**Structure-Reactivity Relationship: Hydrocarbon Reactivity**

Together, you and your TA are comparing the reactivity of an assortment of hydrocarbons with bromine. Watch the required videos of the experiment when noted. These will help you to determine what you will see when performing the reaction. Experimental details will be provided where necessary. Please use ChemDraw for all of your figures and schemes.

Today, you will be reacting the following hydrocarbons with bromine. Complete the following questions.

1. Why is hydrocarbon reactivity with bromine important? Eg. Why would we want to brominate a hydrocarbon?
2. Research how bromine reacts with the three different functional groups that are present in the following table. For each functional group name the reaction type and draw a general reaction mechanism. For those involving a catalyst, draw the reaction scheme only. Ensure that you indicate if a catalyst, light, heat, or otherwise is required for the reaction.
3. Complete the following table

|  |  |  |  |
| --- | --- | --- | --- |
| **Compound** | **Structure** | **Functional Groups** | **Reaction Type** |
| Cyclohexane |  |  |  |
| Cyclohexene |  |  |  |
| Toluene |  |  |  |
| Ethylbenzene |  |  |  |
| Isopropylbenzene |  |  |  |
| *t*-Butylbenzene |  |  |  |

1. Using the following information, determine the products of the reaction and show the calculation of the limiting reagent for the reaction of bromine with cyclohexane.

 

|  |  |  |
| --- | --- | --- |
| **MW (g/mol)** |  |  |
| **Amount** | 0.5 mL | 1.0 mL |
| **Conc.** | / | 0.5 M |
| **Density (g/mL)** | 0.779 |  |
| **mmol** |  |  |

Limiting Reagent: ­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Why do we limit this specific reagent in the reaction? What does is tell us about what we should SEE during the reaction?

Time for the lab to commence! You have 6 unknown sample vials. You know that the contents of each of the vials corresponds to one of hydrocarbons you outlined above. Assess the following reactions to help you determine which unknown number belongs to which hydrocarbon!

1. A bromine water mixture can be used to help determine whether a compound contains an alkene functional group. A bromine/water mixture is added to the hydrocarbon and shaken. There is NO UV light used for this reaction. Watch the following video and assess your in-lab data from the table below to help you determine which hydrocarbon belongs to each unknown number.

<https://www.youtube.com/watch?v=vBMGNzRYngk>

|  |  |
| --- | --- |
| **Unknown Number** | **Observations** |
| 1 | Colour remained yellow |
| 2 | Colour remained yellow |
| 3 | Colour remained yellow |
| 4 | Colour slowly changed to clear upon shaking |
| 5 | Colour remained yellow |
| 6 | Colour remained yellow |

1. Why does the reaction described above not require UV light to react?
2. To each of your unknown samples (0.5 mL) is added 1.0 mL of liquid bromine in the fumehood. The samples are gently shaken and then exposed to UV-light for a period of time. Watch the following video and assess your in-lab data from the table below to help you determine which hydrocarbon belongs to each unknown number.

<https://www.youtube.com/watch?v=-UZxyJX0gHo>

|  |  |  |
| --- | --- | --- |
| **Unknown Number** | **Observations** | **Time to React (seconds)** |
| 1 | Red colour rapidly changed to clear | 725 |
| 2 | Red colour became slightly lighter, but never became clear | 1310 |
| 3 | Red colour immediately became clear | 1 |
| 4 | Red colour immediately became clear | 1 |
| 5 | Red colour did not change | 1800 |
| 6 | Red colour rapidly changed to clear | 320 |

1. Why does this reaction require exposure to UV-light?
2. Complete the following table assigning each hydrocarbon to an unknown number

|  |  |
| --- | --- |
| **Unknown Number** | **Hydrocarbon** |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |

1. Describe how you assigned each hydrocarbon to an unknown number. Take into consideration the reaction type, the reaction intermediates, what controls the rate of each reaction, and factors affect the stability of various intermediates. A well-rounded discussion will make it clear *chemically* why a reaction order or type is expected for each of the hydrocarbons.