Chemical reactions of alkanes and alkenes

Purpose: 1) to demonstrate that different classes of organic molecules undergo different characteristic reactions, 2) To compare the reactivity of a single bond vs. a double bond.

Safety:

- Cyclohexane, cyclohexene, and bromine are pungent and toxic. Proper ventilation is necessary. Handle these chemicals, as much as possible, directly under the fumehood. Thus, when you need to add chemicals to cyclohexane and cyclohexene leave the test tubes under the fume hood and get the necessary chemical(s) from the front of the room. Return chemicals immediately after use so that other students will not have to look around for them.
- Potassium permanganate can stain clothing and skin.
- If you get any chemicals on your skin, wash with soap and water.
- At the end of the lab all chemicals should be placed in the organic waste container provided.

Prelab: Complete parts 1 and 2 in the chart below.

Procedure:

1. Get a 50 mL beaker. Fill it halfway with distilled water. Get a plastic eyedropper (note: the eyedropper is only to be used for dispensing distilled water).
2. Place 4 small test tubes containing cyclohex**a**ne in a test tube rack. Using tape and a ballpoint pen, label the tubes A1, A2, A3, A4 (the **A** indicates an alk**a**ne is present).
3. Place 4 small test tubes containing cyclohex**e**ne in a test tube rack. Using tape and a ballpoint pen, label the tubes E1, E2, E3, E4 (the **E** indicates an alk**e**ne is present).
4. Place 10 drops of water in A1 and 10 drops of water in E1. Take note of where the water phase is (top vs. bottom) and where the cyclohexene phase is. Stopper and shake each. Record the solubility of the chemicals in water (as soluble or insoluble).
5. Add 10 drops of distilled H_2O to both A2 and E2. Have your instructor add 3 drops of H_2SO_4 (conc.). Stopper and shake. Record your observations in the chart below.
6. Record the colour of bromine water, $Br_2(aq)$. Add 5 drops of $Br_2(aq)$, to A3 and to E3. Stopper and shake (for about 15 seconds). Record the colour of the $Br_2(aq)$ after shaking.
7. Record the colour of the $KMnO_4(aq)$. Add 5 drops of $KMnO_4(aq)$ to A4 and to E4. Stopper and shake. Allow to react for 15 seconds. Record the colour of the $KMnO_4(aq)$ after shaking.
8. Dump all reagents into the organic waste container at the front of the room. Remove the tape from test tubes. Wash test tubes and stoppers well using a test tube brush and the cleaning solution provided. When you are finished there should be no residue in the test tubes (from either the chemicals or the soap). Shake any water out of test tubes. Return all equipment.

	Cyclohex**ane**	Cyclohex**ene**
1. Structural diagram		
2. Polarity (polar or non-polar)		
3. Physical properties	Colourless liquid (b.p. 81°C)	Colourless liquid (b.p. 83°C)
4. Solubility in H_2O		
5. Reaction with H_2SO_4 and H_2O		
6. $Br_2(aq)$ colour before adding		
$Br_2(aq)$ colour after shaking		
7. $KMnO_4(aq)$ before adding		
$KMnO_4(aq)$ after shaking		

Chemical reactions of alkanes and alkenes

Questions:

1. Explain in detail, using terminology from the last unit, why cyclohexane and cyclohexene are soluble or insoluble in water.

2. Based on your observations, which group (alkanes or alkenes) was unreactive. Which was most reactive.

3. Read 8.5 (pg. 283 – 284) up to the diagram of C_2H_2. The double bond in cyclohexene contains which bond(s): sigma (σ), pi (π), both, or neither

4. Read the first paragraph under the subtitle "Some Chemical Properties of Carbon-Carbon Double Bonds" (pg. 1022). Give the two reasons why a pi (π) bond is more reactive (more easily broken) than a sigma (σ) bond.

5. Read the remainder of "Some Chemical Properties of Carbon-Carbon Double Bonds" (pg. 1022-3). The following questions concern the reaction of water, H_2SO_4, and cyclohexene (number 5 in the chart)
   a) What kind of reaction occurred when water, H_2SO_4, and cyclohexene were mixed?
   b) What function did H_2SO_4 serve in the reaction?
   c) Define catalyst.
   d) The reaction of 2-butene is shown. Draw the reaction that would occur for cyclohexene.
   e) Where would this new chemical be found (in the water phase or the cyclohexene phase of the mixture)? Why?
   f) What chemical gave the water phase a white, cloudy appearance after the reaction?

6. The following questions concern #6 in the chart (the reaction of Br_2 with cyclohexene)
   a) What colour is Br_2?
   b) What kind of reaction occurs when Br_2 and cyclohexene are mixed?
   c) The reaction of ethene is shown. Draw the reaction that cyclohexene underwent.
   d) Why did the colour change during the reaction?

7. $KMnO_4$ is known as an "oxidizing agent" because it adds oxygen to other compounds. In this lab, $KMnO_4$ acts as an oxidizing agent by adding oxygen across the double bond of cyclohexene. The mechanism of this reaction is more complicated than the other reactions we have looked at. However, the result is easy to understand: a double bond is broken and an alcohol group is placed on either side of the bond. For example:
   $CH_2{=}CH_2 + KMnO_4 + H_2O \rightarrow HO\text{-}CH_2\text{-}CH_2\text{-}OH + MnO_2 + KOH$ (general, unbalanced reaction).
   a) Draw the reaction for cyclohexene plus $KMnO_4$(aq).