention
- (2) S_N1 – Racemisation ; S_N2 – Inversion
- (3) S_N1 – Retention ; S_N2 – Inversion
- (4) S_N1 – Inversion ; S_N2 – Retention

Correct Answer: (2)

Solution:

Step 1: S_N1 mechanism.

S_N1 involves formation of a planar carbocation intermediate. Nucleophile can attack from both sides → mixture of 50

Step 2: S_N2 mechanism.

S_N2 is a one-step backside attack mechanism. Backside attack always causes inversion of configuration (Walden inversion).

Step 3: Conclusion.

S_N1 → racemisation, S_N2 → inversion.

Quick Tip

S_N1 = planar carbocation → racemisation. S_N2 = backside attack → inversion.

22. Which of the following has maximum enol content?



Correct Answer: (1)

Solution:

Step 1: Understand enolisation.

Enol content depends on stability of the enol form. More resonance or intramolecular H-bonding $\rightarrow$ greater enol content.

Step 2: Analyse option (1).

The compound has two carbonyl groups positioned to allow strong intramolecular hydrogen bonding in its enol form. This stabilizes the enol tautomer significantly.

Step 3: Compare with other options.

Other compounds have less resonance or no intramolecular H-bonding $\rightarrow$ less enol content.

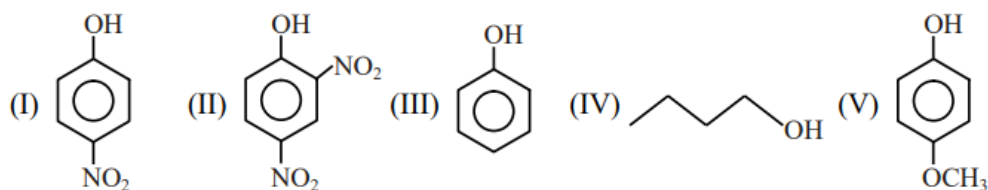
Step 4: Conclusion.

Thus, option (1) has the maximum enol content.

Quick Tip

Enol content increases with intramolecular hydrogen bonding and conjugation.

23. The correct order of acidic strength of the following compounds is:



- (1) II > I > III > V > IV
(2) II > I > V > III > IV
(3) I > II > III > V > IV
(4) V > IV > III > I > II

Correct Answer: (1)

Solution:

Step 1: Identify electron-withdrawing and donating groups.

- NO_2 is strong $-M$, $-I \rightarrow$ increases acidity.
- OCH_3 is strong $+M \rightarrow$ decreases acidity.

Step 2: Analyse compounds.

- (II) has two NO_2 groups $\rightarrow$ strongest acid.
- (I) has one NO_2 group $\rightarrow$ next strongest.
- (III) phenol $\rightarrow$ moderately acidic.
- (V) methoxy phenol $\rightarrow$ electron donation reduces acidity.
- (IV) alcohol $\rightarrow$ least acidic.

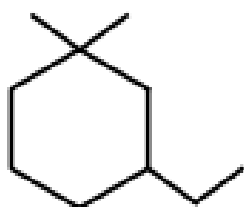
Step 3: Conclusion.

Hence the order: $\text{II} > \text{I} > \text{III} > \text{V} > \text{IV}$.

Quick Tip

Electron-withdrawing groups increase acidity; electron-donating groups decrease acidity.

24. The correct IUPAC name of the following compound is:



- (1) 1,1-Dimethyl-3-ethyl cyclohexane
- (2) 3-Ethyl-1,1-dimethyl cyclohexane
- (3) 1-Ethyl-3,3-dimethyl cyclohexane
- (4) 3,3-Dimethyl-1-ethyl cyclohexane

Correct Answer: (2)

Solution:

Step 1: Select parent chain.

Cyclohexane is the parent ring.

Step 2: Number the ring.

Two methyl groups are on the same carbon $\rightarrow$ must be C-1,1 substituents. Ethyl group gets the lowest possible number for next substituent $\rightarrow$ C-3.

Step 3: Arrange substituents alphabetically.

Ethyl (E) appears before methyl (M).

Step 4: Conclusion.

Correct name: 3-Ethyl-1,1-dimethyl cyclohexane.

Quick Tip

When multiple substituents are present, assign lowest locants and use alphabetical order.

25. Cyclohexene is classified as:

- (1) Benzenoid aromatic
- (2) Alicyclic
- (3) Benzenoid non aromatic
- (4) Acyclic

Correct Answer: (2) Alicyclic

Solution:

Step 1: Examine structure.

Cyclohexene is a cyclic compound (ring) but not aromatic.

Step 2: Classification rule.

A cyclic compound that is not aromatic is called an alicyclic compound.

Step 3: Conclusion.

Cyclohexene is an alicyclic compound.

Quick Tip

Alicyclic = cyclic but not aromatic.

26. Which of the following is a polar solvent?

- (1) CCl_4
- (2) CHCl_3
- (3) $\text{CH}_2=\text{CH}_2$
- (4) CO_2

Correct Answer: (2) CHCl_3

Solution:

Step 1: Check polarity.

CHCl_3 (chloroform) is polar because of C–Cl bond dipoles that do not fully cancel.

Step 2: Compare with others.

- CCl_4 : symmetrical tetrahedral $\rightarrow$ nonpolar.
- $\text{CH}_2=\text{CH}_2$: alkene, nonpolar.
- CO_2 : linear and symmetrical $\rightarrow$ nonpolar.

Step 3: Conclusion.

Only CHCl_3 is polar.

Quick Tip

Symmetry cancels dipole moments $\rightarrow$ molecule becomes nonpolar.

27. When nucleotides form a dimer, the linkage present between them is:

- (1) Disulphide linkage
- (2) Glycosidic linkage
- (3) Phosphodiester linkage
- (4) Peptide linkage

Correct Answer: (3) Phosphodiester linkage

Solution:

Step 1: Understand nucleotide structure.

