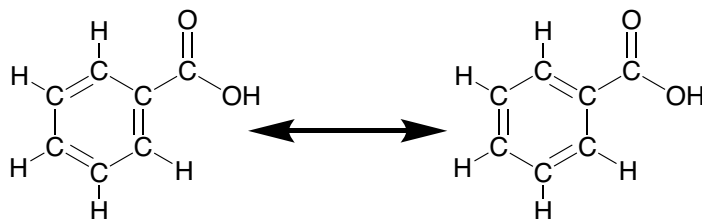


## How can acid/base chemistry be used to separate molecules?

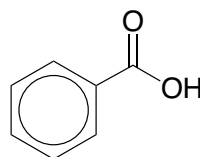
Next year many of you will take organic chemistry, together with its lab. You'll take advantage of acid-base chemistry to help you purify molecules. One of the first labs in CHEM 2203 (Organic Chemistry I Lab) has students separating benzoic acid from a neutral compound (9-fluorenone, which rather surprisingly does not contain fluorine!) by using acid-base chemistry.

Benzoic acid ( $\text{C}_6\text{H}_5\text{COOH}$ ) has many uses, from the practical (as a food preservative) to the pretty (as the "snow" in a snow globe).

A. Benzoic acid is fully represented by the resonance structures:



but organic chemists will use the following shorthand:



The  $\text{pK}_a$  for benzoic acid is 4.20 at 25 °C.

First, give the value of  $K_a$  for benzoic acid, write the chemical equation that corresponds to that equilibrium constant, and formulate the equilibrium expression.

*Having trouble? Review questions from Chapter 14: 7, 8, 9 and 10.*

B. Sketch the conjugate base of benzoic acid. You can start with the shorthand form at right above. Why do you think, of the six H atoms in benzoic acid, the organic chemists only bother drawing that one?

*Having trouble? Review questions from Chapter 14: 40 and 41.*

C. If you made 1.00 L of a 0.200 M solution of benzoic acid in water at 25 °C, what would be the concentrations of (still un-ionized) benzoic acid, its ionized conjugate base,  $\text{H}_3\text{O}^+$ , and  $\text{OH}^-$ ? What would be the pH of the solution? Be sure to show all your work.

*Having trouble? Review questions from Chapter 14: 60 and 61.*

D. If you add 0.050 moles of NaOH to the solution from part (C), what would be the resulting concentrations of benzoic acid and its conjugate base? What would be the solution pH? Be sure to show all your work.

*Having trouble? Review questions from Chapter 14: 94.*

- E. In the CHEM 2203 lab, students separate a mixture of (neutral and essentially non-polar) 9-fluorenone and benzoic acid. The mixture starts out in the solvent methylene chloride ( $\text{CH}_2\text{Cl}_2$ : it's a little bit polar but not nearly as polar as water). In this lab students add excess NaOH in water to the mixture. The water isn't miscible with the  $\text{CH}_2\text{Cl}_2$  solvent, so it makes two layers. Explain using drawings and chemical reactions how adding NaOH in water helps to separate 9-fluorenone and benzoic acid.

*Having trouble? Review questions from Unit 1, 2 and 3.*