2.2: Alkanes and Alkenes Procedure

Learning Objectives

- Observe the reactions of hydrocarbons with oxygen, bromine, and potassium permanganate.
- Use chemical tests to distinguish alkanes from alkenes.
- Draw the products of combustion, addition and/or substitution reactions of alkanes and alkenes.

Safety

- The organic compounds in the lab should be handled with care. If they are spilled on the skin, flood with water for 15 minutes. They are highly flammable and may cause dizziness if too much is inhaled. Wear gloves when working with this substance.
- $KMnO_4$ can cause skin and eye irritation. It also stains your skin and clothing with direct contact. If $KMnO_4$ is spilled on the skin, flood with water for 15 minutes. Wear gloves when working with this substance.
- Bromine is dangerous and can burn your skin with contact. If bromine is spilled on the skin, flood with water for 15 minutes while using soap. Wear gloves when working with this substance.
- **ALL WASTE FROM THIS LAB MUST GO IN THE WASTE CONTAINER PROVIDED.** Glass can be rinsed after the majority is in the waste container.
- **This experiment must be done in the hood.**

Background:

Alkanes are saturated hydrocarbons, as they only contain single bonds between carbon atoms. The alkenes and alkynes are unsaturated hydrocarbons, containing at least one double or triple bond respectively. The alkenes and alkynes are more reactive than alkanes due to the double or triple bond present. Alkanes are typically inert under normal circumstances. This means that they only participate in reactions that involve other more reactive substances. Most reactions involving alkenes are called addition reactions as they involve the addition of atoms or groups of atoms to the carbons involved in the double bond. This breaks the double bond leaving only a single bond. The reason these bonds are so reactive is that an addition reaction results in a net gain of bonds. Consider the addition of hydrogen to ethene.

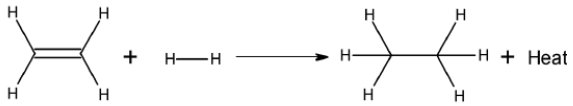

Figure 2.2.1: Reaction of ethene with hydrogen gas results in ethane and heat.

The double bond of the ethane and the single bond between the hydrogens are replaced with 3 new single bonds. Two of the bonds are C-H bonds and one is a C-C bond. This is an exothermic reaction. As energy is released in this reaction the products are more stable than the reactants. This move from a lower stability to higher stability is the reason the reaction occurs. The reaction still needs the proper activation energy to occur.

This lab will have you explore three types of reactions that alkanes and alkenes experience. You will look for the differences or similarities between these types of molecules in these reactions. The three reactions are: Combustion, Halogenation and oxidation.

Definition: Combustion

Combustion is the when a compound burns in the presence of oxygen. The products of this reaction are carbon dioxide and water. Both alkanes and alkenes combust in the presence of oxygen with enough activation energy.

$$CH_4(g) + O_2(g) \rightarrow CO_2(g) + 2\,H_2O(g) \tag{2.2.1}$$

Definition: Halogenation

Halogenation is the addition of a halogen atom(s) to an alkane or alkene with the addition of heat or light. For alkanes one atom of the halogen is added to a carbon of the alkane. For alkenes both atoms are added. One to each of the carbons involved in the double bond. Halogenation of alkenes will be a fairly fast process due to the higher reactivity of alkenes. Halogenation of alkanes will be a **slower** process as alkanes are not as reactive.

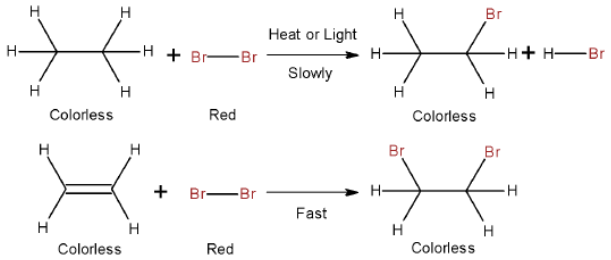

Figure 2.2.2: The reaction of bromine gas with ethane and ethene.

You will be using a bromine test in this lab. When bromine reacts with an alkene, the dark red color of the bromine disappears quickly as the atoms of the bromine bond with the carbon atoms in the double bond. If the red color disappears **rapidly**, we know the compound contains a double bond. If the color disappears **slowly** the compound does not contain a double bond.

Definition: Oxidation

Oxidation is the addition of oxygen atoms to the carbons of an organic compound. The oxidation of an alkene occurs at the carbons of the double bond. As alkanes have no double bonds the reaction does not occur.

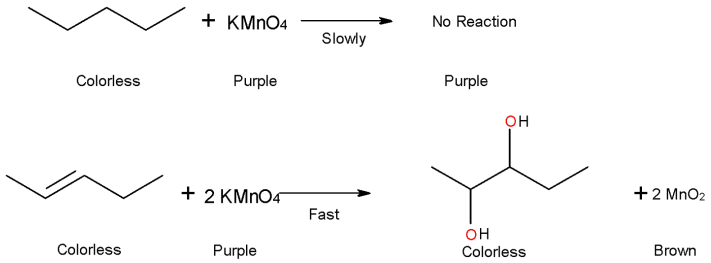

Figure 2.2.3: The reaction of $KMnO_4$ with ethane and ethene.

You will use a potassium permanganate test in this lab. When $KMnO_4$ reacts with alkenes it adds an OH to each carbon of the double bond. This causes a change from $KMnO_4$ which is purple to MnO_2 which is brown. No reaction would be seen with alkanes.

Materials

- 3 evaporation dishes
- Matches
- Pipet pump
- Dropper bottle of unknown
- Test tube rack with 6 test tubes
- Dropper bottle of 1% bromine solution
- Model kit
- Wooden splint
- Dropper bottle of cyclohexane
- Dropper bottle of cyclohexene
- Dropper bottle of 1% $KMnO_4$

Procedure

> **Note**
>
> There are not enough bottles of each reagent for each lab group. You will have to share reagents.

Combustion

1. **Working in the hood**, place 5 drops of cyclohexane in an evaporation dish. Using a lighted splint **carefully** ignite the sample.
2. Record your observations in the data table.
3. Repeat step 1 with 5 drops of cyclohexene
4. Repeat step 1 with one of the unknowns.
5. Rinse the split with water and place in the trash. Clean the evaporation dishes and set them to dry

Halogenation – Bromine Test

1. **Working in the hood**, place 15 drops of each hydrocarbon in a separate dry test tube. Carefully add 3-4 drops of the bromine solution to each. Observe whether the red color disappears immediately or not.
2. Record your observations in the data table.
3. Empty the contents of your test tubes into the waste container. Clean the test tubes in the sink and set them to dry on the rack you found them on.

Oxidation – Potassium Permangnate ($KMnO_4$) Test

1. **Working in the hood**, place 5 drops of each hydrocarbon in a separate test tube. Add 15 drops of 1% KMnO4 solution. Observe whether a change from purple to brown occurs.
2. Record your observations in the data table.
3. Empty the contents of your test tubes into the waste container. Clean the test tubes in the sink and set them to dry on the rack you found them on.

Identification of Unknown ($KMnO_4$) Test

Complete the questions as directed.

Modeling and Naming

Complete the questions and make the models as directed.
