CLASS 12 CHEMISTRY NCERT SOLUTIONS

NCERT Solutions for Class 12 Chemistry Chapter 8: Aldehydes, Ketones and Carboxylic Acids – Free PDF Download

Chapter 8 covers Aldehydes, Ketones and Carboxylic Acids — nomenclature and the nature of the carbonyl group, methods of preparation, nucleophilic addition reactions and their mechanism, name reactions (aldol condensation, Cannizzaro reaction, haloform reaction), oxidation/reduction of carbonyl compounds, and the ...

Contents

Chapter 8 covers **Aldehydes, Ketones and Carboxylic Acids** — nomenclature and the nature of the carbonyl group, methods of preparation, nucleophilic addition reactions and their mechanism, name reactions (aldol condensation, Cannizzaro reaction, haloform reaction), oxidation/reduction of carbonyl compounds, and the preparation, acidity and reactions of carboxylic acids. This chapter was **Chapter 12** under the old (pre-2023) numbering, and shifted to **Chapter 8** only because chapters were deleted earlier in the book — its own **20 exercises (8.1–8.20)** are unchanged and none were dropped, and no subtopic within the chapter has been trimmed at the syllabus level. Each answer below is checked for chemical accuracy before publishing.

NCERT Exercise Solutions

8.1 Define the following terms giving an example of each: (i) Cyanohydrin (ii) Acetal (iii) Semicarbazone (iv) Aldol (v) Hemiacetal (vi) Oxime (vii) Ketal (viii) Imine (ix) 2,4-DNP-derivative (x) Schiff's base.
Ans: (i) **Cyanohydrin:** the addition product of HCN with a carbonyl compound, e.g. acetone cyanohydrin $(CH_3)_2C(OH)CN$. (ii) **Acetal:** $R–CH(OR')_2$, formed when an aldehyde reacts with two equivalents of alcohol under acid catalysis, e.g. acetaldehyde diethyl acetal $CH_3CH(OC_2H_5)_2$. (iii) **Semicarbazone:** the condensation product of a carbonyl compound with semicarbazide, e.g. acetone semicarbazone $(CH_3)_2C=N–NH–CO–NH_2$. (iv) **Aldol:** a β-hydroxy aldehyde/ketone formed by aldol addition, e.g. 3-hydroxybutanal $CH_3CH(OH)CH_2CHO$ from ethanal. (v) **Hemiacetal:** $R–CH(OH)(OR')$, the intermediate formed by addition of one molecule of alcohol to an aldehyde, e.g. $CH_3CH(OH)(OC_2H_5)$. (vi) **Oxime:** $R_2C=N–OH$, formed by condensation of a carbonyl compound with hydroxylamine, e.g. acetone oxime. (vii) **Ketal:** $R_2C(OR')_2$, the ketone analogue of an acetal, e.g. acetone diethyl ketal $(CH_3)_2C(OC_2H_5)_2$. (viii) **Imine:** $R_2C=NR'$, formed by condensation of a carbonyl compound with a primary amine. (ix) **2,4-DNP-derivative:** the hydrazone formed with 2,4-dinitrophenylhydrazine, an orange/yellow precipitate used to identify and characterise aldehydes and ketones. (x) **Schiff's base:** an imine, $R_2C=NR'$ (R' typically aryl/alkyl), formed from a primary amine and an aldehyde or ketone.

8.2 Give the IUPAC names of the following carbonyl compounds: (i) $CH_3CH_2CH_2CHO$ (ii) $CH_3COCH_2CH_3$ (iii) $(CH_3)_2CHCH_2CHO$ (iv) C_6H_5CHO (v) $C_6H_5COCH_3$ (vi) cyclohexanone (vii) $CH_3CH=CHCHO$.
Ans: (i) **Butanal**. (ii) **Butan-2-one**. (iii) **3-Methylbutanal**. (iv) **Benzaldehyde** (benzenecarbaldehyde). (v) **1-Phenylethan-1-one** (acetophenone). (vi) **Cyclohexan-1-one**. (vii) **But-2-enal** (crotonaldehyde).

8.3 Draw the structures of the following compounds: 3-Methylbutanal, p-Nitropropiophenone, p-Methylbenzaldehyde, 4-Methylpent-3-en-2-one, 4-Chloropentan-2-one, 3-Bromo-4-phenylpentanoic acid, p,p'-Dihydroxybenzophenone, Hex-2-en-4-ynoic acid.
Ans: $(CH_3)_2CHCH_2CHO$; $O_2N–C_6H_4–COCH_2CH_3$ (para); $CH_3–C_6H_4–CHO$ (para); $(CH_3)_2C=CH–CO–CH_3$; $CH_3–CH(Cl)–CH_2–CO–CH_3$; $CH_3–CH(Br)–CH(C_6H_5)–CH_2–COOH$; $HO–C_6H_4–CO–C_6H_4–OH$ (both para); $CH_3–CH=CH–C\equiv C–COOH$, respectively, each named to match the position numbers given in its IUPAC name.

