



Using Mobile Applications and Custom-made Devices for conducting Chemistry Practical Tasks

Science Education Section, CDI
Education Bureau

Experiment 4B

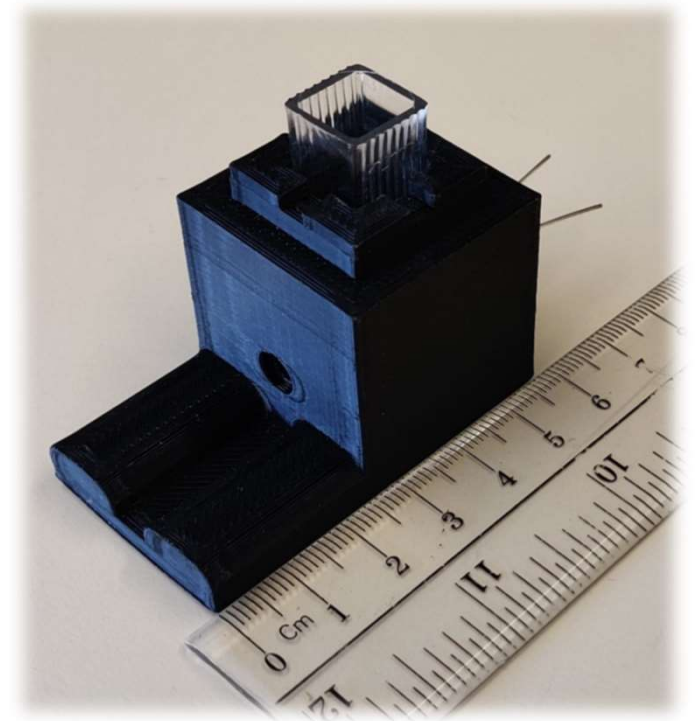
Determination of Ethanol Content in a Beverage (using custom-made LED colorimeter)

- Preparation of colouring reagent, ethanol standard solutions, and the wine sample
 - Refer to Part B of Experiment 4A
- Construction of custom-made LED colorimeter
- Measurements of absorbance of standard solutions and the sample

