CLASS 11 CHEMISTRY NCERT SOLUTIONS

NCERT Solutions for Class 11 Chemistry Chapter 9: Hydrocarbons – Free PDF Download

Hydrocarbons is the ninth and final chapter of the NCERT Class 11 Chemistry textbook (Part 2) under the 2026-27 rationalised CBSE syllabus, coming right after Organic Chemistry -- Some Basic Principles and Techniques. It brings together everything you have learned about IUPAC nomenclature, isomerism and electron-mov...

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Hydrocarbons is the ninth and final chapter of the NCERT Class 11 Chemistry textbook (Part 2) under the 2026-27 rationalised CBSE syllabus, coming right after Organic Chemistry — Some Basic Principles and Techniques. It brings together everything you have learned about IUPAC nomenclature, isomerism and electron-movement mechanisms and applies it to four families of carbon compounds — alkanes, alkenes, alkynes and aromatic hydrocarbons. Across the chapter you will classify hydrocarbons, work through free-radical halogenation, Markovnikov and peroxide-effect additions, and the electrophilic substitution mechanism of benzene, and solve numerical problems built around ozonolysis and combustion stoichiometry. These NCERT Solutions for Class 11 Chemistry Chapter 9 work through all 25 in-text exercise questions from the current rationalised textbook with complete, independently-verified step-by-step reasoning, so you can check your own working and download the free PDF for offline revision.

NCERT Solutions for Class 11 Chemistry Chapter 9: Hydrocarbons

Q9.1: Formation of Ethane During Chlorination of Methane

Question: How do you account for the formation of ethane during chlorination of methane?

Chlorination of methane proceeds by a free-radical chain mechanism with three stages.

Initiation: UV/heat homolytically cleaves Cl-Cl: $Cl_2 \rightarrow 2Cl\bullet$

Propagation: $CH_4 + Cl\bullet \rightarrow \bullet CH_3 + HCl$. Then $\bullet CH_3 + Cl_2 \rightarrow CH_3Cl + Cl\bullet$, regenerating the chain-carrying radical.

Termination: Because radicals are present at low, fluctuating concentration, two methyl radicals can occasionally combine directly: $\bullet CH_3 + \bullet CH_3 \rightarrow CH_3\text{-}CH_3$ (ethane). This radical-radical coupling termination step is exactly how the ethane by-product forms.

Ethane arises as a termination by-product when two methyl free radicals combine directly during the free-radical chain chlorination of methane.

Q9.2: IUPAC Names of Given Compounds

Question: Write IUPAC names of the following compounds: (a) $CH_3CH{=}C(CH_3)_2$ (b) $CH_2{=}CH\text{-}C{\equiv}C\text{-}CH_3$ (c) $CH_2{=}CH\text{-}CH{=}CH_2$ (d) a benzene ring joined to $\text{-}CH_2\text{-}CH_2\text{-}CH{=}CH_2$ (e) a benzene ring carrying -OH and -CH_3 on adjacent carbons (f) $CH_3(CH_2)_4CH(CH_2CH(CH_3)_2)(CH_2)_3CH_3$ (g) $CH_3\text{-}CH{=}CH\text{-}CH_2\text{-}CH{=}CH\text{-}CH(C_2H_5)\text{-}CH_2\text{-}CH{=}CH_2$

(a) Longest chain with the double bond has 4 carbons with a methyl branch on C2 → **2-methylbut-2-ene.**

(b) Numbering from the $CH_2{=}$ end gives locants {1,3} (lower than {2,4} from the other end) → **pent-1-en-3-yne.**

(c) A straight 4-carbon chain with double bonds at 1,3 → **buta-1,3-diene.**

(d) Parent chain but-1-ene with a phenyl group on C4 → **4-phenylbut-1-ene.**

(e) Benzene ring with -OH as principal group (C1) and -CH_3 on C2 → **2-methylphenol.**

(f) Main chain is 10-carbon decane; numbering from the end nearer the branch gives it locant 5 → **5-(2-methylpropyl)decane.**

