PGIMER BSc Nursing Chemistry

Sample Paper – 10

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. The vapour density of a gaseous compound is 16. Using the relation molar mass $= 2\times$ vapour density, its molar mass is:

(A) 32 g mol^{-1}

(B) 16 g mol^{-1}

(C) 8 g mol^{-1}

(D) 48 g mol^{-1}

Q2. An atom of chlorine is represented as $^{35}_{17}\text{Cl}$. The number of neutrons present in its nucleus is:

(A) 17

(B) 35

(C) 52

(D) 18

Q3. Which of the following statements about the screening (shielding) effect of inner electrons is correct?

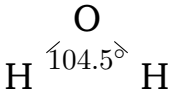
(A) Inner electrons increase the effective nuclear charge felt by the valence electrons.

(B) Greater shielding always increases the ionization energy of an atom.

(C) Shielding by inner electrons has no influence on atomic size.

(D) Inner electrons reduce the effective nuclear charge experienced by the valence electrons.

Q4. Considering molecular shape and the resulting dipole moment, which of the following molecules is *polar*? The bent shape of water is shown for reference.



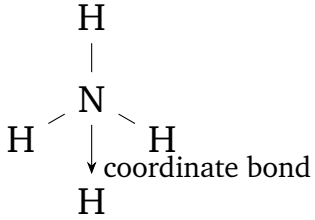
(A) CO_2

(B) H_2O

(C) BF_3

(D) CH_4

Q5. In which of the following species is a coordinate (dative) bond present? The bonding in the ammonium ion is shown, where the arrow marks the dative bond.



(A) CH_4

(B) H_2O

(C) NH_4^+

(D) CO_2

Q6. Which of the following thermodynamic quantities is a *path function* (its value depends on the path followed)?

(A) Internal energy (U)

(B) Work (w)

(C) Enthalpy (H)

(D) Entropy (S)

Q7. A 0.1 M solution of a weak monobasic acid has an acid dissociation constant $K_a = 1.0 \times 10^{-5}$. The pH of the solution (using $[H^+] = \sqrt{K_a\, C}$) is:

(A) 1

(B) 5

(C) 3

(D) 2

Q8. Which of the following is a *redox* reaction?

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

(B) $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

(C) $CaCO_3 \rightarrow CaO + CO_2$

(D) $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

Q9. Based on the electrochemical (activity) series, which of the following metals can displace copper from an aqueous solution of copper(II) sulphate?

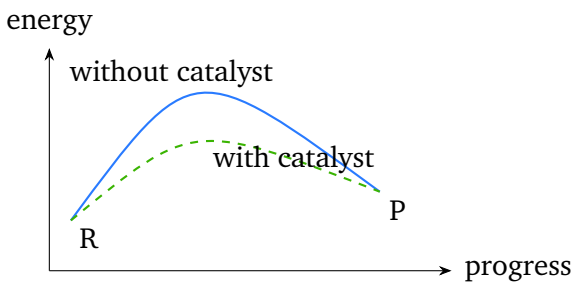
(A) Silver (Ag)

(B) Gold (Au)

(C) Zinc (Zn)

(D) Mercury (Hg)

Q10. A catalyst speeds up a reaction. Referring to the energy profile shown, a catalyst acts by:



(A) lowering the activation energy while leaving ΔH of the reaction unchanged.

(B) raising the activation energy of the reaction.

(C) decreasing the enthalpy change (ΔH) of the reaction.

(D) increasing ΔH to make the reaction more exothermic.

Q11. According to Henry's law, at a constant temperature the solubility of a gas in a liquid is:

(A) inversely proportional to the partial pressure of the gas.

(B) independent of the partial pressure of the gas.

(C) directly proportional to the partial pressure of the gas.

(D) proportional to the square of the partial pressure of the gas.

Q12. The ethylenediaminetetraacetate ion ($EDTA^{4-}$) is a polydentate ligand. Its denticity (the number of donor atoms that bind the metal) is:

(A) 6 (hexadentate)

(B) 2 (bidentate)

(C) 4 (tetradentate)

(D) 1 (monodentate)

Q13. In the brown ring test for the nitrate ion, the brown ring formed at the junction of the two liquid layers is due to:

(A) solid ferrous sulphate ($FeSO_4$).

