CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)
Jeremy M. Hahn

Project Number
J1517

Project Title
Using Solutions' Absorbance Spectra to Predict Their Heating by Light

Abstract

Objectives/Goals
It is interesting and practical to determine exactly how much a solution is heated by light. In this project I developed a model to predict a solution's heating rate, used this model to determine what factors affected heating rates, and tested the predictions of the model in real situations.

Methods/Materials
I derived a mathematical model and, using Excel, created a program to predict the heating rate of a given solution under lighting from a given source. Using the yabasic programming language, I created a program to generate fake absorbance spectra of imaginary solutions to compare within the program. I used Sharpie ink solutions in experiments with a tungsten bulb and a laser to test the program in real situations.

Results
Comparisons of artificial spectra showed that heating rate is not directly proportional to concentration, that two solutions with equal total absorbance can heat very differently depending on the wavelengths absorbed, and that "color" and "darkness" are good predictors of heating. Surprisingly, the program predicted the heating rate of the Sharpie solutions held close to a tungsten bulb to be only 3.08*10^(-5) degrees over 12 minutes. Testing showed that the heating rate was very small as predicted. Later, experiments with a laser showed the model to be accurate to within 8%.

Conclusions/Discussion
The program created correctly predicts that heating rate is not proportional to concentration because of absorbance's logarithmic dependence on energy, and the uneven power output spectrum of a typical light source caused two different, equally absorbing solutions to heat differently. The two major surprises of this project were the small predicted heating rate of Sharpie ink solutions irradiated by the tungsten bulb and the fact that color and darkness are actually predictors of heating.

Summary Statement
This project is about how solutions are heated by light, and what factors produce what effects on heating.

Help Received
Father: providing access to equipment at The Scripps Research Institute, editing my work, and advice; Mother: editing, gluing and preparing of board; Teachers: editing; Mike Adams of the Scripps Research Institute: laser experiment.