PGIMER BSc Nursing Chemistry

Sample Paper – 5

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. In the synthesis of ammonia, 2 mol of nitrogen gas is mixed with 3 mol of hydrogen gas according to $N_2 + 3H_2 \rightarrow 2NH_3$. The number of moles of NH_3 formed is:

(A) 1.5 mol

(B) 4 mol

(C) 3 mol

(D) 2 mol

Q2. The number of unpaired electrons in the Fe^{2+} ion (electronic configuration $[Ar]3d^6$, shown below) is:

[↑↓] [↑] [↑] [↑] [↑]

one paired set + four unpaired ($3d^6$)

(A) 6

(B) 0

(C) 2

(D) 4

Q3. The species N^{3-}, O^{2-}, F^- and Na^+ are isoelectronic (each has 10 electrons). The correct order of their ionic radii is:

(A) $N^{3-} > O^{2-} > F^- > Na^+$

(B) $Na^+ > F^- > O^{2-} > N^{3-}$

(C) $F^- > O^{2-} > N^{3-} > Na^+$

(D) $O^{2-} > N^{3-} > Na^+ > F^-$

Q4. The hybridization of each carbon atom in ethyne (acetylene), shown below, is:

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

H–C≡C–H

(A) sp

(B) sp^2

(C) sp^3

(D) sp^3d

Q5. Hydrogen fluoride (HF) has an abnormally high boiling point compared with the other hydrogen halides (HCl, HBr, HI). This is mainly because:

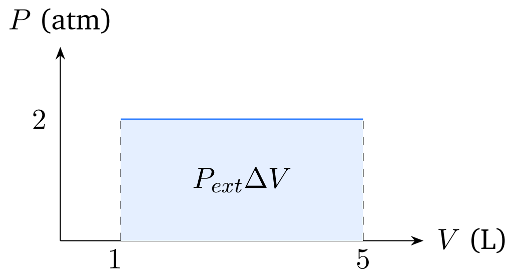
(A) fluorine has the largest atomic size in the group

(B) HF molecules are associated through intermolecular hydrogen bonding

(C) HF has the highest molar mass among the hydrogen halides

(D) only weak van der Waals forces operate between HF molecules

Q6. An ideal gas expands against a constant external pressure of 2 atm from a volume of 1 L to 5 L, as represented below. The work done by the gas is:



(A) $+8$ L atm

(B) -10 L atm

(C) 0 L atm

(D) -8 L atm

Q7. An acetic acid–sodium acetate buffer contains 0.2 M acetate ion and 0.02 M acetic acid. Given pK_a of acetic acid $= 4.74$, the pH of the buffer (Henderson–Hasselbalch equation) is:

(A) 5.74

(B) 4.74

(C) 3.74

(D) 9.26

Q8. Which of the following is a disproportionation reaction?

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

(B) $2H_2 + O_2 \rightarrow 2H_2O$

(C) $Fe + S \rightarrow FeS$

(D) $Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$

Q9. For the reaction $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$, the standard electrode potentials are $E^\circ_{Cu^{2+}/Cu} = +0.34$ V and $E^\circ_{Zn^{2+}/Zn} = -0.76$ V. Which statement is correct?

(A) The reaction is non-feasible because E°_{cell} is negative.

(B) The reaction is feasible because $E^\circ_{\text{cell}} = +1.10$ V is positive.

(C) The reaction is at equilibrium because $E^\circ_{\text{cell}} = 0$.

(D) The reaction is non-feasible because ΔG° is positive.

