

# SPECTRUM

## Special Issue

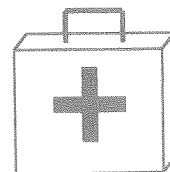
### SAFETY. IN THE SCIENCE CLASSROOM

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#### CAUTION:

Always wear eye goggles when in the laboratory. Never mix any chemicals without first having approval from the teacher. Follow all safety guidelines for each laboratory activity. Clean up afterwards.

SAFETY  
FIRST!



*Do As You Otter . . .  
Add Acid to Water!*

When All Else Fails, Read the Instructions!

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WINTER 1999

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# SPECTRUM

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The Illinois Science Teachers Association (ISTA) is a state chapter of the National Science Teachers Association, 1840 Wilson Boulevard, Arlington, VA 22201-3000.

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**Cover:** Kevin Finson. Special Thanks go to Kevin for inviting the expert authors and compiling and editing the articles for the entire safety section of this issue.

The Illinois Science Teachers Association recognizes and strongly promotes the importance of safety in the classroom. However, the ultimate responsibility to follow established safety procedures and guidelines rests with the individual teacher. The views expressed by authors are not necessarily those of ISTA, the ISTA Board, or the *Spectrum*.

SPECTRUM IS PRINTED ON RECYCLED/RECYCLABLE PAPER

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# ISTA NEWS

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## PRESIDENT'S LETTER

### Illinois' Teacher Recertification Program: Good News, Bad News or No News?

At a recent ISTA Board Meeting, I casually asked our board members and officers for their reaction to Illinois' teacher recertification process. I got quite an ear full. I know I have strong opinions on the subject, so I guess I shouldn't be surprised that everyone else does too! Our Board includes teachers of science from across the K-12 continuum, representatives of local and state education agencies, members of informal education organizations, and faculty and administrators from the universities. In other words, ISTA's organizational leadership truly represents the science education community in Illinois. Furthermore, their responses to the teacher recertification process (for, against, and ambivalent) are probably indicative of the opinions of our larger membership. This discussion helped me to realize that while many of us have been involved in the "run up" to recertification, our organization has yet to come to a consensus on value of the program.

Part of the problem may be the program's structure (many of the details are yet to be worked out); its complexity ("CEUs, CPDUs, LADCs, RFDRCs, lions, tigers and bears, oh my") and uncertainty about its implementation ("How is this actually going to affect me?"). These concerns are certainly legitimate, but I believe that the gist of our discussion centered on a more basic question, "Is the recertification program a good idea?"

Let me share with you some of the comments that seem to characterize the responses to this question:

- This is just one more effort by politicians to regulate teachers and their profession.
- Other professions have to maintain continuing certification, why shouldn't teachers?
- This process demeans teachers by dictating how teachers will maintain their skills.
- There are variety of professional choices available from which teachers may select.
- Eight hours of graduate credit in five years!? Give me a break, most teachers can complete a thirty-hour Masters program in two years!
- Some of the teachers in my school have done nothing professionally in decades!
- Much of current professional development seem so "one shot."
- This program will help teachers develop focused and coordinated continuous learning plans.
- Administrators and our school improvement plan will drive teachers' professional development plans, the teachers will just be "rubber stamping" the priorities of others.
- This process "lowers the bar" by asking too little of classroom teachers.
- How can teachers be expected to include all of these recertification activities on top of sixty and seventy-hour work weeks? What about their families?
- One thing for sure, the paper work will provide jobs for many more secretaries!

Well, you get the idea. Obviously, these are rather dichotomous opinions and many comments fell somewhere in between. Ok, so now what? Those of you who have been around Illinois schools as long as I have, have seen many school reform programs come and go. The current teacher recertification program could be categorized as one more such mandated program heaped on top of the others. It would certainly be understandable for Illinois teachers to react with a well-earned sense of cynicism to the recertification effort. While such a reaction would be understandable, it is my hope that science teachers will withhold judgment long enough to engage in a professional dialogue on the value of the recertification program.

I would like to propose that you, our ISTA members, inform yourselves about the teacher recertification process and share your thoughts with others. To facilitate this effort, the Illinois Science Teachers Association will supply the forum for these discussions. First, our listserv "ISTA-Talk" will provide an interactive setting for exchanging ideas; second, our journal *Spectrum* will invite you to send your thoughts concerning recertification for inclusion in future issues; and our webpage <[www.ista.il.org](http://www.ista.il.org)> will establish a Members' Feedback page where your comments from the listserv and the *Spectrum* can be posted (anonymously, of course). In addition, ISTA will use these same venues to provide you with information about the teacher recertification program as it becomes available. While it may be easy to sit by and wait for the "axe to fall," I believe that activism is the best way to combat the teacher-as-victim mentality that we all at times assume. I look forward to hearing from you...let the dialogue begin!

Here's what you need to do to get involved — ISTA-Talk Listserv. If you are already on the listserv, watch for your opportunity to jump in on the questions and comments that I'll be putting "out there" in the near future. If you are not currently on the listserv (Come on, get with the program!), you can sign up by going to our webpage at [www.ista-il.org](http://www.ista-il.org) and following the simple instructions found there.



Don Nelson  
President, Illinois Science Teachers Association



**THANKS TO ALL OUR WONDERFUL VENDORS WHO DONATED THEIR TIME, ENTHUSIASM AND PRODUCTS TO HELP MAKE OUR 1999 CONVENTION A HUGE SUCCESS!**

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WARD'S Natural Science, Inc.  
Wildlife Prairie Park  
Worldwide Youth in Science & Engineering

ALSO A VERY SPECIAL THANK-YOU TO HARRY HENDRICKSON (I-DNR) for coordinating the 40 Illinois state agencies who participated and donated thousands of dollars worth of educational materials. Agencies represented included: DNR—Global climate change, Illinois State Museum—Staff Dev. Opportunities for Teachers, DNR—PLAN-IT EARTH, DNR—Groundwater Science, SIUE—Rivers Project, DNR—Educational Services, USGS—Water Education and Careers, DNR—Urban Fishing, DNR—Forestry, UI-Extension—Secret Agent Worm Books & other publications, DNR—Internet and Web Demonstation, DNR—GIS- Computer mapping, DNR—C2000, EPA—ozone, lakes, EE, Illinois Natural History Survey, Illinois State Water Survey—Water Science, IDOT—Highway Science, IDPH—groundwater protection, IDPH—lead awareness, IDPH—STD/HIV/AIDS prevention, IDNS—Radon, NRCS—Soil Science, Illinois State Geological Survey—Geology Maps, etc., DNR-ECOWATCH—Citizen monitoring, IDOA—Soil and Water Conservation, IDOA—Water Resources Protection, IDPH—Fish Contamination Advisory Program, IDPH—Division of Laboratories, ISP—Forensic Science, IDPH—Immunization Program, PIE (Partnership of Informal Educators)—Interest survey of science teachers, USEPA Region V—Waste, Pesticides, and Toxics Division, IDOA—Ag Technology, AISWCD—Envirothon/SWCD Resources.



**CALL FOR PRESENTATIONS**  
**THE MILLENNIUM WINDOW: VISIONS FOR THE FUTURE**  
**ILLINOIS SCIENCE TEACHERS ASSOCIATION ANNUAL CONFERENCE**  
**PHEASANT RUN RESORT AND CONFERENCE CENTER**  
**ST. CHARLES**

**OCTOBER 27-28, 2000**

**DEADLINE FOR SUBMISSION: APRIL 1, 2000**

ATTACH NAMES AND ADDRESSES FOR ALL CO-PRESENTERS SO THEY WILL APPEAR IN THE FINAL PROGRAM.

I can be available for    ☐ Friday's program                      ☐ Saturday's program                      ☐ either day

PLEASE PRINT OR TYPE AND FILL OUT COMPLETE FORM

Name	Day phone
Affiliation (School or Organization)	Home phone
Address of above organization	Home address
City, State, Zip Code	City, State, Zip Code
FAX	E-mail address

Title of presentation (10 word maximum) \_\_\_\_\_

Program description as you wish to appear in the program book (25 word maximum)

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**DUE TO LIMITED SPACE, PRESENTATIONS MUST BE LIMITED TO 50 MINUTES.**

- |   |  |   |  |
|---|--|---|--|
| <b>I. Type of Session</b><br><input type="checkbox"/> hands-on workshop<br><input type="checkbox"/> demonstration<br><input type="checkbox"/> lecture<br><input type="checkbox"/> other | <b>II. Intended Audience</b><br><input type="checkbox"/> preschool<br><input type="checkbox"/> elementary<br><input type="checkbox"/> middle/jr.high<br><input type="checkbox"/> high school<br><input type="checkbox"/> college<br><input type="checkbox"/> teacher preparation<br><input type="checkbox"/> general | <b>III. SubjectArea</b><br><input type="checkbox"/> earth and space science<br><input type="checkbox"/> chemistry<br><input type="checkbox"/> physics<br><input type="checkbox"/> biology<br><input type="checkbox"/> ecology/environment<br><input type="checkbox"/> science/tech/society<br><input type="checkbox"/> technology | <b>IV. Science Goals</b><br>(see back of form)<br><input type="checkbox"/> Goal 11<br><input type="checkbox"/> Goal 12<br><input type="checkbox"/> Goal 13 |
|---|--|---|--|

**IV. Equipment Required**                      ☐ overhead projector                      ☐ slide projector

**Note:** We are prepared to furnish only overhead, screen, and slide projector. Other equipment, including computers, needs to be furnished by presenters. If you need any special arrangements or equipment, including internet connection, contact Diana Dummitt ASAP at 217-244-0173, e-mail ddummitt@uiuc.edu

**V. How many participants can you accommodate at your session?**

- ☐ 30-50                      ☐ 51-80                      ☐ 81-150

As a professional, nonprofit organization, the Association is unable to reimburse participants for travel or other conference expenses. **ALL PARTICIPANTS INCLUDING PRESENTERS, ARE REQUIRED TO REGISTER FOR THE CONFERENCE.** This form is not for commercial or non-commercial exhibits. It is only for educators!  
All Presentations are required to conform with the NSTA safety guidelines.

Signature \_\_\_\_\_ Date \_\_\_\_\_

**SEND OR FAX SIGNED FORM TO:**

**Rose Camillone, Science Department Chair, Homewood-Flossmoor High School, 999 Kedzie Ave., Flossmoor, IL 60422**  
**708-799-3000 x 1122                      Fax 708-799-3142                      e-mail: rcamillone@kiwi.dep.anl.gov**

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## THE ILLINOIS LEARNING STANDARDS FOR SCIENCE

The Illinois Learning Standards for Science were developed using the 1985 State Goals for Science, the National Science Education Standards, various other state and national works, and local education standards contributed by team members. Science is a creative endeavor of the human mind. It offers a special perspective of the natural world in terms of understanding and interaction. The aim of science education is to develop in learners a rich and full understanding of the inquiry process; the key concepts and principles of life sciences, physical science, and earth and space sciences; and issues of science, technology, and society in historical and contemporary contexts. The National Science Education Standards present these understandings and their interactions with the natural world as eight science content standard categories. The Illinois Learning Standards for Science integrate these categories into a powerful resource for the design and evaluation of science curricula taught in Illinois schools.

The Illinois Learning Standards for Science are organized by goals that inform one another and depend upon one another for meaning. Expectations for learners related to the inquiry process are presented in standards addressing the doing of science and elements of technological design. Unifying concepts connect scientific understanding and process and are embedded in standards spanning life science, physical science, and earth and space science. The importance of this knowledge and its application is conveyed in standards describing the conventions and nature of the scientific enterprise and the interplay among science, technology and society in past, present and future contexts.

### **STATE GOAL 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.**

#### **Why This Goal Is Important:**

The inquiry process prepares learners to engage in science and apply methods of technological design. This understanding will enable students to pose questions, use models to enhance understanding, make predictions, gather and work with data, use appropriate measurement methods, analyze results, draw conclusions based on evidence, communicate their methods and results, and think about the implications of scientific research and technological problem solving.

#### **As a result of their schooling students will be able to:**

- A. Know and apply the concepts, principles and processes of scientific inquiry.
- B. Know and apply the concepts, principles and processes of technological design.

### **STATE GOAL 12: Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.**

#### **Why This Goal Is Important:**

This goal is comprised of key concepts and principles in the life, physical and earth/space sciences that have considerable explanatory and predictive power for scientists and non-scientists alike. These ideas have been thoroughly studied and have stood the test of time. Knowing and being able to apply these concepts, principles and processes help students understand what they observe in nature and through scientific experimentation. A working knowledge of these concepts and principles allows students to relate new subject matter to material previously learned and to create deeper and more meaningful levels of understanding.

#### **As a result of their schooling students will be able to:**

- A. Know and apply concepts that explain how living things function, adapt and change.
- B. Know and apply concepts that describe how living things interact with each other and with their environment.
- C. Know and apply concepts that describe properties of matter and energy and the interactions between them.
- D. Know and apply concepts that describe force and motion and the principles that explain them.
- E. Know and apply concepts that describe the features and processes of the Earth and its resources.
- F. Know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

### **STATE GOAL 13: Understand the relationships among science, technology and society in historical and contemporary contexts.**

#### **Why This Goal Is Important:**

Understanding the nature and practices of science such as ensuring the validity and replicability of results, building upon the work of others and recognizing risks involved in experimentation gives learners a useful sense of the scientific enterprise. In addition, the relationships among science, technology and society give humans the ability to change and improve their surroundings. Learners who understand this relationship will be able to appreciate the efforts and effects of scientific discovery and applications of technology on their own lives and on the society in which we live.

#### **As a result of their schooling students will be able to:**

- A. Know and apply the accepted practices of science.
- B. Know and apply concepts that describe the interaction between science, technology and society.

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# EDITORIAL

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## IT WON'T HAPPEN . . .

How many times have you heard, or even yourself said, "It won't happen in my classroom," or "It won't happen to me," or something similar to that? How long has it been since you took a careful look around your classroom and assessed it from the standpoint of safety? How much consideration do you give to thoughts on safety when you select or write activities for students? How much stress do you place on safety procedures when discussing activities with your students?

Some of the things I've come across that are frequently done in this nation's classrooms are truly alarming if one stops to think about them. When I was in college (and this will probably date me), we learned to do some really nifty volcano demonstrations using an orange crystalline chemical called ammonium dichromate. When spooned into the top of a volcano model and ignited with a strip of magnesium ribbon, the orange chemical would splatter and spark and smoke, and green fluffy stuff would flow out of the volcano mouth and down its slopes, just about like real lava. The effect was stunning when the lights were turned off. It was just a couple of years later that we learned ammonium dichromate was a potential carcinogen, and its use in classrooms was discouraged. How many years has that been? And you know what? Just two years ago I came across a newly published list of "really neat chemistry demos" that included the very ammonium dichromate volcano demonstration I learned about in college. Would you willingly expose yourself or your students to known carcinogens? "Kids getting cancer from this won't happen . . ."

Another example is from last year and involved a physics teacher in California who was using a methanol cannon with his students, and the cannon exploded and seriously burned several students. Still another example is a recent court case involving a teacher who still used mercury in the classroom, and one of his students took some home to play with it. Needless to say, mercury ended up on the walls and in the carpet at home, and the parents got serious — attorney serious. Would you be willing to expose yourself or your students unnecessarily to potential explosions, fires, or harmful chemicals? "This won't explode; it hasn't any of the times I've done this." "No one has caught fire before, so it won't happen today either."

When I watch teachers conduct science activities, there are instances in which proper procedures are not even written down, let alone discussed with the students and then followed. For example, when doing hardness tests on minerals, how many times have you seen students holding the specimen in the palm of one hand while trying to scratch it with a nail held in the other hand? Would you willingly expose your students to the potential of jamming a sharp instrument into

their hands? I've seen many times when students are using candles, yet the teacher makes no mention of keeping long hair or shirt sleeves away from the flame. I've seen teachers heating water on a hot plate coil while having students crowd around it to watch something else. Would you willingly risk burning your students?

Obviously, the answers to these questions is, "No, of course not!" None of us would willingly expose ourselves or our students to undue danger. Our thoughts are probably along the lines of, "It won't happen. It hasn't happened to any of my students yet, in all the years I've done this." Yet it happens every day. Sometimes, the cause is simply ignorance. We are ignorant of the dangers an activity poses, or we are ignorant of proper procedures to follow. Sometimes, the cause is haste ("I've got to get the students through this, and don't want to slow them down with having to get the goggles."). Sometimes, the cause is taking a gamble. The gamble is, "I know what the risks and dangers are, but the chances of something going wrong are so small . . ." Sometimes, the cause is simply carelessness.

It is true that there is sometimes overkill on safety. There are times when the emphasis on safety is so pronounced that the principle illustrated by the activity is lost. Should you always have students wear safety goggles, even when the activity is using rubber bands to shoot marshmallows? Should students wear lab aprons or some other item to protect their clothing when all they are working with are food coloring, water, salt, and sugar? Obviously, the decision is yours. But to ignore safety matters is to be foolhardy. To fail to alert students of safety procedures, then to fail to follow those procedures, is to greatly increase your liability in the classroom or in the field. The way the courts look at it, do you do what a reasonable person would do, knowing the risks involved? Do you make every reasonable effort to prepare your students to ensure things won't go wrong? Almost everything we do in science involves some level of risk. That's just the nature of the beast. So do I minimize the risk?

Safety issues will probably come more to the forefront as we implement the "new" national and state science standards, moving us toward (hopefully) more hands-on, inquiry types of teaching approaches. So the matter of considering safety should become more common. Regardless of the educational level at which you teach, whether it be preschool, elementary, middle level, high school, or college, you should be aware of science safety and follow appropriate procedures, regardless of the type of instructional strategy you employ. If you don't know what the potential dangers or procedures are, it is your responsibility to find out.

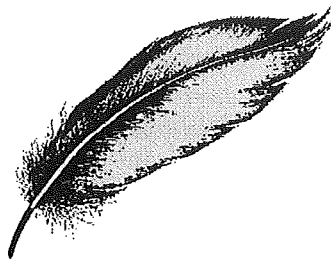
This special issue of the *Spectrum* has been put together to help you review (hopefully) and learn about science classroom safety issues. We can by no means cover the entire spectrum of possibilities, but we've tried to provide something about safety in the elementary classroom, general safety considerations, field trip safety, and so forth. Awareness is the key, and then action is critical. Any of you who have presented at either NSTA or ISTA know the importance that is placed on guaranteeing the safety of others during your presentation. We cannot expect less in our classrooms. Just for you to consider, we've included a copy of the NSTA's minimum safety guidelines for presenters. Read them, and see how much they also speak to what you do in your classroom. I would also like to direct your attention to a new publication from NSTA entitled the *NSTA Guide to School Science Facilities*. This publication spells out many things regarding science classroom space, including safety issues relating to storage facilities for chemicals, crowding of students, technology, and more. The publication is available from NSTA publications (1-800-722-NSTA) for \$69.95 (ask for stock #PB149X1). It is designed to closely follow the *National Science Education Standards*, and should prove to be useful to science teachers and administrators.

You might also find the September, 1999 issue of *The Science Teacher* of use since it was devoted to safety. There is much useful information in that issue which you shouldn't miss. In particular, pages 39 and 42 list several great safety resources available to teachers.

Here's to a safe year — indeed, a safe teaching career — in your teaching of science!

Kevin

Kevin Finson, Spectrum Editor



## Help!

At the ISTA convention in October, Kay Helms from the Forest Park Nature Center agreed to send a Snowy Owl puppet to a teacher. She has misplaced the name and address of that teacher. If you ordered and paid for the puppet and have not received it, please call Kay at 1-309-686-3360.

## Services for Educators

offered by Forest Park Nature Center and  
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- Resource for topics, materials, and questions related to nature
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<http://hrn.bradley.edu/members/fpnc>



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# NSTA Minimum Safety Guidelines for Presenters and Workshop Leaders

## Preamble

The National Science Teachers Association, an organization of science education professionals dedicated to the stimulation, improvement, and coordination of science teaching and learning, supports scientific safety at all levels. Presenters, workshop leaders, contestants, and authors at NSTA-sponsored activities serve as role models for other science educators. As role models, these individuals must develop, encourage, and display good safety habits at all times. A good safety role model promotes positive safety in actions, words, behavior, and deeds. Science safety is an integral part of science education and serves as a preparation for life.

Accordingly, NSTA encourages teachers to offer meaningful and safe science experiences both inside and outside the classroom. NSTA requires that all presentations, workshops, and related science education activities be conducted in accordance with recognized safety procedures and good common sense. The intent of the safety guidelines that follow is to promote safe science practices at all NSTA-sponsored activities.

