PGIMER BSc Nursing Chemistry

Sample Paper – 15

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. A sample of an ideal gas occupies a volume of 4.926 L at a pressure of 2 atm and a temperature of 300 K. The number of moles of the gas present is ($R = 0.0821$ L atm K^{-1} mol^{-1}):

(A) 0.4 mol

(B) 0.2 mol

(C) 0.8 mol

(D) 1.0 mol

Q2. The radius of a Bohr orbit is proportional to n^2/Z. The ratio of the radius of the third orbit of the Li^{2+} ion to that of the first orbit of the hydrogen atom is:

(A) 1

(B) 3

(C) 9

(D) $\frac{1}{3}$

Q3. An element has the atomic number 26. To which block and period of the periodic table does it belong?

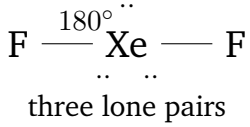
(A) p-block, period 4

(B) d-block, period 4

(C) s-block, period 4

(D) d-block, period 3

Q4. The molecule xenon difluoride (XeF_2) has a central xenon atom surrounded by five electron pairs (three lone pairs and two bond pairs), as shown. Its molecular shape is:



(A) bent (angular)

(B) trigonal planar

(C) linear

(D) T-shaped

Q5. The formal charge on the central oxygen atom of the ozone molecule (O_3), in the resonance structure where it forms one single and one double bond and carries one lone pair, is:

(A) -1

(B) 0

(C) $+2$

(D) $+1$

Q6. Using Hess's law and the three enthalpy values below, the enthalpy of formation of methane, $C(s) + 2H_2(g) \rightarrow CH_4(g)$, is:

$$C(s) + O_2(g) \rightarrow CO_2(g), \quad \Delta H_1 = -393 \text{ kJ}$$

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(l), \quad \Delta H_2 = -286 \text{ kJ}$$

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l), \quad \Delta H_3 = -890 \text{ kJ}$$

$$C + 2H_2 + 2O_2 \xrightarrow{\Delta H_f = ?} CH_4 + 2O_2$$

$$\Delta H_1 + 2\Delta H_2 \searrow \qquad \swarrow \Delta H_3$$

$$CO_2 + 2H_2O$$

(A) $+75$ kJ

(B) -1571 kJ

(C) -965 kJ

(D) -75 kJ

Q7. The pH of a 0.01 M aqueous solution of sodium hydroxide (a strong base) at 25°C is:

(A) 2

(B) 12

(C) 11

(D) 13

Q8. Which of the following is a comproportionation reaction (two species containing the same element in different oxidation states combine to give a single intermediate oxidation state)?

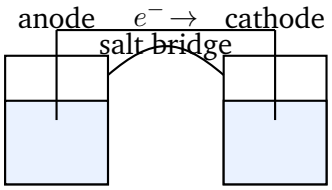
(A) $Cl_2 + 2OH^- \rightarrow Cl^- + ClO^- + H_2O$

(B) $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$

(C) $HCl + NaOH \rightarrow NaCl + H_2O$

(D) $2H_2S + SO_2 \rightarrow 3S + 2H_2O$

Q9. For the galvanic cell shown, the standard cell potential is $E^\circ_{\text{cell}} = 0.295$ V and the number of electrons transferred is $n = 2$. Using $E^\circ_{\text{cell}} = \dfrac{0.0591}{n}\log K$, the value of $\log K$ is:



(A) 5

(B) 20

(C) 10

(D) 2

Q10. The acid-catalysed hydrolysis of an ester in dilute aqueous solution obeys first-order kinetics, even though two reactants (ester and water) take part. This is because:

(A) the reaction is truly unimolecular with a single reactant

(B) water is present in such large excess that its concentration stays practically constant, giving pseudo-first-order kinetics

(C) the ester behaves as a catalyst and is not consumed

(D) the activation energy of the reaction is zero

Q11. Benzoic acid dimerises in benzene. If the degree of association is $\alpha = 0.5$ (that is, 50% of the molecules pair into dimers), the van't Hoff factor i for the solution is (use $i = 1 - \dfrac{\alpha}{2}$):

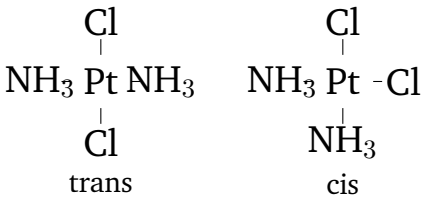
(A) 0.75

(B) 0.50

(C) 1.5

(D) 2.0

Q12. Which of the following complexes can exhibit geometrical (cis–trans) isomerism, as illustrated below for a square-planar MA_2B_2 complex?



