PGIMER BSc Nursing Chemistry

Sample Paper – 9

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. On strong heating, 10 g of calcium carbonate decomposes completely as $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$. The volume of CO_2 evolved at STP is (molar mass of $CaCO_3 = 100$ g mol^{-1}; molar gas volume $= 22.4$ L mol^{-1}):

(A) 1.12 L

(B) 2.24 L

(C) 22.4 L

(D) 4.48 L

Q2. According to the $(n+l)$ rule for the order of filling of orbitals, the orbital that is filled immediately after the $4s$ orbital is:

(A) $4p$

(B) $4d$

(C) $3d$

(D) $4f$

Q3. The electron gain enthalpy of chlorine is more negative than that of fluorine. The best explanation for this anomaly is:

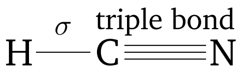
(A) The fluorine atom is very small, so strong inter-electronic repulsion in its compact $2p$ subshell opposes the incoming electron.

(B) Fluorine has a higher effective nuclear charge than chlorine.

(C) Chlorine is more electronegative than fluorine.

(D) Fluorine has a larger atomic size than chlorine.

Q4. The number of sigma (σ) and pi (π) bonds present in a molecule of hydrogen cyanide (HCN, shown below) is:



$$H-C\equiv N$$

(A) 3 sigma and 1 pi

(B) 2 sigma and 2 pi

(C) 4 sigma and 0 pi

(D) 1 sigma and 3 pi

Q5. Lattice energy increases with higher ionic charge and smaller ionic size. Among the following ionic solids, the one with the highest lattice energy is:

(A) NaCl

(B) KCl

(C) NaF

(D) MgO

Q6. For a reaction at constant temperature, the relation $\Delta G^\circ = -RT\ln K$ holds. If the equilibrium constant $K > 1$, then:

(A) $\Delta G^\circ > 0$ and the reactants are favoured.

(B) $\Delta G^\circ < 0$ and the products are favoured.

(C) $\Delta G^\circ = 0$ and the system is always at equilibrium.

(D) $\Delta G^\circ < 0$ but the reactants are favoured.

Q7. For a reversible reaction at a certain temperature, the reaction quotient is $Q = 2.0 \times 10^3$ while the equilibrium constant is $K_c = 2.0 \times 10^2$. The reaction will:

(A) proceed in the forward direction to form more products.

(B) already be at equilibrium with no net change.

(C) stop completely.

(D) proceed in the reverse direction to form more reactants.

Q8. The oxidation state of chromium in the dichromate ion $Cr_2O_7^{2-}$ is:

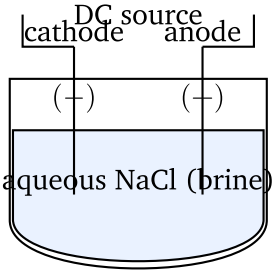
(A) $+6$

(B) $+7$

(C) $+3$

(D) $+2$

Q9. In the electrolysis of a concentrated aqueous solution of sodium chloride (brine), shown in the cell below, the products liberated at the cathode and the anode, respectively, are:



(A) Na and Cl_2

(B) O_2 and H_2

(C) H_2 and Cl_2

(D) Na and O_2

Q10. For the reaction $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$, the correct expression relating the rate of reaction to the rates of change of concentration is:

(A) Rate $= -\frac{d[N_2]}{dt} = -\frac{d[H_2]}{dt} = +\frac{d[NH_3]}{dt}$

(B) Rate $= -3\frac{d[N_2]}{dt} = -\frac{d[H_2]}{dt} = +2\frac{d[NH_3]}{dt}$

(C) Rate $= -\frac{d[N_2]}{dt} = -3\frac{d[H_2]}{dt} = +2\frac{d[NH_3]}{dt}$

(D) Rate $= -\frac{d[N_2]}{dt} = -\frac{1}{3}\frac{d[H_2]}{dt} = +\frac{1}{2}\frac{d[NH_3]}{dt}$

Q11. A 250 g sample of water is found to contain 0.005 g of a dissolved pollutant. The concentration of the pollutant expressed in parts per million (ppm) is:

(A) 5 ppm

(B) 50 ppm

(C) 20 ppm

(D) 2 ppm

Q12. Which of the following is an *ambidentate* ligand?

