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Research exercise: The Development of a First Year Chemistry Laboratory

UNIVERSITY of DAYTON

The Development of a First Year Chemistry Lab Experiment

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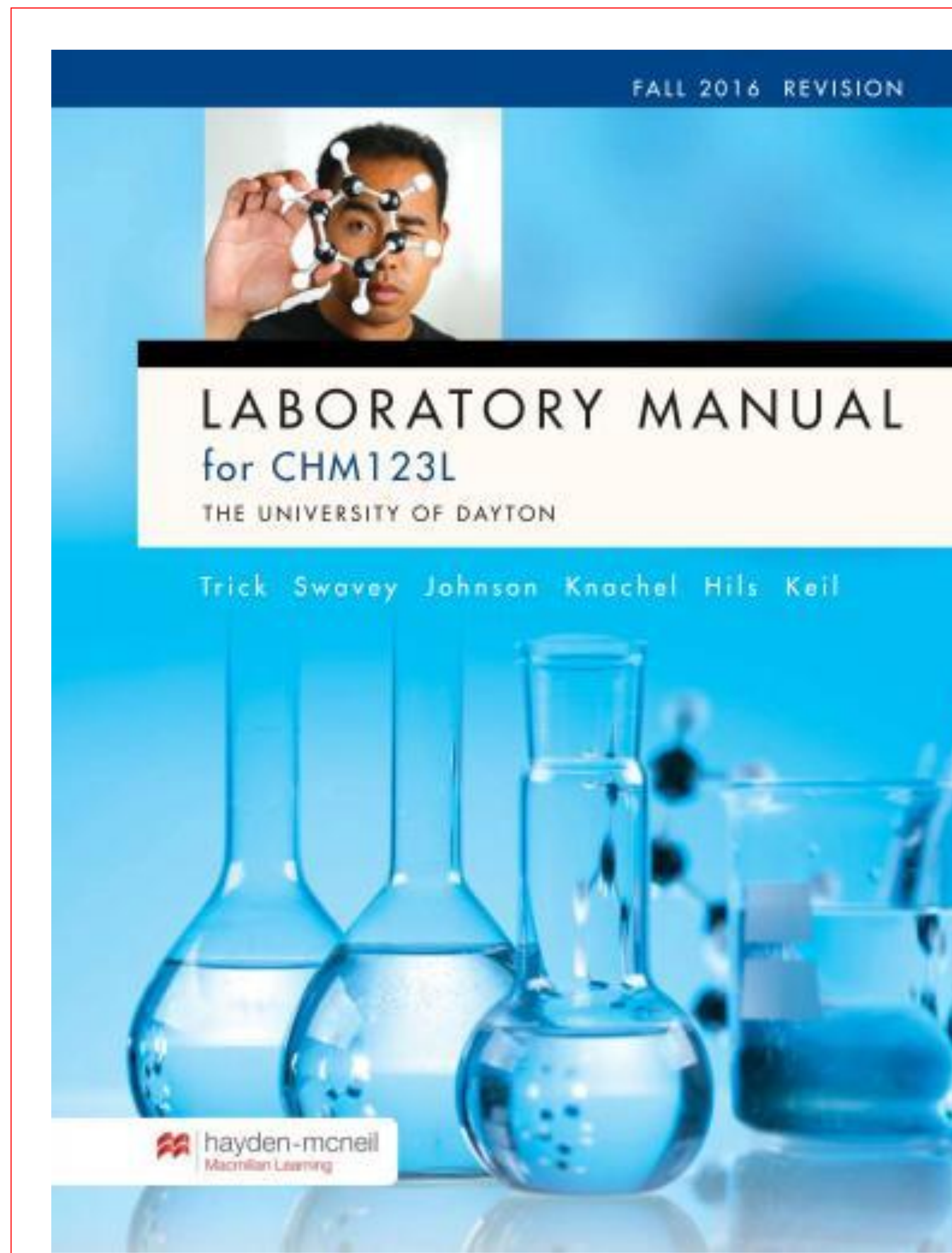

Purpose

The purpose for this project was to redesign a past General Chemistry Laboratory experiment with emphasis on student learning objectives in support of lecture material. The experiment was first introduced into the second semester CHM124L course in 1997 as "Preparation and Investigation of Salt Solutions". For the Fall 2016 curriculum, the modified experiment will be conducted in the first semester General Chemistry course CHM123L as "Equilibrium of Salt Solutions".

