KENT STATE UNIVERSITY TUSCARAWAS

Conceptual Chemistry

Repurposed Materials for Low-cost Science Experiments

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Conceptual Chemistry

Conceptual Chemistry is a graduate course designed for grade school and middle school teachers to assist in their understanding of chemistry and to provide concrete ideas that they can take back to their classrooms to teach their students.

http://personal.kent.edu/~cfenk/Chemistry/Conceptual_Chemistry.html

Conceptual Chemistry

Participants in this course receive:

- Free tuition and five graduate credit hours from the College of Education of Kent State University. *($2,425 value)*
- Over $850 worth of materials and supplies to take back to the classroom.

Conceptual Chemistry

Support for ***Conceptual Chemistry*** and the development/production of this material was provided by a grant under the federally funded ***Improving Teacher Quality State Grants Program***, administered by the ***Ohio Department of Higher Education***.

Activity Objectives

Key Concepts

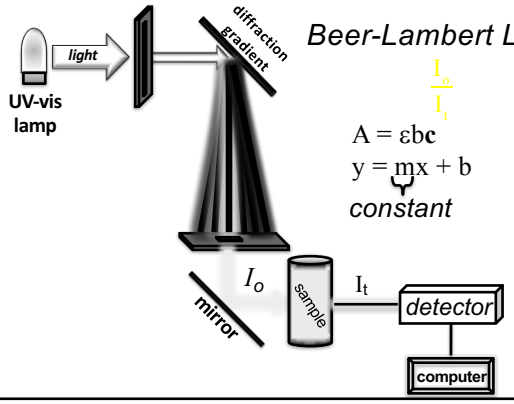
- Laboratory Safety
- Molecular Spectroscopy
- Electromagnetic Radiation
- Quantitative Analyses
- Forensic Science
- Having fun with science!

Spectroscopy

Spectroscopy
The investigation into the nature of matter using electromagnetic radiation.

Most Common Types
Infrared, ultraviolet, visible, NMR, X-ray and microwave.

UV-Vis Spectroscopy



Beer-Lambert Law

$$\frac{I_o}{I_t}$$

$A = \varepsilon b\mathbf{c}$

$y = mx + b$

constant

UV-Vis Spectroscopy

Pro's

- Safe
- Accurate
- Easy to use

Con's

~$2,100 each

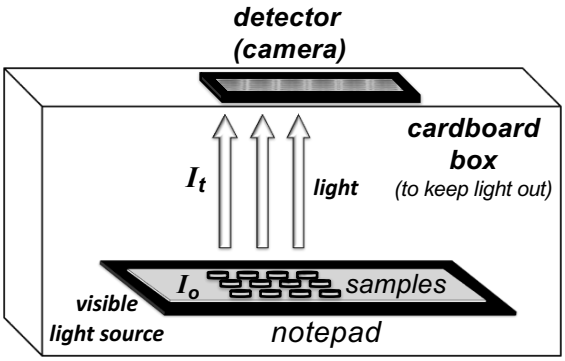
- *$$$ Expensive $$$*
- Not generally available

Mobile-Phone Spectroscopy

Purpose

To determine the concentration food coloring in an unknown sample using quantitative visible light spectroscopy.

UV-Vis Spectroscopy



Mobile-Phone Spectroscopy

Materials

- 15 ml aqueous food coloring solution
- distilled water
- 96-well plate or ½" **bubble wrap**
- 5.8 ml fine tip plastic pipet
- 1 push pin
- 2 smart phones or similar devices
- 25 - 30 cm high box

The stock solution of food coloring is prepared by dissolving 1.00 mL (20 drops) of food coloring into a total of 1.00 L solution.

Safety Overview

- Goggles and gloves are provided for all participants.
- Green food coloring solutions are completely benign, but care should be taken to prevent splashes into your eyes.

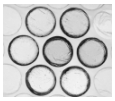
Safety Overview

- Eyewash bottles are available in case of emergency.
- In the event of an emergency, flush your eyes until the wash bottle is empty.

Mobile-Phone Spectroscopy

Procedure

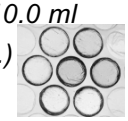
1. Obtain a 15 ml plastic conical tube containing *15.0 ml "stock" solution.*
2. Use a plastic pipette to withdraw exactly 5.0 ml of *"stock"* solution from the conical tube and place it into a small plastic cup. *(This leaves 10.0 ml stock solution in the plastic tube.)*



Mobile Phone Spectroscopy

Procedure (cont.)

3. Add 5.0 ml water to the plastic conical tube, replace the cap and mix thoroughly. *(This gives 15.0 ml of solution again!)*
4. Withdraw 5.0 ml of the diluted stock solution from the conical tube and place it into a second plastic cup. *(This leaves 10.0 ml drink mix in the plastic tube again.)*



Mobile-Phone Spectroscopy

Procedure (cont.)

