



TeachEngineering

Much More Than Pretty Colors



Subscribe to our newsletter at TeachEngineering.org to stay up-to-date on everything TE!


Brought to you by



POWERADE

POWERADE  @POWERADE

...

What do you get when you compile a list of the best [#BluePowerade](#)  tweets and user content? This. Very. Moment.



— POWERADE  @POWERADE

Drink. Blue. Powerade.

 19

 28

 193





GATORADE®
THIRST QUENCHER

ORANGE

NATURAL FLAVOR

80
CALORIES
PER BOTTLE

12 FL OZ (355 mL) ©



GATORADE®
THIRST QUENCHER

FRUIT PUNCH

NATURAL FLAVOR

80
CALORIES
PER BOTTLE

12 FL OZ (355 mL) ©



GATORADE®
THIRST QUENCHER

BERRY

ARTIFICIAL FLAVOR

80
CALORIES
PER BOTTLE



GATORADE®
THIRST QUENCHER

LEMON-LIME

NATURALLY FLAVORED WITH
OTHER NATURAL FLAVORS

12 FL OZ (355 mL) ©





INGREDIENTS:

**WATER, SUGAR, DEXTROSE, CITRIC ACID,
NATURAL AND ARTIFICIAL FLAVOR, SALT,
SODIUM CITRATE, MONOPOTASSIUM
PHOSPHATE, MODIFIED FOOD STARCH,
GLYCEROL ESTER OF ROSIN, BLUE 1**

**Have you ever thought about
what makes a good food
coloring?**



A good food coloring needs to be:

- **Soluble in water**
- **Able to retain their color for a long time**

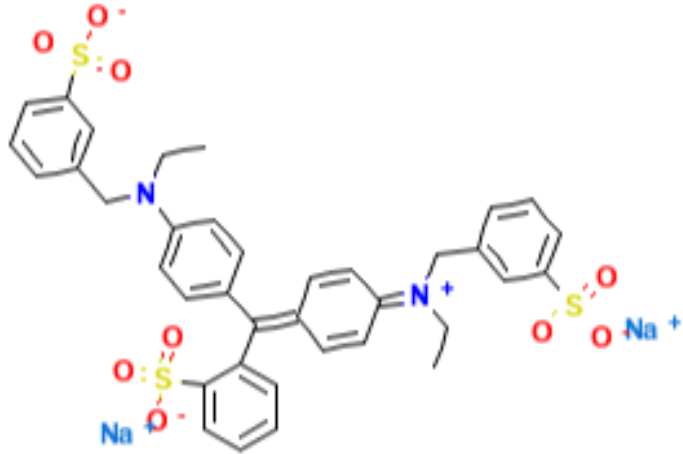


How is that possible?



FD&C blue dye #1

Ionic compounds that dissolve in water are polar.



Food dyes absorb and transmit a certain color



How much?



Absorbance and concentration are related

Engineers use this relationship in quality control laboratories for food and pharmaceutical industries.

Today's Activity

Lab Connection: Measuring the absorbance of solutions with various concentrations of food dye and measure the concentration of a Gatorade sample.

