PGIMER BSc Nursing Chemistry

Sample Paper – 13

Duration: 23 Minutes **Maximum Marks: 25**

Instructions

- This paper contains **25** Multiple Choice Questions (Single Correct Answer), modelled on the Chemistry portion of the **PGIMER BSc Nursing** entrance exam.
- Each correct answer carries **+1 mark**. **0.25 mark** is deducted for every incorrect answer. Unattempted questions carry **0 marks**.
- Only **one** option is correct. Choose carefully.
- Syllabus level: **Class 11 and 12 (NCERT) Chemistry**.
- The exam is conducted as a computer-based test. Personal calculators, mobile phones, log tables, and other electronic gadgets are strictly prohibited.

Q1. Boron occurs naturally as two isotopes, ^{10}B (relative mass 10, abundance 20%) and ^{11}B (relative mass 11, abundance 80%). The average atomic mass of boron is:

(A) 10.2

(B) 11.0

(C) 10.8

(D) 10.0

Q2. Which of the following sets contains species that are all isoelectronic (i.e. all have the same number of electrons)?

(A) Na^{+}, Ca^{2+}, K^{+}

(B) F^{-}, Cl^{-}, Br^{-}

(C) O^{2-}, S^{2-}, Se^{2-}

(D) N^{3-}, O^{2-}, F^{-}, Ne, Na^{+}

Q3. Among the following elements, the most electropositive (most metallic) one is:

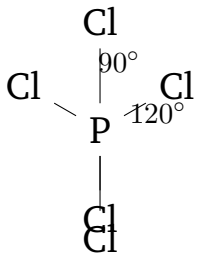
(A) Na

(B) Cs

(C) Mg

(D) Ca

Q4. Phosphorus pentachloride (PCl_5) has the gas-phase shape shown below, with three chlorine atoms in a plane and two along the vertical axis. Its molecular geometry is:



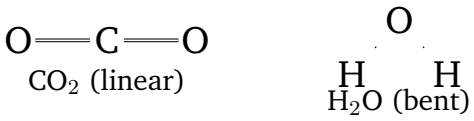
(A) octahedral

(B) trigonal bipyramidal

(C) square planar

(D) tetrahedral

Q5. The shapes of carbon dioxide and water are shown below. Which statement about their net dipole moments is correct?



(A) Both molecules have zero dipole moment.

(B) CO_2 has a nonzero dipole moment while H_2O has zero.

(C) CO_2 has zero dipole moment (bond moments cancel) while H_2O has a nonzero dipole moment.

(D) Both molecules have equal, nonzero dipole moments.

Q6. When 0.25 mol of a fuel is burned completely in a bomb calorimeter of heat capacity 5.0 kJ K^{-1}, the temperature rises by 3.0 K. The enthalpy of combustion of the fuel is:

(A) -15 kJ mol^{-1}

(B) -60 kJ mol^{-1}

(C) -30 kJ mol^{-1}

(D) $+60$ kJ mol^{-1}

Q7. For the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, the relationship between K_p and K_c is:

(A) $K_p = K_c(RT)^{-2}$

(B) $K_p = K_c(RT)^2$

(C) $K_p = K_c(RT)$

(D) $K_p = K_c$

Q8. In the reaction $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$, the oxidising agent is:

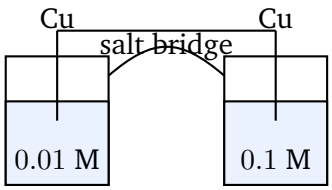
(A) Zn

(B) $CuSO_4$

(C) $ZnSO_4$

(D) Cu

Q9. For the copper concentration cell shown, $Cu \mid Cu^{2+}(0.01\ M) \parallel Cu^{2+}(0.1\ M) \mid Cu$, the EMF at 25°C (take $\frac{0.059}{n}$ with $n = 2$) is:



(A) 0.0295 V

(B) 0.059 V

(C) 0 V

(D) 0.118 V

Q10. A first-order reaction has a rate constant $k = 2.303 \times 10^{-3}$ s^{-1}. The time required for the reaction to reach 99% completion is:

(A) 1000 s

(B) 460 s

(C) 4000 s

(D) 2000 s

Q11. Which of the following liquid pairs forms a maximum-boiling azeotrope, i.e. shows negative deviation from Raoult's law?

