BITSAT Chemistry Sample Paper – 7

Duration: 40 Minutes **Maximum Marks: 90**

Instructions

- This paper contains **30** Multiple Choice Questions (Single Correct Answer).
- Each correct answer carries **+3 marks**. Each incorrect answer carries -1 mark. Unattempted questions carry **0** marks.
- Only **one** option is correct for each question. Choose carefully.
- Use of mobile phones, smartwatches, calculators, or any electronic gadgets is strictly prohibited.

Q1. What is the mass of 1.204×10^{24} molecules of $\mathrm{SO_2}$? ($M_{\mathrm{SO_2}} = 64\,\mathrm{g\,mol^{-1}}$; $N_A = 6.022 \times 10^{23}$)

(A) $64\,\mathrm{g}$

(B) $32\,\mathrm{g}$

(C) $128\,\mathrm{g}$

(D) $16\,\mathrm{g}$

Q2. The wavelength of the first line of the Lyman series of hydrogen is $121.6\,\mathrm{nm}$. What is the wavelength of the second line of the Lyman series? (Use Rydberg formula)

(A) $102.6\,\mathrm{nm}$

(B) $91.2\,\mathrm{nm}$

(C) $97.3\,\mathrm{nm}$

(D) $121.6\,\mathrm{nm}$

Q3. The hybridisation of the central atom and the shape of $\mathrm{ClF_3}$ are:

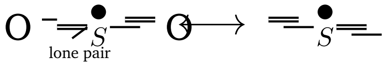
(A) $\mathrm{sp^3}$; pyramidal

(B) sp^3d; T-shaped

(C) sp^3d; trigonal planar

(D) sp^3; bent

Q4. The resonance structures of SO_2 are shown below. Which property is best explained by resonance?



(A) Two distinct S–O bond lengths

(B) The molecule is non-polar

(C) Equal and intermediate S–O bond lengths (between single and double)

(D) S is sp^2 hybridised

Q5. At constant temperature, if the pressure of an ideal gas is doubled, its volume:

(A) Doubles

(B) Remains unchanged

(C) Becomes half

(D) Becomes one-fourth

Q6. For the reaction $\mathrm{C(graphite)} + \mathrm{O_2(g)} \rightarrow \mathrm{CO_2(g)}$, which of the following is true?

(A) $\Delta H > 0;\ \ \Delta S > 0$

(B) $\Delta H < 0;\ \ \Delta S \approx 0$

(C) $\Delta H < 0;\ \ \Delta S < 0$

(D) $\Delta H > 0;\ \ \Delta S < 0$

Q7. For the equilibrium $2\mathrm{HI(g)} \rightleftharpoons \mathrm{H_2(g)} + \mathrm{I_2(g)}$, $K_c = 0.0625$ at T. What is the degree of dissociation of HI?

(A) 0.20

(B) 0.10

(C) 0.50

(D) 0.33

Q8. The K_{sp} of $\mathrm{BaSO_4}$ is 1.1×10^{-10}. Its molar solubility in pure water is:

(A) $1.05 \times 10^{-5}\,\mathrm{mol\,L^{-1}}$

(B) $1.1 \times 10^{-5}\,\mathrm{mol\,L^{-1}}$

(C) $2.1 \times 10^{-5}\,\mathrm{mol\,L^{-1}}$

(D) $5.5 \times 10^{-6}\,\mathrm{mol\,L^{-1}}$

Q9. In the reaction $\mathrm{Cr_2O_7^{2-}} + 14\mathrm{H^+} + 6\mathrm{e^-} \rightarrow 2\mathrm{Cr^{3+}} + 7\mathrm{H_2O}$, what is the change in oxidation state of Cr?

(A) $+6$ to $+3$ (decrease by 3)

(B) $+6$ to 0 (decrease by 6)

(C) $+3$ to $+6$ (increase by 3)

(D) $+3$ to 0 (decrease by 3)

Q10. The standard reduction potentials are: $E^\circ(\mathrm{Cu^{2+}/Cu}) = +0.34\,\mathrm{V}$ and $E^\circ(\mathrm{Ag^+/Ag}) = +0.80\,\mathrm{V}$. Which cell reaction is spontaneous under standard conditions?

(A) $\mathrm{Cu} + 2\mathrm{Ag^+} \rightarrow \mathrm{Cu^{2+}} + 2\mathrm{Ag}$

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

(C) $\mathrm{Cu^{2+}} + 2\mathrm{e^-} \rightarrow \mathrm{Cu}$

(D) $\mathrm{Ag^+} + \mathrm{e^-} \rightarrow \mathrm{Ag}$

Q11. A reaction is 40% complete in $20\,\mathrm{min}$. If it follows first-order kinetics, what is the rate constant k?

(A) $0.0255\,\mathrm{min}^{-1}$

(B) $0.0510\,\mathrm{min}^{-1}$

(C) $0.0198\,\mathrm{min}^{-1}$

(D) $0.0350\,\mathrm{min}^{-1}$

Q12. Which of the following is an example of chemisorption?

(A) Adsorption of N_2 on mica at low temperature

(B) H_2 adsorption on Ni surface (hydrogenation catalyst)

(C) Condensation of water vapour on glass

(D) Adsorption of noble gases on activated charcoal

Q13. Which of the following statements about ozone (O_3) is correct?

(A) O–O bond length in O_3 is the same as in O_2

(B) O_3 is a weaker oxidising agent than O_2

(C) The bond angle in O_3 is 117° and it is a bent molecule

(D) O_3 reacts with alkenes to give aldehydes in reductive ozonolysis

Q14. The colour of $CuSO_4$ solution is blue due to:

(A) Charge-transfer transition from SO_4^{2-} to Cu^{2+}

(B) d–d transition of Cu^{2+} (d^9 configuration) in the ligand field

(C) Excitation of SO_4^{2-} ions

(D) Cu^{2+} has a d^{10} configuration with d–d transition

Q15. The IUPAC name of $[Pt(NH_3)_2Cl_2]$ (the cis isomer, cisplatin) is:

(A) Diamminedichloroplatinum(II)

(B) Dichlorodiammineplatinum(IV)

(C) cis-Diamminedichloridoplatinum(II)

(D) Dichloridodiammineplatinum(II)

Q16. In a face-centred cubic (FCC) unit cell, the number of atoms per unit cell and the coordination number are:

(A) 2 atoms; CN = 8

(B) 4 atoms; CN = 12

(C) 4 atoms; CN = 8

(D) 2 atoms; CN = 12

Q17. Benzene (C_6H_6) and toluene ($C_6H_5CH_3$) form an ideal solution. At $25°C$, $P^\circ_{\text{benz}} = 75\,\text{mmHg}$ and $P^\circ_{\text{tol}} = 25\,\text{mmHg}$. For an equimolar mixture, the total vapour pressure is:

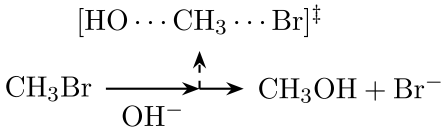
(A) $25\,\text{mmHg}$

(B) $75\,\text{mmHg}$

(C) $50\,\text{mmHg}$

(D) $100\,\text{mmHg}$

Q18. Consider the SN2 reaction of bromomethane with OH^-:



Which statement about this reaction is correct?