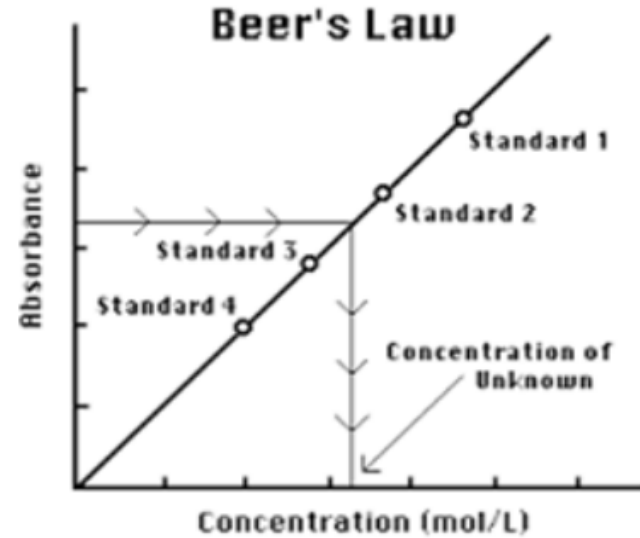
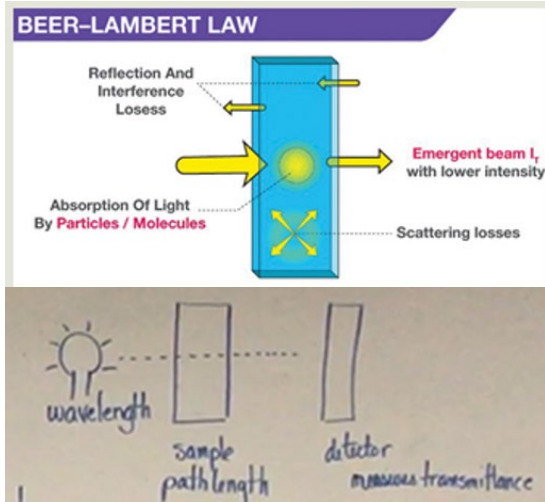
Engineering: To design/construct a spectrophotometer/measuring instrument/analyzers

Teacher Demonstration - Absorbance

Food dyes have molecules that absorb some wavelengths of light and let others pass through.

Absorption is caused by bringing an electron in a molecule, atom, or ion to a higher energy level.





$$y = mx + b$$

$b = 0 = y$ intercept is zero

$$y = abc$$

Absorbance \propto concentration

Absorbance = constant \times concentration

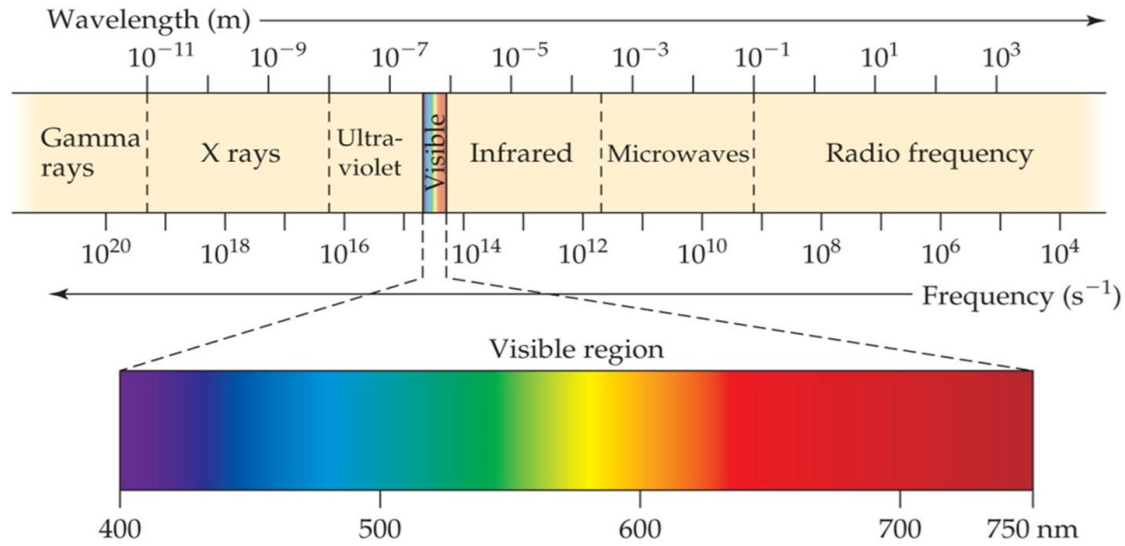
Absorbance = abc

Where a = absorptivity is constant for the substance

b = pathlength which is going to be same for the instrument (cuvette)

c = concentration

$$A = \epsilon bc$$



- **Spectroscopy is the study of the interaction of light and matter as a function of wavelength.**
- **Engineers and scientists use spectroscopy as a tool to analyze the interaction between light and matter.**

