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Karen Kay Canestraight

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INVOLVING PARENTS IN A CHEMISTRY CURRICULUM

By

Karen Kay Canestraight

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ABSTRACT

INVOLVING PARENTS IN A CHEMISTRY CURRICULUM

By

Karen Kay Canestraight

A program to increase parental involvement with their student's education was designed and implemented in five college prep chemistry courses. The primary goal was to increase the average time per week that parents and students spent interacting with each other about chemistry. Other goals included increasing student awareness of household chemicals and increasing the amount of independent laboratory work that students perform.

The primary method for achieving these goals was to have students perform a series of eight experiments at home that required the use of household chemicals. They then discussed the experiment with a parent and obtained their signature. A lab sheet was given with a few instructions and the teacher provided necessary materials.

A survey was given to both parents and students before and after the series of experiments. The average time that parents and students spent conversing with each other about chemistry increased somewhat but the time discussing other school issues was unaffected. Parents thought their involvement was beneficial and made excellent suggestions for improvement. Students resisted having to work independently but thought it was a unique, beneficial experience.

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INTRODUCTION

Statement of the problem and rational for the study:

When I was deciding on a topic for my thesis, I focused on one aspect of teaching that was very important to me. I wanted the study to be something that fit well into my established curriculum. A lack of time has limited what topics in chemistry I can teach each year. It was hard for me to imagine some other topic, unrelated to what I normally cover, replacing something like redox reactions. I wanted a topic that would compliment what I already do instead of replace it. The idea of developing and analyzing home labs came to me through a colleague of mine. He mentioned to me how much he enjoyed doing an at home experiment each fall because it was something positive parents would bring up at parent teacher conferences. I recalled that parents seemed to attach to that one thing they had seen their child do and bring it up at parent teacher conferences. According to my colleague, they had, at least for that one evening, talked to their child about what they were learning. This conversation with my colleague, along with my own observations about parents being out of the loop in the education of their children, were the seeds of this project.

The purpose of this study was to try to increase the degree of involvement of parents in their children's chemistry education. Parental involvement in their children's education is very important to the success of that child. There are many ways a parent can show support. They can choose to live in a community where high taxes fund a comprehensive school system. They can join parent groups. Most importantly, they can impress upon their children the importance of education and demonstrate their beliefs by getting involved with the child's learning experience. Parents can communicate with teachers regularly to keep abreast of the topics being covered in school and the progress their youngster is making. They can attend parent teacher conferences. Most significant of all, they can talk with their child on a daily basis about what they are learning. The parents can give praise when topics are mastered and support when they are still in the process. If a parent is continually having this type of conversation with their child, the child will sense that their parents feel school is important and they will think it is too.

One source for the lack of communication between parents and the school community might be curriculum related. When the child is in elementary school, the parent can help them read, do mathematics and create science projects etc. As students advance in their education, however, they study areas where their parents may not have expertise or even rudimentary knowledge of the subject. This causes parents to be less likely to participate in topic- based discussions. Additionally, as students mature into teenagers they begin to assert their independence and are less likely to seek parental guidance in many areas including academics. The result is a void of communication between students and their parents regarding chemistry and other school subjects. Parents are unable to state what material their child is currently learning and the extent of their progress with it. Research findings, reported in the pedagogical review of this document, support the idea, however, that parental involvement increases the academic success levels of students. Even as children mature into adults, communication between students and their parents is extremely beneficial. It is a very impressionable time in a young person's life. Increased parental involvement in their child's chemistry education increases success in the course and can then spill over into other subjects as well.

To support the involvement of parents in an eleventh grade college prep chemistry curriculum, I developed eight take home labs. The students were given experiment sheets with instructions, a list of necessary materials, and a time span of at least one week to complete the activity. At the conclusion of each experiment, the students were required to explain to a parent what they had done, what the results were, and what they had learned. As evidence the conversation had taken place, the parent would sign the experiment sheet.

I believed there might be several other benefits to the take home experiment strategy besides the increased involvement of parents. Before this project, the chemistry curriculum revolved mainly around learning in the classroom and from the textbook. The students read about every day applications of chemistry in their textbook but rarely saw chemistry in action. This project might give them the opportunity to have hands on experience with many materials that are commonly found in the home. As a result, it might raise the level of interest in chemistry for many. For students who go on into non-science careers in their futures, the take home experiments might provide them with learning experiences they can see on a daily basis and could trigger recollections of chemical concepts.

Another positive aspect would be that kids would be performing the labs on their own and could not depend on a lab partner. I have noticed in class that some kids seem to take the lead in the laboratory work while others are left to gather materials and record data. It is important for a science student to experience all parts of performing an experiment. Having to do the lab on their own may build their confidence in labs in chemistry and also in other science classes the student may take in the future.

Review of Pedagogical Literature:

Many studies show correlations between a student's socioeconomic status (SES) and their academic achievement. SES is based on a combination of several factors such as education of the mother and father and the total household income. The higher a student's SES, the more likely his/her academic achievement will be greater. The reason for this correlation is complicated and still under research but there are some substantial findings on this topic. In one study, (Baker and Stevenson, 1986) mothers were asked to list as many strategies as possible for assisting their child through school. High SES and low SES mothers listed the same number of strategies on average. The difference came in the number of these that the mothers actually implemented. High SES mothers tended to actively engage in the things they suggested. As a result, they knew more about their child's interests and strengths, and they participated more in scheduled events such as parent teacher conferences.

This information leads one to ask why low and high SES parents respond differently. One study by Annette Lareau (1987) has a possible answer to this question. Two schools, with students having very different average SES, participated in her observations and interviews. Her findings suggest that parents with higher SES felt more comfortable communicating with teachers because they saw themselves as partners in their children's education. The lower SES parents tended to defer to the teacher because they had doubts in their own educational capabilities.

There are high and low achievers even among students with similar SES. When SES factors are controlled, there are several other factors that correlate to high achievement. The most significant of them is the degree of parental involvement. Eva

Eagle (1989) conducted a study to control SES and observed the highest level of education achieved. When parents were highly involved, 27% of the students went on to earn a four-year degree where as when the parents were not very involved, only 8% did. In a follow-up paper she says, "Parents of any social class can contribute to their child's post-secondary educational attainment by monitoring educational progress during high school" (p. 12). Another study (Phillips, et al., 1985) done in 22 school districts in the Milwaukee area reported similar findings. In the report the authors say, "Parental involvement is generally associated with higher school performance even after we control for socioeconomic background and the location of the school in the city or suburbs" (p. 27). It seems then, that although SES is a predictor of student achievement, it is not the sole factor. Instead, the involvement of parents is the significant factor on which to focus.

There is a lot of evidence that parental support improves student achievement. In a book that covers a wide range of research on parental involvement, Rhonda McShane Becher (1984) states, "In summarizing the research on parental involvement, it becomes very clear that extensive, substantial, and convincing evidence suggests that parents play a crucial role in both the home and school environments with respect to facilitating the development of intelligence, achievement, and competence in their children" (p. 39). In a study that compared a private Catholic school that had high achieving students with a public school with lower achieving students (Coleman and Hoffer, 1987), it was clear that the Catholic school parents were more involved. A larger percentage of them went to conferences and PTA meetings, visited classrooms, volunteered, and contacted teachers if there was a problem. The authors stated, "One of the most important factors in a child's success in school, is the degree to which his or her parents are actively involved in the child's education" (p. 52).

A study of 28,000 students (Fehrmann et al., 1987) called "High School and Beyond" also shows a positive relationship between parental involvement and grades. In this report the authors conclude that "parents might well help their high school children achieve higher grades through monitoring (their) daily activities, by keeping track of how they are doing in school, and by working closely with the students concerning planning for post-high school pursuits" (p. 335). Another similar idea was stated as a conclusion for a nationwide study done earlier by McDill et al., (1969). The authors say that the degree of parental involvement is "the critical factor in explaining the impact of high school environment on the achievement and educational aspirations of students" (p. 27).

There are many ways that parents can become involved in their child's education. One way is for the parent and child to communicate about daily learning. There is much evidence to support this method. One researcher, Reginald M. Clark (1983), studied ten poor minority families to determine why some of them had students that were high achievers and some did not. Among factors such as encouragement and consistent monitoring, was the characteristic of frequent dialogs between parents and children. The same researcher in another study (1990) on twelfth graders in Chicago, noted that the difference between high and low achieving students might be the guidance of adults outside of school. He said of high achieving students, "In a given week, this would consist of four or five hours of discussion with knowledgeable adults or peers" (p.19)

Herbert J. Walberg (1984) wrote an article that summarized over 2500 studies on learning. One section discussed how children were very successful when the learning environment of the home was good. An important component of any strong home learning environment is parent-child conversations about everyday events. In a report which reviews research and program evaluations, Suzanne Ziegler (1987) sums the idea up nicely. She says, "The influence of the home on children's success at school is profound. Whether indirectly, as models, or directly, as readers, audience, or homework helpers, parents' learning related and school related activities at home are a very strong influence on children's long term academic success" (p. 5).

As the research presented thus far has shown, parental involvement is extremely important for school achievement. As an educator, this information is valuable. There is a resource out there for my students that is underused: their own parents. One reason that parents are not typically used as a resource may be a miscommunication between teachers and parents. Dauber and Epstein (1993), find that many teachers think that parents do not wish to be involved. The parents disagree saying that they are involved at home but would like more and better information from teachers about how to help. The authors say, "The strongest and most consistent predictors of parent involvement at school and at home are the specific school programs and teacher practices that encourage and guide parental involvement" (p.61). A review of a large body of research on parental involvement draws several conclusions (Kellaghan et al., 1993). One is that parents are more likely to encourage learning activities at home if they are informed of specific things they can do.