Q10. A first-order reaction has a half-life of 20 minutes. The time required for 75% of the reactant to be consumed is:

(A) 20 minutes

(B) 30 minutes

(C) 40 minutes

(D) 60 minutes

Q11. When 0.5 mol of a non-volatile, non-electrolyte solute is dissolved in 1 kg of water ($K_b = 0.52$ K kg mol^{-1}), the elevation in boiling point ΔT_b is:

(A) 0.26 K

(B) 0.52 K

(C) 1.04 K

(D) 0.13 K

Q12. The complex ion $[\text{Ni(CN)}_4]^{2-}$, whose shape is drawn below, has the hybridization and geometry:

CN
| 90°
CN – Ni – CN
|
CN

(A) sp^3, tetrahedral

(B) sp^3d^2, octahedral

(C) dsp^2, square planar

(D) sp^3d, trigonal bipyramidal

Q13. Which of the following represents the correct order of decreasing acidic strength of the period-3 oxides?

(A) $Cl_2O_7 > SO_3 > P_4O_{10} > SiO_2$

(B) $SiO_2 > P_4O_{10} > SO_3 > Cl_2O_7$

(C) $P_4O_{10} > Cl_2O_7 > SiO_2 > SO_3$

(D) $SO_3 > SiO_2 > Cl_2O_7 > P_4O_{10}$

Q14. Transition metals and their compounds act as good catalysts mainly because:

(A) they have very large atomic sizes

(B) they show variable oxidation states and form unstable intermediate compounds

(C) they have low melting and boiling points

(D) all of their ions are diamagnetic

Q15. Permanent hardness of water, caused by the chlorides and sulphates of calcium and magnesium, can be removed by:

(A) simply boiling the water

(B) adding a calculated amount of slaked lime (Clark's method)

(C) treatment with washing soda (sodium carbonate)

(D) ordinary filtration through filter paper

Q16. The number of hyperconjugative (no-bond resonance) structures possible for the tert-butyl carbocation $(CH_3)_3C^+$ is:

(A) 3

(B) 6

(C) 1

(D) 9

Q17. Which of the following compounds gives a red precipitate when treated with ammoniacal cuprous chloride (Cu_2Cl_2)?

(A) propene (CH_3-$CH=CH_2$)

(B) prop-1-yne (CH_3-$C \equiv CH$)

(C) but-2-yne (CH_3-$C \equiv C$-CH_3)

(D) propane (CH_3-CH_2-CH_3)

Q18. Methylmagnesium bromide (CH_3MgBr) reacts with acetone (propanone) and the product is then hydrolysed. The final organic product is:

(A) propan-1-ol

(B) propan-2-ol

(C) 2-methylpropan-2-ol

(D) ethanol

Q19. When ethanol is heated with acetic acid in the presence of a little concentrated sulphuric acid, the main organic product is:

(A) methyl acetate

(B) ethyl formate

(C) ethyl acetate

(D) acetic anhydride

Q20. Which of the following compounds gives a positive iodoform (haloform) test?

(A) methanol (CH_3OH)

(B) propan-1-ol ($CH_3CH_2CH_2OH$)

(C) pentan-3-one ($CH_3CH_2COCH_2CH_3$)

(D) propan-2-ol ($CH_3CH(OH)CH_3$)

Q21. In the Hell–Volhard–Zelinsky (HVZ) reaction, acetic acid is treated with chlorine in the presence of a small amount of red phosphorus. The main product is:

(A) trichloromethane ($CHCl_3$)

(B) chloroacetic acid ($ClCH_2COOH$)

(C) acetyl chloride (CH_3COCl)

(D) carbon dioxide (CO_2)

Q22. The Gabriel phthalimide synthesis is a convenient laboratory method to prepare:

(A) secondary amines only

(B) tertiary amines only

(C) aliphatic primary amines

(D) quaternary ammonium salts

Q23. Which of the following is a water-soluble vitamin whose deficiency causes scurvy?

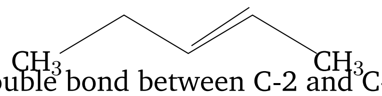
(A) Vitamin A

(B) Vitamin D

(C) Vitamin K

(D) Vitamin C

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



(double bond between C-2 and C-3)

(A) pent-2-ene

(B) pent-3-ene

(C) pent-1-ene

(D) pent-2-yne

Q25. In Lassaigne's (sodium fusion) test, a chlorine-containing organic compound gives a fused extract that, after boiling with dilute nitric acid and adding silver nitrate solution, produces:

(A) a black precipitate

(B) a white precipitate soluble in aqueous ammonia

(C) a violet colouration

(D) a blood-red colouration

Detailed Solutions

Q1.