**All presenters and workshop leaders must follow these NSTA Minimum Safety Guidelines.**

**The following may NOT be part of any presentation of workshop at an NSTA conference under ANY circumstances:**

1. Parts of the body are not to be placed in danger, such as placing dry ice in the mouth or dipping hands or fingers into liquid nitrogen or molten lead. Demonstrations such as the following should not be conducted: walking on broken glass or hot coals of fire with bare feet, passing an electric current through the body, and lying on a bed of nails and having a concrete block broken over the chest.
2. Live vertebrate animals may not be used in demonstrations or for experimental purposes. Such animals may be used only for observational purposes provided the animals have been lawfully acquired, are housed in proper containers, and are handled in a humane way following NSTA's "Guidelines for Responsible Use of Animals in the Classroom" (NSTA Position Statement).
3. Live ammunition, firearms, or acutely dangerous explosives, such as benzoyl peroxide, diethyl ether, perchloric acid, picric acid, and sodium azide, may not be used. Commercially available firecrackers and blasting caps should never be employed.
4. Plants with poisonous oils (e.g. poison ivy), saps (e.g. oleander) or other plants known to be generally toxic to humans are not to be used. (Resource: *Human Poisoning from Native and Cultivated Plants* by James W. Hardin and Jay M. Arena, published by Duke University Press, Durham, NC 27708.)
5. Experiments or demonstrations with human blood/body fluids may not be conducted.
6. Radioactive powders, liquids, or solutions are not to be used in a nonlaboratory facility.

## Guidelines for Preparing Your Presentation

1. Practice all demonstrations or workshop procedures BEFORE presenting them to an audience or having participants try them.
2. Research and understand the properties, chemical reactions, and dangers involved in all demonstrations. Plan to use correct handling procedures for all biohazards used. Arrange to have a fire extinguisher available whenever the slightest possibility of fire exists.
3. Prepare a handout that gives participants detailed instructions about the procedures, safety precautions, hazards, and disposal methods for each demonstration.
4. Prepare photographs, slides, videotapes, and so on that show safe science practices. When preparing these materials, safety goggles and equipment should not be removed for aesthetic considerations.
5. In planning demonstrations and/or workshops, keep quantities of hazardous materials to a minimum. Use only those quantities that can be adequately handled by the available ventilation system. Do not carry out demonstrations that will result in the release of harmful quantities of noxious gases into the local air supply in the demonstration or other rooms. The following gases should not be produced without using a fume hood: nitrogen dioxide, sulfur dioxide, and hydrogen sulfide. Volatile, toxic substances such as benzene, carbon tetrachloride, and formaldehyde should not be used unless a fume hood is available.
6. Make sure your glassware and equipment are not broken or damaged. The use of chipped or cracked glassware should be avoided. If glassware is to be heated, Pyrex™ or its equivalent should be used.
7. Thoroughly check motor-driven discs that will be revolved at moderate or high speeds. Make sure the disc is sturdy, that it contains no parts that may come free, and that the safety nut is securely fastened.

- 
8. Arrange to use a safety shield and/or eye protection for audience members and interpreters for any demonstration(s) in which projectiles are launched or when there is the slightest possibility of an unsafe explosion. Arrange for proper shielding and protection for demonstrations that involve radiation. Only low-level, radioactive sources should be employed. Do not allow direct viewing of the Sun or infrared or ultraviolet sources.
  9. Make sure any lasers to be used in demonstrations are helium-neon lasers with a maximum output power rating not exceeding 1.0 milliwatt. At all times, avoid direct propagation of the laser beam from the laser into the eye of an observer or from a reflected surface into the eye.
  10. Secure pressurized gas cylinders by strapping or chaining them in place or by using proper supports, i.e., lecture bottles.
  11. Obtain in advance the necessary state and/or local permits needed for the firing of model rockets. Activities involving the firing of rockets must be well planned and follow Federal Aviation Agency (FAA) regulations, state and local rules and regulations, and the National Association of Rocketry's (NAR) Solid Propellant Model Rocketry Safety Code.
  12. Arrange for appropriate waste containers and for the disposal of materials hazardous to the environment.
  13. Plan to dress safely for your presentation or workshop.
  14. If you have any questions concerning safety and your presentation, contact the NSTA Associate Executive Director of Conventions at (703)-243-7100.

### **During the Presentation**

1. Comply with all local fire and safety rules and regulations. Follow the "NSTA Minimum Safety Guidelines."
2. Wear appropriate eye protection, an apron, and similar protective gear for all chemical demonstrations or when appropriate for other demonstrations. Provide eye protection, aprons, and safety equipment for participants who will be handling chemicals, hazardous substances, or working with flames.
3. Do not select "volunteers" from the audience. Assistants used in demonstrations should be recruited and given the proper instructions beforehand.
4. Warn participants to cover their ears whenever a loud explosion is anticipated.
5. Use a safety shield for all demonstrations that involve the launching of projectiles, or whenever there is the slightest possibility that a container, its fragments, or its contents could be propelled with sufficient force to cause injury. Shield moving belts attached to motors. Use caution when motor-driven discs are revolved at moderate or high speeds. Shield or move participants to a safe distance from the plane of the rotating disc.
6. Follow proper procedures for working with pressurized gases.
7. Use appropriate gloves and shields when working with hazardous chemicals, cryogenic materials, hot materials, radioactive substances, vacuums, electromagnetic radiation, and when presenting animals for observation.
8. Do not taste or encourage participants to taste any non-food substance. A food substance subjected to possible contamination or unsafe conditions should never be tasted.
9. Note clearly at the beginning of the program the presence or production of allergenic materials such as "theater" smoke, lycopodium powder, or live animals.
10. Maintain clear egress during the demonstration or workshop.
11. Emphasize and demonstrate appropriate safety precautions throughout the presentation or workshop.
12. Distribute a handout that will give participants detailed instructions about the procedure, safety precautions, hazards, and disposal for each demonstrations.

— Passed by the NSTA Board of Directors, August 1994

**These guidelines are annually reviewed by the NSTA Safety Advisory Board. Suggestions and recommendations may be directed to:**

Chairperson  
NSTA Safety Advisory Board  
NSTA Headquarters  
1840 Wilson Blvd.  
Arlington, VA 22201  
703)-243-7100

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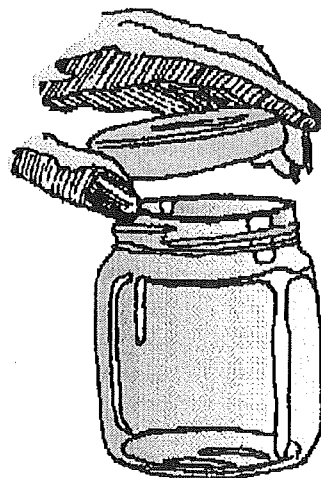
Gwen Pollock  
Illinois State Board of Education  
100 North First Street  
Springfield, IL 62777-0001

## REFLECTIONS ON SCIENCE CLASSROOM SAFETY IN ILLINOIS SCHOOLS

The understandings necessary for assuring safety in the science classrooms of Illinois are far broader than many realize, underestimated by decision-makers at all levels and more applicable to daily lives than many of the concepts we include in our curricula. The focus on safety for a full issue, of the *Spectrum* validates our concern and interest in this issue which could and does permeate our science classroom efforts. The conversations concerning these ideas in this *Spectrum* issue need to reverberate among greater and deeper thinkers and do-ers around the state.

As a science teacher for nearly twenty years, I came to realize my shortcomings in the arena of safety in my biology/chemistry/physics combination classrooms fairly early in my career. My college education methods courses had not included such topics for consideration, nor had I volunteered or been required to serve in the chemical storeroom for my lab courses. Now with a few years of experience at the Illinois State Board of Education, I have begun to understand the scope of the dilemma that school districts face in assuring safe science classroom facilities.

There was a common denominator in each of the schools I taught—beyond the absolute reverence to the science teacher's expertise (yeah, right!!) — immediately upon attempting to settle into my classrooms, the mysteries of the science storeroom facilities' odors always beckoned. Of course, the heat of the summer, the lack of sufficient ventilation and adequate storage space played into the scenario. Some of the bottles were from some sort of supplier that my predecessors had borrowed or offered to store. Some labels remained, but many were corroding away. Some of lids were just metal flaps on top of bottles of unnamed powders. Solutions were waiting with no hints of contents, dates, or concentrations. Beakers with evaporated remains were in the sinks. Volumetric flasks had contents, but the stoppers had become permanent fixtures. In only one of the schools labs was there a fume hood, but it was some sort of miscellaneous storage facility with no ventilation capabilities at all. Generally, the alphabet reigned for the arrangements of the chemicals, liquids, solids, acids, oxidants, poisons, whatever. Surely these reminiscences ring familiar bells among you. The necessity of setting up first-day and everyday attention-grabbers by the new teacher were met with the difficulties of finding anything which could work, fit or amaze. Then, we all continued to contend with the real substance of the essence of science, beyond the table of contents regimen and whatever remnants of usable equipment we could find.

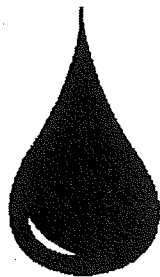


For a new teacher, the first accident is mind-altering. Hopefully, it was just a spill or a slight cut or broken glass. It is amazing that the circumstances are not worse for such memories. There were times that it was suggested by the text guides to use Potassium Chlorate, or Mercuric Chloride or Hydrogen Sulfide or Formaldehyde or Mercury, itself or similar undesirables. Ignorance was bliss for a short time! One's feelings of inadequacy could easily remove the sense of wonderment in the sciences, especially in an over-crowded classroom of high school students just wanting to explode something!

Now we realize that we, in the education settings, must be more knowledgeable about the purchase, inventory, storage, use and disposal of our chemical inventories. This understanding must be shared among our colleagues in all of the science classrooms of a building and district, with colleagues in our feeder middle and elementary schools, as well as our administrators and the business office folks (who are referred to as the "designated felons" by safety experts because their names appear on the shipping orders). Chemical safety interests go beyond the education settings. These understandings must be shared and addressed locally by emergency management agencies and associated businesses, including local fire departments, waste-haulers and landfills; regionally through offices for agencies such as the Environmental Protection Agency, Regional Offices for Education or Intermediate Service Centers; at the state level by the agencies charged with the regulation and technical assistance for such challenges (the State Fire Marshall, Illinois Emergency Management, Environmental Protection, State Board of Education, Labor, etc.); by politicians at each level who bear the responsibilities of fiscal and regulatory decision-making; and for the parents of our students to assure the confidence in the impact, breadth, depth of understanding safety in and by our learning communities.

In 1995, the Guidebook for Science Safety in Illinois, A Safety Manual for Illinois Elementary and Secondary Schools was sent to all high schools and K-8 district offices around the state. (The whole document can be found on the ISBE website at [www.isbe.state.il.us](http://www.isbe.state.il.us).) The document was actually released in two sections. The first section focused entirely on the issues of chemical safety and was penned in partnership with local sections of the American Chemical Society and the Illinois Association of Chemistry Teachers. The twelve chapters plus appendix of federal regulations were focused on the legal aspects and responsibilities for administrators, teachers, students and parents; recommendations for classroom facilities, curriculum and personal safety; and classroom preparations and procedures. Issues associated with the equipment and procedures used in the physical science/physics classrooms (such as lasers, vacuum pumps, cryogenics, batteries and electrical equipment, radioisotopes, etc.) are addressed within Chapter 9 and 10. Computer discs were developed and included for direct classroom application and individual personalization. Perhaps the most important information in the guidebook is found in Chapter 12, the Model Chemical Hygiene Plan. The plan is offered specifically for school application and must be considered as a requirement for all schools. The chapter begins with this explanation for action:

In 1992, Illinois adopted the federal "Occupational Exposures to Hazardous Chemicals in Laboratories" legislation (29 CFR 1910.1450). This legislation requires all employers to develop a Chemical Hygiene Plan which details how each employee will be protected from overexposure to hazardous chemicals and to describe specific work practices and procedures in the laboratory to minimize employee risk. Students are not considered employees under this law, but prudence dictates that they should be expected to comply with all practices and procedures in this plan. The plan outlines responsibilities for administrators, teachers and students; basic rules and procedures; control measures; provisions for medical consultation; waste disposal strategies and training information. Compliance sign-offs are required by the Illinois Department of Labor for all public schools and by OSHA for all nonpublic schools.



The second section of the Guidebook was distributed in the summer of 1997 and included chapters for the safety issues associated with classrooms in the life sciences, elementary classrooms and outdoor classroom experiences. These chapters were written through the shared expertise of the Illinois Association of Biology Teachers, the Illinois Science Teachers Association and the Environmental Education Association of Illinois. Now in 1999, many professional issues require our attentions as we plan for safe and effective standards-led, hands-on inquiry learning experiences for our students. We must cope with the chemophobic tendencies of society and the media, arbitrary budgetary cuts, as well as technology capabilities, expenses and hesitancy. We must share an understanding of how safety goes far beyond the science classroom into societal decision making and help our students develop critical-thinking skills to help make such decisions in their future.

In the considerations of the Science Learning Standards, the benchmarks at each learning level for Goal 13, Standard A (stating that students should be able to know and apply the accepted practices of science) expressly note that students should understand the issues of safety in the classroom. The original learning standards drafts proposed that such safety understanding needed to go beyond the classroom, trying to include the issues of fire safety at home and at play, specifically considering home smoke detectors, the operation of fire extinguishers and community awareness for chemical storage and disposal precautions and more.

All teachers are realizing the value of such inclusions for real-life applications for their students. From Stop-Drop-and-Roll to the issue investigations of local water quality policies and landfill geographies, teachers are touching the concepts of science safety. As a teacher, I parlayed assistance from the local poison control units at emergency rooms to provide materials describing home, garage and gardening poisons and first aid, as well as assistance from local fire departments for an understanding of the requirements for posting the diamonds for emergency responses. The periodic assistance from the Illinois Environmental Protection Agency (IEPA) for Household Waste Clean-Up Saturdays helped families to know what and how to manage some familiar (or unfamiliar) chemicals hidden away in our garages. Every lab had an emphasis on the Material Safety Data Sheets (MSDS) of the chemicals used, plus the check on the disposal requirements for each one. Students were regularly asked to check on the storage of various categories of chemicals, making sure that acids were ventilated properly or that oxidants were arranged safely. I realize now that probably none of the recipe labs I perpetuated really helped students to inquire, beyond their proposed explanations for anomalies in the results and conclusions. The advent of microscale chemistry procedures and the use of various technological probes probably helps chemistry classrooms more effectively address safety issues without some of the difficulties we used to consider. As for the future prospects for chemical safety in Illinois classrooms, there is still much to be accomplished.



The repeat of a state-wide hazardous waste pickup for schools is absolutely necessary but unbelievably difficult. The funds necessary to accomplish such a pickup are beyond the reach of most schools and must be appropriated by the legislature. The management of such an initiative must be directed by specialists from appropriate agencies as a preventative measure, rather than waiting for incidents that cause harm to our students and teachers.

Teachers need extensive professional development training in the areas of purchase, inventory, use, storage and disposal of appropriate chemicals, alternative procedures and strategies that promote the inquiry and design processes of science; the new technologies and their applications; and the understandings of the societal implications of past, current and future safety challenges.

The partnerships between industries associated with the sciences and technologies and their direct connections to science classrooms need to be built and nurtured for teachers and their students, possibly even including internships for all of these learners.

Administrators and local boards of education need to address the issues associated with classroom safety, including the concerns of insuring schools and assuring their science efforts to be the best possible, with the most effective laboratory design and redesign for classroom safety issues and a special focus on disabled students and the inclusion of applicable technologies.

State agencies need to provide schools better technical and fiscal assistance to keep up with the changes of technology and society to meet the demands of safe 21st century science classrooms, which have been encumbered with the restraints of infrastructural facilities and lack of experience.

These reflections on the past and projections for the future are surely shared by many. The conversations that can follow must yield action. As you study the rest of this special issue, I suggest that readers consider the school safety audit, which was included in the Guidebook. Try to objectively assess where your school is in its efforts to promote learning safely. Consider how safety issues can and should be a part of the established curriculum in your classrooms, from elementary to high school situations. Look at specific benchmarks from the Illinois Learning Standards and consider how you can help your students learn about the concept of safety. Discuss this with your colleagues and administration. The schools of Illinois must realize the necessity of action in this challenge. We, as decision-makers at all levels, must make informed decisions and maintain the vigilance necessary to make learning safer and more applicable to our daily lives.

Enrollment

Test Scores

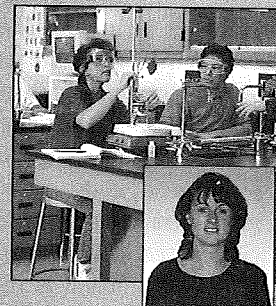
Comprehension

Gender Equity

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## SCIENCE SAFETY IN THE ELEMENTARY CLASSROOM

While thinking about this topic, it occurred to me that often in the elementary school setting, especially those that are self-contained and not having a science specialist or lab, science safety is something we think about occasionally, if at all. There is so much to do on a daily basis we relegate science safety to common sense, not something to teach. Many of the activities we use do not even address safety issues, thus there is no reminder for the teacher.

As background material for this article was being sought out, it was discovered that there is very little and it is difficult to locate when you want it. That usually translates into many teachers not knowing there are safety documents from ISBE already in their district, including one for elementary and outdoor education. Do you know where the ISBE Safety Standards manual is in your district? According to Gwen Pollock, ISBE, (see her article), the elementary documents, along with Life, Physical, and Outdoor Education, were sent to the districts in the summer of 1997 to be added to the first Chemistry Safety Standards document.

The topic of safety is so immense that a brief article in any journal will only touch on some aspects of it. It seems most useful to list some key areas of safety and consider options available for those teachers with little access to special safety equipment such as goggles, aprons, or fire blankets. Many of us work in less than an ideal situation, yet bring hands on activities to our students. We do need to look at our own classroom situation, inform administration of special safety needs, and practice being good role models for our students.

In these times of standard based education we need only look at Science Goal 13A: As a result of their schooling students will be able to know and apply the accepted practices of science. The Benchmarks for Early Elementary include: 13.A.1 a.: Use basic safety practices (e.g., not tasting materials without permission, "stop/drop/toll"), and Late Elementary: 13.A.2a.: Demonstrate ways to avoid injury when conducting science activities (e.g., wearing goggles, fire extinguisher use). From this we can see teaching safety is not only important, but expected. We cannot just assume that students will act safely in the classroom; it is a life skill to be taught.

The beginning of a new school year is an excellent time to introduce science safety standards into our classrooms. In addition to a general discussion you might consider a safety contract for students to sign as well as posting science safety rules. Following are some general safety tips divided into three categories, general safety, animals in the classroom, and outdoor education. These are gleaned from years of experience teaching science both in a lab and self-contained classroom.

### General Science Safety

- Be a positive role model by practicing safe behaviors: wear a protective apron, gloves, and goggles and tie hair back when using fire or chemicals, if needed. Since most of us do not have the correct aprons, a splash apron can be made from a garbage bag with holes cut for head and arms. Students can see this protects clothing and skin in the event of a spill or splash.
- Properly store or dispose of hazardous materials, including plant fertilizers, alcohol, ammonia, and all chemicals. If you are unsure how to dispose of a chemical, your high school chemistry teacher will have resources to help you.
- Review safety instructions with students prior to each lab activity.
- Use plastic instead of glassware when possible. If using recycled small jars (baby food jars are a staple in many elementary rooms!) wrap masking tape around the sides and across the bottom. If it breaks, the tape keeps the jar somewhat intact so there is less mess and broken glass. Metal cans, with the tops and bottoms removed, should have tape applied to the cut edges to prevent cuts on the sharp edges.
- Pipettes are a joy for students, but squirting others, even with water can not be tolerated. Removing the student from the activity at once is often very effective for the entire class. Straws are sometimes used to pipette solutions, these should never be put into the mouth to suck up the liquid.
- Teach wafting as a safe method for observations using the sense of smell.
- Open flames and hot plates require extra caution, review "Stop, Drop, and Roll", as well as how to avoid burns: tie hair back, do not reach or lean over an open flame or hot plate, do not wear loose clothing such as jackets or sweaters, keep the work area organized. If using a candle, put sand in a pie tin and place the candle in it, this will catch drippings and stabilize the candle to help prevent tipping over.
- Science experiments should not be eaten unless specifically told to do so by the teacher. Students should not have snacks or drinks while working on science lab activities.
- Have electrical cords covered, tacked, or taped down along a wall to prevent tripping. Use extra caution when extension cords are being used. Our older classrooms were not designed to support the number of electrical cords we may have with computers, AV equipment, and science equipment.
- Wash hands with soap and water after labs or handling animals. Maybe as an added bonus there will be fewer colds and flu.

