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A Laboratory Excercise in Gas Chromatography for High School Students

Bernard Hermanson
Sumner High School

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Bernard Hermanson
Sumner High School
Sumner, Iowa 50674

Introduction

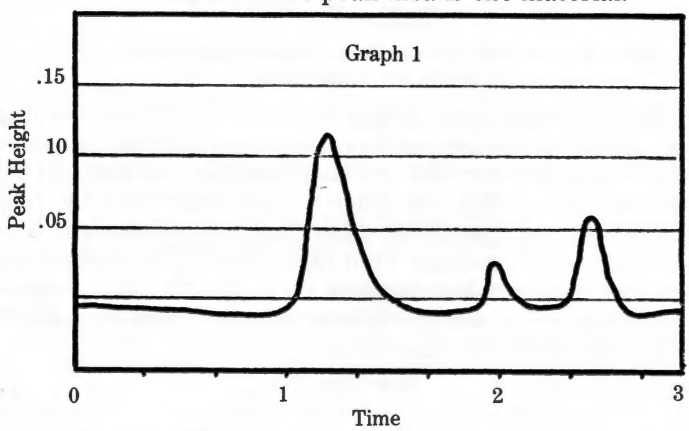
Gas chromatography is a sophisticated tool for the isolation, identification and quantification of chemical compounds. The purpose of this exercise is to introduce the principles of gas chromatography to first year chemistry students. For the exercise, students inject their own chemical samples, estimate the purity of these samples by counting the number of peaks on a print out, measure retention times for the materials observed, and compare the "r" values to those of known substances.

Methods and Materials

Students are first introduced to chromatography by using paper chromatography to separate various colors of inks. From this activity they are taught concepts such as separation, carrier, and retention. A SEP-PAK®[1] cartridge is used to demonstrate the separation of food dyes through the use of a liquid flowing through a closed column. Comparisons are then made between these two forms of chromatography. The detection device is explained only to the extent that the student learns to interpret graphic output.

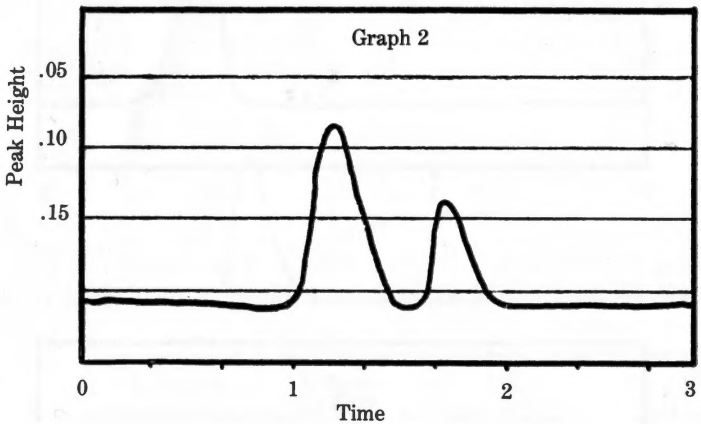
Graphs 1-7 are given out and the following questions asked:

Graph 1 How many materials were present in this sample? (answer: 3) This question is asked to reinforce the idea that one peak means one material.