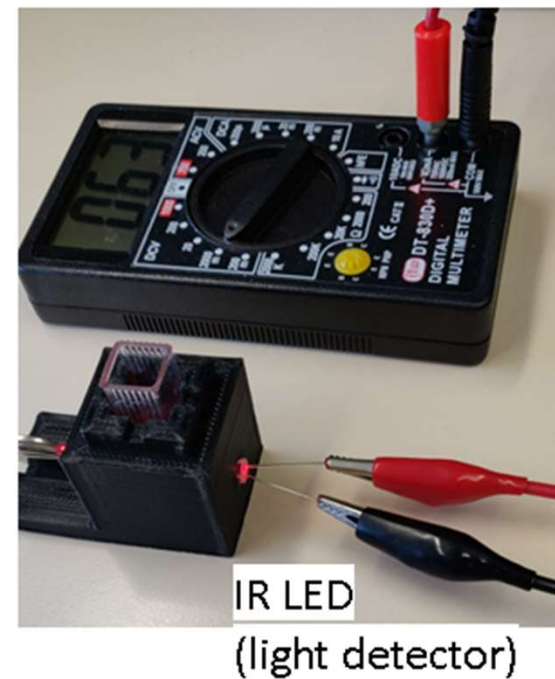
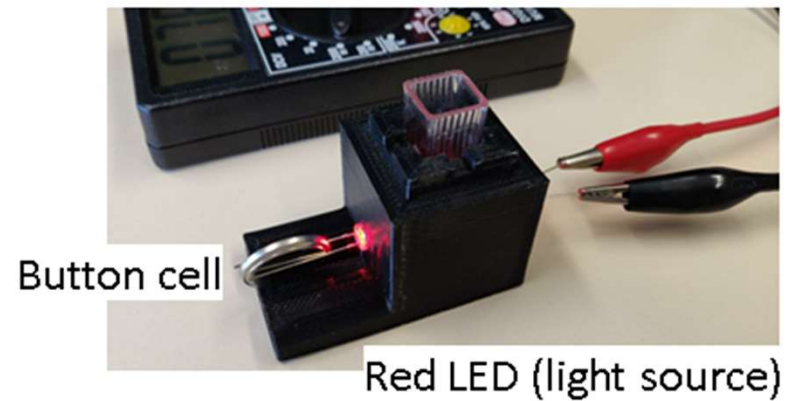
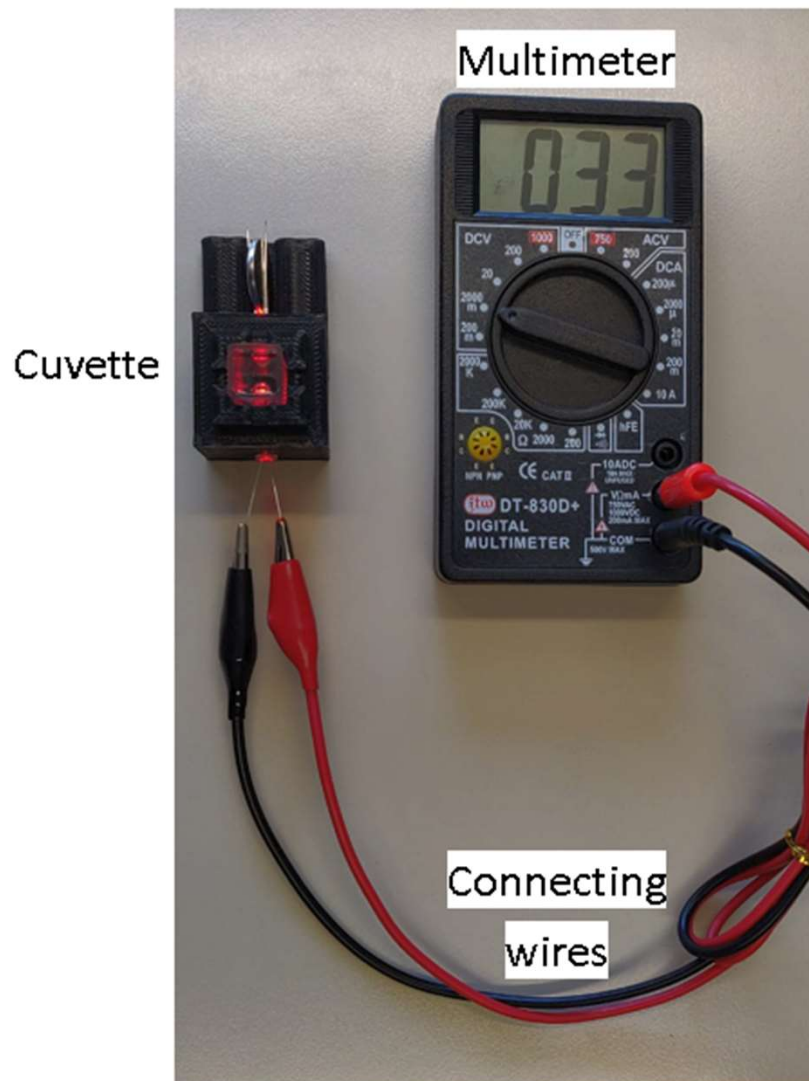
Custom-made LED colorimeter

Equipment and materials:

- Red LED (light source) x 1
- Infra-red (IR) LED (light detector) x 1
- Digital multimeter x 1
- 3V button cell (e.g. CR2032) x 1
- Connecting wires x 2
- Blu-tack
- Custom-made cuvette holder x 1



Construction of LED colorimeter



Measurement of Absorbance

- Blank solution
 - 2/3 fill the plastic cuvette with blank solution (i.e. acidified $\text{K}_2\text{Cr}_2\text{O}_7$ (aq))
 - Place the cuvette in the compartment of the cuvette holder, measure and record the voltage reading on the multimeter.
- Standard and sample solutions
 - Repeat the measurement procedure by replacing blank solution with standard / sample solution in turn.



Results (9/6/2021)

