Multimedia Problems in General Chemistry

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Textbook problems are an important part of a General Chemistry course because they give students an opportunity to practice using the concepts they have learned in lecture. They have the disadvantage of being text-based without much reference to things students have observed in laboratory or lecture demonstrations. They also usually are classified according to the sections of the text to which they correspond. This is useful for beginners, but reinforces the compartmentalization that is one of the weaknesses of the traditional General Chemistry course.

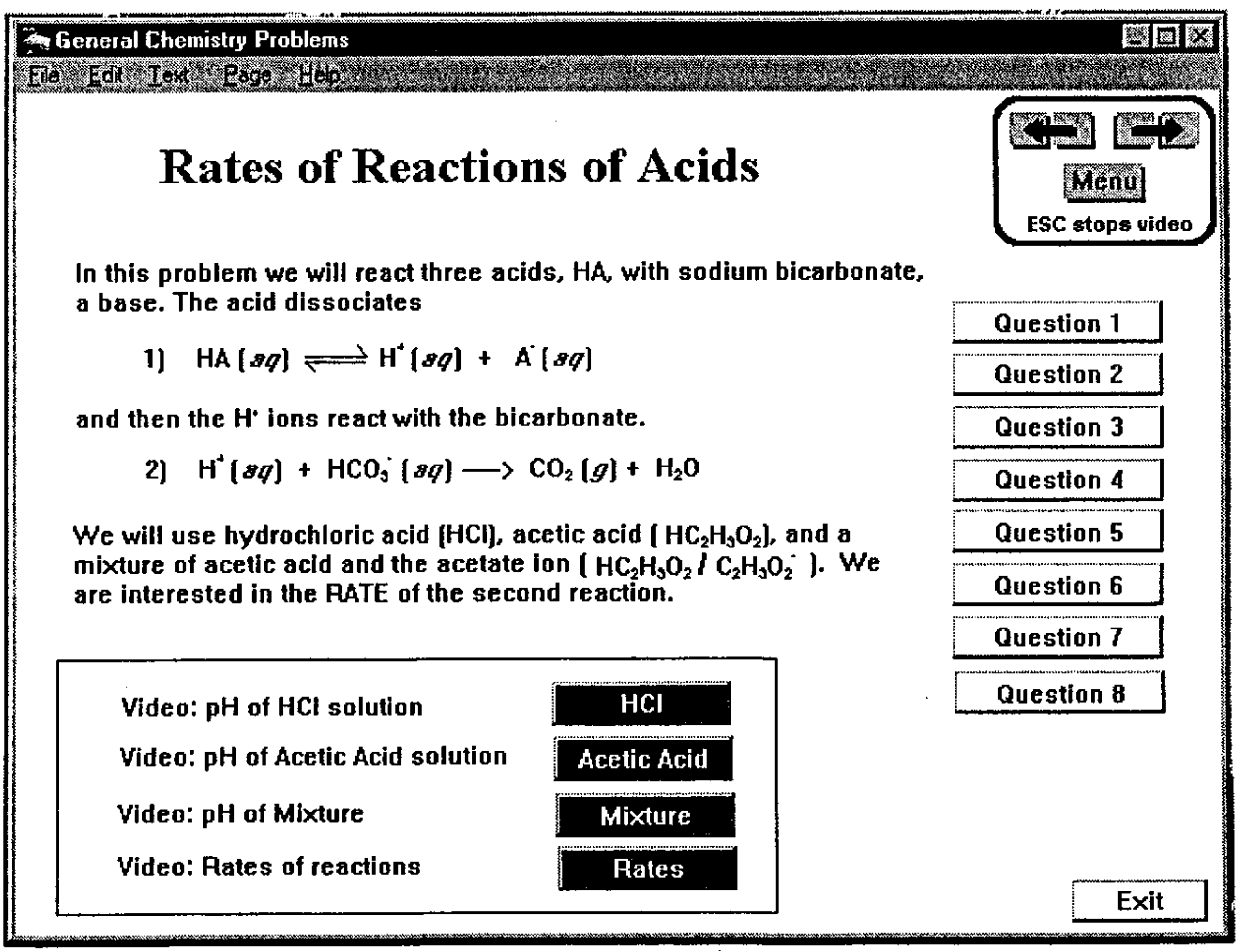
For the last two years, in cooperation with John Moore and others at the University of Wisconsin, I have been developing multimedia problems to supplement textbook problems for the General Chemistry course. These problems, written for Intel-based PCs using ToolBook 4.0 and Quicktime video, draw on the large number of chemical demonstration videos available through the Journal of Chemical Education: Software1. The problems are based on observations that students make in videos of the demonstrations. They draw on concepts from different sections of the course and emphasize conceptual rather than numerical problem-solving. We furnish the problems and video files on CD-ROMs for the students to work on out of class. At the present, answers are not furnished with the problems. We have used these problems in several ways.