Solution

Concept — Limiting reagent: The reactant that is completely consumed first limits the amount of product; compare the available mole ratio with the stoichiometric ratio.

Step 1 — Write the balanced equation:

$$N_2 + 3H_2 \rightarrow 2NH_3.$$

Step 2 — Check how much H_2 the nitrogen needs: To react fully, 2 mol N_2 would require $2 \times 3 = 6$ mol H_2.

Step 3 — Identify the limiting reagent: Only 3 mol H_2 is available (less than 6 mol), so hydrogen is the limiting reagent.

Step 4 — Find the moles of NH_3 from H_2: From the equation, 3 mol H_2 gives 2 mol NH_3.

$$n(NH_3) = \frac{2}{3} \times 3 = 2 \text{ mol}.$$

Why other options are wrong:

- Option A (1.5 mol) and Option C (3 mol): do not follow the $3 : 2$ ratio of the limiting H_2.
- Option B (4 mol): wrongly assumes nitrogen is limiting.

Final Answer: NH_3 formed $= 2$ mol $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q1

Q2.

Solution

Concept — Unpaired electrons: Fill the d orbitals using Hund's rule (singly first), then count the electrons that remain unpaired.

Step 1 — Write the configuration of Fe^{2+}: Iron is $[Ar]3d^6 4s^2$; removing two $4s$ electrons gives $Fe^{2+} = [Ar]3d^6$.

Step 2 — Distribute the six d electrons: Five d orbitals first take one electron each (five unpaired); the sixth electron pairs up in one orbital.

Step 3 — Count the unpaired electrons: One orbital is now paired and four orbitals still hold a single electron, so the number of unpaired electrons is 4.

Why other options are wrong:

- Option A (6): counts the total d electrons, not the unpaired ones.
- Option B (0): would apply only if all electrons were paired.
- Option C (2): too few; only one pair forms in $3d^6$.

Final Answer: Fe^{2+} has 4 unpaired electrons $\Rightarrow \boxed{D}$

Answer: (D) Go Back to Q2

Q3.

Solution

Concept — Isoelectronic ions: For species with the same number of electrons, the radius decreases as the nuclear charge (atomic number) increases, because more protons pull the same electron cloud inward.

Step 1 — List the nuclear charges: N^{3-} $(Z = 7)$, O^{2-} $(Z = 8)$, F^- $(Z = 9)$, Na^+ $(Z = 11)$.

Step 2 — Apply the trend: Each has 10 electrons; the larger the Z, the stronger the pull and the smaller the ion.

Step 3 — Arrange the radii: Smallest Z gives the largest radius, so

$$N^{3-} > O^{2-} > F^- > Na^+.$$

Why other options are wrong:

- Option B: exactly reverses the correct trend.
- Option C and Option D: place the ions out of order with respect to nuclear charge.

Final Answer: $N^{3-} > O^{2-} > F^- > Na^+ \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — Hybridization: Count the sigma bonds and lone pairs on each carbon; the number of these regions gives the hybridization.

Step 1 — Look at one carbon of ethyne: Each carbon forms one C–H sigma bond and one C–C sigma bond (the triple bond is one sigma + two pi).

Step 2 — Count the sigma regions: Two sigma bonds and no lone pair ⇒ two regions of electron density.

Step 3 — Assign the hybridization: Two regions ⇒ two hybrid orbitals ⇒ sp hybridization, giving the linear $180°$ geometry.

Why other options are wrong:

- Option B (sp^2): three regions, as in ethene.
- Option C (sp^3): four regions, as in ethane/methane.
- Option D (sp^3d): five regions, not possible for carbon.

Final Answer: Each carbon in ethyne is sp hybridized ⇒ $\boxed{\text{A}}$

Answer: (A) Go Back to Q4

Q5.

