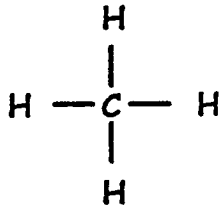
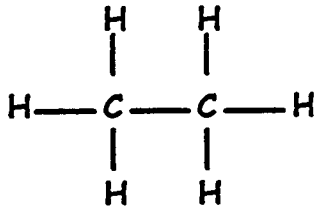
Teaching Activity: Naming and Creating Hydrocarbons

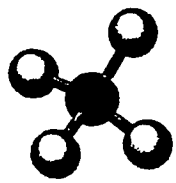
Introduction: Fossil fuels are made up of complex chemical compounds called *hydrocarbons.* Hydrocarbons are the simplest organic compounds and contain only hydrogen and carbon. Each carbon atom has four bonds, and each hydrogen atom forms only one bond, so the simplest hydrocarbon compound that is possible is CH_4, which is called *methane.* It is the main component of natural gas and has the structure:

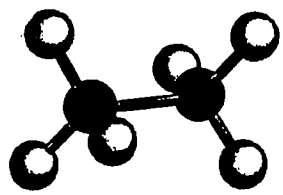


Methane is the first member of a group of related compounds called *alkanes*, which are hydrocarbons that contain only single bonds. The next member of the series is *ethane* (C_2H_6):

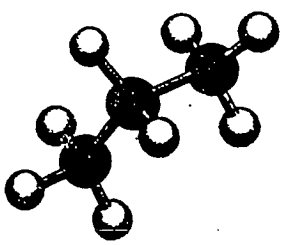


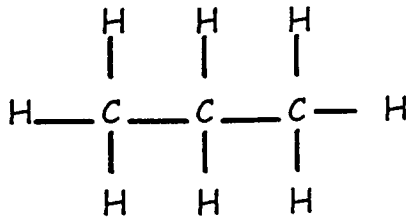
The methane molecule is tetrahedral and the ethane molecule is also three-dimensional. The drawings below are ball-and -stick models of these molecules and show the bond angles very clearly. Ordinarily, simple *structural formulas* like the ones shown above for methane and ethane are used, since they are much easier to draw. These formulas show you which atoms are bonded to each other, but they do not attempt to show the actual shapes of the molecules.





The 3-carbon alkane is *propane.* A model of propane is shown below as well as its structural formula.





A pattern should now be apparent: alkanes of any length can be built simply by tacking carbon atoms together in long chains and adding sufficient hydrogen atoms to give each of the carbon atoms a total of four bonds. Even the naming of these compounds follows a pattern. For compounds of five carbon atoms or more, each stem or root is derived from the Greek or Latin name for the number of carbon atoms in the molecule. The compounds names end in -ane, signifying that the compounds are alkanes. The table below gives the names for continuous-chain alkanes up to 10 carbon atoms in length. An infinite number of alkanes can be made simply by lengthening the chain- 100 or 1000 or 1 million.

Prefix	Number of Carbon Atoms
Meth-	1
Eth-	2
Prop-	3
But-	4
Pent-	5
Hex-	6
Hept-	7
Oct-	8
Non-	9
Dec-	10

Objective:

To identify hydrocarbon molecules by the number of carbon atoms;
To create structural formulas for 10 hydrocarbon molecules;

Important Terms: Carbon, hydrogen, hydrocarbon, alkane, bond, compound, structural formula, organic;

Materials: Copy of **Student Activity Sheet**, colored pencils, ruler, blank paper, pencil/pen;

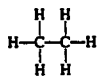
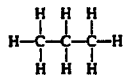
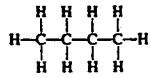
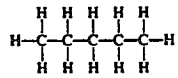
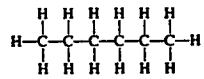
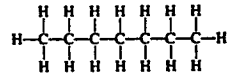
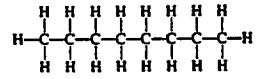
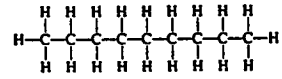
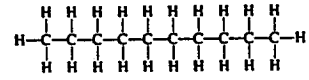
Procedure:

1. Direct students to the chart of alkane prefixes in their **Introduction** and the structural formula of alkanes in Part I of their activity sheet.
   - Instruct students to refer to this chart and name the alkanes shown in **Part I** of the activity sheet.
   - Students should write the chemical formula for each illustration along with the name of the compound.

2. Direct students to **Part II** of their activity sheet
   - Instruct them to draw 10 equal sections on a piece of blank paper.
   - In each section of the paper they will draw the structural diagram for each of the chemical formulas listed.
   - Students should follow the example given and be sure to include the name of the alkane and the chemical formula along with the drawing.