(A) ethylenediamine (en)

(B) ammonia (NH_3)

(C) chloride (Cl^-)

(D) thiocyanate (SCN^-)

Q13. The maximum (highest positive) oxidation state shown by the elements of group 15 (the nitrogen family) is:

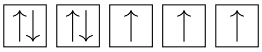
(A) $+3$

(B) $+5$

(C) $+7$

(D) $+4$

Q14. The number of unpaired electrons in the Co^{2+} ion (electronic configuration $3d^7$, shown in the orbital boxes below) is:



$3d^7$ configuration of Co^{2+}

(A) 5

(B) 3

(C) 1

(D) 4

Q15. The thermal stability of the carbonates of group 2 (alkaline earth) metals increases down the group. The most thermally stable carbonate among the following is:

(A) $BaCO_3$

(B) $BeCO_3$

(C) $MgCO_3$

(D) $CaCO_3$

Q16. The number of optical isomers possible for a molecule containing two dissimilar (non-equivalent) chiral carbon atoms is:

(A) 1

(B) 2

(C) 8

(D) 4

Q17. The acid-catalysed hydration of propene ($CH_2{=}CH\text{-}CH_3$) with dilute sulphuric acid, following Markovnikov's rule, gives mainly:

$$CH_2{=}CH\text{-}CH_3 \xrightarrow{H_2O/H^+} \quad ?$$

(A) propan-1-ol

(B) propane

(C) propan-2-ol

(D) 2-chloropropane

Q18. The Wurtz–Fittig reaction of bromobenzene (C_6H_5Br) with bromomethane (CH_3Br) in the presence of sodium metal in dry ether gives mainly:

(A) biphenyl

(B) toluene (methylbenzene)

(C) benzene

(D) ethane

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

(A) p-nitrophenol $>$ phenol $>$ p-cresol

(B) p-cresol $>$ phenol $>$ p-nitrophenol

(C) phenol $>$ p-nitrophenol $>$ p-cresol

(D) p-cresol $>$ p-nitrophenol $>$ phenol

Q20. When acetone (propanone) is treated with 2,4-dinitrophenylhydrazine (2,4-DNP reagent), the carbonyl derivative formed is a:

(A) oxime

(B) cyanohydrin

(C) 2,4-dinitrophenylhydrazone

(D) semicarbazone

Q21. Considering the effect of substituents on acidity, the strongest acid among the following substituted benzoic acids is:

(A) p-nitrobenzoic acid

(B) p-methoxybenzoic acid

(C) benzoic acid

(D) p-methylbenzoic acid (p-toluic acid)

Q22. In the *gas phase* (where the solvation effect of water is absent), the order of basicity of the methylamines and ammonia is governed only by the inductive (+I) effect. The correct order is:

(A) $NH_3 > CH_3NH_2 > (CH_3)_2NH > (CH_3)_3N$

(B) $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2 > NH_3$

(C) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$

(D) $CH_3NH_2 > (CH_3)_2NH > (CH_3)_3N > NH_3$

Q23. Which of the following statements best describes the *denaturation* of a protein?

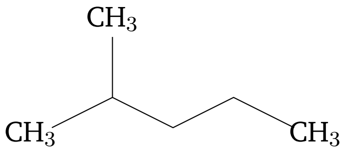
(A) All the peptide bonds are hydrolysed, breaking the protein into free amino acids.

(B) New peptide bonds are formed, joining several amino acids together.

(C) The alpha-helix is converted into a beta-sheet with no loss of biological activity.

(D) The secondary and tertiary structures are disrupted while the primary structure (peptide bonds) stays intact, and biological activity is lost.

Q24. Applying the lowest-locant rule, the correct IUPAC name of the branched alkane whose carbon skeleton is shown below is:



(carbon skeleton: 5 carbons in the main chain)

(A) 4-methylpentane

(B) 2-ethylbutane

(C) 2-methylpentane

(D) 3-methylpentane

Q25. The cleansing action of soap in removing oily dirt from cloth is mainly due to:

(A) the formation of micelles in which the hydrophobic tails trap the grease while the hydrophilic heads face the water, so the grease is washed away.

(B) a chemical reaction that converts the grease into water-soluble salts.

(C) the high pH of the soap solution dissolving the dirt completely.

