CHEMISTRY (CODE - 043)

CHAPTER TEST - STEP-BY-STEP SOLUTIONS AND MARKING SCHEME

Class XI (2026-27) | Chapter 8: Organic Chemistry – Some Basic Principles and Techniques

Max. Marks: 35

SECTION A (12 × 1 = 12 marks)

Each correct answer carries 1 mark.

Q1. Ans: B. sp^3, sp [1]

The CH_3 carbon has four σ bonds → sp^3. The nitrile carbon has one σ bond to CH_3, one σ and two π bonds to N (two regions of electron density) → **sp** (linear).

Q2. Ans: C. 5-Methylhexan-2-one [1]

Counting the zig-zag: CH_3–CO–CH_2–CH_2–CH(CH_3)–CH_3. Longest chain containing C=O = 6 carbons (hexane); the ketone gets the lowest number (C-2, suffix –one); the methyl branch is on C-5 → **5-methylhexan-2-one**.

Q3. Ans: D. 9 and 2 [1]

Three C–C σ bonds + six C–H σ bonds = **9 σ**. Each of the two C=C bonds has one π bond = **2 π**.

Q4. Ans: A. 0.75 [1]

R_f = distance moved by the substance / distance moved by the solvent = 6.0 cm / 8.0 cm = **0.75**.

Q5. Ans: B. $(CH_3)_3C^+$ [1]

Stability of carbocations: $(CH_3)_3C^+ > (CH_3)_2CH^+ > CH_3CH_2^+ > CH_3^+$, because of the +I effect and hyperconjugation of the alkyl groups.

Q6. Ans: C. $(CH_3)_3N$: [1]

A nucleophile has a lone pair to donate. $(CH_3)_3N$: has a lone pair on N. BF_3 (sextet), NO_2^+ and CH_3^+ are electron deficient → electrophiles.

Q7. Ans: B. sublimation [1]

Camphor is a sublimable solid; calcium sulphate is non-sublimable. On heating, camphor vapours are collected on cooling, leaving $CaSO_4$ behind.

Q8. Ans: D. $Fe_4[Fe(CN)_6]_3$ [1]

$6CN^- + Fe^{2+} \rightarrow [Fe(CN)_6]^{4-}$; $3[Fe(CN)_6]^{4-} + 4Fe^{3+} \rightarrow Fe_4[Fe(CN)_6]_3 \cdot xH_2O$ (Prussian blue).

Q9. Ans: A. nitrobenzene [1]

Kjeldahl's method is not applicable to compounds containing nitrogen in nitro (–NO_2) or azo groups or in the ring (e.g. pyridine), because their nitrogen does not change into ammonium sulphate. Aniline, acetamide and methylamine are suitable.

Q10. Ans: A. Both A and R are true, and R is the correct explanation of A. [1]

Hyperconjugation delocalises the σ electrons of adjacent C–H bonds into the empty p orbital and stabilises the cation; $(CH_3)_3C^+$ has nine such C–H bonds, while CH_3^+ has none.

Q11. Ans: D. A is false but R is true. [1]

In steam distillation the mixture boils when $p_1 + p_2 = p$ (atmospheric pressure). Since $p_1 < p$, the organic liquid vaporises at a temperature **lower** than its normal boiling point (close to but below 373 K). A is false; R is true.

Q12. Ans: C. A is true but R is false. [1]

Fusion with sodium converts covalent N, S and X into ionic NaCN, Na_2S and NaX (true). For the lead acetate test the extract is acidified with **acetic acid**, not sulphuric acid (which would form $PbSO_4$ precipitate). R is false.

SECTION B (4 × 2 = 8 marks)

Q13. [2]

(i) P = thermometer; Q = (water) condenser; R = water inlet of the condenser; S = conical flask (receiver). [½ + ½ for any two pairs correct = 1]

(ii) Simple distillation. The boiling points differ widely (457 − 334 = 123 K), so the more volatile liquid vaporises first and can be condensed and collected separately. [½] **Chloroform** (lower b.p.) distils first and is collected in S. [½]

Q14. [2]

A = –CHO **B** = –oic acid **C** = $CH_3CH_2COCH_3$ **D** = –ol [½ each]

Q15. [2]

(a) **Chain isomerism** (different carbon skeletons). (b) **Position isomerism** (OH at different positions). (c) **Functional group isomerism** (ketone and aldehyde, C_3H_6O). (d) **Metamerism** (different alkyl groups on either side of the ether oxygen, $C_4H_{10}O$). [½ each]

Q16. [2]

(i) Pent-4-en-2-ol: five carbons (pent), C=C at C-4 (4-en), –OH at C-2 (2-ol) → **CH_2=CH–CH_2–CH(OH)–CH_3** [1]

(ii) 6-Hydroxyheptanal: seven-carbon aldehyde (C-1 is CHO), –OH on C-6 → **CH_3CH(OH)$CH_2CH_2CH_2CH_2$CHO** [1]

