ACS

Chemistry for Life™

American Chemical Society

Chem Club

Advisor's Handbook

ACS High School *ChemClub* Application

Name of School	
Street Address	
City, State, Zip	
Phone Number	
School Website	
Faculty Sponsor	
Sponsor's Email Address	
How did you learn about us?	____ Recommendation ____ (Please let us know who recommended ChemClubs, so we can thank them.) ____ Website ____ Advertisement/Brochure ____ Email ____ Internet Search ____ Other ____

School Principal	
What category would your school be classified?	____ Public ____ Private ____ Home School ____ Parochial ____ Other ____
What area is your school located?	____ Metropolitan ____ Large City ____ Small City ____ Rural ____ Other ____
Are you at a Title I School?	____ Yes ____ No
What size is your high and/or middle school?	____ Less than 100 students ____ 100-400 students ____ 400-1000 students ____ 1000-2000 students ____ 2000+ students

The students at the above high school, under the leadership of the faculty sponsor listed above, apply for recognition as an official ACS-Sponsored High School ChemClub.

Endorsed by: ____
(Signature of Faculty Sponsor)

Please fax this application to: (202) 833-7732 or mail to:
American Chemical Society
Office of High School Chemistry
1155 Sixteenth Street, NW
Washington, DC 20036

Or visit our website to apply online
www.acs.org/chemclub

Handbook Content

Administrative

This section includes tips for establishing your ChemClub.

a. Mission Statement
b. Steps for Establishing Your *ChemClub*
c. Sample Proposal Letter for your administration
d. Sample Bylaws

The American Chemical Society

This section provides information about the American Chemical Society (ACS) and various groups and activities within ACS.

a. The American Chemical Society
b. Resources – Local Sections, Student Chapters, etc.
c. Sponsored Activities – National Chemistry Week, Chemists Celebrate Earth Day, etc.
d. Technical Divisions

Activities: Laboratory Investigations

This section provides information on activities your ChemClub might engage in during club meetings.

a. Laboratory Investigations
b. "Cloud in a Bottle"
c. "Make Your Own Hot Air Balloon"
d. "Bubble, Bubble, Toil and Trouble"
e. "Colorful Lather Printing"
f. "More Than Meets the Eye: Nonvisual Observations in Chemistry"

Activities: Service Learning Opportunities

This section includes tips for planning and executing service learning projects with your ChemClub.

a. Service Learning Opportunities
b. Safety Guidelines
c. Adopt-a-Stream
d. Blood Drive
e. Kids & Chemistry Activities ("Lava Lamp", "Bruno the Elephant's Toothpaste", "Slime", and "Pop Rockets")
f. Milli's Rules

Education and Career Planning

This section offers resources on education and careers in chemistry.

a. Education and Career Planning
b. Biotechnologists
c. Chemical Engineers
d. Environmental Chemists
e. Forensic Chemists
f. Oil and Petroleum Chemists
g. Químicos Ambientales
h. Químico Forense
i. Químicos Del Petróleo Y Derivados

Appendix

The appendix includes additional information that may be of use to you. Of particular note are the safety contract and photo release forms.

a. Association with ACS – Important Notice
b. Safety Contract
c. Photo Release Form

Administrative

Mission Statement

ChemClub invites, motivates, and encourages high school students who are fascinated by the many ways that chemistry connects to their world. Supported by the American Chemical Society, *ChemClub* provides fun, authentic, and hands-on opportunities for members to:

- experience chemistry beyond what is taught in the classroom,
- learn about study and career opportunities in the many and varied fields of chemistry, and
- provide service for the betterment of their communities.

Steps for Establishing an
American Chemical Society *ChemClub*

Getting Started

- Involve the department chair and principal; enlist their approval and support for the club. Share the support materials contained in the handbook.

Your First Two Meetings

- Set up dates and post publicity in hallways, science classrooms, etc. Ask other science teachers to make announcements in their classrooms about *ChemClub*. Make announcements over the school PA system. We can provide publicity posters, as well.
- At your first meeting, perform a demonstration to automatically engage students and make them wonder, "What's next?" *Sourcebook*, available for purchase in the ACS Education Division catalog, is a great resource for demonstration ideas. A short icebreaker might be fun to get students who do not know each other to interact.
- At your first meeting, discuss what the club will be about. As advisor, you may decide or allow your students to make this decision. Will the organization of the club be purpose-driven or theme-driven?
    - ◊ Purpose-driven
        - ❖ Decide on a single purpose (or multiple purposes) for the club to focus on.
        - ❖ Ideas include:
            - ☐ ACS-Sponsored Activities
            - ☐ Community Service
            - ☐ Education/Career Planning
            - ☐ Laboratory Activities/Experiments
    - ◊ Theme-driven

- ❖ Each quarter, semester or year, the club votes on a theme to investigate and chooses corresponding activities. Activities might include performing experiments, inviting speakers, community service, reading and discussing articles, games, etc. . .
- ❖ Sample themes are:
  - ☐ Chemistry of Forensics
  - ☐ Green Chemistry
  - ☐ Chemistry of Make-Up
  - ☐ Chemistry of Food
  - ☐ Chemistry of Art
  - ☐ Chemistry of Movie Magic

- During the first two meetings, think about establishing bylaws. Discuss whether your club will have officers and/or committees. Types of committees might include an executive committee, publicity committee, activities committee, service committee, fundraising committee, etc… Appointment, nomination and/or elections could take place at this time or at a later date.
- Discuss activities in which the club will participate and create a calendar of events. Consider including ACS-sponsored events, like National Chemistry Week, Chemists Celebrate Earth Day and Chemistry Olympiad. See "The American Chemical Society" section of the handbook for more information on these events.

