AIIMS Paramedical Chemistry
Sample Paper – 3

Duration: 30 Minutes **Maximum Marks: 30**

Instructions

- This paper contains **30** Multiple Choice Questions (Single Correct Answer), modelled on the Chemistry portion of **AIIMS Paramedical** entrance.
- Each correct answer carries **+1 mark**; each incorrect answer carries **a penalty of** $-\frac{1}{3}$ **mark**; an unattempted question carries **0 marks**.
- Only **one** option is correct. Choose carefully.
- Syllabus level: **Class 11 & 12 NCERT Chemistry**
- Use of mobile phones, calculators, or electronic gadgets is strictly prohibited.

Q1. For the reaction $N_2 + 3H_2 \rightarrow 2NH_3$, if 4 mol of N_2 are mixed with 9 mol of H_2, the maximum moles of NH_3 that can be formed is

(A) 4

(B) 6

(C) 8

(D) 9

Q2. The de Broglie wavelength associated with an electron of mass m moving with velocity v is given by (h = Planck's constant)

(A) $\lambda = mvh$

(B) $\lambda = \dfrac{mv}{h}$

(C) $\lambda = \dfrac{h}{mv}$

(D) $\lambda = \dfrac{h}{mv^2}$

Q3. A vessel contains 2 mol of O_2 and 3 mol of N_2 exerting a total pressure of 5 atm. The partial pressure of O_2 in the vessel is

(A) 2 atm

(B) 3 atm

(C) 5 atm

(D) 1 atm

Q4. A system absorbs $50\,\text{J}$ of heat and does $20\,\text{J}$ of work on the surroundings. The change in internal energy ΔU of the system is

(A) $-70\,\text{J}$

(B) $+70\,\text{J}$

(C) $-30\,\text{J}$

(D) $+30\,\text{J}$

Q5. For the dissociation $PCl_5 \rightleftharpoons PCl_3 + Cl_2$, 1 mol of PCl_5 is taken in a vessel and at equilibrium 0.4 mol of Cl_2 is formed. The degree of dissociation of PCl_5 is

(A) 0.2

(B) 0.4

(C) 0.6

(D) 0.8

Q6. A buffer solution contains $0.1\,\text{M}$ CH_3COOH and $0.1\,\text{M}$ CH_3COONa. If pK_a of acetic acid is 4.74, the pH of the buffer is

(A) 3.74

(B) 5.74

(C) 4.74

(D) 7.00

Q7. In the reaction $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$, the oxidising agent is

(A) Cu^{2+}

(B) Zn

(C) SO_4^{2-}

(D) Zn^{2+}

Q8. The specific conductivity of a 0.1 M solution of an electrolyte is 0.02 S cm^{-1}. Its molar conductivity (in S cm^2 mol^{-1}) is

(A) 2

(B) 20

(C) 0.2

(D) 200

Q9. The unit of the rate constant for a first-order reaction is

(A) mol L^{-1} s^{-1}

(B) s^{-1}

(C) L mol^{-1} s^{-1}

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

Q10. The depression in freezing point of a solution is given by $\Delta T_f = K_f\, m$. Here K_f is the

(A) molality of the solution

(B) ebullioscopic constant

(C) molal depression (cryoscopic) constant

(D) mole fraction of solute

Q11. Which of the following elements has the most negative (most exothermic) electron gain enthalpy?

(A) F

(B) O

(C) S

(D) Cl

Q12. As we move from left to right across a period, the nature of the oxides of the elements generally changes from

(A) basic to acidic

(B) acidic to basic

(C) neutral to basic

(D) acidic to neutral

Q13. The number of sigma (σ) and pi (π) bonds present in an ethyne (C_2H_2) molecule is

(A) $2\ \sigma$ and $3\ \pi$

(B) $3\ \sigma$ and $2\ \pi$

(C) $4\ \sigma$ and $1\ \pi$

(D) $5\ \sigma$ and $2\ \pi$

Q14. Which of the following species is best described by resonance, having all bonds of equal length?

(A) CH_4

(B) H_2O

(C) CO_3^{2-}

(D) NH_3

Q15. Because of the diagonal relationship, lithium shows the closest resemblance in properties to which of the following elements?