A nucleotide contains a sugar, phosphate, and nitrogen base.

Step 2: How two nucleotides link.

The phosphate group of one nucleotide links to the 3'-OH of another nucleotide. This bond is called a phosphodiester bond.

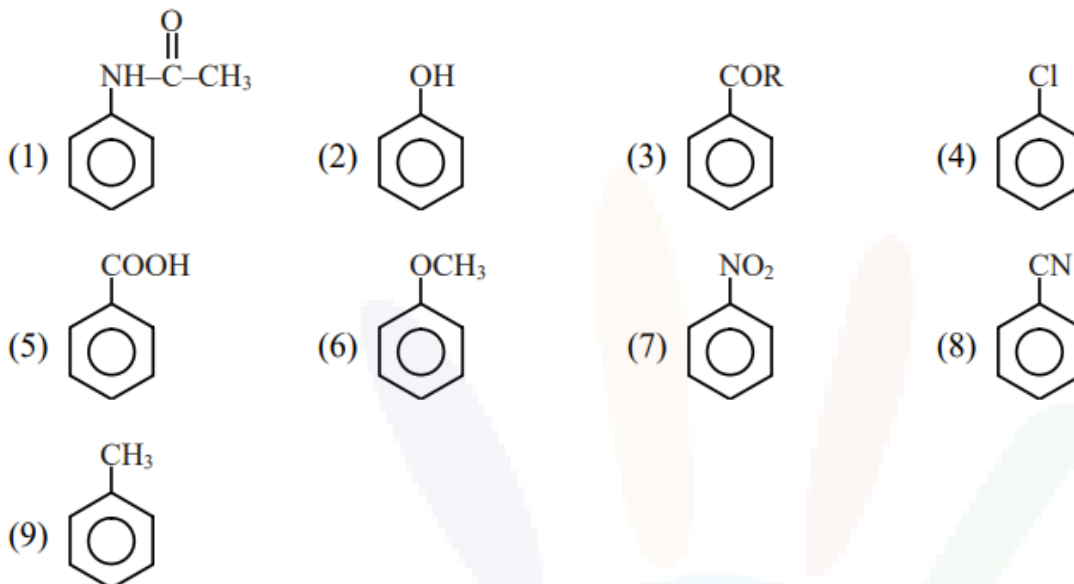
Step 3: Conclusion.

Therefore, nucleotides form dimers through phosphodiester linkage.

Quick Tip

DNA and RNA strands grow via 3'-5' phosphodiester bonds.

28. How many groups show meta-directing effect on benzene ring?



- (1) 3
- (2) 5
- (3) 6
- (4) 4

Correct Answer: (4)

Solution:**Step 1: Identify the nature of substituents.**

Meta-directing groups are electron-withdrawing groups ($-M$ or strong $-I$) that deactivate the ring.

Step 2: Check each substituent:

- (1) $-NHCOCH_3$: Electron-donating (amide) $\rightarrow$ ortho/para directing.
- (2) OH : $+M$ group $\rightarrow$ ortho/para directing.
- (3) COR (acyl): Strong $-M \rightarrow$ Meta directing
- (4) Cl : $-I$ but $+M \rightarrow$ overall ortho/para directing.
- (5) $COOH$: Strong $-M$, $-I \rightarrow$ Meta directing
- (6) OCH_3 : $+M \rightarrow$ ortho/para directing.
- (7) NO_2 : Very strong $-M$, $-I \rightarrow$ Meta directing
- (8) CN : Strong $-M$, $-I \rightarrow$ Meta directing
- (9) CH_3 : $+I \rightarrow$ ortho/para directing.

Step 3: Count meta directors.

Meta directing groups = (3), (5), (7), (8) = 4 groups.

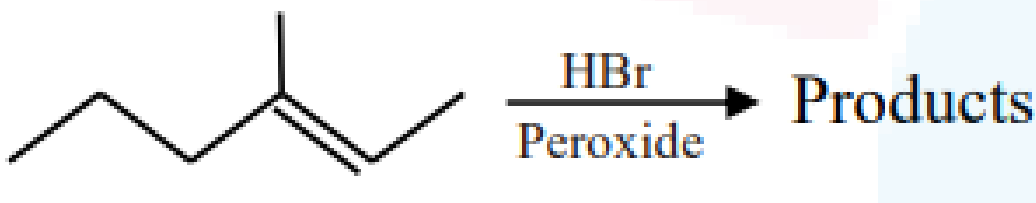
Step 4: Conclusion.

Total meta-directing groups = 4.

Quick Tip

All strong electron-withdrawing groups ($-NO_2$, $-CN$, $-COOH$, $-COR$, $-SO_3H$) are ALWAYS meta-directing.

29. The following reaction is carried out with HBr in the presence of peroxide:
How many products including stereoisomers are obtained?



- (1) 2
- (2) 3
- (3) 4
- (4) 5

Correct Answer: 4

Solution:**Step 1: Understand the reaction mechanism.**

$HBr + \text{Peroxide} \rightarrow$ Anti-Markovnikov addition (free radical mechanism). Br adds to the less substituted carbon of the double bond.

Step 2: Identify the two new chiral centers.

The product formed has two stereocenters (marked *):



Two stereocenters $\rightarrow$ possible stereoisomers $= 2^2 = 4$.

Step 3: List types of stereoisomers.

Four stereoisomers include: - RR - SS - RS - SR

Step 4: Conclusion.

Thus, total products including stereoisomers $= 4$.

Quick Tip

Anti-Markovnikov addition of HBr in the presence of peroxides follows a radical pathway and often creates new chiral centers $\rightarrow$ multiple stereoisomers.