(B) ferric oxide (Fe_2O_3).

(C) brown nitrogen dioxide gas (NO_2).

(D) the nitrosyl complex $[Fe(H_2O)_5(NO)]^{2+}$.

Q14. Which of the following is a characteristic feature of the actinide series of elements?

(A) They show only the $+3$ oxidation state.

(B) All of the actinides are radioactive.

(C) They are all diamagnetic.

(D) They belong to the s-block of the periodic table.

Q15. In the Solvay (ammonia-soda) process for the manufacture of sodium carbonate, the gas passed through ammoniacal brine to precipitate sodium hydrogen carbonate is:

(A) ammonia (NH_3)

(B) oxygen (O_2)

(C) carbon dioxide (CO_2)

(D) chlorine (Cl_2)

Q16. Taking inductive and resonance effects together, the correct order of *decreasing* acidic strength among ethanol, phenol, p-nitrophenol and acetic acid is:

(A) ethanol $>$ phenol $>$ p-nitrophenol $>$ acetic acid

(B) acetic acid $>$ p-nitrophenol $>$ phenol $>$ ethanol

(C) phenol $>$ acetic acid $>$ ethanol $>$ p-nitrophenol

(D) p-nitrophenol $>$ acetic acid $>$ ethanol $>$ phenol

Q17. Benzene reacts with acetyl chloride (CH_3COCl) in the presence of anhydrous $AlCl_3$ (Friedel–Crafts acylation). The main organic product is:

$$\text{benzene} \xrightarrow[\text{anhyd. } AlCl_3]{CH_3COCl} \text{product}$$

(A) toluene

(B) chlorobenzene

(C) benzoic acid

(D) acetophenone ($C_6H_5COCH_3$)

Q18. In the Finkelstein reaction, an alkyl chloride or bromide is converted into the corresponding alkyl iodide using:

(A) NaI in dry acetone

(B) AgF (silver fluoride)

(C) Cl_2 in the presence of sunlight

(D) alcoholic KOH

Q19. The correct order of reactivity of alcohols towards a given hydrogen halide (HX) is:

(A) tertiary $>$ secondary $>$ primary

(B) primary $>$ secondary $>$ tertiary

(C) secondary $>$ primary $>$ tertiary

(D) all react at the same rate

Q20. In the Wolff–Kishner reduction, the carbonyl group ($>C=O$) of a ketone is reduced to a methylene group ($>CH_2$) using the reagent:

(A) Zn–Hg amalgam with concentrated HCl

(B) $LiAlH_4$

(C) $NaBH_4$

(D) hydrazine (NH_2NH_2) followed by KOH and heat

Q21. A carboxylic acid can be readily identified because, unlike phenol, it:

(A) gives a violet colour with neutral $FeCl_3$ solution.

(B) gives a white precipitate with bromine water.

(C) liberates carbon dioxide with brisk effervescence when treated with sodium hydrogen carbonate ($NaHCO_3$).

(D) does not react at all with sodium hydroxide.

Q22. Nitrobenzene is reduced to aniline most conveniently in the laboratory by:

(A) tin (Sn) with concentrated hydrochloric acid

(B) $NaBH_4$ in water

(C) aqueous sodium hydroxide

(D) bromine in aqueous KOH

Q23. Which of the following statements about biomolecules is correct?

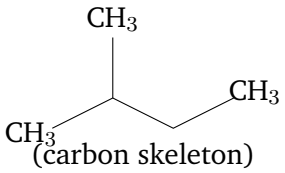
(A) Insulin is a digestive enzyme.

(B) Fats are triesters of glycerol with long-chain fatty acids.

(C) Glucose is a protein.

(D) Cholesterol is a carbohydrate.

Q24. The carbon skeleton of 2-methylbutane is shown below. Its molecular formula is:



(carbon skeleton)

(A) C_5H_{12}

(B) C_4H_{10}

(C) C_5H_{10}

(D) C_6H_{14}

Q25. Which chemical test can be used to distinguish ethanol from phenol?

