

Naming organic compounds and their isomers

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Worksheet answers

Each answer gives the reasoning, the correct name or number in bold, and the rule used. When naming, check the longest chain, then the lowest locants, then alphabetical order of the prefixes.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB S3.2

Problem 1 Alkane names and formulae

1. **methane, ethane, propane, butane, pentane, hexane.**
2. **C_nH_{2n+2} .**
3. $n = 7$ gives **C_7H_{16} .**

Problem 2 Name the straight chains

1. **pentan-1-ol**
2. **propanal**
3. **butanone**
4. **propanoic acid**

Problem 3 Condensed formulae

1. **$CH_3CH(CH_3)CH_2CH_3$**
2. **$(CH_3)_4C$ or $C(CH_3)_4$**
3. Both are **C_5H_{12} .**

Problem 4 Identify functional groups

alkene and alcohol; ester; amine; halogenoalkane.

Problem 5 Which type of isomerism

1. **position**
2. **chain**
3. **functional group**
4. **functional group**

Problem 6 Branched names

1. **2,2-dimethylbutane**
2. **2-chlorobutane**

3. **2,3-dimethylpentane**
4. **3-bromopentane**

Problem 7 Isomers of C_4H_9Br

1. **1-bromobutane, 2-bromobutane, 1-bromo-2-methylpropane, 2-bromo-2-methylpropane.**
2. Primary, secondary, primary, tertiary respectively (the carbon bonded to Br has 1, 2, 1 and 3 carbon neighbours).

Problem 8 Boiling points of C_5H_{12} isomers

1. $36 - 10 = 26\text{ }^{\circ}\text{C}$.
2. More branching makes the molecule more compact with a smaller surface area for contact, so the London forces are weaker and the boiling point is lower.

Problem 9 E and Z but-2-ene

1. Left is **Z** (both CH_3 on the same side); right is **E**.
2. In but-1-ene, one double-bond carbon has two H atoms, so it lacks two different groups.
3. The π bond needs overlapping p orbitals, which would be broken by twisting the bond.

Problem 10 Chiral or not

3-methylhexane (carbon 3 has H, CH_3 , C_2H_5 , C_3H_7) and **2-bromopentane** (carbon 2 has H, Br, CH_3 , C_3H_7) are chiral. The others have a carbon with two identical groups or no sp^3 carbon with four different groups.

Problem 11 Combustion analysis

1. $n(\text{CO}_2) = 0.6600 \div 44.0 = 0.01500\text{ mol}$ so $n(\text{C}) = \mathbf{0.0150\text{ mol}}$; $n(\text{H}_2\text{O}) = 0.3600 \div 18.0 = 0.0200\text{ mol}$ so $n(\text{H}) = \mathbf{0.0400\text{ mol}}$.
2. $\text{C} : \text{H} = 0.015 : 0.040 = 3 : 8$, so **C_3H_8** .
3. $M_r = 44$, so the molecular formula is C_3H_8 and there is **one** structure (propane).

Problem 12 Enantiomeric excess

1. $ee = 5.0 \div 20.0 \times 100 = \mathbf{25\%}$.
2. $(+) = (100 + 25) \div 2 = \mathbf{62.5\%}$; $(-) = \mathbf{37.5\%}$.

Problem 13 Formula from percentages

1. $\text{C } 54.5 \div 12.0 = 4.54$; $\text{H } 9.1 \div 1.0 = 9.1$; $\text{O } 36.4 \div 16.0 = 2.275$. Dividing by 2.275 gives $2 : 4 : 1$, so **$\text{C}_2\text{H}_4\text{O}$** .
2. Empirical mass 44; $88 \div 44 = 2$, so **$\text{C}_4\text{H}_8\text{O}_2$** .

3. For example **butanoic acid** and **ethyl ethanoate** (also 2-methylpropanoic acid, methyl propanoate).

Problem 14 Alkenes and alkynes

1. **but-2-yne**
2. **2-methylbut-1-ene**
3. **pent-2-ene** (shows E/Z)
4. **but-1-yne**

Problem 15 Spot the errors

1. The longest chain has five carbons: **3-methylpentane**.
2. Number from the end giving the lowest locant to OH: **butan-2-ol**.
3. In a Z isomer they are on the **same** side.

Problem 16 Assign E or Z

1. Left carbon: Cl (atomic number 17) > CH₃. Right carbon: CH₃ > H.
2. Cl is top-left and CH₃ is top-right, on the same side: Q is **Z**.
3. The other isomer has CH₃ on the right carbon at the bottom, giving **E**.

Problem 17 Lactic acid

1. Carbon 2 with **H, OH, COOH and CH₃**.
2. Same melting point and boiling point; they rotate plane-polarised light in **opposite directions**.
3. The reaction can attack a flat intermediate from either face with equal chance, forming equal amounts of both enantiomers.

Problem 18 Isomers of C₄H₈

1. **but-1-ene, but-2-ene, 2-methylpropene** and **cyclobutane** (also methylcyclopropane).
2. **But-2-ene**.
3. Five structural isomers; but-2-ene has two stereoisomers, so **6** in total.

Problem 19 Isomers of C₃H₆O₂

1. **propanoic acid**, CH₃CH₂COOH.
2. **methyl ethanoate** and **ethyl methanoate**: functional group (and position) isomers.
3. Add Na₂CO₃: an acid releases CO₂ and fizzes, whereas esters do not.

Problem 20 Name complex structures

1. **4-chloro-2-methylpentan-1-ol**

2. **2-methylpent-2-ene**
3. **3-methylbutanoic acid**
4. **$\text{CH}_3\text{CHClC}(\text{CH}_3)\text{ClCH}_2\text{CH}_3$**
5. Two chiral centres, so $2^2 = 4$ stereoisomers.