Questions to Answer

- How many salt solutions will be analyzed?
- What is the most effective way to organize the data?
- What kind of analysis should the students be expected to perform?

Process

- ✓ Tested the pH of salt solutions based on the old lab procedure.
- ✓ Compared the theoretical and experimental pH values.
- ✓ Chose three salts whose theoretical and experimental agreed.
- ✓ Redesigned experiment introduction, data collection and analysis reporting format.
- ✓ Ran the lab to gain a sense of time
- ✓ Examined the pH of deionized water on the pH of the solutions.
- ✓ Tested the effect of heating on pH
- ✓ Added a forth salt to the experimental procedure.
- ✓ Finalized lab report and created answer key.

Example: Calculate the pH of a 0.100M NaCN solution.

Write the dissociation reaction of the salt.

$$NaCN\ (s) \rightarrow Na^+(aq) + CN^-(aq)$$

Explain whether the cation and/or the anion will react with water to effect pH.

Only the anion CN^- will react with water to effect pH. Na^+ is the cation of a strong base (i.e. NaOH) and does not have acid-base properties. Therefore, it will not react with water and will have no effect on pH of the solution.

Write the equilibrium reaction for the hydrolysis of water. Label the acid, base, conjugate acid, and conjugate base.

$$CN^-(aq) + H_2O(l) \rightleftharpoons HCN(aq) + OH^-(aq)$$

Write the equilibrium equation in terms of concentration.

$$K_b = 1.6\times10^{-5} = [HCN][OH-]/[CN-]$$

Calculate the value of the equilibrium constant for the hydrolysis reaction.

$$K_b = K_w/K_a = 1.0\times10^{-14}/6.2\times10^{-10} = 1.6\times10^{-5}$$

Create an ICE table to determine the pH of the solution when the initial concentration of CN^- is 0.100M.

	$CN^-(aq)$	$+H_2O(l) \rightleftharpoons$	$HCN(aq)$	$+ OH^-(aq)$
I	0.100		0	0
C	-x		+x	+x
E	0.100-x		x	x

$$K_b = 1.6\times10^{-5} = x^2/(0.100-x)$$

Approximate a small change $1.6\times10^{-5} = x^2/0.100$

$$x = 1.26\times10^{-3} = [OH-]$$

Check to see if the approximation is valid.

$(1.26\times10^{-3}/0.100)\times100\ \% = 1.26\%$ *Yes, it is valid.*

Calculate the pH.

$$pOH = -\log 1.26\times10^{-3} = 2.90$$

$$pH = 14.00 - pOH = 14.00 - 2.90 = 11.10$$

Results

- A total of four salt solutions will be analyzed: one acidic solution and three basic solutions
  - ➢ Two solutions demonstrate how acid strength effect the pH of the solution.
  - ➢ One solution investigates the effect of deionized water pH on the overall pH of the solution.
- New reporting format walks students through a series of exercises to emphasize important learning objectives.
- Key learning objectives from lecture are carried through to this lab exercise. These include:
  - ➢ Writing dissociation reactions.
  - ➢ Identifying weak acids or weak bases that can undergo hydrolysis.
  - ➢ Identification of the equilibrium constant K_a or K_b.
  - ➢ Using an equilibrium chart to calculate pH of a solution.
- Reinforce experimental objectives such as:
  - ➢ Making volumetric solutions.
  - ➢ Use of a pH meter.
- Eye catching format will stimulate students interest in equilibrium.