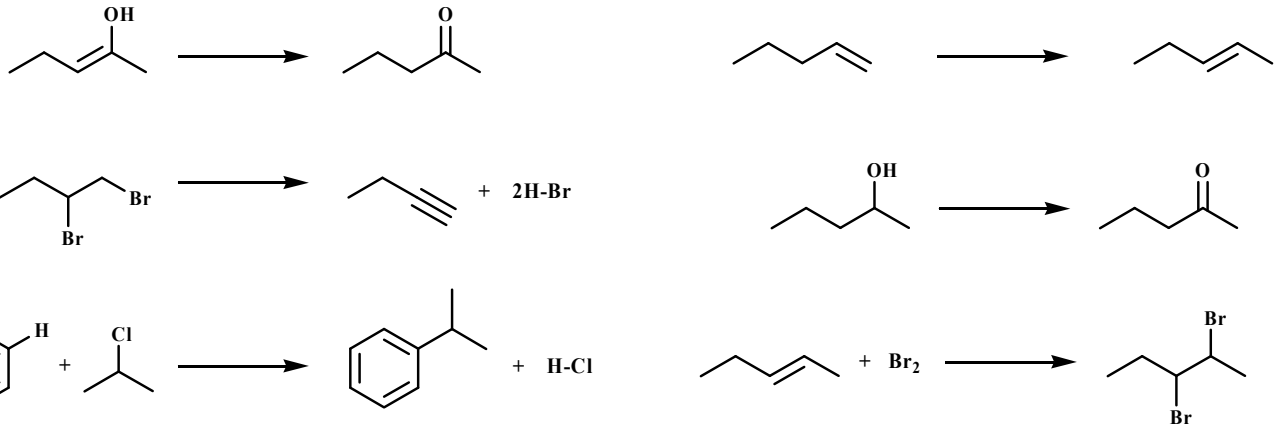
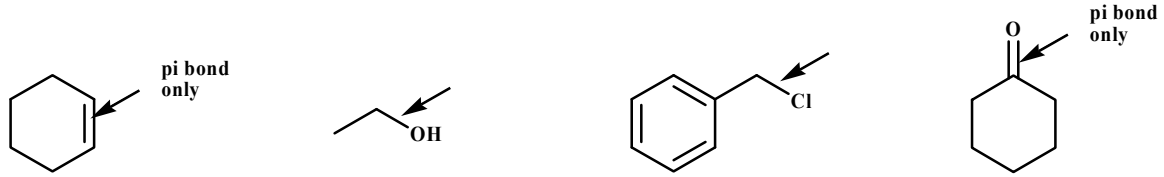
HOMEWORK PROBLEMS: DESCRIBING ORGANIC REACTIONS

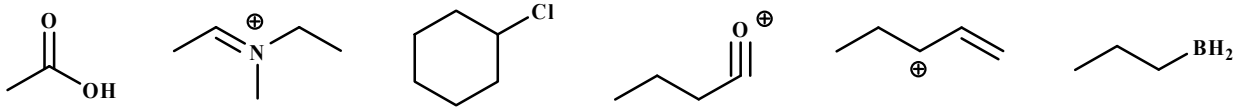
1. Classify the reaction type for each of the following organic reactions:



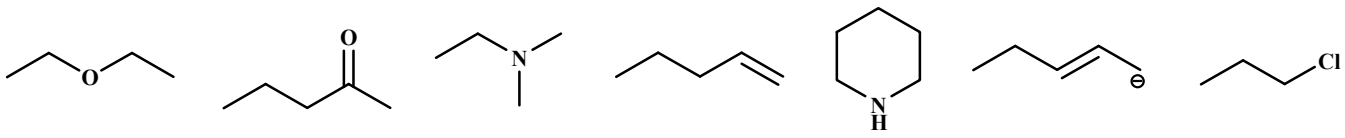
2. Break the indicated bonds in both a homolytic and heterolytic fashion. Use curved arrows to illustrate electron movement and draw the expected products. For heterolytic bond breaking, there are two directions the bond can break. Draw both options and circle which is more likely.