Subsequent Meetings

Suggestions and sample activities are included in this handbook to assist you in planning subsequent meetings. Feel free to incorporate any of these into the activities program of your club. Additionally, depending on the goals of your club and requirements of your school, you may want to do the following:

- Follow a "formula" for club meetings. A formula used by one *ChemClub* is: 15-20 minutes of socializing (perhaps with snacks), 10-15 minutes of club business chaired by an elected president, and 30 minutes of hands-on science.
- Have the secretary and/or publicity committee take the lead on advertising events and meetings.
- Plan and hold fundraisers (food sales are easy) to earn money for supplies and/or field trips. You can find fundraiser ideas on our website: www.acs.org/chemclub.
- Set up an account with your financial office at school to handle any funds that flow into or out of the club.
- If your club will conduct laboratory activities, discuss safety and have students sign a Safety Contract (see Appendix).
- Have students sign up to assist with lab set-up or clean-up for laboratory activities.

- Have a luncheon or dessert reception at the end of the year to celebrate your *ChemClub* members and all of their hard work.

Photographs and written accounts of club activities are especially valuable to the maintaining of the *ChemClub* program. You are encouraged to document club activities and send copies to the ACS Office of High School Chemistry. A student photo release form is included for your use (see Appendix). ACS requires this release for a photograph to be posted on the website or used in any print material.

Sample Proposal Letter for a new *ChemClub*

(Feel free to use/edit this sample or design your own, as needed)

Date

High school official and title (principal or activities committee chair)
High school name
Street address
City, State Zip

Dear Mr./Mrs. _____________________,

Based on the interest of the student body in science, and particularly in chemistry, this letter is a proposal to form a high school chemistry club. The main goal of this club is to provide a fun opportunity for students to broaden their knowledge of chemistry and to interact with other students who have a shared interest in chemistry. As such, the proposed club's members would like to participate as an ACS *ChemClub* at _________________________ (name of school), which is a program supported by American Chemical Society, Office of High School Chemistry.

There are several reasons why the establishment of a high school chemistry club is important. A chemistry club can…

…allow students to cultivate their interest in Chemistry in an informal environment, without the pressure of being graded.

…reinforce the relevance of Chemistry to students' everyday lives.

…introduce students to the possibility of future study or employment in Chemistry.

…offer students the opportunity to do community service. For example, they might reach out to younger students and encourage their interest in science.

Chartering our high school chemistry club with the American Chemical Society (ACS) provides us with several benefits. Among those benefits are:

- Participation in a nationwide network of high school chemistry clubs
- Access to selected ACS activities, projects and information
- Receiving materials and resources from ACS
- Connections with ACS Local Sections and ACS Student Chapters at local colleges and universities

It is our hope that this proposal will be approved. Please feel free to contact me with any questions you may have. Thank you for your prompt attention to this very important matter.

Regards,
(Your name and title)

Possible Enclosures: Member list, Planned Activities, Club Bylaws, Mission Statement, ACS Information

Bylaws for ACS *ChemClub* at

____

(name of school)

*(may be modified to meet individual club needs)

Article I. Name

The name of this organization shall be the ACS *ChemClub* at ______________________________ (name of school)

Article II. Objectives

The objective of this *ChemClub* shall be to provide opportunities for sharing and promoting interest in the chemical sciences, to provide students experiences in preparing and presenting experiments and technical information before groups, to share career, technical training, and college opportunities information, to meet role models in the professional chemistry community, to participate in national ACS special programs, and to take an active role in applying chemistry to improving life in the community.

Article III. Membership

The membership of this organization shall be composed of students who are interested in the physical sciences and who associate as members of the ACS *ChemClub* organization.

Article IV. Officers

The officers of this *ChemClub* shall be a President, a Vice President, a Secretary, and a Treasurer, who shall constitute the Executive Committee. The officers shall be elected at the first meeting in ___________ (month) from nominees chosen by _____________ (nominations from the floor, a nominating committee, etc). They shall take office in ________ (month) and shall hold office for one year or until their successors are duly elected.

Article V. Duties of Officers

There shall be four officers of the Executive Committee consisting of a President, Vice President, Secretary and Treasurer. Their duties are as follows:

The President shall convene and preside over regularly scheduled meetings.

The Vice President will chair committees on special subjects as designated by the Executive Committee.

The Secretary shall be responsible for maintaining records, including the taking of minutes at all meetings and sending out announcements.

The Treasurer shall chair the finance committee, assist in the preparation of the budget, and help develop fundraising plans.

Article VI. Faculty Advisor

The *ChemClub* shall be led by a Faculty Advisor, whose duties shall be to advise the *ChemClub* both in its local activities and in its relations with the ACS. The advisor shall be present for all *ChemClub* activities and shall have authority to approve or disapprove all plans. The advisor previews all club activities for safety, and seeks approval for any school-wide or public outreach activities from the school administration.

Article VII. Professional and Student Advisors

The *ChemClub* at its annual election may appoint a non-faculty Professional Advisor who is a member of the American Chemical Society. This person shall assist the *ChemClub* in its relations with the Local Section of the Society and with the industrial community. The *ChemClub* may appoint a collegiate advisor who is an ACS student chapter member at a local university and who will coordinate mutual activities between the *ChemClub* and the chapter.

Article VIII. Meetings

Regular meetings shall be held ________________ (on the first Tuesday of each month, once a month, etc.). Special events may be arranged through the Executive Committee. There shall be at least four activities per year.

Article IX. Safety

To remain in good standing, each member must sign and abide by the Safety Contract administered upon joining.

Article X. Dues (optional)

The Treasurer of the Chapter shall collect annual dues of $______. Voting membership in the Chapter is limited to those who have paid dues.

Article XI. Amendments

Bylaws may be amended by a two-thirds vote of the members, provided that the amendments have been proposed at the prior meeting.

The American Chemical Society

The American Chemical Society

What is the American Chemical Society?

With more than 163,000 members, the American Chemical Society (ACS) is the world's largest scientific society and one of the world's leading sources of authoritative scientific information. A nonprofit organization, chartered by Congress, ACS is at the forefront of the evolving worldwide chemical enterprise and the premier professional home for chemists, chemical engineers and related professions around the globe.

What does ACS do?

The Society publishes numerous scientific journals and databases, convenes major research conferences and provides educational, science policy and career programs in chemistry. ACS gives more than $25 million every year in grants for basic research in petroleum and related fields.

ACS also plays a leadership role in educating and communicating with public policy makers and the general public about the importance of chemistry in our lives. This includes identifying new solutions, improving public health, protecting the environment and contributing to the economy.