(A) Na

(B) K

(C) Be

(D) Mg

Q16. In which of the following oxides of nitrogen is the oxidation state of nitrogen $+5$?

(A) N_2O_5

(B) N_2O_3

(C) NO

(D) N_2O

Q17. The brown ring formed in the test for nitrate ions is due to the formation of the complex

(A) $[Fe(CN)_6]^{4-}$

(B) $[Fe(H_2O)_5(NO)]^{2+}$

(C) $[Fe(H_2O)_6]^{3+}$

(D) $[Fe(SCN)]^{2+}$

Q18. The spin-only magnetic moment of the Fe^{3+} ion (atomic number of Fe $= 26$) is approximately

(A) 1.73 BM

(B) 3.87 BM

(C) 5.92 BM

(D) 2.83 BM

Q19. The effective atomic number (EAN) of the central metal atom in $[Fe(CN)_6]^{4-}$ (atomic number of Fe $= 26$) is

(A) 30

(B) 32

(C) 34

(D) 36

Q20. Hydrogen peroxide can act both as an oxidising agent and as a reducing agent. When H_2O_2 acts as a reducing agent in acidic medium, it is

(A) oxidised to O_2

(B) reduced to H_2O

(C) oxidised to H_2O

(D) reduced to O_2

Q21. Hyperconjugation involves the delocalisation of electrons of a

(A) lone pair into an empty orbital

(B) $C-H$ sigma bond adjacent to an unsaturated system

(C) pi bond into a pi bond

(D) filled p orbital into a sigma bond

Q22. Which of the following compounds is chiral (optically active)?

(A) $CH_3CH_2CH_3$

(B) CH_3CHCl_2

(C) $CH_3CHBrCl$

(D) CH_2ClCH_2Cl

Q23. Catalytic hydrogenation of ethene ($CH_2{=}CH_2$) in the presence of nickel gives

(A) ethyne

(B) ethanol

(C) benzene

(D) ethane

Q24. Which of the following hydrocarbons reacts with ammoniacal silver nitrate solution to give a white precipitate?

(A) $CH \equiv CH$

(B) $CH_3{-}C \equiv C{-}CH_3$

(C) $CH_2{=}CH_2$

(D) $CH_3{-}CH_3$

Q25. When a Grignard reagent CH_3MgBr reacts with formaldehyde ($HCHO$) followed by acidic hydrolysis, the product formed is

(A) methanol

(B) ethanol

(C) propan-1-ol

(D) propan-2-ol

Q26. Dehydration of ethanol with concentrated H_2SO_4 at 443 K ($170°$C) gives mainly

(A) diethyl ether

(B) ethanal

(C) ethene

(D) ethane

Q27. Which of the following aldehydes undergoes the Cannizzaro reaction?

(A) CH_3CHO

(B) CH_3CH_2CHO

(C) $(CH_3)_2CHCHO$

(D) $HCHO$

Q28. Which of the following carboxylic acids is the strongest acid?

(A) $Cl_3C{-}COOH$

(B) $ClCH_2{-}COOH$

(C) $CH_3{-}COOH$

(D) $H{-}COOH$

Q29. The carbylamine reaction, which produces a foul-smelling isocyanide, is a test for

(A) secondary amines

(B) primary amines

(C) tertiary amines

(D) quaternary ammonium salts

Q30. The pH at which an amino acid exists predominantly as a dipolar zwitterion with no net charge is called its

(A) pK_a value

(B) neutral point

(C) isoelectric point

(D) equivalence point

Detailed Solutions

Q1.

Solution

Concept — Limiting reagent: The reactant that is completely consumed first limits the amount of product. Compare available moles against the stoichiometric requirement.

Step 1 — Reaction and ratio: $N_2 + 3H_2 \rightarrow 2NH_3$. One mole of N_2 needs 3 mol of H_2.

Step 2 — Requirement for 4 mol N_2: To fully react 4 mol N_2 we would need $4 \times 3 = 12$ mol H_2.

Step 3 — Available H_2: Only 9 mol H_2 is present, which is less than 12 mol. Hence H_2 is the limiting reagent.

Step 4 — Product from limiting reagent: From 3 mol $H_2 \rightarrow 2$ mol NH_3.