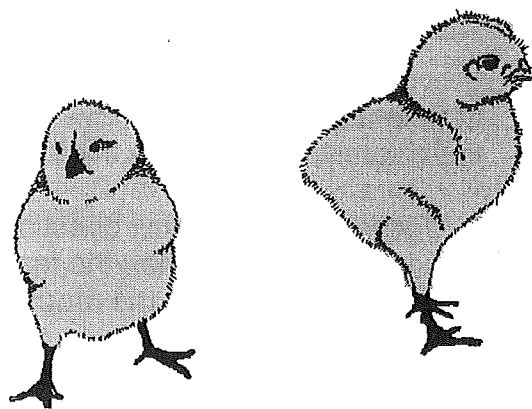
- Be aware of students' allergies and alert to reactions they may have from materials they have never been exposed to. I had a student have an allergic reaction on his hands and arms from handling diatomaceous earth. This material needs to be pre-wet so students are not exposed to the dust, but I had not anticipated the redness/burning feeling he had when conducting the experiment. Have an extra pair of rubber gloves available for students who may be allergic to materials that do not affect others.

### Animals in the Classroom

Animals in the elementary classroom are often pets as well as providing an opportunity to learn by observation. The animal's safety, as well as the students', needs consideration.

#### Pets

- Keep all habitats clean and the animals properly fed and watered, this prevents disease and keeps the animal content, thus less likely to bite or scratch. Provide gloves for cleaning cages or aquariums and insist that hands are washed with soap and water following the cleaning.
- Handle animals with gloves or wash as soon as the animal is returned to the cage. Do not allow the pet to be over-handled, if it tires of handling it may bite or scratch. Get to know your pet's tolerance and slowly introduce it to handling if it is new to the classroom. Students are excited about new pets or the return of old ones at the beginning of the year. I give my returning pets one day of "observation only" to get used to the noise of a busy room. When a new pet arrives, we observe it's behavior, moving from observation only, to touching while the animal is in the cage, to removing and holding it for a short time, as the animal tolerates. It is important to stress that an animal will be easier to handle if the students are quiet and careful not to frighten it.
- Larger pets such as rabbits can scratch as they try to jump or get their footing when carried improperly. First, instruct students how to pick up and carry the different animals. Then, in the case of rabbits, provide a long sleeve shirt to wear when holding the rabbit or cut the tops off tube socks, slip over the hands, and use as an arm protector. Rabbits and other rodents will chew on electrical cords, keep an eye on them when loose in the room.
- Teach students how to approach an animal in the classroom, especially one that does not know them. They should approach quietly, slowly offer their hand to be smelled, and talk quietly to the animal. Pet it before picking it up. They should be reminded never to approach strange animals, domestic or wild, outside.



#### Non-pets

- Students often bring in insects, snakes, and other wild creatures to share with their classmates. It is best not to encourage this, but we all know it will happen when someone spots an interesting spider or finds a rabbit nest in the garden. Prepare ahead, have a well ventilated cage or aquarium to keep them in. A screen top is best for aquarium habitats. Keep the animal for observation only a day or two, then return to its natural environment. Students should not handle wild animals or insects while in the classroom.

### Outdoors

- Establish ground rules and boundaries prior to leaving the classroom.
- Have students wear proper clothing for a field trip. To prevent ticks, poison ivy, or scratches students should wear long sleeves, long pants, and sturdy shoes.
- Do not eat wild plants.
- If you are planning to be in a wooded area or near water, it is a good idea to have parental help.
- Teach students to recognize poisonous plants such as poison ivy and to stay on paths and with the group.
- Have a first aid kit available and don't forget student inhalers or special medical needs. Know if your students have allergies to bee stings.

Now we have reviewed a few of the most common situations those of us in self-contained classrooms may encounter. You may want to learn more by reviewing your district's safety policy, the ISBE Elementary Science Safety Standards document (see Gwen Pollock's article for availability if you don't locate it in your district). Have a safe school year.

#### References:

"Guidebook for Science Safety in Illinois, a Safety Manual for Illinois Elementary and Secondary Schools". 1997 and 1995: Springfield, IL. Illinois State Board of Education.

"The Ideal Student Safety Contract", Vol. 96-2 Chemistry Edition. 1996: Batavia, IL Flinn Scientific Inc

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## Classroom Safety Contract

In Science class you will have the opportunity to do many activities. In order to do them safely, you must do the following:

1. Understand and follow directions. Ask if you do not understand.
2. Do activities only when the teacher or adult supervisor is there.
3. Use all materials for the proper activity, no squirting or spraying water or other materials on self or others; no pranks or horseplay.
4. Tie back hair and roll up loose sleeves when working with fire or chemicals.
5. Never reach over a flame or leave it unattended.
6. Wear safety goggles, aprons, or other safety equipment as needed.
7. Never eat or drink materials unless specifically told to do so.
8. Report broken or missing equipment before doing the activity and any accident or injury immediately.
9. Leave work area clean and organized.
10. Wash hands when completing activities involving animals or chemicals.

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### Safety Contract

I, \_\_\_\_\_, understand that the above safety rules must be followed when doing science activities. I agree to follow any written or spoken safety rules set forth by my teacher or the activity directions.

Student:

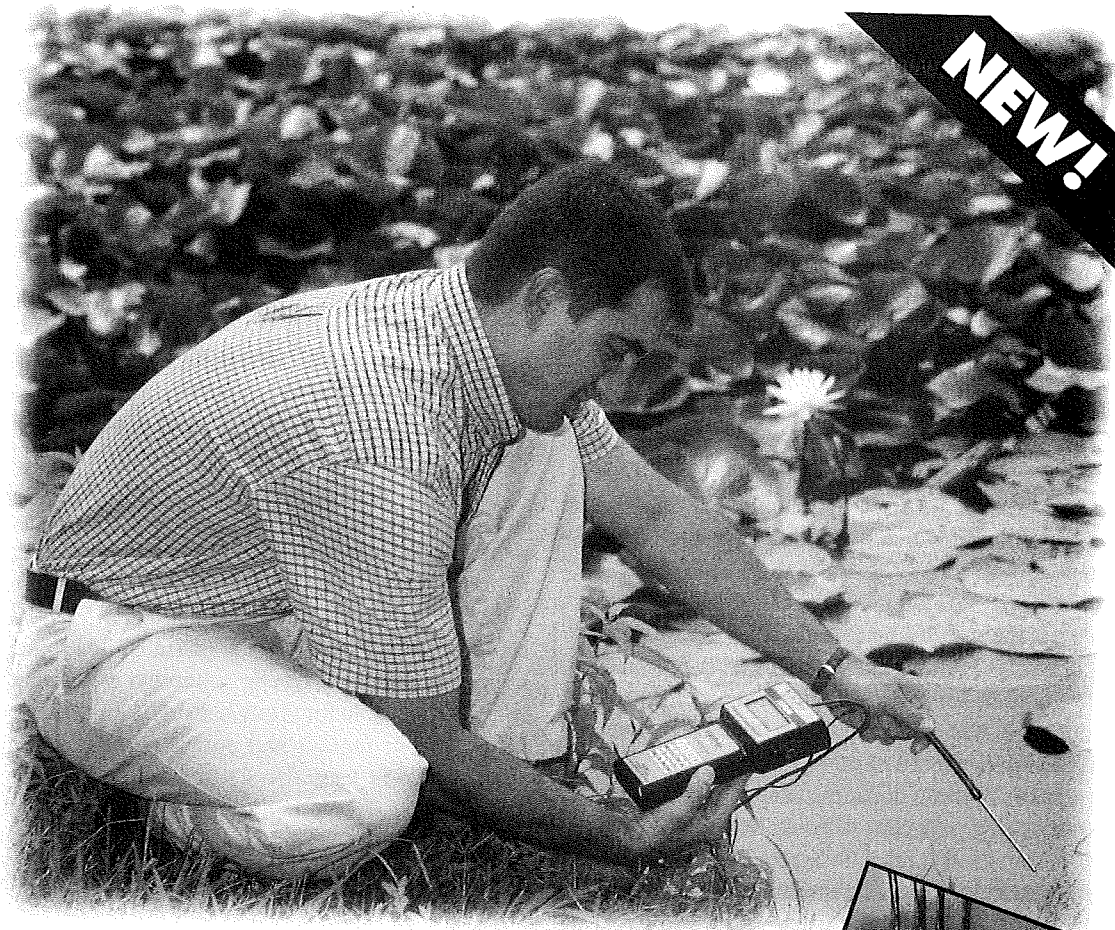
Date:

I have read the above rules and agree to instruct my child to follow the above rules and procedures in class:

Parent

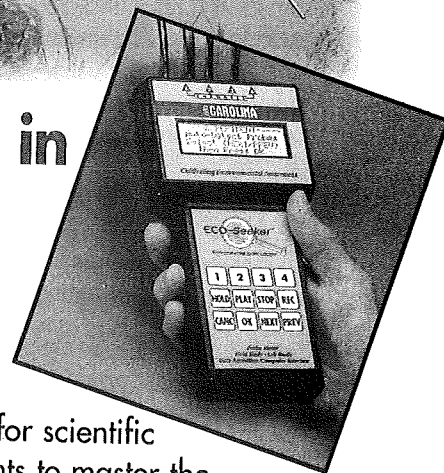
Date

*adapted from Karen Meyer, Rock Island, IL, original source unknown*



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## **GENERAL SAFETY IN THE SCIENCE CLASSROOM**

### **Laboratory Techniques for Science Teachers Safety Modules**

There is no area of science teaching which requires more constant teacher surveillance than does safety. We frequently encounter potential safety hazards or potential health problems in science settings. Have you ever been in a classroom where a teacher mixed hydrogen and air in a pop bottle and ignited it? Have you ever made oxygen gas using Manganese Dioxide and Potassium Chlorate? Have you ever been in a classroom or actually done a demonstration using Ammonium Dichromate to illustrate something like a volcanic eruption? Did you know that all of these are so potentially dangerous that they should never be done in a high school science laboratory? You might say, "But those are chemicals, and we expect them to be dangerous. I am going to teach biology." There are numerous common solvents used in biology that may be cancer causing and/or explosive. Then there are concerns with handling living materials. There are many areas in science instruction in which safety should be more of a concern to those doing the teaching. In this article, we'll provide a brief overview of a number of these areas.

Modern science programs have provided students with opportunities to have a greater amount of involvement in learning through hands-on approaches and activities. This increase in direct, concrete experiences makes safety and health considerations more important than ever before. Safety and health should be an integral part of the planning and conducting of any science lesson. Any science lesson possesses potential dangers, but in most cases teachers and students can cope with them.

Responsibility for safety in the science classroom is shared between the school principal, the teacher, and the student. Carelessness and apathetic attitudes toward safety are the major causes of most accidents. Sometimes, simple ignorance of what is involved leads to violations of the basic tenets of safety. Too often, safety and health training are often neglected because they are considered ancillary. Only when an accident happens does attention get focused on safety procedures.

The teacher has three main general areas of responsibility for safety: (1) instruction in safe practices and health hazards, (2) supervision of students' work and insuring that students follow safe practices and procedures, and (3) provision of safety equipment and instruction in its proper use (e.g. eyewash fountains, fire blankets, etc.). The courts have viewed failures in each of these areas to be a failure of teachers to perform their primary duties, and have held

teachers liable for injury to students. In some cases, the teacher has been held liable for injury to the student's family as well, as was illustrated in a relatively recent case in which a student took home some mercury from the classroom and spilled it on the living room carpet and walls while "playing around" with it. The costs of cleaning the mercury out of the home were included in the penalty the teacher paid.

Teachers need to "debug" each experiment they have students conduct and recognize that just because it may be printed "in the book" does not make it safe. Many classic experiments appear in textbooks, and many of those experiments include the use of materials or even procedures which are now recognized as hazardous. Even when the "activity" is a demonstration in which the students are only observers, the teacher should weigh the dangers of doing the demonstration with the educational benefits to be derived from doing it.

Teachers should work to maintain a safe and appropriate work environment for students, and should immediately report any hazards to their administrators. Notice should be in writing and the teacher should retain copies of such notices. Among the physical features of a laboratory to be considered are proper ventilation (including fume hoods and room circulation), lighting (although poor lighting is not solely responsible for safety hazards, it can be a contributing factor), room ingress and egress (every laboratory room should have at least two exits, both being accessible and unobstructed for all individuals — especially those with disabilities), showers and eyewashes, electrical and gas outlets, and materials storage (certain chemicals should not be stored with others, for example).

Administrators have been held legally liable when things go wrong in the science classroom. Administrators need to be aware of safety requirements and guidelines, and should be certain their faculty is current on them and employs them during their classroom instruction. Similarly, students need to be instructed in proper safety procedures and in the handling of materials and equipment. Many accidents in the laboratory occur due to student misbehavior. Those who fail to adhere to the guidelines should not participate in most activities.

Negligence, in the eyes of the courts, may be defined as conduct that falls below a standard of care established by law to protect others against an unreasonable risk of harm. When the standard of care is not defined by law, then the actions or inactions of an individual will be judged against what a hypothetical, reasonably prudent individual would have done under the same circumstances. One important aspect of the "conduct of the reasonable individual" is anticipation. This includes being aware of the foibles of human nature and being able to anticipate where difficulties might arise. The teacher should provide instruction in the basic procedures to be followed, and provide suggestions on conduct while performing the activity, taking care to identify and clarify potential risks.

**Here are some basic guidelines for teachers to consider for avoiding negligent acts.**

1. Teachers are expected to protect the health, welfare, and safety of their students. Among the typical protections are eye and face protection, protection for clothing (e.g. lab aprons), and sometimes hand protection.
2. Teachers must recognize that they are expected to foresee the reasonable consequences of their inaction.
3. Teachers must carefully instruct their classes and must give careful directions before allowing students to attempt independent projects. Written sets of rules for safety is a must. The list should be long enough to cover all basic requirements for laboratory safety as well as special notes for certain activities which present exceptions to the basic rules.
4. Teachers must carefully plan all activities.
5. Teachers must be careful to relate any risks inherent to a particular laboratory experiment to students prior to their engagement in that activity. Before laboratory work begins, teachers should conduct initial safety orientations with their students, and then remind them of the procedures periodically.
6. Teachers should create an environment in which appropriate laboratory behavior is maintained.
7. Teachers should report all hazardous conditions to supervisory personnel immediately, in writing, and insist that the conditions be corrected immediately.
8. Teachers should keep adequate records covering all aspects of the laboratory operations.
9. Teachers must be present in the laboratory to assure adequate safety supervision occurs.
10. Teacher should be aware of local, state, and federal laws and regulations that relate to laboratory activities in science.

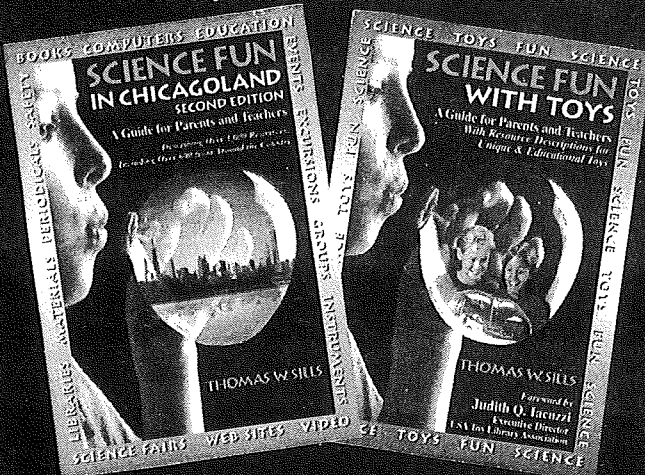
**In addition, below are described some specific safety concern areas to which science teachers should attend.**

## EYE AND FACE PROTECTION

The eye is probably the most vulnerable portion of the body surface from an injury standpoint. It is also the most important link between the individual and the outside world. It is a complex organ which does not recover from injury as do other tissues. There is a variety of possible injuries that can happen in or out of the science laboratory. Foreign bodies are the most common danger. Flying glass from broken glassware or stone particles/chips are two obvious examples. Copper and iron particles can enter the eye and have toxic effects on the tissue beside their scratching effects on the cornea. Laboratory activities which generate liquid droplets or splashes include pouring, stirring, heating, and chemical reactions. In addition, radiation from the ultraviolet, visible, and infrared spectra can cause damage if the intensity of the light is high enough. Every student and the teacher (plus anyone else who is in the room during the activity) should be provided with and wear eye/face protection. There are safety goggles and face shields available of differing qualities, some of which might not be appropriate for a particular type of laboratory activity (i.e. some afford better protection than do others, such as the Z87 coded safety goggles). Corrective eye wear (eye glasses and contact lenses) should not be regarded as safety glasses since they do not provide protection from high angle splashes (and should therefore be covered with appropriate safety goggles). Contact lenses may trap substances between the lens and the eye, causing increased injury due to time in contact between the eye and the substance, even after eye irrigation has been accomplished. When using lasers, the type of eye protection used must be attuned with the characteristics of the particular laser light used. Each laser wavelength requires a particular color and density lens.

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## BIOLOGICAL HAZARDS

The earliest known example of laboratory-acquired infections occurred in 1893. Of all the infections acquired in the laboratory, however, the exact source/cause of nearly 80% were unknown. Over time, the causes for the remaining 20% have been narrowed to five possible frequent vectors: (1) oral aspiration through pipettes, (2) accidental syringe inoculations, (3) animals, (4) spray from equipment such as syringes or inoculating loops, and (5) centrifuge accidents (cracks or breaks in centrifuge tubes during centrifuging). Other common causes are cuts from contaminated glassware, cuts from dissecting/autopsy instruments, the spilling or dropping of pathogenic cultures on table tops and floors, and contact with infected laboratory animals (not only through bites, but also through scratches, generation of aerosols, fecal matter, contaminated bedding, etc.). Some laboratory activities involve handling of embryonated eggs, and eggs infected with viruses afford little protection. Another common source of hazard is activity involving blood letting or blood sampling, or even the sampling of other bodily fluids.

The use of animals in the classroom is essential if students are to fully understand and appreciate life processes. Students need ample opportunities to observe and experiment with living organisms at all levels in the curriculum. Good safety procedures should be established and followed for the protection of both students and animals. The humane treatment of animals is a foremost consideration. The NSTA guidelines on animal use in the classroom should be consulted, as should guidelines provided by the U.S. Humane Society and legislation and regulations from state and federal entities. If the teacher is not trained in the proper care of laboratory animals, he/she should either arrange the services of a consultant who does, or he/she might contact a local veterinarian, many of whom are pleased to offer help in this area. Each study involving animals should have a clearly defined objective and the animals used must be acquired lawfully in accordance with state and local statutes. Studies involving the use of drugs, surgical procedures, toxicological products, etc. should only be undertaken under the direction and supervision of a certified teacher or other qualified adult (e.g. dentist, physician, veterinarian). All animals used in a classroom should be inoculated for rabies unless purchased from a reliable scientific supplier. Animals should only be handled if it is necessary, and then the handling should be done properly according to the particular animal. Special handling is required if the animal is excited, is feeding, is pregnant, is with its young, or is injured. Students should wash their hands after handling animals, and students should be taught to never tease animals or insert their fingers or objects through wire mesh cages. Any student who is bitten or scratched by an animal in the classroom should immediately report it to the teacher and then report to the school nurse. Before a small animal is brought into the classroom, plans should be made for proper habitat and food, care for the animal over weekends and during vacation periods, and the living quarters should be maintained in a clean, sterile man-

ner with proper space for the animal to exercise and with proper ways to secure the cage. After a period of animal observation is completed, animals should be returned to their natural environments. The following animals should never be brought into the classroom: wild rabbits, snapping turtles, poisonous snakes, or insects that may be disease carriers. All laboratory animals should be handled with gloves worn at all times. Animals may contract diseases from humans, including salmonellosis, influenza, tuberculosis, and infectious hepatitis.

When working with microorganisms, known pathogenic organisms should not be used. Regardless, all cultures should be treated as though they might contain pathogens, particularly since nonpathogenic cultures may become accidentally contaminated through coughs, sneezes, etc. Proper sterile techniques should be followed and used at all times. Petri dishes or other containers to be used for culturing should be carefully disinfected with such a chemical as phenol before being washed. Glassware and equipment known to be contaminated with hazardous material (or suspected of being so) should be autoclaved first, then cleaned. Disinfectants are sometimes ineffective, particularly if the contamination level is high or organic matter is present or — more troubling — if the microorganisms have developed resistance to standard disinfectants. Washing should be done with a household detergent, followed by sterilization in an autoclave if possible. In the absence of an autoclave, a pressure cooker can suffice. The maximum pressure should be limited to no more than twenty pounds per square inch, but sterilizing dishes at a pressure of fifteen pounds per square inch for fifteen minutes usually is adequate. If cultures are to be passed around the class for observation, the petri dishes or other containers should be sealed tight with transparent tape to help prevent accidental release of microorganisms. Finally, the work area where cultures are used should be thoroughly scrubbed and disinfected and students should wash carefully before leaving the area.