ACS is Local, National, and Global

Locally

ACS has 187 local sections throughout the United States. Local sections allow members to:

- Connect with other chemists and chemical engineers in their geographic area
- Participate in programs near their homes that can enhance their professional development
- Contribute to the public's understanding of chemistry in their communities.
- Participate in ACS regional meetings which are hosted by local sections in various geographic regions across the United States.

Nationally

ACS offers members the opportunity to participate in 33 specialty divisions, ranging from food and agriculture to industrial and engineering chemistry. These divisions help members:

- Keep up with the latest developments in their areas of expertise
- Monitor advances in related fields
- Network with colleagues
- Contribute to the advancement and recognition of their scientific discipline.

Twice annually, ACS sponsors national meetings – five days of symposia, tutorials, and poster sessions that cover every area of chemistry, chemical engineering and related sciences. Short courses with renowned instructors, workshops, divisional and committee meetings and other related sessions also occur at national meetings.

Globally

The Society's international membership exceeds 24,000 and represents more than 100 countries.

More than 60 percent of the articles published in ACS journals and more than half of the material covered in the Society's Chemical Abstracts Service – the world's most comprehensive source of chemical information – originates outside the United States.

ACS sponsors or promotes a number of international activities such as joint conferences with chemical societies in India and other countries, and the International Chemical Congress of Pacific Basin Societies (PacifiChem), a weeklong scientific meeting, held once every five years in conjunction with ACS counterparts in Australia, Canada, Japan, Korea, New Zealand, and China.

<u>ACS Supports Real-World Initiatives</u>

ACS works to improve the world through other initiatives including:

- **ACS Green Chemistry Institute** promotes the implementation of green chemistry and engineering principles into all aspects of the chemical enterprise.
- **ACS Scholars Program** provides underrepresented minority undergraduates with scholarship and mentoring support that they need to earn degrees in the chemical sciences.
- **Project SEED** offers bright, economically disadvantaged high school students an opportunity to spend a summer conducting chemical laboratory research with the guidance of a chemical scientist.
- **Teacher Training** supports the professional development of science teachers so that they can better present chemistry in the classroom and foster the scientific curiosity of our nation's youth.

We encourage all ACS *ChemClub* sponsors to establish membership within ACS at some level – whether it is within a local section, the Division and/or ACS at large. Please see the information below about different levels of membership:

- ***Local Section Affiliate*** – It is possible to belong to your ACS Local Section without any other kind of ACS membership. A ***Local Section Affiliate*** has all the privileges of Local Section membership but can't hold or vote for elective positions in the Local Section, or serve on its Executive Committee. The ACS bylaws require that Local Sections collect annual dues of at least $2.00, but Local Sections can set their own policy. If there is a teacher affiliate or support group which is sponsored by, or affiliated with the local section, this would also qualify. To find out about your Local Section membership contact olsa@acs.org.
- ***Division of Chemical Education Member or Affiliate –*** The Division of Chemical Education (DivCHED) is a technical division of the American Chemical Society. ***Division Affiliates*** are individuals who join the Division of Chemical Education but have not established full membership with the ACS. Affiliate membership in the Division of Chemical Education is just $20.00. For more information visit www.divched.org. ***Division Members*** are individuals who are full members of the ACS.
- **ACS at Large Membership - ACS offers four categories of membership:**
  - **Regular Member** - A person that has a degree or certification in chemical or related sciences; or certification as a teacher of a chemical science. Regular member dues are $146/year.
  - **Graduate Student Member** - A person who is a full-time graduate student, majoring in a chemical science or a related academic discipline. Graduate Student member dues are $73/year.
  - **Undergraduate Student Member** - A person actively working toward an undergraduate degree in chemistry or in a related academic discipline. Undergraduate Student member dues are $46.00 with C&EN. Without electronic or print delivery of C&EN, the Undergraduate Student member dues are $24.00.
  - **Non-Scientist/Society Affiliate** - A person who is not eligible to become a member of the Society but whose major vocational effort is directly concerned with the practice of a chemical science. Non-Scientist/Society Affiliate membership dues are $146.00

  For questions concerning membership contact service@acs.org.

Resources

ACS Local Sections

Wherever your school is located, chances are there's one of the 187 local sections of the ACS nearby. Local sections let you connect with other chemists and chemical engineers in your geographic area, which can be a great resource for your *ChemClub*. To search for a local section use the following link: www.acs.org/localsections

ACS Student Chapters

ACS Student Chapters is an organization for undergraduate chemical science majors. Members participate in a wide range of programs and activities that enhance their college experience and prepare them for successful careers. A student chapter near your school would be another great resource, especially for seniors! To find a chapter in your area go to www.acs.org/undergrad

ACS Committee on Community Activities (CCA)

The Committee on Community Activities provides programs that connect chemists with their communities and improve the public's perception of chemistry. For more information about upcoming programs, go to www.acs.org/outreach

ACS Committee on Technician Affairs (CTA)

The Committee on Technician Affairs is dedicated to the advancement of chemical technicians in the chemical enterprise through ACS governance channels and Society resources. The Awareness Subcommittee of CTA is eager to work with high school chemistry clubs to promote the contributions of technicians to society. For more information, go to http://www.acs.org/cta

ACS Office of High School Chemistry

The Office of High School Chemistry is committed to providing products, programs, and resources that support high school teachers and their students. The Office of High School Chemistry is the source of administrative support for *ChemClub*. For more information, go to http://www.acs.org/highschool

Sponsored Activities

The ACS sponsors several activities each year in which your club is welcome to participate. Some can be conducted within your school building exclusively; others may require contacting your ACS Local Section for assistance. Information on each of these activities can be found below; more detailed information can be found by visiting www.acs.org or by referring to the contact information listed below.

As an official *ChemClub*, you will be kept up-to-date with the most current information on ACS-sponsored K-12 activities.

National Chemistry Week

National Chemistry Week (NCW) is a community-based program of the American Chemical Society (ACS). This annual event unites ACS local sections, businesses, schools, and individuals in communicating the importance of chemistry to our quality of life.