Unknown Sample - Gatorade

**Known Sample - Stock solution with
blue food color**

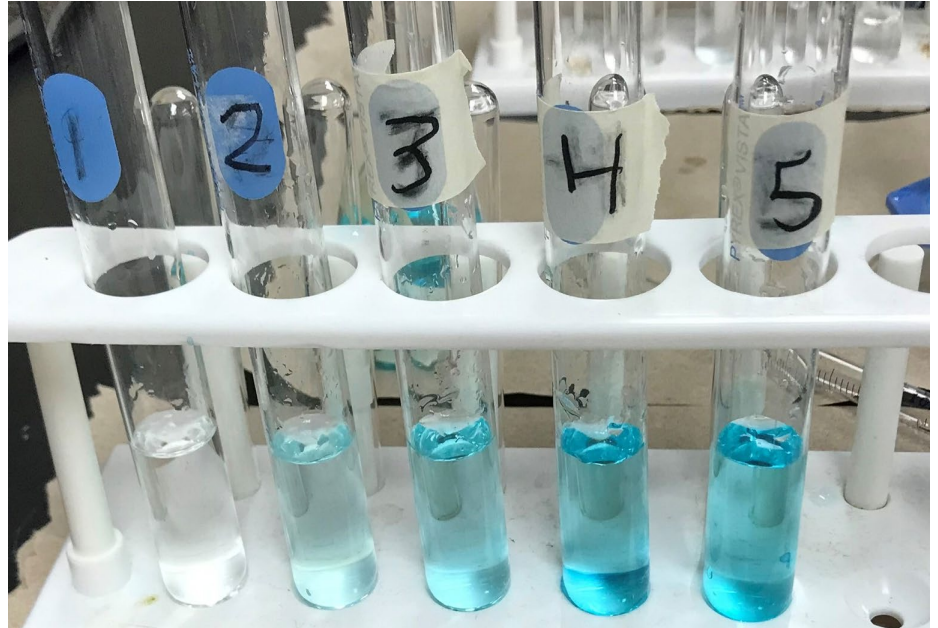
**What is the unit of
concentration of a solution?**



Molarity (M)

Write the dilution formula

$$M_1V_1=M_2V_2$$



$$M_1 = 6 \times 10^{-6} \text{ (for all)}$$

$$V_2 = 10 \text{ ml (for all)}$$

V_1 from the data table

Substitute and calculate M_2

$$M_1 V_1 = M_2 V_2$$

$$6 \times 10^{-6} \times 2 = M_2 \times 10$$

$$M_2 = (6 \times 10^{-6} \times 2) / 10$$

Data Table

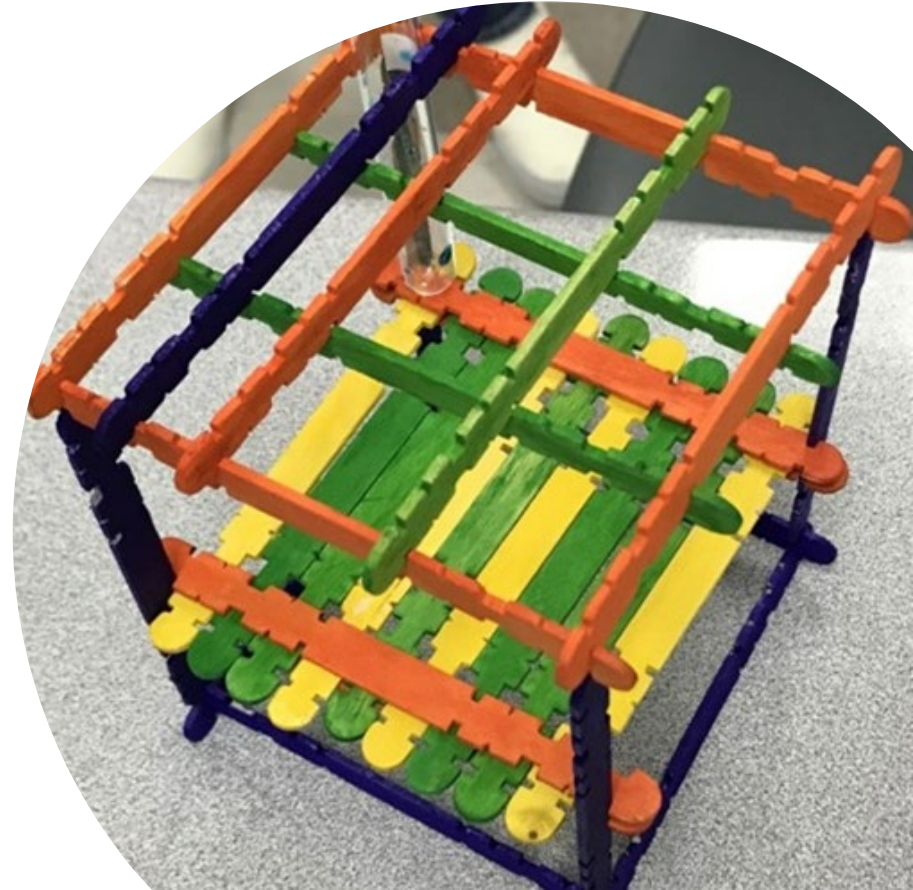
$M_1 = 6 \times 10^{-6}$ (for all) $V_2 = 10$ ml (for all)