3. When they are done with **Parts I and II**, they should go on to answer the questions in the **Analysis** section.

NOTES: Structural Formulas for the First 10 Continuous-Chain Alkanes

Name	Molecular Formula	Structural Formula
Methane	CH_4	
Ethane	C_2H_6	
Propane	C_3H_8	
Butane	C_4H_{10}	
Pentane	C_5H_{12}	
Hexane	C_6H_{14}	
Heptane	C_7H_{16}	
Octane	C_8H_{18}	
Nonane	C_9H_{20}	
Decane	$C_{10}H_{22}$	

Student Activity Sheet: Naming and Creating Hydrocarbons

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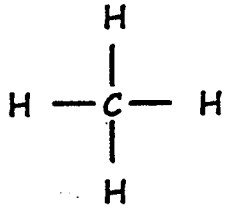

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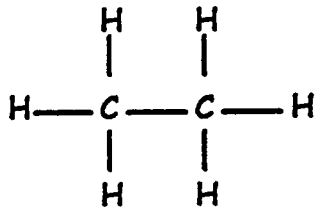

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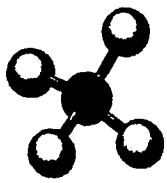

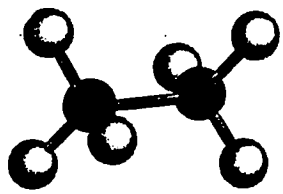

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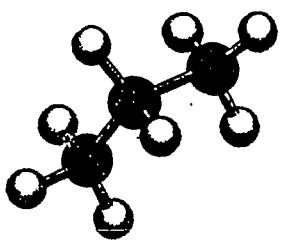

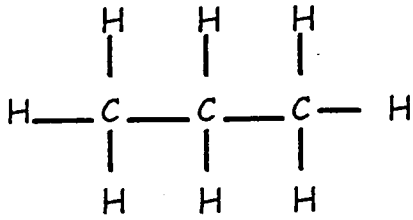

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Objective:

To identify hydrocarbon molecules by the number of carbon atoms;
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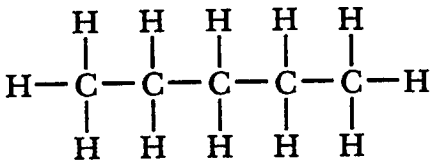
Procedure:

1. Carefully study the chart of alkane prefixes in the **Introduction**.
   - Refer to this chart and name the alkanes shown in **Part I** of your activity sheet.
   - Write the name of the alkane and the chemical formula on the lines provided.
2. Go to **Part II** of your activity sheet.
   - Draw 10 equal sections on a piece of blank paper.
   - In each section draw the structural diagram for one of the alkanes listed.
   - Follow the example given and be sure to include the name of the alkane and the chemical formula along with the drawing.
3. Answer the questions in the **Analysis** section.

Student Activity Sheet #1 : Naming and Creating Hydrocarbons

Part I: Naming Hydrocarbons - Name the hydrocarbons shown below. Write than name and chemical formula on the lines provided.

1. 

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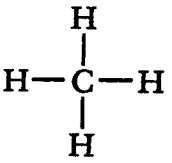
2. 

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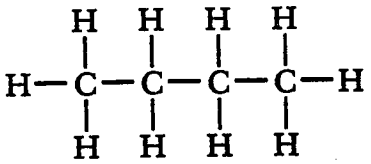
3. 

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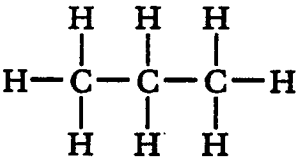
4. 

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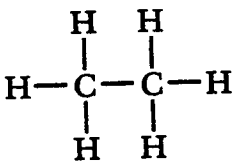
5. 

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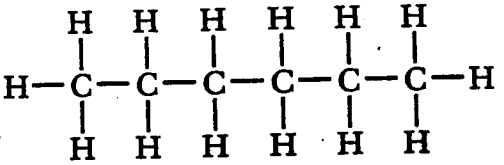
6. 

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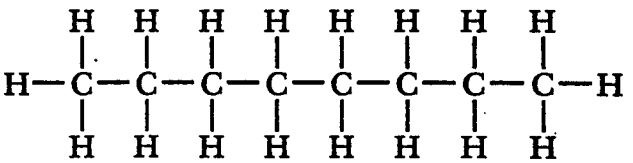
7. 

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Student Activity Sheet #2

Part II: Creating Hydrocarbons

Example: Carbon dioxide

CO_2 

1. CH_4
2. C_2H_6
3. C_3H_8
4. C_4H_{10}
5. C_5H_{12}
6. C_6H_{14}
7. C_7H_{16}
8. C_8H_{18}
9. C_9H_{20}
10. $C_{10}H_{22}$

Part III: Analysis

1. Which is the simplest alkane compound? _____

2. Which atom in an alkane is capable of forming 4 bonds? _____

3. Which atom can only form 1 bond? _____

4. As you proceed down the list of the first ten continuous- chain alkanes, what happens to the number of carbon atoms in each compound?

   _____

5. Referring to the same list as in #4, what happens to the number of hydrogen atoms in each compound? _____

   _____

6. Write the correct number for each prefix.

Dec-_____	Meth- _____
Hex- _____	Hept- _____
But- _____	Pent- _____
Oct- _____	Eth-_____
Prop-_____	Non - _____

Student Activity Sheet #3

Part III: Analysis

7. What energy source is composed of hydrocarbon compounds?

_____

8. What are the only 2 elements found in hydrocarbon compounds"

_____

9. What is an alkane? _____

10. What shape does a methane molecule have? _____

11. What is the advantage of a ball-and- stick model over a structural formula?

_____

12. Why are structural formulas used more than ball-and -stick diagrams?

_____

13. What pattern appears when going down the list alkanes? _____

_____

14. Is there a limit to how big an alkane can become? _____

15. Where do the stem or root words for the names of alkanes come from?

_____

16. Write the names of 2 alkanes that are used commercially and how.

_____

18. The word *octane* refers to the anti-knock potential of gasoline. The hilgher the octane, the less engine "knock" will occur. Why would a gasoline rated at 92 octane be better for a car than one with an 85 rating?

_____

_____

_____

_____