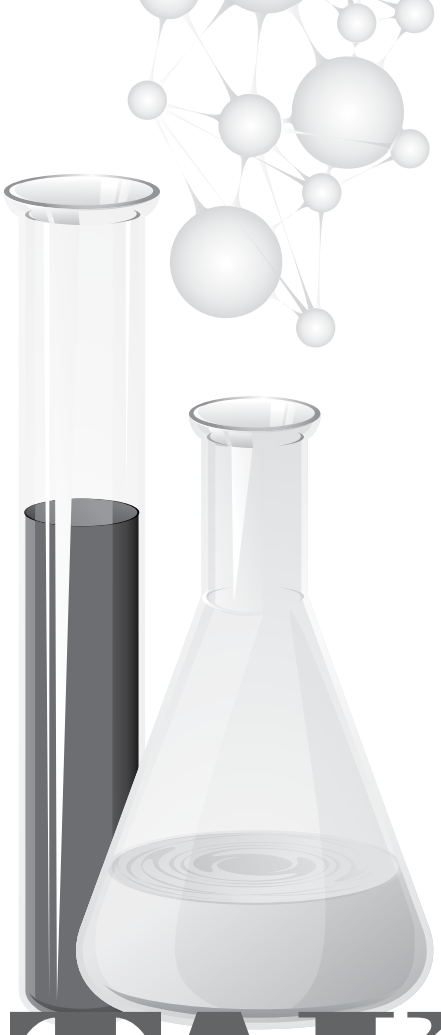

TAKE-HOME CHEMISTRY:

50 Low-Cost Activities to Extend Classroom Learning

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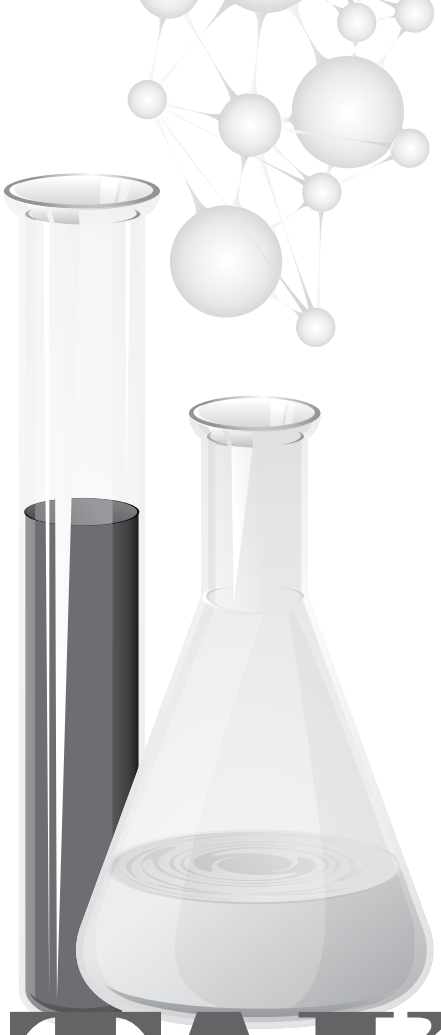

TAKE-HOME CHEMISTRY:

50 Low-Cost Activities to Extend Classroom Learning

Michael Horton

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Arlington, Virginia

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INTRODUCTION

Research has shown that homework can be an effective and meaningful learning tool for high school students if it is relevant, engaging, and hands-on. These take-home chemistry activities are designed to match those criteria. The activities also cost far less than $10 per student the first year, and only a small amount each year after to refill the consumables. Educational writer Alfie Kohn said in a 2006 interview that there are only two ways that homework is effective for high school students. One way is using "activities that have to be done at home, such as … a science experiment in the kitchen" (Oleck 2006). This book is a collection of such activities.

This book is a collection of chemistry labs that lend themselves to being performed at home with simple materials. It is not intended to be a chemistry textbook or to cover every topic encountered in high school chemistry. Most of the labs are written as structured or Level 2 inquiry (see Inquiry in Chemistry, page xiii), and some include instructions to raise the level of inquiry if the teacher feels comfortable doing so. A few activities just are not compatible with inquiry at home and are written as Level 1 labs but are still important because they introduce topics critical for other experiments or topics that have common misconceptions. Most of the activities involve measuring, graphing, calculating, extrapolating graphs, and performing other science-process skills.

Because this is one piece of a complete chemistry curriculum, it is assumed that traditional learning and hands-on activities in the classroom will fill in where take-home labs are not practical. Teachers may choose to eliminate some of the labs and substitute others without breaking the flow of the labs. Used in this way, the hands-on activities can be a powerful tool for learning chemistry concepts and preparing students for chemistry standardized assessments that are highly dependent on charts, graphs, and conceptual questions. These activities have been piloted in schools across the United States and used by teachers who received the material during conference presentations. The success that these teachers have had with the labs helps refute the common misconception among teachers and students that lectures are for learning and labs are for fun. Students *can* learn chemistry from labs.

Although the labs are written as take-home activities for high school students, many of the activities in the book are well suited for homeschooled students as well as those who take online courses. These activities would also be appropriate

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for family science nights and museum outreach programs. If a teacher does not have sufficient materials to send an activity home with every student, the lab could be performed in class as an alternative. One teacher used the activities in after-school intervention programs for students who were not proficient after being exposed to the concepts in the classroom.

Why Take-Home Labs?