Many parents seem to be more interested in being involved in their children's education when they are younger (Stevenson and Baker, 1987). In a study of home and school influences on literacy achievement, Snow et al. (1991) concluded that there was a steep decline in many student's achievement when they entered secondary school that seemed directly related to a decline in support involving parents. Parents were overwhelmed by the variety of staff that their child came in contact with: many teachers, counselors, and administration. As a result, communication and involvement dropped to a minimum.

In another study of parental involvement, Melnick and Fiene (p.7, 1990) find that a "working partnership between parents, teachers, and administrators" may be much more important than the traditional methods of involvement, which are commonly separate from day to day learning activities.

It is abundantly clear that parental involvement is beneficial to all children of any age. Teachers may view parents as being uninterested and unsupportive but in reality they need guidance in how to be involved. If teachers provide specific ways to encourage parental involvement, most parents will participate with a positive effect on the future of their children. This study was developed to implement this concept and determine its practicality in a high school curriculum.

Demographics of the classroom:

This research was performed at a school in the suburbs of Lansing, Michigan. The population of the school was approximately 1338 and included grades nine through twelve. The school is not diverse with 0.9% American Indian students, 6.05% Asian, 4.63% Black, 1.80% Hispanic, and 86.62% White students. The school is mostly middle to upper class socioeconomically.

Many of the parents are professionals at Michigan State University, General

Motors, or our state capitol. The school is well respected in the area and receives excellent support from its community. The community has very high expectations of its students and therefore its schools.

In general, the students at this school are very motivated to perform well at school. Their parents have high expectations for their learning. The high school graduates go on to some of the best universities and colleges in the United States. Most of the students participate in extracurricular activities.

In the five college prep chemistry classes that participated in this project, there were 143 students. 43.3% were boys and 56.6% were girls. 5.60% of my students were Black, 2.80% were Asian American, 3.50% were Indian, and 88.12% were White. Only 3 students out of 143 were seniors and 7 were sophomores. The rest were juniors.

IMPLEMENTATION OF UNIT

During my summer research, I developed a series of eight take home experiments and a set of surveys to act as my assessment tool. In constructing the take home experiments, I focused on several requirements. The labs had to be relevant to a topic in my curriculum but not ones I previously employed, use safe, inexpensive materials that could be found in the home, and be fairly simple to execute.

I chose to grade the student's home lab reports based on their effort. As long as the students carried out the experiment, completed the lab sheet, and discussed it with their parent, they would receive full credit. To assess the project as a whole, I designed surveys so that I could obtain data regarding information such as the amount of time parents and students spent conversing together.

The eight take home experiments I developed fit mostly with the second half of the curriculum. This worked well because I could start school and teach as usual for the first several months and then take the initial survey to get some base line data. I could then begin sending the experiments home and at their completion, give another survey and compare the results. The schedule, determined by when the corresponding unit was covered, was as follows:

October 24	Mail home a summary of the program and parent survey #1. Give the students survey #1. (Appendicies A-C)
November 21	Chromatography (Appendix F)
January 16	Stoichiometry (Appendix G)
February 3	Boyle's Law (Appendix H)

March 9	Equilibrium (Appendix I)
March 19	Precipitation (Appendix J)
April 1	Making and Testing an Indicator (Appendix K)
April 17	Titration (Appendix L)
May 6	Rates of Reaction (Appendix M)
May 11	Mail home parent survey #2 Give students survey #2 (Appendices D & E)

The primary new teaching technique used in this project was to make the laboratory portion of the course more hands on and student directed. The labs that students performed at home did not replace preexisting ones. They were assigned in addition to the regular labs. My course jumped from having twenty-three labs per year to thirty-one. Not only did this project increase the student's hands on experience with a larger number of laboratory exercises, it also included a different breed of labs. The experiments that students perform in my regular class are of the "cook book" variety – another area of teaching I need to target for revision. The labs designed for this project allowed for students to make choices. Sometimes they had to write the entire procedure and sometimes simply make decisions within a framework. In the description of each experiment I will emphasize the student choice aspect.

The analysis that each student was required to complete was also very different than the in class labs. I wanted the assessment tools I used to reveal their thought processes as opposed to looking for right and wrong answers. With the help of Dr. Joyce Parker, I came up with questions that directed students to express results in pictures as well as words, apply concepts they learned to other circumstances, and give their impressions of observations they made.

I encouraged students to take more active roles in the experiments. As I mentioned previously, undirected students would choose the same partners and assume the same roles each time. I was concerned that some students may be getting all the experience performing the lab while others watched or did the more menial tasks such as clean up. To counteract this problem, I used two approaches. For the in class labs I assigned different partners each time. It was my hope that having different partners would prevent students from developing particular roles. For the take home labs, I required the students to perform the lab either by themselves, or with a parent. This would force them to handle materials directly and build confidence in themselves.

IMPLEMENTATION AND EVALUATION
OF LABORATORY EXERCISES

Each experiment was unique and provided different opportunities for the students and me. In the following section I will give a description of each lab and how it fit in with the curriculum, any unique features in the experiment, how the students fared with it, and corrections to be made before next year.

<u>Chromatography</u>: (See Appendix F)

This lab was a revised version of the one the colleague I mentioned in the introduction had sent home with his students. When I first passed this lab out to my students, I heard a few moans and groans. They had seen chromatography multiple times before at various science fairs and thought it was an elementary topic. When I asked them how and why it works they realized there was still knowledge to learn regarding chromatography. This lab was the most teacher - directed of the group. I thought the first take home lab should be one that allowed them to try an experiment at home and build confidence before asking them to try one that required them to make a lot of decisions.

At the time we were covering a chapter in our text entitled "Molecular Shape". The students learned how to determine the shape of molecules after drawing a Lewis dot diagram. The students then learned how to determine whether a molecule is polar or not. They learned that a molecule's polarity determines many of its properties, one of which is solubility. The first take home lab was an analysis of that property.

Each student received three strips of paper with an ink dot on it. They had to immerse one in water, one in vinegar, and one in oil. Before any color reached the top they would pull it out and let it dry before taking measurements. They would then calculate the ratio of the distance of a color of ink to the distance the solvent traveled, (the R_f factor). The students were asked to relate the R_f factor to the solubility of the ink in the media. Follow up questions directed students to look at sources of error and to predict what would happen in other situations where different solvents or solutes are used.

The students did very well for their first experience. Several from each class came in quite flustered after trying it because the oil didn't move the ink at all and they were concerned that they had done something wrong. Some students had trouble because they walked away from the experiment and the solvent went all the way to the end before they returned. A few students let the paper fall against the side of the glass and so the colors all mixed together. I had to hand out a lot of extra slips of paper so they could redo the experiment at home.

The only thing in this lab that I asked them to design by themselves was the data table. Most students handled this fairly well. Several came in to ask if what they had done was acceptable. A few students said they were "completely lost" and needed a bit of guidance to create it. I hoped by the end of the course this aspect of lab work would be greatly improved. Many of the in class labs require them to create their own data table.

Next year I may try to simplify the directions about making the data table or I could make a data table for them to fill in. This lab's measurements are probably harder to organize than most.

One problem that arose and never went away for the entire project was that of kids forgetting to get parent signatures. They often said that they had discussed the lab with a parent but had forgotten to get the signature. Sometimes the students waited until the last night to do the lab and then realized their parent was out or busy that night. I gave kids extra time in these situations.

Stoichiometry: (See Appendix G)

This experiment was adapted from one that an M.S.U. chemistry professor, Dr. Hunter, does with his college freshmen. I used it during a chapter on stoichiometry where mole- mole, mass- mass, volume- volume, and mixed relationships were introduced. We had not yet covered the chapter on gases, which led to a few difficulties. The students had not yet learned about how volume varies with changes in temperature and pressure. They converted from volume to moles using the 22.4L figure, which is actually only correct at standard temperature and pressure. Some students identified this as a source of error for the experiment. The students had done many practice problems of the conversions and also performed a mass- mass experiment in class. They reacted baking soda with vinegar to produce carbon dioxide gas and salt. The mixture was dried and weighed.

In the take home lab, a measured amount of vinegar was placed in a clean bottle. A measured amount of baking soda, the limiting reactant, was put into a previously stretched balloon. (I suggested wrapping a piece of paper around to make a funnel.) The mouth of the balloon was stretched over the mouth of the bottle and the balloon was tipped up mixing the baking soda with the vinegar. The reaction produced CO_2, which caused the balloon to expand. Students measured the volume of the balloon and compared the volume to the one they predicted using stoichiometric calculations.

After comparing the measurements, students were required to think of as many sources of error as possible. As I mentioned before, some students noted that the experiment was not performed at standard temperature and pressure. Others mentioned that using the diameter of the balloon to determine its volume was not accurate because it is not perfectly round. Also, they said it was difficult to find the widest part of the balloon. Still others felt that some of the baking soda could have been stuck to the inside surface of the balloon. Another interesting comment was that some students used plastic bottles and reported that they puffed out when the gas was produced and that a glass bottle would have worked better.

The results students obtained varied greatly. Some hit the prediction right on and others had huge percent errors. One negative aspect of take home labs is that the instructor is not there to see what the student is doing incorrectly so there were several situations where I never determined the error. I had not expected the results to always match the prediction since I knew it was not performed at standard temperature and pressure but some of the percent errors the students calculated were pretty large.

Besides looking for sources of error, I also asked the students to predict the volume of the balloon given different amounts of the baking soda. Most were very successful at this using a simple proportion.

I think that next year I may have the kids do multiple trials and average the results. Some students mentioned that they had done this anyway after one trial because they were uncertain if they had done it correctly. I think it would also be interesting to have an extension of this lab, still performed at home, where the students investigate limiting reactants. I could also wait to assign this lab until after the chapter on gas laws so they could correct the volume of the balloon to standard temperature and pressure for a better comparison.

Boyle's Law: (See Appendix H)

This experiment obviously fits well in a unit on gases, which is exactly where I put it. The students had read about the law and practiced calculations. They had also seen a simple demonstration of air being compressed in a syringe as I applied pressure to the plunger. I believe they knew that when pressure was increased, volume was decreased, but most had probably not thought about whether that relationship was linear or logarithmic.

