(Out of 20 points total)

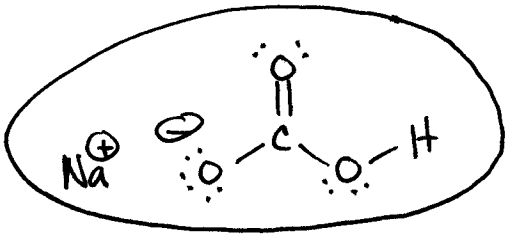
Key

Problem Set #1, 5.12 Spring 2003
Due Monday, 2/10 at 4pm

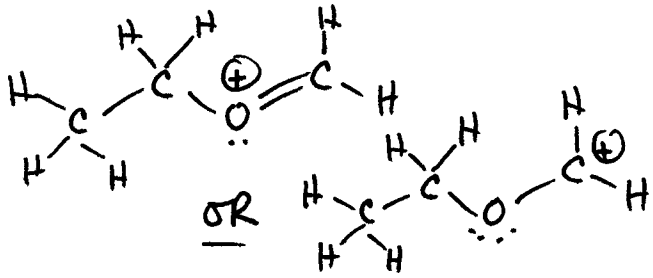
Hint: Anytime you see Na, Li, or K in a formula, you should immediately think of ionic bonding!

3 pts. 1. Draw out valid Lewis structures (lines or dots) for the following formulas. Circle structures that have ionic bonds. (Show lone pairs and formal charges.)

$NaHCO_3$



$[CH_3CH_2OCH_2]^+$

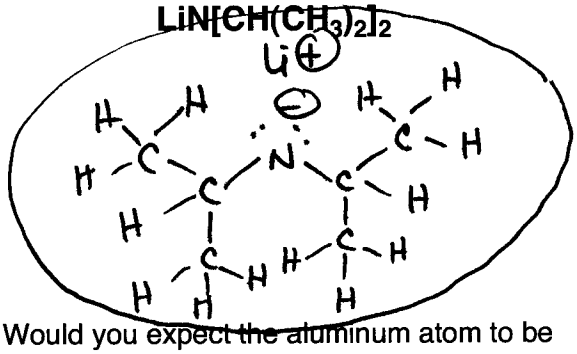


OR

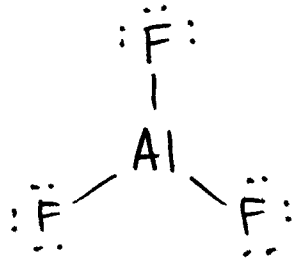
C_2H_2

H-C≡C-H

$LiN[CH(CH_3)_2]_2$



2 pts. 2. Draw a valid Lewis structure for AlF_3. Would you expect the aluminum atom to be electrophilic or nucleophilic? Why?



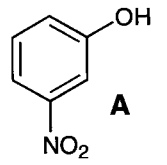
Aluminum, like boron, only starts with three valence electrons. This means that the aluminum atom in AlF_3 has six valence electrons and an empty p-orbital. It can accept electrons.

→ The aluminum atom is electrophilic.

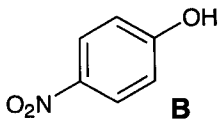
(6 pts.) 3. You learned in lecture that phenol is more acidic than cyclohexanol because its conjugate base (phenoxide ion) is stabilized by resonance. **Strong acids have stable conjugate bases.**

a) Draw the relevant resonance structures for the conjugate bases of **A** and **B**.
b) Which would you expect to be more acidic? Why?

In other words, see how much you can delocalize the negative charge.