(D) oxidation of the grease by the soap molecules.

Detailed Solutions

Q1.

Solution

Concept — Gas stoichiometry: First find the moles of the solid that reacts, use the balanced equation to find the moles of gas, then multiply by the molar gas volume at STP.

Step 1 — Moles of $CaCO_3$:

$$n = \frac{m}{M} = \frac{10}{100} = 0.1 \text{ mol}.$$

Step 2 — Use the mole ratio: The equation $CaCO_3 \to CaO + CO_2$ shows 1 mol $CaCO_3$ gives 1 mol CO_2.

So moles of $CO_2 = 0.1$ mol.

Step 3 — Convert moles of gas to volume at STP:

$$V = n \times 22.4 = 0.1 \times 22.4.$$

$$V = 2.24 \text{ L}.$$

Why other options are wrong:

- Option A $(1.12$ L$)$: corresponds to only 0.05 mol of gas.
- Option C $(22.4$ L$)$: assumes a full 1 mol of gas.
- Option D $(4.48$ L$)$: assumes 0.2 mol of gas.

Final Answer: Volume of $CO_2 = 2.24 \text{ L} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — $(n + l)$ rule: Orbitals are filled in increasing order of $(n + l)$. When two orbitals have the same $(n + l)$ value, the one with the lower n is filled first.

Step 1 — Find $(n + l)$ for $4s$: For $4s$, $n = 4$, $l = 0$, so $(n + l) = 4$.

Step 2 — Compare the candidate orbitals: $3d$: $n = 3,\ l = 2$, so $(n + l) = 5$.

$4p$: $n = 4,\ l = 1$, so $(n + l) = 5$.

Step 3 — Break the tie: Both $3d$ and $4p$ have $(n+l)=5$, so the one with the lower n is filled first.

$3d$ has $n=3$, which is lower than $n=4$ of $4p$, so $3d$ is filled immediately after $4s$.

Why other options are wrong:

- Option A ($4p$): filled after $3d$, since both have $(n+l)=5$ but $4p$ has the higher n.
- Option B ($4d$): $(n+l)=6$, filled much later.
- Option D ($4f$): $(n+l)=7$, filled even later.

Final Answer: The $3d$ orbital is filled just after $4s \Rightarrow \boxed{\text{C}}$

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

Q3.

Solution

Concept — Electron gain enthalpy anomaly: Although fluorine is at the top of group 17, chlorine releases more energy when it gains an electron because of fluorine's unusually small size.

Step 1 — Note the size of fluorine: Fluorine is a very small atom; its $2p$ subshell is extremely compact and already packed with electrons.

Step 2 — Explain the repulsion: When an extra electron is added to this small, electron-dense $2p$ subshell, it experiences strong inter-electronic repulsion, which offsets the energy released.

Step 3 — Compare with chlorine: Chlorine's $3p$ subshell is larger and more diffuse, so the incoming electron faces less repulsion, making its electron gain enthalpy more negative.

Why other options are wrong:

- Option B: a higher nuclear charge would make fluorine's value more negative, not less.
- Option C: greater electronegativity does not by itself explain the lower electron gain enthalpy.
- Option D: fluorine is smaller than chlorine, not larger.

Final Answer: The small size and electron repulsion in fluorine's compact $2p$ subshell is the reason $\Rightarrow \boxed{\text{A}}$

$\boxed{\text{Answer: (A)}}$ Go Back to Q3

Q4.

Solution

Concept — Counting sigma and pi bonds: A single bond is one sigma bond; a triple bond is one sigma bond plus two pi bonds.

Step 1 — Write the structure of HCN: H-C $\equiv$ N: an H–C single bond and a C≡N triple bond.

Step 2 — Count the sigma bonds: H–C single bond contributes 1 sigma.

The C≡N triple bond contributes 1 sigma.

Total sigma bonds $= 2$.

Step 3 — Count the pi bonds: A triple bond has 2 pi bonds, and the H–C bond has none.

Total pi bonds $= 2$.

Why other options are wrong:

- Option A $(3\sigma, 1\pi)$: wrongly treats the triple bond as containing extra sigma bonds.
- Option C $(4\sigma, 0\pi)$: ignores the pi bonds of the triple bond.
- Option D $(1\sigma, 3\pi)$: a triple bond has only 2 pi bonds, not 3.