The theme for NCW 2011 is "Chemistry—Our Health, Our Future!". Activities targeted toward secondary students include a poster contest and other related events coordinated with local ACS sections.

Please contact the Office of Community Activities for more information at ncw@acs.org, or 800-227-5558, ext. 4353, or visit the NCW website at www.acs.org/ncw.

Chemistry Olympiad

The U.S. National Chemistry Olympiad (USNCO) is a multi-tiered competition designed to stimulate and promote achievement in high school chemistry.

ACS Local Sections conduct local competitions to select nominees for the national exam. Local sections select their nominees by various means including: the USNCO local section exam, a locally-prepared exam, laboratory practicals, teacher recommendations, or other regional events with competitive activities among school teams. These local competitions occur in March. Local nominees then participate in the USNCO national examination. Both local and national competitions provide a forum for interactions between students, teachers, and other chemists. Often, local sections recognize their top students with monetary or other awards.

Twenty of the top scoring students from the USNCO national exam are invited to a two-week study camp held at the US Air Force Academy (USAFA) in Colorado. Under the tutelage of three mentors and USAFA faculty members, the students participate in an intensive program that includes instructions in analytical, organic, inorganic, physical chemistry and biochemistry.

From these students, the 4-student U.S. team is selected which will compete at the International Chemistry Olympiad (IChO). In 2012, the IChO will be held in Washington, DC.

Please contact usnco@acs.org at the ACS Olympiad office or visit www.acs.org/olympiad for more details.

Chemists Celebrate Earth Day

The American Chemical Society (ACS) observes Earth Day with the Chemists Celebrate Earth Day (CCED) program. ACS highlights one of four general topics (water, air, plants/soil or recycling) to serve as the theme on a rotating basis. A specific "theme name" under the topic is chosen to focus the CCED celebration each year. For example, the topic for 2012 will be recycling. An illustrated poem contest is held nationwide for K-12 students relating to this theme.

More information about the 2012 Earth Day topic will be available during the fall of 2011. Visit the CCED website at www.acs.org/cced.

ChemMatters

ChemMatters is an award-winning quarterly magazine for high school chemistry students. Each issue includes articles which reveal chemistry at work in everyday life. *ChemMatters* was designed for teachers to use as a supplement to their first year high school chemistry course. A teacher's guide is available on-line which provides additional information on articles, follow-up hands-on activities, classroom demonstrations, and additional resources.

To view a sample copy of *ChemMatters* or to place an order, call 1-800-227-5558 or visit www.acs.org/chemmatters

Project SEED

Project SEED was established to encourage economically disadvantaged high school students to expand their education and career outlook in the chemical sciences.

For 8 to 10 weeks during the summer, students have a unique opportunity to work in a laboratory doing hands-on research guided by a scientist-mentor. Project SEED is for students from an economically disadvantaged background with an annual family income below $34,340 or does not exceed 200% of the Federal Poverty Guidelines for family size. Exceptions can be made for incomes of up to $48,260, depending on family size and circumstances.

Students who have not graduated from high school are eligible for the Summer I program, and those returning for a second summer of research may participate in the Summer II program.

Project SEED scholarships, available only to former Project SEED students, are nonrenewable and only awarded to first-year college students. The scholarships are restricted to students who will major in a chemical science field such as chemistry, chemical engineering, biochemistry, or materials science. The scholarships are intended to assist former SEED participants in their transition from high school to college and consist of up to $5,000.

For more information on Project SEED, please email projectseed@acs.org, call (800) 227-5558 ext. 4380, or visit www.acs.org/projectseed.

Scholars Program

ACS awards renewable scholarships to underrepresented minority students who want to enter the fields of chemistry or chemistry-related fields. Awards of up to $5,000 (number and amount of awards subject to available funding) are given to qualified students based on academic standing, financial need, career objective, leadership skills, and involvement in school activities and community service. African American, Hispanic/Latino, or American Indian students, who demonstrate high academic achievement in chemistry or science, intending to or majoring in a chemical science/ technology, may be eligible.

For more information on Scholars Program or the application process, please email scholars@acs.org, call 800-227-5558, ext. 6250, or visit www.acs.org/scholars.

Technical Divisions

There are 33 ACS Divisions, each focusing on a specific field of the chemical endeavor. The dynamic growth of Divisions - individually and collectively - is an excellent indicator of the Society's intellectual vitality and responsiveness to members' ever-expanding scientific and technological interests. You will find one or more Divisions to meet your professional needs, while other Divisions suggest new avenues of exploration. You may select one, or choose several serving your areas of special interest.

The American Chemical Society's 33 Divisions are your professional resources. Upon joining the Divisions of your choice, you will

- Keep up with the latest developments in your current area of specialization
- Monitor advances in related fields
- Stay in touch with favorite subject areas that may later affect your career
- Network with colleagues from across the United States and around the world
- Contribute to the advancement and recognition of your special discipline

For more information on ACS Technical Divisions or to visit the websites of the various Technical Divisions, please go to www.acs.org and follow the path Membership & Networks>Technical Divisions.

Agricultural & Food Chemistry

Agrochemicals

Analytical Chemistry

Biochemical Technology

Biological Chemistry

Business Development & Management

Carbohydrate Chemistry

Catalysis Science and Technology (probationary)

Cellulose and Renewable Materials

Chemical Education

Chemical Health & Safety

Chemical Information

Chemical Toxicology

Chemistry & the Law

Colloid & Surface Chemistry

Computers in Chemistry

Environmental Chemistry

Fluorine Chemistry

Fuel Chemistry

Geochemistry

History of Chemistry

Industrial & Engineering Chemistry

Inorganic Chemistry

Medicinal Chemistry

Nuclear Chemistry & Technology

Organic Chemistry

Petroleum Chemistry

Physical Chemistry

Polymer Chemistry

Polymeric Materials: Science & Engineering

Professional Relations

Rubber

Small Chemical Businesses

Activities:

Laboratory Investigations

Laboratory Investigations

Your students may be interested in carrying out laboratory investigations at some of their *ChemClub* meetings. You may already have a collection of laboratory investigations or demonstrations that you would love to do with students, but cannot fit into the busy school year. Those activities are a great resource to use with your *ChemClub* students. Your students may also indicate to you the types of investigations that they would like to carry out.