V_1 (from the data table) Substitute and calculate M_2

Test tube #	Volume of the stock solution (ml) V_1	Volume of water (ml)	Concentration of diluted sample (M) $M_1V_1 = M_2V_2$
1 Blank	0	10	0
2	2	8	1.2×10^{-6}
3	4	6	2.4×10^{-6}
4	6	4	3.6×10^{-6}
5	8	2	4.8×10^{-6}

Construct a spectrophotometer with the given popsicle sticks.

Make a sample holder that holds the sample, the detector and light source at an appropriate distance.



Download ColorimeterX on your smartphone

App Store Preview



Colorimeter X 4+

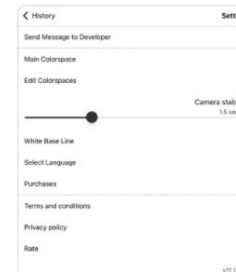
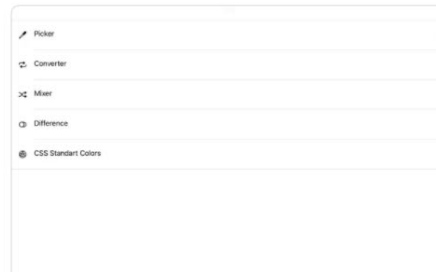
Detailed color information