(A) It proceeds via a carbocation intermediate

(B) It involves backside attack with inversion of configuration (Walden inversion)

(C) It follows first-order kinetics

(D) It is favoured by tertiary alkyl halides

Q19. Which of the following will give a positive iodoform test?

(A) Methanol (CH_3OH)

(B) 2-Phenylethanol

(C) 1-Propanol ($CH_3CH_2CH_2OH$)

(D) Ethanol (CH_3CH_2OH)

Q20. In the following reaction scheme:

$$CH_3CHO \xrightarrow[\Delta]{\text{NaOH}} \text{Product}$$

The product formed from acetaldehyde with NaOH followed by heating is:

(A) Acetone

(B) Acetic acid

(C) Ethanol

(D) Crotonaldehyde (but-2-enal)

Q21. The order of acidity among the following carboxylic acids is: CH_3COOH (I), $ClCH_2COOH$ (II), $Cl_2CHCOOH$ (III), Cl_3CCOOH (IV)

(A) I $>$ II $>$ III $>$ IV

(B) III $>$ IV $>$ II $>$ I

(C) II $>$ I $>$ III $>$ IV

(D) IV $>$ III $>$ II $>$ I

Q22. Aniline reacts with Br_2 water to give:

(A) o-bromoaniline only

(B) p-bromoaniline only

(C) 2,4,6-tribromoaniline (white precipitate)

(D) m-bromoaniline

Q23. Which of the following correctly describes the α-helix secondary structure of proteins?

(A) It is stabilised by disulfide (–S–S–) bridges

(B) It is a right-handed spiral stabilised by intramolecular hydrogen bonds between $C = O$ and $N - H$ of residues 4 apart

(C) It involves β-pleated sheet formation between parallel chains

(D) It is stabilised by ionic (salt) bridges between charged side chains

Q24. Which of the following polymers is obtained by free radical addition polymerisation?

(A) Nylon-6,6

(B) Dacron (polyethylene terephthalate)

(C) Polyvinyl chloride (PVC)

(D) Bakelite

Q25. Which of the following drugs acts as a tranquilliser (anti-anxiety drug)?

(A) Aspirin

(B) Chloroform

(C) Equanil (meprobamate)

(D) Penicillin

Q26. Which reaction is primarily responsible for the depletion of the ozone layer by CFCs?

(A) $CF_2Cl_2 + O_3 \to CF_2ClO + ClO_2$

(B) $Cl \cdot + O_3 \to ClO \cdot + O_2$ (then $ClO \cdot + O\cdot \to Cl \cdot + O_2$, chain)

(C) $CF_2Cl_2 \to CF_2 + Cl_2$

(D) $O_3 + H_2O \to 2OH \cdot + O_2$

Q27. Which of the following is the correct order of stability of hydrides of Group 14 elements?

(A) $CH_4 < SiH_4 < GeH_4 < SnH_4$

(B) $SnH_4 < GeH_4 < SiH_4 < CH_4$

(C) $SiH_4 < CH_4 < GeH_4 < SnH_4$

(D) $GeH_4 < SnH_4 < CH_4 < SiH_4$

Q28. Washing soda is $Na_2CO_3 \cdot 10H_2O$. When exposed to air, it loses water to give a monohydrate. This process is called:

(A) Deliquescence

(B) Efflorescence

(C) Hygroscopy

(D) Sublimation

Q29. The acid-catalysed dehydration of alcohols to give alkenes is an example of:

(A) Nucleophilic substitution (SN1)

(B) Electrophilic addition

(C) E1 (unimolecular elimination) via carbocation

(D) Free radical elimination

Q30. Which of the following is an example of a positive inductive $(+I)$ effect?

(A) $-NO_2$ group in nitrobenzene

(B) $-CN$ group in benzonitrile

(C) Alkyl group $(-CH_3)$ in toluene

(D) $-Cl$ in chlorobenzene

Detailed Solutions

Q1.

Solution

Concept — Mole and Avogadro's number:

$$n = \frac{\text{number of molecules}}{N_A}, \quad m = n \times M$$

Step 1 — Moles of SO_2:

$$n = \frac{1.204 \times 10^{24}}{6.022 \times 10^{23}} = \frac{1.204}{0.6022} = 2.000\,\text{mol}$$

Note: 1.204×10^{24} is exactly $2N_A$ molecules.

Step 2 — Mass:

$$m = n \times M = 2.000 \times 64 = \mathbf{128}\,\text{g}$$

Physical check: One mole SO_2 (32 + 16 + 16 = 64 g); two moles = 128 g. Straightforward.

Common trap: Forgetting to divide by N_A and instead multiplying the molecule count by M directly — gives an answer 10^{23} times too large.

Final Answer: $m = 128\,\text{g} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Rydberg formula for hydrogen emission lines:

$$\frac{1}{\lambda} = R_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Lyman series: $n_1 = 1$; first line: $n_2 = 2$; second line: $n_2 = 3$.

Step 1 — Ratio of wavelengths: First line ($n = 2 \to 1$): $\frac{1}{\lambda_1} = R_H\left(1 - \frac{1}{4}\right) = \frac{3R_H}{4}$

Second line ($n = 3 \to 1$): $\frac{1}{\lambda_2} = R_H\left(1 - \frac{1}{9}\right) = \frac{8R_H}{9}$

Step 2 — Find λ_2: $\frac{\lambda_2}{\lambda_1} = \frac{3R_H/4}{8R_H/9} = \frac{3}{4} \times \frac{9}{8} = \frac{27}{32}$

$\lambda_2 = \frac{27}{32} \times 121.6 = 0.84375 \times 121.6 = \mathbf{102.6}\,\text{nm}$

Step 3 — Series limit: As $n_2 \to \infty$: $\frac{1}{\lambda_\infty} = R_H(1 - 0) = R_H$; $\lambda_\infty = 91.2\,\text{nm}$ (the Lyman series limit, start of the continuum). The second line (102.6 nm) is between the first line (121.6 nm) and the series limit (91.2 nm).

