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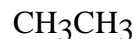
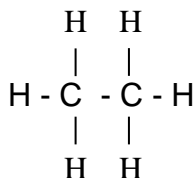
## VISUALIZING ORGANIC REACTIONS THROUGH USE OF MOLECULAR MODELS

## 1) HYDROCARBONS:

## a. Saturated Hydrocarbons:

Construct a model for propane,  $C_3H_8$ , using black balls for carbon atoms and white balls for hydrogen atoms. Write the graphic structural formula, using a single line to represent a shared pair of electrons. Finally, write the condensed structural formula.

Examples for ethane:



Full Structural Formula

Condensed Structural Formula

## PROPANE:

Full Structural Formula

Condensed Structural Formula

The object is to show that structural formulas do not represent the geometry of a molecule and when one speaks of a "straight chain" hydrocarbon one is not referring to a carbon framework with angles of  $180^\circ$ . The principal function of a structural formula is to show which atoms are bonded to which.

## Structural Isomers:

On your propane model, replace one white (hydrogen) ball with an orange one for bromine. You have made a mono-bromopropane isomer. You may have various isomers, depending on which hydrogen you replaced. Draw below the structural formulas for all the mono-bromopropane isomers, and give their IUPAC names.

Replace another hydrogen atom with a bromine atom. Draw structural formulas and give the IUPAC names for all the isomers of dibromopropane ( $C_3H_6Br_2$ ).



2) ALCOHOLS:

- a. What does the "R" in the general formula for alcohols (ROH) represent?

\_\_\_\_\_

- b. What is the functional group in an alcohol?

\_\_\_\_\_

- c. Make a model of 1-propanol. Use a red ball to represent the oxygen atom. When the sample is mildly oxidized, two hydrogens are removed and water is formed. Make the necessary change on your model. Then write an equation for the reaction, using structural formulas.

Give the IUPAC name for the organic compound produced.

\_\_\_\_\_

What is the new functional group formed?

\_\_\_\_\_

Note that one hydrogen was removed from the oxygen atom, the other from the adjacent carbon atom,

- d. What is meant by "secondary" alcohol?

\_\_\_\_\_

Make a model of 2-propanol.

Oxidize this compound. Write an equation for the reaction using structural formulas.

Give the IUPAC names for reactants and products.

What is the new functional group formed?

\_\_\_\_\_

What class of compounds is formed by oxidation of secondary alcohols?

\_\_\_\_\_

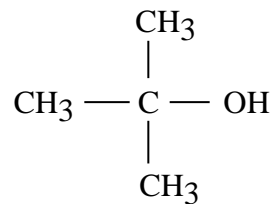
What class of compounds is formed by the mild oxidation of primary alcohols (part c, above)?

\_\_\_\_\_

e. What is meant by "tertiary" alcohol?

\_\_\_\_\_

Make a model of the compound shown at the right.  
What is the IUPAC name of this compound?



\_\_\_\_\_

Oxidize this compound.

What is formed?

\_\_\_\_\_

Why?

\_\_\_\_\_

### 3) ALDEHYDES:

a. Make a model of ethanal.

The organic chemist uses the term "oxidize" to refer to either of two processes:

1. The removal of two hydrogen atoms, with the formation of water (as in 2 a above) OR
2. The addition of an oxygen atom into the molecule.

b. Remove the hydrogen atom from the aldehyde group in your model of ethanal. Put in an oxygen atom (red ball), and then put the hydrogen onto this oxygen.

You have now made an organic acid.

Give the IUPAC name of this acid.

\_\_\_\_\_

Write the equation for the oxidation of ethanal using structural formulas.

What is the name of the "functional group" of an organic acid?

\_\_\_\_\_

Write the "general formula" for an organic acid.

\_\_\_\_\_

4) ORGANIC ACIDS:

- a. Organic acids are neutralized by inorganic bases.

Make models to show the reaction between propanoic acid ( $\text{CH}_3\text{CH}_2\text{COOH}$ ) and NaOH (an inorganic base). Write an equation for the reaction of propanoic acid ( $\text{CH}_3\text{CH}_2\text{COOH}$ ) with NaOH (an inorganic base) using structural formulas. Name the products.

- b. Organic acids also react with alcohols (ROH) which are NOT BASES. They have  $-\text{OH}$ , but it is not ionized. In fact, when an alcohol reacts with an organic acid, the  $-\text{OH}$  comes off the acid, and the  $-\text{H}$  comes off the alcohol.

Make models to show the reaction between ethanoic acid and ethanol. Write the equation for this reaction using structural formulas.

What is the characteristic structure (functional group) of an ester?

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5) ETHERS:

Build models to show the production of an ether from two molecules of ethanol with the loss of  $\text{H}_2\text{O}$ .

Write the equation for this reaction using structural formulas.

- 6) Write structural formulas either graphic or condensed (and give IUPAC names) for all the structural isomers of the alkane  $C_7H_{16}$ . There are nine isomers.