Solution

Concept — Hydrogen bonding: When hydrogen is bonded to a small, highly electronegative atom (F, O, N), strong intermolecular hydrogen bonds form, raising the boiling point.

Step 1 — Examine HF: Fluorine is the most electronegative element and is small, so H–F bonds are highly polar and molecules link through F···H hydrogen bonds.

Step 2 — Compare with HCl, HBr, HI: Cl, Br and I are larger and less electronegative, so they form no effective hydrogen bonds; only weaker dipole and dispersion forces act.

Step 3 — Conclude: Breaking the extra hydrogen bonds in HF needs more energy, so HF boils much higher than expected.

Why other options are wrong:

- Option A: fluorine actually has the smallest size in the group, not the largest.

- Option C: HF has the lowest molar mass of the hydrogen halides, yet still boils highest.
- Option D: if only van der Waals forces acted, HF would boil lowest.

Final Answer: Intermolecular hydrogen bonding raises the boiling point of HF ⇒ B

Answer: (B) Go Back to Q5

Q6.

Solution

Concept — Pressure–volume work: For expansion against a constant external pressure, $w = -P_{ext}\,\Delta V$; the negative sign shows the gas does work on the surroundings.

Step 1 — Find the change in volume:

$$\Delta V = V_f - V_i = 5 - 1 = 4\ \text{L}.$$

Step 2 — Substitute into the formula:

$$w = -P_{ext}\,\Delta V = -(2\ \text{atm})(4\ \text{L}).$$

Step 3 — Evaluate:

$$w = -8\ \text{L atm}.$$

Step 4 — Interpret the sign: The gas expands, so it does work on the surroundings; work done by the gas is negative in the chemistry sign convention.

Why other options are wrong:

- Option A ($+8$ L atm): wrong sign; expansion cannot give positive system work here.
- Option B (-10 L atm): uses the wrong ΔV.
- Option C (0): would require no volume change.

Final Answer: $w = -8$ L atm ⇒ D

Answer: (D) Go Back to Q6

Q7.

Solution

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

Step 1 — Identify the concentrations: $[\text{salt}] = [\text{CH}_3\text{COO}^-] = 0.2$ M; $[\text{acid}] = [\text{CH}_3\text{COOH}] = 0.02$ M.

Step 2 — Find the ratio:

$$\frac{[\text{salt}]}{[\text{acid}]} = \frac{0.2}{0.02} = 10.$$

Step 3 — Take the logarithm:

$$\log 10 = 1.$$

Step 4 — Substitute into the equation:

$$\text{pH} = 4.74 + 1 = 5.74.$$

Why other options are wrong:

- Option B (4.74): would need equal salt and acid concentrations.
- Option C (3.74): uses the ratio upside down.
- Option D (9.26): this is $14 - 4.74$, a pOH/basic value, not the buffer pH.

Final Answer: pH of the buffer $= 5.74 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q7

Q8.

Solution

Concept — Disproportionation: A reaction in which the same element is simultaneously oxidised and reduced, ending in both a higher and a lower oxidation state.

Step 1 — Examine option D:

$$\text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaCl} + \text{NaOCl} + \text{H}_2\text{O}.$$

Chlorine starts at oxidation state 0.

Step 2 — Track the chlorine: In NaCl chlorine is -1 (reduced); in NaOCl chlorine is $+1$ (oxidised). The same element goes both up and down.

Step 3 — Conclude: Because one element is both oxidised and reduced, this is a disproportionation reaction.

Why other options are wrong:

- Option A: a simple displacement (Zn oxidised, Cu reduced — different elements).
- Option B: a combination/redox where H and O change, not one element splitting.
- Option C: a combination reaction, no single element disproportionating.

Final Answer: The reaction of Cl_2 with NaOH is disproportionation $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Feasibility of a cell reaction: A reaction is spontaneous (feasible) when $E^\circ_{\text{cell}} > 0$, since $\Delta G^\circ = -nFE^\circ_{\text{cell}}$ is then negative.