(A) square-planar $[Pt(NH_3)_4]^{2+}$

(B) octahedral $[Co(NH_3)_6]^{3+}$

(C) tetrahedral $[Zn(NH_3)_4]^{2+}$

(D) square-planar $[Pt(NH_3)_2Cl_2]$

Q13. Diborane (B_2H_6) has fewer valence electrons than are needed for normal two-centre two-electron bonds. It is therefore classified as which type of hydride?

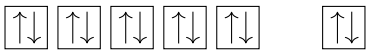
(A) electron-deficient hydride

(B) electron-precise hydride

(C) electron-rich hydride

(D) interstitial (metallic) hydride

Q14. Zinc ($Z = 30$) has the outer configuration shown below. It is not regarded as a typical transition element because:



(A) it contains no d electrons at all

(B) its $3d$ subshell is completely filled ($3d^{10}$) in the atom and in its common ions, so it has no partially filled d-orbitals

(C) it is actually a p-block element

(D) it cannot form any compounds because of its low atomic mass

Q15. The chemical formula of washing soda is:

(A) $NaHCO_3$

(B) Na_2CO_3 (anhydrous)

(C) $Na_2CO_3 \cdot 10H_2O$

(D) NaOH

Q16. Which of the following compounds can show keto–enol tautomerism?

(A) benzaldehyde (C_6H_5CHO)

(B) formaldehyde (HCHO)

(C) benzophenone ($C_6H_5COC_6H_5$)

(D) acetone (CH_3COCH_3)

Q17. For the ethyne molecule (C_2H_2) shown below, the hybridization of each carbon atom and the number of pi (π) bonds present are:

$$H - \overset{\text{triple bond}}{C \equiv C} - H$$

(A) sp hybridized, 2 pi bonds

(B) sp^2 hybridized, 1 pi bond

(C) sp^3 hybridized, 0 pi bond

(D) sp hybridized, 1 pi bond

Q18. When a single enantiomer of an optically active alkyl halide is hydrolysed by an S_N1 mechanism, the organic product is:

(A) a single enantiomer with complete retention of configuration

(B) a single enantiomer with complete inversion of configuration

(C) a racemic mixture (equal amounts of both enantiomers)

(D) an optically active product with the same specific rotation as the reactant

Q19. The correct order of decreasing acidic strength among the following is:

(A) ethanol > water > phenol > carbonic acid

(B) carbonic acid > phenol > water > ethanol

(C) phenol > carbonic acid > ethanol > water

(D) water > phenol > carbonic acid > ethanol

Q20. Which one of the following reagents can be used to distinguish an aldehyde from a ketone?

(A) Tollens' reagent (ammoniacal silver nitrate)

(B) 2,4-dinitrophenylhydrazine (2,4-DNP)

(C) sodium hydrogensulphite ($NaHSO_3$)

(D) hydroxylamine (NH_2OH)

Q21. On simple heating, which of the following acids readily loses water to form a cyclic (five-membered) anhydride?

(A) acetic acid (CH_3COOH)

(B) formic acid (HCOOH)

(C) oxalic acid (HOOC-COOH)

(D) succinic acid (HOOC-CH_2-CH_2-COOH)

Q22. In the Sandmeyer reaction, benzenediazonium chloride is treated with cuprous chloride (CuCl/HCl). The main organic product is:

(A) chlorobenzene

(B) phenol

(C) benzene

(D) nitrobenzene

Q23. Deficiency of vitamin C (ascorbic acid) in the diet causes which of the following diseases?