So 9 mol $H_2 \rightarrow \frac{2}{3} \times 9 = 6$ mol NH_3.

Why other options are wrong:

- 4, 8: assume N_2 is limiting, which is incorrect here.
- 9: equates moles of product to moles of H_2, ignoring stoichiometry.

Final Answer: Maximum NH_3 formed $= 6$ mol $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — de Broglie hypothesis: Every moving particle has an associated wavelength $\lambda = \frac{h}{p}$, where $p = mv$ is the linear momentum.

Step 1 — Substitute momentum: With $p = mv$, we get

$$\lambda = \frac{h}{mv}.$$

Step 2 — Interpretation: Wavelength is inversely proportional to mass and velocity, so heavier or faster particles have shorter wavelengths.

Why other options are wrong:

- $\lambda = mvh$ and $\lambda = \frac{mv}{h}$: dimensionally and conceptually wrong (place momentum in numerator).
- $\lambda = \frac{h}{mv^2}$: uses v^2 instead of v, which is incorrect.

Final Answer: $\lambda = \frac{h}{mv} \Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q2**

Q3.

Solution

Concept — Dalton's law of partial pressures: The partial pressure of a gas equals its mole fraction times the total pressure: $p_i = x_i\,P_{\text{total}}$.

Step 1 — Total moles: $n_{\text{total}} = 2 + 3 = 5$ mol.

Step 2 — Mole fraction of O_2: $x_{O_2} = \frac{2}{5} = 0.4$.

Step 3 — Partial pressure of O_2: $p_{O_2} = 0.4 \times 5 = 2$ atm.

Why other options are wrong:

- 3 atm: this is the partial pressure of N_2, not O_2.
- 5 atm: the total pressure, not a partial pressure.
- 1 atm: arithmetic error.

Final Answer: $p_{O_2} = 2$ atm $\Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q3**

Q4.

Solution

Concept — First law of thermodynamics: $\Delta U = q + w$, where q is heat absorbed by the system and w is work done *on* the system. Work done *by* the system is negative w.

Step 1 — Identify signs: Heat absorbed $q = +50\,\text{J}$. The system does $20\,\text{J}$ of work on the surroundings, so $w = -20\,\text{J}$.

Step 2 — Apply first law:

$$\Delta U = q + w = 50 + (-20) = +30\,\text{J}.$$

Why other options are wrong:

- -70, $+70\,\text{J}$: use the wrong sign for one of the terms.
- $-30\,\text{J}$: correct magnitude but wrong sign.

Final Answer: $\Delta U = +30\,\text{J} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Degree of dissociation: The fraction of the initial reactant that has dissociated at equilibrium, $\alpha = \dfrac{\text{moles dissociated}}{\text{initial moles}}$.

Step 1 — Set up the change: $PCl_5 \rightleftharpoons PCl_3 + Cl_2$. For every mole of PCl_5 dissociated, 1 mol Cl_2 forms.

Step 2 — Moles dissociated: Since 0.4 mol Cl_2 is formed, 0.4 mol of PCl_5 has dissociated.

Step 3 — Degree of dissociation:

$$\alpha = \frac{0.4}{1} = 0.4.$$

Why other options are wrong:

- 0.2: halves the dissociated amount without basis.
- 0.6: uses remaining PCl_5 wrongly as dissociated.
- 0.8: doubles the correct value.

Final Answer: $\alpha = 0.4 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q5

Q6.

Solution

Concept — Henderson–Hasselbalch equation: For an acidic buffer, $\text{pH} = pK_a + \log \dfrac{[\text{salt}]}{[\text{acid}]}$.

Step 1 — Ratio of salt to acid: Both are $0.1\,\text{M}$, so $\dfrac{[\text{salt}]}{[\text{acid}]} = \dfrac{0.1}{0.1} = 1$.

Step 2 — Logarithm of the ratio: $\log 1 = 0$.

Step 3 — Compute pH:

$$\text{pH} = 4.74 + 0 = 4.74.$$

Why other options are wrong:

- 3.74, 5.74: would require the salt/acid ratio to be 0.1 or 10, not 1.
- 7.00: the pH of pure water, not of this acidic buffer.

Final Answer: $\text{pH} = 4.74 \Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q6**

Q7.