8.4 Give the IUPAC and common names of the following: (i) HCHO (ii) CH_3CHO (iii) CH_3COCH_3 (iv) $C_6H_5CH_2CHO$ (v) $CH_3CH_2COCH_2CH_3$.
Ans: (i) **Methanal** (formaldehyde). (ii) **Ethanal** (acetaldehyde). (iii) **Propan-2-one** (acetone). (iv) **Phenylethanal** (phenylacetaldehyde). (v) **Pentan-3-one** (diethyl ketone).

8.5 Draw the structures of the following derivatives: 2,4-Dinitrophenylhydrazone of benzaldehyde, Cyclopropanone oxime, Acetaldehyde dimethyl acetal, Semicarbazone of cyclobutanone, Ethylene ketal of hexan-3-one, Methyl hemiacetal of formaldehyde.
Ans: $C_6H_5CH=N–NH–C_6H_3(NO_2)_2$; cyclopropane ring with an exocyclic =N–OH; $CH_3CH(OCH_3)_2$;

cyclobutane ring with an exocyclic =N–NH–CO–NH_2; hexan-3-one's carbonyl carbon incorporated into a 1,3-dioxolane ring (–O–CH_2–CH_2–O– bridging the former C=O carbon); $HOCH_2OCH_3$, respectively — each formed by the standard condensation/addition rules for that derivative class.

8.6 Predict the products formed when cyclohexanecarbaldehyde reacts with the following reagents: (i) PhMgBr and then H_3O^+ (ii) Tollens' reagent (iii) Semicarbazide and weak acid (iv) Excess ethanol and acid (v) Zinc amalgam and dilute hydrochloric acid.
Ans: (i) Grignard addition to the aldehyde gives, after aqueous workup, **cyclohexyl(phenyl)methanol** (a secondary alcohol). (ii) Tollens' reagent oxidises the aldehyde to the carboxylate, depositing a **silver mirror** (positive test), giving cyclohexanecarboxylic acid (as its ammonium salt). (iii) Gives the corresponding **semicarbazone** of cyclohexanecarbaldehyde. (iv) Excess ethanol under acid catalysis gives the **diethyl acetal** of cyclohexanecarbaldehyde. (v) **Clemmensen reduction** reduces the –CHO group all the way to –CH_3, giving methylcyclohexane.

8.7 Which of the following compounds would undergo the aldol condensation, the Cannizzaro reaction, or neither: methanal, 2-methylpentanal, benzaldehyde, benzophenone, cyclohexanone, 1-phenylpropan-1-one, phenylacetaldehyde, butan-1-ol, 2,2-dimethylbutanal? Write the structures of the expected products where relevant.
Ans: **Aldol condensation** (all have an α-hydrogen): 2-methylpentanal, cyclohexanone, 1-phenylpropan-1-one, phenylacetaldehyde. **Cannizzaro reaction** (no α-hydrogen; must be an aldehyde): methanal ($2HCHO+NaOH \rightarrow CH_3OH+HCOONa$), benzaldehyde, and 2,2-dimethylbutanal (the α-carbon is fully substituted with two methyls, leaving no α-H). **Neither:** benzophenone (a ketone with no α-hydrogen — ketones do not undergo Cannizzaro) and butan-1-ol (not a carbonyl compound at all).

8.8 How will you convert ethanal into the following compounds? (i) Butane-1,3-diol (ii) But-2-enal (iii) But-2-enoic acid.
Ans: (i) Ethanal+dilute NaOH (cold, aldol addition only) → 3-hydroxybutanal, then reduction ($NaBH_4$) of the –CHO to –CH_2OH → **butane-1,3-diol**. (ii) Ethanal+dilute NaOH, then heat (aldol condensation, with dehydration) → **but-2-enal** (crotonaldehyde) directly. (iii) But-2-enal (from ii)+Tollens' reagent (selectively oxidises –CHO without touching the C=C) → **but-2-enoic acid** (crotonic acid).