These take-home labs, if implemented effectively, can address most or all of the following problems, which are common with chemistry labs and homework.

Students will not do homework. This sentiment could be rephrased as *Students will not do busy work at home*. When presented with fun and challenging assignments that open doors to understanding the physical world around them, students will rise to the occasion. Throughout four years of implementing these activities, I found that the homework completion rate improved greatly, and test scores indicate that student achievement increased as well (see Evidence of Success below).

Students do poorly on standardized tests. Most standardized science tests are weighted toward science-process skills. These skills include drawing and interpreting charts and graphs, finding patterns, interpreting diagrams, and analyzing experimental data. The take-home labs in this book support each of these skills.

There is not enough class time to cover all the standards. A great deal of class time is used on simple labs that students could do at home. These labs are important, but they consume valuable class time. By having students perform these labs at home, teachers recover days of class time in which new concepts can be taught or reinforced.

Students do not experience enough labs. By assigning take-home lab work, teachers can increase the number of labs students complete over the course of the year. This will lead to a more engaging, fulfilling learning experience for students, which will lead to deeper, longer-lasting learning.

Chemistry labs are expensive. There are 50 labs in this book, and the collection of materials needed to complete the labs costs $10 or less, or approximately 20¢ per lab per student the first year. After the first year, only breakages and consumables need to be replaced, at a cost of less than a dollar per kit.

Chemistry students lack basic skills when they get to my class. Some of the take-home labs teach about background information and skills that students are supposed to remember from middle school but rarely do. These labs are a good refresher that you can refer back to throughout the year. As mentioned earlier, it can also buy you extra days of class time to teach the chemistry curriculum for your grade level.

My school will not let me do take-home labs because of No Child Left Behind. NCLB prohibits some schools from allowing take-home labs because the materials are not provided to every student. That practice, it is argued, puts some students at a disadvantage. However, teachers can easily provide almost every object needed to do *Take-Home Chemistry* labs, with the exception of a couple of

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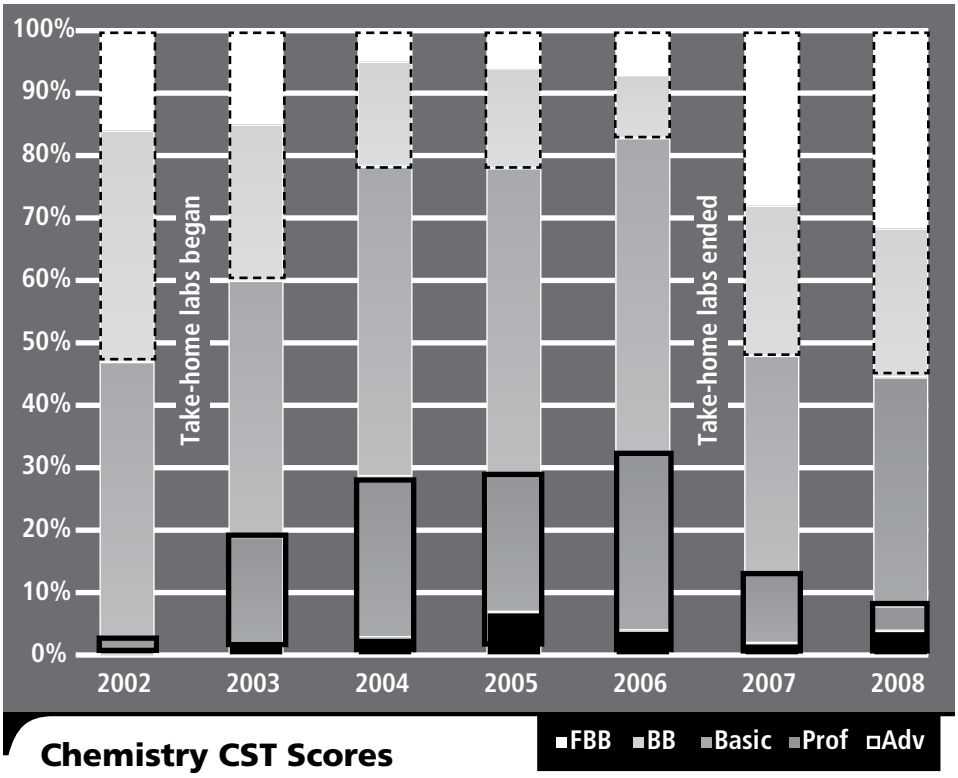
labs that require students to provide water or other common materials. If students inform the teacher in advance that they do not have certain required items at home, the teacher can provide these materials as well. Appropriate safety precautions should be followed if and when the teacher sends household chemicals home with students.

Evidence of Success

A chemistry teaching colleague and I have informally collected data on the success of these take-home labs. We began by sending individual activities home in sandwich bags in 2003 and increased the number and quality of the activities over the next several years. Most chemistry students were 10th and 11th graders. As shown in Figure 1.1, four years of implementing chemistry take-home labs coincided with a more than tenfold increase from 3% to 32% (solid box) in the proportion of proficient and advanced students in chemistry based on the 2002 baseline. In the same time period, the number of students testing below basic and far below basic decreased dramatically from 53% to 17% (dashed box).

Figure 1.1

Chemistry Proficiency Before, During, and After Implementation



FBB = Far Below Basic, BB = Below Basic, Prof = Proficient, and Adv = Advanced. California considers FBB, BB, and Basic to be nonproficient.

