BLUE PRINTING

Objective: Students will use a cyanotype process to make blueprint paper. They will then use lithography to pattern the paper using a mask.

National Science Education Standard: Physical Science: Chemical reactions

NYS MST Learning Standard: Standard 4: Students will understand and apply scientific concepts principles and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Materials:

10% potassium hexacyanoferrate(III) solution —an irritant

18% ammonium iron(III) citrate solution

White paper

Petri dishes

Transfer pipettes

Paper towels

Masks

Background: The cyanotype process was invented in 1842 by Sir John Herschel, after he had first discovered the photosensitivity of ferric (iron +3) salts. In this process, a suitable (both chemically and physically) sheet of paper is made sensitive to high energy ultra violet (UV) light by coating it with a solution of ferric ammonium citrate and potassium ferricyanide. Exposure to UV light reduces a portion of the ferric (Fe^{+3}) salt to the ferrous (Fe^{+2}) state, and a portion of the ferricyanide (Fe^{+3} in $Fe(CN)_6^{3-}$) to ferrocyanide (Fe^{+2} in $Fe(CN)_6^{4-}$), resulting in the formation of a pale yellow-blue image consisting of ferrous ferrocyanide. Washing removes the soluble, unreduced (unexposed) salts, leaving behind a deep blue and white image. The image intensifies upon drying as ferrous ferrocyanide is slowly oxidized to a deep blue color that results from ferric ferrocyanide. The oxidation can be hastened by treating the image in an oxidizing bath of either hydrogen peroxide or potassium dichromate.

[from http://www.sewanee.edu/, William Crawford, *The Keepers of Light*, p.163-165, 177-180 and Catharine Reeve and Marilyn Sward, *The New Photography*, p 55-63]

Check for prior learning:

What is blueprint paper and what is it used for?

How does it work?

New learning:

Procedure 1 (In pairs):

- Turn off the lights and darken the room as much as possible.
- Pipette 4mL of each solution into a Petri dish and stir them together. (The top line on the transfer pipettes is 1mL.)
- Put a piece of white paper into the liquid just long enough to get it damp – not wet!
- Remove the paper and place it on a paper towel to dry. Be sure to keep the room dark.
- Do as many sheets of paper as amount in Petri dishes will allow.

Procedure 2:

- Place the mask on top of the blueprint paper.
- Find a location with direct sunlight and place your mask and paper in the sunlight to develop. Wait 2-5 minutes, depending on the amount of sunlight.
- Remove the mask and compare your pattern to the mask. Did it turn out clear? If not, why?
- Rinse paper in water to stop the chemical reaction with the sunlight.

Check for learning:

What chemical reaction creates the pattern on the blueprint paper?

Why do you need sunlight to develop the pattern?

Extension:

Students can vary the paper's exposure to light to find how to make the darkest blue.