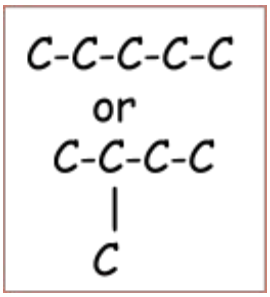
Lab - Alkane Isomers

Introduction:



The alkane molecules you have considered so far are **straight-chain alkanes** – each carbon atom is linked to only one or two other carbon atoms. In alkanes with four or more carbon atoms, many other arrangements of carbon atoms are possible. Alkanes in which one or more carbon atoms are linked to three or four other carbon atoms are called **branched-chain alkanes**. An alkane with four or more carbon atoms can have either a straight chain or a branched-chain structure. In this activity you will use molecular models to investigate such variations in alkane structures – variations that can lead to different properties.

Purpose: To identify what an isomer is and how isomerization affects the properties of alkanes.

Part 1: Building Isomers

Procedure:

1) Assemble a model of a molecule with the formula C_4H_{10}. Compare your model with those built by other groups. How many different arrangements can be constructed?

Molecules that have identical molecular formulas but different arrangements of atoms are called **isomers**. By comparing models, convince yourself that there are only two isomers of C_4H_{10}. The formation of isomers help to explain the large number of compounds that contain carbon chains or rings.

2a) Draw a Lewis dot structure for each isomer of C_4H_{10}.

b) Draw a structural diagram for each isomer.

3) As you might expect, alkanes containing larger number of carbon atoms also have larger numbers of isomers. In fact, the number of different isomers increases rapidly as the number of carbon atoms increases. For example, chemists have identified three pentane (C_5H_{12}) isomers. Their structural diagrams are shown in Table 2. Are other isomers of pentane possible?

4) Now consider possible isomers of C_6H_{14}.
a) Draw structural diagrams for as many different C_6H_{14} isomers as possible. Compare your structures with those drawn by other groups.
b) How many different C_6H_{14} isomers were found by your group? How many by your class?

5a) Build models of some of your C_6H_{14} isomers.
b) Compare your three-dimensional models built with corresponding structures drawn on paper. Based on your examination of the three-dimensional models, how many different C_6H_{14} isomers are possible?

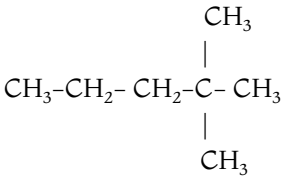
Part 2: Boiling Point of Alkane Isomers.

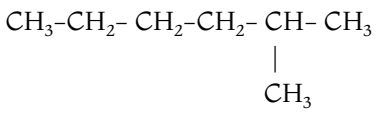
You have already observed that boiling points of straight-chain alkanes are related to the number of carbon atoms in their molecules. Now consider the boiling points of some isomers.

1) Boiling points of two sets of isomers are listed in Table 2. Within a given set, how does the boiling point change as the extent of carbon-chain branching increases?

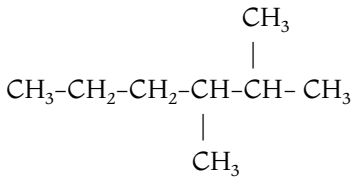
2) Assign each of the boiling points to the appropriate C_7H_{16} isomer: 98.4 °C, 92.0 °C, 79.2 °C.

a) CH_3–CH_2– CH_2–CH_2–CH_2– CH_2– CH_3

b)


c)


3) Here is the structural diagram of a C_8H_{18} isomer:

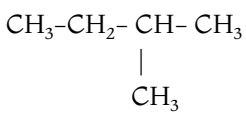
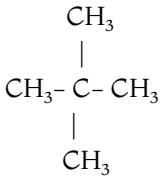
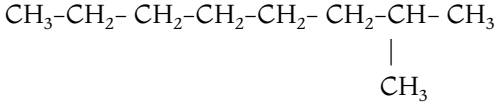
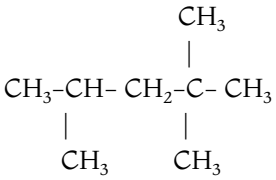


a) Compare it to each C_8H_{18} isomer in Table 2. Predict whether is has a higher or lower boiling point than each of the other C_8H_{18} isomers.
b) Would the C_8H_{18} isomer shown here have a higher or lower boiling point than each of the three C_5H_{12} isomers shown in Table 2?

4) How do you explain the boiling point trends that you observed in this activity?

Conclusion:

Table 2: Alkane Isomers

Alkane	Structural Diagram	Boiling Point (°C)
C_5H_{12} isomers	$CH_3–CH_2–CH_2–CH_2–CH_3$	36.1
		27.8
		9.5
Some C_8H_{18} isomers	$CH_3–CH_2–CH_2–CH_2–CH_2–CH_2–CH_2–CH_3$	125.6
		117.7
		99.2