

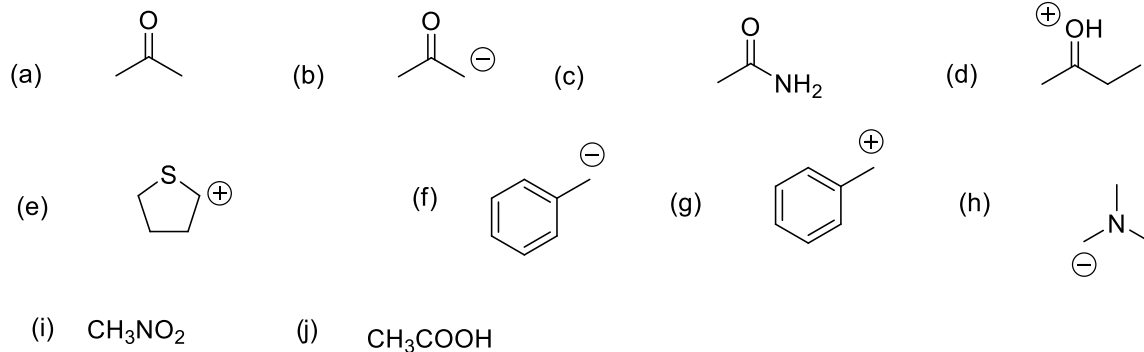
# CHM 1321

## Problem set 6

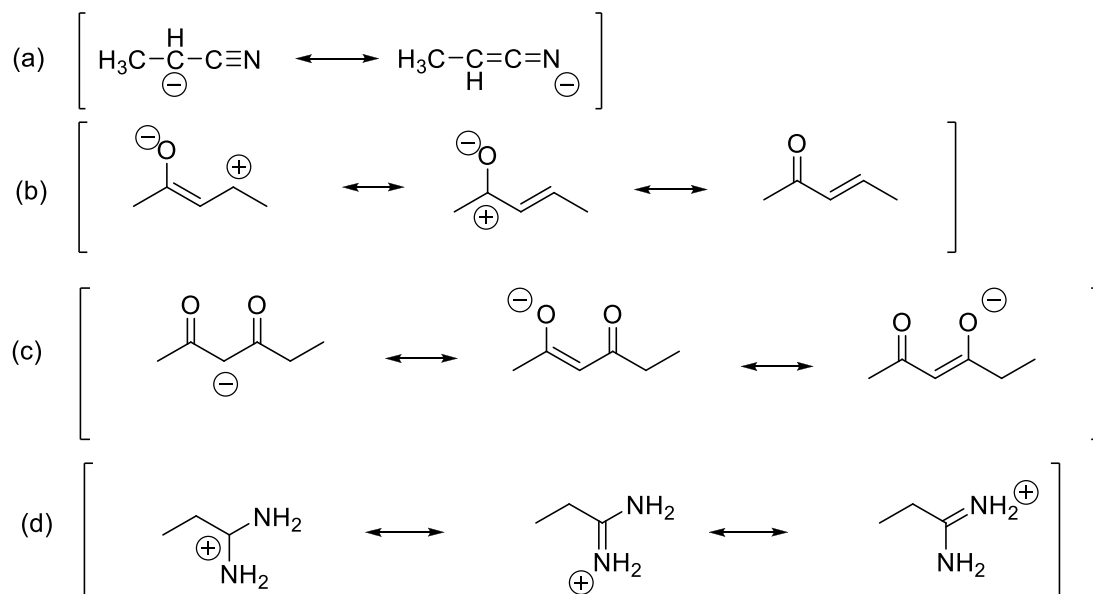
**In this assignment:**

- Resonance
- Acid/base reactions

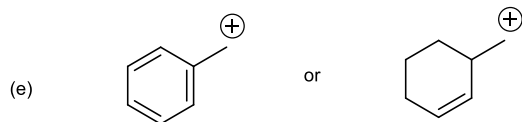
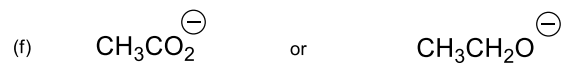
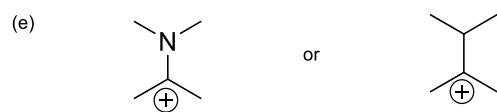
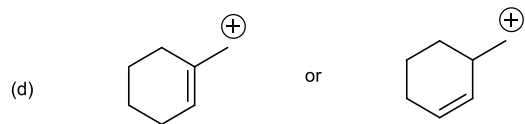
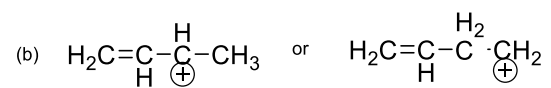
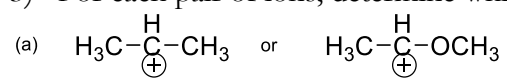
1) Draw the important resonance forms and show the resonance hybrid structures for the following:



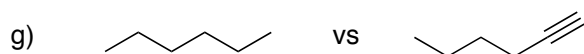
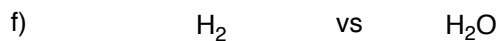
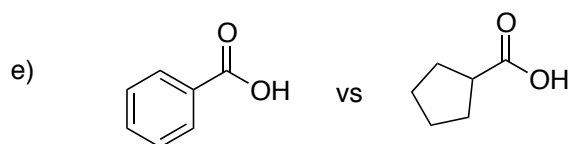
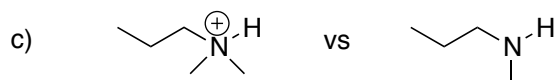
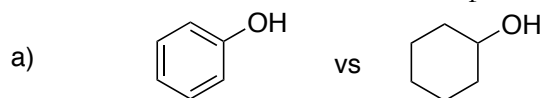
2) For the following, label the major and minor resonance forms, and show which ones are of equal energy. Briefly justify your choices.



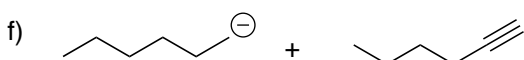
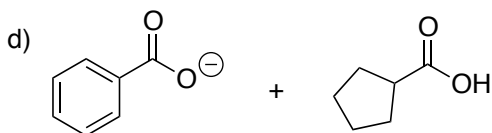
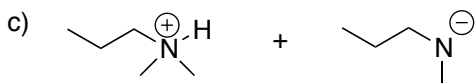
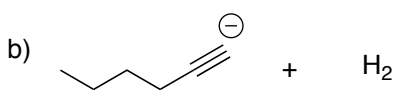
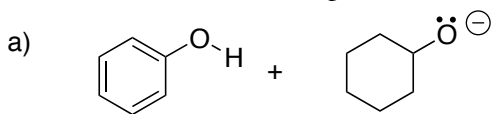
3) For each pair of ions, determine which is more stable. Justify your answer in each case.



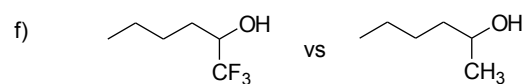
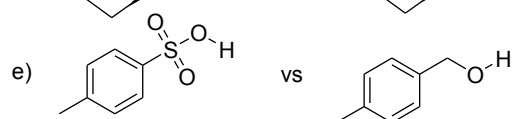
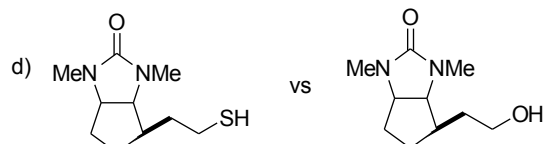
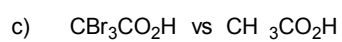
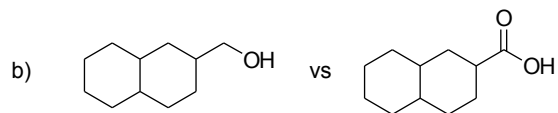
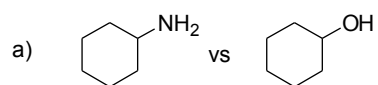
4) For the following pairs of compounds, predict which one will be the strongest acid and justify your choice. Hint: Use table 3.1 (Solomons) to justify your choices. This table is also available in the content section of the virtual campus site under Required downloads.