(g) Numbering the 10-carbon chain from the CH2=CH- end gives locants {1,5,8} (lower than {2,5,9}) → **4-ethyldeca-1,5,8-triene.**

Q9.3: Structural Isomers with One Double or Triple Bond

Question: Write structural formulas and IUPAC names for all possible isomers: (a) C4H8 (one double bond) (b) C5H8 (one triple bond)

(a) CH2=CH-CH2-CH3 (but-1-ene), CH3-CH=CH-CH3 (but-2-ene), CH2=C(CH3)-CH3 (2-methylprop-1-ene). **Three isomers: but-1-ene, but-2-ene and 2-methylprop-1-ene.**

(b) CH≡C-CH2-CH2-CH3 (pent-1-yne), CH3-C≡C-CH2-CH3 (pent-2-yne), CH≡C-CH(CH3)-CH3 (3-methylbut-1-yne). **Three isomers: pent-1-yne, pent-2-yne and 3-methylbut-1-yne.**

Q9.4: IUPAC Names of Ozonolysis Products

Question: Write IUPAC names of the products obtained by the ozonolysis of: (i) Pent-2-ene (ii) 3,4-Dimethylhept-3-ene (iii) 2-Ethylbut-1-ene (iv) 1-Phenylbut-1-ene

Ozonolysis cleaves the C=C bond, converting each carbon into a C=O group (aldehyde if it carried an H, ketone if it carried two carbon substituents).

(i) Pent-2-ene splits at C2-C3: **ethanal (CH3CHO) and propanal (CH3CH2CHO).**

(ii) 3,4-Dimethylhept-3-ene splits at C3-C4, both fully substituted: **butan-2-one and pentan-2-one.**

(iii) 2-Ethylbut-1-ene splits at C1-C2: **pentan-3-one ((C2H5)2CO) and methanal (HCHO).**

(iv) 1-Phenylbut-1-ene splits at C1-C2: **benzaldehyde (C6H5CHO) and propanal (CH3CH2CHO).**

Q9.5: Structure of Alkene from Ozonolysis Products (Ethanal + Pentan-3-one)

Question: An alkene ‘A’ on ozonolysis gives a mixture of ethanal and pentan-3-one. Write structure and IUPAC name of ‘A’.

Ethanal, CH3-CHO, contributes CH3-CH=. Pentan-3-one, (C2H5)2C=O, contributes =C(C2H5)2. Joining: CH3-CH=C(CH2CH3)2. Taking one ethyl as chain, the longest chain through the double bond is pentene with an ethyl on C3.

A is 3-ethylpent-2-ene, CH3-CH=C(C2H5)-CH2CH3.

Q9.6: Identifying Alkene ‘A’ from Bond Count and Ozonolysis Product

Question: An alkene ‘A’ contains three C-C, eight C-H sigma bonds and one C-C pi bond. ‘A’ on ozonolysis gives two moles of an aldehyde of molar mass 44 u. Write IUPAC name of ‘A’.

An aldehyde of molar mass 44 u is C2H4O (12×2+1×4+16=44), i.e. ethanal, CH3CHO. Two identical moles means the alkene is symmetrical: CH3-CH=CH-CH3 (but-2-ene). Checking: C-C sigma bonds = 3 (C1-C2, C2-C3, C3-C4); C-H sigma bonds = 3+1+1+3 = 8; one C=C pi bond. All three data points match.

A is but-2-ene, CH3-CH=CH-CH3.

Q9.7: Structural Formula of Alkene from Propanal and Pentan-3-one

Question: Propanal and pentan-3-one are the ozonolysis products of an alkene. What is the structural formula of the alkene?

Propanal contributes CH3CH2-CH=. Pentan-3-one contributes =C(C2H5)2. Joining gives an 8-carbon alkene; taking one ethyl as a chain extension, the longest chain is hex-3-ene with an ethyl substituent on C3. Re-cleaving confirms it regenerates both original products.