(A) Both liberate hydrogen gas on reaction with sodium metal.

(B) Phenol gives a violet colouration with neutral $FeCl_3$ solution, whereas ethanol does not.

(C) Ethanol gives a white precipitate with silver nitrate, whereas phenol does not.

(D) Both decolourise bromine water rapidly.

Detailed Solutions

Q1.

Solution

Concept — Vapour density and molar mass: The vapour density (VD) of a gas is the ratio of the mass of a given volume of the gas to the mass of the same volume of hydrogen. It is related to the molar mass by $M = 2 \times \text{VD}$.

Step 1 — Note the given value: Vapour density of the gas $= 16$.

Step 2 — Apply the relation:

$$M = 2 \times \text{VD} = 2 \times 16.$$

Step 3 — Evaluate:

$$M = 32 \text{ g mol}^{-1}.$$

Why other options are wrong:

- Option B (16): this is just the vapour density itself, not the molar mass.
- Option C (8): this is half of the vapour density (wrong direction).
- Option D (48): would require a vapour density of 24.

Final Answer: Molar mass $= 32$ g mol^{-1} $\Rightarrow$ A

Answer: (A) Go Back to Q1

Q2.

Solution

Concept — Composition of the nucleus: In the symbol ${}^{A}_{Z}\text{X}$, A is the mass number (protons + neutrons) and Z is the atomic number (number of protons). The number of neutrons is $A - Z$.

Step 1 — Read off the numbers for ${}^{35}_{17}\text{Cl}$: Mass number $A = 35$; atomic number $Z = 17$.

Step 2 — Apply the formula:

$$\text{Neutrons} = A - Z = 35 - 17.$$

Step 3 — Evaluate:

$$\text{Neutrons} = 18.$$

Why other options are wrong:

- Option A (17): this is the number of protons (and of electrons in the neutral atom), not neutrons.
- Option B (35): this is the mass number.
- Option C (52): this incorrectly adds 35 and 17 instead of subtracting.

Final Answer: Number of neutrons $= 18 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q2

Q3.

Solution

Concept — Screening (shielding) effect: The inner-shell electrons repel the outer (valence) electrons and partly cancel the pull of the nucleus. As a result the valence electrons feel a reduced, or effective, nuclear charge Z_{eff} that is less than the actual nuclear charge Z.

Step 1 — State the relationship:

$$Z_{\text{eff}} = Z - \sigma,$$

where σ is the screening constant due to inner electrons.

Step 2 — Interpret it: A larger screening constant σ means a smaller Z_{eff}, so the valence electrons are held less tightly. This is exactly what option D states.

Why other options are wrong:

- Option A: inner electrons *reduce*, not increase, the effective nuclear charge.
- Option B: greater shielding lowers Z_{eff}, which *decreases* (not increases) the ionization energy.
- Option C: more shielding loosens the valence electrons and tends to *increase* atomic size, so it does influence size.

Final Answer: Inner electrons reduce the effective nuclear charge on the valence electrons $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q3

Q4.

Solution

Concept — Polarity and molecular shape: A molecule is polar only if the individual bond dipoles do not cancel. In symmetrical shapes (linear, trigonal planar, tetrahedral) the bond dipoles cancel, giving a non-polar molecule; in a bent or pyramidal shape they do not cancel.

Step 1 — Examine water (H_2O): Water is bent (angle $\approx 104.5°$), so the two O–H bond dipoles add to a net dipole. Water is polar.

Step 2 — Examine the others: CO_2 is linear, BF_3 is trigonal planar and CH_4 is tetrahedral; in each, the symmetrical arrangement makes the bond dipoles cancel, so the net dipole is zero.

Why other options are wrong:

- Option A (CO_2): linear and symmetric, the two C=O dipoles cancel.
- Option C (BF_3): trigonal planar and symmetric, dipoles cancel.
- Option D (CH_4): tetrahedral and symmetric, dipoles cancel.

Final Answer: Water (H_2O) is the polar molecule $\Rightarrow$ $\boxed{B}$

Answer: (B) Go Back to Q4

Q5.