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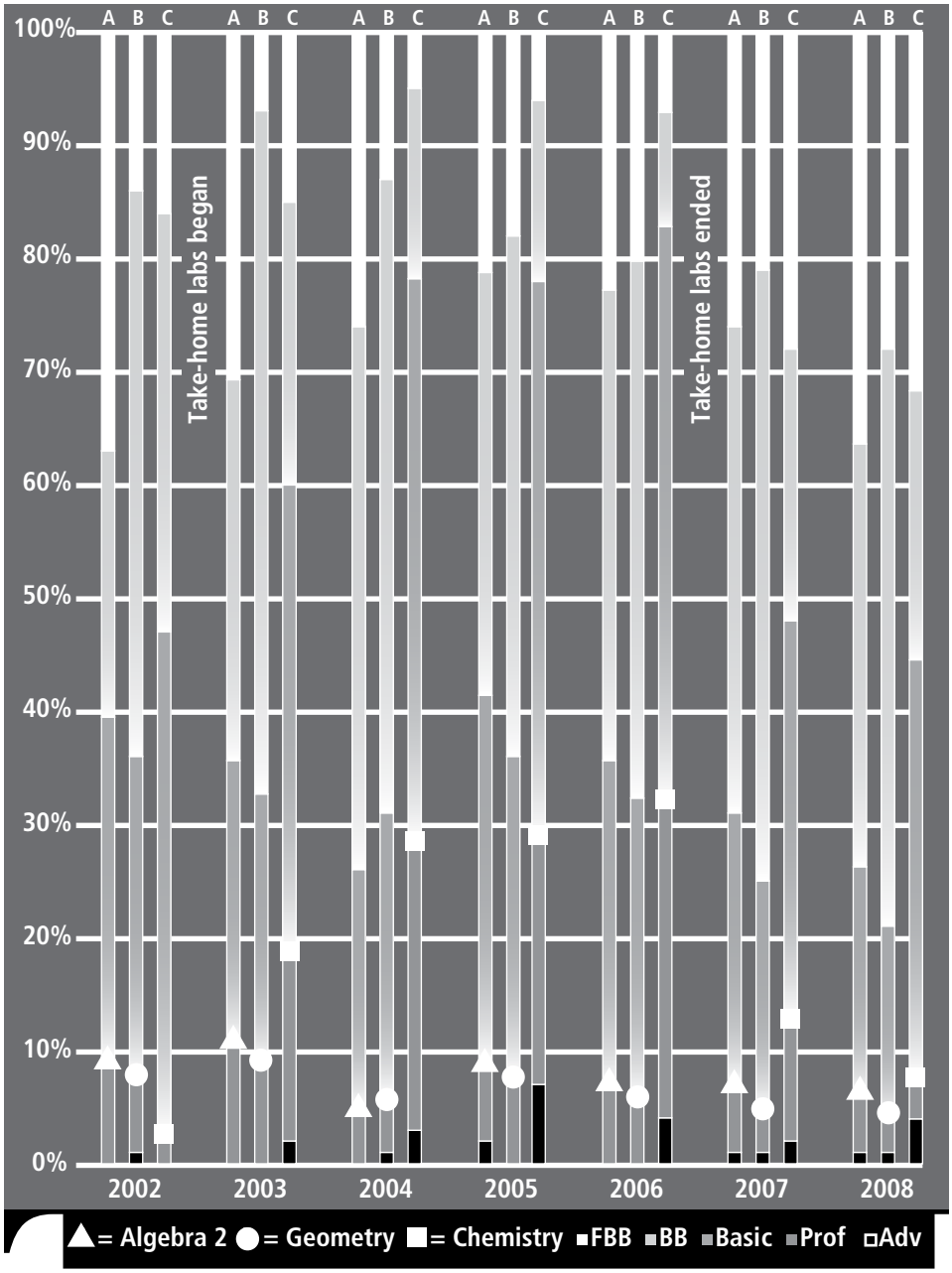
Figure 1.2

Comparison of Student Proficiency in Chemistry, Geometry, and Algebra 2



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To strengthen the argument that the score changes were due to the take-home labs and not to other changes in the school or the student body, student performance in Algebra 2 and Geometry over the same period was examined (see Figure 1.2). Those scores stayed nearly the same over this time period. Most chemistry students are in either Algebra 2 or Geometry.

Although I left the classroom early in the 2005–2006 school year, my chemistry colleague collaborated with the long-term substitute teacher and continued the take-home labs. Figure 1.1 shows that in 2007, when the chemistry colleague became an administrator and the take-home labs ended, the test scores went back to almost where they had been before we started. That trend continued in 2008.

During implementation of these activities, this high school was a state-identified underperforming school with more than 70% of the students qualifying for free or reduced-price lunch. More than 40% of parents never graduated from high school and more than 25% of students are English language learners. The state also puts schools into groups of 100 similar schools based on dozens of criteria. My school had far higher chemistry scores than those similar schools, as much as a 156-times-larger ratio of proficient and advanced students to below-basic and far-below-basic students. Overall, the school was ranked in the second decile from the bottom in the state in 2006. In chemistry, the school was above the state average, putting it at least five deciles from the bottom.

In short, the chemistry scores at this school were above school, district, county, and state averages despite lower scores in other subjects schoolwide. Although the same results cannot be guaranteed at every site, this program was highly effective for these teachers and these groups of diverse students.