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

$\boxed{\text{Answer: (B)}}$ Go Back to Q4

Q5.

Solution

Concept — Lattice energy: Lattice energy is proportional to the product of the ionic charges and inversely proportional to the inter-ionic distance. Higher charges and smaller ions give a larger lattice energy.

Step 1 — Compare the ionic charges: NaCl, KCl and NaF are all made of singly charged ions ($+1$ and -1).

MgO is made of doubly charged ions (Mg^{2+} and O^{2-}).

Step 2 — Apply the charge factor: For MgO the charge product is $(2)(2) = 4$, far larger than the $(1)(1) = 1$ of the other three, so MgO has by far the highest lattice energy.

Step 3 — Note the size factor: Mg^{2+} and O^{2-} are also small ions, which further increases the lattice energy.

Why other options are wrong:

- Options A (NaCl) and B (KCl): only singly charged ions, and K^+ is larger, so even smaller lattice energy.
- Option C (NaF): singly charged ions, so much smaller than MgO despite the small F^-.

Final Answer: MgO has the highest lattice energy $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q5

Q6.

Solution

Concept — ΔG° and K: The sign of the standard free energy change is fixed by the equilibrium constant through $\Delta G^\circ = -RT \ln K$.

Step 1 — Examine $\ln K$ when $K > 1$: If $K > 1$, then $\ln K$ is positive.

Step 2 — Substitute into the relation:

$$\Delta G^\circ = -RT \ln K.$$

With R, T positive and $\ln K > 0$, the right-hand side is negative.

So $\Delta G^\circ < 0$.

Step 3 — Interpret the direction: A negative ΔG° means the forward reaction is spontaneous under standard conditions, so the products are favoured at equilibrium.

Why other options are wrong:

- Option A: $K > 1$ gives $\Delta G^\circ < 0$, not > 0.
- Option C: $\Delta G^\circ = 0$ corresponds to $K = 1$, not $K > 1$.
- Option D: a negative ΔG° favours products, not reactants.

Final Answer: $K > 1 \Rightarrow \Delta G^\circ < 0$, products favoured $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Reaction quotient and direction: Comparing Q with K_c tells the direction in which a reaction must shift to reach equilibrium. If $Q > K_c$, the reaction goes backward; if $Q < K_c$, it goes forward; if $Q = K_c$, it is at equilibrium.

Step 1 — Compare the values:

$$Q = 2.0 \times 10^3, \qquad K_c = 2.0 \times 10^2.$$

Here $Q > K_c$.

Step 2 — Decide the direction: Because $Q > K_c$, there are too many products relative to equilibrium, so the reaction shifts in the reverse direction to form more reactants.

Step 3 — Conclude: The net reaction proceeds backward until Q falls to equal K_c.

Why other options are wrong:

- Option A: forward shift happens only when $Q < K_c$.
- Option B: equilibrium needs $Q = K_c$, which is not the case here.
- Option C: a reaction never simply stops; it adjusts toward equilibrium.

Final Answer: Since $Q > K_c$, the reaction goes in the reverse direction $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q7

Q8.

Solution

Concept — Oxidation state in an ion: The sum of the oxidation numbers of all atoms in an ion equals the charge on the ion; oxygen is taken as -2.

Step 1 — Set up the equation for $Cr_2O_7^{2-}$: Let the oxidation state of Cr be x. There are 2 Cr atoms and 7 O atoms (-2 each):

$$2x + 7(-2) = -2.$$

Step 2 — Simplify:

$$2x - 14 = -2.$$

$$2x = 12.$$

Step 3 — Solve:

$$x = +6.$$

Why other options are wrong:

- Option B $(+7)$: this is the state of Mn in MnO_4^-, not Cr here.
- Option C $(+3)$: the state of Cr in Cr^{3+} or Cr_2O_3.
- Option D $(+2)$: the state of Cr in CrO.

Final Answer: Oxidation state of Cr in $Cr_2O_7^{2-}$ is $+6 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q8

Q9.

Solution

Concept — Electrolysis of brine: In aqueous electrolysis the species easiest to reduce is liberated at the cathode and the species easiest to oxidise at the anode. In concentrated NaCl solution, water is reduced at the cathode and chloride is oxidised at the anode.

