Simple Colorimeter constructed by Micro:bit and Smartphone

The aim of this project

1. Improve students' understanding of the relationship between the concentration of solution and its absorbance – Beer Lambert's Law;

2. Improve students' pratical skills and problem-solving skills;

3. Develop a lower-cost colorimeter with relatively higher sensitivity;

4. Enhance students' integrated skills and interest of science.

Experiment Flow

Prepare standard colored solution

Build up the device

Use the device and ChemEye/Color Picker to measure the RGB value of light after passing through the solution
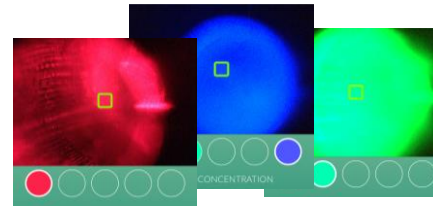
Data Analysis

Introduction

command

FLAT EDGE ▶

RED GND GREEN BLUE

0   1   2   3V   GND

ChemEye
HKBU ARC
OPEN

RGB取色器
Bin Gu
OPEN

CONCENTRATION

Emit specific value of RGB light

Light passes through the solution and it is detected by APP
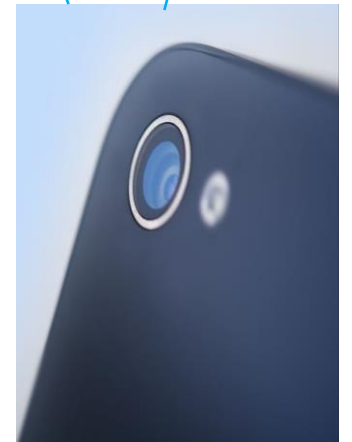
Preparation of Standard Solution (Tartrazine-檸檬黃)
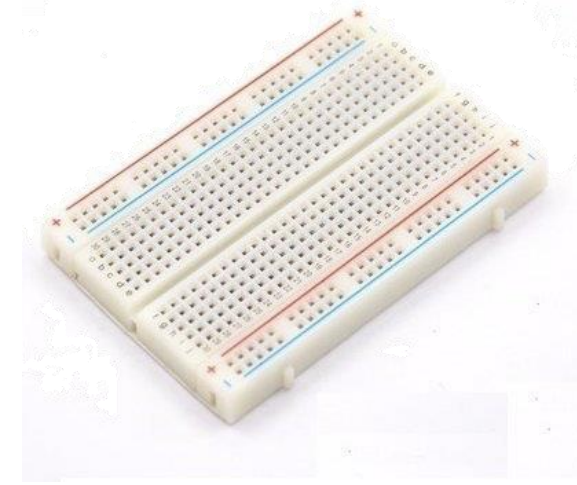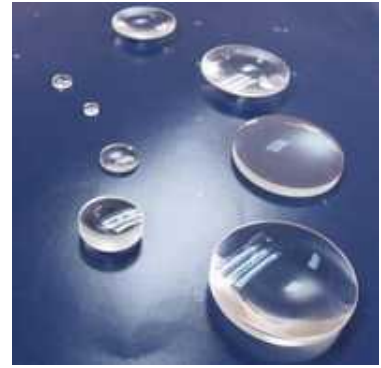