All data in Figures 1.1 and 1.2 were taken from the California Department of Education website (*cde.ca.gov*) for Perris High School in the Perris Union High School District in Riverside County, California.

Inquiry in Chemistry

The topic of inquiry in science instruction—what it looks like, how best to implement it in the classroom, ways to assess its success—far exceeds the scope of this introduction. The following is a brief explanation of inquiry and how I define it in this volume. For a full and more detailed discussion of inquiry, please consult the resources list.

When inquiry is discussed in science education, it has two meanings. The first meaning is the creation of an atmosphere of inquiry in the classroom in which students interact with one another and the teacher facilitates open-ended investigation of student-generated questions daily. The second use of the term refers to inquiry activities. This book alone cannot accomplish the first task, but it is intended to provide the second. The post-lab questions take the place of the teacher's guiding questions during an inquiry activity performed in the classroom. Although both forms of inquiry are valuable and effective, this book only aims to provide structured inquiry activities to be used as high-level, hands-on homework and practice.

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It is a common misconception that inquiry is all or nothing. Most of the research about inquiry activities identifies four levels of inquiry (Banchi and Bell 2008; Colburn 2000; McComas 2005), although the first level is not inquiry at all (see Figure 1.3). What changes at each level is how much information is given to the student (i.e., the question, the procedure, the answer) (Bell, Smetana, and Binns 2005). Herron (1971) first described inquiry by distinguishing among three different levels. Since then, rubrics and matrices have been created with three, four, five, and seven levels (Lee et al. 2001). Because most education researchers refer to four levels, that is the model that will be used in this book.

Figure 1.3

What Is Provided to Students at the Different Levels of Inquiry

	Question Given	Procedure Given	Answer Known
Level 1	X	X	X
Level 2	X	X	
Level 3	X		
Level 4			

Level 1 inquiry activities are also known as verification, or "cookbook," activities. In a Level 1 activity, students are given the question or problem and the procedure, and they already know the answer to the question. They simply verify something they have already learned. Technically, the activities are not inquiry at all. This is not to say that they are completely ineffective, but not as effective as higher levels of inquiry.

In a **Level 2**, or "structured inquiry," activity, students are given the question and procedure, but they do not yet know the answer. Having students perform an activity before learning the concept raises the activity to Level 2. In performing this significant step, the teacher is giving all students the same background knowledge, an activity on which to hang the concept in their memory, and a common experience to refer back to in class when covering or practicing the concept. Robert Marzano (2004, p. 3) says, "Students who have a great deal of background knowledge in a given subject area are likely to learn new information readily and quite well. The converse is also true." Dochy, Segers, and Buehl (1999) found through meta-analysis that differences in students' prior knowledge explain 81% of the variance in post-test scores. The research of Langer (1984) and Stevens (1980) shows a well-established correlation between prior knowledge and academic achievement.

Most of the labs in this book are written as Level 2 inquiry, which means the teacher must assign the activities to students before teaching the concept in class. Assigning the activities this way increases the level of inquiry and also allows teachers to afford students prior knowledge when the concept is covered formally in class later. Marzano states that "what students *already know* about the content is

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one of the strongest indicators of how well they will learn new information relative to the content" (2004, p. 1). Douglas Llewellyn, in *Teaching High School Science Through Inquiry: A Case Study Approach* (2005), recommends doing the lab first to raise the inquiry level. Bell (Bell, Smetana, and Binns 2005, p. 33) comments, "The difference between a Level 1 and Level 2 activity can be a matter of timing. A confirmation lab can become a structured inquiry lab by simply presenting the lab before the target concept is taught." To get the full effect from these activities, teachers are expected to use them in this way. Teachers who are uncomfortable with this method are welcome to use them as cookbook labs, but should not expect the same results.

As Level 2 inquiry activities, deep explanations are not included, as that would lower them to Level 1. As such, it is expected that the teacher will use these activities as introductions to topics and give formal instruction after the activity to take advantage of the prior knowledge gained.

In a **Level 3** activity, referred to as "guided inquiry," students are given an appropriate question and asked to determine the procedure and develop the answer on their own. Many activities in this book can be converted to Level 3 simply by removing the procedure and having students determine how to accomplish the task. For example, a lab inviting students to follow a procedure to determine what affects the rate of a chemical reaction could be increased to Level 3 by changing the activity to "Which affect(s) the rate of a chemical reaction—particle size, temperature, or stirring?" and having students determine an appropriate procedure. Some of these take-home labs are already Level 3, and teachers are free to modify others to meet the Level 3 criteria. Most of the extension activities, which are often provided at the end of the activities, are opportunities for Level 3 inquiry, and several of the post-lab questions encourage students to test ideas on their own. Teachers can remove some steps in the procedure, add unnecessary steps and have students identify them, remove data tables and have students create their own, add extensions, or rearrange the steps to transition to Level 3 gradually (Llewellyn 2005). Some of the labs in this book already require students to create their own data charts.

In a **Level 4** activity, referred to as "open inquiry," students pose their own question and are given the resources to answer that question. This type of inquiry is most easily demonstrated with science fair projects. Students investigate their own questions by following their own procedures and then draw their own conclusions.