(A) ethanol + water

(B) acetone + carbon disulphide

(C) benzene + toluene

(D) nitric acid + water

Q12. Which of the following is a chelating (polydentate) ligand?

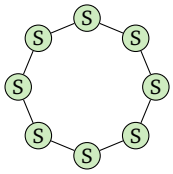
(A) NH_3 (ammonia)

(B) Cl^- (chloride)

(C) ethylenediamine (en)

(D) H_2O (aqua)

Q13. Sulphur exists in several forms; its S_8 molecule has the puckered crown ring shown below. Which of the following is a *crystalline* allotrope of sulphur?



S_8 crown ring

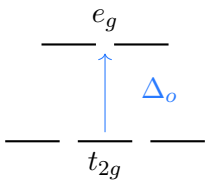
(A) plastic sulphur

(B) colloidal sulphur

(C) rhombic sulphur

(D) milk of sulphur

Q14. The blue colour of the hydrated Cu^{2+} ion (a $3d^9$ system, whose split d-levels are shown) arises because of:



(A) d–d electronic transitions within the partially filled d-orbitals

(B) transitions between fully filled s and p orbitals

(C) the complete absence of any unpaired electrons

(D) nuclear transitions of the copper nucleus

Q15. Plaster of Paris, used in surgical casts, is obtained by partial dehydration of gypsum. Its chemical formula is:

(A) $CaSO_4 \cdot 2H_2O$

(B) $CaSO_4$ (anhydrous)

(C) $CaSO_4 \cdot \frac{1}{2}H_2O$

(D) $Ca(OH)_2$

Q16. Which of the following groups exerts the strongest electron-withdrawing mesomeric ($-M$) effect when attached to a benzene ring?

(A) $-NO_2$ (nitro)

(B) $-OCH_3$ (methoxy)

(C) $-CH_3$ (methyl)

(D) $-NH_2$ (amino)

Q17. Kolbe's electrolysis of an aqueous solution of sodium acetate (CH_3COONa) is shown schematically below. The chief hydrocarbon obtained at the anode is:

$$\begin{matrix} CH_3COO^- \\ CH_3COO^- \end{matrix} \xrightarrow{-2e^-} CH_3-CH_3 + 2\,CO_2$$

(A) ethane (C_2H_6)

(B) methane (CH_4)

(C) ethene (C_2H_4)

(D) methanol (CH_3OH)

Q18. Which of the following halides is the most reactive towards nucleophilic substitution (via a resonance-stabilised carbocation)?

(A) vinyl chloride ($CH_2=CHCl$)

(B) benzyl chloride ($C_6H_5CH_2Cl$)

(C) chlorobenzene (C_6H_5Cl)

(D) 2-chlorobut-2-ene (a vinylic chloride)

Q19. Oxidation of a primary alcohol with a *mild* oxidising agent such as pyridinium chlorochromate (PCC) gives mainly:

(A) a carboxylic acid

(B) a ketone

(C) an ester

(D) an aldehyde

Q20. The addition of hydrogen cyanide (HCN) to acetaldehyde (CH_3CHO) gives a product that belongs to which class of compounds?

(A) an ester

(B) an amide

(C) a cyanohydrin (α-hydroxynitrile)

(D) a carboxylic acid

Q21. The reaction of acetic acid (CH_3COOH) with thionyl chloride ($SOCl_2$) gives, as the organic product:

(A) acetamide (CH_3CONH_2)

(B) ethyl acetate ($CH_3COOC_2H_5$)

(C) acetic anhydride ($(CH_3CO)_2O$)

(D) acetyl chloride (CH_3COCl)

Q22. Reduction of ethanenitrile (CH_3CN) with lithium aluminium hydride ($LiAlH_4$) gives:

(A) ethanamide (CH_3CONH_2)

(B) ethylamine ($CH_3CH_2NH_2$)

(C) methylamine (CH_3NH_2)

(D) acetic acid (CH_3COOH)

Q23. The α-helix and β-pleated sheet arrangements, held together mainly by hydrogen bonds, are examples of which level of protein structure?

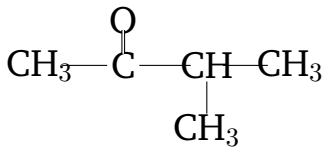
(A) primary structure

(B) tertiary structure

(C) quaternary structure

(D) secondary structure

Q24. The IUPAC name of the branched ketone whose carbon skeleton is shown below (a carbonyl group with a methyl branch) is:



(A) 3-methylbutan-2-one

(B) 2-methylbutan-3-one

(C) pentan-2-one

(D) 3-methylbutanal

Q25. A very dilute (about 0.2%) aqueous solution of phenol, which is safe to apply to living tissue such as wounds, acts as an:

(A) antiseptic

(B) disinfectant

(C) antibiotic

(D) analgesic

Detailed Solutions

Q1.