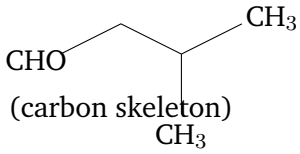
(A) night blindness

(B) rickets

(C) scurvy

(D) beri-beri

Q24. The IUPAC name of the aldehyde whose carbon skeleton is shown below is:



(A) butanal

(B) 2-methylbutanal

(C) 3-methylbutanal

(D) 3-methylbutanoic acid

Q25. Which of the following substances is commonly used as a food preservative?

(A) sodium benzoate

(B) monosodium glutamate

(C) aspartame

(D) sodium lauryl sulphate

Detailed Solutions

Q1.

Solution

Concept — Ideal gas equation: For an ideal gas, $PV = nRT$, so the number of moles is $n = \dfrac{PV}{RT}$.

Step 1 — List the given values: Pressure $P = 2$ atm.

Volume $V = 4.926$ L.

Temperature $T = 300$ K, and $R = 0.0821$ L atm K^{-1} mol^{-1}.

Step 2 — Substitute into the formula:

$$n = \frac{PV}{RT} = \frac{2 \times 4.926}{0.0821 \times 300}.$$

Step 3 — Simplify:

$$n = \frac{9.852}{24.63} = 0.4 \text{ mol}.$$

Why other options are wrong:

- Option B (0.2 mol): would need half the pressure or half the volume.
- Option C (0.8 mol): doubles the correct value.
- Option D (1.0 mol): would correspond to a much larger PV product.

Final Answer: $n = 0.4$ mol $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q1

Q2.

Solution

Concept — Bohr orbit radius: The radius of the nth orbit is $r_n \propto \dfrac{n^2}{Z}$, where n is the orbit number and Z the nuclear charge.

Step 1 — Write the ratio in terms of n^2/Z:

$$\frac{r(\text{Li}^{2+},\, n=3)}{r(\text{H},\, n=1)} = \frac{(n^2/Z)_{\text{Li}^{2+}}}{(n^2/Z)_{\text{H}}}.$$

Step 2 — Put in the values: For Li^{2+}, $Z = 3$ and $n = 3$, so $\dfrac{n^2}{Z} = \dfrac{9}{3} = 3$.

For H, $Z = 1$ and $n = 1$, so $\dfrac{n^2}{Z} = \dfrac{1}{1} = 1$.

Step 3 — Divide:

$$\text{Ratio} = \frac{3}{1} = 3.$$

Why other options are wrong:

- Option A (1): ignores the higher nuclear charge and orbit number.
- Option C (9): uses only n^2 and forgets to divide by $Z = 3$.
- Option D ($\frac{1}{3}$): inverts the ratio.

Final Answer: The ratio of radii is $3 \Rightarrow$ B

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Block and period from configuration: The last electron entering an s, p, d or f subshell fixes the block; the highest principal quantum number gives the period.

Step 1 — Write the electronic configuration of $Z = 26$: $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^6\,4s^2$, i.e. $[\text{Ar}]3d^6\,4s^2$.

Step 2 — Identify the block: The differentiating electron enters the $3d$ subshell, so the element is a d-block element.

Step 3 — Identify the period: The highest principal quantum number is 4 (the $4s$ orbital), so it lies in period 4.

Why other options are wrong:

- Option A (p-block): the last electron enters $3d$, not a p subshell.
- Option C (s-block): s-block elements have only $ns^{1\text{ or }2}$ outermost, with no partly filled d.
- Option D (period 3): the outermost shell is $n = 4$, not $n = 3$.

Final Answer: d-block, period 4 (this element is iron) $\Rightarrow$ B

Answer: (B) Go Back to Q3

Q4.

Solution

Concept — VSEPR shape: The shape is set by the arrangement of all electron pairs; lone pairs occupy positions but are not counted in the visible molecular shape.

Step 1 — Count electron pairs around Xe in XeF_2: Two bond pairs (to the two F atoms) and three lone pairs give five electron pairs in total.

Step 2 — Choose the geometry: Five electron pairs adopt a trigonal bipyramidal arrangement; the three lone pairs occupy the three equatorial positions to minimise repulsion.