Solution

Concept — Coordinate (dative) bond: A coordinate bond is a covalent bond in which both shared electrons are supplied by the same atom. It forms when an atom with a lone pair donates it to an atom or ion that is short of electrons.

Step 1 — Look at the ammonium ion, NH_4^+: Ammonia (NH_3) has a lone pair on nitrogen. It donates this lone pair to a proton (H^+), forming the fourth N–H bond as a coordinate bond.

Step 2 — Check the other species: CH_4, H_2O and CO_2 are formed entirely by ordinary covalent bonds in which each atom contributes one electron to each shared pair; none contains a dative bond.

Why other options are wrong:

- Option A (CH_4): four normal C–H covalent bonds, no donated pair.
- Option B (H_2O): two normal O–H covalent bonds.
- Option D (CO_2): C=O double bonds formed by mutual sharing, no coordi-

nate bond.

Final Answer: The ammonium ion NH_4^+ contains a coordinate bond $\Rightarrow$ C

Answer: (C) Go Back to Q5

Q6.

Solution

Concept — State and path functions: A state function depends only on the initial and final states of the system (for example internal energy, enthalpy, entropy). A path function depends on how the change is carried out; heat (q) and work (w) are the two common path functions.

Step 1 — Classify each option: Internal energy U, enthalpy H and entropy S are all state functions.

Step 2 — Identify the path function: Work (w) is not fixed by the end states alone; its value depends on the path (for example reversible versus irreversible expansion). Hence work is the path function.

Why other options are wrong:

- Option A (U): internal energy is a state function.
- Option C (H): enthalpy is a state function.
- Option D (S): entropy is a state function.

Final Answer: Work (w) is the path function $\Rightarrow$ B

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — pH of a weak acid: For a weak monobasic acid of concentration C and dissociation constant K_a, the hydrogen-ion concentration is $[H^+] = \sqrt{K_a\, C}$, and $pH = -\log[H^+]$.

Step 1 — Substitute the values:

$$[H^+] = \sqrt{K_a\, C} = \sqrt{(1.0 \times 10^{-5})(0.1)}.$$

Step 2 — Simplify inside the root:

$$(1.0 \times 10^{-5})(0.1) = 1.0 \times 10^{-6}.$$

$$[\mathrm{H}^+] = \sqrt{1.0 \times 10^{-6}} = 1.0 \times 10^{-3}\ \mathrm{M}.$$

Step 3 — Take the negative logarithm:

$$\mathrm{pH} = -\log(10^{-3}) = 3.$$

Why other options are wrong:

- Option A (1): this would be the pH of 0.1 M strong acid (full dissociation).
- Option B (5): this mistakenly uses pK_a directly as the pH.
- Option D (2): obtained by forgetting to take the square root of 10^{-6}.

Final Answer: $\mathrm{pH} = 3 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Redox reactions: A reaction is a redox reaction only if the oxidation numbers of some elements change, that is, electrons are transferred (one species is oxidised and another reduced).

Step 1 — Examine Zn+CuSO$_4$ → ZnSO$_4$+Cu: Zinc goes from 0 to $+2$ (oxidised); copper goes from $+2$ to 0 (reduced). Electrons are transferred, so this is a redox reaction.

Step 2 — Check the other reactions: In options A, B and C no element changes its oxidation number, so they are not redox reactions.

Why other options are wrong:

- Option A: acid–base neutralisation; no change in oxidation states.
- Option B: a double-displacement (precipitation) reaction; oxidation states are unchanged.
- Option C: thermal decomposition of CaCO$_3$; Ca, C and O keep their oxidation numbers.

Final Answer: $\mathrm{Zn} + \mathrm{CuSO_4} \rightarrow \mathrm{ZnSO_4} + \mathrm{Cu}$ is the redox reaction $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Displacement and the activity series: A metal can displace another metal from solution only if it is more reactive, that is, it lies above the other metal in the activity series (it has a more negative standard reduction potential).

Step 1 — Locate copper: Copper has a positive reduction potential ($E^\circ = +0.34$ V) and is fairly unreactive.