Solution

Concept — Oxidising and reducing agents: The oxidising agent is the species that is reduced (gains electrons); the reducing agent is the species oxidised (loses electrons).

Step 1 — Track oxidation states: Zn goes from 0 to $+2$ (loses electrons, oxidised). Cu^{2+} goes from $+2$ to 0 (gains electrons, reduced).

Step 2 — Identify the oxidising agent: The species reduced is Cu^{2+}, so Cu^{2+} is the oxidising agent. Zn is the reducing agent.

Why other options are wrong:

- Zn: it is oxidised, so it is the reducing agent.
- SO_4^{2-}: a spectator ion, unchanged.
- Zn^{2+}: a product, not the oxidising agent.

Final Answer: Oxidising agent is $Cu^{2+} \Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q7**

Q8.

Solution

Concept — Molar conductivity: It relates specific conductivity κ to concentration C by $\Lambda_m = \dfrac{\kappa \times 1000}{C}$, with κ in $\mathrm{S\,cm^{-1}}$ and C in $\mathrm{mol\,L^{-1}}$.

Step 1 — Substitute values: $\kappa = 0.02\ \mathrm{S\,cm^{-1}}$, $C = 0.1\ \mathrm{mol\,L^{-1}}$.

Step 2 — Compute:

$$\Lambda_m = \frac{0.02 \times 1000}{0.1} = \frac{20}{0.1} = 200\ \mathrm{S\,cm^2\,mol^{-1}}.$$

Why other options are wrong:

- 2, 20, 0.2: arise from dropping the factor of 1000 or mis-dividing by concentration.

Final Answer: $\Lambda_m = 200\ \mathrm{S\,cm^2\,mol^{-1}} \Rightarrow \boxed{\mathrm{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Units of the rate constant: For an n-th order reaction the units of k are $\mathrm{mol^{1-n}\,L^{n-1}\,s^{-1}}$ (equivalently $(\text{concentration})^{1-n}\,\text{time}^{-1}$).

Step 1 — Set order: For a first-order reaction, $n = 1$.

Step 2 — Substitute $n = 1$:

$$\text{units} = \mathrm{mol^{1-1}\,L^{1-1}\,s^{-1}} = \mathrm{mol^{0}\,L^{0}\,s^{-1}} = \mathrm{s^{-1}}.$$

Why other options are wrong:

- $\mathrm{mol\,L^{-1}\,s^{-1}}$: units for a zero-order reaction.
- $\mathrm{L\,mol^{-1}\,s^{-1}}$: units for a second-order reaction.
- $\mathrm{mol^{-1}\,L^{2}\,s^{-1}}$: units for a third-order reaction.

Final Answer: Unit is $\mathrm{s^{-1}} \Rightarrow \boxed{\mathrm{B}}$

Answer: (B) Go Back to Q9

Q10.

Solution

Concept — Depression of freezing point: A colligative property, $\Delta T_f = K_f\, m$, where m is molality and K_f is a property of the solvent.

Step 1 — Identify K_f: K_f is the molal depression constant, also called the cryoscopic constant. It equals ΔT_f for a 1 molal solution.

Step 2 — Distinguish from K_b: The ebullioscopic constant K_b relates to elevation of boiling point, a different colligative property.

Why other options are wrong:

- molality: that is m, not K_f.
- ebullioscopic constant: this is K_b for boiling-point elevation.
- mole fraction of solute: not involved in this expression.

Final Answer: K_f is the molal depression (cryoscopic) constant $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Electron gain enthalpy trend: Electron gain enthalpy generally becomes more negative across a period. However, second-period elements (F, O) have unusually small size, so incoming electrons feel high repulsion, making their values less negative than expected.

Step 1 — Compare groups: Chlorine (Cl) has the most negative electron gain enthalpy of all elements because it accommodates the extra electron in a larger $3p$ orbital with less electron–electron repulsion than F.

Step 2 — Order: $Cl > F > S > O$ (in terms of most negative value).

Why other options are wrong:

- F: high repulsion in the compact $2p$ subshell makes it less negative than Cl.
- O, S: less negative than the halogens in their periods.

Final Answer: Cl has the most negative electron gain enthalpy $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q11

Q12.