The alkene is 3-ethylhex-3-ene, CH3CH2-C(C2H5)=CH-CH2CH3.

Q9.8: Combustion Equations for Butane, Pentene, Hexyne and Toluene

Question: Write chemical equations for the combustion reaction of: (i) Butane (ii) Pentene (iii) Hexyne (iv) Toluene

Every hydrocarbon burns in excess oxygen: $C_xH_y + (x+y/4)O_2 \rightarrow xCO_2 + (y/2)H_2O$.

(i) Butane, C_4H_{10}: **$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$.**

(ii) Pentene, C_5H_{10}: **$2C_5H_{10} + 15O_2 \rightarrow 10CO_2 + 10H_2O$.**

(iii) Hexyne, C_6H_{10}: **$2C_6H_{10} + 17O_2 \rightarrow 12CO_2 + 10H_2O$.**

(iv) Toluene, C_7H_8: **$C_7H_8 + 9O_2 \rightarrow 7CO_2 + 4H_2O$.**

Q9.9: Cis and Trans Hex-2-ene — Boiling Point Comparison

Question: Draw the cis and trans structures of hex-2-ene. Which isomer will have higher b.p. and why?

In cis-hex-2-ene, the -CH3 and -CH2CH2CH3 groups lie on the same side of the double bond, and their bond dipoles reinforce, giving a net dipole moment. In trans-hex-2-ene, they lie on opposite sides and the dipoles largely cancel. A more polar molecule has stronger intermolecular dipole-dipole attraction, requiring more energy to vaporise.

The cis isomer of hex-2-ene has the higher boiling point because it is more polar than the trans isomer, giving it stronger intermolecular attractions.

Q9.10: Why Benzene Is Extraordinarily Stable

Question: Why is benzene extraordinarily stable though it contains three double bonds?

All six carbons are sp2, forming a planar hexagonal sigma-framework. Each carbon’s unhybridised p orbital

overlaps sideways equally with both neighbours, forming one continuous delocalised pi cloud rather than three fixed double bonds. This delocalisation lowers the molecule's energy well below a hypothetical localised structure (resonance energy about 152 kJ/mol), making all six C-C bonds identical (139 pm) and resistant to addition reactions.

Benzene is unusually stable because its six pi electrons are fully delocalised around the ring rather than confined to three fixed double bonds, lowering the molecule's energy substantially below the localised Kekule structure.

Q9.11: Necessary Conditions for Aromaticity

Question: What are the necessary conditions for any system to be aromatic?

(i) The ring must be planar; (ii) every ring atom must have an unhybridised p orbital for uninterrupted delocalisation; (iii) the ring must contain (4n+2) delocalised pi electrons, n = 0,1,2,3… (Huckel's rule).

A system is aromatic only if it is cyclic and planar, has an uninterrupted, fully conjugated ring of p orbitals, and contains (4n+2) pi electrons (Huckel's rule).

Q9.12: Why Cycloheptatriene, Cyclopentadiene and Cyclooctatetraene Are Not Aromatic

Question: Explain why the following systems are not aromatic: (i) cyclohepta-1,3,5-triene (ii) cyclopenta-2,4-dien-1-yl system with an sp3 CH2 (iii) cycloocta-1,3,5,7-tetraene.

(i) Has one sp3 -CH2- carbon interrupting the ring, so even with 6 pi electrons the conjugation is broken. **Not aromatic — conjugation broken despite 6 pi electrons.**

(ii) One sp3 -CH2- carbon and only 4 pi electrons, which is not a (4n+2) number. **Not aromatic — broken conjugation and 4 pi electrons.**

(iii) 8 pi electrons (a 4n number, n=2, not 4n+2), and the real molecule is non-planar (tub-shaped). **Not aromatic — non-planar and 8 pi electrons (4n count).**

Q9.13: Converting Benzene to Four Named Products

Question: How will you convert benzene into (i) p-nitrobromobenzene (ii) m-nitrochlorobenzene (iii) p-nitrotoluene (iv) acetophenone?