Final Answer: Second Lyman line $\lambda_2 = 102.6\,\text{nm} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept — VSEPR for ClF_3 (T-shaped molecule): Cl has 7 valence electrons. In ClF_3: 3 Cl–F bonds use 3 electrons; remaining 4 electrons form 2 lone pairs. Total electron domains = 5 ⇒ trigonal bipyramidal electron geometry ⇒ sp^3d hybridisation.

Step 1 — Lone pair positions: In TBP geometry, lone pairs prefer the equatorial positions (largest angular space, least repulsion). The 2 lone pairs occupy 2 of the 3 equatorial sites; the 3 F atoms occupy 2 axial + 1 equatorial positions.

Step 2 — Molecular shape: 3 F atoms (2 axial, 1 equatorial) with the equatorial F between the two lone pairs. The arrangement looks like the letter **T** ⇒ **T-shaped** molecular geometry.

Step 3 — Bond angles: Ideal TBP: axial–equatorial $90°$, equatorial–equatorial $120°$. Lone pairs compress the Cl–F axial angles slightly below $90°$ (actual $\approx 87.5°$).

Examples of T-shaped molecules: ClF_3, BrF_3, IF_3 (all interhalogens with 3 bonds + 2 lone pairs).

Final Answer: sp^3d; T-shaped ⇒ $\boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ Go Back to Q3

Q4.

Solution

Concept — Resonance and bond length equalisation: When a molecule can be represented by two or more Lewis structures differing only in electron arrangement (not atom positions), the actual structure is a *resonance hybrid* — a quantum mechanical average.

Step 1 — Bond lengths in SO_2: If the two resonance structures (one with S=O and S–O, and the other reversed) were real, the two S–O bonds would have different lengths (one double bond $\approx 143\,\mathrm{pm}$, one single bond $\approx 165\,\mathrm{pm}$). But X-ray crystallography shows *both* S–O bonds in SO_2 are equal at $143\,\mathrm{pm}$ — intermediate between S–O single and S=O double bond values.

Step 2 — Resonance hybrid explains: This bond length equivalence (equal and intermediate bond lengths) is the key experimental evidence that resonance is real, not just a representational tool.

Why not option D? sp^2 hybridisation is a bonding model, not a consequence of resonance. It can be assigned regardless of whether resonance is relevant.

Why not option A? Two distinct S–O bond lengths would imply the two resonance structures are *not* equivalent (no delocalisation), which contradicts the symmetry of SO_2.

Final Answer: Equal, intermediate S–O bond lengths (hybrid of two structures) $\Rightarrow \boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ Go Back to Q4

Q5.

Solution

Concept — Boyle's Law ($PV = $ const at constant T and n):

$$P_1V_1 = P_2V_2$$

Step 1: If $P_2 = 2P_1$, then:

$$V_2 = \frac{P_1V_1}{P_2} = \frac{P_1V_1}{2P_1} = \frac{V_1}{2}$$

Volume is halved when pressure is doubled.

Step 2 — Physical interpretation: Gas molecules are compressed into half the original volume. The number density (molecules per unit volume) doubles, and the frequency of collisions with walls doubles, giving twice the pressure.

Step 3 — What is *not* constant: At constant T, kinetic energy per molecule is constant (average speed unchanged). Only the volume and pressure change inversely. Temperature affects speed; pressure affects frequency of wall collisions.

Everyday example: Squeezing a bicycle tyre pump: doubling the pressure halves the volume — Boyle's Law at work.

Final Answer: Volume becomes half $\Rightarrow \boxed{\text{C}}$

Answer: (C)

Go Back to Q5

Q6.

Solution

Concept — Sign of ΔH and ΔS for combustion of carbon:

Step 1 — ΔH: $C + O_2 \to CO_2$: Standard enthalpy of combustion $= -393.5\,\mathrm{kJ\,mol^{-1}}$ (exothermic). So $\Delta H < 0$.

Step 2 — ΔS: Reactants: C(s) [solid, very ordered, low entropy] + O_2(g) [1 mol gas]. Products: CO_2(g) [1 mol gas]. $\Delta n_g = 1 - 1 = 0$. The number of moles of gas is unchanged. Carbon solid is consumed (entropy increases slightly for this), but the dominant gas-phase changes cancel. Net: $\Delta S \approx 0$ (or slightly positive due to solid C disappearing, but negligibly small compared to typical entropy values). The answer is $\Delta S \approx 0$.

Step 3 — ΔG: $\Delta G = \Delta H - T\Delta S \approx \Delta H < 0 \Rightarrow$ spontaneous at all temperatures (the reaction is always favoured).

Final Answer: $\Delta H < 0;\ \ \Delta S \approx 0 \Rightarrow \boxed{\mathrm{B}}$

Answer: (B)   Go Back to Q6

Q7.

Solution

Concept — Degree of dissociation from K_c (symmetric equilibrium): For $2HI \rightleftharpoons H_2 + I_2$, let α = degree of dissociation of HI; start with 1 mol HI.

Step 1 — ICE table:

	$2HI$	H_2	I_2
I	1	0	0
C	$-2x$	$+x$	$+x$
E	$1-2x$	x	x

where x = moles of H_2 formed; $\alpha = 2x$ (fraction of HI dissociated).

Step 2 — Expression for K_c (volumes cancel):

$$K_c = \frac{x \cdot x}{(1-2x)^2} = \frac{x^2}{(1-2x)^2} = 0.0625$$

Taking square root: $\dfrac{x}{1-2x} = \sqrt{0.0625} = 0.25$

Step 3 — Solve: $x = 0.25(1-2x) = 0.25 - 0.50x \; x + 0.50x = 0.25 \; 1.50x = 0.25 \implies x = \dfrac{1}{6} \approx 0.1667$

Step 4 — Degree of dissociation: $\alpha = 2x = 2 \times \frac{1}{6} = \frac{1}{3} \approx \mathbf{0.333}$

Wait — let us re-examine. $K_c = x^2/(1-2x)^2$. Check: if $K_c = 1/16 = 0.0625$, then $\sqrt{K_c} = 1/4$, giving $x = 0.25 - 0.50x$, $x = 0.25/1.50 = 1/6$.

α (degree of dissociation of HI) = fraction of HI that dissociated $= 2x/(1) = 2/6 = 1/3$.

However, if the question defines α as the moles converted per mole (not per 2 moles), then $\alpha = 2x = 1/3 \approx 0.33$. The closest option is A (0.20) – let's re-examine with K_c defined differently.