Solution

Concept — Nature of oxides across a period: Metallic character decreases and non-metallic character increases from left to right. Metal oxides are basic; non-metal oxides are acidic.

Step 1 — Left side: Elements like Na, Mg are metals; their oxides (Na_2O, MgO) are basic.

Step 2 — Right side: Elements like S, Cl are non-metals; their oxides (SO_3, Cl_2O_7) are acidic. Middle elements (Al, Si) often give amphoteric oxides.

So the trend is basic → amphoteric → acidic, i.e. basic to acidic overall.

Why other options are wrong:

- acidic to basic: the reverse of the actual trend.
- neutral to basic, acidic to neutral: do not match the periodic behaviour.

Final Answer: Oxides change from basic to acidic $\Rightarrow \boxed{\text{A}}$

$\boxed{\textbf{Answer: (A)}}$ **Go Back to Q12**

Q13.

Solution

Concept — Counting sigma and pi bonds: A single bond is one σ; a double bond is one $\sigma +$ one π; a triple bond is one $\sigma +$ two π.

Step 1 — Structure of ethyne: $H{-}C \equiv C{-}H$.

$$\mathrm{H}-\mathrm{C}\equiv\mathrm{C}-\mathrm{H}$$

triple bond $(1\sigma + 2\pi)$

Step 2 — Count sigma bonds: Two $C{-}H$ bonds (2σ) plus one σ in the $C \equiv C$ triple bond $= 3\ \sigma$.

Step 3 — Count pi bonds: The $C \equiv C$ triple bond contributes $2\ \pi$.

Why other options are wrong:

- $2\sigma, 3\pi$ and $4\sigma, 1\pi$ and $5\sigma, 2\pi$: miscount the $C{-}H$ bonds or the triple-bond contribution.

Final Answer: Ethyne has $3\ \sigma$ and $2\ \pi$ bonds $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q13

Q14.

Solution

Concept — Resonance: When a single Lewis structure cannot describe a molecule, it is represented by several resonance structures; the actual species is a hybrid with delocalised electrons and equivalent bonds.

Step 1 — Examine CO_3^{2-}: The carbonate ion has three equivalent $C–O$ bonds. The double bond is delocalised over all three oxygens, giving three resonance structures and equal bond lengths.

Step 2 — Other species: CH_4, H_2O, NH_3 have localised single bonds and lone pairs, with no resonance delocalisation.

Why other options are wrong:

- CH_4, H_2O, NH_3: single, localised bonds, no resonance.

Final Answer: CO_3^{2-} shows resonance with equal bond lengths $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q14

Q15.

Solution

Concept — Diagonal relationship: The first element of a group resembles the second element of the next group diagonally, due to similar charge-to-size ratios. Examples: Li–Mg, Be–Al, B–Si.

Step 1 — Identify the diagonal partner of Li: Lithium (Group 1) resembles magnesium (Group 2) placed diagonally to it.

Step 2 — Shared properties: Both Li and Mg form covalent, hygroscopic compounds, react with N_2 to form nitrides, and have similar solubility patterns.

Why other options are wrong:

- Na, K: same group as Li but show group (not diagonal) similarity.
- Be: the diagonal partner of Al, not of Li.

Final Answer: Li resembles Mg (diagonal relationship) $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q15

Q16.

Solution

Concept — Oxidation state in nitrogen oxides: Oxygen is taken as -2. The sum of oxidation states equals the overall charge (zero for a neutral oxide).

Step 1 — Apply to N_2O_5: Let oxidation state of N be x. Then $2x + 5(-2) = 0 \Rightarrow 2x = 10 \Rightarrow x = +5$.

Step 2 — Check others: $N_2O_3 \Rightarrow +3$; $NO \Rightarrow +2$; $N_2O \Rightarrow +1$.

Why other options are wrong:

- N_2O_3: nitrogen is $+3$.
- NO: nitrogen is $+2$.
- N_2O: nitrogen is $+1$.

Final Answer: Nitrogen is $+5$ in $N_2O_5 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q16

Q17.

Solution

Concept — Brown-ring test: A standard test for nitrate ions. Freshly prepared $FeSO_4$ is added, then concentrated H_2SO_4 is poured slowly down the side of the tube.