Step 2 — Compare the choices with copper: Zinc ($E^\circ = -0.76$ V) is more reactive than copper, so zinc displaces copper:

$$\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}.$$

Why other options are wrong:

- Option A (Ag) and Option B (Au): silver and gold are less reactive than copper, so they cannot displace it.
- Option D (Hg): mercury is also less reactive than copper and cannot displace it.

Final Answer: Zinc displaces copper from CuSO_4 solution $\Rightarrow$ C

Answer: (C) Go Back to Q9

Q10.

Solution

Concept — Action of a catalyst: A catalyst provides an alternative reaction path of lower activation energy. Because more molecules can now cross the lowered barrier, the rate increases. The catalyst does not alter the energies of the reactants or products, so ΔH stays the same.

Step 1 — Read the energy profile: The solid curve (without catalyst) has a higher peak than the dashed curve (with catalyst), but both start at R and end at P with the same energy difference.

Step 2 — Interpret the diagram: Lower peak $\Rightarrow$ smaller activation energy E_a. Same start and end levels $\Rightarrow$ the enthalpy change ΔH is unchanged.

Why other options are wrong:

- Option B: a catalyst lowers, not raises, the activation energy.
- Option C: a catalyst cannot change ΔH; the reactant and product energies are fixed.
- Option D: ΔH is a property of the reactants and products only and is unaffected by a catalyst.

Final Answer: A catalyst lowers E_a while leaving ΔH unchanged $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q10

Q11.

Solution

Concept — Henry's law: Henry's law states that, at a fixed temperature, the amount (solubility) of a gas dissolved in a liquid is directly proportional to the partial pressure of that gas above the liquid: $p = K_H\, x$, where x is the mole fraction of the dissolved gas.

Step 1 — Rearrange the statement: Since $p \propto x$, the dissolved amount x is directly proportional to the partial pressure p.

Step 2 — Conclude: Increasing the pressure of the gas increases its solubility in direct proportion (this is why fizzy drinks are bottled under high CO_2 pressure).

Why other options are wrong:

- Option A: solubility increases with pressure, it is not inversely related.
- Option B: solubility clearly depends on pressure.
- Option D: the relation is linear (first power), not a square law.

Final Answer: Solubility is directly proportional to the partial pressure $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Denticity and the chelate effect: Denticity is the number of donor atoms of a ligand that simultaneously bind to a central metal ion. Ligands that occupy several sites form stable ring structures (chelates).

Step 1 — Identify the donor atoms of EDTA^{4-}: EDTA^{4-} has two nitrogen atoms (from the two amine groups) and four oxygen atoms (from the four carboxylate groups) that can coordinate.

Step 2 — Count them: 2 nitrogen $+$ 4 oxygen $=$ 6 donor atoms, so EDTA^{4-} is hexadentate.

Step 3 — Note the chelate effect: By wrapping around the metal through six points, EDTA^{4-} forms an unusually stable chelate complex.

Why other options are wrong:

- Option B (2): this is the denticity of a bidentate ligand such as ethylenediamine.
- Option C (4): this would be a tetradentate ligand, not EDTA.
- Option D (1): a monodentate ligand such as NH_3 binds through only one atom.

Final Answer: EDTA^{4-} is hexadentate (denticity $= 6$) $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q12

Q13.

Solution

Concept — Brown ring test: This test detects the nitrate ion. Nitrate is reduced by freshly prepared $FeSO_4$ in the presence of concentrated H_2SO_4 to nitric oxide (NO), which then combines with Fe^{2+} to form a brown nitrosyl complex.

Step 1 — Reduction of nitrate:

$$NO_3^- + Fe^{2+} + H^+ \rightarrow Fe^{3+} + NO + H_2O.$$

Step 2 — Formation of the brown ring: The NO produced binds to Fe^{2+} to give the complex

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

which appears as a brown ring at the interface of the two layers.

Why other options are wrong:

- Option A ($FeSO_4$): the reagent used, but it is colourless/pale green, not the brown ring.
- Option B (Fe_2O_3): not formed in this solution test.
- Option C (NO_2): brown NO_2 gas is not the species responsible for the ring; the ring is the dissolved nitrosyl complex.