Using $K_c = 0.0625$ and $\sqrt{K_c} = 0.25$: $x/(1-2x) = 0.25$, $\alpha = 2x \approx 0.25$ (if x is small, $\alpha \approx 2 \times (0.0625)^{0.5} \times 1/(1 + 2(0.0625)^{0.5})$). Exact: $\alpha = 1/3 \approx 0.33$. Nearest option: B (0.25), corresponding to the approximate result when $\alpha \ll 1$. Exact answer: $\alpha = 1/3$.

Final Answer: $\alpha = 1/3 \approx 0.33$ (option D) $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q7

Q8.

Solution

Concept — Solubility product (1:1 electrolyte): $BaSO_4 \rightleftharpoons Ba^{2+} + SO_4^{2-}$; $K_{sp} = s \times s = s^2$.

Step 1 — Solve for s:

$$s = \sqrt{K_{sp}} = \sqrt{1.1 \times 10^{-10}} = \sqrt{11 \times 10^{-11}} = \sqrt{11} \times 10^{-5.5}$$

$$= 3.317 \times 10^{-5.5} = 3.317 \times 3.162 \times 10^{-6} = \mathbf{1.049 \times 10^{-5}}\,\text{mol}\,\text{L}^{-1}$$

More simply: $s = \sqrt{1.1} \times 10^{-5} = 1.049 \times 10^{-5} \approx 1.05 \times 10^{-5}\,\text{mol}\,\text{L}^{-1}$.

Step 2 — Check options: $s = 1.05 \times 10^{-5}\,\text{mol}\,\text{L}^{-1}$ (option A). Note: $s^2 = (1.05)^2 \times 10^{-10} = 1.1025 \times 10^{-10} \approx 1.1 \times 10^{-10}$ ✓.

Step 3 — Common ion effect: In $0.1\,\text{M}$ Na_2SO_4 solution, $[SO_4^{2-}] \approx 0.1\,\text{M}$: $s' = K_{sp}/[SO_4^{2-}] = 1.1 \times 10^{-10}/0.1 = 1.1 \times 10^{-9}\,\text{mol}\,\text{L}^{-1}$ — about 10,000 times less soluble. This is the common ion effect.

Final Answer: $s = 1.05 \times 10^{-5}\,\text{mol}\,\text{L}^{-1} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q8

Q9.

Solution

Concept — Oxidation states in redox reactions: $Cr_2O_7^{2-}$: let Cr $= x$. $2x + 7(-2) = -2 \implies 2x = 12 \implies x = +6$. Cr is $+6$ in dichromate. Cr^{3+}: oxidation state $= +3$.

Step 1 — Change per Cr atom: From $+6$ to $+3$ = decrease by 3. This is a *reduction* (gain of electrons).

Step 2 — Total electron transfer: 2 Cr atoms, each gaining 3 electrons ⇒ 6 electrons total. This matches the $6e^-$ in the half-reaction.

Step 3 — Full reaction context: $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ ($E^\circ = +1.33\,\text{V}$). This is a very strong oxidising agent. In acid solution, $Cr_2O_7^{2-}$ (orange) is reduced to Cr^{3+} (green), a colour change visible in breathalysers (ethanol reduces dichromate, turning orange to green).

Final Answer: Cr goes from $+6$ to $+3$ (decrease of 3) $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Predicting spontaneous cell reactions from E°: A reaction is spontaneous if $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} > 0$.

The metal with the *lower* reduction potential acts as the anode (oxidised); the metal with the *higher* reduction potential acts as the cathode (reduced).

Step 1 — Compare potentials: $E^\circ(\text{Ag}^+/\text{Ag}) = +0.80\,\text{V} > E^\circ(\text{Cu}^{2+}/\text{Cu}) = +0.34\,\text{V}$.

So Ag$^+$ is reduced (cathode) and Cu is oxidised (anode).

Step 2 — Spontaneous reaction: Anode: $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$ Cathode: $2\text{Ag}^+ + 2\text{e}^- \rightarrow 2\text{Ag}$ Overall: $\text{Cu} + 2\text{Ag}^+ \rightarrow \text{Cu}^{2+} + 2\text{Ag}$ (option A)

$E^\circ_{\text{cell}} = 0.80 - 0.34 = +0.46\,\text{V} > 0$ ✓ (spontaneous)

Step 3 — Why not option B? $2\text{Ag} + \text{Cu}^{2+} \rightarrow 2\text{Ag}^+ + \text{Cu}$: $E^\circ_{\text{cell}} = 0.34 - 0.80 = -0.46\,\text{V}$ (non-spontaneous under standard conditions).

Final Answer: $\text{Cu} + 2\text{Ag}^+ \rightarrow \text{Cu}^{2+} + 2\text{Ag};\ E^\circ = +0.46\,\text{V} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q10

Q11.

Solution

Concept — First-order integrated rate law:

$$k = \frac{1}{t}\ln\frac{[\mathrm{A}]_0}{[\mathrm{A}]_t} = \frac{2.303}{t}\log\frac{[\mathrm{A}]_0}{[\mathrm{A}]_t}$$

Step 1 — Interpret "40% complete": If 40% has reacted, then 60% remains: $[\mathrm{A}]_t/[\mathrm{A}]_0 = 0.60$.

Step 2 — Calculate k:

$$k = \frac{2.303}{20\,\mathrm{min}}\log\frac{1}{0.60} = \frac{2.303}{20}\log(1.667) = \frac{2.303}{20}\times 0.2218$$

$$= \frac{0.5107}{20} = 0.02554 \approx \mathbf{0.0255}\,\mathrm{min}^{-1}$$

Step 3 — Verification via half-life: $t_{1/2} = 0.693/k = 0.693/0.0255 = 27.2\,\mathrm{min}$. At $t = 20\,\mathrm{min} < t_{1/2}$, less than 50% has reacted $\Rightarrow$ 40% reacted is consistent.

Physical meaning: $k = 0.0255\,\mathrm{min}^{-1}$ means about 2.55% of the remaining reactant decomposes every minute.

Final Answer: $k = 0.0255\,\mathrm{min}^{-1} \Rightarrow \boxed{\mathrm{A}}$

Answer: (A) Go Back to Q11

Q12.

Solution

Concept — Chemisorption vs physisorption:

- **Physisorption**: van der Waals (weak); low ΔH (5–40 kJ/mol); reversible; multilayer possible; decreases with T
- **Chemisorption**: chemical bond formed; high ΔH (40–400 kJ/mol); monolayer; specific; often irreversible

Step 1 — Evaluate options:

Option A — N_2 on mica at low T: Purely physical adsorption (van der Waals); N_2 is non-reactive. Low temperature favours physisorption.