Solution

Concept — Average atomic mass: The average atomic mass is the weighted mean of the isotopic masses, each weighted by its fractional abundance: $\bar{A} = \sum(\text{mass} \times \text{fractional abundance})$.

Step 1 — Convert the abundances to fractions: ^{10}B: $20\% = 0.20$.

^{11}B: $80\% = 0.80$.

Step 2 — Multiply each mass by its fraction:

$$10 \times 0.20 = 2.0.$$

$$11 \times 0.80 = 8.8.$$

Step 3 — Add the contributions:

$$\bar{A} = 2.0 + 8.8 = 10.8.$$

Why other options are wrong:

- Option A (10.2): would need a much higher share of ^{10}B.
- Option B (11.0): the mass of pure ^{11}B, ignoring the ^{10}B share.
- Option D (10.0): the mass of pure ^{10}B, ignoring the ^{11}B share.

Final Answer: Average atomic mass $= 10.8 \Rightarrow$ C

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Isoelectronic species: Species are isoelectronic when they contain the same total number of electrons, regardless of nuclear charge.

Step 1 — Count electrons for the option D set: N^{3-}: $7+3 = 10$; O^{2-}: $8+2 = 10$; F^-: $9+1 = 10$; Ne: 10; Na^+: $11-1 = 10$.

Step 2 — Confirm they match: Every species in option D has exactly 10 electrons, so the whole set is isoelectronic.

Why other options are wrong:

- Option A: $Na^{+} = 10$, but $Ca^{2+} = 18$ and $K^{+} = 18$; not all equal.
- Option B: $F^{-} = 10$, $Cl^{-} = 18$, $Br^{-} = 36$; all different.
- Option C: $O^{2-} = 10$, $S^{2-} = 18$, $Se^{2-} = 36$; all different.

Final Answer: The set $N^{3-}, O^{2-}, F^{-}, Ne, Na^{+}$ is isoelectronic $\Rightarrow$ $\boxed{D}$

Answer: (D) Go Back to Q2

Q3.

Solution

Concept — Electropositive (metallic) character: Electropositive character increases down a group (electrons are more loosely held) and decreases across a period (nuclear charge rises). The element that loses its outer electron most easily is the most electropositive.

Step 1 — Place the elements: Na and Cs are group 1 (alkali) metals; Mg and Ca are group 2 (alkaline earth) metals.

Step 2 — Compare within group 1: Cs lies far below Na, so its valence electron is much more loosely held; Cs is more electropositive than Na.

Step 3 — Compare with group 2: Group 1 metals are more electropositive than group 2 metals of comparable period, so Cs beats Mg and Ca as well.

Why other options are wrong:

- Option A (Na): more electropositive than Mg/Ca, but well above Cs in the group, so less electropositive than Cs.
- Option C (Mg) and Option D (Ca): group 2 metals hold their electrons more tightly than the heavy alkali metal Cs.

Final Answer: Caesium (Cs) is the most electropositive $\Rightarrow$ $\boxed{B}$

Answer: (B) Go Back to Q3

Q4.

Solution

Concept — VSEPR geometry: The number of sigma bonds plus lone pairs on the central atom fixes the electron geometry. Five bond pairs and no lone pair give a trigonal bipyramidal shape.

Step 1 — Count around phosphorus in PCl_5: Phosphorus forms five P–Cl sigma bonds and has no lone pair.

Step 2 — Assign the geometry: Five regions of electron density with no lone pair $\Rightarrow$ trigonal bipyramidal.

Step 3 — Match to the figure: Three equatorial Cl atoms lie in a plane at 120° and two axial Cl atoms lie along the vertical axis at 90° to the plane, exactly as drawn.

Why other options are wrong:

- Option A (octahedral): needs six bond pairs, as in SF_6.
- Option C (square planar): four bond pairs plus two lone pairs, as in XeF_4.
- Option D (tetrahedral): only four bond pairs, as in CH_4.

Final Answer: PCl_5 is trigonal bipyramidal $\Rightarrow$ B

Answer: (B) Go Back to Q4

Q5.