Step 1 — Identify cathode and anode: Cu^{2+} is reduced (cathode); Zn is oxidised (anode).

Step 2 — Calculate E°_{cell}:

$$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} = (+0.34) - (-0.76).$$

$$E^\circ_{\text{cell}} = +1.10 \text{ V}.$$

Step 3 — Test feasibility: $E^\circ_{\text{cell}} = +1.10$ V is positive, so $\Delta G^\circ < 0$ and the reaction is feasible (spontaneous).

Why other options are wrong:

- Option A: E°_{cell} is positive, not negative.
- Option C: E°_{cell} is not zero, so the system is not at equilibrium.
- Option D: ΔG° is negative here, so the conclusion is wrong.

Final Answer: The reaction is feasible since $E^\circ_{\text{cell}} = +1.10 \text{ V} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q9

Q10.

Solution

Concept — First-order kinetics: For a first-order reaction the half-life is constant; each half-life consumes half of the remaining reactant.

Step 1 — Relate 75% completion to half-lives: After one half-life, 50% remains; after two half-lives, 25% remains, meaning 75% has reacted.

Step 2 — Count the half-lives needed: 75% consumption corresponds to exactly 2 half-lives.

Step 3 — Compute the time:

$$t = 2 \times t_{1/2} = 2 \times 20 = 40 \text{ minutes.}$$

Why other options are wrong:

- Option A (20 min): only one half-life (50% consumed).
- Option B (30 min): does not correspond to a whole number of half-lives for 75%.
- Option D (60 min): three half-lives (87.5% consumed).

Final Answer: Time for 75% reaction $= 40$ minutes $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Elevation of boiling point: $\Delta T_b = K_b\, m$, where m is the molality (moles of solute per kg of solvent) and K_b is the ebullioscopic constant.

Step 1 — Find the molality:

$$m = \frac{0.5 \text{ mol}}{1 \text{ kg}} = 0.5 \text{ mol kg}^{-1}.$$

Step 2 — Substitute into the formula:

$$\Delta T_b = K_b\, m = 0.52 \times 0.5.$$

Step 3 — Evaluate:

$$\Delta T_b = 0.26 \text{ K.}$$

Why other options are wrong:

- Option B (0.52 K): uses $m = 1$ instead of 0.5.
- Option C (1.04 K): doubles the molality.
- Option D (0.13 K): halves the correct value.

Final Answer: $\Delta T_b = 0.26$ K $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q11

Q12.

Solution

Concept — Hybridization of complexes: Strong-field ligands such as CN^- force pairing of the metal d electrons, allowing inner d orbitals to take part in bonding.

Step 1 — Find the metal oxidation state: In $[Ni(CN)_4]^{2-}$, each CN^- is -1; for an overall -2 charge, nickel is Ni^{2+} ($3d^8$).

Step 2 — Apply the strong-field ligand effect: CN^- is a strong-field ligand, so the $3d^8$ electrons pair up, freeing one $3d$ orbital.

Step 3 — Determine the hybridization and shape: One $3d$, one $4s$ and two $4p$ orbitals combine to give dsp^2 hybridization, which is square planar (bond angles $90°$).

Why other options are wrong:

- Option A (sp^3, tetrahedral): occurs with weak-field ligands, e.g. $[NiCl_4]^{2-}$.
- Option B (sp^3d^2, octahedral): needs six ligands.
- Option D (sp^3d): a five-coordinate geometry, not four.

Final Answer: $[Ni(CN)_4]^{2-}$ is dsp^2, square planar $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q12

Q13.

Solution

Concept — Acidic nature of oxides: Across a period the oxides change from basic (metals) to amphoteric to acidic (non-metals); acidic strength increases with the non-metallic character and oxidation state of the central element.

Step 1 — Place the four oxides: SiO_2, P_4O_{10}, SO_3 and Cl_2O_7 are oxides of Si, P, S and Cl, moving left to right across period 3.