Additionally, you will receive activities from the ACS Office of High School Chemistry to incorporate into the programming of your *ChemClub* as desired. Mailings of these laboratory activities (and other supplemental material) will occur on a quarterly basis. You are encouraged to take photographs of *ChemClub* members in action and share those photographs with the ACS *ChemClub* office at hschemclubs@acs.org. If you choose to submit photographs, each student in the photograph must complete the ACS "Photo-Release Form." (see Appendix).

We have enclosed five investigations to get you started, "Cloud in a Bottle", "Make Your Own Hot Air Balloon", "Bubble, Bubble, Toil and Trouble", "Colorful Lather Printing", and "More Than Meets the Eye: Nonvisual Observations in Chemistry." Before starting these or any investigations, you may wish to remind students of safety protocol for the laboratory setting. A "Student Laboratory Safety Agreement" can be found in the Appendix.

Activity

"Nature is a mutable cloud, which is always and never the same."

Ralph Waldo Emerson (1803–1882)

Assemble materials.

By Bob Becker

We've all done it: lain back on a grassy hillside staring up at a multitude of puffy white clouds—one looking like an elephant, the next like Abraham Lincoln. But how often do we stop and consider why clouds form in the first place?

We know that clouds comprise small suspended droplets of water and that they have a great influence on weather patterns. But what causes their appearance and subsequent disappearance in the sky overhead? The following activity will enable you to make your own clouds in a plastic bottle and then to explore some of the factors responsible for their formation.

Safety:

Use standard precautions for any use of open flames. Strike match on safety strip; be sure the area is free of flammable material; wear safety goggles in the laboratory; be sure to have fire extinguishing equipment handy.

You will need:

- One empty 2-L soda bottle, preferably colorless, rinsed out, and allowed to dry
- 50 mL of room-temperature tap water
- One match
- One dark-colored backdrop such as a black tabletop or notebook cover
- Safety goggles

What to do:

1. Remove the label from the bottle to ensure an unobstructed view. Screw the cap on to the bottle securely. Then, using a dark backdrop to provide greater contrast, squeeze the bottle and release three to five times near the bottom as you observe the air space in the upper portion of the bottle. Since nothing has been added to the bottle, this can serve as a control for future observations.

2. Now remove the cap, and pour in 50 mL of water. Screw the cap back on securely and swirl the water around inside the bottle for 10–15 seconds. This should ensure that the air inside the bottle is well saturated with water vapor. Or, in other words, that the inside humidity is 100%. Now, repeat the squeezing technique used in step 1. What do you observe inside the bottle after the repeated squeezing?

3. Remove the cap again. In one hand, hold the bottle sideways with a slight upward tilt. In the other hand, take a lit wooden match and insert it partially into the bottle. Immediately give the bottle a quick squeeze to extinguish the match. You should see a small amount of smoke from the match trapped in the bottle. Withdraw the match, screw the cap back on, and set the bottle upright. Repeat the squeezing technique used in step 1. What do you observe inside the bottle when you squeeze? When you release the squeeze?

What's going on?

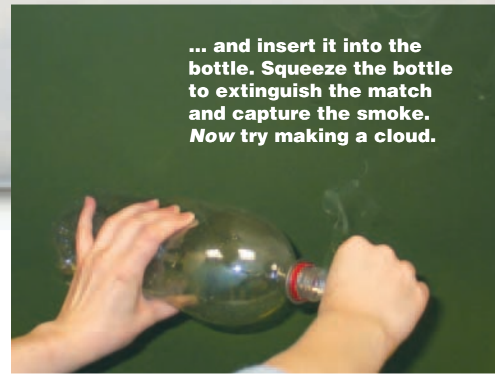
Although you couldn't tell from looking at it, there were two important changes occurring when the air-filled bottle was squeezed in **the first trial:** (1) a substantial increase in pressure, which should be obvious, because you were decreasing the volume of the bottle by squeezing it, and (2) a slight increase in temperature, although you probably didn't observe this change. This happens whenever a gas is compressed in this fashion.

When the squeeze is released, the gas molecules suddenly occupy a larger volume. Again you probably didn't notice it, but there was a slight decrease in

in a Bottle

Try making a cloud. First, use dry air, then humid air.

Next, light a match ...



... and insert it into the bottle. Squeeze the bottle to extinguish the match and capture the smoke. ***Now*** try making a cloud.

STAFF PHOTOS

temperature. This type of cooling is quite noticeable whenever you let the air out of a pressurized tire. It cools off quite substantially, and the valve stem can become quite cold. When you increase the pressure in a tire, the exact opposite occurs.

During **the second trial,** you introduced water vapor. As you might imagine, the amount of moisture that air can hold greatly depends on the temperature; the higher the temperature, the more water evaporates. 100% humidity at 32 °C (90 ºF) translates into twice as much moisture content in the air as 100% humidity at 20 °C (68 °F). Thus, when the bottle was squeezed and the temperature increased slightly, so did the moisture content of the air as the water at the bottom and on the sides of the bottle evaporated a bit more. When the squeeze was released and the temperature dropped slightly, that extra vapor had to condense back into a liquid.

Water condenses best when it has a place to condense. The only surfaces available were the sides of the bottle and the water layer at the bottom. The total amount of moisture condensing would have been just a fraction of a drop, so this evaporating and condensing went pretty much unnoticed.

Then in **the third trial,** you introduced smoke into the bottle: not much—probably only a few millionths of a gram—but enough to create microscopic condensation sites throughout the bottle. This time when the squeeze was released and the temperature dropped, the water could condense onto the smoke particles and form miniscule water droplets suspended throughout the bottle. In other words, it formed a *cloud*. When the bottle was resqueezed and the temperature went back up, these droplets evaporated, but the smoke particles were still there, and so the whole process could be repeated. Eventually, the smoke precipitates out—onto the sides of the bottle or into the liquid layer below—and the cloud effect wears off.

