Lesson #11: Hydrocarbon Models

Stage 1 – Desired Results

Established Goals: SLO D1: Use the concepts of similarity and diversity for organizing our experiences with the world

Understandings:	Essential Questions:
Students will understand that… 1. The length of the carbon chain informs us about the nature of the physical properties of the compound (melting and boiling point) 2.	What is the basic chemistry of hydrocarbons and how do we TAKE them from earth and MAKE products out of them? **SLO D1:** How can we use the concepts of similarity and diversity for organizing our experiences with the world?
Students will know… 1. Melting and boiling point is a characteristic physical property that depends on the length of the carbon chain. 2. Melting and boiling points of hydrocarbons increase more rapidly with chains of lengths of 1 C to 8 C 3. How to interpret a graph	Students will be able to… 1. Name, draw and construct structural models of the first 10 alkanes *(C11-5-05)* alkenes (C11-5-09), alkynes (C11-5-12) 2. Compare and contrast the molecular structures of alkanes,. *Include: trends in melting points and boiling points of alkanes only.* 3. Transfer numerical representation of data in the table to graphical representation using graph paper or graphing technology 4. Transfer graphical representation of structural formula to macroscopic representation (ie constructed model) 5. **SLO C5:** Work cooperatively with others and value their ideas and contributions

Stage 2- Assessment Evidence

Knowledge: 1. Assess ability to interpret graphs using a different property that also increases with length of C chain (or use an unrelated context like the value of a car as it ages- a negative slope)	**Skills:** 1. Assess "Physical Properties of Hydrocarbons" Graphing Activity using Checklist of Graphing Skills (SYSTH, 2.16) 2. Assess questions #5 (to see if they determined the pattern) and #6 (to see if they have an understanding of the slope of the line as a rate of change) from Physical Properties of Hydrocarbons"

Materials Required

Organic Chemistry Sets (ideally one per student)
HANDOUT: Organic Chemistry Sets
HANDOUT: Alkanes **(Source: Physical Science 301)**
HANDOUT: "Physical Properties of Hydrocarbons" Graphing Activity **(Source: Manitoba Education, Citizenship & Youth. (2006). Grade 11 Chemistry: A Foundation for Implementation. (p.15, 16, 17): Manitoba.)**
Graph paper (or graphing technology)

Stage 3 – Learning Plan

1. Handout: Organic Chemistry Sets. Guide students as they familiarize themselves with how the organic chemistry sets can (and should) be used.
2. Handout: Alkanes
3. Utilize organic chemistry model kits to build models of organic compounds. Begin with the alkanes so that the graphing activity can complement the activity more closely. Students will likely use the structural formula to guide them but a discussion of the molecular formula is useful as well.
4. Introduce double and triple bonds using springs and guide students as they construct the first 10 alkenes/alkynes. Stress differences in single-double-triple bonds in naming the hydrocarbons

5. GUIDE students to complete HANDOUT: "Physical Properties of Hydrocarbons" Graphing Activity using graph paper or graphing technology **(Source: Manitoba Education, Citizenship & Youth. (2006). Grade 11 Chemistry: A Foundation for Implementation. (p.15, 16, 17): Manitoba.)**
Extension Learning Activities

ORGANIC CHEMISTRY SETS

PREPARING THE ORGANIC CHEMISTRY SET

Since YOU are responsible for the contents of your organic chemistry set, you need to take inventory of what you have and learn how to use it properly so that you are not liable for any damaged/missing parts.

FIRTLY, the sets are for learning. They are NOT to be treated as toys. Stick to the plan that is set out in each lab. If you work with the set properly, or be responsible for its contents, or leave it stored NEATLY in its ORIGINAL place, you will simply have to draw the structural formulas instead of using the organic chemistry set.

For your ORGANIC CHEMISTRY set, verify that you have the correct number of atoms of the correct color as indicated.

If you do not have enough of one particular color of atom , write this on the "sticky note" in the following way EX: NEED 2 hydrogen (yellow)

If you have extra atoms of a particular element, write this on the sticky note as well in the following way:
EX: EXTRA 1 carbon (black)

INVESTIGATING the ORGANIC CHEMISTRY SET

Read the rest of the handout and answer the following questions about the organic chemistry set. HAND THESE IN FOR LAB MARKS ON A SEPARATE SHEET. These must be clearly labelled and written in complete sentences.

1. Wooden pegs 2 inches long can represent at least 2 different types of bonds. Name them.

2. Wooden pegs 1 inch long represent at least 2 different types of bonds. Name them.

3. In terms of what bonds they represent, what is the difference between wooden pegs 2 inches and wooden pegs 1 inch long (besides 1 inch, of course) ? (Hint – find out what univalent means)

4. Helical springs 2 inches long represent 2 different bonds. What are they?

5. How are the atoms held together n the models you will make?

6. What is important to remember when fastening the helical spring connectors?

7. Which direction is the direction which will “compress the spring”? (ie clockwise or counterclockwise?)
Explain why.

8. How were the colors for the atoms chosen, you ask? There is some significance to each color.
a) Why is the carbon black? Which form of carbon is black?
b) Why is chlorine yellow?
c) Why is bromine orange?
d) Why is iodine purple?
e)Why is potassium purple?