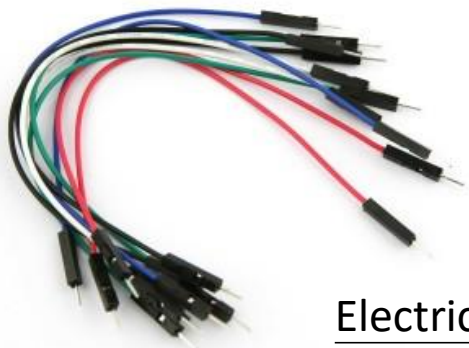**Blank** **20ppm** **40ppm** **50ppm** **80ppm** **100ppm**
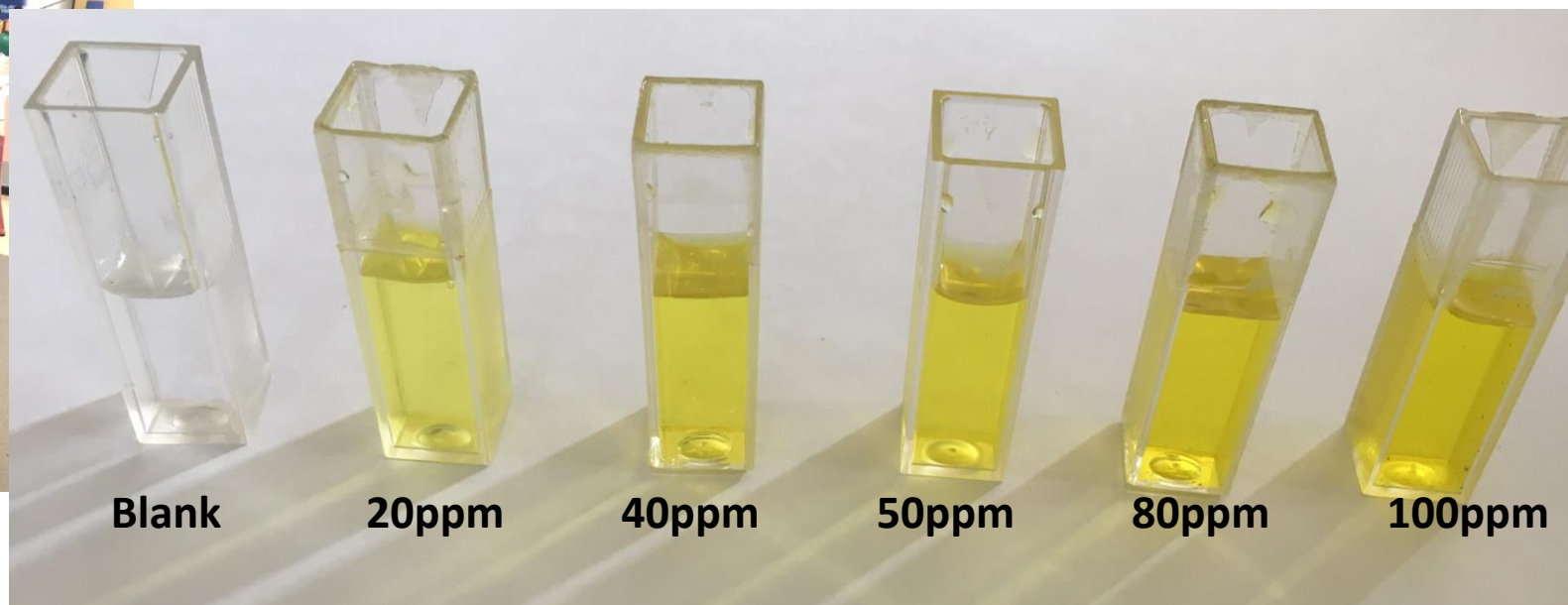