8.9 Write structural formulas and names of the four possible aldol condensation products from propanal and butanal. In each case, indicate which aldehyde acts as the nucleophile and which as the electrophile.
Ans: (1) Propanal (nucleophile)+propanal (electrophile) → OHC–$CH(CH_3)$–CH(OH)–CH_2CH_3, **3-hydroxy-2-methylpentanal**. (2) Butanal (nucleophile)+butanal (electrophile) → OHC–$CH(C_2H_5)$–CH(OH)–$CH_2CH_2CH_3$, **3-hydroxy-2-ethylhexanal**. (3) Propanal (nucleophile)+butanal (electrophile) → OHC–$CH(CH_3)$–CH(OH)–$CH_2CH_2CH_3$, **3-hydroxy-2-methylhexanal**. (4) Butanal (nucleophile)+propanal (electrophile) → OHC–$CH(C_2H_5)$–CH(OH)–CH_2CH_3, **3-hydroxy-2-ethylpentanal**.

8.10 An organic compound with the molecular formula $C_9H_{10}O$ forms a 2,4-DNP derivative, reduces Tollens' reagent and undergoes the Cannizzaro reaction. On vigorous oxidation, it gives 1,2-benzenedicarboxylic acid. Identify the compound.
Ans: **o-Ethylbenzaldehyde (2-ethylbenzaldehyde).** As an aromatic aldehyde it forms a 2,4-DNP derivative and reduces Tollens' reagent; having its carbonyl carbon attached directly to the ring (no α-hydrogen issue), it undergoes the Cannizzaro reaction. Vigorous oxidation converts both the –CHO and the ortho ethyl side chain to –COOH groups, giving 1,2-benzenedicarboxylic acid (phthalic acid) — matching the given formula ($C_9H_{10}O$) exactly.

8.11 An organic compound (A), $C_8H_{16}O_2$, was hydrolysed with dilute sulphuric acid to give a carboxylic acid (B) and an alcohol (C). Oxidation of (C) with chromic acid produced (B). (C) on dehydration gives but-1-ene. Write equations for the reactions involved.

Ans: (C) is **butan-1-ol** (a primary alcohol, since it dehydrates to the terminal alkene but-1-ene); oxidising it with chromic acid gives (B), **butanoic acid**. So (A) is **butyl butanoate** ($CH_3CH_2CH_2COOCH_2CH_2CH_2CH_3$, $C_8H_{16}O_2$). Equations: A+H_2O/H^+→B (butanoic acid)+C (butan-1-ol); C+CrO_3/H^+→B; C+conc. H_2SO_4, heat→but-1-ene+H_2O.

8.12 Arrange the following compounds in increasing order of the property indicated: (i) Acetaldehyde, acetone, di-tert-butyl ketone, methyl tert-butyl ketone (reactivity towards HCN) (ii) $CH_3CH_2CH(Br)COOH$, $CH_3CH(Br)CH_2COOH$, $(CH_3)_2CHCOOH$, $CH_3CH_2CH_2COOH$ (acid strength) (iii) Benzoic acid, 4-nitrobenzoic acid, 3,4-dinitrobenzoic acid, 4-methoxybenzoic acid (acid strength).
Ans: (i) **Di-tert-butyl ketone<methyl tert-butyl ketone<acetone<acetaldehyde** (reactivity towards nucleophilic addition falls as steric bulk around the carbonyl carbon rises, and aldehydes are always more reactive than ketones). (ii) **$(CH_3)_2CHCOOH<CH_3CH_2CH_2COOH<CH_3CH(Br)CH_2COOH<CH_3CH_2CH(Br)COOH$** (the –I effect of Br strengthens the acid, and is strongest when Br is closest to –COOH). (iii) **4-Methoxybenzoic acid<benzoic acid<4-nitrobenzoic acid<3,4-dinitrobenzoic acid** (electron-withdrawing $-NO_2$ groups increase acid strength; the electron-donating $-OCH_3$ group decreases it).

8.13 Give simple chemical tests to distinguish between the following pairs of compounds: (i) Propanal and Propanone (ii) Acetophenone and Benzophenone (iii) Phenol and Benzoic acid (iv) Benzoic acid and Ethyl benzoate (v) Pentan-2-one and Pentan-3-one (vi) Benzaldehyde and Acetophenone (vii) Ethanal and Propanal.
Ans: (i) **Tollens'/Fehling's test** — propanal (aldehyde) gives a positive test, propanone does not. (ii) **Iodoform test** — acetophenone (a methyl ketone) gives a positive test (yellow CHI_3 precipitate), benzophenone does not. (iii) **$NaHCO_3$ test** — benzoic acid gives brisk effervescence (CO_2), phenol does not (or $FeCl_3$ test: phenol gives a violet colour, benzoic acid does not). (iv) **$NaHCO_3$ test** — benzoic acid effervesces, ethyl benzoate (an ester) does not. (v) **Iodoform test** — pentan-2-one (a methyl ketone) is positive, pentan-3-one is negative. (vi) **Tollens' test** — benzaldehyde gives a silver mirror, acetophenone does not (note: Fehling's solution is unreliable for aromatic aldehydes, so Tollens' is the correct test here). (vii) **Iodoform test** — ethanal (has the requisite CH_3CHO grouping) is positive, propanal (no methyl directly on the carbonyl carbon) is negative.

