# Molecule Kit Activity: Discovering organic isomers!

Name _____ Date _____

In today's activity, we are going to learn about organic isomers by building their structures to model their appearance. An **isomer** is defined as each of two or more compounds that have the same molecular formula but a different chemical structure, or arrangement of atoms.

1. Begin by obtaining 6 carbon atoms (black), 14 hydrogen atoms (yellow), 14 short pegs, 5 long pegs, and 2 springs. The colored balls are your atoms while the pegs and springs represent bonds. The long pegs will only be used to connect one carbon atom to another carbon. The short pegs will be used to connect the hydrogen atoms to the carbon atoms.
2. Now connect 3 carbon atoms in a row.
   Note: When connecting the atoms, they will NOT connect in a straight line. They connect in a zigzag pattern to best represent the real angles that are formed.
3. Connect hydrogen atoms to the remaining holes in the carbon atoms.
4. This molecule is propane. Draw its structure and write its molecular formula:
   Note: When drawing, label parts of the drawing using "C" to represent carbon atoms, "H" to represent hydrogen atoms, and lines for bonds.

   Are there any other ways you can arrange this molecule and still use all of the atoms and bonds? If so, how many different structures? _____
   Draw how each structure would be arranged and write its corresponding molecular formula:

5. Now remove 1 hydrogen from the end of the molecule and connect a $4^{th}$ carbon to the chain.
6. Fill all of the open bonds holes with hydrogens.
7. This molecule is butane. Draw its structure and write its molecular formula:

   Are there any other ways you can arrange this molecule and still use all of the atoms and bonds? If so, how many different structures? _____
   Draw how each structure would be arranged and write its corresponding molecular formula:

8. Disconnect the 4th carbon from the chain. Remove 1 hydrogen from the 2nd carbon and connect the disconnected carbon in its place.
9. Now make sure all empty bond holes are filled with hydrogen atoms.
   Draw the structure you just created and write its molecular formula:

   Does this structure match your prediction?

   Is the molecular formula of this structure the same or different from the original structure? Why?

   What is the relationship between these two structures?

10. For the next molecule, connect 5 carbons in a chain.
11. Fill in all open bond holes with hydrogen.
12. This molecule is pentane. Draw its structure and write its molecular formula:

    Are there any other ways you can arrange this molecule and still use all of the atoms and bonds? If so, how many different structures? _____
    Draw how the structure would be arranged and write its corresponding molecular formula:

13. Now connect 6 carbon atoms in a chain.
14. Fill in all of the open bond holes with hydrogen atoms.
15. This molecule is hexane. Draw its structure and write its molecular formula:

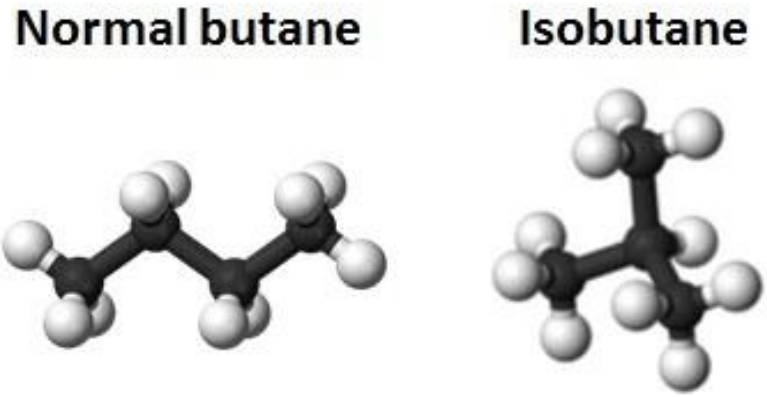
    Are there any other ways you can arrange this molecule and still use all of the atoms and bonds? If so, how many different structures? _____
    Draw how the structure would be arranged and write its corresponding molecular formula:

16. Now assemble the original hexane isomer as a zigzag chain of 6 carbon atoms. Remove the first carbon-carbon single bond peg and 1 hydrogen from each of the 2 carbons.
17. Reconnect the 2 carbon atoms using 2 springs to represent a double bond.
18. This molecule is hexene. Draw its structure and write its molecular formula:

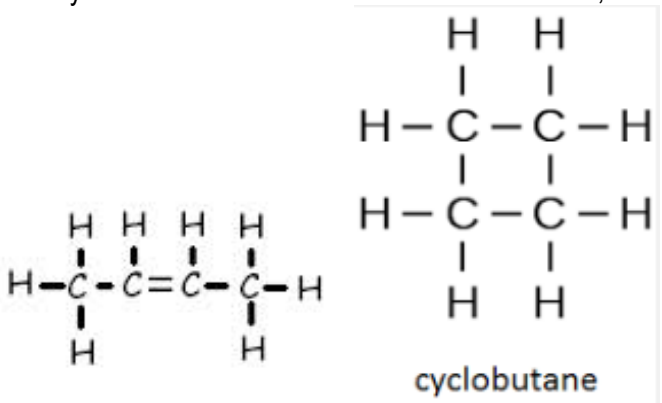
    Are there any other ways you can arrange this molecule and still use all of the atoms and bonds? If so, how many different structures? _____
    Draw how the structure would be arranged and write its corresponding molecular formula:
    HINT: You may need to move the double bond to different locations within the structure.

