

Sources of Energy

References:

- Zumdahl, Chemistry- 5th edition, Houghton Mifflin Company, Boston MA, 2000. (pages 267-269)
Davis, Metcalf, Williams, Castka, Modern Chemistry, Hoit, Rinehart & Winston, Austin TX, 1999. (pages 643-645)
Shakhashiri, Chemical Demonstrations: A Handbook for Teachers of Chemistry, The University of Wisconsin Press, Madison WI, 1985. (~5.12, pages 48-50)

State Standards Addressed

Chemistry J. Organic and Biochemistry - the bonding characteristics of carbon lead to many different molecules with varied sizes' shapes, and chemical properties, providing the biochemical basis of life. As a basis for understanding this concept, students will know:

1. the bonding characteristics of carbon lead to a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.
2. the system for naming the ten simplest linear hydrocarbons and isomers containing single bonds, simple hydrocarbons with double and triple bonds, and simple molecules containing a benzene ring.

Materials:

pen & paper for note taking
overhead projector w/ screen
Samples of Crude Oil in water and chunks of coal
transparency masters
 Figure 20-13 Diagram of Fractional Distillation Process
 Table 6.4 Uses of Various Petroleum Fractions
 Table 20-6 Petroleum Fractions
 Table 20-5 Properties of Straight Chain Alkenes
Velcro Strips of varying lengths Ball & Stick models of butane & 2-methylpropane
Chemistry Lab equipment for determining the molecular mass of the gas from a butane lighter

Procedure

1 - Draw a picture of the sun and a plant on the board. Ask students to explain, in simple terms, the process of photosynthesis. Pass around the room the samples of coal and crude oil. Ask the students to explain how these materials were formed.

2 - Explain to student that photosynthesis is the process by which plants convert sunlight into complex biological molecules which can then be used by humans for obtaining energy. The biological material can be burned directly to obtain energy or the material can be buried and decay over a long period of time to form fossil fuels (coal, petroleum, natural gas) which can then be burned to obtain energy.

3 - Define Petroleum = thick, dark liquid composed of hydrocarbons (5-25 carbons in chains). formed from the remains of marine organisms approx. 500 million yrs ago. Extremely valuable natural resource ("Black Gold").

4 - open a gas valve and light a bunsen burner. Explain that natural gas is always associated with petroleum deposits and that it is a combination of methane, ethane, propane and butane.

5 - Show the transparency of the fractional distillation process. Explain that petroleum is separated into fractions by boiling (the refining process). Explain that because fractions contain hydrocarbons of different masses, they condense and are drawn off at different levels.

6 - Show the transparency of Table 6.4 (Uses of Various Petroleum Fractions) and ask the students to give examples of common petroleum products that they use in everyday life.

7 - Show the transparency of Table 20-6 (Petroleum Fractions) and ask the students "Why are the boiling points different for the different fractions?"

8 - Show the transparency of Table 20-5 (Properties of Straight Chained Alkenes). Point out that not only do the boiling points increase as the length of the molecules increase, but also that the phase changes from gas to liquid to solid as the molecules increase in length: longer molecules = greater mass = higher boiling point. Ask students to explain this phenomenon. Why is it harder (more energy required) to boil molecules that are longer?

9 - The melting and boiling points of a substance depend on the amount of attraction that holds molecules together. Use two Velcro strips to model the attraction between two molecules. The longer the strips, the stronger the attraction. Also, two pairs of strips of the same length will have the same attraction, unless the individual strips of one pair are rolled up. Similarly, the attraction between 2-methylpropane molecules is much less than the attraction between butane molecules. As a result, more energy is required to separate butane molecules from one another during melting and boiling. Use Molecular models of these molecules to show a long straight chain holds more tightly together than branched molecules, even though they have the same mass.

Summation

Have the student read the text and rewrite their notes for tomorrow's quiz. Prior to the quiz let students ask questions and volunteer summary statements about the material covered.

Evaluation

Quiz questions

1) What is catenation? How does catenation contribute to the diversity of organic compounds?

2) What trend occurs in the boiling points of alkanes? How would you explain this trend? How the trend in alkane boiling points used in petroleum fractional distillation?

3) How does the structure of alkanes affect the octane rating of gasoline?

Extended paper. Discuss the benefits and disadvantages of using fossil fuels like coal and petroleum for our energy needs. Present information on an alternative source of energy.

Laboratory Exercise

Determination of the Molecular Mass of the Gas from a Butane Lighter.