Each student was given a plastic pipet along with the lab sheet in class. They filled the bulb with colored water and sealed the tip by melting it with the flame from a match and then pressing it flat with a knife. Next they placed a bucket or large bowl on the bulb and measured the length of the air column in the stem. They then added a measured amount of water (their choice) and measured the new length of the air column. They continued to add this same quantity of water each time and measured the air column each time. I asked them to take eight data points.

The students were required to write down their general observations of the experiment. Most noted that the volume was decreasing and a few even noticed that it was decreasing less and less each time.

Next the students were asked to construct two graphs. The first was a graph of pressure versus volume and the second was pressure versus the inverse of the volume. This turned out to be one of the most frustrating experiences of this project. There were two major problems that caused the measurements and therefore the graphs to be constructed poorly. The first problem was an obvious case of students not following directions. Some students had measured the amount of liquid in the stem instead of the air column. They saw that as pressure increased, volume (of liquid) in the stem increased. They had graphs showing direct proportions. I asked them to do the lab over again. The other major measurement problem, which had not previously occurred to me, was that I let the students choose the increment of water they added each time instead of giving them a minimum volume. Some students chose a small amount of water to add each time and so the air volume changes were very small and appeared linear when graphed. They hadn't carried the experiment out far enough to see the curve in the pressure versus volume graph.

Yet another problem that was a surprise was my student's lack of skills in graphing. When graphing pressure versus the inverse of volume, they incorrectly labeled the x- axis. They took volumes of 6 and 7 and made them into 1/6 and 1/7 but still left them the same distance apart. They did not have the intervals constant. To make matters worse, very few had bothered to use graph paper and instead just sketched it roughly on notebook paper.

All of these graphing problems together created quite a mess. I now have many ideas for improving this experiment. To begin with, I will make sure I give a minimum volume for the water increments. To improve the graphs I will either give them graph paper and a lesson in graphing or require them to bring in their data and graph it on a computer graphing program.

After the graphing, I asked the students to predict how much water would have to be added to get a specific, small volume. I had thought the students could extrapolate their second graph to determine this. Since the second graphs were so poor, this question was also answered poorly. Many students, who thought the graph was linear from using small water increments, used a proportion to determine the volume indicating they thought the relationship was linear.

Another question asked students to draw a picture of the particles of the gas in the pipet before the experiment began and again after the last of the water was added. They did a really nice job of this in general. Some of the students that had measured the water in the pipet instead of the air column drew the water molecules instead of the gas.

Overall, this experiment was a major learning experience for me. It was really interesting to have a discussion with each class about how I had intended the lab to turn out and how it actually turned out. I think they enjoyed the discussion also, as everything became clear to them. It was my first serious taste of how a person can think everything is easy and clear and then be completely shocked at the problems that arise.

Equilibrium: (See Appendix I)

This experiment was a great way to start off our chapter on equilibrium. I saw a colleague doing a demonstration similar in concept to this lab and that is where the idea originated. My colleague had two students with different size beakers dip and pass water from their own bucket to another. The buckets were transparent and it was clear after a while that the water levels stopped changing even though they were not equal and water was still being passed back and forth. I thought it was a terrific illustration of equilibrium.

For this take home lab, I gave each student two test tubes, two straws with different diameters and a piece of graph paper. During class I had them go back into the lab and calibrate their test tubes. They measured a milliliter at a time and drew the mark on the tube. They also labeled one with an "R" for reactant and one with a "P" for product. At home, the students filled the reactant test tube almost full with water. They recorded the initial volume of both test tubes. Then they used the straws to begin transferring liquid back and forth, recording the volumes after each transfer. The straws had to stay in the same test tube each time. Just as in the bucket demonstration, the reactant level dropped as the product level rose until eventually, the levels remained constant.

The students then made a graph with the transfer number on the x – axis and the volume on the y – axis. These graphs turned out really well. A few students had forgotten to keep the same straw in each test tube the whole time and that caused their data to come out poorly. I had those students perform the experiment over again. In general though, the graphs looked terrific.

In some follow up questions, I tried to get the students thinking about what was happening at a molecular level so this whole experience could easily be transferred to a chemical reaction. I asked students if after equilibrium was reached, were the reactants always the same water molecules. They answered that they were not the same since molecules were still being moved back and forth with the straws. I was trying to introduce the idea that equilibrium is "dynamic".

I asked the students to determine when equilibrium was reached and how they decided that time. Almost every student, armed with a definition of equilibrium from their textbook, easily answered this based on when the lines on their graphs plateaued.

One thing I would have liked to go into a little deeper was the concept of rate. The rates of transfer are not equal until equilibrium is reached and I would like to think of some questions to lead students to this realization. As far as the physical aspects of performing this lab, I learned two things that can potentially cause problems. If the test tubes are too small relative to the straws, equilibrium is reached very quickly and the graph lines are jerky instead of smooth. Another thing to work out is the student's transportation of the glass tubes. I had my students wrap them in tissue and paper towel, which worked very well.

Overall I really enjoyed this experiment and thought it very useful and worthwhile. One advantage to doing it as an in – class activity would be that the students could just use graduated cylinders instead of calibrating test tubes. It was still a very successful take home lab.

Precipitation: (See Appendix J)

This experiment was derived from one I performed as a student in the chemistry course (NSC 861) I took for this program. Sheldon Knoespel was the lab director and source of the original idea. After the chapter on equilibrium, my course goes on to cover other, specific kinds of equilibrium systems. The first is a chapter on solubility and precipitation. Students learn, among many things, how to write double replacement reactions and predict the formula of the solid produced in a precipitation reaction. We also convert them into "complete' and "net" ionic equations.

While in class, I had each student label three plastic pipets with the codes AX, AY, and BZ, which represented the formulas of the substances in the solutions they were to use. I had them draw up some of each of the corresponding solutions from stock solutions.

At home, in the first part of the experiment, the students recorded whether each combination was soluble or insoluble. They had to write double replacement reactions to predict the products and then determine which product was the precipitate that formed when two of the solutions reacted. This required the students to use some reasoning. Many students had trouble with this because it was the furthest thing from a "cook book" lab that we had done. They tried the combinations, but many came to me very confused. I encouraged them to have patience and look more closely at what they already had. It helped them to write down the double replacement reactions so they could see them. I think next year I would like to put a space on the lab sheet that directs them to do this.

Once the students determined the formula of the precipitate, writing the "complete" and "net" ionic equations were relatively easy since we had practiced them in a lab performed in class.

The second part of the lab asked students to determine the identity of the solutions. I told them that they were epsom salt, table salt, and lye. I gave some crystals of each in a separate plastic bag to any of the students that needed them. I required them to think of a possible procedure and then write down the steps of their experiments. This part of the exercise went really well. Most students did this easily and just a few came in to ask for confirmation.

This was a very enjoyable lab to do and had very few problems. The only troublesome spot was with the student's determining the formula of the precipitate in part one as I mentioned before. Although it was challenging and a little frustrating for many students, it was a very good opportunity for them to use some reasoning skills.

<u>Making and Testing an Indicator:</u> (See Appendix K)

This experiment is one that most science teachers have seen multiple times. A fruit or vegetable is boiled in water or crushed in alcohol to extract its color. The solution is then used to test the pH of various substances. I had used red cabbage indicator for demonstrations at school and at science fairs at local malls. Many of my students had seen the test before but few had actually tested materials on their own.

We had just finished a unit introducing acids and bases. I had demonstrated universal indicator and phenolphthalein, common acid – base indicators. We had discussed what made acids and bases strong and weak and how to measure that strength. I introduced the pH scale and we practiced calculations with the formula for pH. At this point they were ready to perform the take home lab. I didn't give them any materials this time. Several students purchased the red cabbage and then gave the leftovers to others.

In part one the students made the indicator solution. They could either boil the cabbage in water or crush pieces of it in a sealed baggie with alcohol. In part two they were to choose at least six household substances and mix them with the indicator and record the color. I was pleased that almost every student went beyond the required six. I gave them a few suggestions such as bathroom or kitchen cleaners and colorless beverages. I had provided a scale on the lab sheet that gave the colors and their corresponding pH values. The students could then assign a pH value to the materials they tested.

I asked two questions as follow up to the experiment. One simply asked if any of the results surprised them and why. I was very pleased with the responses. Only two kids gave the response, "No, nothing surprised me". Everyone else made some really interesting observations. Many noted that cleaners are not necessarily acids. They had thought they must be acidic to kill germs etc. Many students think of acids as being very dangerous and "toxic" but not bases. Many students thought that lemonade and orange juice would have lower pH values than they did because science teachers always used them as examples of acids and so they thought they must be strong ones. Several students measured bleach and were shocked at the bright yellow. They weren't aware that they had things in their home that were so extremely acidic and basic.

The second question asked why determining the pH of purple grape juice using our method would be difficult. Most students had an easy time with this one and also commented on concerns that some of the colored materials they tested might have been assigned an incorrect pH value because of this source of error.

Overall, I felt that this lab was a terrific experience. It was really enjoyable to have students come into class talking about the amusing things they tested and some of the surprising results they found. I think that next year it would be nice to have students develop their own scale that matched color to pH instead of it being provided for them. I have dropper bottles of standard pH solutions from two to twelve. I could provide the cabbage juice and they could develop their own scale before doing the take home portion.

In addition, I would like to be more specific on how to test the materials with the cabbage juice. I had one student who reported that nothing changed color. Upon questioning I discovered that he had a mixed a very small quantity of the indicator with a large quantity of the material. That is a problem I could easily fix with some instructions. On the other hand, maybe it was a valuable experience for that student. He should have tried something different when he saw he was not getting any changes. I asked him to repeat the experiment again after our discussion.

I would highly recommend this experiment to any chemistry teacher, even if it were done in the classroom. I think the students really enjoyed testing some common materials and I felt great about the comments I read and heard about later.