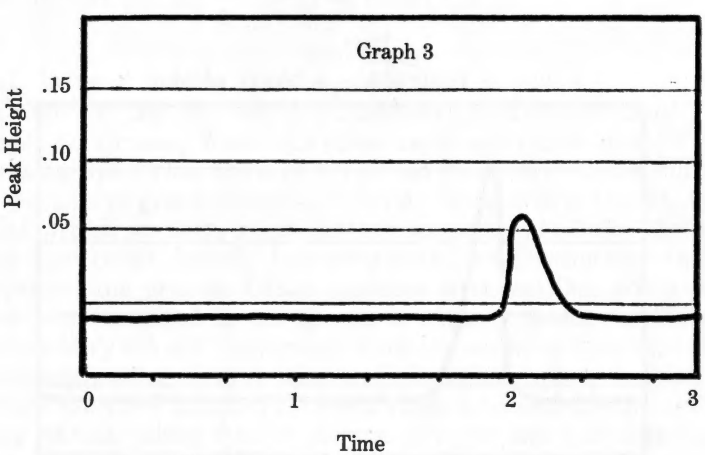


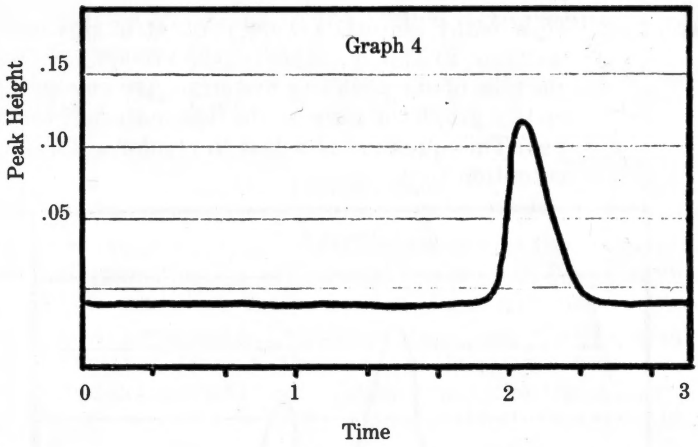
[1] SEP-PAK® available from Waters Associate Inc., Milford, MA 01757.

Graph 2 How many materials were present in this sample? (answer: 2) This question is asked to again reinforce the idea of one peak to a material. Are any materials on this graph the same as the first material? (answer: yes) This question is asked to reinforce the idea of retention time.



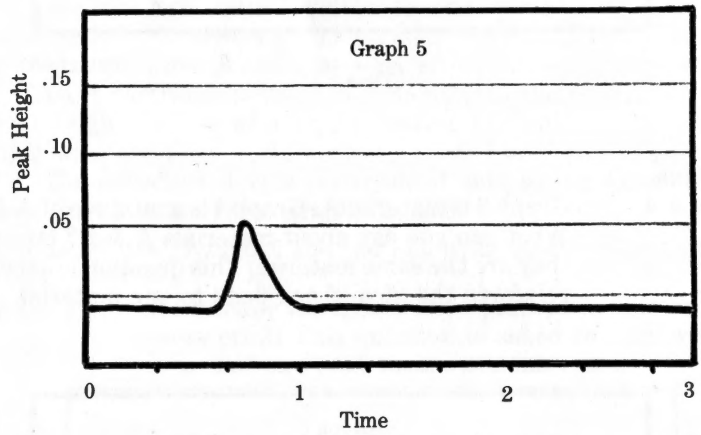
Graphs 3 & 4 Graph 3 is material A. Graph 4 is a mixture of A & B. What can you say about materials A & B? (answer: they are the same material) This question is asked to reinforce the idea of one peak to one material.



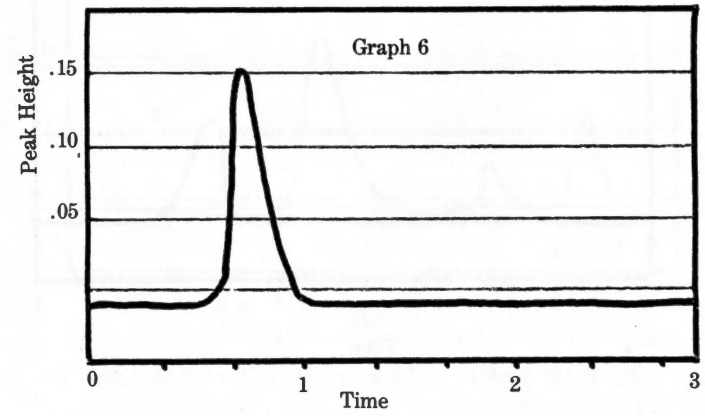


Graphs 5-7

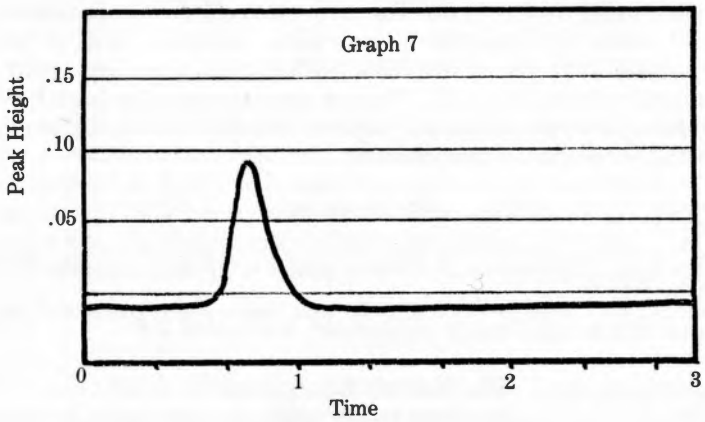
Graph 5 represents a blood alcohol level of .05%.



