

1.4.2 Structural isomers: chains and saturated rings

Name: _____ Class: _____ Date: _____

Total: 32 marks

KEY WORDS structural isomer

• skeletal formula

• cycloalkane

Objective

Generate and name structural isomers without counting rotated or renumbered drawings twice. Use a fixed total carbon count and distinguish chains from saturated single rings.

1 Key knowledge and worked examples

■ Make a systematic list

For an acyclic alkane, start with the longest possible chain, shorten it and distribute the remaining carbons as branches. Renumber for the lowest locants. $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$ is 2-methylbutane; reversing the drawing does not create a second isomer called 3-methylbutane.

For a saturated single ring, start with the largest possible ring and distribute remaining carbons outside it. A ring has at least three carbons. Check C_nH_{2n} after assigning enough H atoms to give every carbon four bonds. Structural isomers change connectivity; stereoisomers keep connectivity.

2 Practice

2.1 Name $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$ and explain why the name 2-ethylbutane does not use the correct parent chain. [3]

2.2 Draw and name all three acyclic structural isomers of C_5H_{12} .

[6]

2.3 An alkane has a four-carbon parent chain and two methyl substituents. Give the two distinct lowest-locant names that produce C_6H_{14} , and explain why 3,3-dimethylbutane is not a third structure.

[3]

3 Exam-style questions

3.1 Draw and name all saturated single-ring structural isomers containing three or four total carbon atoms. Give the molecular formula of each.

[6]

3.2 Draw and name all five saturated single-ring structural isomers of C_5H_{10} . Do not count separate cis/trans arrangements as structural isomers. [10]

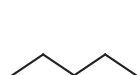
3.3 A student claims that C_6H_{12} has just one cycloalkane structure because it must be a six-carbon ring. Give three counterexample names containing different ring sizes, and explain why changing the ring size can preserve the molecular formula. [4]

Solutions

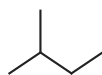
Original guidance. For drawing items, award one mark per correct connectivity and one per correct name unless specified otherwise. Equivalent clear displayed/structural/skeletal drawings are accepted.

2.1 3-methylpentane. The longest continuous chain has five carbons; selecting a four-carbon chain incorrectly treats part of that chain as an ethyl substituent.

2.2



pentane



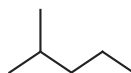
2-methylbutane



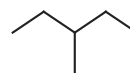
2,2-dimethylpropane



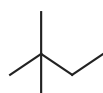
hexane



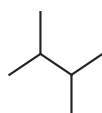
2-methylpentane



3-methylpentane



2,2-dimethylbutane



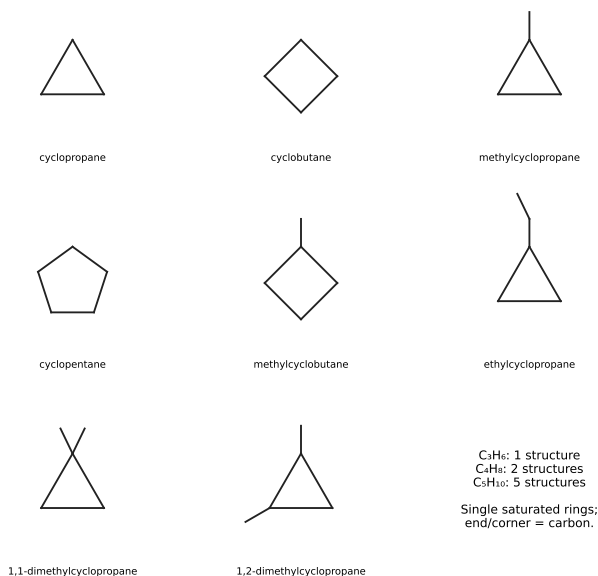
2,3-dimethylbutane

C₅H₁₂: 3 structures
C₆H₁₄: 5 structures
Hydrogen atoms fill
each carbon valency to 4.

Top row only: three correct structures and three correct names, 6 marks. The lower rows show the distinct C₆H₁₄ structures used in 2.3.

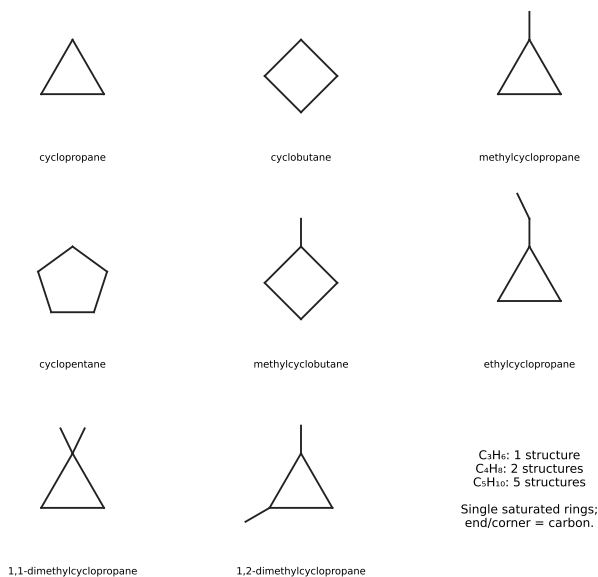
2.3 2,2-dimethylbutane and 2,3-dimethylbutane. Reversing the numbering turns 3,3 into 2,2 without changing connectivity.

3.1



First row: cyclopropane C₃H₆; cyclobutane C₄H₈; methylcyclopropane C₄H₈. Award one mark per correct structure and one per name with formula, 6 marks.

3.2



Five correct structures and names: cyclopentane, methylcyclobutane, ethylcyclopropane, 1,1-dimethylcyclopropane and 1,2-dimethylcyclopropane. Award one mark per correct structure and one per name, 10 marks. Cis/trans forms of the last name do not add another connectivity.

3.3 Cyclohexane, methylcyclopentane and ethylcyclobutane are examples with six-, five- and four-carbon rings. Moving carbons from the ring into saturated side chains retains one ring and six total carbons, so each has C₆H₁₂. Accept a correct three-carbon-ring example in place of another ring size.