

# “Beat Michigan” Demo

Starting with six beakers containing colorless solutions, you mix two pairs to create blue and maize.  
Adding a third solution to each mixture changes the colors to Scarlet and Grey.  
Go Sportsball!

## Chemicals

- Beat Michigan Demo Kit – **O5**
  - Thymolphthalein
  - Acid fuchsin
  - *p*-nitrophenol
  - 6 M HNO<sub>3</sub>
  - NaBH<sub>4</sub>
  - 0.1 M AgNO<sub>3</sub>
- d-H<sub>2</sub>O
- 6 M NaOH – **S1**
- 0.1 M NaOH – **S1**
- 1 M HCl – **K1**
- 95% ethanol – **R2**

## Equipment for Prep

- 6-600 mL beakers – **Q1**
- Several graduated cylinders – **Q3/4**

## Equipment for Demo

- 2-300 mL tall beakers – **Q2**
- 4-100 mL beakers – **Q3**
- 2 White backgrounds – **A1**
- 6 petri dish lids – **P3**

**Preparation of solutions:** Prepare the following six solutions and store them in the labeled bottles.

### Solution A

20 drops thymolphthalein  
20 mL 1 M HCl  
400 mL 95% EtOH

- Dilute to 1L with d-H<sub>2</sub>O

### Solution A1

10 mL acid fuchsin  
13.5 mL 6 M NaOH

- Dilute to 1L with d-H<sub>2</sub>O

### Solution A2

80 mL 1 M HCl

- Dilute to 1L with d-H<sub>2</sub>O

### Solution B

40 drops *p*-nitrophenol  
14 drops 6 M HNO<sub>3</sub>

- Dilute to 1L with d-H<sub>2</sub>O

### Solution B1

0.10 g NaBH<sub>4</sub>  
50 mL 0.1 M NaOH

- Dilute to 1L with d-H<sub>2</sub>O

### Solution B2

4 mL 0.1 M AgNO<sub>3</sub>  
8 mL 6 M HNO<sub>3</sub>

- Dilute to 1 L with d-H<sub>2</sub>O

**These solutions should keep for ~2 weeks, if necessary**

Make sure to test the demo beforehand.

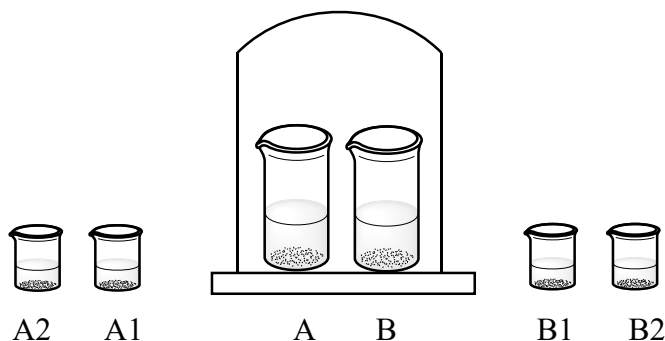
- If the blue solution is too light after mixing A and A1, make a new thymolphthalein solution
- NaBH<sub>4</sub> is flammable and expires after several years. If the grey (silver) solution fails to form, takes a long time, or is very brown, get new NaBH<sub>4</sub>.

Older protocol used 6 mL of 8 M HNO<sub>3</sub>, (and 10 drops) but that is dumb. Can change back if it affects the colors.

### Preparation of the demo:

- Label the tall beakers **A** and **B**, and the 100 mL beakers **A1**, **A2**, **B1**, **B2**. Label lids with the same designations.
- Measure out 50 mL of each solution into the proper beaker (use the marks on the side of the beaker)
- Place the tall beakers in front of the white background, and the small beakers to the sides

### Set up:



### Presentation

- At the same time, add **A1** to **A** and **B1** to **B**, the solutions will turn blue and maize. Then add **A2** to **A/A1** and **B2** to **B/B1**, the solutions will turn scarlet and grey. (the grey takes a little while to change)

### Discussion:

- This demonstration only takes a few seconds and is intended to be just for fun. If you would like to provide a more educational experience, here is some more information about the chemical reactions.
- There are three acid-base reactions with indicator color changes, and one redox reaction involving the reduction of  $\text{Ag}^+$  to  $\text{Ag}$  (s- finely divided) via  $\text{NaBH}_4$ .
- In the A beakers, thymolphthalein has a color change from colorless to blue over a pH range of 9.4 to 10.6. Acid fuchsin is a red dye that presents as colorless in base, but turns cherry red in acid. Adding **A1** to **A** produces a blue solution because the mixture becomes basic, so thymolphthalein turns blue while acid fuchsin stays colorless. When **A2** is added to **A/A1**, the solution turns red because the mixture is acidic, so thymolphthalein turns colorless while the acid fuchsin turns cherry red.
- In the B beakers, *p*-nitrophenol has a color change from colorless to yellow over a pH range of 5.6 to 7.6.  $\text{NaBH}_4$  serves as a reducing agent to convert  $\text{Ag}^+$  (aq) to colloidal  $\text{Ag}$  (s) [the boron product is presumed to be  $\text{NaH}_2\text{BO}_3$  (aq)]. Adding **B1** to **B** produces a maize solution because the mixture becomes basic, and  $\text{AgNO}_3$  (aq) stays colorless. When **B2** is added to **B/B1**, the solution turns grey because the mixture is now acidic, so *p*-nitrophenol is colorless, while the redox reaction produces colloidal silver, creating a grey color.

### Clean-Up

- Pour solutions down the sink with plenty of water.

**Acknowledgement:** This demonstration was developed by Mary H. Bailey ([bailey.3@osu.edu](mailto:bailey.3@osu.edu)) and Robert J. Ouellette of The Ohio State University, who should be acknowledged if the demonstration is shared with others.

### Beat LSU variation:

Change solution A to:  
10 drops thymolphthalein  
18 drops phenolphthalein  
10 mL HCl

200 mL 95% EtOH

- Dilute to 500 mL with d- $\text{H}_2\text{O}$