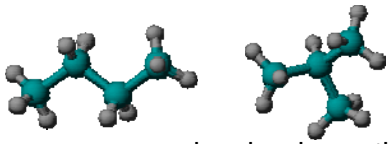
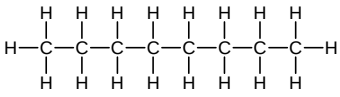


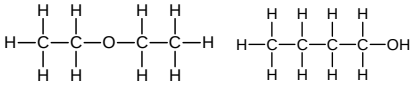
Isomer

When two or more molecules have the same chemical formula but different structures they are called isomers. There are two types of isomers: structural isomers and geometric isomers. Each isomer has its own unique IUPAC name to distinguish it from other isomers. Work in groups of two for this exercise. Each person should have his or her own molecular model kit. Answer all questions on a separate sheet.

Structural isomers

1. Models of butane and 2-methylpropane are shown on the top of this page. Both molecules have the same chemical formula (C_4H_{10}). However, they have different structures and, as a result, different physical and chemical properties. Thus, they are structural isomers. Draw condensed structural diagrams (e.g. CH_3-CH_2-…) for butane and 2-methylpropane.
2. There are five structural isomers of C_4H_8. a) In groups of two, build all 5 structures. b) draw condensed structural diagrams and give the correct IUPAC for each. Remember that each molecule must have its own unique name; if two diagrams have the same name then they aren't isomers – they are the same compound. Show your teacher when you have all five built, drawn, and named.
3. Isomerism is one reason why there are so many different organic compounds. As the number of carbon atoms increases, the number of possible isomers rapidly increases. For example, C_8H_{18} has 18 potential isomers, $C_{10}H_{22}$ has 75, $C_{20}H_{42}$ has 366,319, and $C_{40}H_{82}$ has 6.25×10^{13}. In addition to size, there are other factors that influence how many isomers can exist. For example, C_4H_{10} has two isomers (shown on the top of this page) whereas C_4H_8 has five. Which two structural features were present in your models for C_4H_8 that cause this formula to have more isomers than C_4H_{10}?
4. Structural isomers can result in changes in functional groups. The general chemical formula C_3H_6O represents molecules from four different functional groups. List the four functional groups that can be represented. Under each, draw one example of a molecule that has the formula C_3H_6O.
5. As mentioned, structural isomers have different physical and chemical properties. Compare the two molecules to the right. The straight-chain isomer has a higher boiling point than the branched isomer; in the straight-chain isomer there are more sites for London forces to form between adjacent molecules. When isomerism results in different functional groups, differences may exist due to changes in ΔEN values and polarity. a) Predict which molecule to the right will have a higher boiling point. Explain. b) Which will be more soluble in water? Explain.





Geometric Isomers

Geometric isomers are two molecules that have the same basic structure but vary subtly in their geometry. Your hands are like geometric isomers – they have the same basic structure but are not identical (a right-handed glove will not fit on your left hand). Geometric isomers exist when two groups are attached to an inflexible structure (a double bond or a ring). "cis-" is added to an IUPAC name to indicate that groups are on the same side. If groups are on opposite sides "trans-" is used.

6. a) Build cis-2-butene and trans-2-butene. Notice that there is no way to rotate these molecules to make them look exactly the same. b) Build 1,2-dichloroethane and 1,2-dichloroethene. Which molecule requires cis or trans to be added to its name? Which molecule does not?
7. Build 1,2-dimethylcyclopentane. a) Is the cis/trans prefix necessary in the naming of this molecule? b) Draw and name all possible variations of 1,2-dimethylcyclopentane.
8. Build 1,1-dimethylcyclopentane. a) Is the cis/trans prefix necessary in the naming of this molecule? b) Draw and name all possible variations of 1,1-dimethylcyclopentane.
9. For these pairs of molecules, indicate if they are structural isomers, geometric isomers, or neither.