MINISTRY OF EDUCATION

SECONDARY ENGAGEMENT PROGRAMME

GRADE 10

CHEMISTRY

WEEK 3 **LESSON 1**

Topic: Hydrocarbons

Sub-topic: Isomers of Alkanes

Objective: Given the steps and examples of constructing isomers of branched alkanes, students will draw structures of branched alkane members correctly.

Content

Alkanes can form branched-chain chemical compounds. The branching of these structures is called Isomerism. Isomerism is a chemical process by which a compound is transformed into any of its isomeric forms. It is important to note that when naming these compounds, the structures must be drawn out (Structural formula).

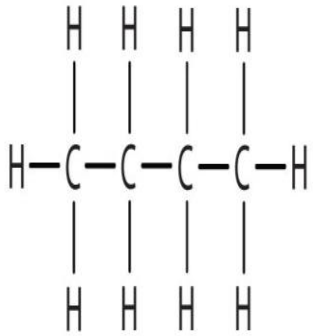
Steps in Naming Alkanes

Alkane molecules can have branched chains and recognize compounds that are isomers.

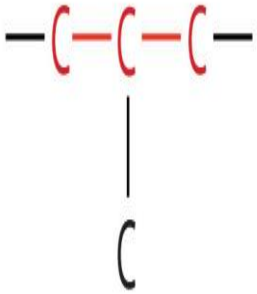
We can write the structure of butane (C_4H_{10}) by stringing four carbon atoms in a row,

–C–C–C–C–

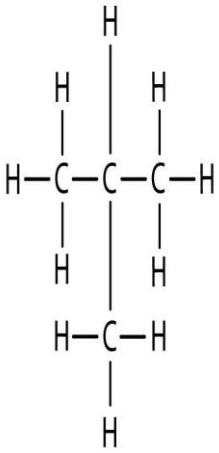
and then add enough hydrogen atoms to give each carbon atom four bonds:



The compound butane has this structure, but there is another way to put 4 carbon atoms and 10 hydrogen atoms together. Place 3 of the carbon atoms in a row and then branch the fourth one off the middle carbon atom:

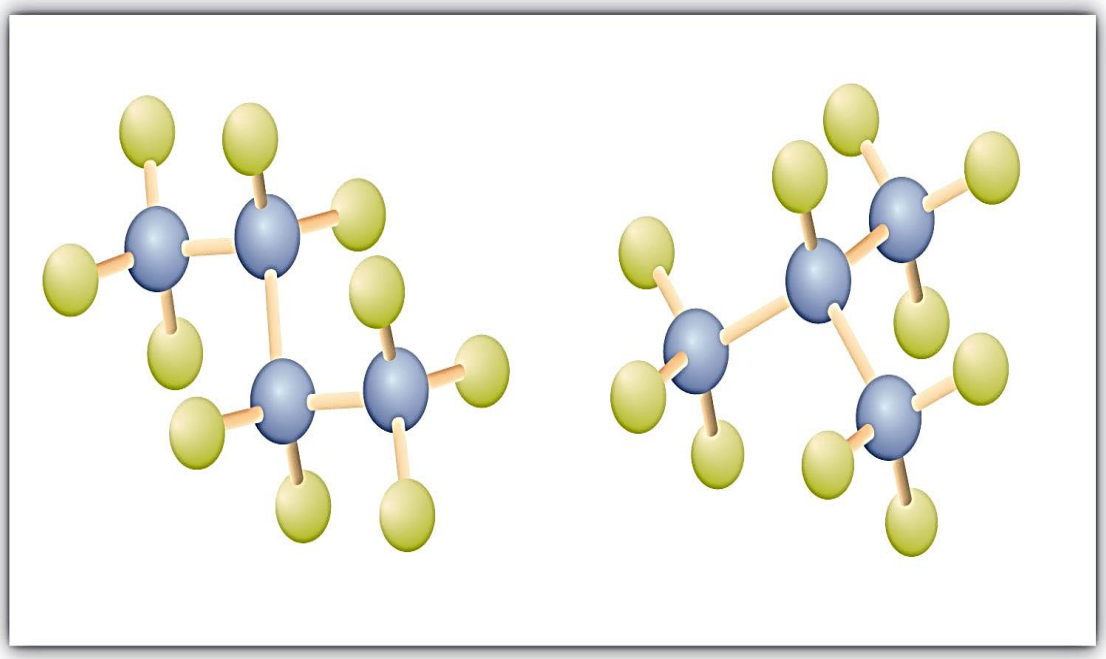


Now we add enough hydrogen atoms to give each carbon four bonds.



