Lesson #12: Hydrocarbon Families from the Fractionation Tower

Stage 1 – Desired Results

Established Goals: SLO D1: Use the concepts of similarity and diversity for organizing our experiences with the world
SLO A5: Describe disciplinary processes used to enable us to investigate and understand natural phenomena and develop technological solutions

Understandings:	Essential Questions:
Students will understand that…. 1. Identify the origins and major sources of hydrocarbons and other organic compounds. *(C11-5-02)*	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. Identify the origins and major sources of hydrocarbons and other organic compounds. *(C11-5-02)* 2. Name, draw and construct structural models of the first 10 alkanes *(C11-5-05)* alkenes (C11-5-09), alkynes (C11-5-12)	Students will be able to… 1. Establish patterns that lead to systematic nature of organic nomenclature 2. **SLO C5:** Work co-operatively with others and value their ideas and contributions

Stage 2- Assessment Evidence

Knowledge:	**Skills:**
1. Provide students with drawings of structural formulae of first 10 alkanes and students must give name (alternately provide name and students must draw) 2. Quiz on facts about fractional distillation and uses of alkanes	1. Assess the students ability to derive patterns within their hydrocarbon family 2. Assess ability to transfer the patterns into generalized rules for naming hydrocarbons

Materials Required

Educator Reading: Teacher notes for websites for more info **(Source: Manitoba Education, Citizenship & Youth. (2006). Grade 11 Chemistry: A Foundation for Implementation. (Topic 5, page 18-21): Manitoba.**
Fractional Distillation "tower" models
Each teacher was provided with a hanging "shoe rack" intended for hanging in closets. Each "layer" of the shoe rack represented a different condensation tray of the fractionation tower. The cards (or the structural models built by the students in Lesson #11 were inserted into the appropriate "layer" of the shoe rack according to boiling point.
Cards – alkanes, alkenes, alkynes (add more if desired) (or the actual models that students built in Lesson #11)
Samples of anthracite coal
Handout: Fractional Distillation **(Source: Physical Science 301, correspondence course, no longer in print)**
Handout: Patterns in Your "Family" of Hydrocarbons
Handout: IUPAC Rules for Nomenclature **(Source: Manitoba Education, Citizenship & Youth. (2006). Grade 11 Chemistry: A Foundation for Implementation. (Topic 5, page 20): Manitoba.**
Organic Chemistry sets

Stage 3 – Learning Plan

1. **Slide 32** – Discuss categories for hydrocarbons.
2. Handout – Fractional Distillation
3. HIGHLIGHT aspects of fractional distillation. Focus on the concept of breaking apart the words to show the meaning of the word

*physical separation of crude oil into fractions
*process of distillation (boiling point is a characteristic property, ie unique to each hydrocarbon "set") Analogize to students families, with each member perhaps having

something in common and still keeping their own unique characteristics
4. Demonstrate coal, crude oil (if available) to show the variation
5. DEMONSTRATE using the organic chemistry sets and how we show abstract compounds using concrete models
6. Form student groups
7. Demonstrate fractional distillation "tower". Release appropriate set of cards from appropriate "condensation tray" according to "boiling point", asking individual students to "catch" the set of cards. Emphasize what the compounds would actually be like in real life (ie some would be gases, some would be solids). Explain that each "set" of hydrocarbons would look, smell, feel similar.
8. **Handout:** Patterns in Your "Family" of Hydrocarbons
Students assemble into their groups and try to deduce the pattern on how to name their "class" of hydrocarbon. Ensure students understand that there is a structural formula, a molecular formula and a "name".
9. Students summarize their pattern for naming and present the pattern to other groups.
10. Summarize on chart paper/board as a large or small group
-the prefixes that are common to all hydrocarbon names
-the suffixes for each of the hydrocarbon classes
-the common aspects (all contain carbon and hydrogen)
11. Refer students to list of alkanes such that the pattern can be seen visually. Prepare numbered steps "How to Name Alkanes", "How to Name Alkenes", "How to Name Alkynes" **OR** use the handout: IUPAC Rules for Nomenclature **(Source: Manitoba Education, Citizenship & Youth. (2006). Grade 11 Chemistry: A Foundation for Implementation. (Topic 5, page 20): Manitoba.**
12. INTRODUCE branched alkanes/alkenes/alkynes if desired (extensions related to chemistry are listed below)

Extension Learning Activities

Chemistry teachers extend this topic to include

Name, draw and construct structural models of branched alkanes *(C11-5-06)*

Name, draw and construct structural models of isomers for alkanes up to six-carbon atoms. Include condensed structural formula *(C11-5-07)*

