Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

Lab Section: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**CHEM 131 Lab Experiment:**  **Molecular Structure Lab**

**Background**

*In this lab, we explore the chemical possibilities offered by carbon atoms which are the fundamental building blocks in organic and biochemistry.*

**Molecular Construction Kit (Eisco)**

|  |  |  |
| --- | --- | --- |
| **Color** | **Atom** | **Bonds (holes)** |
| Black | Carbon (C) \* | 4 |
| White | Hydrogen (H) | 1 |
| Red | Oxygen (O) | 2 |
| Green | Chlorine (Cl) \*\* | 1 |
| Blue | Nitrogen (N) | 3 |
| Yellow | Sulfur (S) | 4,6 |

*\*There may be* ***black spheres with two holes.*** *Do not use them*

*\*\*Green can be used for other halogen atoms; F, Br and I*

Three types of "sticks" are provided:

* + Stubby one - do not use
  + Short straight - use this for a single bond
  + Long straight - use two of these for a double bond

**Procedure**

**Part I — Look at the molecules listed on the attached sheet**

Construct the six molecules in the Table and verify that the shape and the bond angles are correct (a protractor is attached for your convenience). Enter "check"

The double underlined atom is at the center

|  |  |  |
| --- | --- | --- |
|  | **Shape** | **Bond Angle** |
| CO2 |  |  |
| H2CO (BF3) |  |  |
| NOF (SO2) |  |  |
| CH4 |  |  |
| H2O |  |  |

**Part II- Carbon to carbon bonds**

Project 2

Bonding of carbon and hydrogen. Since carbon has four holes and hydrogen has one, you can construct a molecule, *CH4* (called methane, a major component of natural gas). You already did this in Part I

**Schematic

Description automatically generated with medium confidenceDiagram, schematic, icon

Description automatically generated with medium confidence**

**Methane (project 2) Chloromethane (project 3)**

It is written on paper as a flat object, but in reality, it is a three-dimensional called tetrahedral. The angle formed by *H — C —* H is 109 °

Project 3

Just like hydrogen chlorine has one bond so you can substitute H by *Cl*, you can form CH3Cl, chloromethane.

Even though on a paper, it may appear that there are four places that you can place chlorine, in reality all positions are identical, and you only have one CH3Cl molecule.

Project 4

Now try to replace two hydrogens by two chlorine atoms. Now you form CH2Cl2, dichloromethane

Schematic

Description automatically generated with low confidence

Again, on paper, it appears that you have two different molecules but in reality, you can see there is only one *CH2CI2 .*

Project 5

Carbon—carbon bond

Carbon atoms can bond together. Let's try connecting two carbon atoms

**A picture containing chart

Description automatically generatedA picture containing chart

Description automatically generated**

ethane (Project 5) chloroethane (project 6)

At this point, each carbon has three vacant spaces which will be used to connect hydrogen atoms. Now you formed a molecule called ethane, C2H6 .

Sometimes, it is written as CH3--CH3*.* The former is a molecular formula, while the latter a structural formula.

The bond between two carbons is made of one spring - called **a single bond.**

Project 6

If you substitute one hydrogen, you will form chloroethane, CH3—CH2Cl *.* There is one only compound for this formula.

Project 7

Now if you replace two hydrogens with chlorine, how many different compounds can you form?

**Diagram, schematic

Description automatically generatedDiagram, schematic

Description automatically generated**

The answer is two - compare your model with others. They both have the same molecular formula, C2H4Cl2, but the structural formulas clearly show they are different, *CH2CI — CH2CI* and *CH3 — CHCl2 .* They are called isomers.

Project 8

Carbon-carbon bond

Now try connecting two carbon atoms using two springs, forming **a double bond.** When you fill the vacant spots with hydrogen, you form a molecule *CH2 ——* CH2, ethane.

**A picture containing text, clock, watch, gauge

Description automatically generated**

It is interesting to note that a double bond is rigid and non-rotatable. Also note that this molecule is a flat molecule.

Project 9

Now in CH2 = CH2, replace two hydrogens with chlorines. How many different molecules can be there?

Project 10

One of the most important organic molecules is benzene, C6H6 . Six carbons form a ring with alternating double and single bonds:

Shape

Description automatically generated with medium confidence

**Part III — Function Groups**

Project 11

A quick review is in order? Form water ( H2O), ammonia ( NH3), and methane (CH4). You did this in Part I

Project 12

From each of the above, remove one hydrogen atom. You will be left with a fragment of a molecule with one bond left unused. Compare this to chlorine atom which also has one bond . In chemistry, these are called functional groups and they can replace hydrogen. Function groups will determine the chemical properties of compounds.

Here are some common function groups:

Table

Description automatically generated

Construct CH3OH (methanol) and C2H5OH (ethanol). These belong to a group of alcohol.

Diagram

Description automatically generated

Project 13

Construct CH3NH2 (methylamine) and C2H5NH2 (ethylamine). These belong to a group of amine. The —NH2 end makes these molecules to act as a base, just like ammonia does.

Project 14

What about C2H5COOH (acetic acid)? The -COOH end makes this molecule to act as an acid.

Diagram

Description automatically generated with medium confidence

Project 15 Construct vinyl alcohol

Diagram, schematic

Description automatically generated

Project 16

Vinyl alcohol can be a polymer (you synthesized polymer during the first lab = Silly Putty and Gooey Gel). You can work with your benchmates

Chart, diagram

Description automatically generated

**Diagram

Description automatically generated**

**A picture containing text, receipt

Description automatically generated**