(12) 1. The following are IR spectra which may contain compounds with the following functional groups: amine; alcohol; nitrile; aldehyde; or amide. Match the appropriate spectrum to the appropriate functional group (you should have 2 functional groups left over!). (3 pts each)
2. Choose **one** of the following equations and give the mechanism for the reaction. Be sure to include **all** important intermediates and resonance structures, and use "arrow pushing" to show the flow of electrons. Credit will be given for only **one** mechanism.

(9) 3. Given the following roadmap, give the appropriate structures for A, B and C.
(26) 4. A compound has the following data. Elemental analysis: 65.04% C and 5.98% H.

Please use the following MS, IR, $^1$H NMR, and $^{13}$C NMR data. Use this information to answer the following questions.

MS:

IR:
a. What is the molecular formula of this compound? (4 pts) How many units of unsaturation does this molecule have? (2 pts.)
b. What feature(s) is(are) present in the IR that indicate functional group(s)? Be specific, list peaks! (5 pts.)

c. What features about the $^1$H NMR spectrum indicate anything about functional groups or connectivity about the compound (details like integration, chemical shift, and/or coupling patterns may be important here)? (7 pts.)

d. What information, if any, does the $^{13}$C NMR spectrum give you (details like chemical shift and coupling patterns may be important here)? (4 pts)

e. Suggest a structure for this compound. (4 pts.)
5. Synthesize one of the following molecules. Legal starting materials include: bromobenzene; toluene; acetylene; unsubstituted 1,3-dithiane; mono-alcohols of four carbons or less; inorganic reagents (including CO$_2$, PPh$_3$, nBuLi - as a base, KOTBu - as a base, etc.); and any solvent needed to carry out the transformation. Remember, if carbons are incorporated into the molecule, you must use legal starting materials! There are multiple correct answers to each compound and partial credit will be assigned to partial syntheses.

6. Predict the product(s) for four out of the next five reactions. Choose only four. Be mindful of details such as regiochemistry.
a. 1) nBuLi, hexanes
    2) CH₃Br, THF
    3) HgCl₂, H₂O, CH₃CN

b. 1) NaBH₄, EtOH
    2) H₃O⁺

c. 1) BrMg-CCH, Et₂O
    2) H₃O⁺
    3) Na₂Cr₂O₇, H₂SO₄

d. 1) PCC, CH₂Cl₂
    2) H₂NNH₂, KOH, Δ

e. mCPBA, CH₂Cl₂
7. Assistant Beaker was making the following fragrant ester in laboratory (see equation below). However, his compound doesn’t seem to smell right. Based on the following IR, what are you going to tell Beaker about his product? Why? (THINK!)

\[
\text{OH} \quad \overset{\text{EtOH}}{\xrightarrow{H^+}} \quad \text{O} \quad \text{green apple}
\]

BONUS: What is the new Pacers’ Arena modeled after?