Hong Kong Student Science Project Competition 2022

Team Number: SABC036
Project Title: Colorimeter on mobile phone
Project Type: Investigation

To our best knowledge and after thorough literature research, as at 18/6/2022, there are similar works. If there are, the reference links are as below:

https://www.seas.upenn.edu/~belab/LabProjects/2002/be209f02w7.doc

The enhancement our project has made for the existing related products or research is summarized as below:

In reality, we wish to determine the concentration of a solution due to the weakness of the big-sized colorimeters, it is difficult to carry out easily, and that leads us to design a tiny and portable colorimeter with mobile device with less complicated devices constructed by others.

I. Background

Colorimeters used to measure the absorbance of light waves. During colour measurement, change in the intensity of electromagnetic radiation in the visible wavelength of the spectrum after transmitting or reflecting by an object or solution is measured. Colorimeters in market is big and hard for portable and it normally used in the laboratory.

II. Objectives

The project mainly is to determine the concentration of different transition metal ion solutions by an own-designed colorimeter.

III. Hypothesis

By our own-designed colorimeter, the more concentrated the solution, the colorimeter shows a lower light intensity. Based on the relationship between the molarity and the light intensity, we can find out the molarity of the solution.

IV. Methodology

3.99g of copper (II) sulphate was used to prepare 0.1M of copper (II) sulphate solution. By the same method, we also used 11.97g, 19.95g and 13.96g copper (II) sulphate to carry out 0.3M, 0.5M and 0.25M copper (II) sulphate solution representatively.
0.74g of potassium dichromate was used to prepare 0.01M of potassium dichromate solution. By the same method, we also used 3.68g, 7.36g and 5.45g potassium dichromate to carry out 0.05M, 0.1M and 0.074M potassium dichromate solution representatively.

Preparation of calibration curves

0.1M copper (II) sulphate solution was transferred to the 1mL cuvette, then place it into our own-designed colorimeter. A red LED is used as a light source. A mobile device with the light sensor and the light reading APP was installed for measurement of light intensity. The process was repeated by using 0.3 M, 0.5M and 0.25M copper (II) sulphate solutions.

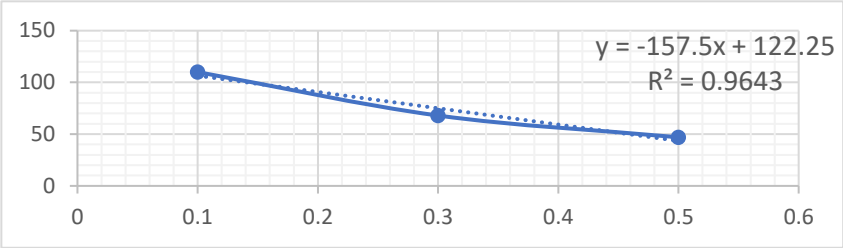
0.01M potassium dichromate solution was transferred to the 1mL cuvette, then place it into our own-designed colorimeter. All setting remains the same but only change the red LED to blue. The reading is recorded. The process was repeated by using 0.05 M, 0.1M and 0.074M potassium dichromate solutions.

V. Results

The prototype of the sample cell is shown below, constructed with toy blocks and its inside is painted black to minimize the experimental errors.

For copper (II) sulphate solution, the transmittance - concentration graph is plotted by following data:

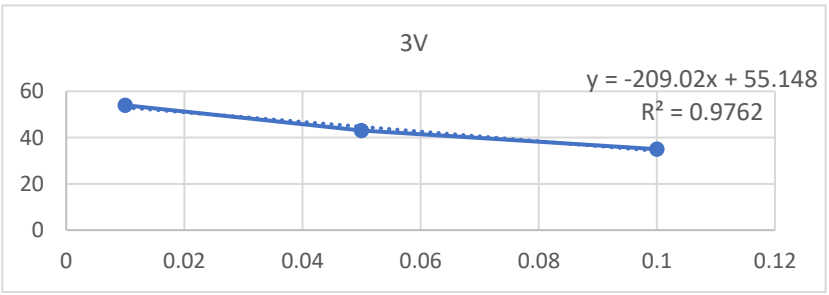
Concentration	Transmittance
0.1 M	110
0.3 M	68
0.5 M	47



After linear regression, the equation is obtained and used to find the molarity of sample solution, which has transmittance 81 units.
From the equation (transmittance = - 157.5 x (molarity) + 122.25), 81 units in transmittance represents to 0.26 M solution. Compare with actual molarity (0.25 M), the deviation is acceptable (~ 4 %).

Same setup is used to plot the calibration curve for potassium dichromate solution.

Concentration	Transmittance
0.01 M	54
0.05 M	43
0.1 M	35



Again, the regressed equation (transmittance = - 209.02 (molarity) + 55.148) is used to find the concentration of the sample dichromate solution, which has 37 units in transmittance.

From calculation, the sample's concentration is 0.087 M, which compare with 0.074 M in actual, the error is 17.5 %.

VI. Conclusion

In this study, it is proved that the mobile device can be used to replace a sophisticated colorimeter.