Solution

Concept — Net dipole moment: The net dipole moment is the vector sum of the individual bond dipoles. In a symmetric linear molecule the bond dipoles cancel; in a bent molecule they do not.

Step 1 — Analyse CO_2: CO_2 is linear (O = C = O). The two C=O bond dipoles are equal in magnitude and point in exactly opposite directions, so they cancel and the net dipole moment is zero.

Step 2 — Analyse H_2O: Water is bent (about 104.5°). The two O–H bond dipoles do not lie opposite one another, so they add to a nonzero resultant pointing towards oxygen.

Step 3 — Combine the results: CO_2 has zero dipole moment while H_2O has a nonzero dipole moment.

Why other options are wrong:

- Option A: water is polar, so "both zero" is false.
- Option B: reverses the two molecules.
- Option D: CO_2 is nonpolar, so "both equal and nonzero" is false.

Final Answer: CO_2 zero, H_2O nonzero $\Rightarrow$ C

Answer: (C) Go Back to Q5

Q6.

Solution

Concept — Bomb calorimetry: Heat released by the reaction equals the heat absorbed by the calorimeter, $q = C \times \Delta T$; dividing by the moles burned gives the molar enthalpy of combustion, which is negative (exothermic).

Step 1 — Compute the heat released:

$$q = C \times \Delta T = 5.0 \text{ kJ K}^{-1} \times 3.0 \text{ K} = 15 \text{ kJ}.$$

Step 2 — Divide by the moles burned:

$$\text{per mole} = \frac{15 \text{ kJ}}{0.25 \text{ mol}} = 60 \text{ kJ mol}^{-1}.$$

Step 3 — Assign the sign: Combustion releases heat, so the enthalpy of combustion is negative: -60 kJ mol^{-1}.

Why other options are wrong:

- Option A (-15 kJ mol^{-1}): the total heat, not divided by moles.
- Option C (-30 kJ mol^{-1}): uses 0.5 mol by mistake.
- Option D ($+60$ kJ mol^{-1}): correct magnitude but wrong sign; combustion is exothermic.

Final Answer: Enthalpy of combustion $= -60$ kJ mol^{-1} $\Rightarrow$ B

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Relation between K_p and K_c: $K_p = K_c(RT)^{\Delta n}$, where Δn is the change in the number of moles of gas = (moles of gaseous products) − (moles of gaseous reactants).

Step 1 — Count gaseous moles for $N_2 + 3H_2 \rightleftharpoons 2NH_3$: Products: 2 mol ($NH_3$).

Reactants: $1 + 3 = 4$ mol ($N_2 + H_2$).

Step 2 — Compute Δn:

$$\Delta n = 2 - 4 = -2.$$

Step 3 — Substitute into the relation:

$$K_p = K_c(RT)^{-2}.$$

Why other options are wrong:

- Option B ($(RT)^2$): uses the wrong sign of Δn.
- Option C ($(RT)^1$): would need $\Delta n = +1$.
- Option D (equal): only true when $\Delta n = 0$, which is not the case here.

Final Answer: $K_p = K_c(RT)^{-2} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q7

Q8.

Solution

Concept — Oxidising agent: The oxidising agent is the species that gets reduced (its oxidation number decreases because it gains electrons) while it oxidises another species.

Step 1 — Track the oxidation numbers: Zn goes from 0 (in Zn) to +2 (in $ZnSO_4$): it is oxidised (loses electrons).

Cu goes from +2 (in $CuSO_4$) to 0 (in Cu): it is reduced (gains electrons).

Step 2 — Identify the oxidant: The species that is reduced, $CuSO_4$ (the source of Cu^{2+}), is the oxidising agent.

Why other options are wrong:

- Option A (Zn): it is oxidised, so it is the reducing agent.

- Option C ($ZnSO_4$): a product; it takes no further part.
- Option D (Cu): the reduced product, not the reactant that does the oxidising.

Final Answer: $CuSO_4$ is the oxidising agent $\Rightarrow$ B

Answer: (B) Go Back to Q8

Q9.

Solution

Concept — Concentration cell: Both electrodes are identical, so $E^\circ_{\text{cell}} = 0$. The EMF arises only from the difference in ion concentrations, given by $E_{\text{cell}} = \frac{0.059}{n} \log \frac{C_{\text{cathode}}}{C_{\text{anode}}}$.