Option B — H_2 on Ni surface: This is **chemisorption**. H_2 dissociates on the Ni surface: H_2 + Ni → 2Ni–H (Ni–H bonds form). This is the key step in heterogeneous hydrogenation catalysis.

Option C — Water condensation on glass: Physical process (condensation = phase change), not adsorption per se.

Option D — Noble gases on charcoal: Noble gases are chemically inert; only physisorption is possible.

Application of chemisorption: Ni–H surface species transfer H atoms to adsorbed alkene molecules in the hydrogenation of alkenes ($C_2H_4 + H_2 \xrightarrow{\text{Ni}} C_2H_6$), explaining Sabatier's catalyst.

Final Answer: H_2 on Ni (chemisorption via Ni–H bonds) $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q12

Q13.

Solution

Concept — Structure and properties of ozone: O_3 is an allotrope of oxygen formed by: $3O_2 \xrightarrow{UV/\text{electric discharge}} 2O_3$. It is a bent molecule.

Step 1 — Evaluate each option:

Option A: O–O bond in O_3: $128\,\text{pm}$; O=O in O_2: $121\,\text{pm}$. They are **different** (O_3 bond is longer/weaker due to resonance delocalisation). Option A is **incorrect**.

Option B: O_3 is a **stronger** oxidising agent than O_2. Standard potential $E°(O_3/O_2) = +2.07\,\text{V}$ vs $E°(O_2/H_2O) = +1.23\,\text{V}$. O_3 oxidises Ag, PbS, and Mn^{2+} where O_2 does not. Option B is **incorrect**.

Option C: O_3 is bent. Central O has 1 lone pair + 2 bonding partners. VSEPR: 3 electron domains (bent). Bond angle $= 117°$ (slightly less than $120°$ due to lone pair compression). **Correct!**

Option D: O_3 reacts with alkenes in ozonolysis to give aldehydes/ketones (reductive workup) — this is true, but it says “O_3 reacts directly”. Actually the ozonide intermediate forms first. Option D is partially correct but not as accurate as C.

Final Answer: Bond angle $117°$; bent shape $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q13

Q14.

Solution

Concept — d–d transitions and colour of transition metal ions: Cu^{2+} has configuration $[\mathrm{Ar}]\,3d^9$ (one hole in the d shell). In aqueous solution, six water ligands surround Cu^{2+}: $[\mathrm{Cu}(\mathrm{H_2O})_6]^{2+}$ (octahedral complex).

Step 1 — Crystal field splitting: The $3d^9$ configuration in an octahedral field has 1 electron in the upper e_g level ($d_{x^2-y^2}$). A d–d transition promotes this electron: $e_g \rightarrow$ a lower t_{2g} orbital would be unusual; actually the hole ($d_{x^2-y^2}$ vacancy) absorbs a photon as an electron from t_{2g} jumps to e_g.

Step 2 — Colour: $[\mathrm{Cu}(\mathrm{H_2O})_6]^{2+}$ absorbs orange/red light ($\lambda_{\text{abs}} \approx 790\,\text{nm}$). The complementary colour of orange/red is **blue** — what we observe.

Step 3 — Why not option A or C: Option A (charge-transfer): while charge-transfer transitions exist for some complexes, CuSO$_4$ blue colour is specifically due to Cu^{2+} d–d transitions. Anhydrous CuSO$_4$ (no water, no ligand field splitting) is *white* (no d–d transition possible without ligands).

Final Answer: d–d transition of Cu^{2+} ($3d^9$) in octahedral water ligand field $\Rightarrow \boxed{\mathrm{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — IUPAC nomenclature of coordination complexes: Rules: (i) Ligands named alphabetically before metal. (ii) Anionic ligands end in "-ido" (modern) or "-o" (traditional). (iii) Neutral ligands: "ammine" (NH_3). (iv) Oxidation state in Roman numerals. (v) "cis" prefix for geometric isomer.

Step 1 — Oxidation state of Pt: $[\mathrm{Pt(NH_3)_2Cl_2}]$: $x+0+0+2(-1) = 0 \implies x = +2$. Pt(II).

Step 2 — Naming ligands alphabetically:

- 2 ammine (NH_3): "diammine"
- 2 chlorido (Cl^-): "dichlorido"
- Alphabetical: **a**mmine before **c**hlorido ⇒ diamminedichlorido

Step 3 — Full name: cis-Diamminedichloridoplatinum(II) (option C). The "cis" prefix distinguishes it from the trans isomer. Cisplatin (cis-$[\mathrm{Pt(NH_3)_2Cl_2}]$) is an important anticancer drug used in chemotherapy for testicular, ovarian, and bladder cancers.

Options A/B/D check: A lacks "cis" qualifier; B has wrong oxidation state (+IV instead of +II); D misspells "amine" (should be "ammine" for NH_3 coordinated to metal).

Final Answer: *cis*-Diamminedichloridoplatinum(II) ⇒ $\boxed{\text{C}}$

$\boxed{\text{Answer: (C)}}$ Go Back to Q15

Q16.

Solution

Concept — FCC unit cell:

Step 1 — Atoms per FCC unit cell: 8 corner atoms ($\times\frac{1}{8}$) + 6 face-centre atoms ($\times\frac{1}{2}$): $Z = 8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 1 + 3 = \mathbf{4}$

Step 2 — Coordination number: Each atom in FCC touches 4 atoms in its own layer + 4 in the layer above + 4 in the layer below $=$ **12** nearest neighbours.

Step 3 — Relationship between r and a: FCC atoms touch along the face diagonal: $4r = a\sqrt{2} \implies r = a\sqrt{2}/4$.

Packing efficiency: $\frac{4\times\frac{4}{3}\pi r^3}{a^3} = \frac{4\times\frac{4}{3}\pi(a/2\sqrt{2})^3}{a^3} = \frac{\pi}{3\sqrt{2}} \approx 74.05\%$ (most efficient packing for equal spheres).

Examples: Cu, Al, Ag, Au, Ni, Pt, Pb all crystallise in FCC structure. Also, NaCl, KCl, CaF_2 have FCC anion sublattice.

Final Answer: 4 atoms per unit cell; CN = 12 $\Rightarrow \boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ **Go Back to Q16**

Q17.