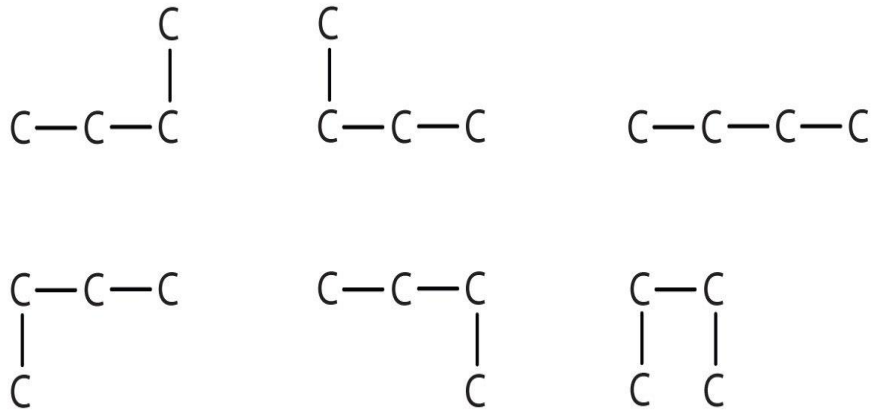
There is a hydrocarbon that corresponds to this structure, which means that two different compounds have the same molecular formula: C_4H_{10}. The two compounds have different properties—for example, one boils at −0.5°C; the other at −11.7°C. Different compounds having the same molecular formula are called **isomers**. The compound with this branched-chain is called *isobutane*.

Figure 12.4 Butane and Isobutane



The ball-and-stick models of these two compounds show them to be isomers; both have the molecular formula C_4H_{10}.

Notice that C_4H_{10} is depicted with a bent chain in Figure 12.4 "Butane and Isobutane". The four-carbon chain may be bent in various ways because the groups can rotate freely about the C–C bonds. However, this rotation does not change the identity of the compound. It is important to realize that bending a chain does *not* change the identity of the compound; all of the structures below represent the same compound:



The formula of isobutane shows a continuous chain of three carbon atoms only, with the fourth attached as a branch off the middle carbon atom of the continuous chain.

Unlike C_4H_{10}, the compounds methane (CH_4), ethane (C_2H_6), and propane (C_3H_8) do not exist in isomeric forms because there is only one way to arrange the atoms in each formula so that each carbon atom has four bonds (see table below).

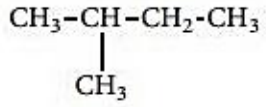
IUPAC Name	Molecular Formula	Condensed Structural formula
Methane	CH_4	CH_4
Ethane	C_2H_6	CH_3-CH_3
Propane	C_3H_8	CH_3-CH_2-CH_3

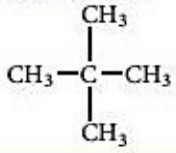
Next beyond C_4H_{10} in the homologous series is pentane. Each compound has the same molecular formula: C_5H_{12}. The compound at the far left is pentane because it has all five carbon atoms in a continuous chain. The compound in the middle is isopentane; like isobutane, it has a -CH_3- - branch off the second carbon atom of the continuous chain. The compound at the far right, discovered after the other two, was named neopentane (from the Greek *neos*, meaning “new”). Although all three have the same molecular formula, they have different properties, including boiling points: pentane, 36.1°C; isopentane, 27.7°C; and neopentane, 9.5°C.