Step 1 — Identify the concentrations: The more concentrated side (0.1 M) is the cathode; the dilute side (0.01 M) is the anode.

Step 2 — Substitute values ($n = 2$):

$$E_{\text{cell}} = \frac{0.059}{2} \log \frac{0.1}{0.01} = 0.0295 \times \log(10).$$

Step 3 — Evaluate:

$$\log(10) = 1, \qquad E_{\text{cell}} = 0.0295 \times 1 = 0.0295 \text{ V}.$$

Why other options are wrong:

- Option B (0.059 V): forgets to divide by $n = 2$.
- Option C (0 V): would require equal concentrations on both sides.
- Option D (0.118 V): uses $n = 1$ and a wrong ratio.

Final Answer: $E_{\text{cell}} = 0.0295$ V $\Rightarrow$ A

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — First-order kinetics: For a first-order reaction, $t = \dfrac{2.303}{k}\log\dfrac{[\mathrm{A}]_0}{[\mathrm{A}]}$. For 99% completion, only 1% remains, so $\dfrac{[\mathrm{A}]_0}{[\mathrm{A}]} = \dfrac{100}{1} = 100$.

Step 1 — Set up the ratio:

$$\frac{[\mathrm{A}]_0}{[\mathrm{A}]} = \frac{100}{1} = 100, \qquad \log(100) = 2.$$

Step 2 — Substitute into the formula:

$$t = \frac{2.303}{2.303 \times 10^{-3}} \times 2.$$

Step 3 — Simplify:

$$\frac{2.303}{2.303 \times 10^{-3}} = 10^3 = 1000, \qquad t = 1000 \times 2 = 2000 \text{ s}.$$

Why other options are wrong:

- Option A (1000 s): corresponds to 90% completion ($\log 10 = 1$).
- Option B (460 s): corresponds to one half-life region, not 99%.
- Option C (4000 s): overcounts by using $\log 10000 = 4$ (i.e. 99.99%).

Final Answer: $t_{99\%} = 2000$ s $\Rightarrow$ D

Answer: (D) Go Back to Q10

Q11.

Solution

Concept — Deviation from Raoult's law: A solution showing negative deviation has stronger solute–solvent interactions than in the pure liquids; the vapour pressure is lower than expected, giving a maximum-boiling azeotrope.

Step 1 — Examine nitric acid + water: Strong hydrogen bonding and partial ionisation make the mixture's escaping tendency lower than Raoult's law predicts, so it shows negative deviation and boils at a maximum temperature.

Step 2 — Contrast with the others: Mixtures whose components interact more

weakly than in the pure liquids show positive deviation and minimum-boiling azeotropes.

Why other options are wrong:

- Option A (ethanol + water): positive deviation, a minimum-boiling azeotrope.
- Option B (acetone + CS_2): positive deviation (weaker interactions).
- Option C (benzene + toluene): nearly ideal, essentially no deviation.

Final Answer: Nitric acid + water shows negative deviation (maximum-boiling azeotrope) $\Rightarrow$ D

Answer: (D) Go Back to Q11

Q12.

Solution

Concept — Chelating ligands: A chelating ligand is polydentate: it has two or more donor atoms that can bind the same metal ion simultaneously, forming a ring. Monodentate ligands have only one donor atom.

Step 1 — Examine ethylenediamine (en): $H_2N\text{-}CH_2\text{-}CH_2\text{-}NH_2$ has two nitrogen donor atoms, so it binds a metal through both and closes a five-membered ring; it is bidentate (chelating).

Step 2 — Compare the others: NH_3, Cl^- and H_2O each have only one effective donor site, so they are monodentate and cannot chelate.

Why other options are wrong:

- Option A (NH_3): one N donor, monodentate.
- Option B (Cl^-): a single donor atom, monodentate.
- Option D (H_2O): one O donor, monodentate.

Final Answer: Ethylenediamine is the chelating (polydentate) ligand $\Rightarrow$ C

Answer: (C) Go Back to Q12

Q13.

Solution

Concept — Allotropes of sulphur: Sulphur has crystalline forms (rhombic and monoclinic, built from S_8 rings arranged in an ordered lattice) and non-crystalline (amorphous) forms.

Step 1 — Identify the crystalline allotrope: Rhombic sulphur (α-sulphur) is the stable crystalline form at room temperature, made of ordered S_8 crown rings as drawn.