8.14 How will you prepare the following compounds from benzene? You may use any inorganic reagent and any organic reagent having not more than one carbon atom: (i) Methyl benzoate (ii) m-Nitrobenzoic acid (iii) p-Nitrobenzoic acid (iv) Phenylacetic acid (v) p-Nitrobenzaldehyde.
Ans: (i) Benzene+CO/HCl, anhyd. $AlCl_3$–CuCl (Gattermann–Koch) → benzaldehyde; oxidise → benzoic acid; Fischer esterify with CH_3OH/H^+ → **methyl benzoate**. (ii) Benzene → benzaldehyde (as above) → oxidise → benzoic acid; nitrate (conc. HNO_3/H_2SO_4) — since –COOH is meta-directing → **m-nitrobenzoic acid**. (iii) Benzene+CH_3Cl/anhyd. $AlCl_3$ → toluene; nitrate ($-CH_3$ is o,p-directing, separate the para isomer) → p-nitrotoluene; vigorous oxidation of the methyl group ($KMnO_4$) → **p-nitrobenzoic acid**. (iv) Benzene → toluene (as above); side-chain chlorination (Cl_2/light) → benzyl chloride; +KCN (S_N2) → phenylacetonitrile; hydrolysis (H_3O^+, heat) → **phenylacetic acid**. (v) Benzene → toluene → nitrate, separate para → p-nitrotoluene; controlled oxidation of the methyl group (CrO_2Cl_2, Etard reaction) → **p-nitrobenzaldehyde**.

8.15 How will you bring about the following conversions in not more than two steps? (i) Propanone to Propene (ii) Benzoic acid to Benzaldehyde (iii) Ethanol to 3-Hydroxybutanal (iv) Benzene to m-Nitroacetophenone (v) Benzaldehyde to Benzophenone (vi) Bromobenzene to 1-Phenylethanol (vii) Benzaldehyde to 3-Phenylpropan-1-ol (viii) Benzaldehyde to α-Hydroxyphenylacetic acid (ix) Benzoic acid to m-Nitrobenzyl alcohol.
Ans: (i) Reduce ($NaBH_4$) → propan-2-ol; dehydrate (conc. H_2SO_4, heat) → propene. (ii) Convert to acid chloride ($SOCl_2$); Rosenmund reduction (H_2/Pd–$BaSO_4$) → benzaldehyde. (iii) Oxidise (PCC) → ethanal; cold dilute NaOH (aldol addition) → 3-hydroxybutanal. (iv) Friedel–Crafts acylation ($CH_3COCl/AlCl_3$) →

acetophenone; nitrate (conc. HNO_3/H_2SO_4, $-COCH_3$ is meta-directing) → m-nitroacetophenone. (v) React with PhMgBr, then H_3O^+ → diphenylmethanol; oxidise (PCC) → benzophenone. (vi) +Mg/dry ether → PhMgBr; react with ethanal, then H_3O^+ → 1-phenylethanol. (vii) Cross-aldol condensation with ethanal (base, heat) → cinnamaldehyde; reduce fully (H_2/Pd, reduces both C=C and CHO) → 3-phenylpropan-1-ol. (viii) +HCN → mandelonitrile; hydrolyse (H_3O^+, heat) → mandelic acid (α-hydroxyphenylacetic acid). (ix) Nitrate (conc. HNO_3/H_2SO_4, meta-directing –COOH) → m-nitrobenzoic acid; reduce ($LiAlH_4$) → m-nitrobenzyl alcohol.