Titration: (See Appendix L)

Just after the indicator and pH lab, students performed several titrations. I introduced them to the concept of titration in class and we completed a typical experiment in class with hydrochloric acid and sodium hydroxide. I showed them the formula that relates the molarity and volume of an acid to the molarity and volume of a base that is titrated against it.

During class each student weighed out a gram of sodium hydroxide drain cleaner and sealed it in a locking bag. They also measured out 50 ml of water and calibrated a paper cup. Finally they each took a little phenolphthalein and sealed it in a plastic pipet.

At home, they mixed the drain cleaner with 50 ml of water to make a standard solution. In a glass or bowl, the student would count out 20 drops of the sodium hydroxide and add one drop of the indicator. The mixture would turn pink. They would then add drops (while counting) of a presumably acidic household cleaner until the pink color disappeared indicating the end point. After recording this data for several cleaners, the students then calculated the strength of the hydronium concentration in each cleaner.

In the follow-up questions I asked the students to rank the acidic substances from strongest to weakest. I asked them to analyze whether the strongest acid was the most expensive and why they might buy a cleaner that was less cost effective.

This lab had many problems that are relatively easy to fix. The first problem was that many students had difficulty identifying which cleaners were acidic. Next year I will go to the store and make a list of all the different acidic cleaners available so the students would have an easier time choosing one. Another problem was that even though the sodium hydroxide solution was not very strong, (0.5M), it managed to eat through the paper cup and get on counter tops. I had tested this experiment with a beaker and had never thought this would happen. There are two possibilities on how to remedy this. One would be to direct the students to make the solution in a glass and only use the Dixie cup as a measuring device. The other, more safe possibility, would be to make the solution at school and have them take a pipet of it home as they did the indicator. I could still show them that I made the solution from a drain cleaner so they didn't lose the home material aspect.

The students had no trouble doing the calculations or ranking the cleaners. The second question about the strongest cleaner being most expensive gave them a lot of trouble. They needed to calculate the price per volume before they could make a comparison and many students did not think of this. I need to rewrite the question to explain this. The last question, about buying a cleaner that was less cost effective, was also troublesome for some students that did not correctly interpret the meaning of "cost effective". I need to either rephrase it or explain the meaning in class.

I think this take home lab has a lot of potential once the problems mentioned above are worked out. I look forward to trying it again.

Rates of Reaction: (See Appendix M)

I teach chemical kinetics toward the end of each school year. We talk about how reaction rates are calculated, the collision theory, and factors that can effect the rate of a reaction. The final take home lab of the year fits here. This was a very simple lab that for the most part worked very well.

In part one of the lab, students put a drop of food coloring in a glass of hot water and then a drop in a glass of cold water and recorded their observations. In part two of the lab, students reacted Alka-Seltzer with water. There were three sections. In the first, the students wrote a procedure for testing how the rate of reaction depended on temperature. They were to carry out the procedure and record their findings in a neat way. In the second section, they developed a procedure for testing how the rate of reaction depended on surface area. Again they had to perform the procedure and record the results. Last, they tested the correlation between the rate of reaction and the concentration of a reactant. I suggested that adding salt would alter the concentration of the water (which is not technically true). Again they had to perform the experiment and record the results of the experiment.

The results of some of these were interesting. Most every student successfully determined the relationship between reaction rate and temperature. The surface area section had some experimental variation, however. I had expected the students to leave a tablet whole and crush another up and put them in water of equal temperatures. Surprisingly, several students left both tablets whole and put them in a drinking glass and a bowl – varying the surface area of the water instead of the Alka seltzer. This caused a few students to draw incorrect conclusions. The third section was performed well by all students but was interpreted in a different way than I had intended. As the salt was added, they all observed that the reaction rate decreased considerably. In the conclusions, several students stated that as concentration increased, the reaction rate decreased, because they were referring to the concentration of the salt. I need to explain ahead of time that the salt is not a reactant and is only being added to make the water molecules less accessible.

Although in the conclusions students had incorrectly related the "concentration" of water to reaction rate, they seemed to understand on a molecular level. On the lab sheet I asked them to explain each section on the level of the molecules. They had no problem in figuring that the salt "got in the way" of the reaction and thus slowed it down.

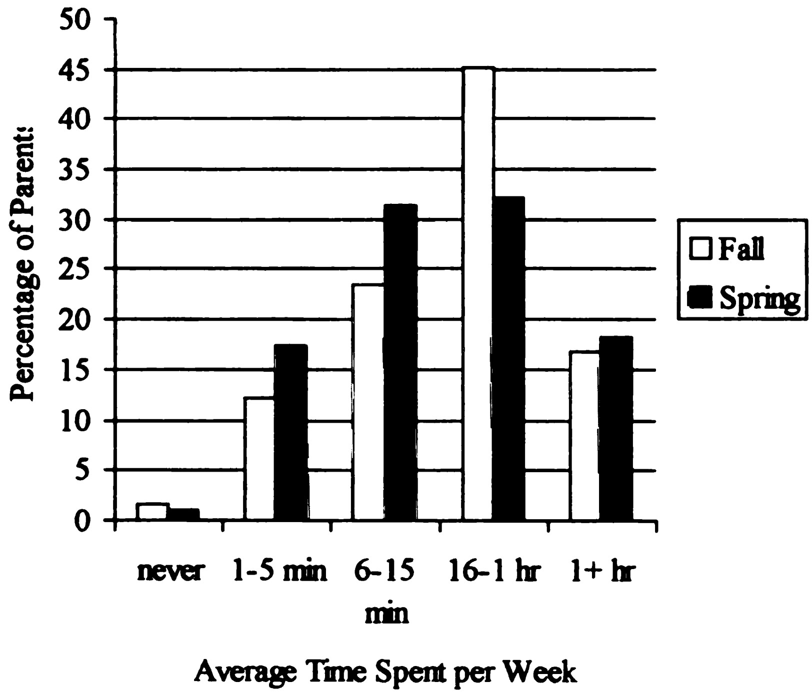
I think this lab went very well in general and could be made better by a little explanation either before hand or on the lab sheet regarding the purpose of adding salt. Some of the higher achieving students felt this lab was too simplistic but I actually thought it was a significant assignment due to the fact that they had to create and carry out an experiment and then explain it at a molecular level.

EVALUATION OF EFFECTIVENESS OF UNIT

The main method of evaluation used for this project was a series of surveys. I gave an initial survey to the parents and students before I began the series of take home labs in October, 1997. After the last of the take home labs, in May 1998, I gave each group a final survey. (See Appendices B – E)

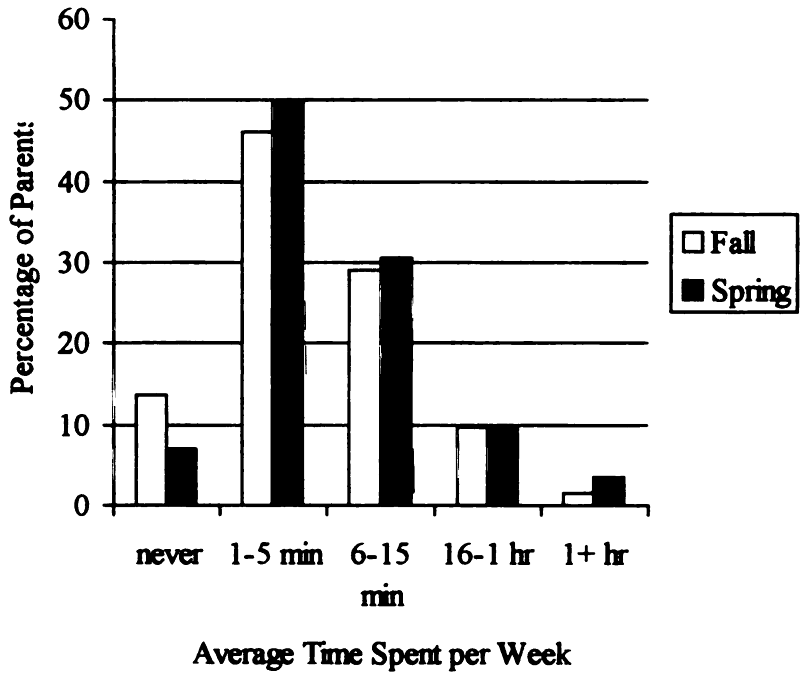
Two questions on all the surveys asked how much time parents and students spent conversing with each other about school in general, and specifically about chemistry class. The four tables on the next pages show the results of those questions.

Table 1: Parental Opinion of Time Spent Interacting with Students on any School Issue



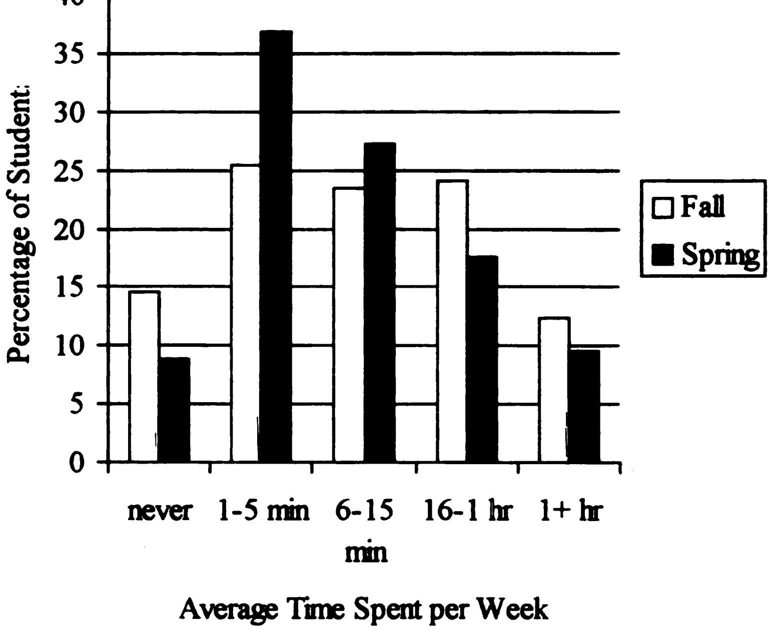
This first graph depicts the initial and final parent recollections of the average time each week spent discussing any school related topic with their child. The percentage of parents that never discussed school with their child remained almost constant. The 1 to 5 minute period and 6 to 15 minute period increased. For the next longer time piece, 16 minutes to an hour, there was a big decrease and for the longest time category, there was very little change.

