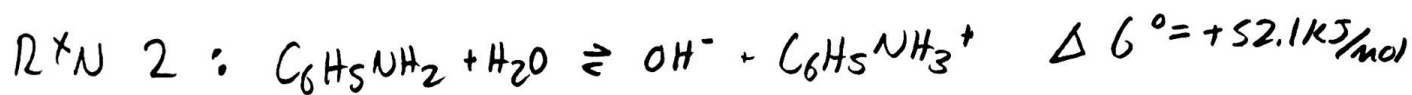
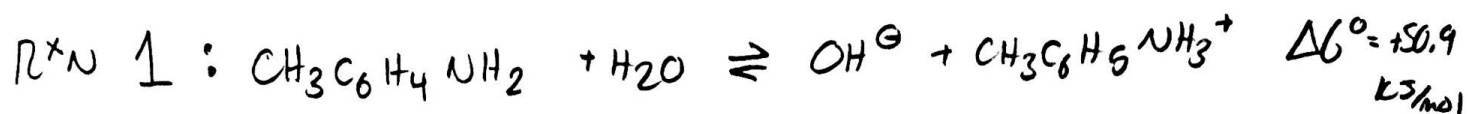


## Free energy and Base equilibria (6 pts)

1) Consider the following two base dissociation reactions with  $\Delta G^\circ$  values at 298 K



a) Circle the correct words to make the statement true  
Given the above  $\Delta G^\circ$  values, Reaction 1 equilibrium is

[more/less] product favoured, so  $\text{CH}_3\text{C}_6\text{H}_4\text{NH}_2$  is a

[stronger/weaker] base than  $\text{C}_6\text{H}_5\text{NH}_2$

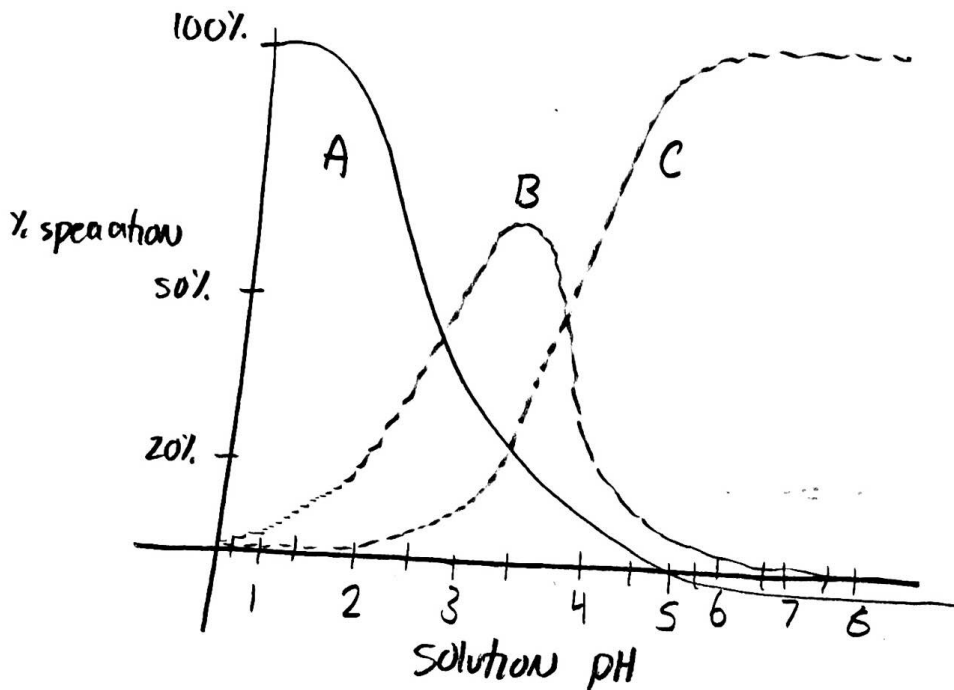
b) Calculate the  $pK_b$  of  $\text{CH}_3\text{C}_6\text{H}_4\text{NH}_2$

c) The  $pK_b$  for  $\text{C}_6\text{H}_5\text{NH}_2$  is 9.13. Calculate the pH of a 0.10 M solution of  $\text{C}_6\text{H}_5\text{NH}_2$

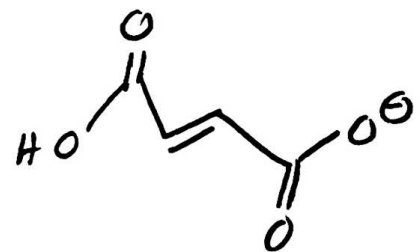
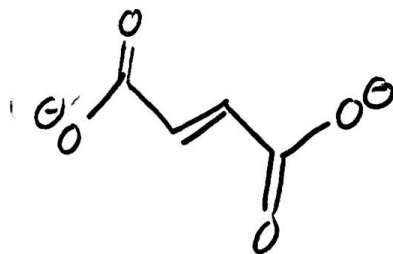
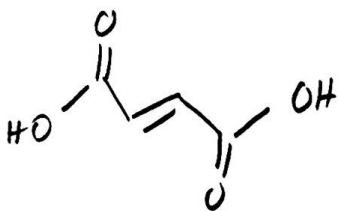
# SPECIATION PLOTS