(i) Brominate benzene (Br2/FeBr3) to bromobenzene; since -Br is o,p-directing, nitrate (HNO3/H2SO4) and separate the para isomer → **p-nitrobromobenzene.**

(ii) Nitrate benzene first (HNO3/H2SO4) to nitrobenzene; since -NO2 is meta-directing, chlorinate (Cl2/AlCl3) to place Cl meta → **m-nitrochlorobenzene.**

(iii) Friedel-Crafts alkylate benzene (CH3Cl/AlCl3) to toluene; since -CH3 is o,p-directing, nitrate and separate the para isomer → **p-nitrotoluene.**

(iv) Friedel-Crafts acylation with CH3COCl/AlCl3 gives the acylium ion which substitutes directly →

acetophenone, C6H5COCH3.

Q9.14: Classifying 1°, 2° and 3° Carbon Atoms

Question: In H3C-CH2-C(CH3)2-CH2-CH(CH3)2, identify 1°, 2°, 3° carbon atoms and give the number of H atoms bonded to each.

Numbering C1-C5: C1 bonded to 1 carbon → primary, 3H. C2 bonded to 2 carbons → secondary, 2H. C3 bonded to 4 carbons → quaternary, 0H (not classified 1/2/3). Its two methyl branches are each primary, 3H each. C4 bonded to 2 carbons → secondary, 2H. C5 bonded to 3 carbons → tertiary, 1H. Its two methyl branches are each primary, 3H each.

Five 1° carbon atoms (15 H total), two 2° carbon atoms (4 H total), one 3° carbon atom (1 H), and one quaternary (4°) carbon atom bonded to no hydrogen.

Q9.15: Effect of Branching on Boiling Point

Question: What effect does branching of an alkane chain have on its boiling point?

Alkane molecules are held together by van der Waals forces, whose strength increases with surface-area contact. A straight chain packs closely along its whole length; branching makes the molecule more compact/spherical, reducing contact area and weakening attraction.

Increased branching lowers the boiling point of an alkane; among isomers, the straight-chain isomer has the highest boiling point and the most branched isomer has the lowest.

Q9.16: Markovnikov vs Peroxide-Effect Addition of HBr to Propene

Question: Addition of HBr to propene yields 2-bromopropane, while in the presence of benzoyl peroxide the same reaction yields 1-bromopropane. Explain and give mechanism.

Without peroxide (ionic, Markovnikov): H+ adds to propene's C1, generating the more stable secondary carbocation CH3-CH+-CH3 (rather than a primary one), which Br- then attacks to give 2-bromopropane.

With benzoyl peroxide (free-radical, anti-Markovnikov): Peroxide generates Br•, which adds to the terminal, less-hindered carbon, forming the more stable secondary radical CH3-•CH-CH2Br, which abstracts H from another HBr to give 1-bromopropane, regenerating Br•.

Without peroxide, ionic addition proceeds through the more stable secondary carbocation to give 2-bromopropane (Markovnikov); with peroxide, free-radical addition proceeds through the more stable secondary radical, giving 1-bromopropane (anti-Markovnikov/Kharasch effect).

Q9.17: Ozonolysis of o-Xylene and Support for the Kekule Structure

Question: Write down the products of ozonolysis of 1,2-dimethylbenzene (o-xylene). How does the result support the Kekule structure for benzene?

o-Xylene has two Kekule structures differing in double-bond placement. Structure I (double bond between the methyl-bearing carbons) gives butane-2,3-dione plus two moles of glyoxal. Structure II (double bonds

shifted by one position) gives two moles of methylglyoxal plus one mole of glyoxal. Experimentally, ozonolysis gives all three products together — glyoxal, methylglyoxal, and butane-2,3-dione — which neither single Kekule structure alone predicts.

Ozonolysis of o-xylene gives a mixture of glyoxal, methylglyoxal and butane-2,3-dione; since no single fixed Kekule structure produces all three, this supports benzene being a resonance hybrid of the two Kekule structures rather than one fixed arrangement.

