



Seeing Is Believing!



Topic: Equilibrium, Reversible reactions, Electronic spectroscopy

Courses: General Chemistry, Physical Chemistry

Text References: Enter references to parts of text(s) that logically go with this experiment (e.g., McMurray Fay 10.1, OFB 8.7, etc.).

Setup: Preparation time is < 5 minutes.

- *p*-Nitrophenol
- 250 mL beaker or a volumetric flask with a cap
- Stirring rod
- Dilute hydrochloric acid solution (HCl)
- Dilute sodium hydroxide solution (NaOH)

Procedure: Demonstration time is < 5 minutes.

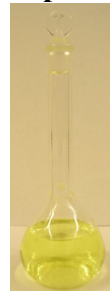
1. Add a small amount of *p*-nitrophenol to the beaker or volumetric flask. (Stir or mix as necessary.)
2. Add a few drops of dilute HCl solution and mix. Observe color.
3. Add a few drops of dilute NaOH solution until the color changes. Observe color.
4. Repeat Steps 2 and 3 as desired, observing color changes.

Observation: The acidic *p*-nitrophenol solution is colorless. Addition of base turns the solution yellow. More acid turns the solution back to colorless.

p-Nitrophenol



p-Nitrophenoxide



Explanation: The acid-base equilibrium between *p*-nitrophenol and its conjugate base, *p*-nitrophenoxide is an example of a reversible reaction (see below). By adding acid or base to the solution, we can shift the equilibrium to the left or right. The wavelength maximum for the electronic excitation of *p*-nitrophenol in water is 318 nm, which is in the UV region of the spectrum. Hence, the solution is colorless. The wavelength maximum for the electronic excitation of *p*-nitrophenoxide in water is 400 nm, which is at the blue edge of the electromagnetic spectrum. Since we see the color of the reflected light (as opposed to the absorbed light), the solution looks yellow.