Final Answer: The brown ring is the nitrosyl complex $[Fe(H_2O)_5(NO)]^{2+} \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q13

Q14.

Solution

Concept — The actinides: The actinides are the $5f$-series elements (Th to Lr). A defining feature is that all of them are radioactive; they also show a wide range of oxidation states.

Step 1 — Recall the key property: Every actinide nucleus is unstable, so all actinides are radioactive (uranium, thorium, plutonium and so on).

Step 2 — Match to the option: This is exactly option B.

Why other options are wrong:

- Option A: actinides show several oxidation states (for example $+3, +4, +5, +6$), not only $+3$.
- Option C: many actinide ions have unpaired f-electrons and are paramagnetic, not all diamagnetic.
- Option D: actinides are inner-transition (f-block) elements, not s-block elements.

Final Answer: All actinides are radioactive $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Solvay process: Sodium carbonate is manufactured by passing carbon dioxide through brine saturated with ammonia. The sparingly soluble sodium hydrogen carbonate precipitates and is then heated to give sodium carbonate.

Step 1 — Precipitation step:

$$\mathrm{NaCl} + \mathrm{NH_3} + \mathrm{CO_2} + \mathrm{H_2O} \rightarrow \mathrm{NaHCO_3}\downarrow + \mathrm{NH_4Cl}.$$

The gas that is passed in here is carbon dioxide.

Step 2 — Conversion to soda ash:

$$2\,\mathrm{NaHCO_3} \xrightarrow{\Delta} \mathrm{Na_2CO_3} + \mathrm{H_2O} + \mathrm{CO_2}.$$

Why other options are wrong:

- Option A (NH_3): ammonia is dissolved in the brine first; the gas then bubbled through is CO_2.
- Option B (O_2): oxygen plays no part in the Solvay process.
- Option D (Cl_2): chlorine is not used; it would not give carbonate.

Final Answer: Carbon dioxide (CO_2) is passed through the ammoniacal brine $\Rightarrow$ C

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Acidity from inductive and resonance effects: A stronger acid has a more stable conjugate base. Carboxylic acids are more acidic than phenols (the carboxylate charge is shared by two oxygens), and an electron-withdrawing $-NO_2$ group makes p-nitrophenol more acidic than phenol. Alcohols are the weakest.

Step 1 — Recall approximate pK_a values: Acetic acid ≈ 4.8; p-nitrophenol ≈ 7.1; phenol ≈ 10; ethanol ≈ 16.

Step 2 — Lower pK_a means stronger acid:

$$\text{acetic acid} > p\text{-nitrophenol} > \text{phenol} > \text{ethanol}.$$

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

Why other options are wrong:

- Option A: reverses the order; ethanol is actually the weakest acid here.
- Option C: wrongly places phenol above acetic acid and ethanol above p-nitrophenol.
- Option D: wrongly puts p-nitrophenol above acetic acid and ethanol above phenol.

Final Answer: acetic acid $>$ p-nitrophenol $>$ phenol $>$ ethanol $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q16

Q17.

Solution

Concept — Friedel–Crafts acylation: In the presence of anhydrous $AlCl_3$, an acyl chloride introduces an acyl group ($-COR$) onto the benzene ring, replacing one ring hydrogen.

Step 1 — Generate the electrophile: CH_3COCl reacts with $AlCl_3$ to give the acylium ion CH_3CO^+.

Step 2 — Substitution on benzene: The acylium ion attacks the ring; loss of a proton restores aromaticity, attaching a $COCH_3$ group:

$$C_6H_6 + CH_3COCl \xrightarrow{AlCl_3} C_6H_5COCH_3 + HCl.$$

Step 3 — Name the product: $C_6H_5COCH_3$ is acetophenone.

Why other options are wrong:

- Option A (toluene): would need a Friedel–Crafts *alkylation* with CH_3Cl, not an acyl chloride.
- Option B (chlorobenzene): a halogenation product, not formed here.
- Option C (benzoic acid): would require oxidation, not acylation.