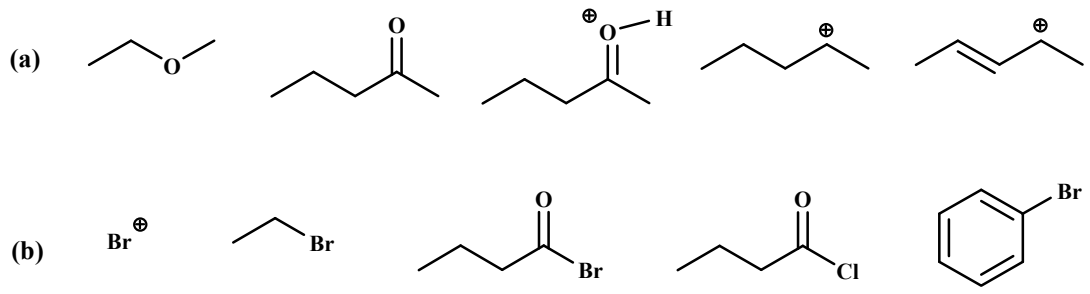
3. Circle all Electrophilic sites in the following compounds.



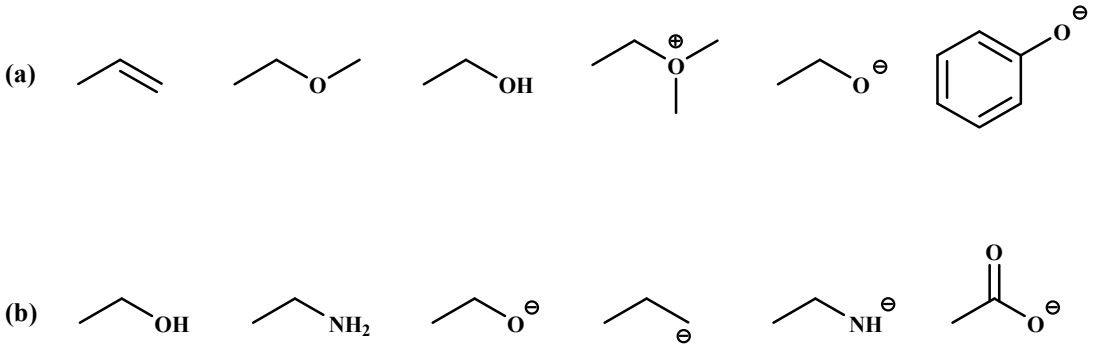
4. Circle all Nucleophilic sites in the following compounds.



5. Rank each series from most reactive (1) to least reactive Electrophiles:



6. Rank each series from most reactive (1) to least reactive Nucleophiles:

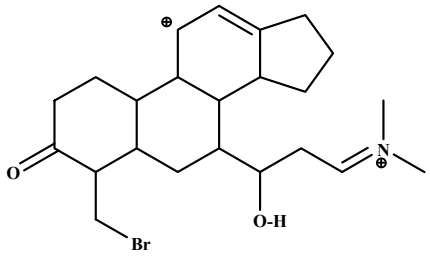


Notes for ranking electrophiles and nucleophiles:

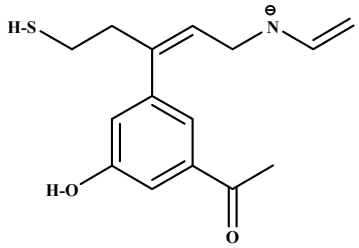
E^+ = less stable + > more stable + > large δ^+ > small δ^+ (also consider sterics)

Nuc - = less stable - > more stable - > less en lone pair > more en lone pair > C=C > (watch sterics)

7. Identify all electrophilic sites in compound A and all nucleophilic sites in compound B. Predict a product if A and B react with each other!