19. There is an additional relationship between isomers. Some molecules are chain isomers, while others are skeletal isomers. The chain isomers are two acyclic molecules while the skeletal isomers are one acyclic isomer and one cyclic isomer.

n-butane and isobutane are chain isomers of each other; both $C_4H_{10}$




butene and cyclobutane are skeletal isomers of each other; both $C_4H_8$




Build the butene molecule using 4 carbons in a chain. You will need to use 2 springs in between the 2nd and 3rd carbons to represent the double bond. Fill in all remaining bond holes with hydrogen atoms.
Write the molecular formula and sketch the model:

Now build the cyclobutane using 4 carbons linked in a square with springs for the single bonds instead of pegs. Fill in all remaining bond holes with hydrogen atoms.
Write the molecular formula and sketch the model:

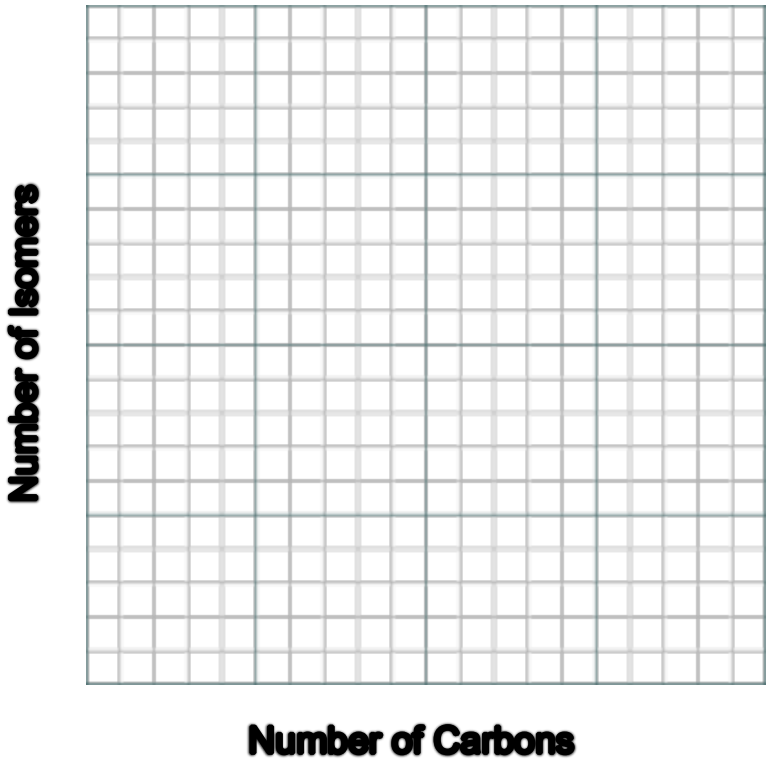
Follow up questions:

1. Using 1-2 sentences, explain what an isomer is using **your own words**.

2. Fill in the following table with the number of possible isomers for the number of carbons in a molecule:

| **Number of Carbons** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|
| **Number of Isomers** | | | | |

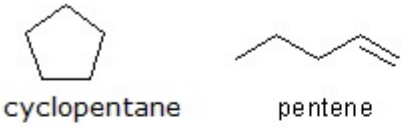
Graph the trend:

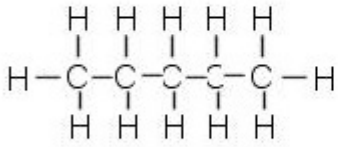


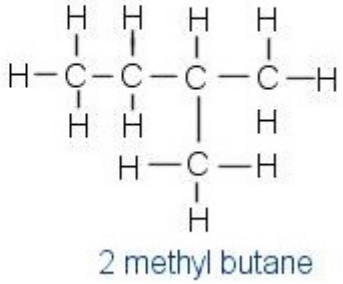

3. What did you notice about the relationship between the number of carbon atoms in a molecule and the possible isomers of that molecule? Is there are pattern or trend?

4. How does this relationship affect the number of possible isomers for a molecule?

5. Identify which molecule are isomers and what kind of isomer they are (chain or skeletal). Put circles around the chain isomers and squares around the skeletal isomers.




6. Create your own molecule and an isomer of that molecule. Include its molecular formula and a sketch of the molecule you built.