Many teachers also use this type of inquiry as differentiated instruction activities. If a student clearly understands a concept while doing an inquiry lab, he or she may be invited to come up with additional questions to answer independently. It is not the intent of this book to provide Level 4 inquiry activities, but teachers are encouraged to motivate students to perform deeper follow-up activities to answer questions they may have after an activity. Students can certainly extend experiments to answer their own questions, hence independently creating their own Level 4 inquiry activities. Some of the extension activities could be replaced with a more general Level 4 question, such as "What other questions do you have about this topic? Create an activity that will lead you to the answer."

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Some teachers are discouraged when they begin using inquiry activities and do not immediately see the achievement gains they expected. Students need experience using inquiry activities to learn. They do not relate classroom lab activities with learning because they have always done verification labs. I have seen low performance the first few times questions were given on a test about a subject learned via inquiry. However, when students were reminded of the activity, they immediately began writing again and performance increased greatly. After a little experience, students no longer need to be reminded and make the connection automatically.

Please be warned that providing question stems such as "Remembering the string and protractor lab …" is not intended to be a long-term strategy because high-stakes tests will not do so. Some of the labs in this book are Level 1. They are included to overcome student misconceptions, provide experiences that allow students to see chemistry phenomena, or enable students to collect and analyze data that will assist them in understanding a concept more thoroughly. Some topics just do not lend themselves well to inquiry at home, but they are far fewer than those topics that do.

Providing Feedback to Students

Keep in mind that feedback of some type should be given on each lab that students do. This can be time consuming but very valuable. The purpose of these labs is not to add more items to the teacher's grade book.

Homework should be used as formative assessment. Often, formative assessments are not even graded. The teacher uses them to judge where the students are in relation to proficiency on the relevant standard. If the purpose of the lab is to give common background information to the students, then the teacher may also consider this a situation that need not be graded formally at all. But keep in mind that whether the teacher grades the labs or not, there must be feedback in the classroom. Some teachers may choose to give the labs credit/no credit or credit/redo marks.

Marzano (2006) reports that students who do not receive feedback after a formative assessment do no better on the summative assessment than if they had not been given the formative assessment at all. He lists several different ways to offer that feedback and gives the pre- and post-test gains that can be expected. Just putting a grade at the top of the paper has a negative effect on summative test results. If the teacher decides to formally grade the labs, then the feedback should be deeper than a simple overall grade. Having students prepare short written summaries, explain their logic aloud to the class, or discuss the activities while the teacher rotates around the room to deal with misconceptions are examples of ways teachers can check for understanding without formal grading. It is also helpful for the teacher to identify the criteria used to deem a conclusion satisfactory and allow students to redo the activity until it is satisfactory. It is also beneficial to show students good and bad examples of lab reports. This simple practice will likely increase the percentage of good lab reports you will get.

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Some schools have not gotten to the point where formative assessments are used this way, however. Teachers may want to give credit for these labs simply to encourage students to perform the labs. Although it is worth repeating that these activities do not have to be graded, following are some tips for easing that burden if the teacher chooses to do so. A compromise could be that the teacher only grades some of the labs but the students do not know in advance which labs will be graded.

Teachers should create a grading guide that identifies which parts of each lab are the most important and assesses only those parts. For those labs that are graded, not every section has to be graded. And for every section that is graded, not every question or detail has to be analyzed.

A grading guide could look something like this:

Name_____ Period_____

Building Your Balance
Data _____/ 5 Post-Lab Questions _____/5 **Total ____/10**

Thickness of Paper Lab
Data ____ /5 Calculations ____/5 **Total ____/10**

Graphing the Ball's Bounce
Post-Lab Questions ___/5 Graphs ____/5 **Total ____/10**

Investigating an Urban Legend
Data ____/5 Conclusion ____/2 **Total ____/7**

The Mole
Data ____/2 Post-Lab Questions ____/5 **Total ____/7**

Calculating Moles Lab
not graded

Completeness and Setup of Lab Notebook **Total ____/15**
Grand Total ____/59

Lab Notebooks

Because students may perform as many as 50 activities at home, a lab notebook is a useful tool for students to keep track of their lab write-ups. They are also great modeling for college and of how real science researchers work. Teachers may choose to collect the notebooks after, for example, 5 or 10 activities have been completed as a means of assessment. Feedback should be given after each activity; the teacher should not wait for five activities to be completed. The teacher should determine in advance the format for the notebooks (e.g., Purpose, Procedure, Data, Calculations, Safety Practices) and establish a set of rules for using the notebooks.

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Figure 1.4

Small Sample of Materials for Lab Boxes



Figure 1.5

Some Items Ready to Distribute



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These rules help students stay organized and save teachers time when reviewing the notebooks. The students' write-ups should include data charts, graphs, and post-lab questions as called for in a given activity's directions. Composition-style notebooks, spiral notebooks, or three-ring binders are all acceptable notebooks. Teachers may also consult their local university instructor to find out how freshmen are required to organize their notebooks, then ask their own students to set up their notebooks in a similar fashion.

Teachers are free to decide on their own whether the activities will be accomplished individually or in groups. If the teacher chooses for them to be completed individually, it is clear when students cheat on a take-home lab. For most of the labs, there is a small chance that any two people would get the exact same answer. If two students do get the exact same answers, it is clear they copied.

Again, it is not imperative to grade every lab or every part of those that are graded. Formal summative assessments will determine which students understood the concepts and which students did not. These labs are not about assigning grades. They are about learning chemistry. Each lab should be reviewed by the teacher to check for understanding, and feedback should be given in one form or another.