Step 1 — Reaction: The nitrate is reduced to NO, which combines with Fe^{2+} to form a brown complex at the acid–solution interface.

Step 2 — The brown ring: The brown colour is due to the complex $[Fe(H_2O)_5(NO)]^{2+}$, in which iron is in the $+1$ state.

Why other options are wrong:

- $[Fe(CN)_6]^{4-}$: ferrocyanide, unrelated to this test.
- $[Fe(H_2O)_6]^{3+}$: hexaaqua ion, not the brown-ring species.
- $[Fe(SCN)]^{2+}$: red colour, used in the thiocyanate test for Fe^{3+}.

Final Answer: Brown ring is $[Fe(H_2O)_5(NO)]^{2+} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept — Spin-only magnetic moment: $\mu = \sqrt{n(n+2)}$ BM, where n is the number of unpaired electrons.

Step 1 — Electronic configuration of Fe^{3+}: Fe $(Z = 26)$ is $[Ar]3d^6 4s^2$. Removing three electrons gives $Fe^{3+} = [Ar]3d^5$.

Step 2 — Unpaired electrons: The $3d^5$ configuration has 5 unpaired electrons, so $n = 5$.

Step 3 — Compute moment:

$$\mu = \sqrt{5(5+2)} = \sqrt{35} \approx 5.92 \text{ BM}.$$

Why other options are wrong:

- 1.73, 2.83, 3.87 BM: correspond to $n = 1, 2, 3$ unpaired electrons respectively.

Final Answer: $\mu \approx 5.92$ BM $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q18

Q19.

Solution

Concept — Effective atomic number (EAN): EAN $= (Z -$ oxidation state of metal$) + 2 \times$ (number of ligands), counting the electrons donated by the ligands.

Step 1 — Oxidation state of Fe in $[Fe(CN)_6]^{4-}$: Each CN^- is -1; six give -6. Overall charge is -4, so $x - 6 = -4 \Rightarrow x = +2$.

Step 2 — Electrons from metal: $Z = 26$, minus oxidation state $+2$, gives $26 - 2 = 24$ electrons.

Step 3 — Electrons from ligands: Six CN^- ligands donate $6 \times 2 = 12$ electrons.

Step 4 — Total EAN:

$$\text{EAN} = 24 + 12 = 36.$$

Why other options are wrong:

- 30, 32, 34: result from wrong oxidation state or miscounting ligand electrons.

Final Answer: EAN $= 36 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept — Dual nature of H_2O_2: In hydrogen peroxide, oxygen is in the -1 state. It can be oxidised to 0 (in O_2) or reduced to -2 (in H_2O).

Step 1 — As a reducing agent: A reducing agent gets oxidised. Here oxygen goes from -1 to 0, i.e. H_2O_2 is oxidised to O_2.

Step 2 — Example: With $KMnO_4$ in acidic medium, H_2O_2 reduces Mn^{7+} and is itself oxidised to O_2 gas.

Why other options are wrong:

- reduced to H_2O: this is its behaviour as an oxidising agent, not a reducing agent.
- oxidised to H_2O, reduced to O_2: incorrect direction of change.

Final Answer: As a reducing agent, H_2O_2 is oxidised to $O_2 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q20

Q21.

Solution

Concept — Hyperconjugation: A stabilising delocalisation in which the electrons of a $C{-}H$ sigma bond adjacent to a positively charged carbon, a double bond, or a radical interact with the empty or partially filled p orbital. It is also called no-bond resonance.

Step 1 — Requirement: There must be at least one α $C{-}H$ bond next to the unsaturated or electron-deficient centre.

Step 2 — Effect: Greater the number of α hydrogens, the greater the stabilisation; this explains the stability order of carbocations ($3^\circ > 2^\circ > 1^\circ$).

Why other options are wrong:

- lone pair into an empty orbital: this describes resonance, not hyperconjugation.
- pi into pi: ordinary conjugation/resonance.

- filled p into a sigma bond: not the standard definition of hyperconjugation.

Final Answer: Hyperconjugation delocalises α $C-H$ sigma electrons $\Rightarrow \boxed{\text{B}}$

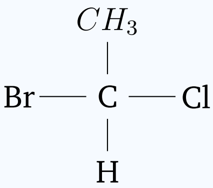
Answer: (B) Go Back to Q21

Q22.