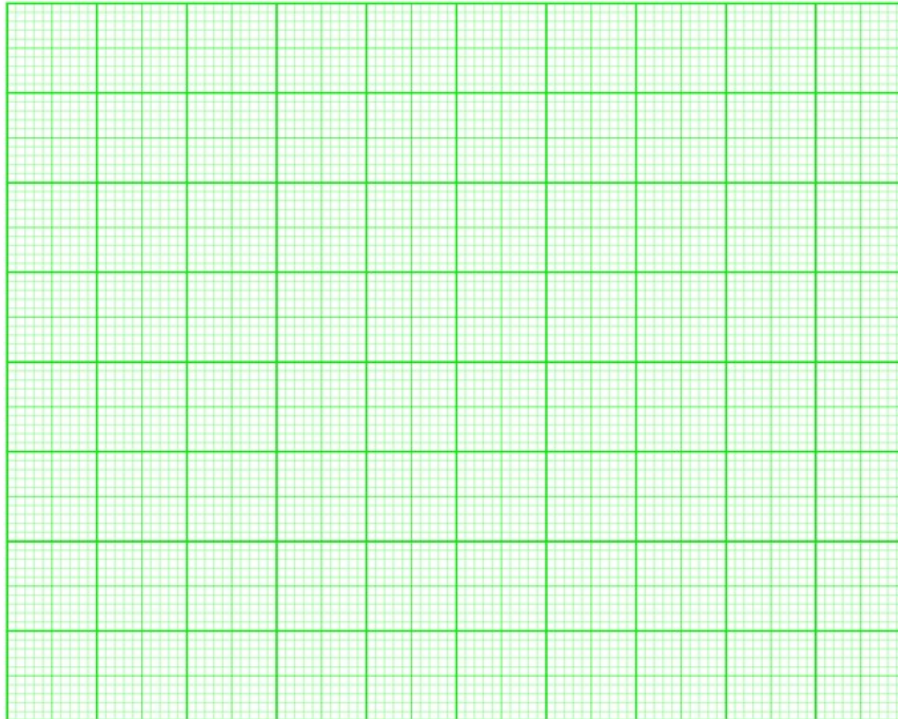
- Complete the following table:

$$A = \log (I_0 / I) = \log (V_0 / V)$$

	Blank	Standard solutions of different alcohol concentration (C)				Sample solution
		5%	10%	15%	20%	
Voltage measured / volt	0.087 (V ₀)	0.063 (V ₀₅)	0.048 (V ₁₀)	0.036 (V ₁₅)	0.027 (V ₂₀)	0.039 (V _s)
Absorbance (A)		0.140	0.258	0.383	0.508	0.348

Results

- Plot a calibration curve (A vs c) below. Since $A \propto c$, a straight line is expected.
- Determine the concentration of the alcohol in the beverage sample from the calibration curve.