Step 1 — At the cathode (reduction): Although Na^+ is present, water is reduced more easily, so hydrogen gas is liberated:

$$2H_2O + 2e^- \rightarrow H_2 + 2OH^-.$$

Step 2 — At the anode (oxidation): In concentrated brine, chloride ions are oxidised in preference to water, giving chlorine gas:

$$2Cl^- \rightarrow Cl_2 + 2e^-.$$

Step 3 — Identify the products: Cathode gives H_2 and anode gives Cl_2 (with NaOH left in solution).

Why other options are wrong:

- Option A: sodium metal is not deposited from aqueous solution; water is reduced instead.
- Option B: reverses the electrodes and the products.
- Option D: neither sodium metal nor oxygen is the main product in concentrated brine.

Final Answer: Cathode H_2, anode $Cl_2 \Rightarrow \boxed{\text{C}}$

$\boxed{\text{Answer: (C)}}$ Go Back to Q9

Q10.

Solution

Concept — Rate in terms of stoichiometry: For a reaction, the rate is the rate of change of concentration of any species divided by its stoichiometric coefficient (negative for reactants, positive for products).

Step 1 — Note the coefficients: In $N_2 + 3H_2 \to 2NH_3$, the coefficients are 1 for N_2, 3 for H_2 and 2 for NH_3.

Step 2 — Divide each rate by its coefficient:

$$\text{Rate} = -\frac{1}{1}\frac{d[N_2]}{dt} = -\frac{1}{3}\frac{d[H_2]}{dt} = +\frac{1}{2}\frac{d[NH_3]}{dt}.$$

Step 3 — Match to the options: This matches the expression with the $\frac{1}{3}$ and $\frac{1}{2}$ factors.

Why other options are wrong:

- Option A: uses no coefficients at all.
- Option B: multiplies by the coefficients instead of dividing.
- Option C: multiplies H_2 and NH_3 terms by their coefficients instead of dividing.

Final Answer: The rate equals $-\frac{d[N_2]}{dt} = -\frac{1}{3}\frac{d[H_2]}{dt} = +\frac{1}{2}\frac{d[NH_3]}{dt} \Rightarrow \boxed{D}$

$\boxed{\text{Answer: (D)}}$ Go Back to Q10

Q11.

Solution

Concept — Parts per million (ppm): ppm is the mass of solute per million parts of solution, $\text{ppm} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^6$.

Step 1 — List the masses: Mass of pollutant $= 0.005$ g.

Mass of solution ≈ 250 g.

Step 2 — Apply the formula:

$$\text{ppm} = \frac{0.005}{250} \times 10^6.$$

Step 3 — Simplify:

$$\frac{0.005}{250} = 2 \times 10^{-5}.$$

$$\text{ppm} = 2 \times 10^{-5} \times 10^{6} = 20.$$

Why other options are wrong:

- Option A (5 ppm): would need a 1000 g sample.
- Option B (50 ppm): too high for these masses.
- Option D (2 ppm): drops a factor of 10 in the calculation.

Final Answer: Concentration $= 20$ ppm $\Rightarrow \boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q11**

Q12.

Solution

Concept — Classifying ligands: A ligand is ambidentate if it has two different donor atoms and can bind to the metal through either of them (but only one at a time).

Step 1 — Examine thiocyanate (SCN^-): Thiocyanate can donate through the sulphur atom (as $-$SCN, thiocyanato) or through the nitrogen atom (as $-$NCS, isothiocyanato).

Step 2 — Confirm the ambidentate nature: Because it has two possible donor atoms (S and N), SCN^- is a classic ambidentate ligand.

Why other options are wrong:

- Option A (en): a bidentate chelating ligand binding through two N atoms at once, not ambidentate.
- Option B (NH_3): a simple monodentate ligand with only one donor atom.
- Option C (Cl^-): a monodentate ligand with a single donor atom.

Final Answer: Thiocyanate (SCN^-) is the ambidentate ligand $\Rightarrow \boxed{\text{D}}$

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

Q13.

Solution

Concept — Oxidation states of group 15: The nitrogen family has the valence configuration ns^2np^3, giving five valence electrons, so the maximum positive oxidation state is $+5$.