## CHEMICAL STORAGE

One cardinal rule in acquiring and storing chemical compounds is that chemical reagents should be purchased and stored in the smallest quantities possible. Unfortunately, the rule of cost effectiveness in purchasing often tempts the science teacher to buy in larger quantities. Safety and health considerations should always be preeminent where possible. No more than two months supply should be stored in the science laboratory.

Some chemicals should be stored in special storage facilities. Safety cans are stainless steel or coated steel cans designed to minimize the probability of ignition of flammable vapors and avoid the accidental breakage of a flammable liquid container, usually glass, which may occur in the typical science laboratory. These safety cans are equipped with spring loaded closures and flame arrestors in the spout. These cans are costly, and cannot be used to store high-purity flammable liquids. Special cabinets to house flammable



liquids are also available, and are designed so that internal temperatures don't exceed 325°F. Some are fitted with a door which closes when temperatures reach a certain level. Explosion-proof refrigerators should be used for storing highly volatile organic solvents. Explosion-proof units have all electrical components enclosed in explosion-proof housings both inside and out. Explosion-safe refrigerators, on the other hand, have no ignition sources on the inside, but are not suitable for use in areas where flammable vapors can be present on the outside. The latter type of refrigerator is the less expensive of the two and is usually adequate for school laboratories.

Teachers should also be mindful that some chemicals should not be stored around other chemicals. Even when capped, vapors from containers can escape and react with those from other chemicals. One commonly found storage technique is to arrange all chemicals alphabetically in cabinets or on shelves. Since not all chemicals are compatible for storage together (e.g. glycerine and nitric acid, or cyanides and acids, or potassium chlorate and organic compounds, or acids and bases), this arrangement should be reconsidered. Some chemical suppliers provide information regarding how chemicals they sell should be stored, and their advice should be followed. Ample space between chemical containers should be provided to allow for safe removal and reduction of chemical interactions. Unlabeled, contaminated, or undesirable chemicals should be properly disposed of and not simply placed in the trash (and don't assume the custodian will know how to dispose of chemicals properly). Check chemical inventories often, and do not keep chemicals which are not used or are used very infrequently. Even though notices were widely circulated years ago, the occasional picric acid container is still found in a chemical stockroom.

### FIRES AND FIRE EXTINGUISHERS

Students should be directly involved in fire prevention. This includes not only awareness and instruction about fires and potential fire hazards, but also the type of clothing one should wear when working around certain equipment or chemicals. As an example of fire prevention involving heat sources, one suggestion would be to utilize hot plates rather than open flames from Bunsen burners whenever possible. The use of alcohol lamps should be avoided, since they can spill and the alcohol begin burning, and burning alcohol is very difficult to see.

Though they are commonly found in the classroom, the type of fire extinguisher found in the laboratory may not be the right one. Or, it may not be in the right location within the laboratory. Sometimes, teachers and/or students also do not know how to operate them. There are four classes of fires: Class A (fires which occur in ordinary combustible materials), Class B (fires which are fueled by flammable liquids like alcohol, gasoline, or mineral spirits), Class C (fires originating in electrical equipment), and Class D (fires fueled by combustible metals such as sodium or potassium). Fire extinguishers are labeled A, B, C, or D, or some combination of these letters, designating the type of fire for which they are

designed to be used. Class A fires can be extinguished with water, dry chemical or halogenated hydrocarbon (halon) portable extinguishers. Class B fires can be extinguished by carbon dioxide, dry chemical, or halon extinguishers. In unskilled hands, this type of extinguisher can cause liquid to spread, thus increasing the fire damage potential. Class C fires can be extinguished after the current has been turned off. Class D fires require special extinguishing agents applied from an extinguisher or shoveled from a bucket. The location of fire extinguishers is important, and they should be close to exits and within fifty feet of any point in the laboratory. Teachers and students should be familiar with the types and locations of all fire extinguishers, and how to use them. Teachers should make it a point to explain to students how to properly use the extinguishers located within the classroom and laboratory. Finally, all commercial fire extinguishers have pressure gauges which indicate the current status of the extinguisher charge. These gauges must be carefully monitored and the extinguishers recharged when appropriate. In many cities, the local fire department is a good place to obtain recharging services. As a rule, fire extinguishers should be checked at least once a year, and tagged to indicate the date on which they were checked and/or recharged.

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## OTHER SAFETY EQUIPMENT FOR THE LABORATORY

Besides fire extinguishers and special chemical storage equipment, the science laboratory should include some additional items. Laboratories should be equipped with at least one first aid kit and a first aid chart, a fire blanket, an eye wash station or two (or at the very least eye wash bottles), locks for cabinets or storerooms where combustible and poisonous chemicals are stored, metal or earthenware waste containers, and an ample supply of plastic or rubberized aprons and protective eye wear (goggles or face shields) and perhaps gloves. Master shut-off valves/switches for gas, water, and electricity should be present and in a convenient location. All electrical outlets should be grounded and regularly checked. Exhaust fans for both laboratory and storeroom are highly recommended.

### SOME OTHER GENERAL LABORATORY SAFETY PROCEDURES

**Alcohol:** No flame should be burning near alcohol, the room should be well-ventilated, and all alcohol should be kept covered.

**Allergies:** Check with students to determine if they have any allergies which may be a problem when working with certain materials or living organisms.

**Asbestos:** The problems with asbestos should be well-known to the science teacher. However, in some school laboratories, particularly where older equipment is common, asbestos wire gauze and asbestos pads might still be found. These items should be removed and not used, and should be properly disposed of.

**Centrifuging:** Centrifuges are commonly used to separate cellular material from the suspending liquid medium. Since the glass tubes might break during centrifuging, careful examination should be made of the tubes before use and student proximity to operating centrifuges should be minimized.

**Common Organic Solvents:** Solvents like methyl alcohol and acetone can have serious toxic effects if inhaled over an extended period. Their use requires good window ventilation or a fume hood.

**Formaldehyde:** Specimens taken from formaldehyde should be removed with tongs or by using rubber gloves. Specimens should be washed and soaked in water with frequent changes in water. Vapors from formalin or formalin solutions should not be breathed directly since they can be very irritating to nasal and throat membranes. Finally, formaldehyde should be used only in a room which is well ventilated. If possible, substitutes for formaldehyde should be used.

**Glass Tubing:** Teachers should instruct students on cutting glass tubing and how to insert it and remove it from such things as rubber stoppers. It is better, for example, to cut the stopper to remove tubing than it is to risk breaking the tubing by pulling or pushing it through the stopper. Be cautious about the ends of cut glass tubing, and be sure to instruct students as to the proper handling of glass tubing that has been heated. Provide for proper disposal containers for any used, discarded glass tubing or other broken glass.

**Handling of Caustic Materials:** Be sure students do not hold a vessel into which an acid or other caustic material is being poured. When possible, place the vessel into a rack before pouring. The outside surface of acid and caustic chemical containers should be flushed before use to avoid contamination of clothing and skin.

**Pipetting:** Although a number of harmless substances may be pipetted, students should never pipette by mouth. All should be done using an aspirator bulb or pipette filter.

**PTC paper:** It is usually used in biology programs to illustrate the genetic transmission of the ability to taste the compound within a family. A cautious attitude is advised toward the use of PTC (phenylthiocarbamide or phenylthiourea) taste papers. The substance has been used as a rodenticide in some instances.

**Radiation Sources:** Because of the increased use and availability of radioactive materials in the classroom, every precaution should be taken to prevent human absorption of ionizing and nonionizing radiation. Anyone who handles radiation sources should be certified in their acquisition, handling, and use. Radiation sources should be stored in locked containers designed to prevent unintended exposure to living things.

**Smelling and Tasting:** Be sure to instruct students as to proper ways to wave hands over containers to waft odors toward their noses rather than putting their noses directly at the rim of or into the container. Caution students about tasting any materials, even if they are common household items like sugar, since they may be contaminated.

**Steel Wool and Glass Wool:** Use gloves to handle these materials, and use scissors to cut glass wool.

**Stock Chemicals:** Be sure students recap storage bottles immediately after use, and try to provide bottles or containers which are easy to handle by students.

**Students' Laboratory "Set Ups:"** Teachers should check students' set ups if there is any danger involved (e.g. gas collection, etc.) and that the apparatus has been properly put together and is properly used. Check tubing and burners frequently. Set the apparatus back from the edge of the table or counter. Be sure test tubes being heated do not point toward other people. Be sure students know to not look down into a test tube or container containing a reagent or hot water.

**Syringes:** The hazards common to syringes are accidental inoculation and aerosol production. Disposable syringes should be used where possible. Air bubbles or excess liquid should be expelled into a piece of cotton moistened with disinfectant, and syringes should not be used for forcibly mixing liquids. Syringes should be kept in locked storage.

## **POLICIES-BASED SCIENCE SAFETY PROGRAMS: A MUST**

### **The Need for Science Safety**

Safety is an essential ingredient in all facets of our lives. It is especially important when working in today's complex sociological and demanding educational settings. Morality and ethics demand that we provide the best protective measures known for children and adolescents to assure the best education possible for the next generation. Legislative mandates and legal precedent further pressure and guide science educators in the pursuit of safety excellence. Even science and education organizations are helping coerce professionals to assure safe teaching and learning environments.

### **The National Science Education Standards**

The *National Science Education Standards* (NSES, 1996) state that students at the K-4, 5-8, and 9-12 levels should know and be able to "utilize safety procedures during scientific investigations." Within Teaching Standard D of the NSES, it is stated:

Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science. In doing this, teachers ensure a safe working environment." "Safety is a fundamental concern in all experimental science. Teachers of science must know and apply the necessary safety regulations in the storage, use, and care of the materials used by students. They adhere to safety rules and guidelines that are established by national organizations such as the American Chemical Society and the Occupational Safety and Health Administration, as well as by local and state regulatory agencies. They work with the school and district to ensure implementation and use of safety guidelines for which they are responsible, such as the presence of safety equipment and appropriate class size. Teachers also teach students how to engage safely in investigations inside and outside the classroom (p. 43)"

The NSES are providing an excellent blueprint for improving science teaching for ALL students. However, they are placing serious demands on teachers as they attempt to make science activities inquiry-based, real-life, open-ended, and directly applicable to today's students. This situation is further aggravated when teachers do not know essential science safety information from federal and state governing agencies, and professional organizations.

### **Teacher Understanding of Science Safety**

In a recent study of 1230 experienced (16 years average teaching) science teachers from 15 states, Gerlovich (1995) found that the level of understanding of experienced professional science educators is dangerously lacking regarding the NSES, Legal Issues, Safety Management Issues, and Chemical Management Issues.

With regards to the NSES, less than 3% knew recommended guidelines for the science learning environments, 26% knew that Occupational Safety and Health Administration (OSHA) was the agency who ultimately establishes most lab safety standards, and only 6% knew the recommended class size for science labs.

Teacher understanding of Legal Issues was equally poor, with only 48% being able to explain tort law as it applied to their position. Between 7% and 11% knew that the "save harmless provision" had succeeded "sovereign immunity" as accepted protection for teachers against "negligence." Only 6% of teachers could explain the "due care" duties a teacher must meet to prevent negligence (9%).

Teacher understanding of safety management Issues was especially poor, with between 5% and 22% knowing the lab size, class/lab size (floor space) per student and counter space recommendations of the National Science Teachers Association (NSTA). While 73% of these teachers knew that labs should have two Exits, only 21 % could explain where fume hoods should be placed for maximum safety and effectiveness of operation. Less than 22% could explain the function of a Ground Fault Interrupter (GFI), while only 13% knew the most appropriate type of fire extinguisher and fire blanket (18%) for science labs. Most disturbing was the fact that only 6% could know the goggle legislation for their states, while 12% knew the best placement of equipment for lab safety needs. Nineteen percent of participants knew NSTA's recommended class size limitations, and recommended eye rinse times.

Chemical management Issues were equally foreign to these experienced teachers with only 30% knowing the most appropriate chemical storage procedures. With regards to Right-to-Know (RTK) and Lab Standard (Chemical Hygiene Plan - CHP) legislation, only 9% of the experienced science educators could explain anything about them. Fourteen percent could explain the National Fire Protection Association (NFPA) codes regarding chemical hazards, while 27% knew the purpose of an Material Safety Data Sheets (MSDS).

This study raised serious suspicions of a growing safety problem in science classrooms and labs. A second study (Gerlovich, 1998) was completed, probing into the possible implications of the lack of essential safety information.

## Increased Numbers of Accidents, Lawsuits, and Costs

In June, 1996, Gerlovich contacted the Iowa Employers Mutual Companies (EMC) and Jester Insurance Services, Inc. to report the results of the 1995 study and to explore the initiation of an extension into it's implications for Iowa science teachers.

The administrators of these companies agreed that more study and training should be undertaken in Iowa. Ed. Wilson, Risk Management Consultant with Jester Insurance Services, Inc., of Des Moines, Iowa, was directed to conduct an internal study of bodily injury claims in Iowa schools for the years 1990-1996. Table I provides a summary of the study. The data is very disturbing, revealing an increase in the number of bodily injury claims as well as an increase in the number of law suits against Iowa schools. There was a corresponding increase in the cost of claims for that same period.

From these two studies alone, it is becoming increasingly obvious that unless preventative measures are taken, accidents among science teachers and students are more likely to occur. This situation is even more probable as more schools begin the widespread implementation of the "inquiry based" NSES.

Districts must plan for, and implement, comprehensive science safety programs. From 15 years of experience in school science safety, the author feels that the keys to safe teaching/ learning science environments are knowledge and district wide science safety policies which are understood, endorsed, and implemented by key administrators, supervisors, and all science teachers.

### Policies: The Key

Safety awareness can only become an integral personal habit if safety issues are discussed regularly among all teachers and supervisors and when they are recognized as essentials by the administration. Safety policies should reflect all known and applicable federal and state legislation (Occupational Safety and Health Administration - OSHA Right-to-Know, Laboratory Standard -Chemical

Hygiene Plans, Bloodborne Pathogens, etc.); Codes (fire, plumbing, architectural, etc.); and professional standards (National Science Teachers Association, National Science Education Leadership Association, American Chemical Society, American Association of Physics Teachers, National Association of Geology Teachers, National Association of Biology Teachers, etc.). See some of the select websites in the References section for more information.

Department chairs must take the responsibility to ensure that all science teachers know and understand the rules, and adhere to them; that a safety orientation is provided for new science teachers, as well as annual updates for veteran faculty, regarding procedures and equipment; that information concerning special hazards is disseminated to teachers; and that adequate, functioning safety equipment is provided.

It is then the science department's (teachers and supervisors) legal, and ethical responsibility to conform to these laws, codes, and standards. This can best be accomplished by informing the administration - in writing. This process documents, to the administration, that everyone is aware of these responsibilities and that they will be taken seriously in their identification and correction. In addition, it lets them know that science teachers and supervisors may periodically require assistance in meeting them. It is imperative that everyone in the science department sign the policies form. This provides a picture of unity of agreement. It is also wise to extend to include junior high and middle schools. A sample Department Science Safety Policies form is provided for reaction in Figure 1. The model has proven effective in thousands of schools across the nation.

Once the policies have been officially adopted by the district, science personnel must identify examples of hazards and initiate and document their correction. Checklists should be obtained, or generated, for this purpose. Forms should also be obtained, or developed, to request administrative assistance for correcting safety problems which are beyond the purview of the science personnel but within the scope of the science safety policies. These forms should be initiated by teachers, sent to the department chair/supervisor, and ultimately to the appropriate administrator for endorsement.

### Bodily Injury Claims/Lawsuits, Iowa School Science Settings, 1990-1996

Time Frame	1990-93	1993-96
Bodily Injury Claims	674	1,002
Cost	\$1,678,075	\$2,300,172
Number of Lawsuits	96	245
Cost	\$566,305	\$1,238,662

Table 1.

## Useful Websites

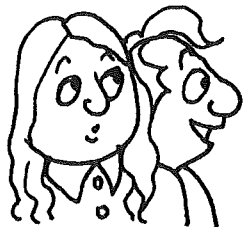
- <http://www.osha.gov> Occupational Safety and Health  
includes federal and state regulations and compliance's  
for Right to Know, Lab Standard (Chemical Hygiene Plan),  
Bloodborne Pathogens, and publications
- <http://www.nsta.org> National Science Teachers Association  
Includes membership and convention information,  
publications, news, and on-line resources.
- <http://www.acs.org> American Chemical Society  
Includes publications, curricular materials for educators,  
and chemical abstract services.
- <http://www.nfpa.org> National Fire Protection Association  
Includes codes, standards, online catalog, projects, and  
publications.
- <http://www.netins.net/showcase/jakel> Science Safety Software (see author's  
note)

This process is critical in keeping everyone informed of progress in meeting district policies and ultimately protecting teachers and students from foreseeable injuries. Not only will such a risk management program improve science safety, it may also lower insurance premiums if the plan is shared with district insurance carriers. Due to the enhanced communications required between teachers, supervisors, and administrators, it will likely also improve teaching and learning.

For information concerning comprehensive science safety software, encompassing applicable laws, codes, professional standards, forms, checklists, chemical databases, and science safety training programs, please see the Reference section (Gerlovich, 1998).

### Summary

The National Science Education Standards, inquiry based science is demanding greater safety awareness among science teachers at a time when their understanding of applicable laws, codes, professional standards, and practices are very poor. The number of accidents, and resulting law suits, and associated costs surrounding science accidents are increasing. It is becoming increasingly apparent that science teachers and supervisors need additional training relative to safety, and that written science safety policies must be implemented in order to identify and address these safety needs.



### References

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National Research Council. (1996). *National Science Education Standards*, National Academy Press, Washington, DC.



### Author's Note

**The Total Science Safety System Software** program was developed by the author along with an attorney and programmer. Initially developed in 1986, the program is now in its 8th edition. It is a very comprehensive commercial program in use in thousands of schools today. It includes applicable laws, codes, professional standards; forms and checklists, and; chemical management. JaKel, Inc., 585 Southfork Dr., Waukegan, IA 50263 (515-225-6317). Software available in Macintosh (MS-Word/Excel, MS-Works, ClarisWorks) and IBM PC (MS-Word/Excel, MS-Works) formats.

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## Department Science Safety Policies

The \_\_\_\_\_ School District Science Department recommends to the administration of \_\_\_\_\_ Board of Education, and requests support for the following policies in order to insure the safe and effective teaching and learning of science in our laboratories. All established policies will be put into practice and applied consistently, without exception, by all science education professionals

1. Science programs are all designed to comply with known and applicable federal, and/or state versions of legislation, such as: Right-to-Know, Laboratory Standard - Chemical Hygiene Plans, Bloodborne Pathogens
2. Science programs are all designed to comply with known and applicable state and local fire, electrical, plumbing, building, codes
3. Science programs are all designed to comply with known and applicable legislation, accreditation standards, and guidelines from such agencies as: the State Department. of Education, Department. of Health, Department of Personnel Services, etc.
4. Science programs are all designed to comply with the professional guidelines of such science education organizations as the National Science Teachers Association (NSTA), National Science Education Leadership Association (NSELA) and parallels regarding:

Instruction according to approved local, state, and national curricula

Supervision for all students at teacher:student ratios of 1:24 or less

Maintenance of all equipment and facilities

Accepted Procedures for science teaching techniques

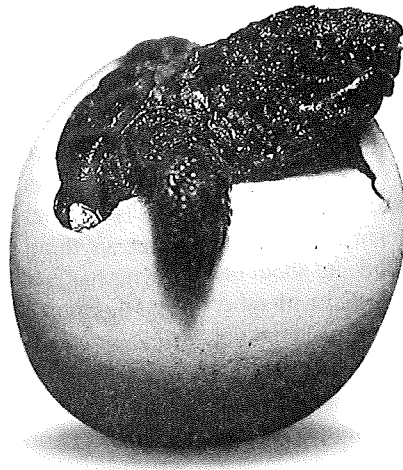
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Date

Signatures of All Science Teachers Supporting these Policies Appear Below

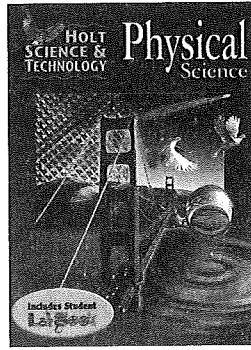
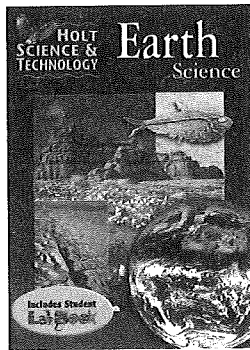
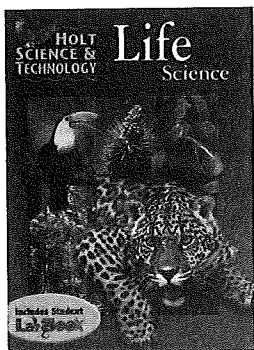
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Figure 1. Sample Department Science Safety Policy Form

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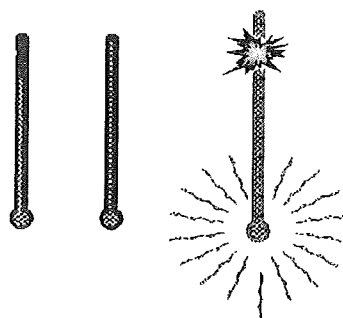
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## Case Studies

### SAFETY IN THE LIFE SCIENCE LABORATORY

Laboratory work sets the sciences apart from all other subjects taught in school. This unique aspect of science is the very part that excites many teachers and students about the subject. Performing laboratory activities coupled with other appropriate pedagogical techniques, such as critical thinking tasks, assists learners in gaining sophisticated scientific understandings of the concepts of science. The research in science education has clearly shown that simply telling students information or even having them read and answer higher-level questions about a concept is insufficient in most cases to help learners gain an accurate understanding of even the most basic concepts. The prominence of laboratory work in the National Science Education Standards (National Research Council, 1996) and the Illinois Learning Standards in Science is in direct response to this research. However, conducting laboratory activities comes with risk. Safety in the laboratory is a chief concern.