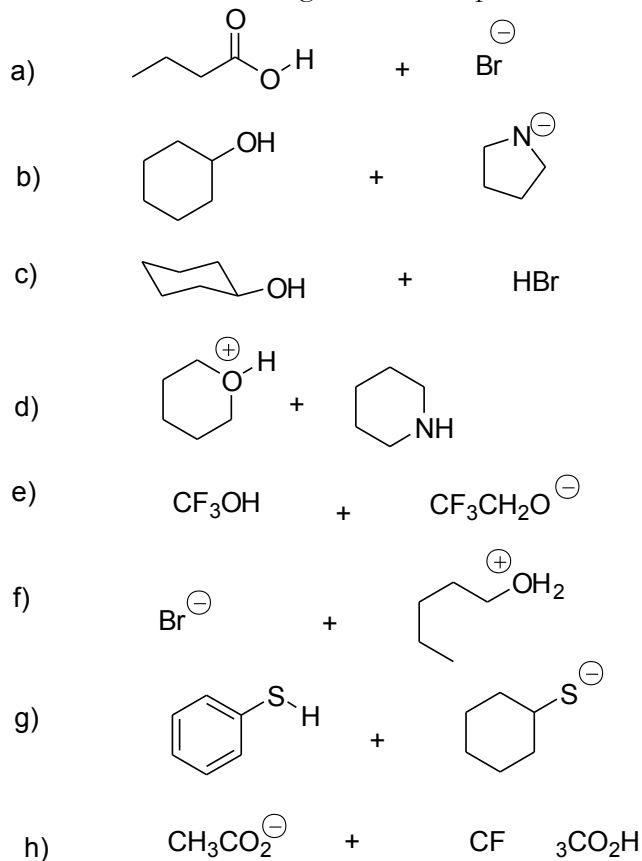
5) Draw the mechanism and products for each of the following reactions:



6) For the following pairs of compounds, predict which one will be the strongest acid and justify your choice. Hint: draw each conjugate base and compare them.



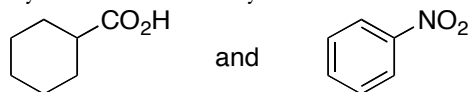
7) Write equations for the following reactions using arrow notation. Predict whether the reaction will favor the starting materials or products and justify your choice.



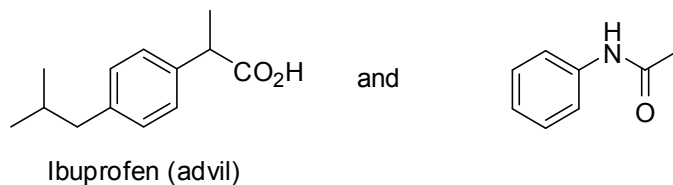
8) EXTRACTION: Please see your lab manual for a complete description of extraction. Below are some of the key points to help you out.

**How would you separate the following mixtures of compounds by extraction?**

- Octan-1-ol and octan-1-amine
- Cyclohexanecarboxylic acid and nitrobenzene



c.



**Extraction works on two principles:**

- Like dissolves like: ionic compounds and compounds with lots of H-bonding relative to their size usually dissolve best in  $\text{H}_2\text{O}$ ; organic compounds (neutral) dissolve in organic solvents.
- Neutral organic compounds can often be transformed into ionic compounds by acid/base reactions. This is especially easy with amines and carboxylic acids.

**TIP:** You can use  $pK_a$ s and pH to help determine whether a compound will be neutral, protonated, or deprotonated (and/or review the Henderson-Hasselbalch equation from general chemistry):

- When  $pH = pK_a$ , there will be a 50:50 mixture of the neutral and ionized form of the compound
- If  $pH > pK_a$ , the compound will be deprotonated
- If  $pH < pK_a$ , the compound will be in the given form (i.e. the structure that you were looking at when reading its  $pK_a$ ), until the pH reaches the  $pK_a$  for the protonated species.
  
- Commonly used solutions
  - o 0.1 M NaOH,  $pH = 13$
  - o 0.1 M HCl,  $pH = 1$
  
- Eg: Acetic acid, which has a  $pK_a$  of  $\sim 5$ , will be in the form:
  - o  $H_3CCO_2^-$  at  $pH 7$  ( $pH > pK_a$ )
  - o  $H_3CCO_2H$  at  $pH 1$  ( $pH < pK_a$ )
  
- Eg: Ammonium ( $NH_4^+$ ), which has a  $pK_a$  of  $\sim 9$ , will be in the form:
  - o  $NH_3$  at  $pH 11$  ( $pH > pK_a$ )
  - o  $NH_4^+$  at  $pH 7$  ( $pH < pK_a$ )