Final Answer: The product is acetophenone ($C_6H_5COCH_3$) $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q17

Q18.

Solution

Concept — Finkelstein reaction: An alkyl chloride or bromide is converted into an alkyl iodide by treatment with sodium iodide in dry acetone. The reaction is driven forward because NaCl and NaBr are insoluble in acetone and precipitate out, while NaI is soluble.

Step 1 — Write the reaction:

$$\text{R–Cl} + \text{NaI} \xrightarrow{\text{dry acetone}} \text{R–I} + \text{NaCl}\downarrow .$$

Step 2 — Reason for completion: The precipitation of NaCl (or NaBr) removes product from the equilibrium, pushing the reaction towards the alkyl iodide.

Why other options are wrong:

- Option B (AgF): this is the Swarts reaction, which makes alkyl *fluorides*, not iodides.
- Option C (Cl_2/sunlight): this is free-radical chlorination of alkanes.
- Option D (alcoholic KOH): this brings about elimination to form an alkene, not an alkyl iodide.

Final Answer: NaI in dry acetone is used (Finkelstein reaction) $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q18

Q19.

Solution

Concept — Reactivity of alcohols with HX: The reaction of an alcohol with a hydrogen halide proceeds through a carbocation. The more stable the carbocation, the faster the reaction; tertiary carbocations are the most stable.

Step 1 — Carbocation stability order:

$$\text{tertiary} > \text{secondary} > \text{primary}.$$

Step 2 — Translate to alcohol reactivity: Because a tertiary alcohol forms the most stable carbocation most easily, the reactivity order towards HX is

$$3^\circ > 2^\circ > 1^\circ.$$

(This is also seen in the Lucas test, where tertiary alcohols react fastest.)

Why other options are wrong:

- Option B: this is the reverse of the correct order.
- Option C: secondary is not the most reactive; tertiary is.
- Option D: the rates clearly differ with the class of alcohol.

Final Answer: Reactivity order is tertiary $>$ secondary $>$ primary $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q19

Q20.

Solution

Concept — Wolff–Kishner reduction: This reaction converts the carbonyl group of an aldehyde or ketone into a CH_2 group under basic conditions. The carbonyl compound is first converted to its hydrazone, which is then heated with a strong base.

Step 1 — Form the hydrazone:

$$>\text{C=O} + \text{NH}_2\text{NH}_2 \rightarrow >\text{C=N–NH}_2 + \text{H}_2\text{O}.$$

Step 2 — Heat with base: The hydrazone is heated with KOH (in a high-boiling solvent such as ethylene glycol), losing N_2 and giving the methylene compound:

$$>\text{C=N–NH}_2 \xrightarrow{\text{KOH, }\Delta} >\text{CH}_2 + \text{N}_2.$$

Why other options are wrong:

- Option A (Zn–Hg / conc. HCl): this is the *Clemmensen* reduction, a different (acidic) method for the same overall change, not Wolff–Kishner.
- Option B ($LiAlH_4$) and Option C ($NaBH_4$): these reduce C=O only to an alcohol ($-\text{CH(OH)}-$), not all the way to CH_2.

Final Answer: Wolff–Kishner uses NH_2NH_2 followed by KOH and heat $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Test for a carboxylic acid: Carboxylic acids are strong enough acids to react with sodium hydrogen carbonate, liberating carbon dioxide as brisk effervescence. Phenols are weaker acids and do not react with $NaHCO_3$.

Step 1 — Write the reaction:

$$R\text{–}COOH + NaHCO_3 \rightarrow R\text{–}COONa + H_2O + CO_2\uparrow .$$

Step 2 — Observation: The escaping CO_2 produces a brisk effervescence, confirming the carboxylic acid; phenol gives no such effervescence.

Why other options are wrong:

- Option A: the violet colour with neutral $FeCl_3$ is a test for *phenols*, not carboxylic acids.
- Option B: decolourising bromine water (white precipitate) is characteristic of phenol, not the acid.
- Option D: carboxylic acids do react with NaOH, so this statement is false.