Safety is a critical part of planning for any kind of activity with children or adolescents. Careful preplanning can eliminate most problems and vastly reduce the risk of accidents. To assist you in thinking about safety in the life science laboratory, this article has been separated into four sections. The first focuses on a number of cases based upon actual events which occurred in science classrooms (note that names in all cases have been changed). You might use some of these cases in discussing safety guidelines and the reasons for those guidelines with your students. The second section focuses on issues teachers must attend to regarding safety in a life science laboratory. The third section includes sample safety rules for students specifically related to life science laboratories. Finally, the fourth section includes a variety of references you might find helpful. As you discuss safety matters with your students, you might include that failure on their part to follow proper safety guidelines may lead to them being held culpable in court if their actions lead to an accident.



#### Thermometer Trouble

Jared, a high school senior, was conducting an experiment in which he was required to insert a thermometer into a rubber stopper. He had been required to do this many times before in chemistry and physics class as well as previously in his Biology II class—each time he was shown the proper technique. On this particular day, the thermometer gave Jared quite a bit of trouble. The teacher, Mr. Hunter, had been called to the office so was not available to assist him. Even though Mr. Hunter reminded the class, just before he left, never to force anything glass into a rubber stopper, Jared decided to use his bare palm to shove the thermometer through the hole. The thermometer broke; the jagged end ripped into Jared's forearm causing a large gash. Fortunately, a second teacher entered the room just as the injury occurred so was able to provide immediate first aid. Also, fortunately for Jared, the break occurred above the level of the mercury thus avoiding mercury poisoning. The wound itself required over 15 stitches to close. The primary safety concern in this case is that the teacher left the room. Had the parents sued, the teacher likely would have been held liable for negligence. The use of mercury thermometers is a secondary concern for reasons described in the next case. In this case, however, use of mercury thermometers rather than alcohol thermometers was justified because they are much more accurate than alcohol thermometers and accurate temperature readings were critical to this lab.

#### Liquid Danger: Mercury Contamination

Mercury can easily pass through the skin directly into the bloodstream. From there it can travel to the brain and liver causing permanent damage. However, many children are allowed to play with mercury in their homes from such sources as broken thermometers.

In one case, a group of students, who were fascinated by the physical properties of mercury, gained unauthorized access to a bottle of it through an unlocked chemical storage facility in their biology lab. Their teacher was absent the day of the event and the substitute teacher did not notice the students removing the mercury. The students proceeded to play with the mercury with their bare hands during a number of their classes. They were not caught until the end of the school day. In the meantime, they had contaminated several classrooms, the lunch room, and hallways. Unbeknownst to them, they left small beads of mercury behind wherever they played and other students were exposed to the toxin. The next day, school was canceled so that a hazardous materials (HazMat) team could clean-up the mercury contamination. Even though the teacher responsible for the storage facility was absent the day of the incident, she was held liable because she had not locked her chemical storage area. Two safety issues are highlighted by this case: (a) keeping dangerous materials in locked cabinets and inaccessible to students and (b) informing students of the dangers of toxic chemicals such as mercury.



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## Scorched Burner

Ms. Stone was generally very conscientious about laboratory safety. As she was preparing her students to conduct a series of experiments to test for sugars, starches, fats, and protein in food, she showed them the materials they were to use. Among the items was an old hot plate, the sort with a coiled element. She had not used this piece of equipment in some time and had not recently checked its condition, but this day the standard laboratory hot plates were not available—they were being used by another teacher. As she proceeded to tell her students that the burner was completely safe, it cracked and began to spark. Fortunately, no one was hurt and the unit was unplugged before a fire started. The primary safety issue highlighted by this case is making sure all equipment is thoroughly checked and in good working order prior to use with students. This is especially critical for pieces of equipment that are old or are infrequently used.

## Facility Problem

No science teacher ever seems to have enough electrical outlets in the lab. This is especially a problem in classrooms that have been converted into labs. In one case, a classroom was converted into a lab room by placing a demonstration table at the front of the room and electrical outlets into the floor near each lab bench and the demonstration table. The demonstration table was outfitted with a gas jet, a sink, and running water. This was the only source of water or gas in the room.

Dissections are regularly performed in this lab room during appropriate sections of the curriculum. Whenever students clean their utensils, including razor blades, scalpels, scissors, etc., they crowd around the sink, up to 12 students at a time. In the process of cleaning their utensils and dissection pans, much water splashes on the floor, including onto the floor outlet near the demonstration table. Though no one has yet been hurt, this is an accident just waiting to happen. The safety issues of concern here include: (a) having too many students cleaning sharp objects in a limited space—someone is likely to be cut, (b) having outlets in the floor close enough to a water supply that a student or the teacher could easily be electrocuted, and (c) having outlets in the floor which could easily be tripped over.

## Playing with Electricity

Jesse, a ninth grade honors student, was always fascinated with electricity. He had always been told, however, never to stick anything into an electrical outlet. One day, while performing a dissection, he decided to find out for himself why. He had a set of forceps in his hand and proceeded to stick the forceps into an electrical outlet as if it was a plug. As he did so, he was thrown half way across the room; the forceps, still in his hand, were melted and the outlet was destroyed. Fortunately he was not seriously hurt, just a little shaken. He was lucky. The obvious safety issue in this case was a student playing in the lab and conducting "experiments" without approval.

## Sodium Metal Disaster

Sodium is one of many chemicals that have special storage requirements. Sodium, along with potassium and phosphorus, are highly volatile when exposed to moisture. They can spontaneously ignite even if exposed to the air on a humid day. As a result, they must be stored under an anhydrous oil such as mineral oil.

Mr. Stein was a young energetic teacher with a major in biology but who taught both physical science and biology. He was always looking for new and exciting demonstrations and experiments for his students. In his second year of teaching, he decided to do a demonstration at the start of a chemistry unit in which he placed a small pea-sized piece of sodium metal in a beaker of water and allowed his students to observe. The students were amazed at the resulting fire in water. He redid the experiment for them a couple of times.

In order to conduct this demonstration, Mr. Stein ordered a pound of sodium metal. Buying by the pound was much less expensive than buying by the gram and he figured he would have it for years to come. Prior to ordering the material, he did not consider the type of packaging in which the metal would arrive. The sodium was packaged in a sealed cylinder which, once opened, could not be resealed or used for continued storage. Therefore, after conducting the experiment, Mr. Stein had to find a new storage container. He found an old glass pickle jar large enough to store the metal and some olive oil. He then proceeded to place the remaining pound of metal in the jar and cover it with the oil. As he finished covering the sodium with the olive oil, he noticed bubbles forming. He was unsure about this so sought the assistance of the chemistry teacher. What Mr. Stein did not realize was that not all oils are anhydrous, olive oil being one of them. He had created a potential disaster. Fortunately this occurred immediately preceding lunch so all the students were already out of that part of the building. All teachers not assisting with the situation were informed of the potential problem and were asked to eat lunch elsewhere, which they quickly did. The local fire department was called but could not assist with the problem. In fact, they had to be educated as to the nature of the problem. Once the gravity of the situation was recognized, the local fire fighters requested assistance from the fire department of a nearby city (the school was located in a suburb of a major city). The city fire fighters understood the problem and immediately sent their bomb squad to dispose of the hazardous material.

This story had a happy ending. But the potential disaster was real. Mr. Stein made several mistakes. First, he ordered much more sodium than he could have used during an academic year. The rule of thumb is never buy more of any chemical than you will use during a single academic year and never store hazardous chemicals for more than two months. Second, he did not fully read the Materials Safety Data Sheet (MSDS) that came with the sodium so did not realize that not just any oil would do. However, he did have the wherewithal to seek help when he noticed a problem. Had he just put the metal away, the sodium in the jar may well have exploded like a fire bomb causing many injuries.

Among the worst horror stories is that of a young elementary school teacher, alias Ms. Drew, who requested sodium metal from a high school science teacher. Ms. Drew had attended a science teachers conference and among the demonstrations she saw was putting a pea sized piece of sodium metal in water and watching it ignite. She wanted to share this awesome experience with her students. She did not, however, realize the reason for using such a small piece of sodium. When she did this with her students she borrowed a pound of sodium metal rather than a few grams, gave each child a hunk of the metal, distributing the full pound. She then moved the class out to the school yard where she had the students simultaneously toss their hunks of metal into a baby swimming pool full of water. The resulting flash fire killed or maimed every member of the class. Both the elementary school teacher and the high school teacher who supplied the sodium were held liable.

### **Leaky Gas Pipe**

In the early 1900's, an elementary school in East Texas blew up as a result of an undetected gas leak in the school. Natural gas, which is odorless and colorless, was pumped directly from the oil fields into the school. The explosion occurred near the end of the school day and killed or seriously injured most of the children, teachers, and staff. As a result of that disaster, Congress mandated that natural gas must have a specific and identifying scent added to it as it is processed.

Today, gas leaks are generally detected as they occur due to the addition of the scent. However, some very small gas leaks produce little detectable odor. Such leaks can, nonetheless, be very detrimental.

Ms. Fernandez taught biology, chemistry, and life science. Her lab room was typical of most. She had sinks and gas jets around the periphery of the room and lab tables, instead of desks, in the center. After teaching in the room for a several weeks, she began becoming ill on a frequent basis. Many of her students also complained of not feeling well as they left her class. They especially complained of headaches, including migraines. A pattern started to emerge. Something in the room was making her and her students ill.

During that first year, Ms. Fernandez detected several gas leaks around the gas jets and those were subsequently fixed. As a result of this, the room was regularly checked for gas leaks for the next two years. Eventually, the root of the problem was identified. A series of small gas leaks were detected in the copper gas pipes imbedded in the concrete under her classroom floor. Copper is generally not used for gas because natural gas reacts with it producing, at first, small pits and, eventually, pin-sized holes. This is exactly what had happened. The school had been built approximately 30 years earlier. Over that time period, the copper pipes weakened eventually allowing the gas to seep into the classroom through the floor. The problem is now fixed. Students no longer complain of headaches as they leave the class. However, the ending is not so happy for Ms. Fernandez. The gas poisoning over that time period compromised her immune system and she now suffers from chronic health problems including

increased susceptibility to colds, the flu, and pneumonia. The safety hazard in this case was one Ms. Fernandez could not avoid. She had neither control over the types of pipe the school district chose to use for the gas lines nor did she previously realize the chemical reactivity between copper and natural gas. This is not common knowledge for most people. This is a case, however, that might be helpful to many teachers if they notice a gas leak whose source cannot be readily identified.

**Etc.**

Many more minor cases could be written about children who improperly light a Bunsen burner only to lose eyebrows and eyelashes, improperly handle a microscope resulting in its destruction, are bitten by class pets due to improper handling of the animal, cut themselves on broken glassware, rub their eyes during an experiment only to introduce a foreign substance such as formalin into their eyes, or put a small amount of acid in a wash bottle only to have someone else get a chemical burn when using it to clean glassware later.

## **Safety Issues**

The above cases include not only issues specific to the cases but also a number of important broad issues teachers must consider when thinking about safety in their science classrooms. Among those broad issues are: chemical storage, hazards, and disposal; proper safety equipment; equipment instructions, proper uses, and safety guidelines; room arrangement and safety equipment instructions; and special considerations for field trips. All of these issues are important to teachers of all grade levels—kindergarten through college and are elaborated upon below.

### **Chemical Safety:**

- An up-to-date chemical inventory should be maintained.
- Material Safety Data Sheets (MSDS) are required by federal law to accompany all chemicals shipped. These sheets provide such safety information as toxicity; flammability; boiling, freezing, and flash points; etc. They must be kept on file and be accessible in the lab. Teachers are required to be familiar with the contents of the MSDS sheets for all chemicals they use. (MSDS sheets may also be obtained for most chemicals on the world wide web.)
- Students should be made aware of any potential chemical hazards, especially toxicity and flammability. Special precautions may be necessary for students who are pregnant.
- Date all chemicals when they arrive. Also, know the shelf life for all chemicals. Some items, such as sodium and phosphorous metal, can become more unstable when stored for long periods of time.
- Order only what you need for an academic year. Though most chemical manufacturer's give discounts for bulk orders, ordering excessive amounts of toxic or flammable materials can be quite hazardous. Many high school chemical storage facilities are not equipped to store hazardous materials for long periods of time.

- Store chemicals according to an approved storage procedure. Flinn Scientific's catalog provides an excellent diagram for proper storage of chemicals. If you plan to store flammables or acids, be sure to have a cabinet specifically designed for that use. Also note, acid cabinets with metal hinges are virtually useless; the acid corrodes the metal hinges quickly.
- Be sure to shut off gas lines when they are not being used. Every lab room equipped with gas should have a shut-off valve located in the room for that room.
- Many labs in biology require the use of organic solvents. When selecting labs, be careful to find ones requiring the least toxic chemicals possible. Many organic solvents, such as benzene and toluene, are carcinogenic.
- Note: The Flinn Scientific catalog is an excellent resource for science teachers with regard to chemical safety.

#### **Safety Materials:**

- Every student should have and be required to use safety goggles and aprons for every lab requiring use of chemicals, involving the heating or pounding of any substance, or involving use of projectiles. In addition, gloves should be provided for all students when using chemicals that may cause skin irritation, including formalin or formaldehyde. Goggles should be cleaned between use. This can be done with the use of an UV goggle cabinet or more simply with a bucket of water mixed with Lysol® or other disinfectant.
- During field trips in which students may wade into streams, lakes, or other bodies of water, appropriate garments such as boots and waders should be provided. Life jackets must also be available for each student.
- Every science lab should be equipped with a fire blanket, fire extinguisher, first aid kit, and biohazard container. All students should be familiar with how to use these items. In addition, all labs in which flammable or toxic chemicals are used should have a chemical hood. Finally, all labs in which chemicals are to be used should have an eye wash station and easy access to a shower. Many high school and most middle school life science labs lack one or more of these items. However, failure to have these necessary safety items can open liability lawsuits if a student is injured in lab.

#### **Bio-Hazards:**

- Labs requiring use of human blood and blood products are no longer permissible in the high school or middle school laboratory setting. Many kits have been created that simulate such previously popular labs as human blood typing. These are available through most biological supply houses.
- For additional information on disposal of material contaminated with bacteria or information on use and care of animals in the lab, please see the Biological Hazards section of the article entitled "General Safety in the Laboratory" located in this issue of *Spectrum*.

#### **Equipment/Material Safety:**

- Be sure all equipment is in proper working order before each lab begins. Be especially cautious with equipment that has not been used recently or that is old.
- Discard all glassware that is cracked or broken.
- Be cautious when heating slides over a Bunsen burner. Glass slides may crack sending shards of glass flying. Pyrex® or Kimex® slides are less prone to crack.
- If a piece of equipment has any moving parts, students should be reminded of special safety concerns such as tying back loose hair or clothing.
- When ordering equipment or materials, be sure to consider both safety and use. For example, when selecting thermometers consider their use. Alcohol thermometers are less accurate than mercury thermometers (they often show the boiling point of water varying from 95 to 105°C), but pose less risk if broken.

#### **Classroom Hazards:**

- **Book Bags.** Students tend to place their book bags on the floor next to their desks during class. This quickly blocks passageways causing a serious hazard if students need to exit the room quickly. Consider having a shelf in the room dedicated to holding book bags.
- **Room Arrangement.** If the room has too few sinks, consider placing water buckets in other locations around the room that could serve as temporary sinks for clean-up. If electrical outlets are in potentially hazardous locations, consider covering them with plastic covers such as those used in baby-proofing a house.

If you are ever unsure of how to use a piece of equipment, how to properly store chemicals, what potential dangers exist for a particular chemical or piece of equipment, or other safety issues, be sure to ask. Many school districts have designated safety officers or other personnel who may know the answer to your question. If no one at your school or district is able to assist you, you might contact a local university, the poison control center, the local fire department, or the chemical or equipment manufacturer to assist. The key is to be safety conscious. Many labs include an element of risk. As you select the activities for your classes, be sure the level of risk does not exceed the potential educational benefits. Also remember, laboratory activities are enjoyable experiences and are part of what makes the sciences so unique.



## Safety Guidelines

On the next page are listed sample safety guidelines to be used with middle or high school students. The guidelines were written not only for purposes of class discussion and communication with parents but also for written communication with students. These guidelines are intended to provide minimum safety and conduct rules. You may need to alter or add to these guidelines in order to make them more specific to your needs. Many science methods books provide nice descriptions of science safety guidelines (e.g. Frederick and Cheesebrough, 1993), which might provide you with additional ideas. For all grade levels, pictures and posters can be placed around the room to remind students of the safety tips (these can be purchased through many scientific supply houses and teacher centers). Before sending any contract such as that written below home with your students, be sure to clear it with your school administration.



## References

Below are listed a number of references which might assist you in attending to laboratory safety issues in your classroom and with your students. The references are categorized into four basic categories: (a) use of live and preserved organisms, (b) general safety information, (c) safety manuals, (d) chemical storage, hazards, and disposal, and (e) specific safety issues.

### Use of Live and Preserved Organisms:

James, R. K. (1999; this issue). General Safety in the Science Classroom. *Spectrum*. (This article has an excellent discussion of safety issues regarding use of live and preserved organisms.)

The Institute of Laboratory Animal Resources, Commission on Life Sciences, National Research Council, 2101 Constitution Avenue NW, Washington, DC 20418 and request the *Principles and Guidelines for the Use of Animals in Precollege Education*. The National Association of Biology Teachers, 11250 Roger Bacon Dr., #19, Reston, VA 20190-5202 (or web site address: [www.nabt.org](http://www.nabt.org)) and request the following Policy Statements—*NABT Guidelines for the Use of Live Animals*; *The Responsible Use of Animals in Biology Classrooms, including Alternatives to Dissection*; *NABT's Policy on the Responsible Use of Animals in Biology Classrooms: A Clarification*; and *The Role of Laboratory and Field Instruction in Biology Education*.

### General Safety Information

Chiappetta, E. L., Koballa, T. R., Jr., & Collette, A. T. (1998). *Science instruction in the middle and secondary schools*. (4th ed.). Upper Saddle River, NJ: Merrill.

Fredericks, A. D. & Cheesebrough, D. L. (1993). *Science for all children: Elementary school methods*. New York: Harper Collins College Publishers, Inc.

Flinn Scientific, Inc. (1999) *Flinn Chemical Catalog Reference Manual*. Batavia, IL:

### Safety Manuals:

Accrocco, J. O., & Cinquanti, M. (1990). *Right to know: Pocket guide for laboratory employees*. Schenectady, N. Y.: Genium Publishing Corporation

American Chemical Society. (1990). *Safety in academic chemistry laboratories* (5th ed.). Washington, D.C.: Author.

American Chemical Society. (1993). *Safety in the elementary (K-6) science classroom*. Washington, D.C.: Author

Gerlovich, J. A., Gerard, T. F., Downs, G. E., Joslin, P. H., & Flinn, L. C., Jr. (1988). *School science safety: Elementary*. Batavia, IL: Flinn Scientific Incorporated.

Gerlovich, J. A., Gerard, T. F., Shriver, B., Downs & Flinn, L. C., Jr. (1988). *School science safety: Secondary*. Batavia, IL: Flinn Scientific Incorporated.

Gerlovich, Jack A. (1981). *Better science through safety* (1st ed.). Ames, Iowa: Iowa State University Press.