Step 1 — Count the valence electrons: Group 15 elements (N, P, As, Sb, Bi) have 5 valence electrons (ns^2np^3).

Step 2 — Find the maximum oxidation state: Losing or sharing all 5 valence electrons gives the highest oxidation state of $+5$ (as in HNO_3, H_3PO_4).

Step 3 — Confirm: The group also shows $+3$ and -3, but the maximum positive value is $+5$.

Why other options are wrong:

- Option A ($+3$): a common lower oxidation state, not the maximum.
- Option C ($+7$): would need 7 valence electrons, as in group 17.
- Option D ($+4$): not the characteristic maximum for group 15.

Final Answer: The maximum oxidation state of group 15 is $+5 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q13

Q14.

Solution

Concept — Unpaired electrons: Fill the five d orbitals following Hund's rule (singly first, then pair up) and count how many remain unpaired.

Step 1 — Write the configuration of Co^{2+}: Cobalt is $[\text{Ar}]3d^74s^2$; removing two electrons (from $4s$) gives $Co^{2+} = [\text{Ar}]3d^7$.

Step 2 — Distribute 7 electrons in five d orbitals: First 5 electrons go singly into the five orbitals (Hund's rule).

The remaining 2 electrons pair up in two of those orbitals.

Step 3 — Count the unpaired electrons: Two orbitals now hold paired electrons; three orbitals each hold one unpaired electron.

Number of unpaired electrons $= 3$.

Why other options are wrong:

- Option A (5): corresponds to a d^5 ion such as Mn^{2+}.
- Option C (1): corresponds to a d^9 ion such as Cu^{2+}.
- Option D (4): corresponds to a d^6 ion such as Fe^{2+}.

Final Answer: Co^{2+} $(3d^7)$ has 3 unpaired electrons $\Rightarrow \boxed{\mathrm{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Thermal stability of carbonates: The thermal stability of alkaline earth metal carbonates increases down the group because the larger cations polarise the carbonate ion less, so the carbonate decomposes at a higher temperature.

Step 1 — Order the cations by size: $\mathrm{Be}^{2+} < \mathrm{Mg}^{2+} < \mathrm{Ca}^{2+} < \mathrm{Ba}^{2+}$ in increasing size down the group.

Step 2 — Apply the polarising-power idea: Smaller cations (like Be^{2+}) polarise and destabilise the carbonate, so it decomposes easily; larger cations (like Ba^{2+}) polarise it least.

Step 3 — Conclude: $\mathrm{BaCO_3}$, with the largest cation, is the most thermally stable carbonate of the four.

Why other options are wrong:

- Option B ($\mathrm{BeCO_3}$): the least stable, decomposing most easily.
- Option C ($\mathrm{MgCO_3}$) and Option D ($\mathrm{CaCO_3}$): less stable than $\mathrm{BaCO_3}$ because their cations are smaller.

Final Answer: $\mathrm{BaCO_3}$ is the most thermally stable $\Rightarrow \boxed{\mathrm{A}}$

Answer: (A) Go Back to Q15

Q16.

Solution

Concept — Number of optical isomers: For a molecule with n dissimilar chiral carbon atoms, the maximum number of optical isomers (stereoisomers) is 2^n.

Step 1 — Identify n: The molecule has two dissimilar chiral carbons, so $n = 2$.

Step 2 — Apply the formula:

$$\text{Number of optical isomers} = 2^n = 2^2.$$

Step 3 — Evaluate:

$$2^2 = 4.$$

Why other options are wrong:

- Option A (1): a single isomer would mean no chiral centres at all.
- Option B (2): corresponds to one chiral carbon (2^1).
- Option C (8): corresponds to three chiral carbons (2^3).

Final Answer: With two dissimilar chiral carbons, $2^2 = 4$ optical isomers $\Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q16**

Q17.

Solution

Concept — Acid-catalysed hydration: Water adds across the double bond of an alkene in the presence of acid, following Markovnikov's rule: the OH group attaches to the more substituted carbon (via the more stable carbocation).

Step 1 — Identify the carbons of propene: $CH_2{=}CH\text{-}CH_3$: the terminal $= CH_2$ has more hydrogens than the internal $= CH-$.

Step 2 — Apply Markovnikov's rule: The proton adds to the terminal carbon, generating the more stable secondary carbocation on C-2; water then attaches there, placing OH on C-2.