Step 2 — Classify the others: Plastic, colloidal and "milk of sulphur" forms lack a regular crystal lattice; they are amorphous or dispersed forms, not crystalline allotropes.

Why other options are wrong:

- Option A (plastic sulphur): amorphous, formed by quenching molten sulphur.
- Option B (colloidal sulphur): a fine dispersion, not a crystal.
- Option D (milk of sulphur): a finely divided precipitated form, not crystalline.

Final Answer: Rhombic sulphur is the crystalline allotrope $\Rightarrow$ C

Answer: (C) Go Back to Q13

Q14.

Solution

Concept — Colour of transition-metal ions: In an octahedral field the d-orbitals split into lower t_{2g} and higher e_g sets separated by Δ_o. An electron absorbs visible light of energy equal to Δ_o and jumps from t_{2g} to e_g; the complementary colour is seen.

Step 1 — Look at Cu^{2+}: Cu^{2+} is $3d^9$, so it has partially filled d-orbitals and a vacancy that allows a d–d transition.

Step 2 — Link to the colour: The ion absorbs red-orange light to promote a d-electron from t_{2g} to e_g; the transmitted complementary light is blue.

Why other options are wrong:

- Option B (s–p transitions): not responsible for the colour of d-block ions.
- Option C (no unpaired electrons): Cu^{2+} actually has one unpaired electron;

ions with fully filled d (like Zn^{2+}) are colourless.
- Option D (nuclear transitions): nuclear changes have nothing to do with visible colour.

Final Answer: The colour is due to d–d electronic transitions $\Rightarrow$ A

Answer: (A) Go Back to Q14

Q15.

Solution

Concept — Plaster of Paris: Heating gypsum ($CaSO_4 \cdot 2H_2O$) to about 393 K drives off most of the water of crystallisation, leaving calcium sulphate hemihydrate, $CaSO_4 \cdot \frac{1}{2}H_2O$, which is plaster of Paris.

Step 1 — Recall the dehydration:

$$CaSO_4 \cdot 2H_2O \xrightarrow{\sim 393\ K} CaSO_4 \cdot \tfrac{1}{2}H_2O + \tfrac{3}{2}H_2O.$$

Step 2 — Identify plaster of Paris: The hemihydrate $CaSO_4 \cdot \frac{1}{2}H_2O$ is plaster of Paris; on adding water it sets back to hard gypsum.

Why other options are wrong:

- Option A ($CaSO_4 \cdot 2H_2O$): this is gypsum, the starting material.
- Option B (anhydrous $CaSO_4$): the "dead-burnt" plaster formed on stronger heating; it no longer sets.
- Option D ($Ca(OH)_2$): slaked lime, an entirely different compound.

Final Answer: Plaster of Paris is $CaSO_4 \cdot \frac{1}{2}H_2O \Rightarrow$ C

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Mesomeric (M) effect: A group with a $-M$ effect withdraws electron density through resonance (it has multiple-bonded electronegative atoms that pull the ring's π electrons towards themselves). Groups with lone pairs that push electrons into the ring show the opposite, $+M$, effect.

Step 1 — Classify each group: $-NO_2$: strong $-M$ (nitrogen doubly bonded to electronegative oxygens withdraws π density).

$-OCH_3$ and $-NH_2$: $+M$ groups (lone pairs donate into the ring).

$-CH_3$: only a weak $+I$ (inductive) donor, no significant M effect.

Step 2 — Pick the strongest $-M$ group: Only $-NO_2$ withdraws electrons by resonance, and it does so strongly; it has the strongest $-M$ effect.

Why other options are wrong:

- Option B ($-OCH_3$) and Option D ($-NH_2$): these donate electrons ($+M$), the opposite effect.
- Option C ($-CH_3$): a weak inductive donor, not electron-withdrawing.

Final Answer: $-NO_2$ has the strongest $-M$ effect $\Rightarrow$ A

Answer: (A) Go Back to Q16

Q17.

Solution

Concept — Kolbe's electrolysis: Electrolysis of the aqueous salt of a carboxylic acid discharges the carboxylate at the anode; it loses an electron and decarboxylates to an alkyl radical, and two such radicals couple to give a symmetrical alkane.

Step 1 — Discharge and decarboxylate:

$$CH_3COO^- \rightarrow CH_3COO^\bullet + e^- \rightarrow CH_3^\bullet + CO_2.$$

Step 2 — Couple the radicals: Two methyl radicals combine:

$$CH_3^\bullet + CH_3^\bullet \rightarrow CH_3\text{-}CH_3.$$

Step 3 — Name the hydrocarbon: CH_3-CH_3 is ethane, liberated together with CO_2 at the anode.