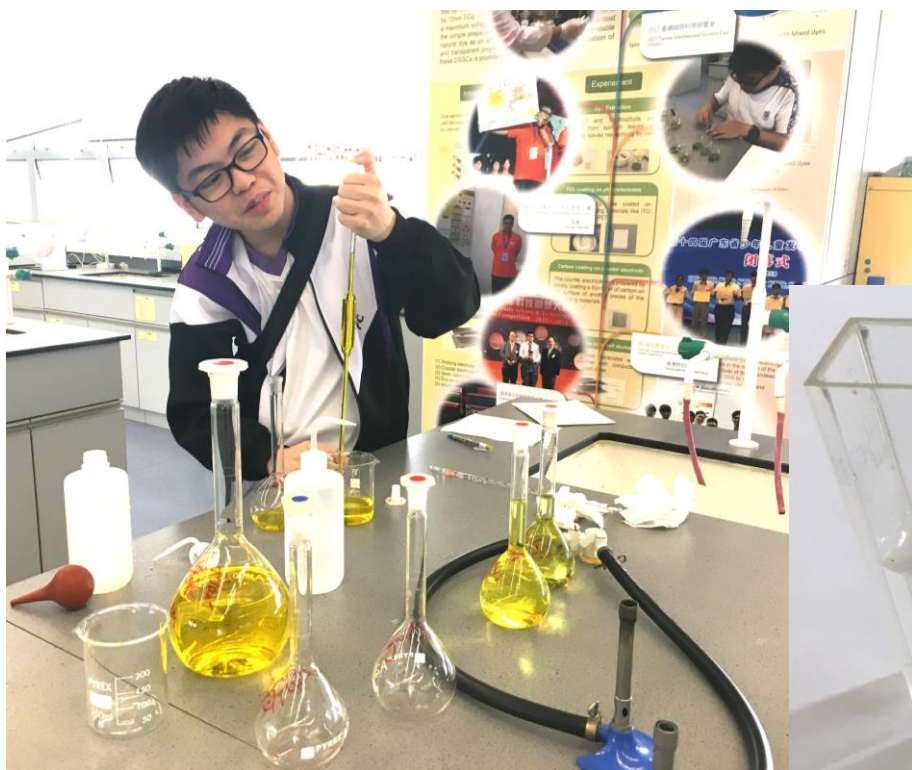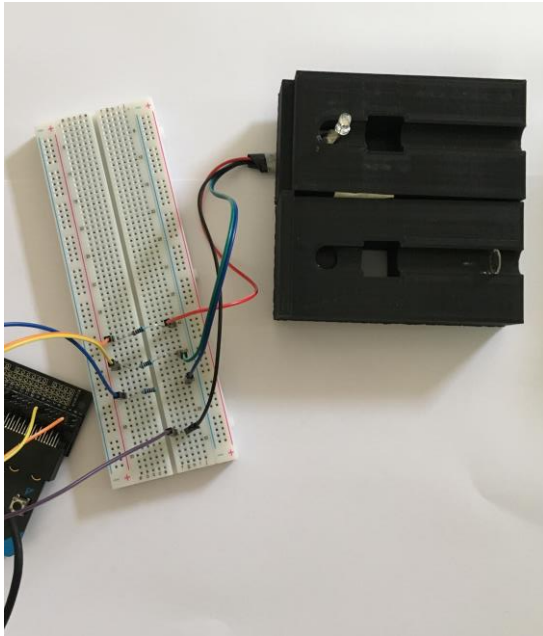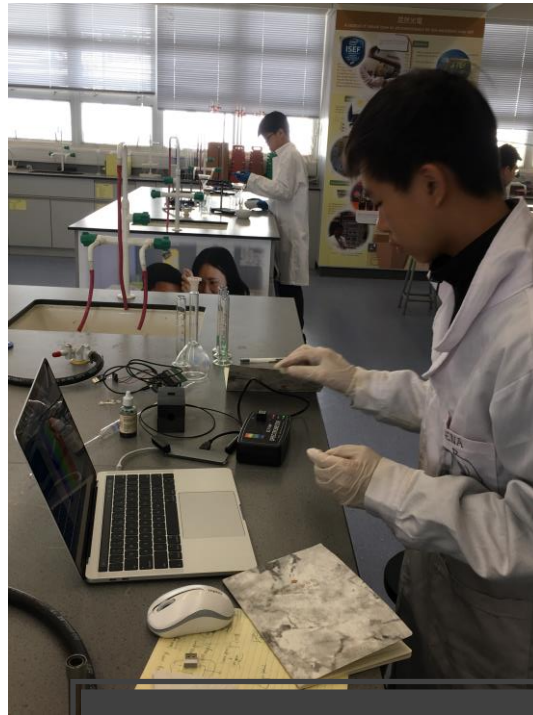
Micro:bit