Step 2 — Apply the trend: Acidic character increases from Si to Cl, so Cl_2O_7 is the most acidic and SiO_2 the least acidic of the four.

Step 3 — Write the decreasing order:

$$Cl_2O_7 > SO_3 > P_4O_{10} > SiO_2.$$

Why other options are wrong:

- Option B: exactly the reverse of the correct order.
- Option C and Option D: scramble the elements out of their period sequence.

Final Answer: $Cl_2O_7 > SO_3 > P_4O_{10} > SiO_2 \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Catalytic activity of transition metals: Their ability to show several oxidation states lets them form unstable intermediate compounds with reactants, providing an alternative low-energy path.

Step 1 — Recall the key property: Transition metals have partly filled d orbitals and exhibit variable oxidation states.

Step 2 — Link to catalysis: They can accept and donate electrons easily, forming intermediate compounds (or adsorbing reactants on their surface), which lowers the activation energy.

Step 3 — Conclude: This is why metals such as Fe, V_2O_5, Ni and Pt are widely used as catalysts.

Why other options are wrong:

- Option A: large size alone does not explain catalysis.
- Option C: transition metals actually have high melting and boiling points.
- Option D: many transition-metal ions are paramagnetic, not all diamagnetic, and magnetism is not the cause of catalysis.

Final Answer: Variable oxidation states and intermediate formation make them good catalysts $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Hardness of water: Permanent hardness is due to chlorides and sulphates of Ca^{2+} and Mg^{2+}; it cannot be removed by boiling and needs chemical treatment that precipitates these ions.

Step 1 — Recall the action of washing soda: Sodium carbonate (Na_2CO_3) supplies carbonate ions that precipitate the hardness-causing ions.

Step 2 — Write the reaction:

$$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 \downarrow +2NaCl.$$

Magnesium ions are removed in the same way.

Step 3 — Conclude: With Ca^{2+} and Mg^{2+} removed as insoluble carbonates, the water becomes soft.

Why other options are wrong:

- Option A: boiling removes only temporary (bicarbonate) hardness.
- Option B: Clark's method (slaked lime) also targets temporary hardness.
- Option D: filtration removes suspended dirt, not dissolved ions.

Final Answer: Permanent hardness is removed by washing soda $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Hyperconjugation: The number of no-bond resonance structures of a carbocation equals the number of α C–H bonds (hydrogens on carbons next to the positive carbon).

Step 1 — Draw the tert-butyl cation: $(CH_3)_3C^+$ has the positive carbon attached to three methyl groups.

Step 2 — Count the α hydrogens: Each methyl group carries 3 hydrogens, and there are 3 methyl groups: $3 \times 3 = 9$ α C–H bonds.

Step 3 — Relate to hyperconjugative structures: Each α C–H bond can overlap with the empty p orbital, giving one hyperconjugative structure, so there are 9 in total. This large number makes the tert-butyl cation very stable.

Why other options are wrong:

- Option A (3): counts only one methyl group.
- Option B (6): counts only two methyl groups.
- Option C (1): ignores the multiple α hydrogens.

Final Answer: The tert-butyl cation has 9 hyperconjugative structures $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Acidic terminal alkynes: The hydrogen on a triple-bonded terminal carbon (≡C–H) is weakly acidic and can be replaced by a metal, forming an insoluble metal acetylide.

Step 1 — Identify the terminal alkyne: Prop-1-yne, CH_3-C $\equiv$ CH, has an acidic ≡C–H hydrogen.

Step 2 — React with ammoniacal cuprous chloride: The acidic hydrogen is replaced by copper, giving a red precipitate of copper(I) acetylide.

Step 3 — Conclude: Only terminal alkynes show this test, so prop-1-yne gives the red precipitate.

Why other options are wrong:

- Option A (propene): an alkene, no acidic terminal ≡C–H.

- Option C (but-2-yne): an internal alkyne, no terminal hydrogen.
- Option D (propane): a saturated alkane, totally unreactive here.