Kaufman, J. A. *Laboratory safety guidelines*. Milton, MA: Curry College.

Kucera, T. J. (Ed.). (1993). *Teaching chemistry to students with disabilities* (3rd ed.). Washington, D.C.: American Chemical Society.

Lab Safety Supply, Inc. (1995). *Lab safety supply catalog*. Janesville, WI: Author.

Steere, N. V. (Ed.). (1971). *Handbook of laboratory safety*. Cleveland, OH: CRC Press.

### Chemical Storage, Hazards, and Disposal:

American Chemical Society. (1994). *Laboratory waste management: A guide book*. Washington, D.C.: Author.

Bretherick, L. (1985). *Handbook of reactive chemical hazards* (3rd ed.). Stoneham, MA: Butterworths.

Consumer Product Safety Commission. (1984). *School science laboratories. A guide to some hazardous substances*. Washington, D.C.: Author.

Lewis, R. J. (1983). *Hazardous chemical desk reference* (3rd ed.). New York: VanNostrand-Rinehold.

Mackison, F. W. et al. (Eds.). (1985). *NOISH/OSHA pocket guide to chemical hazards*. (Technical Publication No.: 78-210). Cincinnati, OH: NOISH Division of Technical Services.

National Fire Protection Association. (1975). *Fire protection guide on hazardous materials*. Boston, MA: Author.

National Research Council. (1981). *Prudent practices for handling hazardous chemicals in laboratories*. Washington, D. C.: National Academy Press.

National Research Council. (1981). *Prudent practices for disposal of chemicals from laboratories*. Washington, D. C.: National Academy Press.

Wahl, G. H. (1992, Oct.). *Reduction of hazardous waste from high school chemistry laboratories*. Raleigh, N. C.: Department of Chemistry, North Carolina State University.

Windholz, M., Ed.. (1983). *The Merck index: An encyclopedia of chemicals and drugs* (10th ed.). Rahway, N. J.: Merck and Co.

### Specific Safety Issues from Flinn:

Flinn Scientific. (1987). *Flinn Fax: Poison/toxic chemical, Safety in the school laboratory*. Batavia, IL.

Flinn Scientific. (1986). *Flinn Fax: Fire Extinguishers, Safety in the school laboratory*. Batavia, IL.

Flinn Scientific. (1987). *Flinn Fax: Science department ventilation, Safety in the school laboratory*. Batavia, IL.

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## Class Safety Rules Guidelines for Middle School/High School

### Rules of Conduct in the Laboratory

Certain rules of conduct, listed below, are advisable in a science laboratory. Study them carefully and then list a reason for each rule in your laboratory notebook.

1. Always maintain a business like attitude.
2. Never bring food or drink into the laboratory room.
3. Dispose of wastes as indicated by the teacher.
4. NEVER return unused reagents to stock bottles.
5. Follow directions carefully using only the amount of materials called for—more is NOT always better, more can ruin the experiment.
6. Wash your hands thoroughly after each and every laboratory session.
7. Always leave your laboratory station clean and dry.
8. Be sure water and gas outlets are turned off completely after use.
9. Whenever you are unsure of a procedure, ask the teacher for help.
10. Anything you damage or break will be paid for by you.

### Safety in the Laboratory

Your personal safety and that of others working near you depend upon the care with which you observe the rules listed below. Become familiar with these rules and follow them **AT ALL TIMES**.

1. Know the location of the fire extinguishers, fire blankets, safety shower and eyewash fountain and how to use them.
2. ALWAYS wear appropriate eye protection when conducting an experiment.
3. Contact lenses can cause an eye hazard so should not be worn during certain laboratories involving chemicals.
4. Appropriate protective aprons should be worn when conducting experiments.
5. Do not wear bracelets, dangling jewelry, ties, long, loose sleeves or a loose coat in the laboratory.
6. If you have long hair, tie it back while working in the laboratory.
7. Only perform experiments which have been approved by your teacher.
8. Notify your teacher of any accident, no matter how minor it may seem to you.
9. NEVER use flammable liquids near an open flame.
10. Flammable liquids should be disposed of in clearly marked containers.
11. Never leave a flame unattended. (A good flame is virtually invisible.)
12. Check the label on ALL reagent bottles twice before using them.
13. If an acid or base spills, immediately notify your teacher.
14. When diluting acids, always put the acid into water. Remember A to W!
15. When inserting glass tubing, a glass rod, or a thermometer into a rubber stopper or rubber tubing, always protect your hand with several layers of cloth and always lubricate the glass before inserting it into the stopper or tubing. Never force the glassware.
16. When heating the contents of a test tube, keep it tilted and moving in the flame with the mouth pointed away from yourself and your neighbors.
17. When investigating odor, always waft the odor toward your nose with your hand.
18. Always respect the laboratory environment, the animals and other materials you use, and the research of others.

**Failure to follow these guidelines is grounds for removal from lab with a grade of zero for the lab or project.**

I \_\_\_\_\_ have read and understood the above safety rules and conduct guidelines and I agree to follow them. I also agree to follow any additional verbal or written guidelines provided by my teacher.

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Signature of Student

Date

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Signature of Parent/Guardian

Date

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## LASER, LIGHT AND LIGHTING SAFETY

Elementary education curriculum units often emphasize the five senses as a focus for study. Vision, taken for granted and too often ignored, is important in school building and planning. Vision is probably one of the most easily damaged senses and deserves more attention than usually given.

### Daytime Astronomy and Meteorology

Viewing eclipses, sunspots, the moon, and cloud formations during the daytime is hazardous if the teacher or student looks at the sun directly. Severe eye damage or blindness may occur if the viewer looks at an object as bright as the sun through a telescope. Students should view a projected or recorded image of the sun and not look directly at the sun at any time. A projected image of the sun viewed on a flat non-reflective surface or even an image on a TV monitor is safe.

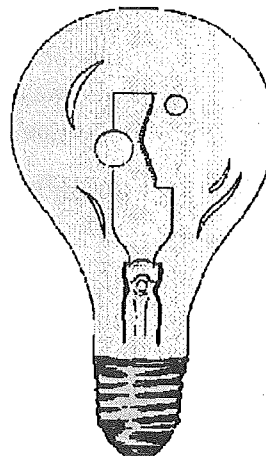
### Lasers Up-to-date

The use of lasers in classrooms is expanding, and students look forward to the interesting uses of this instrument in demonstrations and experiments. However, careless and indiscriminate use of lasers by students and teachers is a newer hazard in schools. Even though lasers may be small, portable, pointer type instruments, they still are a potential problem. Teachers should inquire about legal issues related bringing laser pointers to school. Some communities and/or states have outlawed student possession of lasers at school. Minors may be prohibited from buying pointer lasers in some areas. A summary by Rodansky (1998) lists Class 2 or 3a lasers as safe for instantaneous viewing, which includes laser pointers. There is a possibility of retinal damage for exposures of 10 seconds or more. Lasers will become more common in the elementary school for simple mirror and lens experiments and for certain activity-based reflection competitions. Low price and availability in almost every hobby shop and hardware store has made lasers accessible to more teachers. Interesting laser experiments and displays with holograms and fiber optics have been adapted to the elementary level. Even though the half milliwatt power of a student He-Ne (Helium-Neon) laser is not normally severely damaging to the eye, teachers and students should be cautioned

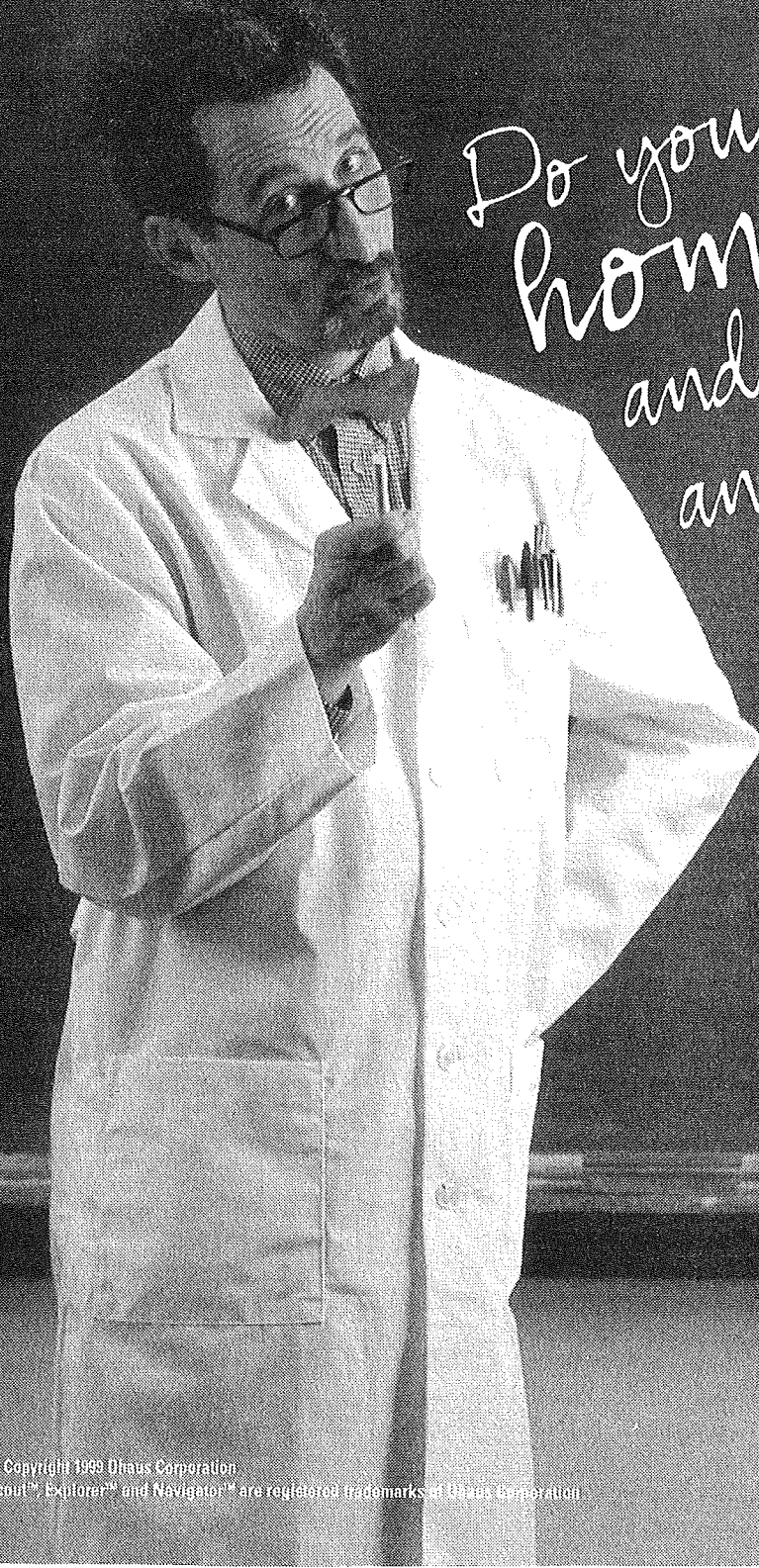
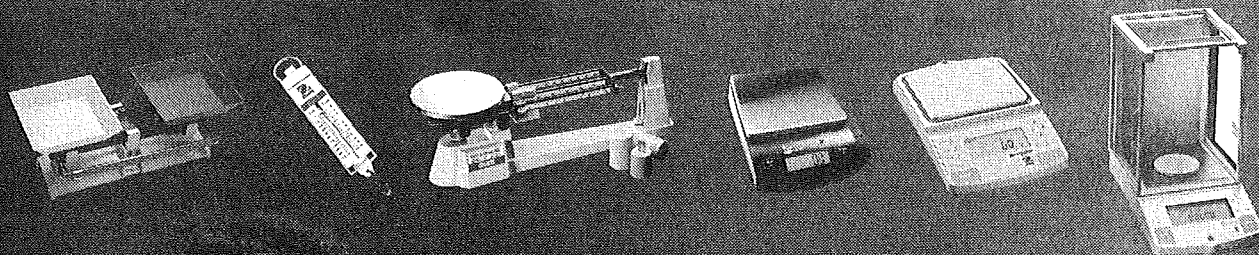
never to look or stare directly into the laser beam or a reflected laser beam for any length of time, FDA (1998). At some recent music festivals, entertainers have been subjected to laser lights shining into their eyes during performances. Pilots have even been temporarily blinded by lasers during take off or landing, as noted by Kurtzwell (1996). These cases demonstrate a clear misuse of the laser light students may emulate in class, during assemblies, or in sporting events. The technology of lasers is important in science classes, and teachers should be aware of the wide variety of laser applications in modern society. Williams (1991) gives a readable summary of non-medical uses of lasers in everyday life.

### Colors as a Warning

It is not just the coral snake with its "red on yellow" that signals danger with colors. It is not just bad tasting insects and frogs that are colored to indicate caution to predators. Animals, including people, send social messages with color patterns, like the colored feathers on birds as a mating signal. We use color to alert others to danger or just to catch your attention. Colors are used to highlight special conditions or areas in working environments. Fire extinguishers are colored red, as are exit signs, emergency switches, fire blankets and other safety devices. The red color, with its long wavelength, catches your eye to help focus on emergency equipment. Orange is often used to indicate machinery that requires caution operating or approaching. Yellow is used to mark physical hazards such as guardrails around uneven steps and low overhanging ceilings or beams. Green is often used to indicate safe areas or first-aid supplies. Electrical panels and controls are often coded with blue color. Sinks, drinking fountains, or areas requiring special cleanliness are often painted white. Striping in black and yellow or black and white is often used to indicate traffic flow, crosswalks, stairwells, and so forth. A teacher should take the time to acquaint students with the colors used for a variety of messages. Shapes of signs combined with colors are important for controlling traffic flow. Interesting lessons can be taught using the interesting colors and shapes of signs.







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## Lighting and Fatigue

Lighting intensity, color, and placement is a key factor in producing and reducing fatigue, or tiredness. We are particularly concerned about the widespread use of computers as technology becomes a driving force in schools. Often the focus is on getting access to computers without thinking through related health issues. Schools have obtained computers and not given much thought to the lighting in computer labs or the color schemes that help students and teachers adjust to the light and print of the computer terminals. Students' vision should not be subjected to long periods of high contrast in lighting. Bright windows in a computer lab create harsh contrasts that fatigue students' eyes. Walls in computer rooms, according to some experts in industrial lighting (Mahnke, 1987), should reflect fifty to sixty percent of the room light. Using the "egg-crate" light coverings on lights can reduce glare from computer screens. That kind of light cover directs light straight down on the working surface. Caution is advised about installing antiglare filters on the computer screen because the image might be blurred as a result and student or staff will lean into the screen adopting an unhealthy posture while working. Long-term posture changes can produce significant fatigue or muscle discomfort. Perhaps educators should talk more about correct posture to students, to encourage awareness, safety, and better health.

### Full Spectrum Lighting

It was over twenty years ago while working with a special education teacher on the effects of lighting on emotionally challenged children that we recognized the effect of narrow spectrum fluorescent lights on the behavior of the special education students. We learned by trial and error that students were calmer when fluorescent lights were turned off. We observed that sunlight through the classroom windows produced the least negative behavioral effects. Over the years we have met other teachers who have said, "kids climb the wall when the fluorescent lights are on." Mayron (1974) demonstrated that first and second graders who were in classrooms lighted by full spectrum lights showed decreased hyperactivity. There are other subtle effects of lighting that have received considerable publicity. Seasonal Affective Disorder (SAD) describes symptoms of depression and fatigue brought on by the lack of sufficient exposure to sunlight, Hawkins (1992), Bickford (1980). Studies indicate that SAD can be treated with full spectrum fluorescent lighting in the workplace or school, Rosenthal (1988). Full Spectrum Light provides visible and ultraviolet light that simulates bright mid-daytime sunlight. Fluorescent bulbs that provide Full Spectrum light are rated about 5600K with a Color Rendition Index (CRI) close to 100. That means that the lighting will provide 100% of bright daylight color rendition. ordinary cool-white lights have a CRI of about 62 and are generally rated between 3600K to 4200K. The Kelvin (K) temperature scale is used for most scientific purposes to indicate the temperature and brightness of an object. The

hotter an object the brighter it glows. The color of light emitted changes from red to orange to yellow and then to white as the object is heated. Full Spectrum lights are a little more expensive (\$6.00-\$10.00 per bulb) than the ordinary fluorescent (\$1.00-\$2.00). Nevertheless, the benefit to children and teachers in improved visual acuity and reduced fatigue is well worth the price, especially in science labs where safety depends on good eyesight and mental awareness.

### Color Has an Effect Too.

Color influences human behavior and mood, although educators and school architects have not adequately addressed this special aspect of lighting in the learning environment. Business and industry that are concerned about efficiency and client or worker satisfaction do pay attention to colors and color schemes in the workplace. Meer (1985) warns that there is no single "magic bullet" or use of color, like green or pink, that will ease stress or reduce aggression. However, there are indications that a combination of full spectrum lighting and varying times of exposure to specific colors may increase attention span, and diminish aggressive or risk-taking behavior. In the future this may influence color and lighting selection in schools to improve the overall health, safety, and sense of well-being among students and staff.

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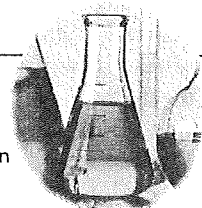
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## FIELD TRIP SAFETY

Field trips and outside activities are an essential part of the science curriculum. One of the most effective ways to study some natural phenomena is to observe them in their own peculiar settings. A field trip can be a valuable teaching/learning experience for both teachers and students. In order to make it so, careful planning is required. More accidents happen while studying in the field than in the laboratory. Careful preparation for field work and special assignments to individual students for attention to safety measures help reduce accidents in the field. The next section focuses on an actual case in which a biology teacher believed she planned for all possible scenarios. The last section focuses on general guidelines that should be considered when preparing for a field trip.

### Field-trip Fun Turned Tragic

Field trips are almost always memorable occasions for students. This is especially true for overnight trips. Each year, Ms. Jones arranged to take her advanced biology class on a week-long trip during spring break as part of their study of ecology. This particular year, the trip was a week-long hike through the Smoky Mountains. The Park Rangers were notified well in advance and appropriate forms were completed. Ms. Jones took time the summer before to meet with the Rangers, to visit the park, and to walk the trails she planned to have her students hike. Adult volunteers were selected to join the class to assist Ms. Jones with chaperoning the students. All the students submitted the necessary permission forms and medical release forms. They were also all given a checklist of materials to bring on the trip and this was double checked at school before they left on the day of departure. Appropriate first aid equipment was obtained. The checklist seemed complete.

The group arrived at their destination on a cool Sunday afternoon in mid-March to begin seven days of hiking. They planned to stay in the park hiking until the following Saturday afternoon. When they started their trip, the weather forecast was not particularly atypical, a bit cooler than normal but no major storms predicted. The students all had gear appropriate for temperatures below the predicted temperatures. By Tuesday afternoon, however, a major snow storm was being predicted for East Tennessee including the area the hikers were hiking; a storm very atypical for March in East Tennessee. The group did not have a functioning radio or other communication device so did not get the information. The blizzard that arrived that Friday dumped in excess of 6 feet



of snow in higher elevations and 2 feet in the valley in less than 24 hours. This was truly a storm of the century for that region. The teacher could not have foreseen such a storm occurring and neither she nor any of the students or other adults were prepared for it. The Park Rangers and many volunteers assisted in bringing the group out of the mountains to warmth and safety. Fortunately, none of the students or sponsors died. Unfortunately, all suffered hypothermia and/or frost bite to some degree. Field Trip Guidelines

No safety checklist can take the place of the foresight and carefully laid plans of a reasonable and prudent teacher in planning field trips. While it is impossible to anticipate every conceivable hazard that might present itself on a given field trip, such as a blizzard the strength of which occurs approximately every 100 years, some general guidelines can cover the most important precautions to consider. These guidelines will suggest the more important areas to consider in providing for the maximum safety of the students involved.

### Preparing for the Field Trip

- Obtain consent, according to school policies, prior to any field trip. This may include parental/guardian and administrative consent. When parents/guardians give consent, the following should be obtained: (a) parent/guardian signature form which includes a description of the nature of the trip, student responsibilities during the trip, phone number at the field trip site, the dates and times of the trip, and parent and student signature lines, (b) names and telephone numbers where parents/guardians can be reached in case of emergency, and (c) medical release form which includes important medical information for the child such as drug allergies and special medical conditions such as diabetes, etc.
- Visit the site in advance of the trip in order to determine potential safety hazards. During the visit, make special note of dangers such as poisonous plants or animals, water hazards, and cliffs or caves. Also make note of locations of such places as restrooms, first aid facilities, phones, etc. Know how to contact the authorities quickly if an emergency arises. If the site is an active research site, make note of areas where students are prohibited.
- Plan adequate supervision for the class size. A good rule of thumb for elementary students is one adult per five students. Older students can be supervised by fewer adults. Generally eight to ten students per adult is recommended for older students but this ratio may be reduced depending on the nature of the field trip.
- If at all possible, use school transportation. School vehicles are designed for safety of students and school bus drivers are accustomed to behavior patterns of students.