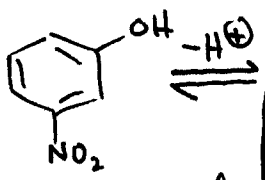
A

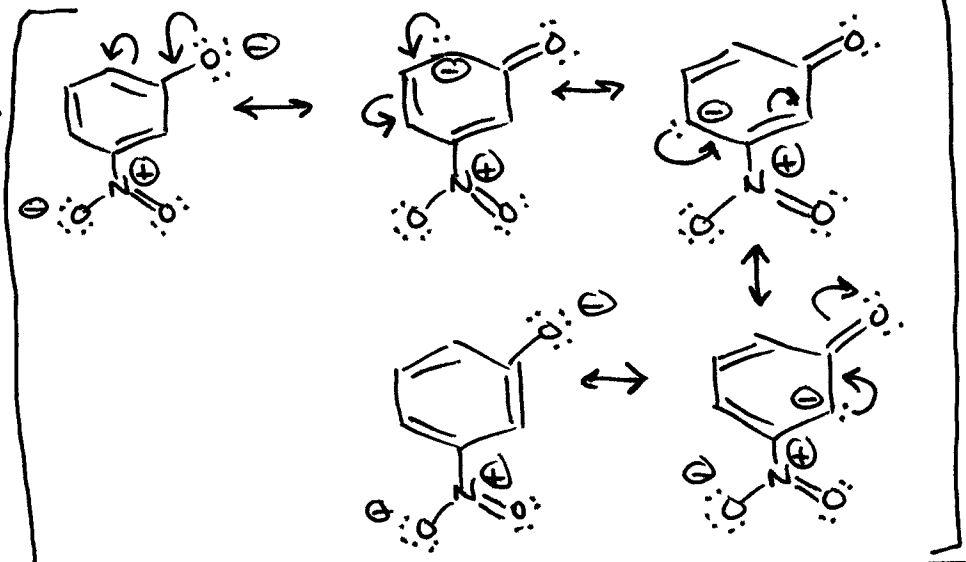


B

a)

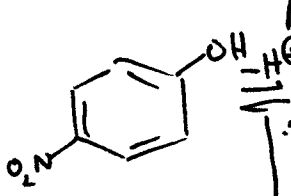
A:

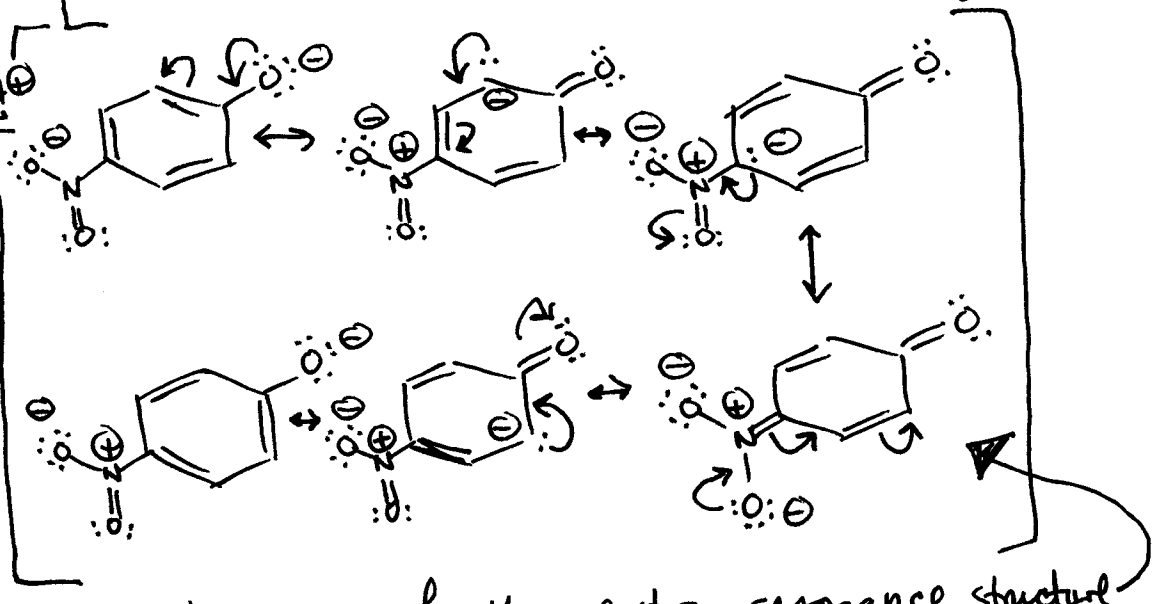




(You could double the # of resonance structures just by switching the nitro resonance, but that doesn't get you anywhere. → irrelevant.)