1. During the course, the students could work the problems, just as they would problems out of the textbook. They then are responsible for the problems on examinations.

2. At the end of the course, different students could be asked to write an essay on different problems, answering the questions in detail.

3. The problems could be assigned as extra credit for the course, with written answers turned in for credit.

As an example, one of the problems deals with



the influence of pH on the rates of reactions of different acid solutions with sodium bicarbonate. The questions in the problem are based on the concepts of pH, buffer solutions, strong and weak acids, rate laws, strong and weak electrolytes, and the microscopic interpretation of acid dissociation. The problem screen looks like the accompanying figure.

The students work through the eight questions using the video buttons to see video clips when needed. The first question describes three solutions — hydrochloric acid, acetic acid, and an acetic acid/acetate buffer. The first three videos show the measurement of the pH of these three solutions using pH paper. The students are asked if the relative pH values they observe agree with what they expect and to explain their answer. In Question2, as a follow-up the students are asked to calculate the pH of the buffer and to compare the results of the calculation with their observations.

In question 4, the students are asked to think about the rate law for the second reaction, H^+ (aq) + HCO_3^- (aq) —> CO_2 (g) + H_2O. How would they expect the rate of the reaction to vary with $[H^+]$? For which of the three acid solutions in this problem would they expect the reaction with bicarbonate ion to be highest? They then observe the fourth video, which shows the reactions with the three acids. The relative rates of reaction can be determined from the rate at which CO_2 bubbles come and go in the test tube.

The questions also sometimes ask about a microscopic representation of what the stuents have seen. Question 6 shows four different representations of the HCl molecules in solution — one undissociated, two partially dissociated, and one completely dissociated[2]. The students are asked which picture best illustrates that HCl is a strong acid and why they think so.

Finally in Question 8, the students observe videos of the measurement of the electrical conductivity of three unknown solutions (one is water, one HCl, and one acetic acid) using a light-bulb probe. They are asked to think about the relative number of ions in each solution and to decide which solution corresponds to which unknown in the videos.

At the present we have finished twenty three of these problems on topics ranging from the drinking bird toy to the paramagnetism of solids, the phlogiston theory of combustion, and the electrolysis of water. Student reaction to the problems generally has been positive (with the exception of one situation in which the videos were incompatible with the computer network). The students seem to take them seriously. We are in the process of testing the problems further and hope to make them available to others later.

Acknowledgments

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1 ChemDemos I and II Laser Videodiscs, JCE: Software Special Issues, University of Wisconsin-Madison, Department of Chemistry, 1101 University Ave., Madison, WI 53706

2 Smith, K. J.; Metz, P. A. J. Chem. Educ. 1996, 73, 233.

Is There a Future for JCE Software?

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The title of this article may be surprising to readers who recall my article in last spring's newsletter (1) in which I reported many new developments at JCE Software. It comes from a question asked by a colleague visiting Journal House a few months ago. As he passed through my office, he asked if, with the comprehensive CDs developed by textbook publishers, there really was any reason to continue to publish the small programs that have been the staple of JCE Software issues. At the time I was a bit defensive. Upon reflection, I realize I should not have been.

It is obvious that JCE Software cannot compete with commercial publishing companies who can afford to hire teams of professional computer programmers and graphic artists to work with chemistry educators in developing instructional material. We do not have the resources, and frankly, it has never been our goal to provide a compressive chemistry curriculum on disk, CD, the Internet, or any other media. Our purpose has been and remains to make available innovative new