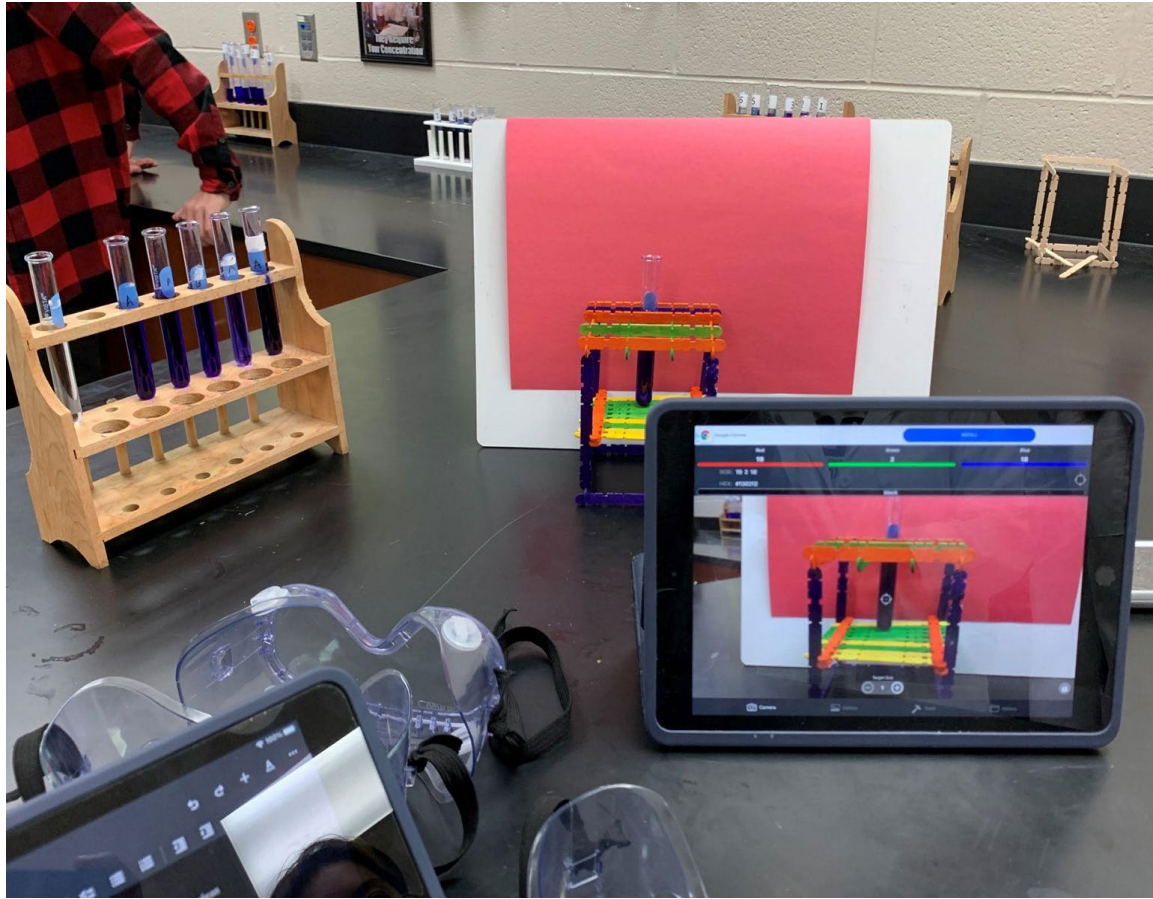
[Dmitry Svishchov](#)