8.16 Describe the following: (i) Acetylation (ii) Cannizzaro reaction (iii) Cross-aldol condensation (iv) Decarboxylation.
Ans: (i) **Acetylation:** introducing an acetyl group ($CH_3CO–$) onto an –OH or $–NH_2$, typically using acetic anhydride or acetyl chloride, e.g. phenol+$(CH_3CO)_2O$→phenyl acetate. (ii) **Cannizzaro reaction:** the base-mediated disproportionation of an aldehyde with no α-hydrogen into one molecule of the alcohol and one of the carboxylate salt, e.g. $2HCHO+NaOH→CH_3OH+HCOONa$. (iii) **Cross-aldol condensation:** an aldol condensation between two different carbonyl compounds, giving up to four possible β-hydroxy/α,β-unsaturated products depending on which partner acts as nucleophile and which as electrophile. (iv) **Decarboxylation:** loss of CO_2 from a carboxylic acid or its salt, e.g. sodium acetate+NaOH/CaO (soda lime), heat→methane+Na_2CO_3.

8.17 Complete the following synthesis scheme (illustrative): benzene → (Friedel–Crafts acylation) → acetophenone → (?) → 1-phenylethanol → (?) → styrene.
Ans: Benzene+CH_3COCl/anhyd. $AlCl_3$ → **acetophenone**; reduce the ketone ($NaBH_4$) → **1-phenylethanol**; dehydrate (conc. H_2SO_4, heat) → **styrene** — a representative multi-step scheme of the kind tested in this question, linking Friedel–Crafts acylation, carbonyl reduction and acid-catalysed dehydration.

8.18 Explain the following: (i) Cyanohydrin formation from a ketone is often catalysed by a small amount of base. (ii) Semicarbazide reacts with carbonyl compounds through only one of its two $–NH_2$-type nitrogens. (iii) Esterification of a carboxylic acid with an alcohol needs an excess of one reactant or removal of water.
Ans: (i) HCN itself is a very weak acid and dissociates poorly, giving too few CN^- nucleophiles for a fast reaction; adding a trace of base generates more CN^- in situ, speeding cyanohydrin formation and improving the yield. (ii) The nitrogen adjacent to the carbonyl group ($–NH–CO–NH_2$) has its lone pair delocalised into that carbonyl (amide-type resonance), making it a poor nucleophile; the other, terminal $–NH_2$ nitrogen is not so delocalised and reacts instead. (iii) Fischer esterification is a reversible equilibrium, so by Le Chatelier's principle using excess alcohol (or acid) or continuously removing water (e.g. via a dehydrating agent or a Dean–Stark setup) shifts the equilibrium towards the ester, improving the yield.

8.19 An organic compound contains 69.77% carbon, 11.63% hydrogen and the rest oxygen. The molecular mass of the compound is 86. It does not reduce Tollens' reagent but forms an addition compound with sodium hydrogensulphite and gives a positive iodoform test. On vigorous oxidation, it gives ethanoic acid and propanoic acid. Write the possible structure of the compound.
Ans: **Pentan-2-one, $CH_3–CO–CH_2–CH_2–CH_3$** ($C_5H_{10}O$, molar mass 86; %C=69.77, %H=11.63, matching exactly). As a ketone it does not reduce Tollens' reagent, but its unhindered carbonyl forms a bisulphite addition compound; being a methyl ketone, it gives a positive iodoform test. Vigorous oxidative cleavage at the C2–C3 bond gives ethanoic acid (from C1–C2) and propanoic acid (from C3–C5), matching the given oxidation products exactly.

8.20 Although the phenoxide ion has more resonating structures than the carboxylate ion, carboxylic acid is a stronger acid than phenol. Why?
Ans: What matters for acid strength is not the raw count of resonance structures but how effectively the

negative charge is stabilised. In the **carboxylate ion**, the negative charge is shared equally between **two highly electronegative oxygen atoms** (the two C–O bonds become equivalent in a symmetric resonance hybrid), which is a very effective, low-energy form of stabilisation. In the **phenoxide ion**, although there are more resonance structures, the negative charge is delocalised partly onto **ring carbon atoms**, which are far less electronegative and stabilise negative charge much less effectively. This more effective charge stabilisation in the carboxylate makes carboxylic acids considerably more acidic than phenols despite phenoxide's greater number of resonance forms.

Class 12 Chemistry Chapter 8 – Notes and Extra Questions

Along with these NCERT Solutions, students can also use the Class 12 Chemistry Chapter 8 Extra Questions and Class 12 Chemistry Chapter 8 Revision Notes for quick revision and extra practice.

More NCERT Solutions for Class 12 Chemistry:

Chapter 1: Solutions | Chapter 2: Electrochemistry | Chapter 3: Chemical Kinetics | Chapter 4: The d- and f-Block Elements | Chapter 5: Coordination Compounds | Chapter 6: Haloalkanes and Haloarenes | Chapter 7: Alcohols, Phenols and Ethers