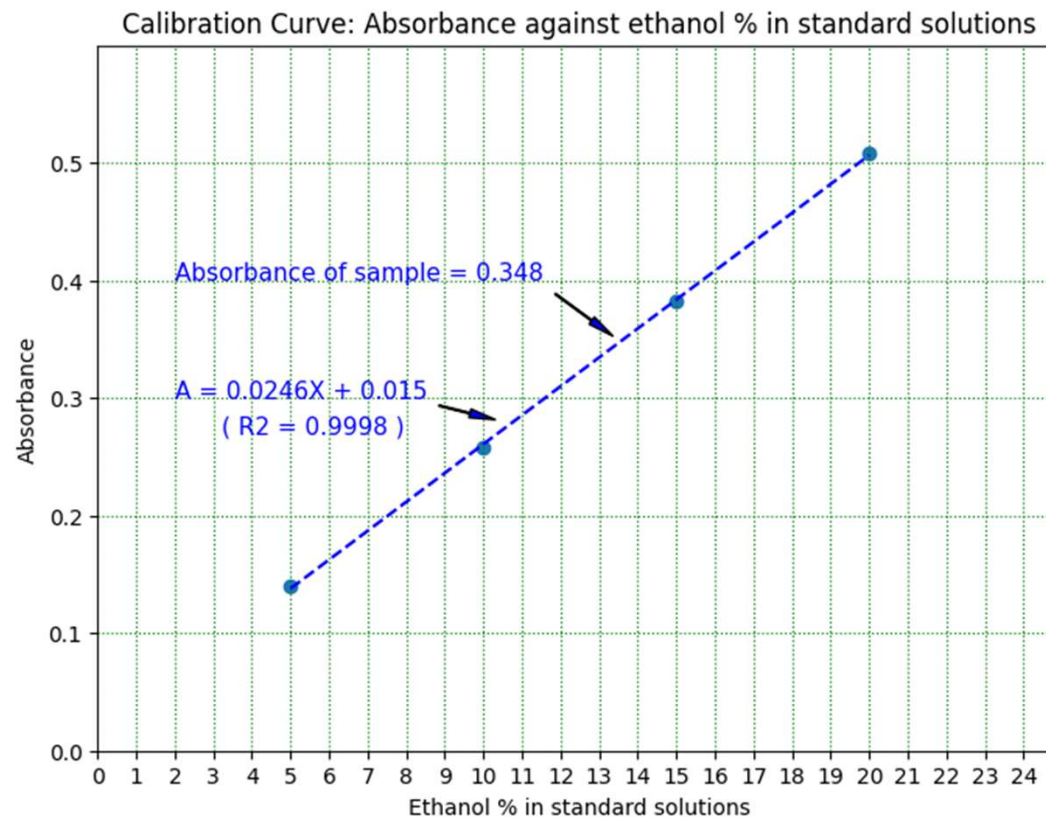


Spreadsheet for checking

	A	B	C	D	E	F
1	Concentration of alcohol (%)	Voltage (V)		Log(V_0/V)		
2	0	0.87	Blank ($K_2Cr_2O_7/H^+$)			
3	5	0.63		0.1402		
4	10	0.48		0.2583		
5	15	0.36		0.3832		
6	20	0.27		0.5082		
7						
8	1. Recorded voltages of standard solution					For equation
9						Concentration
10		Sample	0.39	0.3485		13.54694
11	2. Recorded voltage of the wine sample					
12						
13						
14						

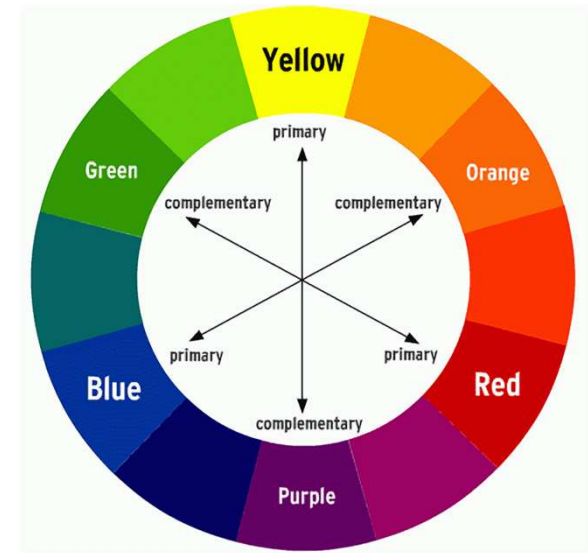
Analysis of the given wine sample

- Sample provided: diluted maotai with alcohol concentration = 13.3% (Original labelled alcohol content = 40%)
- Measured voltage = **0.039 V**
- Absorbance of the sample solution = **0.348**
- Measured alcohol content % of the sample = **13.5%**



Remarks:

- Brightness of the light source should be adjusted so that the measurements falls into the **linear range** of the custom-made colorimeter (Beer-Lambert Law).
- Using a stable power supply for the light course is preferred.
- Complementary colour – the use of different LEDs as light source allows the measurement of light intensity of different colours.
- IR LED can be used to detect visible light and Red LED can be used as a light source