Graph 6 represents a blood alcohol level of .15%.



Graph 7 represents an unknown level from an arrested person. If the law says that .1% or higher is the legal drunk level, was the above person legally drunk or not? (answer: no, at .095%) This question was asked to reinforce the idea of peak height being proportional to amount.



After this introduction to the machine and its output, students are given the task of fractionally distilling an unknown mixture containing some pair of the following compounds: pentane, hexane, heptane, methylcyclohexane, 2-2, dimethylbutane, and cyclohexane. They are to carry out the distillation, collect two fractions that they consider to be pure and then inject their own samples on the gas chromatograph to check for purity (number of peaks). Then they inject the original sample to identify the components using a comparison of retention times between the sample and the original materials.

Summary

At Sumner, the day was organized so that Dr. Collins of Viterbo College, La Crosse, Wisconsin introduced and demonstrated the gas chromatograph to the 5th and 8th period chemistry classes during 5th period in a large group situation. Then the remainder of the 5th, 6th, 7th and 8th period students injected their samples and labeled their print-outs so they could identify their print-outs the following day when they interpreted the graphs. Other teachers were notified and a student helper was recruited to act as retriever and messenger during the non-chemistry 6th and 7th periods when the students were scheduled to leave study halls and other classes in order to inject their samples. All 40 students ran their samples between 12:30 p.m. and 3:10 p.m. without feeling rushed, taking 5 to 10 minutes to inject and run their samples.

Out of the 40 students, 100 percent correctly identified one material and 85 percent correctly identified both materials on the first try. On the

second try, 95 percent of the students were able to identify both materials. Since this was a trial unit, no formal test was given. None of the 40 students had to ask how to interpret the results. Some students actually reached the point of taking over and running the entire operation of the machine by themselves. A survey that was handed out indicated that only 1 of the 40 students felt rushed and confused.

This unit will be done again. The interest level shown was extremely high and, since the experiment was done, students have constantly referred back to the machine and have asked more questions about what the machine can and cannot do. We now plan to expand the unit for blood alcohol level determination and hope to include a reaction completion monitoring experiment using esters.

References

Bauer, H., G.D. Christen, and J.E. O'Reilly. 1978. *Instrumental Analysis.* Allyn and Bacon pp. 678-708.

Willard, H.H., J.A. Dean, and L.L. Merritt. 1965. *Instrumental Methods of Analysis (4rth ed.).* Van Nostrand-Reinhold pp. 495-524.

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The Hawaii Experience
July 16-29, 1981

For the second year, a special program will be offered from July 16-29, 1981, to provide educators with the opportunity to study in Hawaii, earn university credit and enjoy the environs of Hawaii.

Last summer, 16 participants snorkeled their way in and out of the coral reefs, hiked Waipio Valley (including an optional hike to the base of the 1000 foot falls), descended into and hiked across the craters of Kilauea and Kilauea Kri, walked through a lava tube, swam in the Royal Bath, soaked in a natural "hot tub," made replication of petroglyphs, and visited the City of Refuge, Pearl Harbor, and the Polynesian Culture Center as well as other interesting sites. The islands of Hawaii and Oahu became "living laboratories" for their observations and field studies in geology, marine biology, biology and botany. Have you thought about planning your vacation around a similar workshop in Hawaii?

A pre-session was held to teach the fundamentals of snorkeling so that each participant could experience the "wonders of the deep." Selected readings and field projects enhanced the learning environment for participants. The program was flexible, allowing for participants to capitalize on their own interests and have some time on their own.

The program may be taken for graduate or undergraduate credit, although this is not essential. The program includes roundtrip air travel, instruction, lodging for five days at Waikiki Beach, ground transportation, most meals and some special activities. The cost based upon current airfare is $1,150. For more information, contact: The Hawaii Program, 455 Physics Building, University of Iowa, Iowa City, Iowa 52242.