Step 3 — Read off the shape: The two F atoms are left at the axial positions, giving a linear molecule with an F–Xe–F angle of $180°$.

Why other options are wrong:

- Option A (bent): would require two lone pairs on a four-pair centre, as in water.
- Option B (trigonal planar): applies to three bond pairs and no lone pairs.
- Option D (T-shaped): applies to three bond pairs and two lone pairs, as in ClF_3.

Final Answer: XeF_2 is linear $\Rightarrow$ C

Answer: (C) Go Back to Q4

Q5.

Solution

Concept — Formal charge: Formal charge = (valence electrons) − (non-bonding electrons) − (number of bonds), where each bond counts as one shared pair.

Step 1 — Describe the central O of ozone: In the given resonance structure the central oxygen forms one single bond and one double bond (three bonds in all) and carries one lone pair (two non-bonding electrons).

Step 2 — Substitute into the formula: Valence electrons of oxygen $= 6$; non-bonding electrons $= 2$; number of bonds $= 3$:

$$\text{FC} = 6 - 2 - 3.$$

Step 3 — Simplify:

$$\text{FC} = +1.$$

Why other options are wrong:

- Option A (-1): this is the formal charge on the singly bonded terminal oxygen, not the central one.
- Option B (0): would need two bonds and two lone pairs, like a neutral terminal O.
- Option C ($+2$): overcounts the bonds or ignores the lone pair.

Final Answer: Formal charge on the central O of O_3 is $+1 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q5

Q6.

Solution

Concept — Hess's law: The enthalpy of a reaction is independent of the path, so target reactions can be built by adding or subtracting the given equations along with their enthalpies.

Step 1 — Write the target and the route: Target: $C(s) + 2H_2(g) \rightarrow CH_4(g)$.

Combine equation (1) once and equation (2) twice (both forming CO_2 and H_2O), then reverse equation (3) to release CH_4.

Step 2 — Assemble the enthalpy expression:

$$\Delta H_f = \Delta H_1 + 2\Delta H_2 - \Delta H_3.$$

Step 3 — Substitute and evaluate:

$$\Delta H_f = (-393) + 2(-286) - (-890).$$

$$\Delta H_f = -393 - 572 + 890.$$

$$\Delta H_f = -75 \text{ kJ}.$$

Why other options are wrong:

- Option A ($+75$ kJ): correct magnitude but wrong sign (from not reversing equation 3 properly).
- Option B (-1571 kJ): simply adds all three enthalpies.

- Option C (-965 kJ): forgets to add back ΔH_3.

Final Answer: $\Delta H_f(\mathrm{CH_4}) = -75$ kJ $\Rightarrow$ D

Answer: (D) Go Back to Q6

Q7.

Solution

Concept — pH of a strong base: A strong base dissociates completely, so $[\mathrm{OH^-}]$ equals its molarity; then $\mathrm{pOH} = -\log[\mathrm{OH^-}]$ and $\mathrm{pH} = 14 - \mathrm{pOH}$.

Step 1 — Find $[\mathrm{OH^-}]$: For 0.01 M NaOH, $[\mathrm{OH^-}] = 10^{-2}$ M.

Step 2 — Calculate pOH:

$$\mathrm{pOH} = -\log(10^{-2}) = 2.$$

Step 3 — Convert to pH:

$$\mathrm{pH} = 14 - \mathrm{pOH} = 14 - 2 = 12.$$

Why other options are wrong:

- Option A (2): this is the pOH, not the pH.
- Option C (11): corresponds to 0.001 M base.
- Option D (13): corresponds to 0.1 M base.

Final Answer: $\mathrm{pH} = 12 \Rightarrow$ B

Answer: (B) Go Back to Q7

Q8.

Solution

Concept — Comproportionation: It is the reverse of disproportionation: two species containing the same element in a higher and a lower oxidation state react to give a single, intermediate oxidation state.

Step 1 — Examine option D: In $2\mathrm{H_2S} + \mathrm{SO_2} \rightarrow 3\mathrm{S} + 2\mathrm{H_2O}$, sulphur is -2 in $\mathrm{H_2S}$ and $+4$ in $\mathrm{SO_2}$.