Solution

Concept — Chirality: A carbon bonded to four different groups is a stereocentre, and the molecule is chiral (optically active) if it is non-superimposable on its mirror image.

Step 1 — Examine $CH_3CHBrCl$: The central carbon bears four different groups: CH_3, H, Br, Cl. It is a chiral centre.



$$\begin{array}{c} CH_3 \\ | \\ \text{Br} — \text{C} — \text{Cl} \\ | \\ \text{H} \end{array}$$

Step 2 — Check others: $CH_3CH_2CH_3$, CH_3CHCl_2 and CH_2ClCH_2Cl all have at least two identical groups on every carbon, so none has four different groups on one carbon.

Why other options are wrong:

- $CH_3CH_2CH_3$, CH_3CHCl_2, CH_2ClCH_2Cl: lack a carbon with four different substituents, hence achiral.

Final Answer: $CH_3CHBrCl$ is chiral $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q22

Q23.

Solution

Concept — Catalytic hydrogenation: Alkenes add hydrogen across the double bond in the presence of finely divided metal catalysts (Ni, Pt, Pd) to give the corresponding alkane (Sabatier–Senderens reaction).

Step 1 — Reaction: $CH_2{=}CH_2 + H_2 \xrightarrow{Ni} CH_3{-}CH_3$.

Step 2 — Product: The double bond becomes a single bond, converting ethene to ethane.

Why other options are wrong:

- ethyne: would require dehydrogenation, the reverse process.
- ethanol: needs addition of water, not hydrogen.
- benzene: unrelated; no aromatisation occurs here.

Final Answer: Hydrogenation of ethene gives ethane $\Rightarrow \boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ **Go Back to Q23**

Q24.

Solution

Concept — Terminal alkyne acidity: The hydrogen on a terminal $\equiv C{-}H$ carbon is acidic because of the high s-character (sp) of the carbon. Such alkynes react with ammoniacal $AgNO_3$ to give silver acetylide precipitates.

Step 1 — Examine $CH \equiv CH$: Ethyne has two terminal acidic hydrogens; it reacts with ammoniacal $AgNO_3$ to give the white precipitate of silver acetylide ($Ag{-}C \equiv C{-}Ag$).

Step 2 — Check others: $CH_3{-}C \equiv C{-}CH_3$ has no terminal $\equiv C{-}H$ (internal alkyne); ethene and ethane have no such acidic hydrogen.

Why other options are wrong:

- but-2-yne: internal alkyne, no terminal acidic H.
- ethene, ethane: no sp $C{-}H$, hence no reaction.

Final Answer: $CH \equiv CH$ gives a white precipitate $\Rightarrow \boxed{\text{A}}$

$\boxed{\textbf{Answer: (A)}}$ **Go Back to Q24**

Q25.

Solution

Concept — Grignard reagents with carbonyls: $RMgX$ adds across a $C{=}O$ bond. Reaction with formaldehyde (after acid workup) gives a primary alcohol with one extra carbon.

Step 1 — Addition: CH_3MgBr adds to $HCHO$ giving $CH_3{-}CH_2{-}OMgBr$.

Step 2 — Hydrolysis: Acidic hydrolysis gives $CH_3{-}CH_2{-}OH$, that is ethanol.

Step 3 — Carbon count: Methyl group (1C) plus formaldehyde carbon (1C) gives a two-carbon alcohol, ethanol.

Why other options are wrong:

- methanol: would need no carbon addition (e.g. reaction of the reagent with itself).
- propan-1-ol, propan-2-ol: have three carbons, requiring a different aldehyde/ketone.

Final Answer: The product is ethanol $\Rightarrow \boxed{\text{B}}$

$\boxed{\text{Answer: (B)}}$ Go Back to Q25

Q26.

Solution

Concept — Dehydration of alcohols: Concentrated H_2SO_4 removes water from alcohols. At high temperature (443 K) intramolecular dehydration gives an alkene; at lower temperature (413 K) intermolecular dehydration gives an ether.

Step 1 — High-temperature route: At 443 K, ethanol loses a molecule of water to form a double bond.