Why other options are wrong:

- Option B (methane): would need a single methyl radical to abstract an H, not the coupling that Kolbe's reaction gives.
- Option C (ethene): no elimination step occurs here; coupling gives the saturated alkane.
- Option D (methanol): an oxygenated product, not formed at the anode in this reaction.

Final Answer: Kolbe's electrolysis of sodium acetate gives ethane $\Rightarrow$ A

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Reactivity of halides: Substitution that proceeds through a carbocation is fastest when that carbocation is resonance-stabilised. A benzylic carbocation is stabilised by delocalisation into the ring, whereas vinylic and aryl halides resist substitution (partial double-bond character in the C–X bond).

Step 1 — Look at benzyl chloride: On losing Cl^-, $C_6H_5CH_2^+$ forms; its positive charge is spread over the ring by resonance, so it is very stable and forms readily.

Step 2 — Compare the others: In vinyl chloride, chlorobenzene and 2-chlorobut-2-ene, the C–Cl bond has partial double-bond character (lone-pair/π overlap), so it is strong and hard to break; these are very unreactive to substitution.

Why other options are wrong:

- Option A (vinyl chloride): vinylic C–Cl, essentially inert to substitution.
- Option C (chlorobenzene): aryl C–Cl, resonance-strengthened and unreactive.
- Option D (2-chlorobut-2-ene): also a vinylic chloride, unreactive.

Final Answer: Benzyl chloride is the most reactive $\Rightarrow$ B

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Controlled oxidation of alcohols: A primary alcohol is oxidised first to an aldehyde and then further to a carboxylic acid. A mild oxidant such as PCC stops the oxidation at the aldehyde stage because it works in anhydrous medium and does not over-oxidise.

Step 1 — Write the mild oxidation:

$$RCH_2OH \xrightarrow{PCC} RCHO.$$

Step 2 — Note why it stops there: PCC in dry conditions cannot carry the alde-

hyde on to the acid (that further step needs water and a stronger oxidant), so the aldehyde is isolated.

Why other options are wrong:

- Option A (carboxylic acid): the product of a *strong* oxidant such as acidified $KMnO_4$, not mild PCC.
- Option B (ketone): comes from a secondary alcohol, not a primary one.
- Option C (ester): requires an acid plus an alcohol, not a simple oxidation.

Final Answer: Mild oxidation of a primary alcohol gives an aldehyde $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q19

Q20.

Solution

Concept — Nucleophilic addition of HCN: The cyanide ion adds to the electron-poor carbonyl carbon and a proton adds to the oxygen, giving an α-hydroxynitrile, commonly called a cyanohydrin.

Step 1 — Add CN^- to the carbonyl carbon:

$$CH_3CHO + HCN \rightarrow CH_3\text{-}CH(OH)\text{-}CN.$$

Step 2 — Recognise the product class: The product has both a hydroxyl ($-OH$) and a nitrile ($-CN$) on the same carbon, which is the defining feature of a cyanohydrin (α-hydroxynitrile).

Why other options are wrong:

- Option A (ester): needs an acid and an alcohol; not formed here.
- Option B (amide): would require a $-CONH_2$ group, which is not produced.
- Option D (carboxylic acid): would require hydrolysis of the nitrile, a separate later step.

Final Answer: HCN addition to acetaldehyde gives a cyanohydrin $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q20

Q21.

Solution

Concept — Making acyl chlorides: A carboxylic acid reacts with thionyl chloride ($SOCl_2$) to replace its $-OH$ with $-Cl$, forming an acyl chloride. The by-products SO_2 and HCl are gases, so this route gives a pure product.

Step 1 — Write the reaction:

$$CH_3COOH + SOCl_2 \rightarrow CH_3COCl + SO_2 \uparrow + HCl \uparrow .$$

Step 2 — Identify the organic product: The $-OH$ of acetic acid is replaced by $-Cl$, giving acetyl chloride (CH_3COCl).

Why other options are wrong:

- Option A (acetamide): would need ammonia, not $SOCl_2$.
- Option B (ethyl acetate): an ester, formed with ethanol, not $SOCl_2$.
- Option C (acetic anhydride): formed by dehydration of two acid molecules, not by $SOCl_2$.

