CHEM1002 Worksheet 2: Bonding and Isomerism

Model 1: Naming Organic Compounds
Critical thinking questions

1. You find a bottle in the lab labeled dimethylpentane. This name is ambiguous, so draw (using stick notation) all the possible structures consistent with this name.

2. You should have drawn 4 structures in Q1. Pick one of these and try to give it an unambiguous name.

Convention has it that compounds are numbered from the end nearest the functional group that provides the root of the name (the alkene in 1-butene, the alcohol of 1-butanol). Where there are no such functional groups, numbering of the parent chain starts from the end nearest a branch.

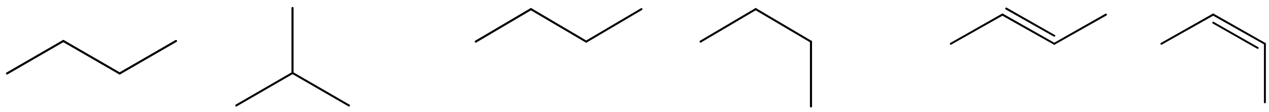
3. Is your answer to Question 2 consistent with this convention? If not, try to name it again.

4. Name the other molecules in your answer to Question 1.

Learning to name organic molecules is a bit like learning a foreign language. There is no substitute for practice!

Model 2: Isomerism

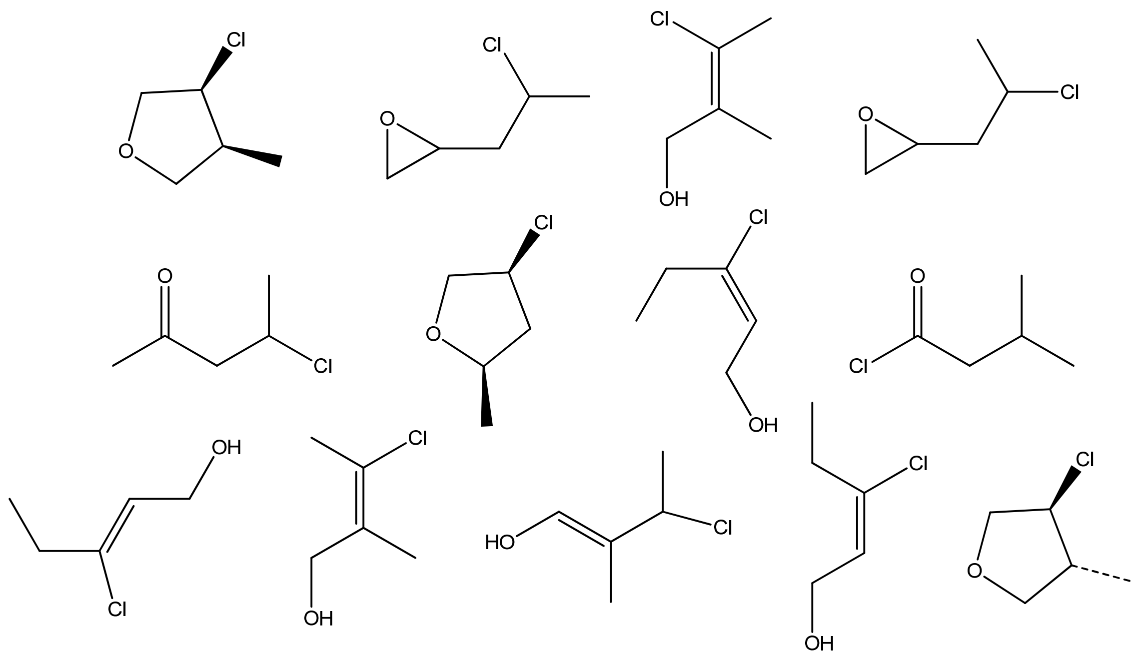
There are three broad classes of isomers.



Constitutional Conformational Configurational

- **Constitutional** isomers have the same formula but different connectivity.
- **Conformational** isomers differ only by rotation about a *single* bond. They interconvert freely at all but extremely low temperatures (ie they are identical).
- **Configurational** isomers (**stereoisomers**) have the same connectivity but cannot be interconverted through single bond rotation. Bond breaking and bond formation are required for interconversion.

Here are some molecules all with the formula C_5H_9ClO



Critical thinking questions

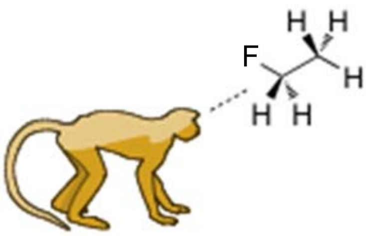
1. With the help from the others in your group, identify and circle at least 7 *constitutional* isomers

2. Identify and *draw* two pairs of conformational isomers

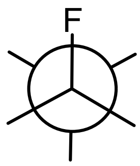
3. Identify and *draw* three pairs of configurational isomers.