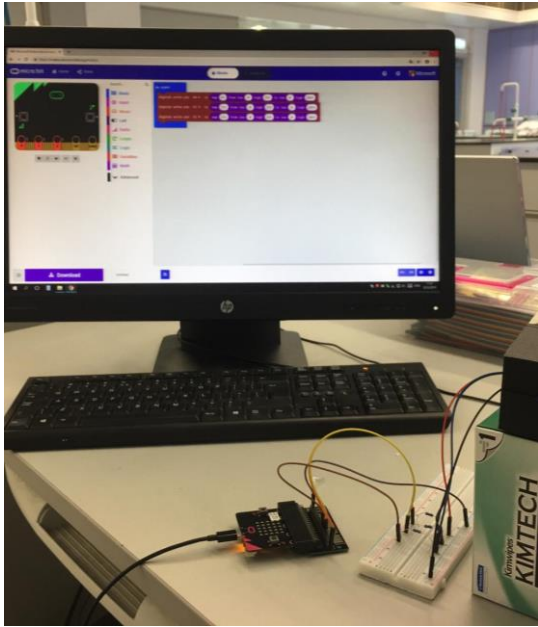
3D-Printing box

Solderless Breadboard
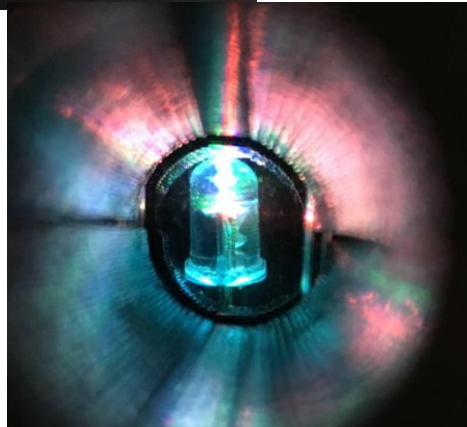

Lens

RGB-LED

Electric Wire
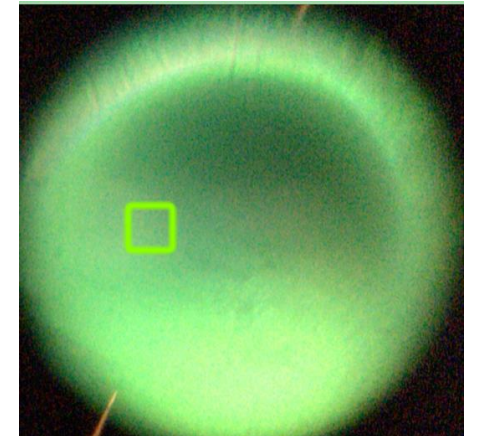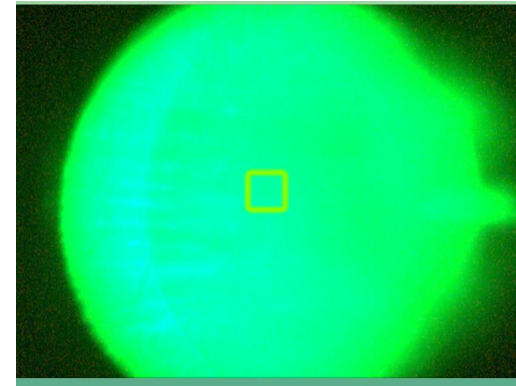
Main Components of colormeter:

Set-up of device

Light Source passes through the sample to the detector

Unwanted ☹

Wanted ☺

Select the most suitable RGB value for the solution of Tartrazine

Coding: Ready for test

Color	Value		Emitted Color		Absorbed Color
R	255	−	196	=	59
G	255	−	169	=	86
B	255	−	16	=	239

forever

analog write pin P0 ▼ to map 59 from low 0 high 255 to low 0 high 1023

analog write pin P1 ▼ to map 86 from low 0 high 255 to low 0 high 1023

analog write pin P2 ▼ to map 239 from low 0 high 255 to low 0 high 1023

micro:bit

➢ Coding: Ready for test

https://makecode.microbit.org/#

➢ Google Drive for more…

https://drive.google.com/open?id=1vO36q5LvfyzhGnbPC7lGpGCa2HTJ-Iu0
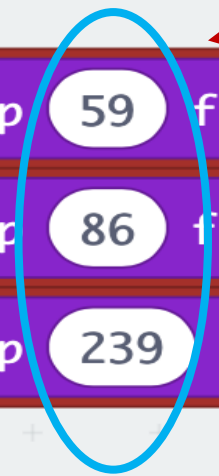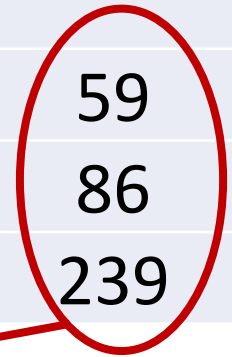
The standard solution is transferred into the cuvette for test, the RGB readings of different concentration of solutions were shown.