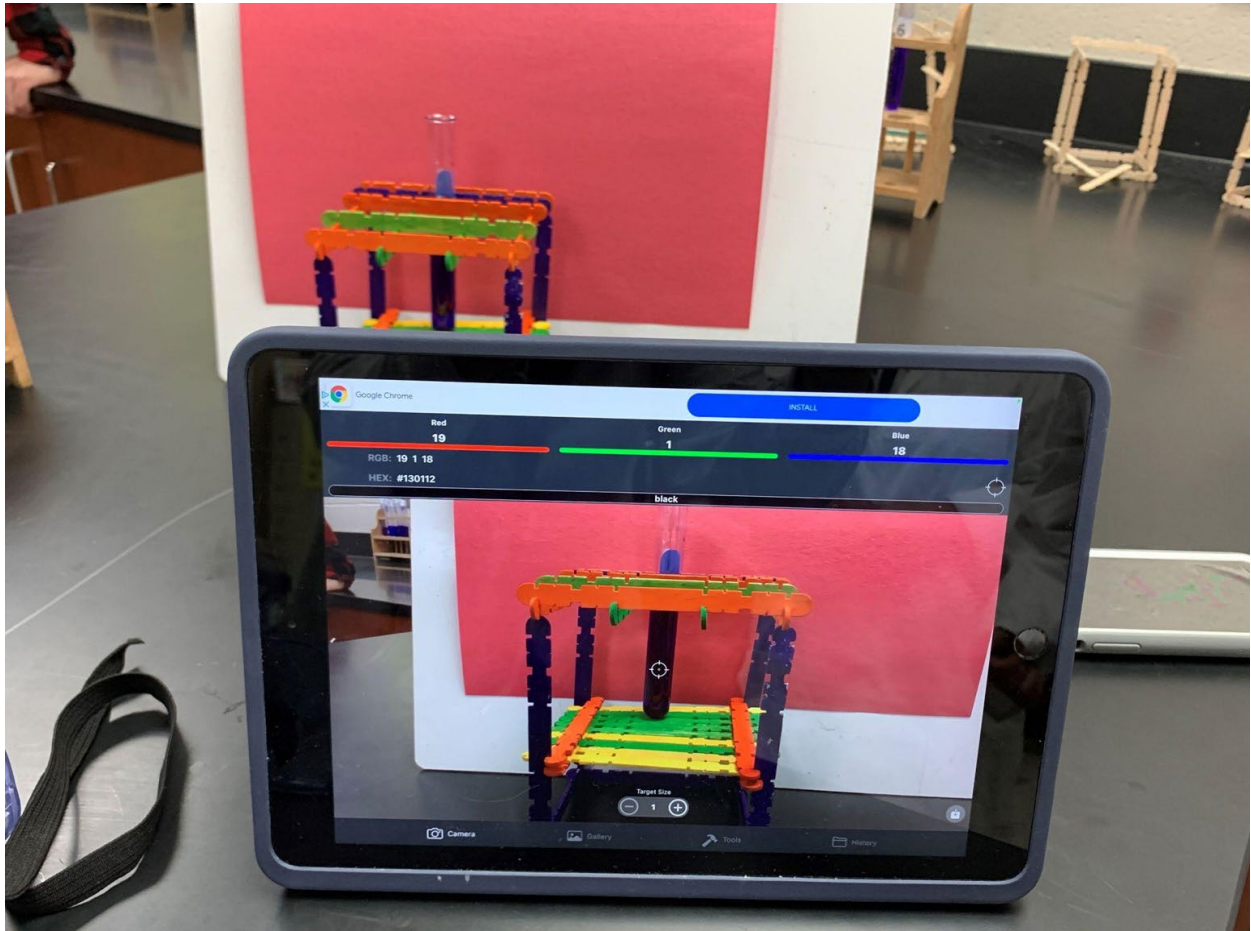
Designed for iPad

Free · Offers In-App Purchases

Screenshots [iPad](#) [iPhone](#)







Procedure to measure absorbance:

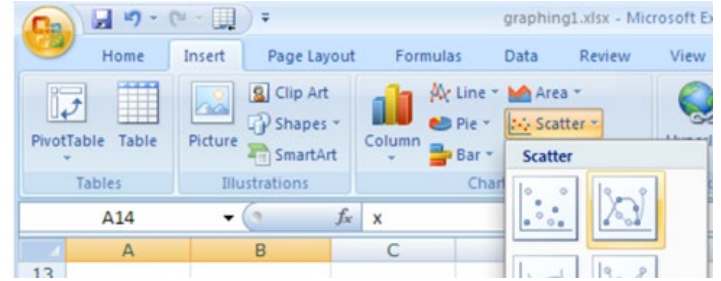
- 1. Take 10 ml of the blank (distilled water) and wipe the side to make it clean and dry.**
- 2. Tap the color identifier on your smartphone and record the red value on your data sheet.**
- 3. Repeat steps 1-3 with diluted samples # 2-5.**
- 4. Record the data in the data table in the appropriate concentration row.**
- 5. Take a picture of your experimental setup and include it in your lab report.**
- 6. Measure the absorbance of the unknown sample.**

Data Table

Test tube	Stock Solution (6×10^{-6} M)	H ₂ O (ml)	Concentration (M)	R value	Absorbance = $-\log(I/I_0)$
1	0	10	0.00		
2	2	8			
3	4	6			
4	6	4			
5	8	2			
6	10	0	6×10^{-6}		

Plot a graph on Excel.

- **Graph the data concentration (x-axis) vs. absorbance (y-axis).**
- **Provide an appropriate title and label x and y axes.**
- **Enter the values of concentration and absorbance into two columns.**
- **Highlight the cells and click on scatter plot.**
- **Right click on the graph and click on Trend Line.**
- **Then click on add equation and display equation. You will get an equation in $y = mx + c$ format.**
- **Select Linear as the Fit Equation → The best -fit linear regression line will be shown on the graph for your five data points.**



Additional Pictures of Experimental Set up