2) The acid base speciation plot for fumaric acid

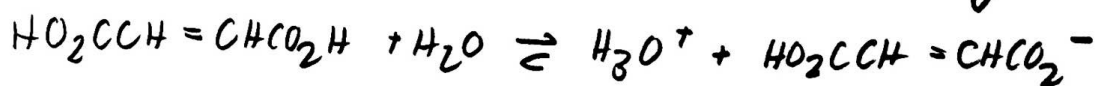
$\text{HO}_2\text{CCH}=\text{CHCO}_2\text{H}$  is shown



a) In the diagram above, each curve is labelled A-C, match the correct species with its chemical structure.

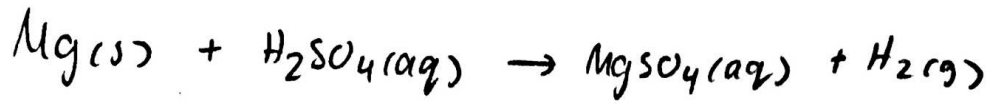


b) what is the pKa value for the following



0.0    2.5    3.7    4.4    9.0

3) Consider the following reaction



a) if the  $\Delta H_{rxn}^\circ$  is  $= -60 \text{ kJ/mol}$  and the  $\Delta S_{rxn}^\circ$  is  $= 22 \text{ J/molK}$   
calculate the equilibrium constant value.

b) Given the following data

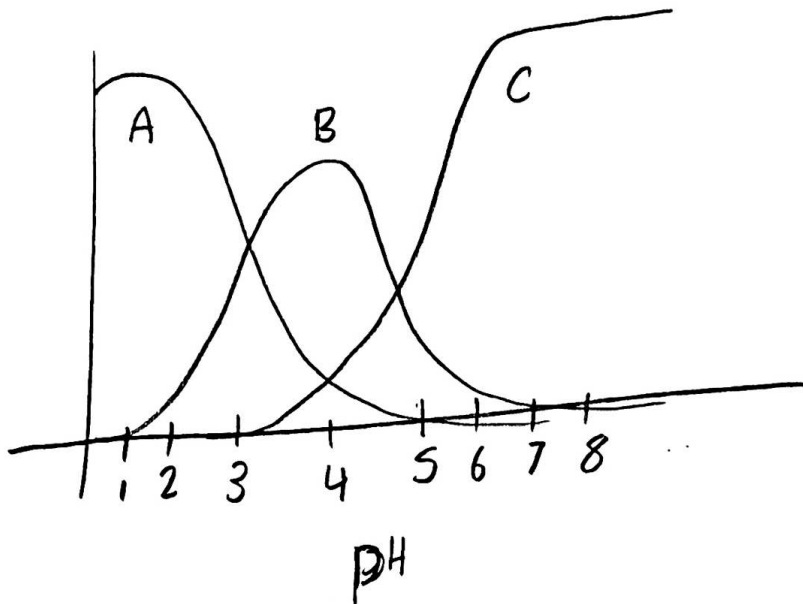
$$P_{\text{MgSO}_4} = 0.0102 \quad P_{\text{H}_2} = 0.02 \quad P_{\text{H}_2\text{SO}_4} = 0.5 \quad P_{\text{Mg}} = 0.006$$

what is the Gibbs free energy of the reaction?

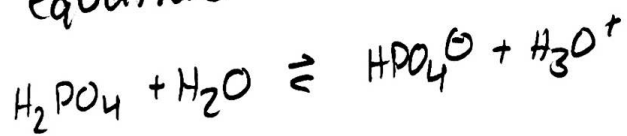
c) At equilibrium the reaction is only spontaneous at a specific temperature, what is this temperature?

# Titration Curves

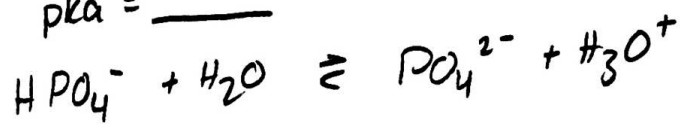
4) consider the following titration curve for  $\text{H}_2\text{PO}_4$



a) what are the  $pK_a$  values for the following equation



$pK_a = \underline{\hspace{2cm}}$



$pK_a = \underline{\hspace{2cm}}$

b) label the following species on the curve