Step 2 — Track the oxidation states: Both are converted to elemental sulphur,

oxidation state 0, which lies between -2 and $+4$.

Step 3 — Conclude: A higher and a lower state of the same element merge into one intermediate state, so this is comproportionation.

Why other options are wrong:

- Option A: chlorine goes from 0 to both -1 and $+1$; this is disproportionation, the opposite process.
- Option B: a simple displacement redox between two different elements.
- Option C: an acid–base neutralisation with no change in oxidation states.

Final Answer: $2H_2S + SO_2 \rightarrow 3S + 2H_2O$ is comproportionation $\Rightarrow$ $\boxed{D}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Relation between E° and K: At equilibrium the Nernst equation gives $E^\circ_{\text{cell}} = \dfrac{0.0591}{n} \log K$, linking the standard potential to the equilibrium constant.

Step 1 — Rearrange for $\log K$:

$$\log K = \frac{n\, E^\circ_{\text{cell}}}{0.0591}.$$

Step 2 — Substitute the given values: $n = 2$ and $E^\circ_{\text{cell}} = 0.295$ V:

$$\log K = \frac{2 \times 0.295}{0.0591} = \frac{0.590}{0.0591}.$$

Step 3 — Simplify:

$$\log K = 10.$$

Why other options are wrong:

- Option A (5): forgets the factor $n = 2$.
- Option B (20): doubles the correct value.
- Option D (2): confuses $\log K$ with n.

Final Answer: $\log K = 10 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q9

Q10.

Solution

Concept — Pseudo-first-order reaction: A reaction that is second-order overall can appear first-order if one reactant is present in such large excess that its concentration barely changes during the reaction.

Step 1 — Look at the ester hydrolysis: $\mathrm{RCOOR' + H_2O \rightarrow RCOOH + R'OH}$ involves both the ester and water.

Step 2 — Note the excess of water: In dilute aqueous solution water is present in vast excess, so its concentration stays essentially constant throughout.

Step 3 — Deduce the observed order: The rate then depends only on the ester concentration, giving apparent (pseudo) first-order kinetics.

Why other options are wrong:

- Option A: the reaction is genuinely bimolecular; it only looks unimolecular.
- Option C: the acid, not the ester, is the catalyst, and the ester is consumed.
- Option D: a zero activation energy is not the reason and is not the case here.

Final Answer: Water in large excess makes it pseudo-first-order $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — van't Hoff factor for association: When n molecules associate, $i = 1 - \alpha + \frac{\alpha}{n}$; for dimerisation ($n = 2$) this reduces to $i = 1 - \frac{\alpha}{2}$.

Step 1 — Identify the association: Benzoic acid forms dimers in benzene, so $n = 2$.

Step 2 — Substitute the degree of association: With $\alpha = 0.5$:

$$i = 1 - \frac{\alpha}{2} = 1 - \frac{0.5}{2}.$$

Step 3 — Simplify:

$$i = 1 - 0.25 = 0.75.$$

Why other options are wrong:

- Option B (0.50): would require complete association ($\alpha = 1$).

- Option C (1.5): applies to dissociation, not association.
- Option D (2.0): is the number of particles per dimer, not the factor i.

Final Answer: $i = 0.75 \Rightarrow$ A

Answer: (A) Go Back to Q11

Q12.

Solution

Concept — Geometrical isomerism: A square-planar complex of type MA_2B_2 can place the two like ligands next to each other (cis) or opposite (trans), giving geometrical isomers; complexes with all identical ligands, or tetrahedral MA_2B_2, cannot.

Step 1 — Test option D: $[Pt(NH_3)_2Cl_2]$ is square-planar of type MA_2B_2.

Step 2 — Draw the possibilities: The two Cl ligands can be adjacent (cis) or across the square (trans), as shown, so two distinct isomers exist.

Step 3 — Conclude: This complex therefore shows cis–trans isomerism.

Why other options are wrong:

- Option A: $[Pt(NH_3)_4]^{2+}$ has four identical ligands, so no isomers.
- Option B: $[Co(NH_3)_6]^{3+}$ has six identical ligands, so no geometrical isomerism.
- Option C: a tetrahedral MA_2B_2 complex cannot show geometrical isomerism (all positions are adjacent).