Final Answer: Prop-1-yne gives the red precipitate $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept — Grignard reagents with ketones: A Grignard reagent adds its alkyl group to the carbonyl carbon; addition to a ketone followed by hydrolysis gives a tertiary alcohol.

Step 1 — Write the reactants: CH_3MgBr adds to acetone, $(CH_3)_2C{=}O$.

Step 2 — Form the addition product: The methyl group bonds to the carbonyl carbon and oxygen becomes O-MgBr:

$$(CH_3)_2C{=}O \rightarrow (CH_3)_3C\text{-}OMgBr.$$

Step 3 — Hydrolyse: Aqueous acid converts O-MgBr to O-H, giving $(CH_3)_3C$-OH, i.e. 2-methylpropan-2-ol (a tertiary alcohol).

Why other options are wrong:

- Option A (propan-1-ol): a primary alcohol, would need formaldehyde.
- Option B (propan-2-ol): a secondary alcohol, would need acetaldehyde.
- Option D (ethanol): would need formaldehyde, not acetone.

Final Answer: The product is 2-methylpropan-2-ol $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q18

Q19.

Solution

Concept — Esterification: A carboxylic acid reacts with an alcohol in the presence of a small amount of concentrated H_2SO_4 to give an ester and water (Fischer esterification).

Step 1 — Write the reactants: Acetic acid CH_3COOH and ethanol C_2H_5OH.

Step 2 — Combine the acyl part and the alkyl part: The $-OH$ of the acid and the –H of the alcohol leave as water; the remaining parts join:

$$CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O.$$

Step 3 — Name the ester: $CH_3COOC_2H_5$ is ethyl acetate (ethyl ethanoate).

Why other options are wrong:

- Option A (methyl acetate): would need methanol, not ethanol.
- Option B (ethyl formate): would need formic acid, not acetic acid.
- Option D (acetic anhydride): a different product, formed from two acid molecules.

Final Answer: The product is ethyl acetate $\Rightarrow$ $\boxed{C}$

Answer: (C) **Go Back to Q19**

Q20.

Solution

Concept — Iodoform test: A positive iodoform test is given by ethanol, methyl ketones, and any compound containing the CH_3CO- group or the $CH_3CH(OH)-$ group (which is first oxidised to a methyl carbonyl).

Step 1 — Examine propan-2-ol: $CH_3CH(OH)CH_3$ contains the $CH_3CH(OH)-$ group required for the test.

Step 2 — Reason through the test: $I_2/NaOH$ oxidises it to acetone (CH_3COCH_3), a methyl ketone, which then gives the yellow iodoform precipitate (CHI_3).

Step 3 — Conclude: Propan-2-ol gives a positive iodoform test.

Why other options are wrong:

- Option A (methanol): no $CH_3CH(OH)-$ group; negative.
- Option B (propan-1-ol): a primary alcohol without the required grouping; negative.
- Option C (pentan-3-one): the carbonyl is flanked by ethyl groups (no methyl ketone); negative.

Final Answer: Propan-2-ol gives a positive iodoform test $\Rightarrow$ $\boxed{D}$

Answer: (D) **Go Back to Q20**

Q21.

Solution

Concept — Hell–Volhard–Zelinsky reaction: A carboxylic acid bearing an α-hydrogen reacts with Cl_2 (or Br_2) in the presence of a little red phosphorus to give the α-halogenated acid.

Step 1 — Identify the α-hydrogen of acetic acid: The CH_3 group of CH_3COOH carries the α-hydrogens.

Step 2 — Substitute chlorine at the α-carbon: One α-hydrogen is replaced by chlorine:

$$CH_3COOH \xrightarrow{Cl_2/\text{red P}} ClCH_2COOH.$$

Step 3 — Name the product: The product is chloroacetic acid (2-chloroethanoic acid).