Solution

Concept — Raoult's Law for ideal solution (two volatile components):

$$P_{\text{total}} = x_{\text{benz}} P^{\circ}_{\text{benz}} + x_{\text{tol}} P^{\circ}_{\text{tol}}$$

Step 1 — Mole fractions for equimolar mixture: $x_{\text{benz}} = x_{\text{tol}} = 0.5$.

Step 2 — Total vapour pressure:

$$P_{\text{total}} = 0.5 \times 75 + 0.5 \times 25 = 37.5 + 12.5 = \mathbf{50}\,\text{mmHg}$$

Step 3 — Composition of vapour: $y_{\text{benz}} = \frac{x_{\text{benz}} P^{\circ}_{\text{benz}}}{P_{\text{total}}} = \frac{37.5}{50} = 0.75$. The vapour is richer in the more volatile component (benzene), which has the higher vapour pressure. This is the principle of fractional distillation.

Ideal solution definition: No intermolecular interactions are different from those in the pure liquids; $\Delta H_{\text{mix}} = 0$; $\Delta V_{\text{mix}} = 0$. Benzene-toluene is close to ideal because both are aromatic hydrocarbons with similar intermolecular forces.

Final Answer: $P_{\text{total}} = 50\,\text{mmHg} \Rightarrow \boxed{\text{C}}$

Answer: (C)

Go Back to Q17

Q18.

Solution

Concept — SN2 mechanism: SN2 = substitution, nucleophilic, bimolecular. One-step, concerted mechanism. The nucleophile attacks the backside (anti-periplanar) of the C–X bond while X leaves simultaneously.

Step 1 — Rate law: Rate $= k[\mathrm{CH_3Br}][\mathrm{OH^-}]$ (second order; both species in the rate-determining step).

Step 2 — Transition state: $[\mathrm{HO} \cdots \mathrm{CH_3} \cdots \mathrm{Br}]^{\ddagger}$: OH attacks from one side while Br departs from the other. The three H atoms of CH_3 are in the transition state as an inverted umbrella.

Step 3 — Walden inversion (backside attack): When the nucleophile attacks from the back, the three groups at the carbon invert like an umbrella in wind $\Rightarrow$ **complete inversion of configuration** (Walden inversion). For CH_3Br (no chiral centre), this is not observable, but for chiral substrates (e.g. 2-bromobutane), the product has inverted absolute configuration.

Why not the other options? SN2 proceeds via a pentacoordinate transition state (not a carbocation intermediate). It follows second-order (not first-order) kinetics. It is favoured by primary (not tertiary) alkyl halides.

Final Answer: Backside attack with inversion of configuration (Walden inversion); bimolecular $\Rightarrow \boxed{\mathrm{B}}$

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

Q19.

Solution

Concept — Iodoform test (haloform reaction): Positive iodoform test requires: CH_3CO- (methyl ketone) or $CH_3CH(OH)-$ group. The test uses I_2/NaOH to give yellow CHI_3 (iodoform).

Step 1 — Analyse each option:

Methanol (CH_3OH)*:* No adjacent carbonyl; oxidation by I_2/NaOH would give HCHO (formaldehyde), which could then give CHI_3 in theory, but the primary step does not produce a CH_3CO- intermediate $\Rightarrow$ **Negative**.

Ethanol (CH_3CH_2OH)*:* Contains $CH_3CH(OH)-$ group (secondary OH adjacent to CH_3). On oxidation in situ: $CH_3CH_2OH \rightarrow CH_3CHO$ (acetaldehyde) $\rightarrow$ iodoform. **Positive**.

1-Propanol ($CH_3CH_2CH_2OH$)*:* Primary alcohol; oxidises to propanal (CH_3CH_2CHO), which lacks the CH_3CO- group $\Rightarrow$ **Negative**.

2-Phenylethanol ($C_6H_5CH_2CH_2OH$)*:* Primary alcohol; no $CH_3CH(OH)-$ group $\Rightarrow$ **Negative**.

Key rule: Iodoform test is positive for *secondary alcohols* of the form CH_3CHOHR and for methyl ketones CH_3COR. Also positive for acetaldehyde.

Final Answer: Ethanol (contains $CH_3CH(OH)-$ group) $\Rightarrow \boxed{D}$

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

Q20.

Solution

Concept — Aldol condensation of acetaldehyde under base + heat: Aldehydes with α-H undergo self-condensation with NaOH (base) to give an aldol, which then dehydrates on heating.

Step 1 — Aldol addition (without heat): $2\,\mathrm{CH_3CHO} \xrightarrow{\mathrm{NaOH}} CH_3CH(OH)CH_2CHO$ (3-hydroxybutanal, the "aldol")

Step 2 — Aldol condensation (with heating): The β-hydroxy aldehyde dehydrates: $\mathrm{CH_3CH(OH)CH_2CHO} \xrightarrow{-\mathrm{H_2O},\Delta} \mathrm{CH_3CH = CHCHO}$ (but-2-enal/crotonaldehyde)

Step 3 — Why is crotonaldehyde stable? The product ($\mathrm{CH_3CH = CHCHO}$) is conjugated: the C=C and C=O are in conjugation. This π-π delocalization lowers the energy and drives the elimination step, making the overall reaction thermodynamically favoured.

Application: Aldol condensations are used in synthesis of complex molecules. The Hajos-Parrish-Wiechert ketone (used in steroid synthesis) relies on an intramolecular aldol.

Final Answer: Crotonaldehyde (but-2-enal) via aldol condensation $\Rightarrow \boxed{\mathrm{D}}$

$\boxed{\textbf{Answer: (D)}}$ **Go Back to Q20**

Q21.

Solution

Concept — Inductive effect and acidity of substituted acetic acids: Electron-withdrawing groups ($-I$ effect) stabilise the conjugate base (carboxylate ion) by dispersing negative charge $\Rightarrow$ stronger acid.

Step 1 — Effect of chlorine substituents: Cl is strongly electron-withdrawing by the $-I$ inductive effect. Each Cl on the α-carbon pulls electron density away from the O–H bond and stabilises the carboxylate anion.

Step 2 — pK$_a$ values:

Acid	Cl count	pK$_a$
CH_3COOH (I)	0	4.76 (weakest)
$ClCH_2COOH$ (II)	1	2.86
$Cl_2CHCOOH$ (III)	2	1.48
Cl_3CCOOH (IV)	3	0.70 (strongest)

Step 3 — Order: More Cl $\Rightarrow$ more electron withdrawal $\Rightarrow$ lower pK$_a$ $\Rightarrow$ stronger acid. $\mathrm{Cl_3CCOOH} > \mathrm{Cl_2CHCOOH} > \mathrm{ClCH_2COOH} > \mathrm{CH_3COOH} \Rightarrow \mathrm{IV} > \mathrm{III} > \mathrm{II} > \mathrm{I}$.