Final Answer: A carboxylic acid gives brisk effervescence with $NaHCO_3 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q21

Q22.

Solution

Concept — Reduction of nitro compounds: An aromatic nitro group ($-NO_2$) is reduced to an amino group ($-NH_2$) by a metal–acid combination such as tin (or iron) with concentrated hydrochloric acid.

Step 1 — Write the reduction:

$$C_6H_5NO_2 \xrightarrow[\text{conc. HCl}]{\text{Sn}} C_6H_5NH_2.$$

Step 2 — Note the role of the reagent: The Sn/HCl supplies the electrons (nascent hydrogen) needed to reduce $-NO_2$ to $-NH_2$, giving aniline.

Why other options are wrong:

- Option B ($NaBH_4$): too mild to reduce an aromatic nitro group to an amine under ordinary conditions.

- Option C (NaOH): a base, not a reducing agent for $-NO_2$.
- Option D (Br_2/KOH): this is the Hofmann bromamide reaction (for amides), not nitro reduction.

Final Answer: Nitrobenzene is reduced to aniline by Sn / conc. HCl $\Rightarrow$ $\boxed{A}$

Answer: (A) Go Back to Q22

Q23.

Solution

Concept — Classes of biomolecules: Fats and oils are esters; specifically they are triesters (triglycerides) formed from one molecule of glycerol and three molecules of long-chain fatty acids.

Step 1 — Examine the correct statement: Glycerol has three $-OH$ groups; each is esterified by a fatty acid, giving a triester. This is exactly option B.

Step 2 — Confirm with structure:

$$\text{glycerol} + 3\ \text{R–COOH} \rightarrow \text{triglyceride (fat)} + 3\,H_2O.$$

Why other options are wrong:

- Option A: insulin is a peptide *hormone*, not a digestive enzyme.
- Option C: glucose is a carbohydrate (a monosaccharide), not a protein.
- Option D: cholesterol is a steroid (a lipid), not a carbohydrate.

Final Answer: Fats are triesters of glycerol with fatty acids $\Rightarrow$ $\boxed{B}$

Answer: (B) Go Back to Q23

Q24.

Solution

Concept — Molecular formula of an alkane: A saturated open-chain alkane follows the general formula C_nH_{2n+2}. 2-methylbutane is an isomer of pentane, so it has five carbon atoms.

Step 1 — Count the carbons: The skeleton is a four-carbon main chain (butane) with one methyl branch, giving $4 + 1 = 5$ carbon atoms.

Step 2 — Apply the alkane formula with $n = 5$:

$$\text{H atoms} = 2n + 2 = 2(5) + 2 = 12.$$

Step 3 — Write the formula: The molecular formula is C_5H_{12} (the same as pentane, since the two are isomers).

Why other options are wrong:

- Option B (C_4H_{10}): only four carbons, the formula of butane, but 2-methylbutane has five.
- Option C (C_5H_{10}): this fits an alkene or cyclo compound, not a saturated alkane.
- Option D (C_6H_{14}): six carbons, which would be a hexane isomer.

Final Answer: 2-methylbutane is $C_5H_{12} \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q24

Q25.

Solution

Concept — Distinguishing phenol from ethanol: Phenols give a characteristic coloured complex with neutral ferric chloride, whereas simple alcohols such as ethanol do not.

Step 1 — Reaction of phenol: Phenol reacts with neutral $FeCl_3$ to form a violet (purple) coloured iron–phenol complex.

Step 2 — Behaviour of ethanol: Ethanol gives no colour change with neutral $FeCl_3$, so the appearance of a violet colour identifies phenol and distinguishes it from ethanol.

Why other options are wrong:

- Option A: both phenol and ethanol react with sodium to release hydrogen, so this does not distinguish them.
- Option C: ethanol does not give a precipitate with silver nitrate; this test is incorrect.
- Option D: ethanol does not decolourise bromine water; only phenol reacts with bromine water (forming a white precipitate), so the statement as written is false.

Final Answer: Phenol gives a violet colour with neutral $FeCl_3$ while ethanol does

not $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q25

Answer Key

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