

Experiment 16: LeChatelier's Principle (with Complex Ions and the Common Ion Effect)

Pre-Lab Hints

1. Review the beginning page of the Introduction section, particularly the *italicized* statement.
2. a. Review experiment steps A1, B1, B2, and D1 for the five “**Caution!**” statements.
Include names and concentrations of substances, along with the reasons for caution.
b. Review technique 13A of the Laboratory Techniques in the front part of your lab manual.
Specifically, review the accompanying note in the margin with this technique.
3. Review equations 16.7, 16.10, 16.12, 16.13, 16.15, and 16.17.
Review the *italicized* statement at the beginning page of the Introduction section again also.
4. Increasing pH removes H^+ , which shifts the reaction to the left, so that both beakers will become the same color. Use the caption (below the experiment title) to identify that color.
5. Review the Buffers section in the Introduction. The two necessary components of a buffer solution are described immediately before equation 16.14.
Note that $CH_3CO_2^-$ is a base that reacts with H_3O^+ in equation 16.14.
6. a. Review “Solubility; Saturated Solutions” in Ebbing and Gammon, section 12.2.
Also, examine the accompanying Figures 12.2 and 12.3 in Ebbing and Gammon.
b. Review equation 16.7. Note that Ag^+ is in the reaction. \\
Explain what Ag^+ will do if added.
c. For (i), review equation 16.7 again. Water shifts the equilibrium by reducing the concentrations of the ions (which are the products). Which direction is that shift? Skip (ii), initial concentrations will be reestablished.
d. Review equations 16.7 and 16.8. Explain how the reaction of H^+ with CO_3^{2-} and the reaction of Ag^+ with Cl^- will shift the equilibrium of equation 16.7.

Procedure Notes and Report Sheet Information

- Part A. The Cu^{+2} solution will change color when NH_3 is added, but will not produce a precipitate. As a result, it will be transparent, not opaque. Use equations 16.2 and 16.5, along with your observations, for your answers on the report sheet.
- Part B. Do not let the silver solutions contact your skin in step 1, as silver leaves brown stains on skin. The stains are temporary, however, and will eventually disappear. Be sure to add enough NH_3 in step 2 to completely dissolve the precipitate. Skip the last two sentences of step 2 (where 8 and 9 are circled) and proceed to step 3 after adding NH_3 . Use equations 16.6 through 16.13, along with your observations, for your answers on the report sheet.
- Part C. Skip.
- Part D. Review equation 16.17. Note that Cl^- and H_2O are both in the reaction.
- Part E. Note that the reaction is endothermic, so adding heat favors the product. Review equation 16.17 again. Also, review the last sentence of the Changes in Temperature section at the end of the Introduction.

Lab Questions

1. Review equation 16.2 and step A1. Note that the product is a soluble complex ion. Use rule 3 of Water-Insoluble Salts in Appendix E (very end of lab manual) to explain what would happen if $\text{Cu}^{+2}_{(\text{aq})}$ was combined with $\text{KOH}_{(\text{aq})}$ instead of $\text{NH}_3_{(\text{aq})}$. Write the balanced net ionic equation with all applicable phase subscripts and ionic charges, where $\text{K}^{+1}_{(\text{aq})}$ is a spectator ion which is cancelled out.
2. Review equations 16.7 and 16.8. Explain how adding $\text{HNO}_3_{(\text{aq})}$ dissolves $\text{Ag}_2\text{CO}_3_{(\text{s})}$. Now, review equation 16.9. Explain why adding $\text{HCl}_{(\text{aq})}$ instead will still result in a precipitate being present. Refer to rules 1 and 2 of Water-Soluble Salts in Appendix E.
3. Review equation 16.10 and step B2. $\text{Ag}^{+1}_{(\text{aq})}$ and $\text{NH}_3_{(\text{aq})}$ will form a soluble complex ion. Use rule 3 of Water-Insoluble Salts in Appendix E to explain what would happen if $\text{Ag}^{+1}_{(\text{aq})}$ was combined with $\text{KOH}_{(\text{aq})}$ instead of $\text{NH}_3_{(\text{aq})}$. Write the balanced net ionic equation with all applicable phase subscripts and ionic charges, where $\text{K}^{+1}_{(\text{aq})}$ is a spectator ion which is cancelled out.
4. Review equation 16.12. Adding $\text{I}^{-1}_{(\text{aq})}$ to the $\text{Ag}(\text{NH}_3)_2^{+1}_{(\text{aq})}$ complex ion forms a precipitate. Explain what happens. Write the balanced overall reaction between $\text{Ag}(\text{NH}_3)_2^{+1}_{(\text{aq})}$ and $\text{I}^{-1}_{(\text{aq})}$. Include all applicable phase subscripts and ionic charges.
5. Equation 16.17 is an endothermic reaction. Explain how this reaction affects the temperature. Explain how changing the temperature can make the reaction go forward.