Blank   **20ppm**   **40ppm**   **50ppm**   **80ppm**   **100ppm**
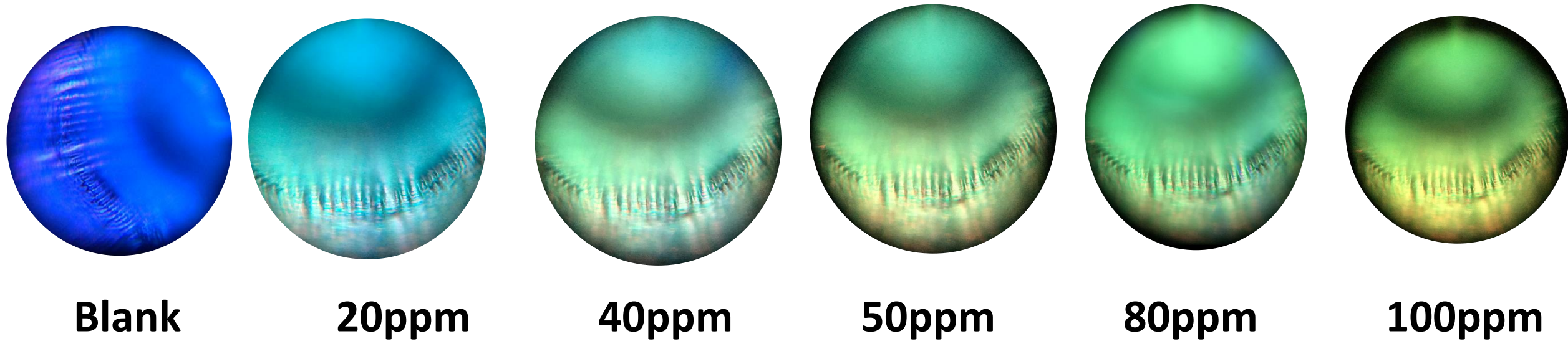
The solutions under the same light appear different colors.

Collect Readings

	0ppm	20ppm	40ppm	50ppm	80ppm
R	2	2	65	75	82
G	84	70	121	126	121
B	253	115	86	67	40

Data Analysis

Transmittance: $T = \dfrac{P_n}{P_0}$

Absorbance: $A = -logT$

	0ppm	20ppm	40ppm	50ppm	80ppm
R	2	2	65	75	82
G	84	70	121	126	121
B	253	115	86	67	40

BLUE	0ppm	20ppm	40ppm	50ppm	80ppm
Pn/P0	1.058577406	0.481171548	0.359832636	0.280334728	0.167364017
log	0.02472262	-0.317700061	-0.44389945	-0.5523231	-0.77633791
-log	0	0.317700061	0.44389945	0.552323098	0.77633791