## Preparing Equipment and Supplies

- A first aid kit is essential. For any field trip a standard first aid kit is minimal. Additional items may be needed if the field trip is to be outdoors especially in wilderness areas. This should be prepared in advance to ensure all necessary items are present.
- For wilderness field trips, be sure to have a functioning radio. Also, consider including a cellular telephone or other means of communication to the list of necessary equipment. If someone becomes ill, hurt, or lost, time is of the essence.
- During field trips in which students may wade into streams, lakes, or other bodies of water, appropriate garments such as boots and waders should be provided. And remember, waders that become filled with water can be like anchors to those who wear them! Life jackets must also be available for each student. Life jackets are also required if students are to be in a boat of any type.
- Use wood, plastic, paper, or cloth containers for containing specimens whenever possible. This limits injury and loss of specimen due to broken glass. Such containers may also reduce the weight to be carried.
- Consider the weight of the materials that must be carried. Whenever feasible use lightweight materials. Remember, you will be taking out everything you carried in and possibly more.
- If your field trip is in a park or wilderness area, be sure to have paper or plastic bags for trash.

## Preparing the Class for the Trip

- Clearly define the rules of conduct and students' responsibilities prior to the trip.
- Fully instruct students about the potential dangers of an area especially when the field trip is to be conducted near deep water or rapid currents, cliffs, caves, hazardous waste sites, certain chemical plants and nuclear facilities, or active research sites.
- Provide students with a list of items they are responsible for bringing on the field trip. This list should include a description of appropriate attire for the terrain and weather. Proper footwear is especially critical!
- Provide students with a clear description of what they are responsible for doing during the field trip. For younger students, including high school freshmen and sophomores, a timetable which suggests how much time they have to complete each task may be helpful in keeping them engaged.

## Field Trip Day

- Be Prepared!!!!
- Develop a "buddy" system. Paired students, each responsible for the other, can help in keeping track of the class.
- Remind students not to touch any plant or animal that is poisonous or that they have not identified. Also remind students not to touch any containers that appear to have

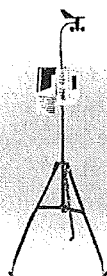
been illegally dumped but to inform the teacher or other adults of the location of such items.

- For wilderness trips, be sure to communicate with a park ranger or other authority who is kept abreast of changes in weather conditions or other important news.
- Be sure each student has a means for carrying his/her own trash. Remind students of the motto: "Take a Hike, Leave Only Footprints."
- At the end of any outdoor or wilderness field trip, check students for mite and tick infestations as well as cuts, scratches, poison ivy outbreaks, etc.

The most important part of any field trip is the preparation that goes into it.

Like good classroom management, preparation can prevent most problems and significantly reduce the likelihood of accidents. Though teachers must stay diligent on the day of the trip to identify unanticipated problems, good preparation will make the day much more enjoyable and allow the teacher to focus more on students' learning than on problems that could have been avoided. An ounce of prevention is worth more than a pound of cure.

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## THE METHANOL CANNON INCIDENT

Fire and explosive demonstrations can serve a good purpose for a chemistry or physics class, but only if the demonstration is performed by a person who is familiar with the hazards and takes the obvious precautions to protect the students from possible accidents involving the use and misuse of such demos. One unfortunate incident occurred this past year in a California school where a physics teacher was teaching about trajectory using a methanol cannon. As some students were operating the device, it virtually exploded, causing severe burns to some of the students.

The construction, use, and precautions for different "methanol cannons" are described in a number of books on demonstrations (Carpenter & Minnix, 1993; Sae, 1991; and Lee & Ealy, 1985). The injuries to the students are tragic examples of what should be considered a MISUSE of the methanol cannon, an educational and entertaining classroom chemistry demonstration that has been used many times by many people. There are several problems inherent in the way the methanol cannon was used in the California incident:

1. High school students should NOT be permitted to operate or hold explosive devices in laboratory class experiments. When used by a demonstrator, the cannon should be held at a distance from students and pointed away or over the heads of the students. Demonstrators should also consider the use of a small Nerf ball instead of a tennis ball. Further, it has been recommended that the cannon be fired horizontally from a table in a hallway, so that the distance to the point where the ball strikes the floor can be used to calculate the muzzle velocity.
2. The methanol cannon is ill-suited for repetitively (or reproductively) "conducting velocity measurements on tennis balls launched from methanol powered cannons."
3. Only a few drops of methanol are needed for the cannon demo; having a gallon container of methanol available for two (or 200!) cannons is totally unwarranted.
4. There is the clear danger from the temptation to increase the tennis ball velocity (physics students would not be very tempted in trying to decrease the velocity) by inappropriately increasing the amount of methanol.
5. One instructor is not adequate for 35 students involved in the pouring and igniting of a flammable liquid.
6. Even in a normal demo, not all of the methanol is usually burned (Summerlin and Ealy noted this; I can confirm it from my experience); repetitive use of the cannon without cleaning out the residue may result in leaking of burning methanol from the ignitor hole (I can also confirm this from experience.) Some texts suggest using lighter fluid rather than methanol. They specify putting 10 drops into the hole

in the firing chamber and rotating the cannon (to volatilize the lighter fluid). Other references suggest using a similar amount of methanol or a methanol-based windshield de-icer. In his book Andy Sae also notes - "After a shot is fired or after a shot is misfired, wave the cannon back and forth to flush the gases out and to let air back into the pipe before you try again."

A colleague has noted that in his science methods courses he teaches his students to question every activity they do in which there is a safety concern. They are, in order:

1. Is there some other way to demonstrate the same concept in a safer way?
  2. If not, is this concept so important that it needs to be taught?
- One must question the real underlying reason for doing either a demonstration or of having students conduct an activity. The methanol cannon incident is a clear case in point. If the objective of the methanol cannon lesson was to make velocity measurements on moving objects or to get an indirect measure of the force generated by the explosion, then the activity is rightfully considered. However, if the reason was to investigate trajectories and the path of flight of projectiles, then the use of methanol cannons was wholly inappropriate. Catapults or other launchers (far safer) should have been employed. There are other activities which bear scrutiny as well. Common examples of such activities are the combustion of hydrogen and the effect on flames of oxygen. My colleague has reported seeing chemistry teachers blow hydrogen soap bubbles and ignite them with a match taped to a metre stick. The question which we must ask ourselves is, "What do we demonstrate because the principle is important and what do we do because we or our students find it entertaining?"

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Douglas Mandt  
Chairman, WSTA Safety and Chemical Hygiene Committee  
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## **SAFETY NOTES: CLASS SIZE AND THE SCIENCE LABORATORY**

One of the most frequent concerns expressed by lab teachers, as I visit their labs or talk with them at conferences or workshops, is the overcrowding in their labs. In the absence of National, or State, regulations on the size of lab classes, professional societies, such as the National Science Teachers and the American Chemical Society, and recognized safety experts, such as Lab Safety Workshop, Flinn Scientific Co., and Dr. Jack Gerlovich, have generally recommended that 24 regular students in a lab class be the maximum to be supervised by one teacher.

Overcrowding can create a significant safety problem. Most school labs, or lab classrooms, are designed with workstations for 24 students. Rarely do they have additional room to allow larger numbers of students to work safely or effectively. The opportunities for spills, falls or other accidents is increased due to lack of space, jostling and too many students attempting to use the same equipment, or space, at the same time.

Another consideration is supervision during a lab activity. In a room designed for 24 students, larger numbers may not allow the teacher to effectively supervise their activities. However, this problem may be ameliorated by the addition of one, or more, classroom aides.

Safety is a paramount concern in the laboratory. However, reducing class size to a more manageable number has another effect which should be of great interest to parents, administrators and teachers. Student achievement is positively related to a lower student/teacher ratio. In a recent issue of the Navigator, the newsletter of the National Science Education Leadership Association (NSELA), the research results of Harold Wenglinsky were briefly reviewed. Conclusions were:

Significant effects of class size reduction on student achievement appears when the class size is reduced to a point between 15 and 20 students. If the class size is reduced from substantially more than 20 students per class to below 20 students, the related increase in students achievement moves the average student from the 50th percentile up to above the 60th percentile. For disadvantaged and minority students the effects are even larger. Students, teacher and parents report positive effects from the impact of class size reductions on the quality of classroom activity. Schools are continually being slammed in the press for reporting poor results on standardized tests. Reduction of class size may be a way for school boards and administrators to assist teachers and students to raise achievement test scores, and also make the learning environment a safer one for students.

**Editor's note:** NSTA has recommended that a minimum of 5.6 square meters per student be provided for laboratory space, with additional space for students with disabilities. Each student should be provided with at least 1.8 meters of longitudinal work space. To see how your laboratory space stacks up, measure its floor area in square meters and divide by 5.6. The number you derive will tell you the number of students the space can safely accommodate.

## **Two Great Ideas to Improve the Safety in Your Science Classroom and Laboratory**

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Douglas Mandt

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## SAFETY NOTES: THE BELOUSOV ZHABOFINSKY OSCILLATING REACTION

In a recent issue of the *Chemical and Engineering News*, several members of the faculty at the University of Tennessee, Knoxville, reported a potential problem with the reagents used in the popular demonstration of the Belousov Zhabotinsky oscillating reaction. In *Chemical Demonstrations: A Handbook for Teachers of Chemistry*, vol 2,2 the reagents used are cerium ammonium nitrate, potassium bromate and malonic acid. When mixed dry, the three reagents are stable. They react as expected when mixed in dilute solutions. This reaction has been carried out numerous times as a demonstration and as a lab assignment for many years. It has not caused any unexpected reactions or represented any unusual hazard. However, when 0.5 grams of each are mixed and a small amount of water (between one drop — about 0.002 ml — and 3 ml) is added, a very exothermic reaction occurs with considerable fuming. When mixed in this fashion on filter paper, ignition occurs. The warning is that during clean up, spilled crystals are mixed as they are swept up. These need to be added to your aqueous heavy metal waste container, or bagged in waterproof bags (plastic ziplock bags) to avoid a potentially dangerous situation. With a little bit of care the Belousov Zhabotinsky oscillating reaction continues to be a safe and very interesting reaction.

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## SAFETY IN SCIENCE EDUCATION: THE LABORATORY SAFETY WORKSHOP

The Laboratory Safety Workshop is a national nonprofit educational organization dedicated to making health and safety an integral and important part of science education. Free copies of our Laboratory Safety Guidelines, Publications List, AVLending Library List, seminar schedule, and membership information are available on request. The LABSAFETYL discussion list is a public service of LSW. Visit our growing web site at [www.LABSAFETY.ORG](http://www.LABSAFETY.ORG)

The Laboratory Safety Workshop has a collection of over 4,000 cases of mostly laboratory accidents in academic institutions. They have edited and compiled 500 examples, arranged alphabetically by topic and cross indexed for reference in a collection entitled "Learning by Accident."

The Laboratory Safety Workshop also provides free copies of their Laboratory Safety Guidelines, publications list, audio- visual lending library list, and schedules for laboratory workshop seminars and membership information.

### Some Resources on School Safety

What follows is a listing of some valuable school safety resources, but it is not by any means an exhaustive list. Some of the resources are handbooks, others are web sites, and still others are journal articles. All contain information worthy of science teachers' reading and use.

American Chemical Society. *Safety in the Academic Chemistry Laboratories*, P.O. Box 57136, Washington, D.C. 20037-0136 [(800)-ACS-9919].

Gerlovich, J.A. (1997). Safety standards: An examination of what teachers know and should know about science safety. *The Science Teacher*, 64(3), 47-49.

National Science Teachers Association. *Safety in the elementary science classroom*, 1840 Wilson Blvd., Arlington, VA 22201-3000 [(800)-722-NSTA].

National Science Teachers Association. *NSTA minimum safety guidelines for presenters and workshop leaders*, 1840 Wilson Blvd., Arlington, VA 22201-3000 [(800)-722-NSTA].

Young, J.A. (1997). Chemical safety: Part I: Safety in the handling of hazardous chemicals. *The Science Teacher*, 64 (3), 43-45.

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## NEW PILOT PROGRAM FOR MIDDLE-LEVEL AND HIGH SCHOOL SCIENCE EDUCATORS

### FDA/NSTA Professional Development in Food Science

Disease outbreaks caused by foodborne organisms frequent the news. How do these organisms cause disease? What measures are being taken by the federal government to prevent transmission of these organisms? What can an individual do to protect themselves from such disease? The science and technology of food production, transportation, storage and preparation has changed to meet the need for safe food products. New research methodologies have enabled scientists to broaden their understanding of food science. Emerging technologies are supportive of individual interest in safeguarding health. Taking advantage of the new understandings, science educators have an opportunity to provide topically relevant lessons in food science for their students. To prepare teachers to do this requires a sustained effort. The

Arnold Guttman  
SAW Coordinator for the U.S. and Canada  
Waukegan H.S.  
Waukegan, IL  
chemteacher@mailcity.com

### SCIENCE ACROSS THE WORLD

The United Kingdom-based organization Science Across the World would like to bring chemistry teachers and students from around the world together through science. Interested high school science teachers are invited to participate in a global project based on the theme Chemistry in our Lives. Student activities will center on gathering information about useful chemicals and sharing the results with another school. The project would entail approximately 3 to 5 hours of classroom and homework time.

The project has a WEB site at [www.bp.com](http://www.bp.com) where you can register to participate and get more information. Any questions may be directed to [sae@b.p.com](mailto:sae@b.p.com). If I can be of further assistance, members are free to contact me.

Food and Drug Administration (FDA) and the National Science Teachers Association (NSTA) have joined as partners to initiate and implement a professional development program in Food Science consistent with the National Science Education Standards. Selected middle-level and high school science educators will have an opportunity to be involved in a multi-dimensional professional development program. Specific activities are scheduled starting with a summer 2000 workshop and followed by a participant led workshop for colleagues during the following academic year. The FDA/NSTA Food Science Professional Development Program is supported by the Food and Drug Administration and implemented by the National Science Teachers Association.

### Specifics of the FDA/NSTA Food Science Professional Development Program

**I. Workshop - Separate one week workshops for middle-level (July 16-23) and high school (July 30-August 6) science educators, to be held in Washington, DC. Travel, lodging and meal expenses will be provided.**

- Content updates by food science specialists
- Visits to government/industry facilities
- Presentations by government and industry leaders
- Hands-on practice with new curriculum materials
- Exchange of teaching/learning strategies

**II. Curriculum Implementation - Participants will implement the FDA/NSTA food science supplementary curriculum during the subsequent school year.**

**III. Follow up Enhancement Conference - To be held in conjunction with an NSTA Area Convention during fall 2000. Travel, lodging and meal expenses will be provided. Activities will include:**

- Curriculum and content updates
- Idea exchange between participants
- Planning for participant presented workshops

**IV. Participant Presented Workshops - Each participant will be expected to present a follow-up workshop in their respective school or district during the 2000-2001 academic year. An honorarium and workshop materials expenses will be provided.**

**V. On-line support - Facilitated by NSTA**

### Participant Eligibility

Applicants must be certified middle level or high school science educators. An independent panel of judges convened by the NSTA will select 25 middle level and 25 high school science educators on the basis of submitted applications. Applicants will be notified by April 25, 2000.

A complete application may be downloaded:

<http://www.nsta.org/programs/fda.htm> or requested by Fax 703-522-5413.



Geoff Haines-Stiles  
Project Director, PASSPORT TO KNOWLEDGE  
Eileen Bendixsen  
Moderator, Discuss-storm

## LIVE FROM THE STORM

Ninth in the award-winning series whose mission is to link students and teachers with America's leading researchers via video and the Internet, and to enliven any curriculum by connecting real world research to essential science concepts Participation is open to all, no matter what level of technology you have in class or at home. Materials available online and via free television broadcasts, or in print and on videotape Sign up now via the Web, share ideas with fellow teachers, and get ready for some of the most exciting educational opportunities ever in Spring 2000

One of the first things every one of us asks each morning is "What's the weather going to be today?" And every student learns about weather and climate at least once between upper elementary and high school. Now PASSPORT TO KNOWLEDGE offers what's been proven to be the most powerful combination of instructional materials and experiences to excite and inform students about the forces which make clouds, winds, snow and seasons. LIVE FROM THE STORM relates weather and climate to key scientific principles and helps teachers meet national, state and district standards and benchmarks using hurricanes, tornadoes, thunder, lightning, winter storms and such powerful climatic phenomena as El Niño and La Niña. Students will gain understanding and meet, on camera and online, the enthusiastic men and women who work for America's leading weather and climate research agencies, NOAA and NASA, discover why they love their work, and how they prepared for their rewarding careers.

LIVE FROM THE STORM is an integrated suite of current, multiple media resources, developed collaboratively by working educators and weather researchers, and designed to be easy to implement successfully in a wide variety of teaching environments

• **VIDEO** — Dynamic and informative TV showing the People, Places and Processes involved in research on weather and climate: 2 one hour programs airing over public television stations (check local schedules), NASA-TV, and also available on tape. The magazine-style videos invite re-use in class in 8-10 minute segments.

Program 1 — THE "WHO, WHAT, WHERE, WHEN AND WHY" OF WEATHER — Tuesday March 7, 2000

Program 2 — RESEARCH TO THE RESCUE! — Tuesday April 11, 2000

Spencer Pasero  
Education Program Leader  
Fermilab Education Office  
spasero@fnal.gov (630)840-3076 \*

## THE NATURE OF SCIENCE

Fermilab's Wilson Hall

Saturday March 18, 2000

8:15 AM - 4:00 PM

<http://www-ed.fnal.gov/symposium/>

Check our website for updates on agenda and speakers. K-12 teachers of science, join world-renowned scientists for a day of exploration and reflection about the nature of science. What constitutes a scientific theory? What constitutes a scientific fact? Why is science not just another belief system? Find out what scientists say about the current state of research on evolution and the origins of the universe and learn why their work is science. Meet with master teachers to discuss classroom implementation of the processes and accepted practices of scientific inquiry. Come early and check out Weird Science and their offbeat take on the nature of science. The registration fee is \$10 for Illinois teachers and \$20 for teachers from other states. Fee includes a box lunch and special CD-ROM of scientists talking to you and your students about the nature of science.

For information and registration contact Nancy Lanning at 630-840-5588 or [lanning@fnal.gov](mailto:lanning@fnal.gov)

• **HANDS-ON**~More than 20 new Activities illuminating and making real the research seen on camera, and a comprehensive MultiMedia Kit An original 64 page Teacher's Guide, with copy masters of worksheets, will be available online (without cost), or in a convenient printed format, accompanied by an oversize color poster (fee.) A Multimedia Teacher's Kit with an hour-long Teacher Resource Video also be available (fee.)

• **ONLINE**~via the WWW and Mail Lists Participating teachers and students will enjoy E-MAIL INTERACTIONS with weather and climate researchers, receive online UPDATES, and connect via MODERATED MAIL LIST with fellow learners. A comprehensive website will be available this month with animations and data, and links to existing meteorological resources.

PASSPORT TO KNOWLEDGE was the 1997 EdNET "Hero" award-winner for its innovative use of telecommunications in education, and was twice a finalist in the prestigious National and Global Information Infrastructure Awards.

[http://passporttoknowledge.com/ptk\\_storm.html](http://passporttoknowledge.com/ptk_storm.html)

For more information call 973.656.9403, or send e-mail to:  
[ptkinfo@passporttoknowledge.com](mailto:ptkinfo@passporttoknowledge.com)

## A FOURTH WEEK WITH WEIRD SCIENCE & WADE

July 25-29, 2000

This Institute, for high school/junior high teachers, combines demos, labs, computers, make-and-takes and lectures in chemistry. This course is Chemistry 572, Teaching Methods in Chemistry, with 3 semester-hours of graduate credit in chemistry. It will have different content/material from last year and may be repeated for additional credit- this years topics- REDOX, Radioactivity, Thermo, and Mole Day Stuff! For details, contact Wade Freeman Univ. of IL. at Chicago, Chem Dept, 845 W. Taylor St. Chicago, IL. 60607 phone; (312) 996-3161; e-mail: Wfreeman@uic.edu

WEIRD SCIENCE is a series of short, easy and sometimes "weird" demonstrations, labs and ideas on chemical and physical phenomena, designed for teachers of the chemistry/physical science, primarily at middle school and high school levels. The program presents novel demonstrations, labs, make & takes, and sharing guaranteed to hook kids and adults into thinking about science concepts. WEIRD SCIENCE entertains while it educates—it is "infotainment." To keep us at equilibrium we have Dr. Wade Freeman author of the much acclaimed college text *Chemistry: Science of Change*.