B:



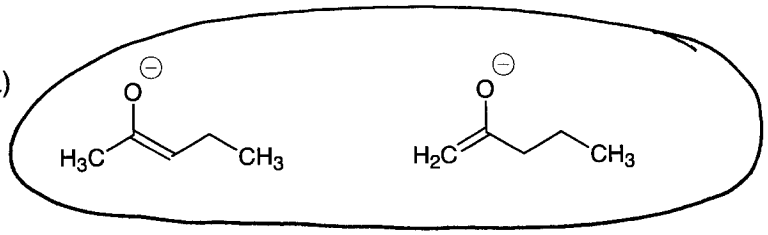


b) B is more acidic because of the extra resonance structure that puts the negative charge on the nitro oxygen. In other words, B is more acidic because the conjugate base is more stable (more delocalization = more stabilization.)

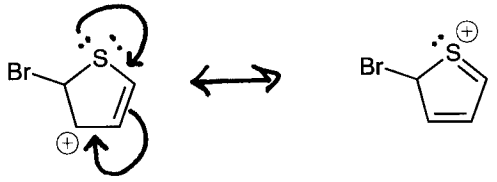
3pts -

4. Circle the following pairs of structures that **do not** constitute resonance structures. For the proper resonance pairs, draw curved arrows to convert the first structure to the second. **Draw in all lone pairs that you move.**

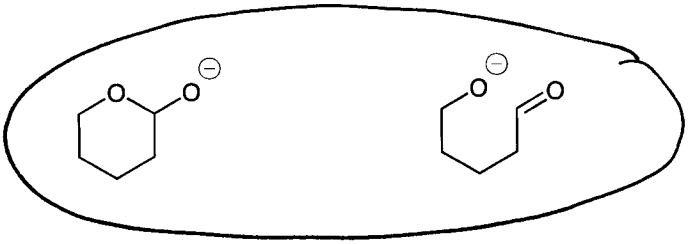
a)



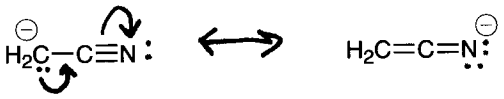
b)



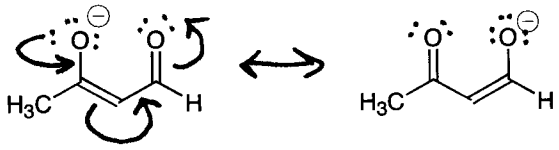
c)



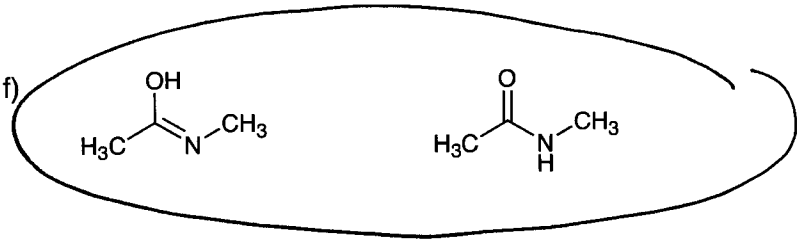
d)



e)



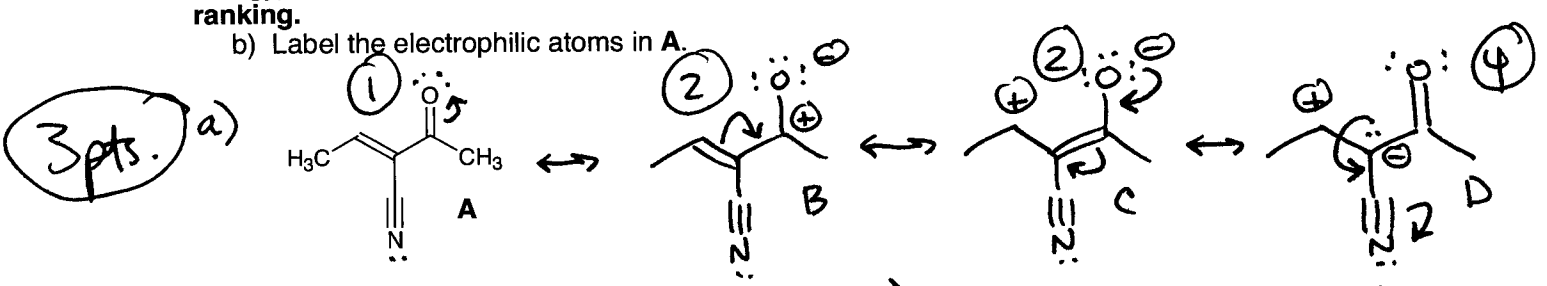
f)