4. **Extension:** How many different functional groups can you identify?

To understand conformers, it helps to look at the molecule from different angles. Imagine you (or in this case, a monkey) were looking at fluoroethane along the central C-C bond:



5. Add hydrogens to the template below to show what you (or the monkey) would see.
(The front C is where the 3 lines meet at the centre of the picture; the back C is the circle.)



Use your picture to explain what is meant by the term *staggered conformation*.

6. Can you draw a picture in the same style to show another conformation of fluoroethane, in which the back C has rotated by 60°, so that all the Hs are lined up with each other?

Use this picture to explain what is meant by the term *eclipsed conformation*.

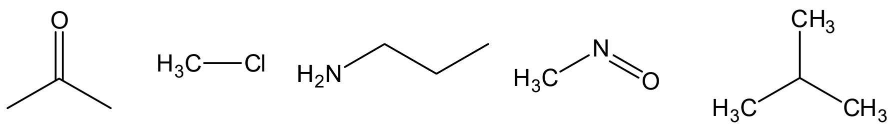
These drawings of molecules obtained by looking along the bonds like this are called *Newman projections*.

Model 3: Polar Reactions

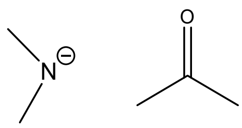
In many covalent bonds, the electrons are not distributed evenly due to differences in the electronegativity of the two atoms involved. We use partial charges (δ^+, δ^-) to denote the resultant polarisation of the bond. C and H have *very* similar electronegativities and so C-H bonds are approximately non-polar.

Critical thinking questions

1. Determine the partial charges on the atoms in the following molecules.



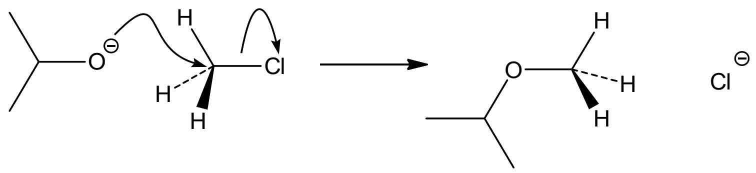
2. We know that there is an attractive force between positively and negatively charged objects. With this in mind, it would seem sensible that the negatively charged nitrogen below would react with the slightly positive carbon of the carbonyl.



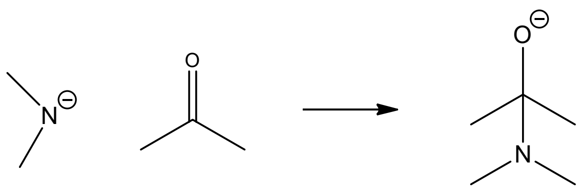
We know from Worksheet 1 that carbon typically forms four bonds. If we form a new bond between the nitrogen and the carbonyl carbon what else needs to happen?

3. Which bond most is likely to break? Why?

Chemists use "curly arrows" to track the movement of electrons in a reaction. Convention has it that the arrow starts at the source of the electrons (a lone pair or a bond) and finishes where the electrons end up (in a bond or as a lone pair on an atom).



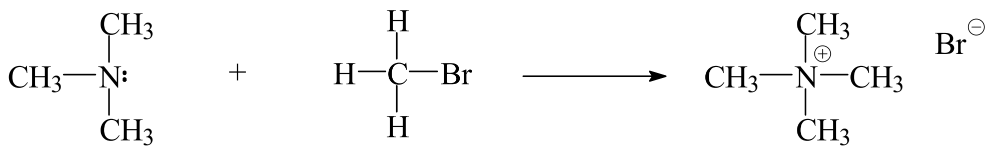
4. Try using curly arrows to describe the movement of electrons in the reaction below.

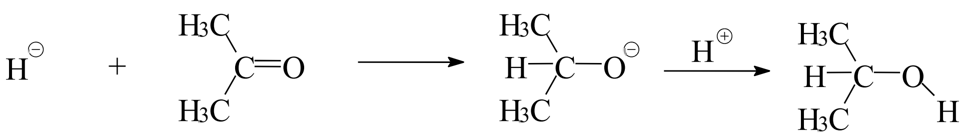


This is an example of a <u>polar reaction</u>, the most common type of reaction in organic chemistry (and the only kind you will see this year). Polar reactions always involve the interaction between an electron rich component (**nucleophile**) and an electron deficient component (**electrophile**).

5. Identify the electrophile and the nucleophile in two reactions above.

6. Draw in appropriate partial charges (δ⊕ and δ⊖) and curly arrows to show the mechanism of the following reactions. Classify the starting materials as nucleophile, electrophile or neither, indicating your choice underneath each reactant.





What is the recipe for success?

Practice **further by completing this week's tutorial homework and suggested exam questions.**