## COSMOLOGY

### Thinking in Four Dimensions to Understand Einstein Relativity

Presented by Dr. Thomas W. Sills

Professor, Wilbur Wright College Center for Distance Learning, Channel 20 Chicago Television

Author, *Science Fun in Chicagoland* and *Science Fun with Toys*

Learn how thinking in four-dimensional space simplifies the complex, and sometimes mystifying, Einstein Relativity Theory. How can the moving twin in Einstein's Twin Paradox age at a slower rate if the moving twin observes a normal aging process? Why can't the moving twin see the Earth as the moving object and on the return trip meet a younger Earth twin? You will learn what happens to the twins and be able to conceptualize the answers in this class. Topics include the history of three-dimensional space, the history of four-dimensional space, and the space-time continuum created by Hermann Minkowski that Albert Einstein used to explain his Theory of Special Relativity. (Two sessions)

**Saturdays March 4, March 11 1:30-3:00 p.m.**

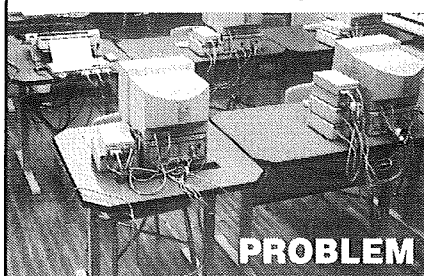
Adler Planetarium and Astronomy Museum

For enrollment information contact:

Registrar, Adult and Family Programs, Adler Planetarium and Astronomy Museum, Phone: 312-322-0551

## CLASS COMPUTER LAB FURNITURE with Exclusive "CABLE-GUARD" System

**Does your computer lab  
look like this?**

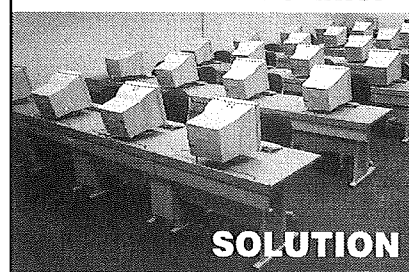


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CLASS desks are built for rugged classroom wear, yet look great. 1" x 2" tubular steel legs support a 1-1/8" thick top that has a solid oak front edge and is covered with a durable light oak Hi-pressure laminate. Desks lock together with steel brackets for a continuous work surface.

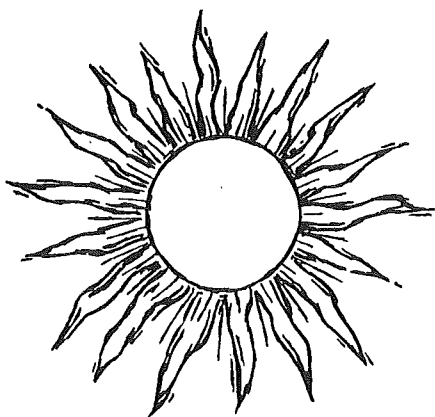
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## 2001 SCIENCE HISTORY TOUR TO IRELAND ADVANCE NOTICE!!!

For three summers in a row Yvonne Twomey and Lee Marek have led history of science tours to England, Ireland and Scotland. Last year we ran the successful tour "SCIENCE AND THE INDUSTRIAL REVOLUTION." Your next opportunity to participate in one of our popular Science History Tours will be in the summer of 2001. We will spend two weeks traveling throughout Ireland on a study trip with the theme "Ireland's Scientific Heritage". Dates will be late June/early July and will be scheduled to fit in with the end of the school year. Among the many places to be visited we will include the basalt Giants Causeway, the limestone pavement of the Burren, the magnificent Lismore Castle, birthplace of Robert Boyle, Trinity College, claiming to have the oldest Chemistry Department in the world, the Dublin Botanic Gardens, homes of the eccentric chemist Richard Kirwan, (a contemporary of Lavoisier). In addition to the science history, every opportunity will be taken to interact with local teachers, historians and other interesting people. Tour members will also be able to participate in cultural and other events. Non-scientist traveling companions are welcome. A graduate course (3 semester hours credit) will be available at a very moderate extra cost. This course will be taught by Lee Marek. Additional lectures on subjects relevant to the theme will be given by experts at various points throughout the tour. Science History Tours is a non-profit organization and both our 1997 & 1998 tours were sponsored by NSTA. See the following web page for info on our first trip. <<http://www.leyhs.w-cook.k12.il.us/Depart/science/zygas/Scitour.htm>> There will be no Science History Tour in the year 2000 as, following three summers organizing these trips Yvonne Twomey will be spending the summer of 2000 in the Southern Hemisphere where she may be researching a future science trip!

To be put on the mailing list for the 2001 tour, contact: Yvonne Twomey, 841 Kinston Court, Naperville, IL 60540 Tel:630-961-9811 e-mail: [ytwomey@mcs.com](mailto:ytwomey@mcs.com) or Lee Marek, Tel: 630-420-7516 e-mail: [LMarek@aol.com](mailto:LMarek@aol.com)



## ENVISION

ENVISION A Regional Environmental Science Institute for Midwestern Teachers, funded by the National Science Foundation, is recruiting for the 2000 institute. ENVISION utilizes modules to prepare middle level leadership teams that are experienced in team-based research and are knowledgeable about:

- environmental science concepts and issues,
- inquiry skills for investigating environmental issues,
- appropriate curricular, pedagogical, and assessment practices for teaching science using studies of local environmental issues, and
- strategies to develop educational partnerships with local government, industry, and business.

**Participant Responsibilities:** Leadership teams consist of four teachers, in grades 4-9, with two teachers participating at each level:

- Level I participants will attend all project activities and will lead a local staff-development program in their school district. They will work with Level II participants in the local adoption of ENVISION concepts and approaches.
- Level II participants, trained by their Level I teammates, will attend project activities conducted at the regional and local school site, will actively implement ENVISION concepts and approaches, and will assist Level I teachers with staff-development.

### Module Descriptions

ENVISION is a multidisciplinary approach to the development of scientific concepts and inquiry skills focusing on:

- Water and Watersheds: emphasis is on environmental science concepts and issues surrounding water, streams, and wetlands.
- Urban and Built Environments: environmental concepts and issues related to buildings, cities, and suburbs are investigated.
- Rural Environments: the effects of human activities and agricultural practices on rural environments are explored.

### How to Get Involved

There are several ways to contact us:

- Our website:

<http://uval.eas.purdue.edu/geoed.html>

- E-mail: [envision@purdue.edu](mailto:envision@purdue.edu)

or send your name and address to:

ENVISION

1442 LAEB Dept. of Curriculum & Instruction

Purdue University

West Lafayette, IN 47907-1442

765-494-0803

**Application Deadline is February 15, 2000 for this year's (2000-2001) activities.**

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### INTRODUCING ELD!N

**eld!n** is a product and process that enables teachers and students to learn by doing. Based on the *New Explorers* science-adventure series, hosted and produced by Bill Kurtis, it is Standards-driven and targeted to enhance the acquisition of problem solving skills through the application of fundamental scientific principles utilizing state of the art technology for students in grades 5-8.

**eld!n** integrates technology that includes the Internet, CD-ROM, and video components with rich science content to help teachers meet learning Standards. **eld!n** engages parents and community leaders to engender true involvement and support of these education initiatives as well as embrace the teachers and students in our nation's classrooms.

**eld!n** students are problem solvers. The scientific problems they tackle are challenging, authentic, and relevant to them. **eld!n** students learn science but they also act as researchers rather than simply listening to lessons as spectators. They are able to discover concepts through their own research and interactions with the world. **eld!n** students analyze, investigate, and evaluate the information they discover resulting in student mastery of knowledge and high order thinking skills, specifically emphasizing problem solving skills. The result is enhanced student performance reflecting fundamental science principles.

Each unit is a complete package including: *The New Explorers* video, teacher and student edition CD-ROMs, hands-on classroom experiments and materials, *\*Some units require specific reusable lab materials, lab kits are purchased with the units*, Website access and links, professional development for teachers, Student Journals, Teacher Guide, and technical and program support.

If you would like to learn more about **eld!n**, please visit the Website at [www.eldln.com](http://www.eldln.com)

**NSTA** National  
Science  
Teachers  
Association

### NATIONAL CONVENTIONS

Orlando—April 6-9, 2000

St. Louis—March 22-25, 2001

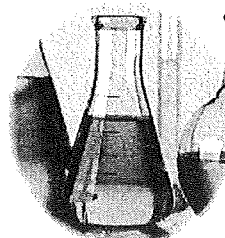
### MIDWESTERN AREA CONVENTIONS

DETROIT—OCTOBER 19-21, 1999

MILWAUKEE—OCTOBER 19-20, 2000

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# AWARDS AND RECOGNITION

## CONGRATULATIONS TO GLORIA D. LATTA

1998/1999 NABT  
OBTA

The National Association of Biology Teachers, in conjunction with Prentice Hall, Leica Inc. and the Scope Shoppe is pleased to present Gloria Latta, Wheaton Warrenville South High School, with the 1998-1999 Outstanding Biology Teacher Award for Illinois. This honor, given annually since 1961, identifies a teacher from each of the United States, its possessions, Puerto Rico, the District of Columbia, and Canada who has made valuable contributions to the profession and to his/her students. Criteria for the award include teaching ability, experience, inventiveness, initiative, inherent teaching strengths, and cooperativeness in the school and community.

A special presentation was made at the national convention of the National Association of Biology Teachers in Fort Worth, Texas in October. In addition, she was recognized by her peers at the awards luncheon at the 1999 Illinois Science Teachers Association annual conference in Springfield.

Congratulations, Gloria!

## Congratulations!

Announced in late November, the following Illinois teachers achieved National Board Certification in science.

### Adolescent Young-Adult/Science

Donald Dosch	Aurora
Philip Sumida	Aurora
Walter Glogowski	Northfield
Jolyon Morton	Peoria

### In Early Adolescent/Science:

Nancy Nega	Darien
Ann Marie Min	Woodstock

*Way to go!*



## CONGRATULATIONS TO ISTA MEMBER BETTY TRUMMEL!

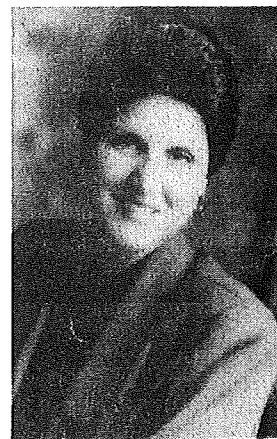
On October 2, 1999, Betty received the Northern Illinois University Outstanding Alumni Award. The award was presented by Dean Alfonso Thurman from the College of Education. She was nominated by Dr. Tom Thompson, professor at NIU. Betty received her M.S.Ed. in Outdoor Teacher Education from NIU. She is a fourth grade teacher at Husman Elementary School, Crystal Lake. Betty has received many honors including being a Presidential Award for Excellence in Science Teaching finalist and one of two Illinois teachers who were chosen last year to travel and work in Antarctica through participation in Teachers Experience the Arctic and Antarctic (TEA) funded by the National Science Foundation.

**Trudi Volk**, education professor at Southern Illinois University Carbondale, has won a coveted award from an international environmental education group. Volk won the 1999 Walter E. Jeske Award, the highest honor conveyed by the North American Association for Environmental Education. The award, a memorial to a longtime employee of the U.S. Soil Conservation Service, came at the group's 28th annual conference, held August 26-30, in Cincinnati.

Established in 1971, the association promotes environmental education and supports the work of those who teacher others about the globe's complex natural environments.

Volk, a faculty in SIUC's Department of Curriculum and Instruction, is known in education circles as one of the authors of a text that teaches youngsters to take informed, responsible actions to remedy environmental problems in their communities. The text has been used in Florida, Hawaii Maryland, Alaska, Washington, Wisconsin Illinois Texas, and overseas.

Volk has coauthored more than 25 research articles in peer-reviewed journals or a book chapters and has given scores of presentations on the effective methods of environmental education.



## WRITE FOR *SPECTRUM*

The quality of *The Spectrum* is directly proportional to the relevance of its contents to your classroom. This invitation is a request for you to help colleagues across the state to take advantage of your experience.

In responding to this invitation, you will get a three-fold return on the opportunity. You will: 1) obtain experience in publishing; 2) receive some "feed-back" from the teachers across the state about your idea(s), and; 3) participate in the responsibility that is key to science: The communication of ideas!

With this in mind, share with us your teaching ideas for curriculum, laboratory experiences, demonstrations, assessment, portfolios and any innovations you have found to be successful with science students. Photographs for the cover are also needed. Please send:

- a typed or printed, double-spaced copy with standard margins.
- if possible, the article on disk (IBM or Mac) saved in RTF format, in addition to a hard copy, or sent electronically as an attached RTF document. Email to: ddummitt@uiuc.edu
- a title page with the author's name and affiliations, a brief biographical sketch of three or four sentences, home address, home telephone number (if there is more than one author, send all information for each), and e-mail address (if applicable).
- black and white photographs that are of good composition and high contrast.
- sketches, figures, and tables when appropriate.
- references if necessary—format is your choice.
- indicate whether or not the article has been published or submitted elsewhere.

*Spectrum* is published 3 times a year. Materials submitted must reach the editor by the following dates: June 15, October 1, February 15. Materials, including photographs, will be returned only if accompanied by a request in writing and a self-addressed stamped envelope.

## CALENDAR YEAR 2000 MEMBERSHIP CATEGORIES

Any person interested in science education is eligible for membership. All memberships include a subscription to the SPECTRUM and a subscription to the Newsletter, the ACTION. Write the number of the option for the membership category on the Membership Form on the back cover. Join now and your 2000 dues will be in force until January 2001. Membership year runs for the calendar year January 1 through December 31.

### Option 1: Full Membership Dues- \$35.00

Full Membership entitles individuals interested in Illinois science education to the following benefits: a one year subscription to the SPECTRUM, and ISTA ACTION. publications of the Illinois Science Teachers Association; notification of regional conferences and meetings; invitations to science issues activities; a reduced registration fee for the Annual ISTA Conference; voting privileges; and the opportunity to hold an ISTA Officer position.

### Option 2: Two Year Full Membership Dues- \$60.00

Two Year Full Membership entitles member to Full Membership benefits for two years.

### Option 3: Five Year Full Membership Dues- \$125.00

Five Year Full Membership entitles member to Full Membership benefits for five years.

### Option 4: Associate Membership Dues- \$15.00

Associate Student Membership applies to full-time students who are not currently employed as professional educators (Requires the signature and institutional affiliation of the student's professor). Entitles member to Full Membership benefits, with the exception of voting privileges and the opportunity to hold an ISTA Officer position. Associate Retired Membership applies to individuals who are on retirement status. Entitles member to Full Membership benefits, with the exception of voting privileges and the opportunity to hold an ISTA Officer position.

### Option 5: Institutional Membership - \$75.00

Institutional Membership entitles the member institution, for a period of one year, to two subscriptions to the SPECTRUM and ISTA ACTION; notification of regional conferences and meetings; invitations to science issues activities; and a reduced registration fee for the Annual ISTA Conference for a maximum of three members of the institution.

## COUNTIES IN EACH REGION( FOR REGION NUMBER ON MEMBERSHIP FORM)

Region I	McHenry, Lake, Kane, Cook (Except City of Chicago which is in Region 7) , DuPage, Kendall, Will, Grundy, Kankakee
Region II	Jo Daviess, Stephenson, Winnebago, Boone, Carroll, Ogle, DeKalb, Whiteside, Lee, Rock Island, Henry, Bureau, LaSalle, Putnam, Marshall, Mercer
Region III	Henderson, Warren, Knox, Stark, Peoria, Hancock, McDonough, Fulton, Tazewell, Schuyler, Mason, Adams, Brown, Cass, Menard, Pike, Scott, Morgan, Sangamon, Christian
Region IV	Woodford, Livingston, Ford, Iroquois, McLean, Logan, DeWitt, Piatt, Champaign, Vermillion, Macon, Shelby, Moultrie, Douglas, Edgar, Coles, Cumberland, Clark
Region V	Calhoun, Greene, Macoupin, Montgomery, Madison, Bond, St. Clair, Clinton, Monroe, Washington, Randolph, Perry, Jersey
Region VI	Fayette, Effingham, Jasper, Crawford, Marion, Clay, Richland, Lawrence, Wayne, Edwards, Wabash, Jefferson, Franklin, Hamilton, White, Jackson, Williamson, Saline, Gallatin, Union, Johnson, Pope, Alexander, Pulaski, Massac, Hardin
Region VII	City of Chicago only



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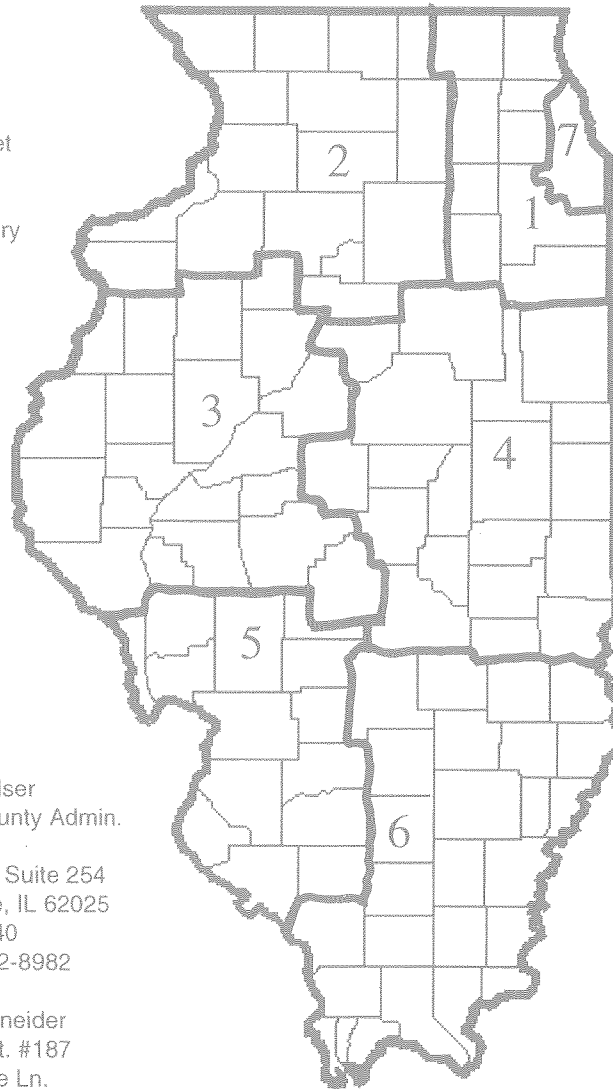
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 kwise@siu.edu

### 1999-2000 Committee Chairs

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 hhendrix@athens-213.org



## ILLINOIS SCIENCE TEACHERS ASSOCIATION MEMBERSHIP APPLICATION

PLEASE PRINT OR TYPE AND FILL OUT COMPLETE FORM

Name	Day phone
Affiliation (School or Organization)	Home phone
Address of above organization	Home address
City, State, Zip Code	City, State, Zip Code
e-mail and/or FAX	

### CHECK APPLICABLE CATEGORIES IN EACH COLUMN

- |   |  |  |
|---|--|--|
| <input type="checkbox"/> Elementary Level                 | <input type="checkbox"/> Elementary Sciences   | <input type="checkbox"/> Teacher       |
| <input type="checkbox"/> Middle Level                     | <input type="checkbox"/> Life Science/Biology  | <input type="checkbox"/> Administrator |
| <input type="checkbox"/> Senior High School               | <input type="checkbox"/> Physical Sciences     | <input type="checkbox"/> Coordinator   |
| <input type="checkbox"/> Community College                | <input type="checkbox"/> Environmental Science | <input type="checkbox"/> Librarian     |
| <input type="checkbox"/> College/University               | <input type="checkbox"/> Earth Science/Geology | <input type="checkbox"/> Student       |
| <input type="checkbox"/> Industry/Business/<br>Government | <input type="checkbox"/> Chemistry             | <input type="checkbox"/> Retired       |
| <input type="checkbox"/> Other _____                      | <input type="checkbox"/> Physics               |  |
|   | <input type="checkbox"/> General Science       |  |
|   | <input type="checkbox"/> Integrated Science    |  |
|   | <input type="checkbox"/> Other _____           |  |

Send form and check or money order made payable to Illinois Science Teachers Association to:  
Diana Dummitt, ISTA Membership, College of Education, University of Illinois, 1310 S. Sixth Street,  
Champaign, IL 61820

REGION (FROM INSIDE BACK COVER) \_\_\_\_\_

MEMBERSHIP OPTION (See page 48) \_\_\_\_\_

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