In our atmosphere, clouds can form whenever warm moisture-rich air comes in contact with cooler air. There, the tiny dispersed solid particles—referred to as aerosols—act as nucleation sites for cloud formation. Although they are quite small, these particles can have huge effects on global climates and weather patterns.

Further investigation

The water you used in this activity was at room temperature. Experiment with water at a variety of temperatures and see what effect it has on the cloud formation. Also try other sources of condensation sites such as smoke from a candle, chalk dust, talcum powder, etc. Does the size and type of particle make a difference in cloud formation?

Using a slide projector or strong flashlight, shine some bright light through the bottle. Have the room as dark as possible and view the bottle from various angles. The scattering and diffraction may cause different colors to emerge, and these colors can change over time as the clouds in the bottle start to thin out.

Reprints of this activity may be purchased by calling 1–800–635–7181, ext. 8158.

ACTIVITY:

Try it! Make Your Own Hot Air Balloon

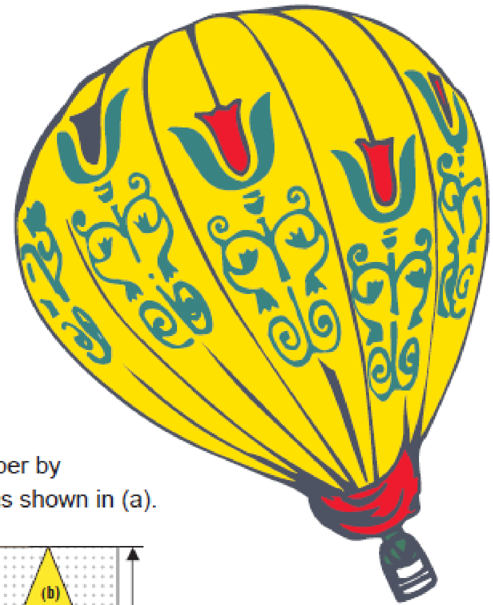


ILLUSTRATION FROM ACS GRAPHICS CL PART FILE

Make your own hot air balloons and launch them from your school grounds. Although there is probably little risk of terrifying the local "peasants" with your "monsters", it's a good idea to get clearance from local authorities before you launch.

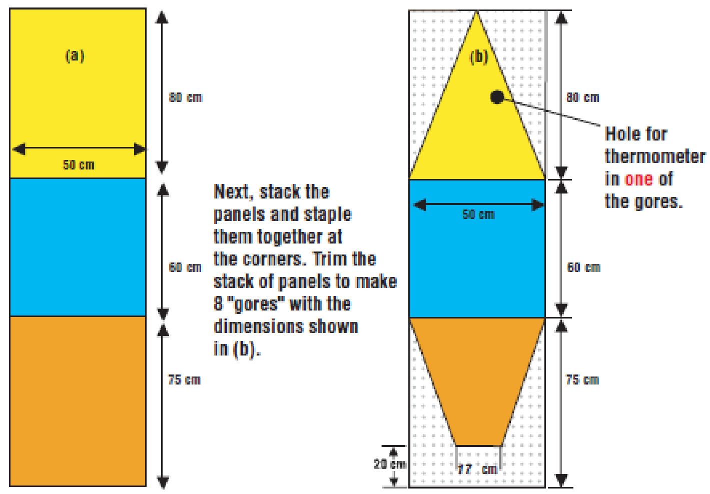
Assemble materials

- 24 sheets of tissue paper, various colors
- Scissors
- Glue
- Masking tape
- Thermometer
- String and/or streamers cut from tissue paper
- Small camp stove with fuel
- Short section of stovepipe
- Short ladder for standing while you read the thermometer
- Heatproof mits for handling the hot stovepipe
- Fire extinguisher
- Balance suitable for weighing the balloon assembly

Build it

1. Prepare a total of 8 panels of tissue paper by gluing together three separate sheets as shown in (a).

2.



3. Separate the gores. Glue each edge to a neighboring gore to form the balloon. Reinforce the open bottom edge with masking tape, and attach several evenly spaced streamers and/or pieces of string to the bottom. These should increase the stability of your balloon.

Determine the mass of your balloon assembly

Do this if you are going to do the calculations your teacher may assign at the end of the activity. After the glue dries, gently fold the balloon. Either weigh it directly, or weigh it enclosed in a tared container.

Check for safety

Do this activity outdoors on a nonwindy day, away from flammable materials. These directions are for supervised classes only. Have a fire extinguisher on site, and review instructions for using it. Wear heatproof mits when handling the hot stovepipe.

Launch it

Record the outside air temperature at time of launch. These temperature readings are important for doing the calculations your teacher may assign.

Punch a small hole in the top section of the balloon, just big enough to lower a thermometer suspended on a string Ignite a small camp stove, and surround it with a few upended bricks. Place your stovepipe section over the camp stove. Position the bottom of the balloon over the stovepipe, and hold the balloon while it inflates with the warm air.

Try to adjust the heat to the point where the balloon just "hovers", neither rising nor falling. Note this temperature. Then, increase the temperature a few more degrees, remove the thermometer, stand back, and let 'er go!

Think about it

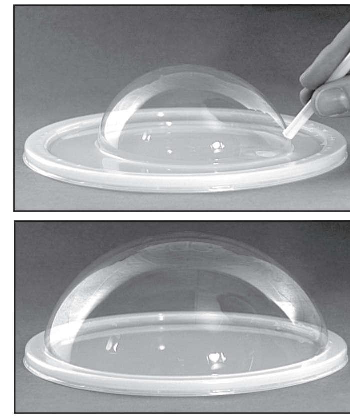
Assuming your balloon survives intact, try launching again with either a lower or higher initial launch temperature. What's the effect of the temperature change on altitude?

Your balloon rises because it is an object at lower density than the air around it. Suppose you had "molecular snapshots" of the way air molecules were arranged inside and outside the balloon. How would they compare?

