**CHM 1321**

**Problem set 6 Answers**

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







1. For the following resonance forms, label the major and minor resonance forms, and show which ones are of equal energy. Justify your choices. 
2. For each pair of ions, determine which is more stable. Justify your answer in each case.

a)



Delocalization with the lone pairs of the oxygen stabilizes the second compound.

b)



Delocalization with the electrons in the double bond stabilizes the first compound. In the second compound, the double bond is too far away. The CH2 carbon has no lone pairs to donate to the positively charged carbon.

c)



Delocalization with the lone pairs of the nitrogen stabilizes the second compound.

d)



Delocalization with the electrons in the double bond stabilizes the first compound. In the second compound, the double bond is too far away. The CH2 carbon has no lone pairs to donate to the positively charged carbon.

e)



Delocalization with the lone pairs of the nitrogen stabilizes the first compound.

f)



Delocalization with the lone pairs of both oxygens stabilizes the first compound.



1. 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.



Explanation (not required as part of your answer; only the above would be for this question): to answer this type of question,

* **First identify the most acidic proton in each molecule**.
  + For example, in the phenol (molecule on left), there are alkene protons which have pKas of approximately 44 (find the most similar functional group in the table. Alkene protons are listed under CH2=CH2) and there is the phenolic proton (alcohol on benzene ring) with a pKa of approx. 9.9 (see C6H5OH). The phenolic proton has the lowest pKa and so is therefore the most acidic proton in that molecule. For cyclohexanol, compare the alkyl protons (pKa of ~50) with the alcohol proton (pKa of ~17). The alcohol is most acidic.
* **Second, compare the most acidic protons on each molecule**.
  + In this case, compare the phenolic proton with pKa of ~10 with alcoholic proton with pKa of ~17.
* **Conclusion:**The phenol has the lowest pKa and is therefore the strongest acid.

























1. Draw the mechanism and products for each of the following reactions:















* 2. 



1. For the following pairs of compounds, predict which one will be the strongest acid and justify your choice.







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







1. How would you separate the following mixtures of compounds?
   1. Octan-1-ol and octan-1-amine

Dissolve both in EtOAc. Add a 10% HCl solution in H2O, which protonates the amine. Now the octan-1-ol is in the EtOAc, and the protonated (charged) amine is in the aqueous layer. Separate the organic and aqueous layers. Evaporate the organic layer to obtain pure octan-1-ol. Deprotonate the amine to make it neutral by adding a 10% NaOH solution in H2O. Extract the aqueous layer with EtOAc. The neutral amine dissolves best in the organic layer. Separate the layers and evaporate the EtOAc to obtain pure octan-1-amine.





In EtOAc



In aqueous layer

in EtOAc

Salts (ex: NaCl)

in aqueous layer

Add HCl(aq)

And EtOAc

Add NaOH(aq)

and EtOAc

Pure 

Evaporate the EtOAc

Pure

Evaporate the EtOAc

* 1. Cyclohexanecarboxylic acid from nitrobenzene

Dissolve both in EtOAc. Add a 10% NaOH solution in H2O, which deprotonates the carboxylic acid. Now we have nitrobenzene in the organic layer, and the deprotonated (charged) cyclohexanecarboxylic acid (a carboxylate) in the aqueous layer. Separate the organic and aqueous layers. Evaporate the organic layer to obtain pure nitrobenzene. Protonate the carboxylate by adding a 10% HCl solution in H2O. Extract the aqueous layer with EtOAc. The neutral acid dissolves best in the organic layer. Separate the layers and evaporate the EtOAc to obtain pure cyclohexanecarboxylic acid.





In EtOAc

 In aqueous layer

 in EtOAc

Salts (ex: NaCl)

in aqueous layer

Add NaOH(aq)

And EtOAc

Add HCl(aq)

and EtOAc

Pure 

Evaporate the EtOAc

Pure 

Evaporate the EtOAc



Same procedure as in part B.



 In EtOAc

 In aqueous

in EtOAc

Salts (ex: NaCl)

in aqueous layer

Add NaOH(aq)

And EtOAc

Add HCl(aq)

and EtOAc

Pure 

Evaporate the EtOAc

Pure 

Evaporate the EtOAc