Table 2: Parental Opinion of Time Spent Interacting with Students on the Topic of Chemistry



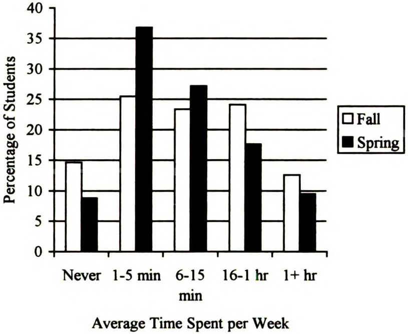
The second graph shows parent's opinions on how much time each week, on average, they spent discussing chemistry with their child. This data shows that the percentage of parents that said they never have discussions went down slightly. Again the 1 to 5 minute and 6 to 15 minute periods increased although not as much as they did for any school issue. This would indicate that only part of that overall increase in conversation time was spent on chemistry.

Table 3: Student Opinion of Time Spent Interacting with Parent on any School Issue



This graph depicts the amount of time on average that students spent discussing any school issue with their parent. It is similar to the first graph but this time it is the student's opinions. More students than parents said they never have general, school related conversations. The percentage of students that said this, decreased. Just as in the first graph, the 1 to 5 minute and 6 to 15 minute periods increased. The upper time categories showed a decrease.

Table 4: Student Opinion of Time Spent Interacting with Parent on the Topic of Chemistry



This last graph shows the student's opinions on how much time each week, on average, they spent discussing chemistry with a parent. Once again there were increases in the 1 to 5 minute and 6 to 15 minute categories and a decrease in the greater time lengths.

When I designed this assessment tool, I tried to choose time categories that might represent reasonable discussion lengths. I wanted to avoid having too many small categories so that the choices weren't too similar but I also didn't want students and parents to have to be vague while choosing between a few larger groupings of time. The problem with the assessment tool I used, however, was that the time categories did not represent the same number of minutes. One category is around 5 minutes where another is around 45 minutes. Once I used this survey in the fall, I was stuck using it again in the spring because I need to compare the two sets of data. Even with this problem, useful information can still be gleaned from the data.

On all the surveys, it was evident that the number of parents and kids that never conversed about school in general, or chemistry, decreased. The results regarding time spent discussing chemistry were much more dramatic than for school in general. The most notable change was reported by students regarding the amount of time spent discussing chemistry. Originally, 47.4% of students said they never talk about chemistry with their parents but at the end, the figure dropped to 22.8%. That's a change of 24.6% of the kids.

There was an increase in the 1-5 minute category, especially as reported by students regarding discussion on chemistry. There was a reported increase of 22.5% in this time slot. Perhaps many of the students that never talked with their parents before started conversing for just one to five minutes a week thus showing this change.

There was one result that I did not really expect to see. Earlier in the year there was a small percentage of students that reported that they spent a significant amount of time (over one hour) in discussion with their parents. At the end of the project, this number had dropped. I don't believe this drop is related to this project. I think that as a school year progresses, students become more familiar with a teacher and the expectations of that teacher and are more likely to work independently from parents. In addition, the numbers of students in that category were fairly small and I must consider the error involved in such a survey.

Although these surveys provide some information, it is evident that there is a lot of error associated with estimating the average time per week. For example, there is inconsistency between what parents and students report. Assuming they are talking to each other, their reported times should coincide. However, there are some sizable discrepancies. Students reported a much larger increase in time spent discussing chemistry: 22.2% compared to 4% or parents. One reason for this may be that parents and students have different impressions of the discussion experience. For example, the time requirement may have seemed longer for the student, who, perhaps wished they didn't have to participate in discussion. Another reason for the discrepancy may be that some students refused to have the discussion and forged a signature and therefore reported false time averages.

A strategy for diminishing the error of time assessment, which I plan to implement next year, was actually suggested by several parents and students when I asked for suggestions for the future. They recommended requiring parents to have certain responsibilities in each lab. Parents would need to help the student find materials, assist the student during the actual procedure, and fill out a section on the lab sheet. This would result in two improvements. One would be a decrease in the number of students forging signatures. It would be much more difficult to forge several sentences in the parent section of the lab as opposed to just a signature. I will also collect the labs from the students and keep them in a file and check with parents at conferences to confirm their participation. A second improvement might be to regulate the time required of the parents. Varying the amount of their required input on the lab sheets could be a way for me to monitor their involvement.

In summarizing the data, it appears that there was a shift toward the middle time increments. Previous to the study, I had a range from never participating in discussion to discussing for over an hour. At the end I had a majority discussing somewhere between 1 and 15 minutes. Overall, it appears that a greater number of students were involved in a discussion with their parents. The overall time increase was very slight however. It appears that 15 minutes a week is the maximum amount of involvement that I can reasonably expect and all labs should be designed for that time limit.

Another aspect of the student survey probed the reasons behind the lack of parental involvement. The student's responses closely matched the comments from parents. The results from the initial survey to the final survey changed very little. Approximately 75% of the students said they don't discuss chemistry more with their parents because they feel they don't need their help. 23.5% said they feel their parents don't understand chemistry and so they couldn't help them anyway. Only approximately 8% said that their parents are too busy and approximately 1% said their parents were not interested and did not want to be involved.

Another question asked on the student surveys was how comfortable they felt performing a lab at home. I anticipated that the number of students feeling comfortable about take home labs would increase over the course of the project. I was surprised to find that the percentages changed only very slightly. Again, the suggestions offered by the students gave me some insight as to why there was no improvement and what I might do to help next year's students. Several students (18.3%) suggested I make the directions on the lab clearer. Of course I did not intend to make them unclear. I often suggested to students that they take a look at the lab well before it was due so that if they had questions they could ask me about them. Many students waited until the last night and only then realized they didn't understand. That was probably also the cause behind a few of the students and parents commenting that they were too busy. I had allotted over a week for each take home lab exercise and warned them that if they waited until the last night, finding materials, understanding the directions, performing the lab, and discussing it with a parents could be quite a crunch. Regardless of their motivation for suggesting rewrites of the labs, it would be a good idea to have several colleagues read the labs and make suggestions as to how to improve the wording.

Also related to the comments about confusing directions was a suggestion made by 16.9% of the students. They asked if I could do a trial demonstration in front of the class on the day I passed out the lab sheets. They said that way they could see how it was supposed to look. Several wrote that when they performed the lab they felt uneasy because they were unsure whether they were doing things correctly. Demonstrating it for them would let them feel more comfortable about performing the lab. I have mixed feelings about this suggestion. It seems as though when you demonstrate an activity for students, they don't bother to read the directions at all. I think there is value to reading directions and relying on one's self to figure out what makes sense. If I demonstrate it, some of the independence of the activity will be lost. The requirement that they discipline themselves to look at it beforehand and plan their time is also lost. On the other hand, if I did demonstrate it, it may alleviate a lot of frustration parents and students might have felt. It would also help with the problem of my directions being unclear. No matter how much effort a person puts into a making clear directions, they will never obtain that goal because there will always be students who interpret things differently. Maybe I can compromise with a very brief demonstration or show the lab set up.

I asked the students if they felt that doing the labs at home and explaining them to their parents helped them to understand the material any better. A majority of the students (64.7%) said it did. They said that the process of organizing their thoughts and putting them into words helped them cement the ideas in their head. They felt that if they know something well enough to explain it, they truly understand it. Some mentioned that as they explained things, they or their parents caught mistakes and were able to clear them up. The rest of the students (35.3%) felt this process did not aid their learning of the material. Some students said they already understood it to begin with. Some mentioned that their parents don't know much about chemistry and so they were not helpful.

I also asked whether performing the lab at home made it easier to focus on the lab concepts since there were not the distractions of the rest of the class. 47.1% said it was beneficial. Some of those students said they tend to goof around in class when there are other students around so working on their own helped. Some said that with less people around they were able to do the lab much more quickly and waste less time. A few students even said it forced them to be responsible for their own learning. 52.9% of the students felt doing the lab on their own did not help them focus on lab concepts. They said they preferred working in class where they could ask questions of the other students and me so they could feel they were doing it correctly. Many said home was just as distracting as class because of siblings and pets. A few others said they really prefer working as a team on labs.

On the parent survey, I asked if they felt being involved with their child's chemistry class in a formal way was beneficial. 85% felt it was. This was interesting since the time of involvement was so small. Perhaps even a slight amount of time seems a great improvement. Parents listed several reasons why they liked it. Several (21%) said they liked knowing what their child was learning in school. 27.8% said they enjoyed interacting with their child since normally the child doesn't wish to. Some parents said they felt their child learned a lot and they did too. 10% said they simply had a lot of fun. I received many suggestions from both parents and students. Many were very useful and I have given them a lot of thought. As I mentioned earlier, some parents suggested having a section on each lab sheet where they write something. I really like this idea. Other excellent suggestions dealt with providing the parents with more information. They would like a schedule at the beginning so that they can help their child start the lab before the last minute and they can organize their time better. Several said they would like a list of materials needed so they could be prepared instead of running out the night before when their child has just informed them of what is needed. A few parents asked if I could provide them with a letter that would inform them of my expectations in general and with regard to each individual lab.

Student suggestions were also plentiful. The best ones I discussed earlier. They recommended that I make the directions more clear and demonstrate the lab for them. Some of their other suggestions worked against some of my goals of the project. A few students asked that I allow them to work in partners instead of being required to do it individually. I believe several students worked with partners anyway during this project. A few students also suggested that I keep the take home lab project but not require any parent involvement.