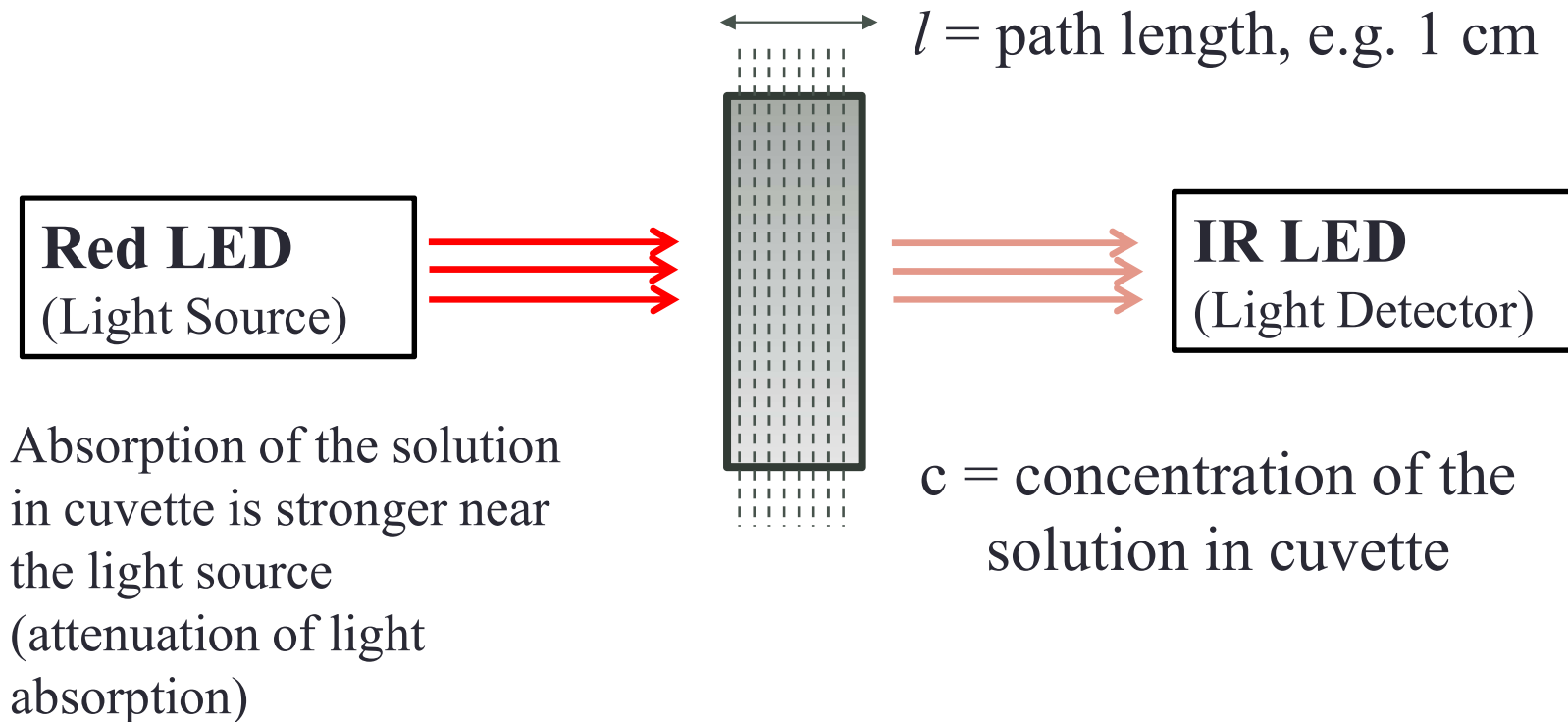


Beer-Lambert Law (for teacher's reference only)

- $A = \log(I_0 / I_s) = \epsilon l c$

ϵ = molar absorptivity

l = path length, e.g. 1 cm



Further L&T activities

1. Further reading

- [Eating with Your Eyes: The Chemistry of Food Colorings - American Chemical Society \(acs.org\)](#)

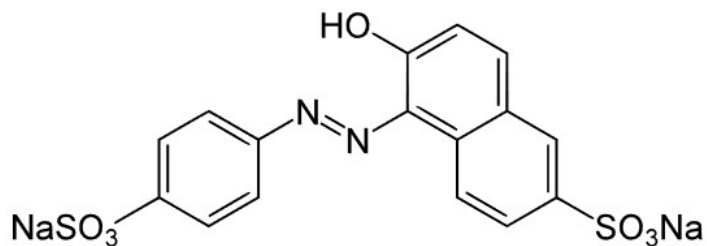
Concepts:

Chemical structures, functional groups, intermolecular forces, solubility, absorbance & transmittance of colour dye

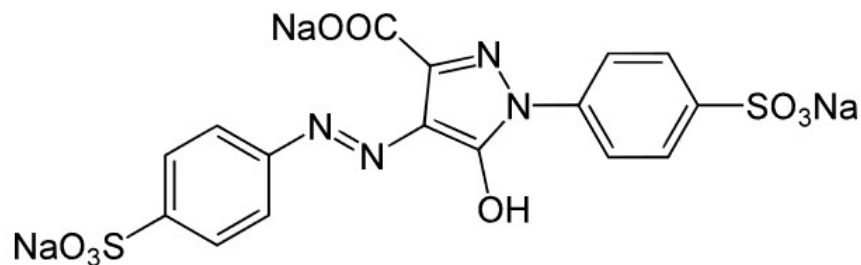
Further L&T activities

Discussion based on the concepts in the reading:

1. Identify the functional groups of sunset yellow and tartrazine.



Sunset yellow



Tartrazine

2. Accounts for the solubility of sunset yellow and tartrazine in water in terms of intermolecular forces/ ionic bonding.

Further L&T activities

1. Further reading

- [食物中的染色料 \(cfs.gov.hk\)](http://cfs.gov.hk)

2. Video on abuse use of food colourant on bigeye fish

- <https://youtu.be/3HLn517ppbU>

Concepts:

colour fading / loss due to exposure to light, air, extremes of temperature and moisture, safety issue

Further L&T activities

Discussion:

1. As mentioned in the article and video, what is the safety issue of the misuse/ abuse of food colourant?
2. According to the video, how does the scientist identify the colour dye?
3. What should we do to avoid consuming abusively added food colourants?