Tips for Using This Book

Teachers may opt to use *Take-Home Chemistry* labs exactly as they are presented or adapt them to better suit the needs of a particular class. Labs may be written on the board or posted via overhead projector for students to copy into their lab notebooks, or teachers may choose to pass out copies to each student. Teachers should let students know that any pages they need to write on or cut out will be given to them separately (those pages are included at the end of this book). Copies can be stored in materials boxes and reused from year to year.

Note: On the teacher pages, the objective will describe what the student is trying to accomplish and the purpose will describe the skill or concept they will learn. For example, sometimes the student will think the objective is to calculate the root mean path of atoms, but the purpose of the activity is for them to practice measuring in metric units and calculating averages.

Based on feedback I received about *Take-Home Physics,* the layout of this book has been changed so it is easier for teachers to use. Student activities are grouped together to ease the process of creating a student lab manual. The white space on the page is arranged so that no information is near the book's binding (allowing for easier photocopying). I hope these changes make this book convenient for the teacher to use. As mentioned above, pages that students will cut out or write on have been included at the back of the book for teachers to give students separately from the lab manual. You can photocopy page xxix to include at the beginning of the student manual

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Assembling the Materials

Once you decide to assign the labs in this book, you will need to start planning. A list of materials is included in the teacher manual for each lab to assist teachers in determining what materials will be needed. A master materials list is included at the end of this section.

The basic idea is that you will send a (plastic, shoe-box size) box of materials home with the students that will enable them to complete all the activities in this book. The box is pictured in Figures 1.4 and 1.5 (p. xviii). Sending all the materials home in one box is preferable to sending individual activities home in plastic sandwich bags because of the time that it will take to check each bag in and out. If individual labs are all you can manage the first year, it is acceptable, but it will bring challenges to the situation (such as getting the materials returned to you). All the materials can fit into one box, which may be purchased for around a dollar, or, alternatively, a 1 gal. plastic freezer bag may be used.

After determining which labs you will assign and how much of each item is necessary, it's time to go shopping. Most of the items can be found at discount or 99-cent stores—from the boxes themselves to the batteries, salt, sugar, balloons, and Epsom salts. A couple of items, such as washers and nails, can be purchased at a home improvement store. Many items can be purchased at a much lower cost online than in stores or catalogs. For example, rubber balls can be purchased online inexpensively, but beware of high shipping costs. The website *www.rebeccas.com* sells 250 bouncy balls for around $22, including shipping. That's less than 9¢ each.

Be sure to buy a few extra of each item in case of loss and breakage. Once purchased, the items will take up quite a bit of space. (Figure 1.4 shows a small sample of the materials used to make lab boxes.) Do not plan to store them in the back of your classroom. (Tip: Purchase a few extra boxes to store items in while you dispense them.) Syringes are far less expensive on veterinary websites than from science suppliers.

When all materials have been purchased, put each item in its own box for easier distribution (see Figure 1.5). Find a large space to spread out the boxes in an assembly line so students can walk by, pick up the boxes, and fill them with the materials. Attach a 3 × 5 in. index card to each box with the quantity that students need to take written on it and instruct students to follow the cards in order (e.g., pick up six marbles, four paper clips, one rubber ball, etc.).

Remind students that they are to return all nonconsumable items with the boxes at the end of the year or upon transferring to another class or school. If not, they will be charged a fine such as for a lost or damaged textbook.

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Master Materials List

Anything with a * next to it will be used up during the year. Anything with a + next to it will be returned at the end of the year.

Material	Source
+ Ruler (plastic with hole in center)	99¢ or discount store
* Small bathroom cups (4–6 if paper, 3 if plastic [like salsa containers])	Warehouse store
+ 60 ml syringe	Veterinary supply
+ Dental floss	99¢ store
+ 6 washers	Home improvement store
+ Rubber ball	Online
* Salt packet	Donated or warehouse store
* Sugar packet	Donated or warehouse store
* Zip-top bag with sand, salt, Styrofoam, iron	(see p. 45)
+ 6 marbles	99¢ store
* Coffee filter	99¢ store
* Transparent drinking straw	99¢ store
* 2 Wint-O-Green Life Savers	99¢ store
* Sugar cubes	Warehouse or grocery store
+Large plastic cup	99¢ store
*Effervescent tablet	99¢ store
*2 water balloons	99¢ store
*1 large balloon	99¢ store
*Zip-top bag with Epsom salts	99¢ store
*Zip-top bag with steel wool (must be real steel wool)	
+9 V battery	99¢ store
+Battery clip	Online or Radio Shack
+2 pieces of graphite (0.7 mm pencil lead)	99¢ store
*2 iron nails (shiny)	Home improvement store
*2 anodized nails (dull gray)	Home improvement store
+Mustard packet	Donated or warehouse store
*Minimarshmallow (provided later)	Grocery store
*pH paper (provided later)	Made by teacher (see p. 199)
*2 empty zip-top bags	99¢ store
+Syringe cap	Flinn Scientific
+Paper clip	99¢ store
*Waxed paper square	99¢ store

+Indirectly vented chemical splash goggles that meet ANSI Z87.1 standard

Inexpensive sources for goggles include Gallaway Safety and Supply ($2.39, item #2235R); *www.envirosafetyproducts.com* ($1.94, SKU: PYRG204), and other similar websites.

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Students will be expected to have the following items at home. If they do not, the teacher should have some extras to loan out.