Some students said the labs were too easy and should be made more challenging. A few wished the labs could be more "exciting". One specifically mentioned explosions. Some students recommended only using materials found in everyone's home so they would not have to go to the store. That would be a pretty tough limitation. I tried to alleviate this by telling the students to get the materials from me ahead of time but again there was the problem of them waiting until the night before it was due.

Overall I thought the feedback from the surveys was very informative. It gave me a lot of information and ideas for improving this project in the future.

DISCUSSION AND CONCLUSIONS

Overall I really enjoyed this project and felt it was beneficial to the students, their parents, and me. I learned a lot about how parental involvement is viewed by researchers, and by my subjects. I also discovered things that worked well and things that still need modification.

One of my goals was to fit a project in with my current chemistry curriculum. The series of labs I assigned worked out very well. The labs were in addition to ones normally scheduled but since they were like a homework assignment, they did not bump any other activities I normally do. I continue to search for more labs appropriate for this project. For this particular year, I did not have any take home labs at the beginning of the school year because I wanted to get some baseline data from parents and students about the time they spend interacting with each other. In the future, I would like to include take home labs that match the curriculum from the very beginning of the school year. I think that since eight labs had a small affect on my students, more labs with greater parental participation would be beneficial.

Another positive result of this project was an increased student awareness of the "chemicals" they have in their own homes. 10.4% of parents even mentioned this as a benefit on their final survey. Students seemed to be quite interested in some of the properties common household substances have. If household materials were included in class labs as opposed to home labs, this goal might have been approached but not to the same degree of success. When a student actually pulls the materials out of their own cupboards and performs the experiment at their own kitchen table, the memory is separate from all the labs done at school and it probably sticks with them much longer. There is a lot more I could do in the area of consumer based chemistry but this project was a good start.

Another goal was to increase the independence of students in their lab work. During in-class labs, students can become dependent on their partners and never really lead an investigation on their own. In the surveys, many students said they prefer in – class labs so that they don't have to be dependent on only themselves. When I asked for suggestions, a few mentioned that they would like to be allowed to have a partner. Doing something by yourself can be an uncomfortable experience when you aren't used to it so their comments don't surprise me. Perhaps what is good for a student isn't always something they prefer.

I think that this project allowed for a balance since the students continued on with in-class labs where they were assigned partners but they had to work alone on the take home labs. I have the impression from a few student and parent comments that some kids did the take home labs together and then discussed it with a parent later. I don't really know how to address this other than to make it clear to the parents as well as the students that they are to be doing the labs on their own. One other observation on this topic is that some kids chose to actually perform the lab with their parent instead of just describing it to them. This went against the goal of working independently but helped increase the parental involvement aspect. Since increasing parental involvement was the major goal of this project, this was acceptable to me.

Another component to the independence issue was in the design of the labs. On all but the first lab there was an openness to the lab procedure. Students had to make their own choices about which materials to test, what measurement increments to use, and how to organize and present data. On two labs they wrote and carried out their own procedure. This was a new teaching technique for me. Previously I had only used "cook book" labs. The "student choice" labs resulted in a nice variety of results. Student data varied from person to person and everyone's lab seemed unique. There were a few times where students seemed frustrated by the lack of specific structure. They were used to the cook book style labs, not just from my course but from years of science classes that relied on them. The students wanted me to just tell them what to do and resisted me when I told them to think about it first and try to figure it out. Again it seems that what is good for a student is not something they necessarily prefer.

The most important goal, of course, was to increase parental involvement and determine how students and parents felt about it. In my introduction, I provided much evidence that the greater the level of parental involvement in their child's education, the greater the achievement of the child. Some of the evidence was specifically concerning high school students. Although parental involvement is definitely a good thing, there are many practical issues that a teacher needs to consider. There is an argument, presented by a few parents, that high school aged students should be becoming more independent, not less independent from parents, as they move toward college. Many students, as they progress through adolescence, strive to separate themselves from their parents and create privacy. A good question, is what is the highest grade level a teacher or school can run a program encouraging parental involvement, and get a positive response.

In general I feel I received a positive response although not as dramatic as I had hoped. There are many good things about involving parents in a chemistry curriculum but there appears to be limitations. Parents enjoy communicating with their child and knowing what's going on in their chemistry education but only for a short amount of time. Perhaps if this had been a school wide project instead of just one class, it would have made more of an impact. Students in their third year of high school may have been working independently of their parents for years and one class may seem a small intrusion in the normal organization of things.

Despite the small improvements, I am looking forward to trying home labs again starting this next school year. I have learned a lot about how to make things run more smoothly. I would like to increase the number of labs and have colleagues critique them so I can improve the wording. I would like to include a section on each lab where the parent writes some comments or answers a question. Finally I would like to show these labs at parent – teacher conferences and confirm the involvement of the parent and get more one on one feedback.

This was a very enjoyable experience. This project has encouraged me to become creative and strive to make improvements in my teaching instead of being stagnant. Although the project seemed intimidating to begin with, I have learned so much and I feel more confident about pursuing other new teaching strategies. I think this experience will stay with me and encourage me to never be wary of taking a risk and making a move toward better things.

APPENDICES

APPENDIX A

Fall Letter to the Parents

Date: October, 1997

To: Parents of Mrs. Canestraight's chemistry students

From: Mrs. Canestraight   ext. 3183

Re: A special project starting soon.

Dear Parents,

I hope this letter finds you well and that you are enjoying this fall season. I am writing to inform you of a special project that will be starting soon. The project is something I started working on this past summer as part of my Master's degree at Michigan State University. I am very excited about trying it out and I wanted to let you know about what will be happening so you know what to expect.

Enclosed with this letter you will find a short questionnaire. The purpose of it is to get some preliminary information regarding how much time you and your child communicate about school work and particularly chemistry. My hope is that the project will increase communication regarding schoolwork over the course of the rest of the year. The questionnaire can be sent back with your child, dropped off in the main office, or mailed to the school.

Starting in November, the students will begin a series of eight experiments that they will perform at home. They will most often use materials that can be found at home and other times they may be sent home with them. If ever they need something that cannot be obtained at home, I will provide it for them. Typical materials involve baking soda, vinegar, oil, sugar, household cleaning solutions and water. Each time they will receive a lab sheet with guided steps and follow up questions. When they have completed the assignment, I am asking the student to explain the experiment design, results, conclusion, and major concepts to a parent. All you need to do is sign the lab sheet to verify they have done this. I also encourage you to include any comments you have. The students will be given a week or two to complete each lab.

At the end of the year you will receive another short questionnaire so I can get your feedback regarding the project. The students will also fill one out.

There are three goals that I hope to make gains on with this project:

1) To increase the amount of communication between student and parent regarding science.
(There might also be increased communication in other areas.)
2) To encourage students to do experimentation more independently.
(In class they may depend on lab partners.)
3) To familiarize students with "chemicals" in the home and bring chemistry out of the classroom.

I am very excited about the project and I hope you will be supportive of it. Please contact me with any concerns or feedback you may have.

Sincerely,

Karen Canestraight

APPENDIX B

Fall Parent Survey

Parent Survey 10/97

1. Realizing that sometimes kids isolate themselves during homework time, how much time, on average, do you spend discussing schoolwork with your child each week?
(circle one)

never 0 - 5 minutes 6 - 15 minutes 16 minutes - 1 hr

1 - 2 hr. 2 - 4 hours more than 4 hours

2. How much time, on average, do you spend discussing chemistry with your child each week?
(circle one)

never 0 - 5 minutes 6 - 15 minutes 16 minutes - 1 hr

1 - 2 hr. 2 - 4 hours more than 4 hours

3. Would you be supportive of activities that required your involvement? (Your involvement would require approximately 20 minutes every 2 weeks.)
(circle one)

not supportive somewhat supportive very supportive

Please return the completed survey to Mrs. Canestraight. You may send it with your child, mail it to the school, or drop it off in the main office. Thank you for your time.

APPENDIX C

Fall Student Survey

Student Survey 10/97

1. How often, on average, does a parent/guardian get involved with your homework each week? (In any class)
(circle one)

never   0 - 5 minutes   6 - 15 minutes   16 minutes - 1 hr

1 - 2 hr.   2 - 4 hours   more than 4 hours

2. How often, on average, does a parent/guardian get involved with your chemistry homework each week?
(circle one)

never   0 - 5 minutes   6 - 15 minutes   16 minutes - 1 hr

1 - 2 hr.   2 - 4 hours   more than 4 hours

3. Why is your parent/guardian not more involved in your chemistry class than they are?
(check any that apply)

____ I don't need their help so I don't ask them.
____ I don't want their help.
____ They are too busy to help me.
____ They are not interested / don't want to be involved
____ They say they don't understand chemistry and can't help
Other

____

____

4. How comfortable would you be doing an experiment all by yourself?
(circle one)

very uncomfortable   mildly uncomfortable   comfortable   very comfortable

APPENDIX D

Spring Parent Survey

Dear parents,

The students have completed the final take home lab of the year. Thank you for all the effort you have made with this project. I would really appreciate your thoughts on how it went so I can know if it is something worth improving and repeating. Below are a few questions to help me organize your opinions. Thank you very much.

Sincerely,
Karen Canestraight

Parent Survey 5/98

1. Realizing that sometimes kids isolate themselves during homework time, how much time, on average, do you spend discussing schoolwork with your child each week?
(circle one)

never 0 - 5 minutes 6 - 15 minutes 16 minutes - 1 hr

1 - 2 hr. 2 - 4 hours more than 4 hours

2. How much time, on average, do you spend discussing chemistry with your child each week?
(circle one)

never 0 - 5 minutes 6 - 15 minutes 16 minutes - 1 hr

1 - 2 hr. 2 - 4 hours more than 4 hours

3. Did you feel that being involved in your child's chemistry class in a formal way was beneficial? If so, in what ways was it beneficial? If not, why wasn't it helpful?

