Objectives for Chapter 4 – Alkanes

I. Introduction to Alkanes

1. Give a definition of alkanes, and explain how they differ from other organic compounds.

Straight-chain alkanes

- 1. List the names of the straight-chain alkanes from 1 to 10 carbons.
- 2. Give the formula for determining a straight-chain alkane and explain where it comes from.
- 3. Explain what a branched alkane is.
- 4. Give a definition of constitutional isomers.
- 5. Determine whether two structures are constitutional isomers, the same compound, or not isomers.
- 6. Draw all constitutional isomers for a given molecular formula.

Cyclic alkanes

1. List the names for the cycloalkane from 1 to 8 carbons, and draw them correctly.

2. Give the formula for determining a cycloalkane and explain why is it different from the straightchain and branched alkanes.

3. Draw all constitutional isomers for a given molecular formula.

Bicyclic alkanes

1. Explain the difference between a compound with more than one ring, and a bicyclic compound.

2. Label bicyclic compounds as spiro, fused, or bridged.

3. Explain how multiple rings affects the molecular formula for a compound.

II. Physical Properties, Sources, and Uses of Alkanes

Physical Properties of Alkanes

1. Explain how the intermolecular force which attracts alkane molecules to each other explains their density, water solubility, and surface tension.

2. Explain how molecular weight and surface area affect the boiling points and melting points of alkanes, and which is the larger affect.

3. Explain why highly rigid and symmetrical molecules can have surprisingly high melting points.

- 4. Predict relative boiling and melting points of two alkanes.
- 5. Predict the state of matter of an alkane at room temperature and atmospheric pressure.

Sources of alkanes

- 1. State where alkanes come from.
- 2. List some of the products of petroleum distillation, and how they are useful to us.

3. Explain how the properties of petroleum products change as the temperature and pressure of the distillation increases.

Uses of Alkanes

1. Give the most common use of alkanes, and explain how this can create problems.

2. Give other uses of alkanes.

IR Spectroscopy

1. List the 2 bands found in alkanes, including their frequencies.

2. Distinguish alkane spectra from spectra of other functional groups.

III. Reactions of Alkanes

1. Explain why alkanes only undergo a few reactions.

2. List the three common reactions of alkanes, match them up with examples, and explain why aren't generally useful in the lab; explain what they are good for.

3. Explain what can happen if combustion occurs without sufficient heat or oxygen.

IV. Nomenclature of Alkanes

1. Explain who created the rules for naming organic compounds, and what the purpose behind those rules is.

2. List the 3 main steps in naming an alkane.

- 3. Explain how to choose the principle chain or ring for an alkane.
- 4. Explain how to number the principle chain or ring of an alkane.

5. Explain how to assemble names for alkanes.

6. Explain how to name alkyl substituents, including straight-chain substituents, cyclic substituents, and branched substituents.

7. Give correct names for alkane compounds using the systematic rules.

8. Draw correct structures for alkanes if given the name of the compound, including names containing common names for substituents.

IV. Conformations of Straight-chain and Branched Alkanes

1. Explain 4 ways in which molecules are in motion.

2. Explain what a conformation is.

3. Draw Newmann projections of a molecule looking down a particular bond as it rotates 0 to 360 degrees.

4. Identify staggered and eclipsed conformations, and explain which has more energy, and why.

5. Determine the relative energy of different staggered conformations of a molecule, and different eclipsed conformations.

6. Identify gauche and anti relationships between substituents in various conformations.

7. Draw an energy diagram showing how the molecule changes energy as it rotates around that bond.

V. Stability of Cycloalkanes

1. Explain what heats of formation tell us about the relative energy of the cycloalkanes.

2. Explain how torsional strain and angle strain contribute to high energy of some cycloalkanes, while others are less affected.

3. Explain why cyclohexane is the most common cycloalkane.

VI. Conformations of Cyclohexane

1. Explain the difference between drawing a cyclohexane molecule as a hexagon with wedges and dashes and as a chair conformation.

2. Correctly draw both chair conformations of a cyclohexane molecule, using correct angles for all axial and equatorial substituents.

3. Explain what happens to the location of the carbon atoms and the orientation of the substituents when one chair conformation flips to the other.

4. Convert compounds from the hexagon form to both chair conformations.

5. Analyze both chair conformations and determine which is lower in energy (or if they are equal).