- Vinegar
- Baking soda
- Ammonia
- Sugar
- Salt
- Cups or drinking glasses
- Coins
- Magnet
- Ink pens
- Scissors
- Ice cube
- Cooking oil
- Dishwashing liquid
- 2 L soda bottle
- Toaster or hair dryer
- Compact disk
- Shoe box
- Rubbing alcohol
- Fruit juice or colored drink (e.g., Gatorade)
- Soda
- Tape
- Cornstarch
- 100 pieces of rice, dried beans, popcorn kernels, or similar small objects
- Comb
- Thread
- Paper towels
- 3 × 5 in. card

Managing the Boxes

Before assigning take-home labs, consider how you will manage the boxes—especially how they will be collected at the end of the school year. Incomplete or lost boxes are a waste of time and money.

Make the distribution of box lids a routine part of the new school year. For example, if the school librarian manages textbook distribution and collection at your school, have that person also assist with the check-in and check-out process for your materials boxes. In my school, when students enrolled in chemistry and picked up their textbooks from the library, they also signed out the chemistry lab materials in the form of a box lid. That is, the lids were labeled with bar codes and checked out to students, and the boxes (in my classroom) were labeled with a matching bar code. When a student brought a lid to class, I gave him or her the matching box to be filled with materials. (Tip: Do not put the materials away yet,

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as you will certainly have students checking into your class late. Just put the lids on the boxes of extra materials and store them somewhere convenient.)

Even with such a system in place, you will need to keep careful watch over the boxes. Students may transfer out of the class or the school and take the box with them. If so, send a letter to their new classes (if they are still enrolled in the school), home, or new school asking for the boxes to be returned. If the boxes are still not returned, treat them just like a textbook and charge a fee to cover the loss. Students should not receive transfer grades until all debts are cleared, including the boxes. It is always preferable—and less costly—to get the box back rather than receive money for a new box.

Tell students at the beginning of the year that the boxes must be returned at the end of the year and some items will be used up while others will remain. Also tell them approximately how much each item is worth in case they are lost or broken. The librarian, or whoever collects textbooks at the end of the year, can charge these partial damages just like damage to a book. After students return the boxes, the teacher determines if all the materials are there and takes the lids and a list of missing items back to the library.

Do not wait until the last day of the school year to collect the boxes, as students inevitably will be absent or forget to bring their boxes. Rather, start collecting the boxes as soon as the last lab is finished. This will give you several weeks to collect them. Then students can drop off the individual materials in the summer storage boxes to be counted and refilled if necessary.

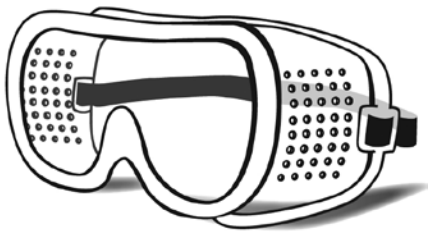
Safety Notes

Goggles

There are generally two philosophies on goggles. One is that students should wear goggles with all chemistry experiments, no matter what. The other is that students should be taught when goggles are necessary and when they are not. The author feels that the latter approach is far more responsible and teaches students lifelong lessons. However, if the former is the policy in your class, then feel free to require goggles on all experiments.

When purchasing goggles, the teacher should know that there is a big difference between impact goggles that keep objects from hitting the eye and chemical splash goggles that keep chemicals out of the eye. Chemical splash goggles are what





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students need for these activities. The goggles should be indirectly vented and meet ANSI Z87.1 standard. The materials list gives sources of these goggles for less than $2 each.

Other Safety Notes

- If a student happens to get splashed with a hazardous material such as vinegar or ammonia, flush eyes directly with warm (60–100°F) tap water for a minimum of 15 minutes. Consult an emergency care provider if the eyes show symptoms such as burning or blurriness.
- There are possible choking hazards for very small children in the home. Emphasize to your students that the boxes of lab materials must be kept out of the reach of small children.
- Material Data Safety Sheets (MSDS) must be provided in kits as hard copy or online for any hazardous materials used, such as ammonia, rubbing alcohol, and vinegar. The teacher should review safety rules with students prior to performing the activity.
- Remind students not to drink or eat materials used in the lab. (The Wint-O-Green Life Savers are individually wrapped and should be sent home separately from the box so as not to send mixed messages.)
- At the end of each lab, students should be reminded to wash hands with soap and water.
- At the end of each lab, students need to appropriately discard all materials used.
- Immediately wipe up any liquid spilled on the floor to prevent slip-and-fall hazards.
- Remind students to use caution when working with sharp objects such as scissors, electrical wires, glass, and metal cans. These items may cut or puncture skin.
- On page xxviii is a label that should be on the top of all boxes before they are distributed. Just print the page onto peel-and-stick paper, cut out the stickers, and place a sticker on each box or lid. If the peel-and-stick paper is made for the computer printer, you may need to scan the page first.
- See page xxv for an acknowledgment form to parents that explains the possible dangers of the box of lab materials. It also notes the need for adult supervision on some activities. This letter should be sent home, signed by a parent or guardian, and returned by all students.

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Dear Parent or Guardian:

Soon your child will bring home a box of materials to perform chemistry labs at home. These activities will give your child more skill in performing labs, analyzing data, and creating charts and graphs, and they will free up time in class to cover other important topics.