5. a) Draw all of the relevant resonance structures for **A**, and rank them by energy (1 = lowest energy). **If two or more resonance structures are similar in energy, give them the same ranking.**

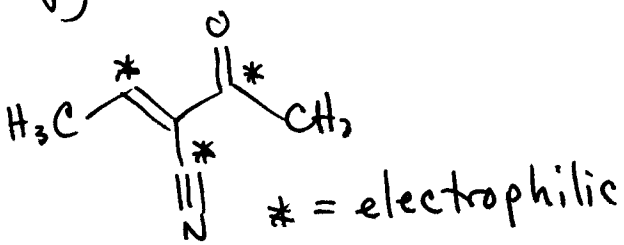
b) Label the electrophilic atoms in **A**.

3pts. a)

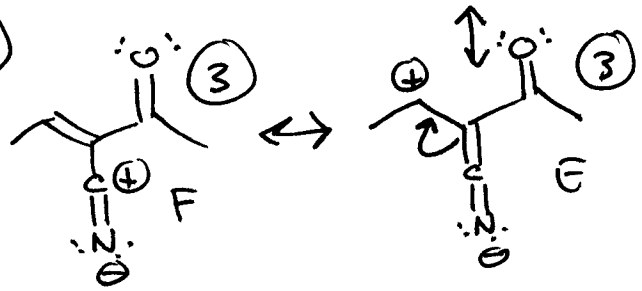


(Energy: A < B ≃ C < E ≃ F < D)

b)



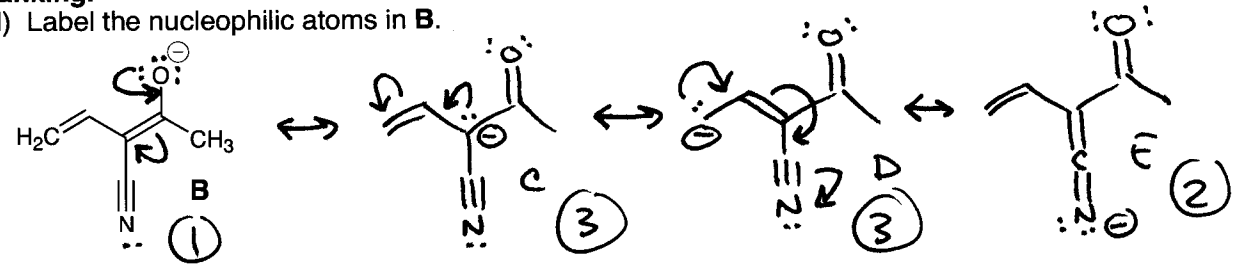
* = electrophilic



c) Draw all of the relevant resonance structures for **B**, and rank them by energy (1 = lowest energy). **If two or more resonance structures are similar in energy, give them the same ranking.**

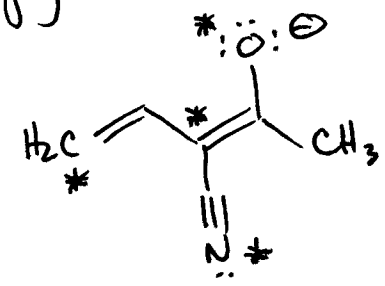
d) Label the nucleophilic atoms in **B**.

3pts. a)



(Energy: B < E < C ≃ D)

b)



* = nucleophilic

Hint: When you start with a charged molecule, don't generate any additional charge. Just move the charge around (delocalization). When you start with a neutral molecular, you usually have to generate charge to draw resonance structures.