OR

(i) Longest chain = 5 carbons (pentane); methyl groups on C-2 and C-4 → **2,4-Dimethylpentane** [1]

(ii) Two keto (>C=O) groups on C-2 and C-4 of a five-carbon chain → **Pentane-2,4-dione** [1]

SECTION C (2 × 3 = 6 marks)

Q17. [3]

(i) Fusion with sodium converts the elements N, S and halogens, which are present in covalent form, into ionic form (NaCN, Na_2S, NaX) that can be extracted in water and detected by ionic tests. [1]

(ii) The extract is boiled with iron(II) sulphate and acidified with concentrated H_2SO_4; a Prussian blue colour confirms N. [½] $6CN^- + Fe^{2+} \rightarrow [Fe(CN)_6]^{4-}$; $3[Fe(CN)_6]^{4-} + 4Fe^{3+} \rightarrow Fe_4[Fe(CN)_6]_3 \cdot xH_2O$ [½]

(iii) Sodium thiocyanate is formed: Na + C + N + S → NaSCN. [½] With Fe^{3+} it gives a **blood red** colour: $Fe^{3+} + SCN^- \rightarrow [Fe(SCN)]^{2+}$ (no Prussian blue as there are no free cyanide ions). [½]

Q18. [3]

(i) Water is absorbed by **anhydrous calcium chloride**; carbon dioxide is absorbed by **concentrated potassium hydroxide solution**. [½ + ½]

(ii) % C = $(12 \times m_2 \times 100)/(44 \times m)$ = $(12 \times 0.44 \times 100)/(44 \times 0.40)$ = **30%** [½]

% H = $(2 \times m_1 \times 100)/(18 \times m)$ = $(2 \times 0.18 \times 100)/(18 \times 0.40)$ = **5%** [½]

(iii) The percentage of oxygen is found by difference: % O = 100 − (30 + 5) = **65%**. [1]

SECTION D (1 × 4 = 4 marks)

Q19. [4]

(i) In P, ammonium sulphate, $(NH_4)_2SO_4$, is formed; in Q, **ammonia gas (NH_3)** is liberated by NaOH. [½ + ½]

(ii) Compounds containing nitrogen in a nitro group (e.g. nitrobenzene), an azo group, or in a ring (e.g. pyridine). [½] Their nitrogen is not converted into ammonium sulphate under these conditions. [½]

(iii) $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$: 25 mL of 1 M H_2SO_4 neutralises 2 × 25 = 50 mL of 1 M NH_3. [½]

Nitrogen in 50 mL of 1 M NH_3 = (14 × 50)/1000 = 0.7 g [½]

% N = (0.7/1.4) × 100 = **50%** [1]

SECTION E (1 × 5 = 5 marks)

Q20. [5]

(i) The inductive effect is the permanent polarisation of a σ bond caused by the polarisation of the adjacent σ bond; it is transmitted along the chain and falls off rapidly with the number of intervening bonds. [½] Electron-withdrawing: $-NO_2$ (or –Cl, –CN, –COOH); electron-donating: $-CH_3$ (or $-CH_2CH_3$). [½]

(ii) Chlorine is electron-withdrawing (–I effect). With more Cl atoms the –I effect is greater; it disperses the negative charge of the carboxylate ion and stabilises it more, so the acid ionises more easily: $Cl_3CCOOH > Cl_2CHCOOH > ClCH_2COOH$. [1]

(iii) Benzene is a resonance hybrid of the two equivalent Kekulé structures (I and II) in which the double and single bonds exchange positions. The real structure has bonds of intermediate character, so all six C–C bonds are equal (139 pm). [1]

(iv) Order of increasing stability: $\mathbf{CH_3^+ < CH_3CH_2^+ < (CH_3)_2CH^+ < (CH_3)_3C^+}$. [1]

Hyperconjugation: the σ electrons of C–H bonds of the alkyl groups attached to the positively charged carbon delocalise into its empty p orbital, dispersing the positive charge. The greater the number of alkyl groups (number of C–H bonds: 0, 3, 6, 9), the greater the hyperconjugation and the stability. [1]

OR

(i) (a) Substitution (nucleophilic: HS^- replaces Br^-); (b) Addition (HCl adds across C=C); (c) Elimination (HBr removed to give the alkene); (d) Rearrangement (the carbon skeleton changes, a methyl shift). [½ each]

(ii) P: **heterolytic** fission – the shared pair goes to the more electronegative Br: CH_3^+ (carbocation) + Br^-; ionic or polar reactions follow. [1] Q: **homolytic** fission – each atom takes one electron (heat or light): $CH_3\bullet$ + $Cl\bullet$ (free radicals); free-radical (non-polar) reactions follow. [1]

(iii) HS^- is a **nucleophile** (it has lone pairs, which it donates to an electron-deficient centre); BF_3 is an **electrophile** (boron has only six valence electrons and accepts an electron pair). [1]

***** END OF SOLUTIONS *****