Why other options are wrong:

- Option A (trichloromethane): not formed under HVZ conditions.
- Option C (acetyl chloride): chlorination occurs at the α-carbon, not at the $-$OH of the acid.
- Option D (carbon dioxide): would require decarboxylation, not HVZ.

Final Answer: The HVZ product is chloroacetic acid $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q21

Q22.

Solution

Concept — Gabriel phthalimide synthesis: Phthalimide is converted to its potassium salt, alkylated with an alkyl halide, and then hydrolysed to release a pure primary amine.

Step 1 — Outline the steps: Potassium phthalimide + R–X gives an N-alkylphthalimide, which on hydrolysis (or hydrazinolysis) gives $R\text{–}NH_2$.

Step 2 — Note the type of amine formed: Only one alkyl group is introduced on nitrogen, so the product is a primary amine, free from secondary or tertiary amines.

Step 3 — Note the limitation: The method works with alkyl halides (aliphatic primary amines) but not with aryl halides, so aromatic primary amines like aniline cannot be made this way.

Why other options are wrong:

- Option A and Option B: secondary/tertiary amines are not produced; the nitrogen takes only one alkyl group.
- Option D: no quaternary ammonium salt is formed.

Final Answer: Gabriel synthesis prepares aliphatic primary amines $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q22

Q23.

Solution

Concept — Classification of vitamins: Vitamins B and C are water-soluble (not stored, excreted in urine), while A, D, E and K are fat-soluble (stored in the liver/fat).

Step 1 — Identify the water-soluble vitamin: Vitamin C (ascorbic acid) is water-soluble.

Step 2 — Recall its deficiency disease: A deficiency of vitamin C causes scurvy (bleeding gums, weakness).

Step 3 — Conclude: The water-soluble vitamin whose lack causes scurvy is vitamin C.

Why other options are wrong:

- Option A (Vitamin A): fat-soluble; its deficiency causes night blindness.
- Option B (Vitamin D): fat-soluble; its deficiency causes rickets.
- Option C (Vitamin K): fat-soluble; needed for blood clotting.

Final Answer: Vitamin C is water-soluble and its deficiency causes scurvy $\Rightarrow \boxed{D}$

Answer: (D) Go Back to Q23

Q24.

Solution

Concept — IUPAC naming of alkenes: Choose the longest chain containing the double bond, number it so the double bond gets the lowest locant, and state that locant in the name.

Step 1 — Count the carbons: The skeleton is a continuous five-carbon chain: CH_3-CH=CH-CH_2-CH_3.

Step 2 — Locate the double bond: The double bond lies between the second and third carbons.

Step 3 — Number for the lowest locant: Numbering from the nearer end gives the double bond the locant 2, so the parent is pent-2-ene.

Why other options are wrong:

- Option B (pent-3-ene): not the lowest locant; the same bond is "2" from the other end.
- Option C (pent-1-ene): the double bond is not at carbon 1.
- Option D (pent-2-yne): a triple bond is shown as a double bond here, so "yne" is wrong.

Final Answer: The compound is pent-2-ene $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q24

Q25.

Solution

Concept — Lassaigne's test for halogens: Sodium fusion converts halogen in the compound to sodium halide; after boiling the extract with dilute HNO_3 (to destroy cyanide/sulphide), silver nitrate precipitates the silver halide.

Step 1 — Form the sodium halide: Fusion with sodium gives NaCl (for a chlorine compound).

Step 2 — Add acidified silver nitrate:

$$NaCl + AgNO_3 \rightarrow AgCl \downarrow + NaNO_3.$$

A white precipitate of silver chloride forms.

Step 3 — Confirm the halogen: The white precipitate is soluble in aqueous ammonia, which confirms chlorine.

Why other options are wrong:

- Option A (black precipitate): indicates sulphur (with lead acetate), not a halogen.
- Option C (violet colouration): the sodium nitroprusside test for sulphur.
- Option D (blood-red colouration): seen when both N and S are present (thiocyanate).

Final Answer: Chlorine gives a white precipitate of AgCl $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q25

Answer Key

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