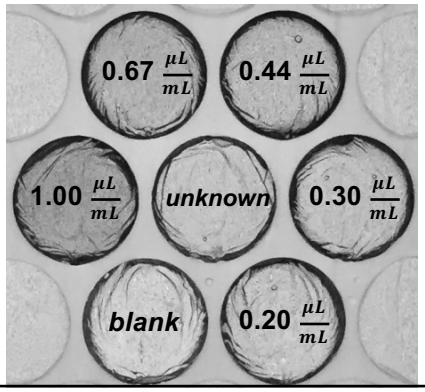
5. Continue this dilution process three more times until all but one of the provided plastic cups are filled.
6. Fill the last plastic cup with 5.0 mL water (blank).

Mobile-Phone Spectroscopy

Procedure (cont.)

6. Use a push pin to puncture seven (7) bubbles in a piece of ½" bubble wrap in a "daisy" pattern.
7. Carefully fill the bubbles of the "daisy" to **capacity** with the prepared solutions.

Mobile-Phone Spectroscopy



Mobile-Phone Spectroscopy

Procedure (cont.)

7. Turn on an iPad and launch **AppBox Pro, Notes, Photos** or any other ***free*** app that can project a plain white screen.
8. Select the ***"Flashlight"*** or other **white screen** function and set the background to white light.
9. Place the filled bubbles onto the iPad and slide the iPad into a box that is ~35 cm high.

Mobile-Phone Spectroscopy

Procedure (cont.)

10. Position a mobile phone on top of the box so that the camera lens is aligned with the pre-cut hole on the box.
11. Focus the camera on the center of the samples and take a photo. *(Double tap iPhone to lock white balance.)*
12. Inspect the image to ensure that it is suitable.

Image Analysis

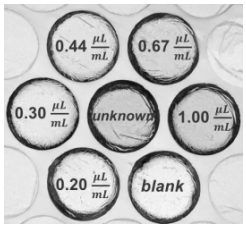
1. For photo analysis directly on the phone use any of the following:

   ColorAssist Pixel Picker
   iDropper **Color Mate**

2. Images may be analyzed on a computer using **"*ImageJ"*** available from the ***National Institute of Health***.

   http://imagej.nih.gov/ij/

Mobile-Phone Spectroscopy



Dilution Math

$$1.00\,\frac{\mu L}{mL}\;x\;\frac{10\,mL}{15\,mL}=0.67\,\frac{\mu L}{mL}$$

ImageJ

Procedure

1. Select the *Analyze* drop-down menu.
2. Select "Image", "Color - Split Channels"
3. Select *Set Measurements…*

   ✓*check: mean value*

3. Select the oval shape in the shapes tool bar.
4. Select a representative part of the image in the first bubble cell in the RED channel.
5. Use keyboard command, ⌘**M,** to analyze image and collect data.

ImageJ

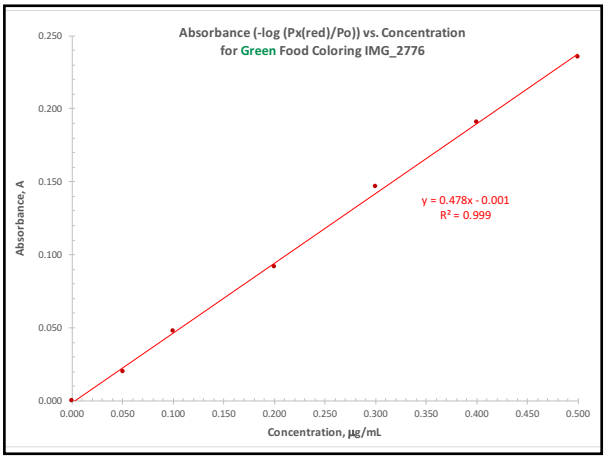
Procedure (cont.)

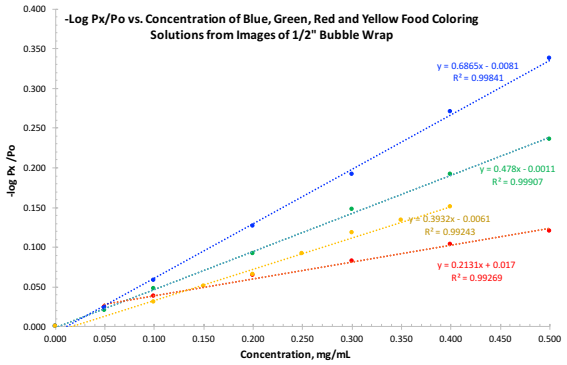
6. Move the oval shape to the next bubble and use keyboard command, ⌘**M**, to analyze image and collect data again. Repeat until all bubbles are analyzed.
7. Cut and paste the tabular data from the **Results** window into a graphing program for review.
8. Other color channels may be evaluated by splitting the color channels.

ImageJ

Procedure (cont.)

7. **RGB** and ***gray scale*** values should be evaluated and the best channel used.
8. Plot P_x vs. Concentration and then absorbance ($-\log(P_x/P_o)$) vs. Concentration. Determine the best fit calibration curve for each graph. *GraphPad.com, Alcula.com, LibreOffice.org*
9. Determine unknown concentration using equations derived above.





Conclusions

- A new colorimetric method incorporating bubble wrap as a storage medium was presented.
- Colorimetric results are readily obtained with mobile phone cameras.
- Free, open source software (***ImageJ***) allows for the easy preparation of standard curves.

References

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