Develop Calibration Curve

檸檬黃的濃度及藍光吸光度之關係

y = 0.1787x - 0.1181

R² = 0.9625
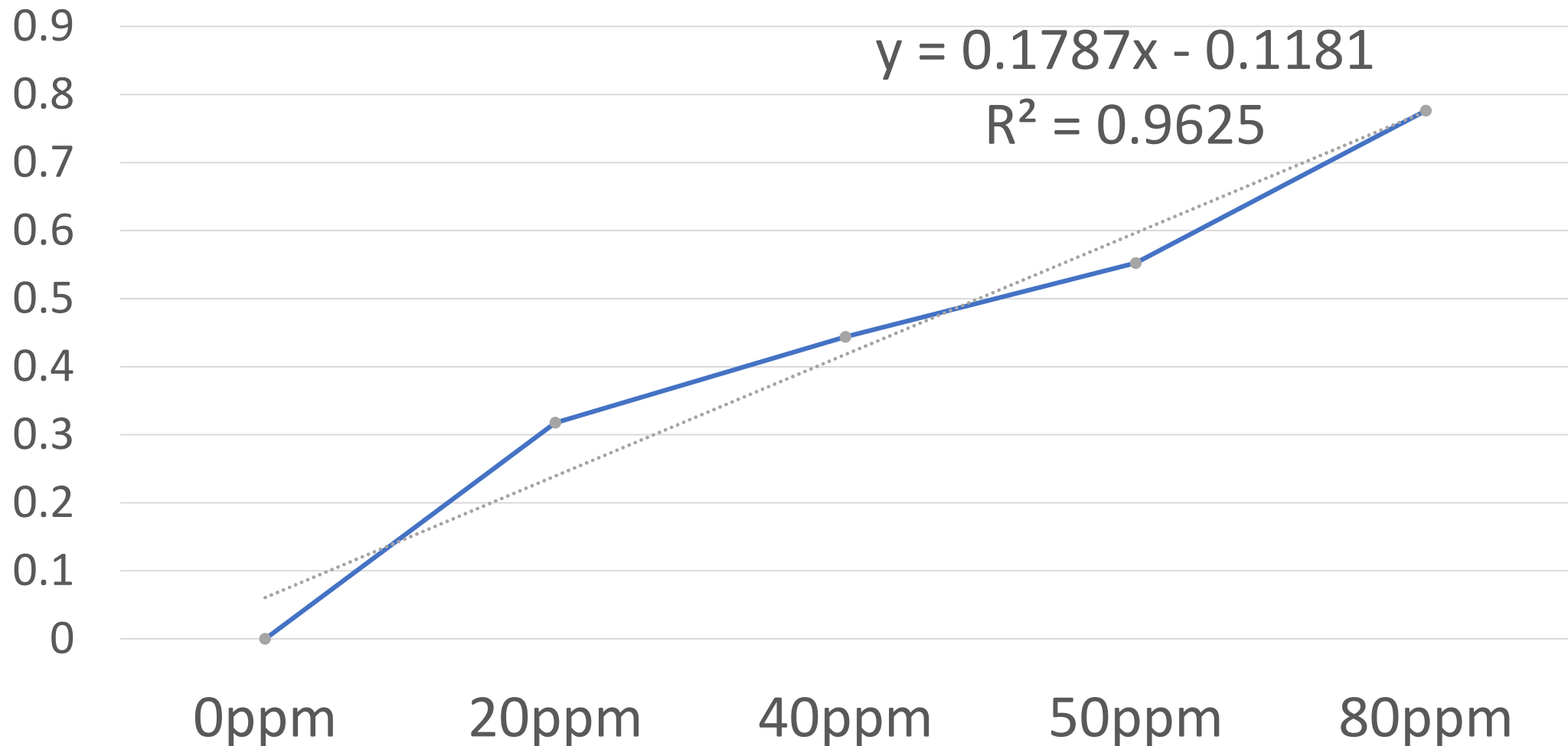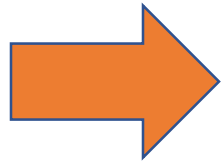
Error and Discussion

1. The smartphone's focal length changes once it resumed. It would cause the error of color recognition.
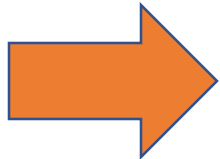
➡️ Use a stand to fix the position of smartphone. Close the function of auto-lock of screen.
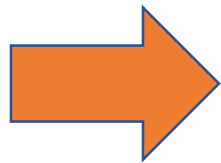
Error and Discussion

2. The Box should be sealed to get rid of any entrance of light. Otherwise, the data would vary and result in a very poor linearity.
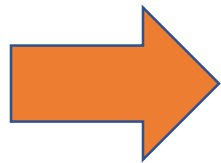
Make sure the box is sealed.