Final Answer: $[Pt(NH_3)_2Cl_2]$ shows cis–trans isomerism $\Rightarrow$ D

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Classification of hydrides: Hydrides are grouped as electron-deficient (too few electrons for normal bonds), electron-precise (exactly enough), and electron-rich (extra lone pairs); this depends on the number of valence electrons available.

Step 1 — Count the bonding needs of B_2H_6: Diborane needs more electron pairs to hold its framework together than the boron and hydrogen atoms can supply for

ordinary two-centre two-electron bonds.

Step 2 — Identify the bonding: It uses three-centre two-electron (banana) bonds at the bridging hydrogens, a hallmark of an electron shortage.

Step 3 — Classify: Because it has fewer electrons than needed for normal bonds, B_2H_6 is an electron-deficient hydride (typical of group 13).

Why other options are wrong:

- Option B (electron-precise): describes group 14 hydrides such as CH_4.
- Option C (electron-rich): describes hydrides with lone pairs, such as NH_3 or H_2O.
- Option D (interstitial): describes hydrogen dissolved in metal lattices, not molecular B_2H_6.

Final Answer: Diborane is an electron-deficient hydride $\Rightarrow$ A

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Definition of a transition element: A transition element must have a partially filled d subshell in its atom or in at least one of its common ions; elements without this are not typical transition metals.

Step 1 — Write the configuration of zinc: Zn is $[\text{Ar}]3d^{10}\,4s^2$; its common ion Zn^{2+} is $[\text{Ar}]3d^{10}$.

Step 2 — Check the d subshell: In both the atom and the Zn^{2+} ion the $3d$ subshell is completely filled ($3d^{10}$), as the paired-arrow boxes show.

Step 3 — Apply the definition: With no partially filled d orbitals, zinc lacks the characteristic transition-metal properties (variable oxidation states, coloured ions, strong paramagnetism).

Why other options are wrong:

- Option A: zinc does have d electrons ($3d^{10}$); they are simply all paired.
- Option C: zinc is a d-block element, though not a typical transition metal.
- Option D: low atomic mass is not the reason, and zinc does form compounds.

Final Answer: The $3d^{10}$ subshell is completely filled in Zn and Zn^{2+} $\Rightarrow$ B

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Common sodium salts: Washing soda is the decahydrate of sodium carbonate, while baking soda is sodium hydrogencarbonate; each has a distinct formula.

Step 1 — Recall washing soda: Washing soda is hydrated sodium carbonate, $Na_2CO_3 \cdot 10H_2O$.

Step 2 — Match to the option: This corresponds to option C.

Why other options are wrong:

- Option A ($NaHCO_3$): this is baking soda, not washing soda.
- Option B (Na_2CO_3 anhydrous): this is soda ash; washing soda specifically carries ten water molecules.
- Option D (NaOH): this is caustic soda.

Final Answer: Washing soda is $Na_2CO_3 \cdot 10H_2O \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Keto–enol tautomerism: A carbonyl compound shows keto–enol tautomerism only if it has at least one hydrogen on the carbon adjacent to the carbonyl (an α-hydrogen).

Step 1 — Look for α-hydrogens: Acetone, CH_3-CO-CH_3, has two methyl groups next to the carbonyl, each supplying α-hydrogens.

Step 2 — Form the enol: An α-hydrogen can shift to the carbonyl oxygen, giving the enol $CH_2 = C(OH)$-CH_3; the keto and enol forms interconvert.

Step 3 — Conclude: Acetone therefore shows keto–enol tautomerism.

Why other options are wrong:

- Option A (benzaldehyde): the carbonyl carbon is attached to a ring and an H, with no α-hydrogen.
- Option B (formaldehyde): has no carbon adjacent to the carbonyl, so no α-hydrogen.
- Option C (benzophenone): both groups on the carbonyl are aryl, so there is no α-hydrogen.

Final Answer: Acetone shows keto–enol tautomerism $\Rightarrow$ D

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Bonding in ethyne: A carbon–carbon triple bond consists of one sigma and two pi bonds; each triple-bonded carbon is sp hybridized.