Over please!

5. Was the time required of you too much, just right, or not significant enough? Please comment.

6. Do you have any suggestions regarding this program for the future?

Please return the completed survey to Mrs. Canestraight. You may send it with your child, mail it to the school, or drop it off in the main office. Thank you for your time!

APPENDIX E

Spring Student Survey

Student Survey 5/98

1. How much time does a parent/guardian get involved with your homework each week? (In all classes combined)
(circle one)

never 0 - 5 minutes 6 - 15 minutes 16 minutes - 1 hr

1 - 2 hr. 2 - 4 hours more than 4 hours

2. How much time does a parent/guardian get involved with your chemistry homework each week?
(circle one)

never 0 - 5 minutes 6 - 15 minutes 16 minutes - 1 hr

1 - 2 hr. 2 - 4 hours more than 4 hours

3. Why is your parent/guardian not more involved in your chemistry class than they are?
(check any that apply)

____ I don't need their help so I don't ask them.
____ I don't want their help.
____ They are too busy to help me.
____ They are not interested / don't want to be involved
____ They say they don't understand chemistry and can't help
Other ____
____

4. Now that you have performed some labs on your own, how comfortable are you with the idea?
(circle one)

very uncomfortable mildly uncomfortable comfortable very comfortable

Over Please!

5. How did you feel about having contact with your parent/guardian on several chemistry assignments? Please explain fully.

6. Do you think that doing the labs and explaining them to your parents helped you understand the material better? Explain

7. Did you find it easier to focus on the lab since there weren't the distractions of a class full of people? (Explain)

8. Do you have any suggestions for this program in the future? Please give real, useful suggestions! :)

9. Any other comments?

APPENDIX F

Chromatography

Chromatography: Solubility and Polarity Name: ___________________

In this lab you will use the same solute and paper for several trials but vary the solvent used and see how the Rf factor changes with solvent.

Materials:

Three strips of Chromatography paper with an ink dot
Water
Cooking oil
Ammonia or vinegar
Drinking glasses
Pencils or pens
Ruler

Background: Chromatography is a method of separating mixtures based on differences in solubility. You are going to perform paper chromatography on water soluble black ink to determine the component colors in the black ink. A spot of black ink will be placed at the bottom of a piece of chromatography paper and the paper placed in various solvents. The solvent will move up the paper and separate the different colors in the black ink.

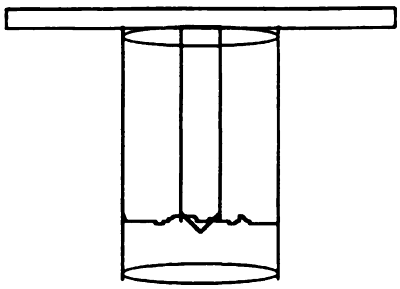
The colors will separate because they have different solubilities in the solvent. A very soluble color will travel a great distance with the solvent while a slightly soluble color will only travel a short distance. One of the major factors that affect the solubility of a solute in a solvent is the polarity of the molecules. A polar solute molecule will tend to be soluble in polar solvent while a nonpolar solute will tend to be soluble in a nonpolar solvent. The rule of thumb is: like dissolves like.

Theory: As the solvent moves up the paper, it tends to carry the sample along with it. When the solvent has risen a distance, D, up the paper, the sample has risen a smaller distance, L. It has been found that the ratio L/D, called the Rf factor, is a constant for a given solvent and paper which is independent of the amount of sample. Once known, the Rf factor can be used to identify the presence of a particular substance in a mixture of unknown composition.

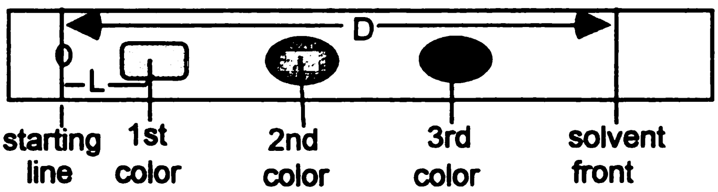
Procedure:

1. Obtain 3 strips of chromatography paper from your teacher. Handle the paper carefully. Whenever you need to work with it, handle the edges, because oils and dirt from your fingers can very easily contaminate the surfaces.

2. Label at the top of each strip the solvent that will be used. You will use water, cooking oil, and either ammonia or vinegar. Tape the strip to the middle of a pencil and lower the paper into the glass so the paper is touching the solvent but the pencil line and dot are not immersed in the solvent. (see drawing below.) Make sure the paper is not touching the sides of the glass.



3. Let the solvent rise on the strips until the solvent front has moved at least 3.5 inches above the pencil line, but not all the way to the top! Remove the strip from the glass and tape it on a clean piece of paper. After the strips have dried, mark a line along the solvent front. Measure the distance from the center of each different band of color, (place a small x there), to the point where the ink dot started (L) and the distance from the starting point to the solvent front (D). Record these values in the data table below. (See the drawing below for help with measurements.)



<u>Data:</u> Fill in the data table below which shows the distance data for each strip of paper. (NOTE: your strips must be taped on a piece of paper, stapled to the back of your lab and labeled at the top to identify the solvent used. They're part of your data.

Measurement Data

	Distance "D"	1st color "L" ( )	2nd color "L" ( )	3rd color "L" ( )		
Oil						
Water						
Vinegar/ Ammonia						

Calculations: For each strip of paper, calculate the Rƒ factor for the first two colors on the strip using the formula: $R_f = L/D$ You don't need to show your work. Enter your answers in the table below.

Rf factors

	1st color ( )	2nd color ( )
OIL		
Water		
Vinegar/ Ammonia		

Conclusions:

What proportional relationship seems to exist between Rƒ and solubility for a given color in different solvents? Defend your answer from the data.

Questions: (Write complete sentences where appropriate. Answer on this paper)

1. Why should a pencil line be drawn to mark the spot to apply the sample in this experiment, instead of ink from a ballpoint pen?

2. What error may be introduced if the paper is left in the solvent for too long a period of time?

3. The solvent moves the first inch in about 10 minutes. What error may be introduced if the experiment is stopped at that time instead of waiting for the solvent to move 3-4 inches?

4. Would you expect the R_f factor of chlorophyll, a non-polar solute, to be high or low in the cooking oil? Explain how you made this determination.

5. Rank the colors of ink from most polar to least polar and explain how you made this determination.

APPENDIX G

Stoichiometry

Stoichiometry Name: ____________________

In this experiment you will predict and test the number of moles of CO_2 produced when vinegar reacts with baking soda.

Materials:

1 Liter plastic bottle (empty and clean)
balloon
1/2 cup vinegar
1 teaspoon baking soda
tape measure or string and a ruler

Preliminary Calculations:

1. Calculate the number of moles of baking soda ($NaHCO_3$) in a teaspoon.
   1 teaspoon = 4.3 grams

2. From the following balanced equation, determine the ratio of moles of $NaHCO_3$ used to the number of moles of CO_2 produced.

$$NaHCO_3 + HC_2H_3O_2 \text{ ---> } NaC_2H_3O_2 + H_2O + CO_2$$

3. Using your answer from #1 & #2, how many moles of CO_2 should be produced if your teaspoon of baking soda reacts completely?

4. If the experiment was carried out at S.T.P. what would be the volume of the gas? (Hint: 1 mole = 22.4 L at S.T.P.)

Procedure:

1. Blow up a balloon and let the air out. Repeat three times. (This will stretch it out.)
2. Measure out one teaspoon of baking soda. Use the flat part of a knife to scrape the excess off the top to make sure you have exactly one teaspoon.
3. Place the baking soda into the balloon. Suggestion: Have another person hold the mouth of the balloon open and pour the baking soda through a funnel made out of paper.

4. Measure out 1/2 cup of vinegar and pour it into the 1 liter bottle.
5. Without letting any of the baking soda fall into the bottle, attach the mouth of the balloon over the mouth of the bottle.
6. Lift up the balloon and shake the baking soda down into the vinegar. While the reaction takes place, keep your fingers around the connection between the balloon and the bottle to keep it from flying off.

Results:

1. Measure the circumference of the balloon at its largest part in units of cm. Use either a tape measure or wrap a string around the balloon and then hold the string against a ruler.

Circumference of balloon = ____________ cm

2. First use the formula $C = 2\pi r$ to solve for the radius of the balloon.

Radius of the balloon = ____________cm

3. Calculate the volume of the balloon using the formula $V = 4/3\ \pi r^3$.

Volume of the balloon = ___________ cm^3 = ___________ L

4. How does this volume compare with the volume you calculated before the lab?

5. Calculate the percent error. $\%E = \frac{M - A}{A} \times 100$

M = measured (in result #3 above) and A = accepted (let the volume you predicted in #4 of the preliminary calculations be the accepted value)

%E = ____________

Questions:

1. List as many sources of error you can think of. Do not just put "human error". Be specific. Name errors by you as well as by the design of the experiment itself.

2. If you had used three teaspoons of baking soda with excess vinegar, what volume of gas would you expect to produce? Explain with words and numbers

APPENDIX H

Boyle's Law

Boyle's Law Name: ___________________

In this lab you will study the relationship between the pressure and volume of a gas.

Materials:

pipet (provided by your teacher)
matches
food coloring
water
ruler or some length measuring device
bucket (or large pitcher) to hold water
large and small glass

Procedure:

Part 1 - Trapping the gas

1. In a small glass, place a drop of food coloring in a third of a glass of water.
2. Fill only the bulb of the pipet with the colored water and leave the stem empty.
3. Soften the tip of the pipet by heating it with a lighted match.
4. Seal the tip by pressing down on it with a knife or some metal object. (Check to see if it is sealed and if not, try again.)