Bubble, Bubble, Toil and Trouble

Background

Soap bubbles burst when their walls thin because of evaporation or the effects of gravity. Glycerin is thought to increase the lifetime of bubbles because it is hygroscopic and very viscous. Since it is hygroscopic, it helps to prevent evaporation of the water. Its high viscosity increases the time that it takes for downward flow of the material in the bubble. Other substances such as corn syrup, liquid fruit pectin, and sugar appear to work similarly. When added to soap solution, rubbing alcohol results in short-lived bubbles, possibly because it greatly increases the solution's evaporation rate.



A bubble is made by blowing air into a soap solution with a plastic drinking straw.

Integrating the Activity into Your Curriculum

Bubbles are a fun way to introduce the concepts of surface tension, intermolecular forces, and the use of surfactants. They also fit into a discussion of organic molecules such as soaps and detergents, and the concept of how a molecule can be both hydrophilic and hydrophobic. The adjectives hygroscopic and viscous are introduced. A previous *JCE* Classroom Activity, "On the Surface" (*1*), addresses the topic of surface tension, including bubbles.

Additional investigations could compare the bubble lifetime and cost of commercial and homemade bubble solutions or could systematically vary solution composition (including type or amount of detergent or soap and amounts of additives) to produce the longest-lasting bubbles possible.

About the Activity

Students first create a standard solution by mixing water with liquid dishwashing detergent. They then add glycerin, rubbing alcohol, and one or more additional substances (corn syrup, liquid fruit pectin [Certo], or sugar) to samples of the detergent solution. The solutions are compared to see which produces the longest-lasting bubbles. It is recommended that solutions be prepared at least an hour before they are used. More consistent results were achieved in our tests when solutions sat overnight. Students are provided with directions for making solutions, but the instructor may wish to prepare them ahead of time. The directions produce enough of each solution to complete the activity 2–4 times.

Only soft or distilled water should be used. Dawn and Joy liquid dishwashing detergents are recommended because they seem to produce the best bubbles. All required materials can be obtained at a supermarket or drug store. The activity can be performed safely as a take-home project.

The environment (air currents, humidity, etc.) can affect the quantitative results. Qualitatively, bubble lifetime is longer when glycerin is added and shorter (it may be impossible to form bubbles) when rubbing alcohol is added. Corn syrup, liquid fruit pectin (Certo), and sugar all tend to increase bubble lifetime. Instructors may wish to have individual students perform only a few trials or to test different substances and then pool the data for discussion and conclusions.

In step 2, students are asked to observe the colors and the patterns that appear on the surface of the bubble. Information on how and why these colors appear is not included here, as there is enough information on this topic alone to form one or more complete activities! References provide explanations about the interaction of light with a soap or detergent film and also include additional background information and experiments (*2, 3*).

Answers to Questions

1. Answers will vary. The glycerin solution is likely to produce the longest-lasting bubbles.
2. Hygroscopic substances attract water. Since it attracts water, glycerin is thought to reduce the rate of evaporation of the water in a bubble, making it last longer. Glycerin's high viscosity is thought to slow the downward flow of the film, increasing the time that it takes for the film to be affected by gravity.
3. Corn syrup and liquid fruit pectin are very similar to glycerin in appearance and consistency. Solid sugar appears very different, but a concentrated sugar solution is similar. They all increase bubble lifetime.
4. Rubbing alcohol lowers viscosity and increases the evaporation rate of the solution, making it difficult or impossible to form bubbles. Any bubbles formed do not last very long. The dilute detergent solution shows that the change was due to the alcohol, not to diluting the soap solution.

References and Additional Activities

1. *J. Chem. Educ.* **1998**, *75*, 176A.
2. Gardner, R. *Experiments with Bubbles*; Enslow: Hillside, NJ, 1995.
3. Bell, J. L. *Soap Science: A Science Book Bubbling with 36 Experiments*; Addison-Wesley: Reading, MA, 1994.

***JCE Classroom Activities* are edited by Nancy S. Gettys and Erica K. Jacobsen**

Bubble, Bubble, Toil and Trouble

Most people enjoy soap bubbles because of their beauty, but it is a challenge to make them last. Water has a very high surface tension and does not form long-lasting bubbles. It tends to pull itself together to form droplets. The addition of soap or detergent lowers the surface tension. When air is blown into the solution, it can form an elastic film consisting of two layers of soap molecules with a layer of water molecules in between. Soap and detergent molecules have a *hydrophilic* (water-loving) head and a *hydrophobic* (water-hating) tail. In a soap film, the heads orient themselves inward toward the water layer, and the tails stick outward. In this activity, you will make bubbles, starting with a solution of liquid dishwashing detergent and water. You will then add different substances to try to make longer-lasting bubbles. One of the longest-lasting soap bubbles ever made lasted over 300 days (*1*)! How long will your bubbles last?

Try This

You will need: soft or distilled water, liquid dishwashing detergent (Dawn or Joy recommended), glycerin, rubbing alcohol, dropper, 1-L or larger container, five 250-mL bottles with caps or stoppers, plastic drinking straw, plastic lid with 5–6-in. (12.70–15.24 cm) diameter and a lip about 0.25 in. (0.64 cm) high (such as a whipped topping lid), marker, measuring cups or graduated cylinder, spoon, vinegar, paper towels, stopwatch or clock, and additional substances such as corn syrup, liquid fruit pectin (Certo), or sugar.

Preparation of Stock Solutions: Stock solutions can be shared with your classmates. Adjust the quantities given below as needed, retaining the proportions specified. You will need 0.25–0.5 cup (59–118 mL) of each solution. For best results, allow solutions to stand at least one hour, preferably overnight.

__A. Measure 4 cups (946 mL) of soft or distilled water into a container. Add 0.25 cup (59 mL) of liquid dishwashing detergent. Stir gently; try not to form bubbles. Transfer 1 cup (236.5 mL) of this solution to a clean bottle and label it "detergent solution". Cap or stopper the bottle.

__B. Measure 1 cup (236.5 mL) of step A solution and place it in a clean bottle. Add 50 drops (2.5 mL or 1/2 teaspoon) of glycerin. Mix thoroughly. Label the bottle "detergent + glycerin solution". Cap or stopper the bottle.