Step 1 — Examine each carbon: In H-C $\equiv$ C-H each carbon forms two sigma bonds (one to H, one to the other C) and no lone pairs.

Step 2 — Assign hybridization: Two sigma bonds and no lone pairs mean two hybrid orbitals, so each carbon is sp hybridized (giving the linear 180° geometry shown).

Step 3 — Count the pi bonds: The remaining two unhybridized p orbitals on each carbon overlap sideways to form two pi bonds.

Why other options are wrong:

- Option B (sp^2, 1 pi): describes a double bond, as in ethene.
- Option C (sp^3, 0 pi): describes a single bond, as in ethane.
- Option D (sp, 1 pi): correct hybridization but a triple bond has two pi bonds, not one.

Final Answer: Each carbon is sp hybridized with 2 pi bonds $\Rightarrow$ A

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Stereochemistry of S_N1: An S_N1 reaction passes through a planar carbocation intermediate, which the nucleophile can attack equally from either face.

Step 1 — Form the intermediate: The C–halogen bond breaks first to give a flat, sp^2 carbocation, destroying the original chirality at that carbon.

Step 2 — Attack from both faces: The nucleophile adds to the front and back of the planar carbocation with nearly equal probability.

Step 3 — Deduce the product mixture: Equal attack from both faces gives

roughly equal amounts of the two enantiomers, i.e. a racemic mixture (racemisation).

Why other options are wrong:

- Option A (retention): would require the nucleophile to add only to the same face, which S_N1 does not.
- Option B (inversion): complete inversion is characteristic of the S_N2 mechanism.
- Option D (same rotation): the product is not optically active in the same way; the rotation averages to zero.

Final Answer: S_N1 hydrolysis gives a racemic mixture $\Rightarrow$ C

Answer: (C) Go Back to Q18

Q19.

Solution

Concept — Relative acidity: A stronger acid has a more stable conjugate base; carboxylic-type acids beat phenol, phenol beats water, and water beats simple alcohols.

Step 1 — Recall the approximate pKa values: Carbonic acid pKa ≈ 6.3; phenol pKa ≈ 10; water pKa ≈ 15.7; ethanol pKa ≈ 16.

Step 2 — Order from lowest to highest pKa: Lower pKa means stronger acid, so the order of acidity is carbonic acid $>$ phenol $>$ water $>$ ethanol.

Step 3 — Match to the option: This decreasing order is exactly option B.

Why other options are wrong:

- Option A: reverses the order, making ethanol the strongest, which is wrong.
- Option C: wrongly places phenol above carbonic acid.
- Option D: wrongly places water at the top.

Final Answer: carbonic acid $>$ phenol $>$ water $>$ ethanol $\Rightarrow$ B

Answer: (B) Go Back to Q19

Q20.

Solution

Concept — Distinguishing aldehydes and ketones: Aldehydes are easily oxidised and give positive tests with mild oxidising reagents, whereas ketones do not.

Step 1 — Recall the Tollens' test: Tollens' reagent (ammoniacal silver nitrate) oxidises an aldehyde and is itself reduced to metallic silver, forming a shiny silver mirror.

Step 2 — Compare the two carbonyls: An aldehyde gives the silver mirror, but a ketone does not react, so the two are clearly distinguished.

Why other options are wrong:

- Option B (2,4-DNP): both aldehydes and ketones give an orange precipitate, so it cannot tell them apart.
- Option C (sodium bisulphite): both react to give bisulphite adducts.
- Option D (hydroxylamine): both form oximes, so no distinction results.

Final Answer: Tollens' reagent distinguishes them (silver mirror with the aldehyde) $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q20

Q21.

Solution

Concept — Cyclic anhydride formation: Dicarboxylic acids whose two -COOH groups are correctly spaced can lose a molecule of water on heating to form a stable five- or six-membered cyclic anhydride.

Step 1 — Examine succinic acid: HOOC-CH_2-CH_2-COOH has its two carboxyl groups four carbons apart.

Step 2 — Heat and cyclise: On heating, the two -COOH groups condense with loss of water to give a five-membered cyclic anhydride (succinic anhydride).