Outline the transformation of alkanes to alkenes and vice versa. Include hydrogenation/dehydrogenation, molecular models. *(C11-5-08)*

Name, draw and construct structural models of alkenes and branched alkenes. Include: six-carbon parent chain, methyl ethyl substituent chains, IUPAC nomenclature, structural formulas, condensed structural formulas, molecular formulas, general formula C_nH_{2n} *(C11-5-09)*

Differentiate between saturated and unsaturated hydrocarbons *(C11-5-10)*

Outline the transformation of alkenes to alkynes and vice versa. Include hydrogenation/dehydrogenation, molecular models. *(C11-5-11)*

Name, draw and construct structural models of alkynes and branched alkynes. Include: six-carbon parent chain, methyl ethyl substituent chains, IUPAC nomenclature, structural formulas, condensed structural formulas, molecular formulas, general formulas C_nH_{2n-2} *(C11-5-12)*

Compare and contrast the structure of aromatic and aliphatic hydrocarbons. Include

condensed structural formulas, molecular formulas *(C11-5-13)*
Describe uses of aromatic compounds. Examples: polychlorinated biphenyls, caffeine, steroids, organic solvents (toluene, xylene) *(C11-5-14)*
At this point there are many other investigations that could be undertaken especially in relation to Biology. See your nearest Bio teacher to discuss these connections!

Write condensed structural formulas for and name common alcohols *(C11-5-15)*
Describe the use of methyl,ethyl and isopropyl alcohols *(C11-5-16)*
At this point there are many other investigations that could be undertaken especially in relation to Biology. See your nearest Bio teacher to discuss these connections!

Write condensed structural formulas for and name organic acids. Include maximum of six-carbon parent chain, IUPAC nomenclature *(C-11-5-17)*
Describe the uses or functions of common organic acids Examples: acetic acid, ascorbic, citric, formic, acetylsalicylic (ASA), lactic *(C11-5-18)*
At this point there are many other investigations that could be undertaken especially in relation to Biology/PhysEd. See your nearest teacher to discuss these connections!

Perform a lab involving the formation of esters, and examine the process of esterification *(C11-5-19)*
Write condensed structural formulas for and name esters Include: up to 6-C alcohols and 6-C organic acids, IUPAC nomenclature *(C11-5-20)*
Describe the uses of common esters. Examples: pheremones, artificial flavorings *(C11-5-21)*
At this point there are many other investigations that could be undertaken especially in relation to Foods. See your nearest teacher to discuss this connection!

Handout – Fractional Distillation

(Source: Physical Science 301, a course offered by Manitoba Education, Citizenship & Youth. No longer in print)
This page contained a graphic of the distillation tower with the specific names of hydrocarbons that would condense out from the various condensation trays.

Similar graphics can be obtained from any basic organic chemistry website.

For example, the website http://www.schoolscience.co.uk/
More specifically from that site,

http://resources.schoolscience.co.uk/SPE/knowl/4/2index.htm?distilling.html

http://resources.schoolscience.co.uk/SPE/knowl/4/2index.htm?distilling.html

Copyright not obtained

Teacher notes – Websites for more info

(Source: Manitoba Education, Citizenship & Youth. (2006). Grade 11 Chemistry: A Foundation for Implementation. (Topic 5, page 19): Manitoba.

IUPAC Rules for Nomenclature (Alkanes)

Source: Manitoba Education, Citizenship & Youth. (2006). Grade 11 Chemistry: A Foundation for Implementation. (Topic 5, page 20): Manitoba.

Patterns in Your "Family" of Hydrocarbons

Materials needed: Organic Chemistry set

A set of cards for your hydrocarbon "family".

Your group will receive a set of cards from wherever in the fractionation tower your "family" of hydrocarbons condenses. Each "family" of hydrocarbons that come from a fractionation tower has

*similar physical properties
*similar chemical properties
*similar types of bonds (single, double, triple)
*similar patterns in how they are "built" (structural formula)

Directions:

1. You need to try to decide on a "pattern" to describe how your "family" of hydrocarbons is named. The first step is to construct the model for each hydrocarbon in your "family" of hydrocarbons using the organic chemistry set. Each member of your group will construct one or two hydrocarbons from your hydrocarbon "family".

2. Now join with the other members of your "family". Compare the name and model of each hydrocarbon in your group's hydrocarbon "family". Look for the following patterns:

Name of hydrocarbon "family":	
Look for patterns in:	**Pattern we discovered**
*number of carbons	
*single, double or triple bonds	
*number of hydrogens	
*similar endings (suffixes) of the names of your set of hydrocarbons	

3. Be able to describe how to name your "set" of hydrocarbons to others. Create a numbered list to help with this.