Isomers of Pentane

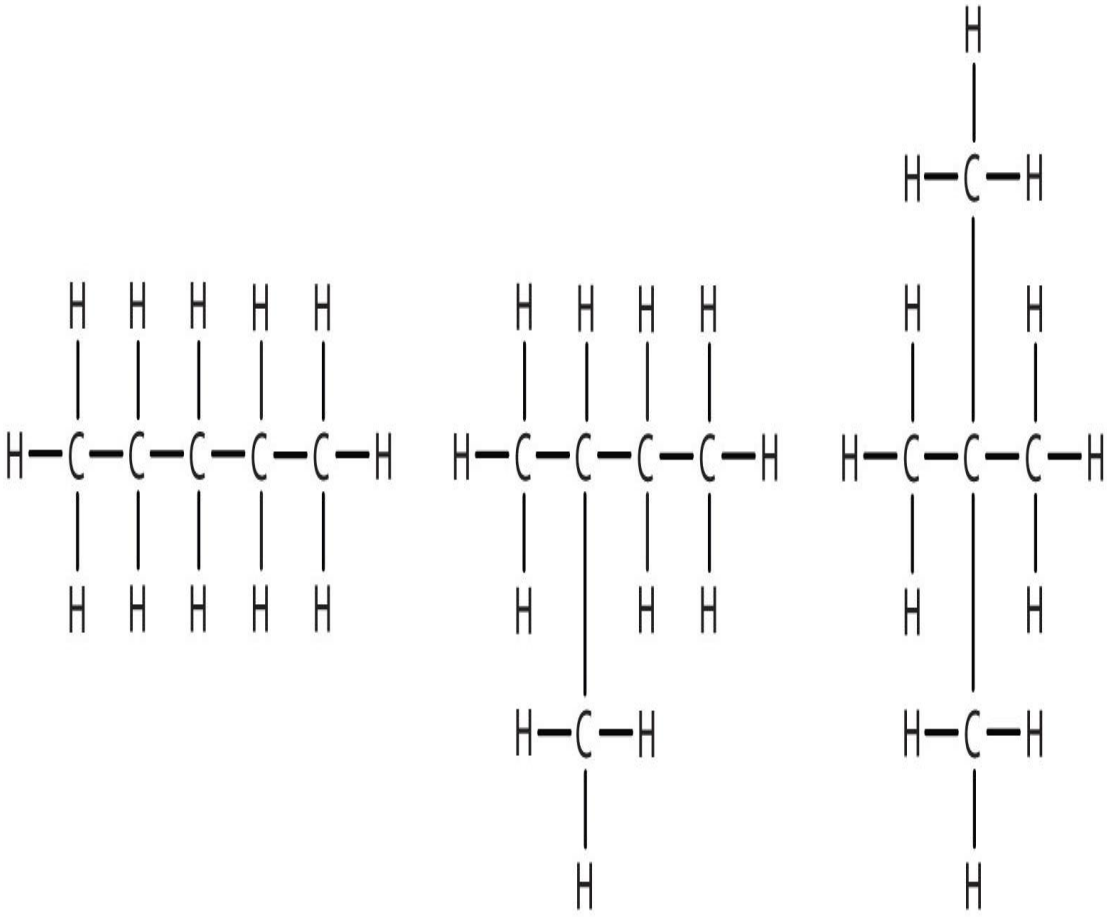
Fill in all the hydrogen atoms so that each carbon forms four bonds

$CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_3$





Condensed Structure



Pentane Isopentane Neopentane

Full Structural Diagram

A continuous (unbranched) chain of carbon atoms is often called a *straight-chain* even though the tetrahedral arrangement about each carbon gives it a zigzag shape. Straight-chain alkanes are sometimes called *normal alkanes*, and their names are given the prefix *n*-. For example, butane is called *n*-butane. We will not use that prefix here because it is not a part of the system established by the International Union of Pure and Applied Chemistry (IUPAC).

References

1. https://www.brainkart.com/article/Nomenclature-and-isomerism-of-Alkanes_36488/
2. http://padakshep.org/otp/subjects/chemistry/organic-chemistry/alkanes-nomenclature/