Step 3 — Conclude: The favourable five-membered ring makes this dehydration easy, so succinic acid is the answer.

Why other options are wrong:

- Option A (acetic acid): being monocarboxylic, it cannot form a cyclic anhydride by itself.

- Option B (formic acid): on heating it decomposes to CO and water, not an anhydride.
- Option C (oxalic acid): on heating it decomposes to CO_2, CO and water rather than a stable ring.

Final Answer: Succinic acid forms a cyclic anhydride on heating $\Rightarrow$ $\boxed{D}$

Answer: (D) Go Back to Q21

Q22.

Solution

Concept — Sandmeyer reaction: A diazonium group is replaced by a halogen when the diazonium salt is treated with the corresponding cuprous halide; with CuCl the product is the chloroarene.

Step 1 — Identify the reactants: Benzenediazonium chloride, $C_6H_5N_2^+Cl^-$, is treated with cuprous chloride in HCl.

Step 2 — Replace the diazonium group: The $-N_2^+$ group leaves as nitrogen gas and is replaced by a chlorine atom on the ring.

Step 3 — Name the product: The product is chlorobenzene, C_6H_5Cl.

Why other options are wrong:

- Option B (phenol): forms on warming the diazonium salt with water, not with CuCl.
- Option C (benzene): forms on reduction with hypophosphorous acid (H_3PO_2).
- Option D (nitrobenzene): is a starting material for making aniline, not a Sandmeyer product.

Final Answer: The Sandmeyer product is chlorobenzene $\Rightarrow$ $\boxed{A}$

Answer: (A) Go Back to Q22

Q23.

Solution

Concept — Vitamin deficiency diseases: Each vitamin has a characteristic deficiency disease; vitamin C is needed for healthy connective tissue and gums.

Step 1 — Link vitamin C to its role: Vitamin C (ascorbic acid) is required for collagen synthesis; its lack weakens gums and blood vessels.

Step 2 — Name the disease: A prolonged deficiency of vitamin C causes scurvy (bleeding gums, swollen joints).

Why other options are wrong:

- Option A (night blindness): caused by a deficiency of vitamin A.
- Option B (rickets): caused by a deficiency of vitamin D.
- Option D (beri-beri): caused by a deficiency of vitamin B_1 (thiamine).

Final Answer: Deficiency of vitamin C causes scurvy $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — IUPAC naming of aldehydes: The chain is numbered so that the aldehyde carbon (-CHO) is C-1; the suffix is "-al" and branches are named as prefixes with their locants.

Step 1 — Write out the structure: The skeleton is CHO-CH_2-CH(CH_3)-CH_3, i.e. a four-carbon chain ending in -CHO with a methyl branch.

Step 2 — Number the chain: Starting from the -CHO carbon: C-1 (CHO), C-2 (CH_2), C-3 (CH with methyl), C-4 (CH_3). The parent chain has four carbons $\Rightarrow$ butanal.

Step 3 — Locate the branch and assemble the name: The methyl group sits on C-3, giving 3-methylbutanal.

Why other options are wrong:

- Option A (butanal): ignores the methyl branch.
- Option B (2-methylbutanal): wrong locant; the branch is on C-3, not C-2.
- Option D (3-methylbutanoic acid): the group is -CHO (an aldehyde), not -COOH.

Final Answer: The compound is 3-methylbutanal $\Rightarrow$ C

Answer: (C) Go Back to Q24

Q25.

Solution

Concept — Food preservatives: Preservatives inhibit the growth of micro-organisms so that food does not spoil; sodium benzoate is a common example.

Step 1 — Recall the use of sodium benzoate: Sodium benzoate is widely added to jams, squashes and acidic foods to prevent microbial growth.

Step 2 — Match to the option: This is option A.

Why other options are wrong:

- Option B (monosodium glutamate): a flavour enhancer, not a preservative.
- Option C (aspartame): an artificial sweetener.
- Option D (sodium lauryl sulphate): a detergent/surfactant, not used in food.

Final Answer: Sodium benzoate is used as a food preservative $\Rightarrow$ A

Answer: (A) Go Back to Q25

Answer Key

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