Error and Discussion

3. The RGB value of blank and standard solution solution varied once the APP restarts.

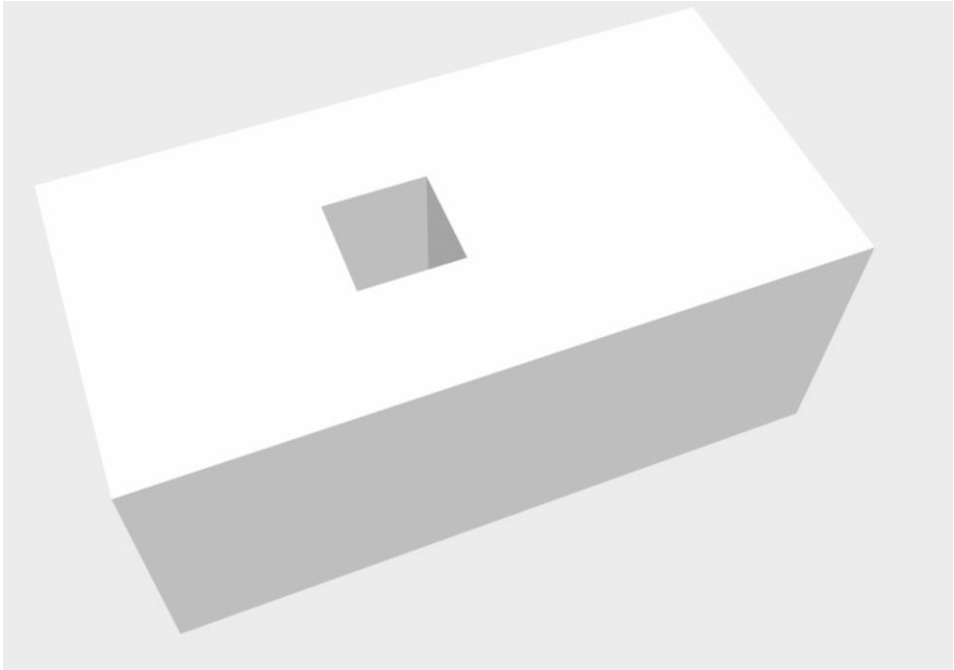➡ The value of blank and standard solution should be retake.

Error and Discussion
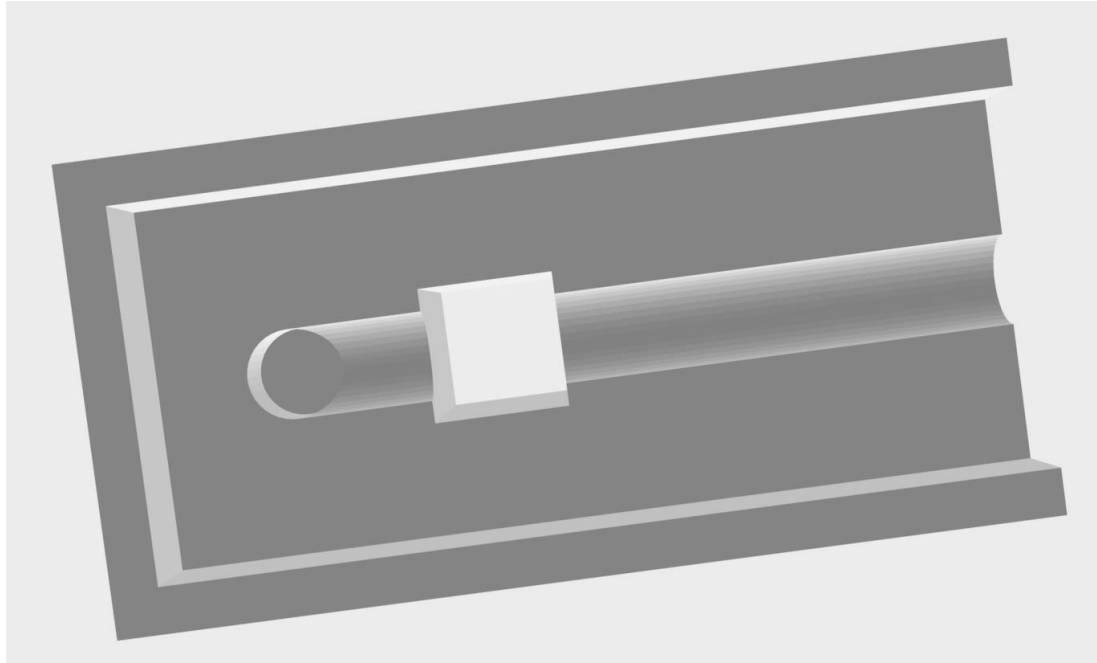
4. The instability of RGB-LED would differ every reading.

Choose a better-quality LED.

Appendix – Design of Box (3D-Printing)

Upper Part

Lower Part

Appendix – Design of Box (Paperboard)