Although safety precautions and training have been provided by the teacher for all of the labs in an effort to help make them safer, there is always a chance that an accident can happen. Please encourage your child to use goggles when appropriate. There are some common household materials, such as ammonia and alcohol, that can be hazardous when used incorrectly. There also are small objects that could present a choking hazard for small children (such as marbles and a rubber ball).

The box will have a warning sticker on top to discourage young children from opening it. Students should keep the lid on the box at all times and keep the box out of the reach of children. Activities should be done under the supervision of an adult.

Sincerely,

I have read and understand and acknowledge that labs must be performed using appropriate safety equipment and following safety procedures, and under adult supervision. Abuse of laboratory instructions and/or safety training could possibly lead to harm. I do not hold the teacher, school, author, or publisher responsible for injuries sustained while performing these labs.

_____

Printed Name Parent Student

_____

Signature Date

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Acknowledgments

Most of the ideas in this book have some basis in my experience as a teacher and teacher educator. I appreciate the contributions of other science authors, and it is my intent to try to provide credit where credit is due for the ideas. But many of these activities were in my lesson repertoire for many years, and the original source cannot be traced. The books and websites that are listed below are valuable resources, and the ideas for many of the labs may have originated in them.

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ACTIVITY 19: DENSITY COLUMN IN A STRAW

Objective
Students will make a series of liquid layers with different densities using nontoxic chemicals.

Purpose
Students will see how the amount of solute in a solution affects its density.

Materials
Sugar, water, transparent drinking straw, three small cups, food coloring or colored drinks (such as Kool-Aid or Gatorade)

Notes
A discussion of why the different liquids do not mix when the column is made is probably beyond comprehension for the average high school class. The solutions will mix if not handled gently. The same effect can be made in a large graduated cylinder as a demonstration in the class. Just fit a large funnel with a rubber tube and a pinchcock clamp (a spring-loaded device that will squeeze the rubber tube closed when you don't want liquid to flow). Starting with the densest solution, add each of the sugar solutions with a different color slowly down the side of the cylinder. Small objects such as corks, marbles, popcorn kernels, and marbles can be placed in the cylinder to see the layer on which they will float. You can test the floating objects in the prepared solutions before you put them in the cylinder. This is far safer than versions with mercury, mineral oil, and alcohols.

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Post-Lab Questions

1. Warmer water will be on top because it expands as it warms and its density is lowered. In the winter in a calm lake, this effect can be reversed slightly as the surface of the water is cooled; it can stay at the surface until it freezes. Then it stays there because ice is less dense than water.
2. The freshwater will stay on the surface because it is less dense than the salt water. Eventually, it will mix with the salt water, but near the mouth of the river the layers are fairly distinct.
3. Water is denser. If one wanted to figure it out, one could just mix some oil and water and see which one floated to the top. The top one is less dense and the bottom is denser. Oil floats on water.

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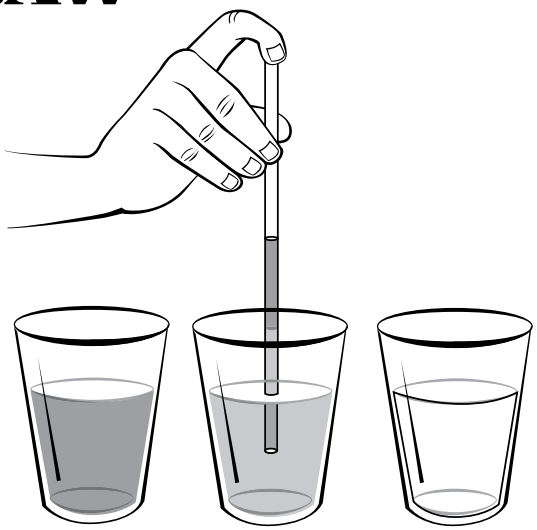
ACTIVITY 19: DENSITY COLUMN IN A STRAW



QUESTION

How do the densities of different sugar solutions compare to one another?

SAFETY

Discard the sugar solutions upon completion and do not drink the liquid. Wipe up any spills immediately.

MATERIALS

Sugar, water, transparent drinking straw, three small cups, food coloring or colored drinks (such as Kool-Aid or Gatorade)

PROCEDURE

Substances with different densities can be made to float on each other like water and oil. This also happens in the ocean as a result of different temperatures (thermoclines) or different salt concentrations (haloclines). Even though it is all salt water, liquids with different temperatures or concentrations can form layers even though it is the same liquid. You will simulate this effect using different solutions of sugar water.

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1. Make three different solutions in small cups. The first cup is 30 ml of pure water, the second is 30 ml of water with a large spoonful of sugar, and the third is 30 ml of water with two large spoonfuls of sugar. Stir the solutions completely.
2. Put a drop of food coloring or colored drink in the middle cup so that you will be able to see the layers.
3. Dip the straw in the pure water and put your thumb over the end of the straw to keep it in. Now put the straw in the middle cup and release your thumb for a moment until the water rises, then put your thumb back over the straw. Now do it again with the third liquid. You could make stronger and stronger solutions and continue this until the straw is full.

Post-Lab Questions

1. In a thermocline, do you think that the warmer water or the colder water will be on top? Explain.
2. When a freshwater river flows into the ocean, will the freshwater stay on top of the salt water or go below? Explain.
3. Which is more dense, cooking oil or water? Explain how you could design a simple experiment to figure it out if you did not know.

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