Final Answer: Acetic acid + $SOCl_2$ gives acetyl chloride $\Rightarrow$ $\boxed{D}$

Answer: (D) Go Back to Q21

Q22.

Solution

Concept — Reduction of nitriles: A nitrile ($-C \equiv N$) is reduced by $LiAlH_4$ (or H_2/Ni) by adding four hydrogen atoms across the triple bond, giving a primary amine with the same number of carbons.

Step 1 — Write the reduction:

$$CH_3CN \xrightarrow{LiAlH_4} CH_3CH_2NH_2.$$

Step 2 — Count the carbons: The nitrile carbon becomes a $-CH_2-$ group, so ethanenitrile (2 carbons) gives ethylamine (2 carbons), a primary amine.

Why other options are wrong:

- Option A (ethanamide): a partial oxidation-level product, not the reduction product.

- Option C (methylamine): has only one carbon; reduction does not remove a carbon.
- Option D (acetic acid): the hydrolysis product of the nitrile, not its reduction product.

Final Answer: Reduction of CH_3CN gives ethylamine $\Rightarrow$ B

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Levels of protein structure: The primary structure is the sequence of amino acids; the secondary structure is the local folding of the chain (the α-helix and β-pleated sheet) held by hydrogen bonds; tertiary is the overall 3D fold; quaternary is the assembly of several chains.

Step 1 — Place the α-helix and β-sheet: Both are regular, hydrogen-bonded local arrangements of the polypeptide backbone, which is exactly the definition of secondary structure.

Step 2 — Conclude: Therefore the α-helix and β-pleated sheet represent the secondary structure of a protein.

Why other options are wrong:

- Option A (primary): only the amino-acid sequence, no folding.
- Option B (tertiary): the overall 3D shape of the whole chain, not the local helix/sheet.
- Option C (quaternary): the way several folded chains come together.

Final Answer: The α-helix and β-sheet are secondary structure $\Rightarrow$ D

Answer: (D) Go Back to Q23

Q24.

Solution

Concept — IUPAC naming of ketones: Choose the longest chain containing the carbonyl carbon, number it so the carbonyl gets the lowest possible locant, add "-one" for the ketone, and name any branch as an alkyl prefix.

Step 1 — Read the skeleton: The structure is CH_3-CO-CH(CH_3)-CH_3: a four-carbon main chain carrying a carbonyl and a methyl branch.

Step 2 — Number the chain: Numbering from the end nearer the carbonyl gives C-1 (CH_3), C-2 (C=O), C-3 (CH with the methyl branch), C-4 (CH_3). The carbonyl is at C-2 and the methyl branch at C-3.

Step 3 — Assemble the name: Butan-2-one parent with a methyl group on C-3 gives 3-methylbutan-2-one.

Why other options are wrong:

- Option B (2-methylbutan-3-one): numbers from the wrong end; the carbonyl must get the lower locant (2, not 3).
- Option C (pentan-2-one): ignores the branch and treats it as a straight five-carbon chain.
- Option D (3-methylbutanal): an aldehyde name, but this compound has an internal C=O (a ketone).

Final Answer: The compound is 3-methylbutan-2-one $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q24

Q25.

Solution

Concept — Antiseptics vs disinfectants: Both kill or stop micro-organisms, but antiseptics are mild enough to be applied to living tissue, while disinfectants are stronger and are used on non-living surfaces. For phenol, concentration decides the role.

Step 1 — Judge the dilute phenol: A 0.2% phenol solution is dilute enough to be safe on skin and wounds, so it is used as an antiseptic.

Step 2 — Contrast with stronger phenol: A about 1% phenol solution is too harsh for living tissue and is used to disinfect floors and instruments (a disinfectant).

Why other options are wrong:

- Option B (disinfectant): that is the role of the more concentrated ($\sim 1\%$) phenol, not the 0.2% solution.
- Option C (antibiotic): antibiotics are substances that act inside the body against microbes, not a dilute phenol wash.
- Option D (analgesic): an analgesic relieves pain; that is not the function here.

Final Answer: Dilute (0.2%) phenol acts as an antiseptic $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q25

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	D	3	B	4	B	5	C
6	B	7	A	8	B	9	A	10	D
11	D	12	C	13	C	14	A	15	C
16	A	17	A	18	B	19	D	20	C
21	D	22	B	23	D	24	A	25	A