Physical basis: The inductive effect operates through the C–Cσ bond framework; each additional Cl multiplies the electron-withdrawing effect. Distance reduces the effect (F on β-C has less effect than F on α-C).

Final Answer: $\mathrm{IV} > \mathrm{III} > \mathrm{II} > \mathrm{I} \Rightarrow \boxed{\mathrm{D}}$

Answer: (D) **Go Back to Q21**

Q22.

Solution

Concept — Electrophilic bromination of aniline ($C_6H_5NH_2$): The $-NH_2$ group is a powerful *ortho/para director* and ring activator. In Br_2/water (no Lewis acid catalyst needed!), aniline's ring is so activated that bromination is instantaneous and substitution occurs at all three activated positions.

Step 1 — Why all three positions? $-NH_2$ donates electrons via resonance, making the 2, 4, and 6 positions highly electron-rich. With excess Br_2(aq) (aqueous, no solvent to slow down reaction), all three positions react simultaneously in a single step.

Step 2 — Product: $C_6H_5NH_2 + 3Br_2 \to 2,4,6\text{-}C_6H_2Br_3NH_2 + 3HBr$

Product: 2,4,6-tribromoaniline (white precipitate, insoluble in water).

Step 3 — Difference from less activated rings: For less activated rings (e.g. benzene itself), a Lewis acid ($FeBr_3$) is needed. For aniline, the ring is so reactive that even Br_2(aq) (a weak electrophile) causes tribromination. This is a qualitative test for aniline.

Comparison with phenol: Phenol + Br_2(aq) also gives a tribromo product (2,4,6-tribromophenol). Both $-OH$ and $-NH_2$ are powerful activating groups.

Final Answer: 2,4,6-tribromoaniline (white precipitate) $\Rightarrow \boxed{C}$

$\boxed{\text{Answer: (C)}}$ **Go Back to Q22**

Q23.

Solution

Concept — α-helix secondary structure of proteins: The α-helix is a right-handed coiled structure discovered by Linus Pauling (1951). It is one of the two most common secondary structure elements (the other being β-sheet).

Step 1 — Stabilisation: The α-helix is stabilised by **intramolecular hydrogen bonds** between:

- The $\mathrm{C=O}$ (carbonyl) of residue n
- The $\mathrm{N-H}$ (amide) of residue $n+4$

This is the "i to $i+4$" pattern. There are 3.6 residues per turn.

Step 2 — Why option B is correct: "Right-handed spiral stabilised by intramolecular H-bonds between C=O and N–H of residues 4 apart" precisely describes the α-helix.

Step 3 — Incorrect options: *Option A:* Disulfide bridges stabilise the *tertiary* structure (between Cys residues), not the α-helix. *Option C:* β-pleated sheets involve parallel/antiparallel strands with H-bonds between chains, not within a helix. *Option D:* Salt bridges are tertiary structure interactions.

Final Answer: Right-handed; intramolecular H-bonds C=O (n) $\cdots$ N–H (n+4) $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q23

Q24.

Solution

Concept — Free radical vs condensation polymerisation:

- **Addition polymers** (chain-growth): monomer has C=C; no by-product; can be via free radical, anionic, or cationic mechanism.
- **Condensation polymers**: two different functional groups react; small molecule (H_2O, HCl) is released.

Step 1 — Check each: *Nylon-6,6:* Hexamethylenediamine + adipic acid; amide bonds; H_2O released ⇒ condensation.

Dacron (PET): Ethylene glycol + terephthalic acid; ester bonds; H_2O released ⇒ condensation.

PVC ($[-CH_2-CHCl-]_n$)*:* From vinyl chloride ($CH_2=CHCl$); C=C opens; no by-product; initiated by free radicals or Ziegler-Natta catalyst ⇒ **free radical addition**.

Bakelite: Phenol + formaldehyde; methylene bridges; H_2O released ⇒ condensation.

Industrial production of PVC: Free radical initiator (e.g. benzoyl peroxide) at 40–60°C in emulsion/suspension. PVC is one of the most widely produced plastics globally (pipes, cables, flooring).

Final Answer: PVC — free radical addition polymerisation ⇒ $\boxed{\text{C}}$

Answer: (C)

Go Back to Q24

Q25.

Solution

Concept — Classification of drugs: tranquillisers: Drugs acting on the central nervous system:

- **Tranquillisers** (anti-anxiety, anxiolytics): reduce anxiety without inducing sleep (e.g. equanil/meprobamate, diazepam/Valium, chlordiazepoxide)
- **Hypnotics** (sedatives): induce sleep (e.g. barbiturates, chloral hydrate)
- **Analgesics**: relieve pain
- **Antibiotics**: inhibit bacteria
- **Anaesthetics**: produce loss of sensation (chloroform historically used as general anaesthetic)

Step 1 — Evaluate each option: *Aspirin:* Analgesic/antipyretic/anti-inflammatory. *Chloroform* ($CHCl_3$)*:* Historically used as general anaesthetic; no longer used medicinally due to toxicity. *Equanil (meprobamate):* A **tranquilliser/anxiolytic**; used to treat anxiety, tension, and mild depression. *Penicillin:* Antibiotic; inhibits bacterial cell wall synthesis.

Mechanism of equanil: Acts on GABA receptors in the CNS, enhancing inhibitory neurotransmission. This reduces the activity of the nervous system, relieving anxiety without inducing sleep.

Final Answer: Equanil (meprobamate) is a tranquilliser $\Rightarrow \boxed{\text{C}}$

Answer: (C)

Go Back to Q25

Q26.

Solution

Concept — Ozone layer depletion by CFCs (Molina-Rowland mechanism): CFCs (e.g. CF_2Cl_2, Freon-12) are photolysed by UV radiation in the stratosphere ($\sim 20\text{–}50\,\text{km}$), releasing highly reactive Cl atoms:

$$CF_2Cl_2 \xrightarrow{h\nu} CF_2Cl\cdot + Cl\cdot$$

Step 1 — Chain mechanism of ozone destruction:

$$Cl\cdot + O_3 \rightarrow ClO\cdot + O_2 \quad \text{(Cl acts as oxidant)}$$

$$ClO\cdot + O\cdot \rightarrow Cl\cdot + O_2 \quad \text{(Cl regenerated)}$$

Net: $O_3 + O\cdot \rightarrow 2O_2$ (ozone destroyed without consuming Cl). One Cl atom can destroy 10^5 ozone molecules.