Q9.18: Decreasing Order of Acidic Behaviour — Benzene, n-Hexane, Ethyne

Question: Arrange benzene, n-hexane and ethyne in decreasing order of acidic behaviour. Also give reason.

Acidity depends on the s-character of the C-H bond's carbon orbital: higher s-character makes carbon more electronegative and H more easily removed. Ethyne is sp (50% s-character), benzene is sp2 (33%), n-hexane is sp3 (25%).

Decreasing order of acidic behaviour: ethyne > benzene > n-hexane, following the s-character order sp > sp2 > sp3.

Q9.19: Why Benzene Prefers Electrophilic Substitution Over Nucleophilic Substitution

Question: Why does benzene undergo electrophilic substitution reactions easily and nucleophilic substitutions with difficulty?

Benzene's six delocalised pi electrons make it electron-rich, strongly attracting electron-deficient electrophiles, which form a resonance-stabilised arenium-ion intermediate before losing H+. Nucleophiles, being electron-rich themselves, are repelled by the electron-dense ring.

Benzene's electron-rich pi cloud attracts electrophiles (favouring electrophilic substitution) but repels electron-rich nucleophiles (disfavouring nucleophilic substitution).

Q9.20: Converting Ethyne, Ethene and Hexane into Benzene

Question: How would you convert the following compounds into benzene? (i) Ethyne (ii) Ethene (iii) Hexane

(i) Cyclotrimerise 3 ethyne molecules through a red-hot copper tube at 873 K.

(ii) Convert ethene to 1,2-dibromoethane (Br2), then double-dehydrohalogenate with alc. KOH to ethyne, then cyclotrimerise as in (i).

(iii) Catalytic aromatisation (reforming) of hexane with Cr2O3/Al2O3 at ~773 K, losing 4H2 to aromatise directly to benzene.

Q9.21: Alkenes That Give 2-Methylbutane on Hydrogenation

Question: Write structures of all the alkenes which on hydrogenation give 2-methylbutane.

2-Methylbutane has skeleton C1-C2(CH3 branch)-C3-C4. Placing the double bond at each possible position: C1-C2 gives 2-methylbut-1-ene; C2-C3 gives 2-methylbut-2-ene; C3-C4 gives 3-methylbut-1-ene. The branch position gives an identical molecule to the C1-C2 case, not a distinct isomer.

Three alkenes hydrogenate to 2-methylbutane: 2-methylbut-1-ene, 2-methylbut-2-ene and 3-methylbut-1-ene.

Q9.22: Decreasing Relative Reactivity Toward an Electrophile

Question: Arrange in decreasing order of reactivity with E+: (a) Chlorobenzene, 2,4-dinitrochlorobenzene, p-nitrochlorobenzene (b) Toluene, p-H3C-C6H4-NO2, p-O2N-C6H4-NO2

(a) -Cl is weakly deactivating, -NO2 strongly deactivating; more -NO2 groups reduce ring electron density further. **Decreasing reactivity: chlorobenzene > p-nitrochlorobenzene > 2,4-dinitrochlorobenzene.**

(b) -CH3 is activating, -NO2 deactivating. **Decreasing reactivity: toluene > p-H3C-C6H4-NO2 > p-O2N-C6H4-NO2.**

Q9.23: Which of Benzene, m-Dinitrobenzene and Toluene Nitrates Most Easily

Question: Out of benzene, m-dinitrobenzene and toluene, which will undergo nitration most easily and why?

Nitration proceeds fastest on the most electron-rich ring. Toluene's -CH3 activates the ring above plain benzene; m-dinitrobenzene's two -NO2 groups strongly deplete ring electron density.

Toluene undergoes nitration most easily due to its activating methyl group; m-dinitrobenzene reacts with the most difficulty due to its two deactivating nitro groups.

Q9.24: A Lewis Acid Catalyst for Ethylation of Benzene

Question: Suggest the name of a Lewis acid other than anhydrous aluminium chloride which can be used during ethylation of benzene.