Step 3 — Name the product: OH on the middle carbon gives propan-2-ol (isopropyl alcohol).

Why other options are wrong:

- Option A (propan-1-ol): the anti-Markovnikov alcohol, not formed in acid

hydration.
- Option B (propane): would require reduction, not hydration.
- Option D (2-chloropropane): would require HCl addition, not water.

Final Answer: Acid hydration of propene gives propan-2-ol $\Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q17**

Q18.

Solution

Concept — Wurtz–Fittig reaction: An aryl halide and an alkyl halide react with sodium in dry ether to couple the aryl and alkyl groups, giving an alkyl-substituted arene.

Step 1 — Identify the reacting halides: Bromobenzene (C_6H_5Br) supplies the phenyl group; bromomethane (CH_3Br) supplies the methyl group.

Step 2 — Couple the groups with sodium:

$$C_6H_5Br + CH_3Br + 2Na \rightarrow C_6H_5\text{-}CH_3 + 2NaBr.$$

Step 3 — Name the product: The phenyl-methyl coupling product is toluene (methylbenzene).

Why other options are wrong:

- Option A (biphenyl): the product of two aryl halides coupling (the Fittig reaction), not the cross product here.
- Option C (benzene): would require loss of the methyl group.
- Option D (ethane): the product of two methyl halides coupling (a pure Wurtz reaction).

Final Answer: The Wurtz–Fittig product is toluene $\Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q18**

Q19.

Solution

Concept — Acidity of substituted phenols: An electron-withdrawing group (like $-NO_2$) stabilises the phenoxide ion and increases acidity, while an electron-donating group (like $-CH_3$ in p-cresol) destabilises it and decreases acidity.

Step 1 — Place the substituents: p-Nitrophenol has an electron-withdrawing $-NO_2$ group; phenol has none; p-cresol has an electron-donating $-CH_3$ group.

Step 2 — Rank the stability of the phenoxide ions: $-NO_2$ delocalises the negative charge, so p-nitrophenoxide is most stable; the methyl group of p-cresol pushes charge onto oxygen, making p-cresoxide least stable.

Step 3 — Write the acidity order: p-nitrophenol $>$ phenol $>$ p-cresol.

Why other options are wrong:

- Option B: reverses the order; p-cresol is actually the weakest acid.
- Option C: wrongly places phenol above p-nitrophenol.
- Option D: places the electron-donating p-cresol as strongest, which is incorrect.

Final Answer: p-nitrophenol $>$ phenol $>$ p-cresol $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q19

Q20.

Solution

Concept — Carbonyl derivatives: The product formed by a carbonyl compound depends on the nitrogen reagent used; 2,4-dinitrophenylhydrazine reacts with the C=O group to give a 2,4-dinitrophenylhydrazone.

Step 1 — Identify the reagent: The reagent is 2,4-dinitrophenylhydrazine (Brady's reagent), written as 2,4-$(NO_2)_2C_6H_3NHNH_2$.

Step 2 — Write the condensation: The $-NH_2$ of the reagent attacks the carbonyl carbon of acetone, and water is eliminated, forming a C=N linkage.

Step 3 — Name the product: The orange solid formed is acetone 2,4-dinitrophenylhydrazone.

Why other options are wrong:

- Option A (oxime): formed with hydroxylamine (NH_2OH), a different reagent.

- Option B (cyanohydrin): formed with HCN, not with 2,4-DNP.
- Option D (semicarbazone): formed with semicarbazide, not with 2,4-DNP.

Final Answer: Acetone with 2,4-DNP gives a 2,4-dinitrophenylhydrazone $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q20

Q21.

Solution

Concept — Substituent effect on benzoic acids: An electron-withdrawing group (EWG) at the para position stabilises the carboxylate anion and increases acidity, while an electron-donating group (EDG) decreases it.

Step 1 — Classify the substituents: $-NO_2$ is a strong EWG; $-OCH_3$ and $-CH_3$ are EDGs; benzoic acid is unsubstituted.

Step 2 — Apply the effect: The p-nitro group withdraws electron density and stabilises the carboxylate ion most, so p-nitrobenzoic acid is the strongest acid.

Step 3 — Order the acids: p-nitrobenzoic acid $>$ benzoic acid $>$ p-methylbenzoic acid $>$ p-methoxybenzoic acid.