9. What direction of turn do you use when REMOVING the spring-from the atom? Why? (2 marks)

11. How were the colors for the atoms chosen, you ask? There is some significanceto each color. (6 marks)
a) Why is the carbon black? Which form of carbon is black?
b) Why is chlorine yellow?
c) Why is bromine orange?
d) Why is iodine purple?
e)Why is potassium purple?

12. What is a monovalent element? What is a bivalent atom? (2 marks)

13. On the back of the Organic Structure Sheet, you will see several different structural models. For example, the first 2 models show 2 ISOMERS of butane. (4 marks)
a) Do these two models of butane contain the same number of carbon atoms?
b) Do these two models of butane contain the same number of hydrogen atoms?
c) Do these two models of butane have the same molecular formula?
d) Do these two models of butane have the same structural formula?

14. Research the word isomer using the glossary of the text. (1 mark)

Other Optional Questions that were originally created to accompany a text I used for the course
(Dorin, H., Demmin, P. & Gabel, D. (1989). Chemistry: A Study of Matter (3rd ed.). USA: Prentice Hall Inc.)

15. Use the index of your text and turn to the appropriate pages to answer the following questions.(10 marks)
a) Name 2 other isomers that we encountered in Chapter 7.(l mark) How are they similar? (1 mark). How are they different? (1 mark)
b) Which of the two models on the Organic Chemistry Set Sheet is 1moi as butane?(I mark)
Whichone is isobutáne? (1 mark)
c) Butane is a gas used as lighter fluid. Do you think that isobutane has exactly the sane properties as butane? (1 mark) Why or why not? (1 mark) -
d) Are there any other possible arrangements for 4 carbon atoms and 10 hydrogen atoms? (Keep in mind that each carbon atom requires 4 electrons to fill its valence energy level and hydrogen atoms require 1 electron to fill their valence energy level.)(l mark)
e) How many different isomers of the compound C15 H32 are there? (1 mark) Why are there so many? (1 mark)
14. Think carefully. Does this organic chemistry set involve COVALENT bonding or IONIC bonding? Explain why you think so. (2 marts)

KEY

1. C-C or C-N or other bonds
2. C-H or C-Cl or other univalent linkages
3. The 2-inch pegs join atoms with valences higher than 1. The 1-inch pegs join atoms with a valence of 1.
4. multiple (double, triple) bonds OR ring structures.
5. friction
6. turn the atom with a motion which will compress the spring.
7. clockwise
8. a) graphite is black, so is soot
b) it is a pale yellowish-greenish gas
c) when mixed with carbon tetrachloride it is orange.
d) when mixed with carbon tetrachloride, it is purple.
e) Potassium permanganate is purple.

Handout - Alkanes

(Source: Physical Science 301, a course offered by Manitoba Education, Citizenship & Youth. No longer in print)
This page contained a chart with basic information related to the alkane family in three columns – name, molecular formula, and structural formula

Similar information can be obtained from any basic organic chemistry website

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Physical Properties of Hydrocarbons

Graphing Activity

(Source: Manitoba Education, Citizenship & Youth. (2006). Grade 11 Chemistry: A Foundation for Implementation. (p.15, 16): Manitoba.)

A scientists measured the melting point (MP) and boiling point (BP) of some of the alkanes. Here is the data she collected.

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(Source: Manitoba Education, Citizenship & Youth. (2006). Grade 11 Chemistry: A Foundation for Implementation. (p.15, 16, 17): Manitoba.)

Recall that melting point marks the change of the substance from solid to liquid phase. She thought it was very neat that all of the alkanes she studied change from solid to liquid at REALLY LOW temperatures (Brrrrrr)! Also, some boiled (changed from liquid into vapour) at temperatures below zero (ie negative!) Others, like pentane would be boiling on a hot summer day!

1. How do you think these melting and boiling points are measured? (what instruments and under what conditions would these be measured?)

2. What patterns do you notice when you look at the melting points of the hydrocarbons? Boiling points?

Physical Properties of Hydrocarbons (cont'd)
Graphing Activity

3. The scientist knew that hydrocarbons are made of chains of carbon atoms bonded to one another and to hydrogen by covalent bonds. She wanted to check whether there was a relationship between the number of carbon atoms that bond together to make the chains of each hydrocarbon and the melting and boiling points. She recorded the following data:

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(Source: Manitoba Education, Citizenship & Youth. (2006). Grade 11 Chemistry: A Foundation for Implementation. (p.15, 16, 17): Manitoba.)

Graph (using graph paper or graphing technology) the melting and boiling points of these hydrocarbons. You will be evaluated using the Checklist of Graphing Skills attached so be sure to check to be sure that you have all the criteria on that checklist.

Physical Properties of Hydrocarbons (cont'd)
Graphing Activity

4. Analyze your results:
   a) The melting point _____as the number of
   increases, decreases, stays the same

   carbons in the chain of the hydrocarbon increases.

   b) The boiling point _____as the number of
   increases, decreases, stays the same

   carbons in the chain of the hydrocarbon increases.

   c) Does the melting point increase by a predictable amount each time?

   d) Does the boiling point increase by a predictable amount each time?

5. Give a statement that describes how the melting and boiling point of hydrocarbons changes as the number of carbons in their chain increases.

6. Do you think this will be true for all hydrocarbons? Why/why not?

Physical Properties of Hydrocarbons –Answers
Graphing Activity

(Source: Manitoba Education, Citizenship & Youth. (2006). Grade 11 Chemistry: A Foundation for Implementation. (p. 16): Manitoba.)