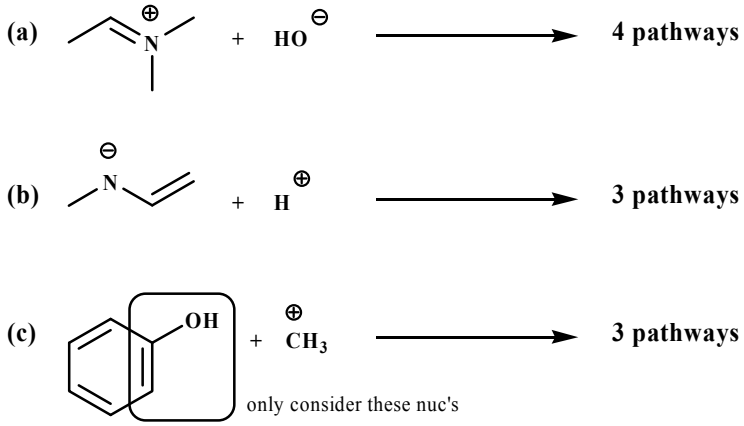


compound A

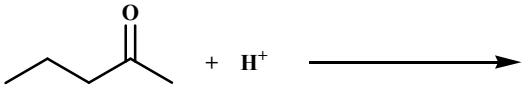


compound B

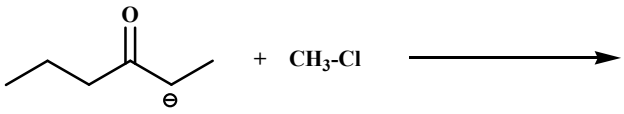
8. For each of the following reactions there are three/four possible pathways for a reaction between a Nucleophile and an Electrophile. Draw all three pathways including curved arrows and structures of products. Then, rank the liklihood of each of the three pathways.



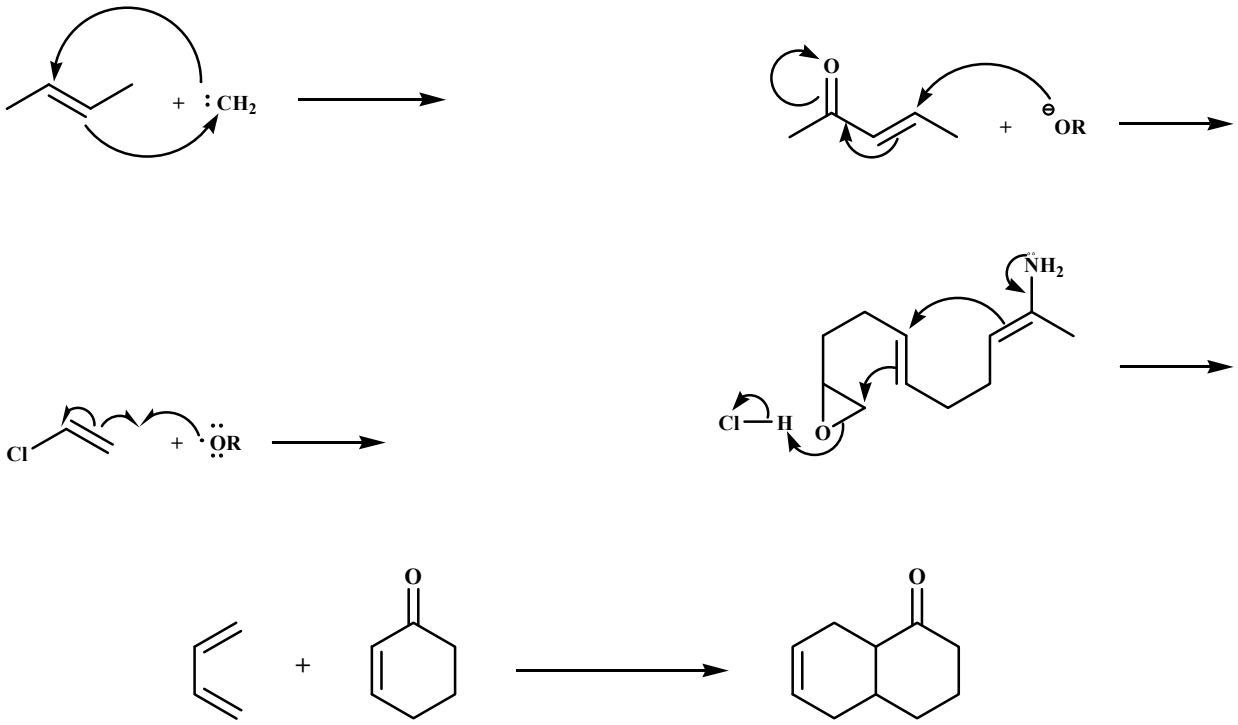
9. For the following reaction between a Lewis acid and base, you can draw the curved arrows in one of two ways, starting from a lone pair or the pi bond. Draw both methods, why does it not matter how you draw it (why are they both correct)?