Why other options are wrong:

- Option B (p-methoxybenzoic acid): the $-OCH_3$ group donates electrons, making it the weakest here.
- Option C (benzoic acid): no EWG, so weaker than the p-nitro acid.
- Option D (p-methylbenzoic acid): the $-CH_3$ group donates electrons, lowering acidity.

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

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — Gas-phase basicity of amines: In the gas phase there is no solvation, so basicity is decided only by the electron-releasing inductive effect of the alkyl groups. More methyl groups means a more available lone pair and a stronger base.

Step 1 — Count the electron-donating methyl groups: $(CH_3)_3N$ has three, $(CH_3)_2NH$ has two, CH_3NH_2 has one, and NH_3 has none.

Step 2 — Apply the inductive effect: More methyl groups push more electron density onto nitrogen, increasing the availability of the lone pair and the basicity.

Step 3 — Write the order: $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2 > NH_3$.

Why other options are wrong:

- Option A: the exact reverse of the correct gas-phase order.
- Option C: this irregular sequence is the aqueous-phase order (where solvation interferes), not the gas phase.
- Option D: places primary amine highest, which is the aqueous, not gas-phase, trend.

Final Answer: In the gas phase, $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2 > NH_3 \Rightarrow \boxed{B}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Denaturation of proteins: Denaturation is the loss of the natural three-dimensional shape of a protein. Heat, acids or other agents break the weak bonds (hydrogen bonds, disulphide and other interactions) that hold the secondary and tertiary structure, but the covalent peptide bonds of the primary structure stay intact.

Step 1 — What is lost: The coiling and folding of the protein (secondary and tertiary structures) unravels.

Step 2 — What is kept: The sequence of amino acids joined by peptide bonds (the primary structure) is not broken.

Step 3 — Consequence: With its shape destroyed, the protein loses its biological activity (for example, boiling an egg coagulates the protein albumin).

Why other options are wrong:

- Option A: hydrolysis of peptide bonds is digestion, not denaturation.
- Option B: forming peptide bonds is synthesis, the opposite process.
- Option C: denaturation involves loss of activity, not a simple structure swap with retained activity.

Final Answer: Denaturation disrupts the secondary/tertiary structure while the primary structure stays intact, with loss of activity $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q23

Q24.

Solution

Concept — Lowest-locant rule: Select the longest chain as the parent, then number it from the end that gives the substituents the lowest set of locants.

Step 1 — Identify the longest chain: The skeleton is a continuous five-carbon chain (pentane) carrying one methyl branch.

Step 2 — Number from both ends: Numbering from the left end puts the methyl on C-2; numbering from the right end puts it on C-4.

Step 3 — Choose the lower locant: Since $2 < 4$, the methyl group is assigned to C-2, giving the name 2-methylpentane.

Why other options are wrong:

- Option A (4-methylpentane): uses the higher locant, against the lowest-locant rule.
- Option B (2-ethylbutane): an incorrect parent chain; the longest chain is five carbons (pentane).
- Option D (3-methylpentane): the methyl is on C-2, not C-3, for this structure.

Final Answer: The correct IUPAC name is 2-methylpentane $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q24

Q25.

Solution

Concept — Cleansing action of soap: A soap molecule has a long hydrophobic (water-repelling) hydrocarbon tail and a hydrophilic (water-loving) ionic head. In water these molecules cluster into micelles that surround and remove oily dirt.

Step 1 — Behaviour of soap in water: The molecules arrange so that the hydrophobic tails point inward and the hydrophilic heads point outward toward the water, forming spherical micelles.

Step 2 — Trapping the grease: The oily dirt dissolves into the hydrophobic core of the micelle, held by the tails, while the charged heads keep the micelle suspended in water.

Step 3 — Removal: The grease-loaded micelles are carried away with the rinse water, cleaning the surface.

Why other options are wrong:

- Option B: soap does not chemically convert grease into salts; it emulsifies it physically.
- Option C: cleansing is not simply due to high pH dissolving dirt.
- Option D: no oxidation of grease occurs in ordinary washing.

Final Answer: Cleansing is due to micelle formation that traps grease $\Rightarrow \boxed{\text{A}}$

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

Answer Key

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