Step 2 — Product: $CH_3CH_2OH \xrightarrow[443\,K]{\text{conc. } H_2SO_4} CH_2{=}CH_2 + H_2O$, giving ethene.

Why other options are wrong:

- diethyl ether: formed at the lower temperature (413 K), not 443 K.
- ethanal: a product of oxidation, not dehydration.
- ethane: would require reduction, not dehydration.

Final Answer: Dehydration at 443 K gives ethene $\Rightarrow \boxed{\text{C}}$

$\boxed{\text{Answer: (C)}}$ Go Back to Q26

Q27.

Solution

Concept — Cannizzaro reaction: Aldehydes that have *no* α-hydrogen undergo self oxidation–reduction (disproportionation) with concentrated alkali, giving an alcohol and a carboxylate salt.

Step 1 — Identify the aldehyde with no α-H: $HCHO$ (formaldehyde) has no carbon adjacent to the carbonyl bearing hydrogen, so it has no α-hydrogen.

Step 2 — Reaction: $2\,HCHO + NaOH \rightarrow CH_3OH + HCOONa$.

Why other options are wrong:

- CH_3CHO, CH_3CH_2CHO, $(CH_3)_2CHCHO$: all possess α-hydrogens and undergo aldol condensation instead.

Final Answer: $HCHO$ undergoes the Cannizzaro reaction $\Rightarrow \boxed{\text{D}}$

$\boxed{\text{Answer: (D)}}$ Go Back to Q27

Q28.

Solution

Concept — Acidity of carboxylic acids: Electron-withdrawing groups stabilise the carboxylate anion by dispersing the negative charge (inductive effect), increasing acid strength. More electronegative atoms and more of them increase acidity.

Step 1 — Compare substituents: $Cl_3C{-}COOH$ (trichloroacetic acid) has three chlorine atoms, the strongest combined $-I$ effect.

Step 2 — Order of acidity: $Cl_3C{-}COOH > ClCH_2{-}COOH > H{-}COOH > CH_3{-}COOH$ (CH_3 is electron-releasing, weakening acidity).

Why other options are wrong:

- $ClCH_2COOH$: only one chlorine, weaker $-I$ effect.
- $HCOOH$: no electron-withdrawing alkyl substituent but still weaker than the trichloro acid.
- CH_3COOH: methyl group is electron-donating, making it the weakest here.

Final Answer: $Cl_3C{-}COOH$ is the strongest acid $\Rightarrow \boxed{\text{A}}$

$\boxed{\text{Answer: (A)}}$ Go Back to Q28

Q29.

Solution

Concept — Carbylamine reaction: Primary amines (aliphatic or aromatic) react with chloroform and alcoholic KOH to form foul-smelling isocyanides (carbylamines). Secondary and tertiary amines do not give this reaction.

Step 1 — Reaction: $R–NH_2 + CHCl_3 + 3KOH \rightarrow R–NC + 3KCl + 3H_2O$.

Step 2 — Diagnostic use: The offensive odour of the isocyanide confirms a primary amine; this is the carbylamine (isocyanide) test.

Why other options are wrong:

- secondary, tertiary amines: do not form isocyanides, so they give no carbylamine test.
- quaternary ammonium salts: have no N–H bond and do not react.

Final Answer: The carbylamine reaction is a test for primary amines $\Rightarrow \boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ **Go Back to Q29**

Q30.

Solution

Concept — Zwitterion and isoelectric point: In solution an amino acid exists as a dipolar zwitterion ($H_3N^+–CHR–COO^-$). The pH at which it carries no net charge is its isoelectric point (pI).

Step 1 — At the isoelectric point: The positive and negative charges balance exactly, so the molecule does not migrate in an electric field.

Step 2 — Property: At pI amino acids have minimum solubility and exist mainly as the neutral zwitterion.

Why other options are wrong:

- pK_a value: relates to the dissociation of one ionisable group, not the net-zero-charge pH.
- neutral point: not the standard term for this property.
- equivalence point: a titration term, not specific to the zwitterion.

Final Answer: This pH is the isoelectric point $\Rightarrow \boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q30**

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
3	A	6	C	7	A	10	C	12	A
14	C	16	A	18	C	20	A	22	C
24	A	26	C	28	A	30	C		