10. For the following reaction between a Lewis acid and base, two products can be formed. Draw the two products and illustrate with curved arrows how each is formed. Which product do you think is favored? Explain.



11. Predict the products from the following curved arrows, or give curved arrows to explain product:



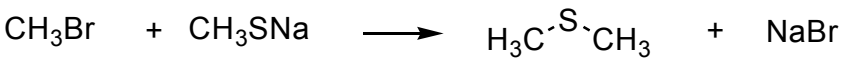
12. Estimate ΔG for the following reactions. What type of reaction is occurring in each step?

Bond energies: C=C 611 kJ/mol; H-Br 366 kJ/mole; C-C 355 kJ/mole; C-Br 274 kJ/mol; C-H 401 kJ/mole; C-OH 380 kJ/mol (note C=C incorrect, but number used in key)

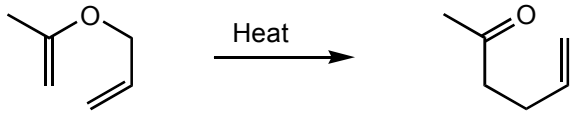
13. Draw a free energy diagram for converting cyclohexene into cyclohexanol as illustrated by the two reactions in question 12 (you know how the first reaction occurs! assume the second reaction is a one step process). Assume that the second reaction is much faster than the first reaction. Label all transition states and draw all the intermediates. Also illustrate the activation energy for each step and the overall energy change.

14. Label the following reactions as addition, elimination, substitution, or rearrangement.

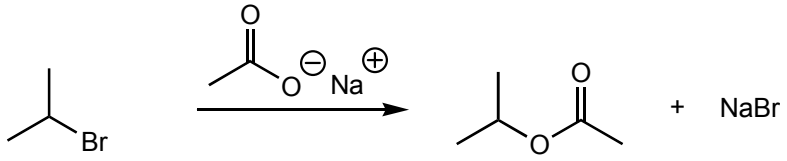
a.



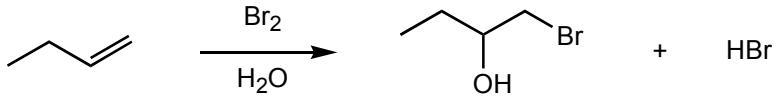
b.



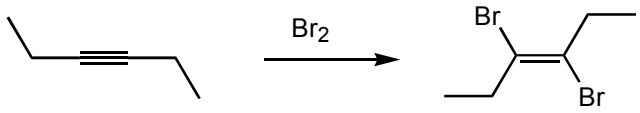
c.



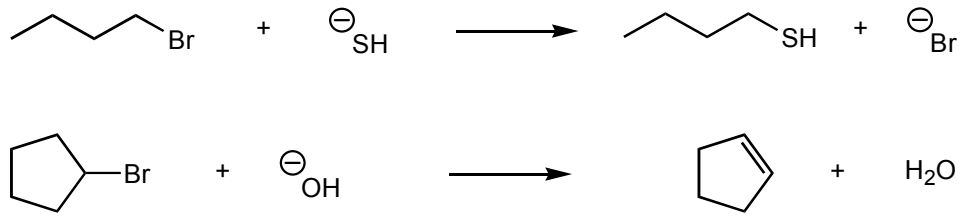
d.



e.



15. For the following transformations, fill in mechanistic arrows to show the mechanism.



16. Based on the mechanistic arrows and the starting materials shown, show the expected products for the following transformations.