Friedel-Crafts alkylation needs a Lewis acid to generate the electrophilic ethyl cation from the alkyl halide; any sufficiently strong, dry Lewis acid can accept a halide ion in the same way.

Anhydrous ferric chloride, FeCl3, can be used in place of AlCl3 (anhydrous SnCl4 or BF3 would also work).

Q9.25: Why Wurtz Reaction Fails for Odd-Carbon Alkanes

Question: Why is Wurtz reaction not preferred for the preparation of alkanes containing an odd number of carbon atoms? Illustrate with an example.

The Wurtz reaction, 2R-X + 2Na → R-R + 2NaX, always doubles the carbon count of a single alkyl halide, giving only even-carbon products directly. To get an odd-carbon alkane, two different alkyl halides must be coupled, but all three combinations (R-R, R'-R', and R-R') form simultaneously as a hard-to-separate mixture with close boiling points. For example, coupling CH3Br and C2H5Br gives ethane, propane and

butane together, not pure propane.

The Wurtz reaction is not preferred for odd-carbon alkanes because making them requires coupling two different alkyl halides, which unavoidably also produces the two symmetrical (even-carbon) alkanes as a mixture that is difficult to separate.

Class 11 Chemistry Chapter 9 – Notes and Extra Questions

Because Hydrocarbons closes out the Class 11 Chemistry syllabus, it is one of the highest-yield chapters for board exams and for JEE/NEET, since it draws directly on the nomenclature and reaction-mechanism foundations built in Chapter 8. Focus your revision on drawing every mechanism (free-radical halogenation, Markovnikov/peroxide-effect addition, and electrophilic aromatic substitution) step by step rather than memorising final products, and practise ozonolysis and combustion numericals until the carbon-counting and locant rules become automatic — these two question types account for a large share of this exercise set. Keep a quick-reference table of ortho/para- versus meta-directing groups handy, since directive influence questions (Q9.13, Q9.22, Q9.23) recur often in exams.

How many questions are there in the NCERT Class 11 Chemistry Chapter 9 Hydrocarbons exercise?

The current rationalised (2026-27) NCERT textbook has 25 in-text exercise questions in Chapter 9, numbered Q9.1 to Q9.25, covering nomenclature, isomerism, ozonolysis, combustion, aromaticity and reaction mechanisms.

Is Hydrocarbons the last chapter of Class 11 Chemistry for 2026-27?

Yes. After the 2023 CBSE/NCERT rationalisation, Class 11 Chemistry has nine chapters in total — six in Part 1 and three in Part 2 (Chapter 7: Redox Reactions, Chapter 8: Organic Chemistry — Some Basic Principles and Techniques, and Chapter 9: Hydrocarbons). Hydrocarbons is therefore the final chapter of the current Class 11 Chemistry book, and everything you learn in it carries forward directly into Class 12 Organic Chemistry.

Was this chapter's exercise list changed during the NCERT rationalisation?

Yes. In the pre-2023 edition, this content appeared as the much later Chapter 13 with a considerably longer exercise list. Under the 2023-24 rationalisation the chapter was moved to Chapter/Unit 9 and its exercises were trimmed down to the 25 questions (9.1-9.25) that appear in the current official NCERT PDF, so students should solve only the current 25-question set and not rely on old chapter-13-numbered question banks, which may include questions that are no longer in the syllabus.

Which topics in Chapter 9 carry the most weightage for exams?

IUPAC nomenclature and isomerism (Q9.2-Q9.3), ozonolysis-based structure determination (Q9.4-Q9.7), reaction mechanisms such as free-radical halogenation and the Markovnikov/peroxide-effect addition of HBr (Q9.1, Q9.16), and the aromaticity/electrophilic substitution chemistry of benzene (Q9.10-Q9.13, Q9.17, Q9.19, Q9.22-Q9.23) are the most frequently tested areas, since they combine conceptual understanding with problem-solving.