Part 2 - Taking data

1. Place the edge of the bucket on the bulb of the pipet.
2. Measure the length of the air column in the stem of the pipet.
3. Enter your data in a data table as shown below.
4. Pour a measured amount of water into the bucket. (For example, the measured amount could be exactly three full large glasses.)
5. Measure and record the new length of the air column.
6. Repeat steps #4 & 5 at least 8 times.

Data Table:

Pressure (units water)	Length of air in pipet (units of length)

Observations:

Describe what you saw in a few sentences.

Results:

Note: Please use a best fit curve or line.

1. Make a graph with pressure on the x axis and volume on the y axis. Be sure to include a title and labels and units on the axes. You can graph by hand or use a computer.
2. Make a second graph with the inverse of pressure on the x axis (1/pressure) and volume still on the y axis.

Conclusions:

1. Write a sentence describing how the pressure and volume of a gas are related? (Use either the term "directly" or "inversely" to describe the relationship.)

2. How much water would you have to add to make the volume of the gas 0.5 cm? Explain how you determined your answer.

3. Draw a picture that shows the molecules of gas before you started the experiment and another after you added the last water. (Let some shape such as circles represent the molecules.)

APPENDIX I

Equilibrium

Equilibrium Name:____________________

In this experiment you will develop an analogy of a system which reaches a state of equilibrium.

Materials:

two test tubes
two straws of different diameter
water
10 ml graduated cylinder
marker

Procedure:

Part 1 - calibrating the test tubes (to be done in class)

1. Measure out one ml of water in the graduated cylinder.
2. Pour the water into a test tube.
3. Draw a line with a marker on the tube at the bottom of the meniscus.
4. Repeat steps #1-3 several times until you have graduated the whole tube. Repeat the process with the other test tube.
5. With the marker, label one test tube with an "R" for reactants and the other with a "P" for products.

Part 2 - taking data

1. Fill the reactant test tube about three quarters full of water. Measure the volume using your calibrations. Record this in the data table as shown before.
2. Place one straw in each test tube. (You choose which one goes where.)
3. Letting the straws rest on the bottom of the test tube, place your index fingers from each hand over the top of the straw. Transfer the liquid trapped in each straw to the opposite test tube. Put the empty straws back in their original test tubes.
4. Record the new volumes of each test tube in the data table.
5. Repeat steps #3 & 4 until your volume measurements stay the same for at least four transfers.

Data Table

Transfer #	Reactant Volume (ml)	Product Volume (ml)
0		0
1		

Results

Make a graph with transfer # on the x axis and volume on the y axis. Include both reactant and product data on the same graph. Don't forget to give your graph a title and to label the axes with units. You can do this by hand or on a computer. Attach it to this sheet when you turn in it.

Analysis

1. Your reaction reached equilibrium when the lines on the graph plateaued out (became horizontal). At what transfer # do you think you reached equilibrium?

2. What can you say about the volumes of the reactants and products during equilibrium?

3. When the system had reached equilibrium, were the reactants always the same molecules?

4. When the reaction has reached equilibrium, what can you say about the rates of the water transfer in both directions?

APPENDIX J

Precipitation

Precipitation Name: ____________________

In this lab you will:

1) Determine the formula of a precipitate you produce.
2) Practice writing complete and net ionic equations for a precipitation reaction.
3) Determine the identity of the solutions using known solutions which you will make.

Materials:

3 unknown solutions
plastic wrap
a few crystals of Drano (or Red Devil) drain opener
a few crystals of Epsom salts
table salt
three plastic pipettes

Procedure:

Part 1 - working with the unknowns

You will be given three solutions labeled AX, AY, and BZ. Assume they are all ionic solutions with charges of +1 or -1. All solutions can be flushed down the drain safely following the experiment.

1. Perform an experiment so that you can fill in the chart below using s = soluble and i = insoluble. It is insoluble if you see a precipitate form. Precipitates appear to be cloudy and sometimes colored. The products of a combination are otherwise soluble. The solutions you start out with are obviously soluble combinations.

	X	Y	Z
A			
B			

2. Determine the formula for the precipitate produced. (Suggestion: Write a double replacement equation with the two reactants on the left and the two products on the right. Of the two products, which one is the precipitate?)

3. For the same precipitation reaction, write the complete and net ionic equation.

Part 2 - Determining the unknowns.

The three solutions you used in part 1 were sodium chloride (table salt), magnesium sulfate (epsom salt) and sodium hydroxide (found in Drano crystals) each dissolved in water.

Obtain samples of each of the three and design and perform an experiment to determine which is AX, which is AY and which is BZ.

1. Briefly outline the steps of your experiment.

2. Identify the following:

AX =

AY=

BZ=

APPENDIX K

Making and Testing an Indicator

Making & Testing an Indicator Name: ____________________

In this experiment you will make an indicator from red cabbage and use it to determine the pH values for several household items.

Materials:

red cabbage
rubbing alcohol and a zip lock plastic bag
(or boiling water)

at least 6 household substances

Procedure:

Part 1 - Making the indicator

Method #1

1. Take several pieces of the red cabbage, rip them into tiny pieces and place them in the plastic bag.
2. Pour in rubbing alcohol. Push the air out and seal the bag.
3. Rub the cabbage pieces together to extract the red color. (You could try a rolling pin too.)
4. When the alcohol is reddish pink, cut a corner off the bag and drain the juice into a cup.

Method #2 (This is a good method but smells a little more - turn on the vent!)

1. Take several pieces of red cabbage and place them in a pan of water.
2. Bring the water to a boil until it turns reddish pink.
3. Allow the mixture to cool. Strain out the cabbage.

Part 2 - Determining the pH of several household items.

Choose at least six household items to test their pH. They can be solids - just dissolve a little of it in water. Try to stick to things that are mostly colorless.

Here are some suggestions:

colorless soda (e.g. Sprite)
baking soda
vinegar
Drano or Red Devil drain opener
lemon juice
bathroom or kitchen cleaners

Compare the color of your sample to the scale below and determine pH.

Colors of Red Cabbage Dye at Different pH Values

pH 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Color red pink purple blue green yellow

highly acidic slightly acidic neutral slightly basic highly basic

Record your results in the table on the back of this sheet.

Substance	Color Description	pH
1.		
2.		
3.		
4.		
5.		
6.		
7		
8.		
9.		

Questions:

1. Did any of the results surprise you? Explain your answer either way.

2. Determining the pH of grape juice using this method would be difficult. Why? What other substances would not work well with this method?

APPENDIX L

Titration

Titration Name: ___________________

In this experiment you will titrate to determine the strength of acid in various household cleaners.

Materials:

1 gram of Red Devil drain opener crystals.
50 ml water in a Dixie cup
pipet with phenolpthalein
various acidic household cleaners
pipets
cups

Procedure:

Part 1 – In class preparation

1. Measure 50 ml of water in a graduated cylinder and pour into a Dixie cup. Use a pen to mark the water level on the outside of the glass.
2. Obtain a pipet and fill the bulb half way with phenolpthalein indicator.
3. Hold the end of the pipet in the warmth above a bunsen burner flame and then press the tip together with a metal spatula to seal the end.
4. Weigh out 1 gram of Red Devil drain opener and put it in a locking baggie.

Part 2 – Making the standard NaOH solution

1. Fill the Dixie cup with water to the mark you made in class.
2. Dissolve the Red Devil crystals into the water in a glass cup.

This makes your base solution. 1 gram is 0.025 moles of NaOH. The Molarity of a solution is moles/liter so

$$M = \frac{0.025 \text{ moles}}{.05 \text{ liter}} = 0.5 \text{ M}$$

Part 3 - Titrating

1. With a clean pipet put 20 drops of the base solution into a clean cup.
2. Cut the melted tip of the indicator pipet. Add one drop of it to the cup. The mixture should turn deep pinkish-red.

3. Take a pipet full of liquid from a bottle of a cleaning solution. Add drops one at a time to the basic solution. Count the number of drops it takes for the mixture to turn clear. (Suggestions: Tip the cup to the side so all of the liquid is together. Swirl the cup after each drop to ensure complete mixing. Repeat two more times and take the average.)
4. Repeat the steps with at least two more acidic substances.
Clean out the pipet used for the cleaning solutions with water between each different substance.

Data:

Substance Tested	Number of drops added
1.	
2.	
3.	
4.	

Calculations:

For each substance collected, calculate $[H_3O^+]$. Use the formula $MaVa = MbVb$.
The molarity and volume of your base was constant each time. The molarity of the base was .5 M and the volume was 20 drops. Circle the concentrations of $[H_3O^+]$ at the end of each calculation.

Results:

1. Rank the substances tested in order of decreasing acidity. (Most acidic first)

2. Is the one that is least acidic the one that is the cheapest? Explain.

3. Describe a reason why you might buy a cleaner that is less cost effective.

APPENDIX M

Rates of Reaction

Rates of Reaction Name: ___________________

In this experiment you will observe a few things which affect the rate of a reaction.

Materials:

food coloring	salt
drinking glasses	watch or clock with a second hand
water	alka-seltzer tablets

Procedure:

Part 1 - Food coloring

1. Get a glass of hot tap water and a glass of very cold tap water and set them near each other.
2. Simultaneously put a drop of food coloring in each glass at the same time.

3. Write down your observations:

Part 2 - Alka-Seltzer

1. Write your own procedure for testing how the rate of reaction (between water and alka-seltzer) is affected by temperature. Carry out your procedure and make a small data table to record your findings.

2. Write your own procedure for testing how the rate of reaction is affected by surface area. Carry out your procedure and make a small data table to record your findings.

3. Write your own procedure for testing how the rate of reaction is affected by concentration. (use the salt to alter concentrations) Again carry out your procedure and make a small data table to record your findings.

Results:

1. Write a few sentences about how temperature, concentration and surface area effect rates of reaction.

2. Explain at a molecular level why temperature affects the rate of a reaction as it does.

3. Explain at a molecular level why surface area affects the rate of reaction as it does.

4. Explain at a molecular level why concentration affects the rate of reaction as it does.

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