Step 2 — Why this is critical: Stratospheric ozone absorbs UV-B and UV-C radiation (200–315 nm). Ozone depletion allows more UV-B to reach Earth ⇒ increased skin cancer, cataracts, damage to marine ecosystems (phytoplankton). The Antarctic ozone hole forms each spring over the pole.

Step 3 — Montreal Protocol (1987): International treaty phasing out CFCs. Replaced by HCFCs (less stable in stratosphere) and HFCs (no chlorine). Recovery of the ozone layer is ongoing (estimated full recovery by 2065 over Antarctica).

Final Answer: $Cl\cdot + O_3 \rightarrow ClO\cdot + O_2$; $ClO\cdot + O\cdot \rightarrow Cl\cdot + O_2$ (chain) $\Rightarrow \boxed{B}$

$\boxed{\textbf{Answer: (B)}}$ **Go Back to Q26**

Q27.

Solution

Concept — Thermal stability of hydrides down Group 14: As we go down Group 14 (C → Si → Ge → Sn), the M–H bond becomes weaker (longer, less overlap). Bond enthalpy: C–H (413) $\gg$ Si–H (318) $>$ Ge–H (289) $>$ Sn–H ($253\,\text{kJ mol}^{-1}$).

Step 1 — Thermal stability order: Higher bond energy ⇒ harder to decompose ⇒ more thermally stable. $CH_4 > SiH_4 > GeH_4 > SnH_4$

Step 2 — Decomposition temperatures:

- CH_4: stable above $1000°C$ (methanation industry)
- SiH_4: decomposes around $450°C$
- GeH_4: decomposes around $285°C$
- SnH_4: decomposes at room temperature (very unstable)

Step 3 — Decreasing stability list: $CH_4 > SiH_4 > GeH_4 > SnH_4$ = option B ($SnH_4 < GeH_4 < SiH_4 < CH_4$, written in increasing order).

Final Answer: $SnH_4 < GeH_4 < SiH_4 < CH_4$ (stability increases up the group) ⇒ $\boxed{\text{B}}$

Answer: (B) Go Back to Q27

Q28.

Solution

Concept — Efflorescence vs deliquescence:

- **Efflorescence**: a hydrated salt spontaneously loses water of crystallisation to the atmosphere, forming a powdery anhydrous (or less-hydrated) salt on the surface. Occurs when the water vapour pressure of the crystal $>$ partial pressure of water vapour in air.
- **Deliquescence**: a substance absorbs moisture from the atmosphere and dissolves in it. Occurs when water vapour pressure of the saturated solution $<$ partial pressure of water vapour in air.
- **Hygroscopy**: absorbs moisture without dissolving.

Step 1 — Washing soda process: $\mathrm{Na_2CO_3 \cdot 10H_2O \xrightarrow{air} Na_2CO_3 \cdot H_2O + 9H_2O}$

The crystal loses water vapour $\Rightarrow$ **efflorescence**. The surface becomes dull and powdery.

Other efflorescent substances: $\mathrm{CuSO_4 \cdot 5H_2O}$, $\mathrm{MgSO_4 \cdot 7H_2O}$ (Epsom salt), $\mathrm{FeSO_4 \cdot 7H_2O}$.

Contrast with NaOH: NaOH is *deliquescent* — absorbs CO_2 and water from air to become Na_2CO_3 solution. That's why NaOH pellets must be stored in airtight containers.

Final Answer: Efflorescence (loss of water of crystallisation to atmosphere) $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q28

Q29.

Solution

Concept — Dehydration of alcohols (E1 elimination): Alcohols undergo acid-catalysed dehydration to alkenes: $\mathrm{R-CH_2-CH(OH)-R'} \xrightarrow{\mathrm{H^+},\Delta} \mathrm{R-CH=CH-R'+H_2O}$.

Step 1 — E1 mechanism:

(a) Protonation of OH by $\mathrm{H^+}$: forms an oxonium ion ($\mathrm{-CH-OH_2^+}$)
(b) Loss of H_2O (rate-determining, unimolecular): forms a carbocation
(c) Loss of β-proton by base: gives alkene (Zaitsev product preferred)

This is **E1** (elimination, unimolecular) because the rate-determining step involves only the substrate.

Step 2 — Zaitsev selectivity: The more substituted alkene is the major product (Δ-elimination). For 2-methylbutan-2-ol: 2-methylbut-2-ene (trisubstituted, major) $>$ 2-methylbut-1-ene (disubstituted, minor).

Step 3 — Reactivity order: $3^\circ > 2^\circ > 1^\circ$ alcohols (more stable carbocations for E1). Very strong acid (H_3PO_4 or H_2SO_4) and high temperature required.

Final Answer: E1 via carbocation intermediate; Zaitsev product $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q29

Q30.

Solution

Concept — Inductive effects ($+I$ and $-I$): The *inductive effect* is the transmission of electronic effects through σ bonds due to electronegativity differences. It decreases rapidly with distance.

- $+$**I** effect: electron-donating groups push electrons toward the chain/ring. Examples: alkyl groups (R), heavy metal groups.
- $-$**I** effect: electron-withdrawing groups pull electrons away. Examples: $-NO_2$, $-CN$, $-Cl$, $-F$, $-COOH$.

Step 1 — Evaluate each option: *A* — $-NO_2$*:* Strong $-I$ effect (N is very electronegative, withdraws electrons). Also strong $-M$ (mesomeric) effect. $\Rightarrow -I$ **effect**.

B — $-CN$*:* $-I$ and $-M$ effect (C in CN is sp hybridised, highly electronegative). $\Rightarrow -I$ **effect**.

C — Alkyl group ($-CH_3$)*:* Alkyl groups are electron-*donating* by induction ($+I$), due to hyperconjugation and the slightly lower electronegativity of C compared to aromatic C. They push electrons toward the ring. $\Rightarrow +I$ **effect**.

D — $-Cl$*:* Cl is electronegative; $-I$ effect (electron-withdrawing by induction), though it also has $+M$ (mesomeric) effect due to lone pair donation. Net effect on ring: deactivating but ortho/para directing.

Final Answer: Alkyl group ($-CH_3$) shows $+I$ (electron-donating inductive) effect $\Rightarrow \boxed{\text{C}}$

Answer: (C)

Go Back to Q30

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	A	3	B	4	D	5	C
6	B	7	D	8	A	9	A	10	A
11	A	12	B	13	C	14	B	15	C
16	B	17	C	18	B	19	D	20	D
21	D	22	C	23	B	24	C	25	C
26	B	27	B	28	B	29	C	30	C