__C. Repeat step B using another substance (corn syrup, liquid fruit pectin, or sugar). Label the bottle appropriately.

__D. Measure 0.5 cup (118 mL) of step A solution and place it in a clean bottle. Add 0.5 cup of rubbing alcohol. Label the bottle "detergent + alcohol solution". Transfer any remaining step A solution to a clean bottle. Add 0.5 cup of water. Mix thoroughly. Label the bottle "dilute detergent solution". Cap or stopper both bottles.

Bubble Procedure:

__1. Place a plastic lid on a flat, stable surface. Pour solution from the bottle marked "detergent solution" into the lid until it is almost full to the rim.

__2. Form a single bubble in the soap solution by blowing into the solution through a plastic drinking straw. (This takes some practice, so keep trying! Once you blow a bubble, it helps to raise the tip of the straw above the solution surface into the interior of the bubble. Otherwise, you'll keep making more bubbles.) Blow into the bubble until it touches the edge of the lid, all the way around. Then remove the straw and begin timing with a stopwatch or clock. Record the number of seconds it takes for the bubble to burst. Do not breathe on the bubble or allow air currents to disturb it. Repeat for several more trials. While timing, observe the colors or shapes that appear in the bubble's surface. Is there a pattern or order in which colors occur? Which colors appear just before the bubble bursts? Can you predict when a bubble is about to burst?

Be Safe! Do not suck on the straw or inhale through it. If solution enters your mouth, rinse with water immediately. If glycerin contacts your skin, wash with water.

__3. When your trials are done, pour the remaining solution from the lid down the drain and rinse the lid with water. Pour a small quantity of vinegar on the lid and wipe it clean with a paper towel.

__4. Repeat steps 1–3 using each of remaining bottled stock solutions.

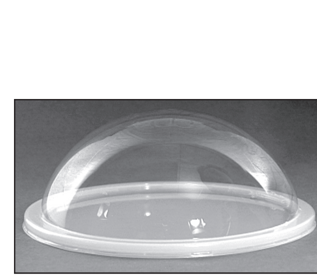
Questions

__1. Calculate and compare the average time that the bubbles lasted for each of the solutions. Which solution made bubbles that lasted the longest?

__2. Glycerin is *hygroscopic* and very *viscous*. What do these two terms mean? How might these properties of glycerin act to affect the lifetime of bubbles?

__3. Compare the additional substance(s) you used to glycerin. How are their properties similar or different?

__4. How did the addition of rubbing alcohol affect bubble lifetime? Why?



References and Information from the World Wide Web *(accessed Nov 2000)*

1. Bubble Formulae: *http://www.exploratorium.edu/ronh/bubbles/formulae.html*
2. Soap Bubbles: *http://www.exploratorium.edu/ronh/bubbles/bubbles.html*
3. The Bubblesphere: *http://www.bubbles.org/index.htm*

Colorful Lather Printing

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In this Activity, students marble paper with shaving cream and food color while exploring water, polarity, and hydrophilic and hydrophobic materials. Although the Activity is familiar, it contains a new twist—exploring how a colored shaving cream mixture behaves when a drop of water is added.

photo: R. Wildman and J. J. Jacobsen

Paper marbled with shaving cream and food color.

Background

Soap is a topic rich in important concepts and familiar to students. Shaving cream contains a mixture of a liquid (soap dissolved in water), additional solid soap, and a propellant gas, which classifies it as a lather. A fatty acid like stearic acid and the base triethanolamine are often used to make the soap in shaving cream. The soap, triethanolammonium stearate, has a hydrophilic head composed of a carboxylate ion and triethaneammonium ion, and a hydrophobic tail made of a 17-carbon-long aliphatic chain from stearic acid.

Integrating the Activity into Your Curriculum

This Activity can be used to introduce the concepts of polarity, soaps, and surfactants. The composition of shaving cream lends itself to a discussion of types of phases, mixtures and, in particular, a discussion of foams as colloids. The careers of consumer product chemists *(1)* and the chemistry of other consumer products may also be relevant. Paper marbling is an ancient art, so the Activity can be effectively integrated with art or history lessons.

About the Activity

Activities that foster creativity as students learn chemistry concepts are popular among educators who believe that "fun, discovery, and creativity" should be part of the exploration of chemistry *(2)*. In this Activity, students first observe how food color spreads into water, paper, and shaving cream (which contains both polar and nonpolar components) and then observe the affinity that paper (cellulose) has for polar substances.

When a water drop is added to the surface of shaving cream tinted with food color, the color instantaneously disappears in the lather at the point of contact. The effect is similar to the demonstration where black pepper floating on the surface of water immediately spreads when soap or detergent contacts the water. Soaps and other surfactants are wetting agents. When a wetting agent dissolves in water, the surface tension of water is lowered. In this Activity, wetting occurs as the soap in the shaving cream dissolves in the drop of water that falls onto the tinted shaving cream. The surface tension of the added water drop is lowered, and the drop of water spreads. While one might guess that the water-soluble food color in the lather would diffuse into the added water drop, this is not immediately observed. Instead, dissolving and spreading of soap on the surface of the added water drop is observed and this causes the color to disappear at the water contact site. If the tinted foam and water drop sit undisturbed for 20–30 minutes, the diffusion of the food color into the white lather is clearly observed.

Foam pump soaps, having more water and alcohol, produce wetter papers with less distinct designs. Although less convenient than prepared food color, tempera and other water-based paints can be used. Shaving cream foam collapses quickly if oil-based paints are used.

Answers to Questions

1. The color diffuses completely and quickly into water and is absorbed by the paper. Due to the nonpolar tail of soap, the color spreads less in shaving cream.
2. The food color dissolves readily in water, and since water is polar, food color must be polar as well. Since the food color spreads into the paper easily, the paper must contain polar substances.
3. Paper primarily contains cellulose, which has polar hydroxyl groups at various locations, making it partially polar.
4. Mousses, whipped cream, some hand soaps, and carpet cleaners are similar examples of colloids.
5. Early artists would not have used the words hydrophilic, hydrophobic, polar or nonpolar to describe their materials, but since these artists might have prepared their materials from natural plants or colored rocks, they would still have acquired extensive knowledge of their materials and their interactions.

References, Additional Related Activities, and Demonstrations

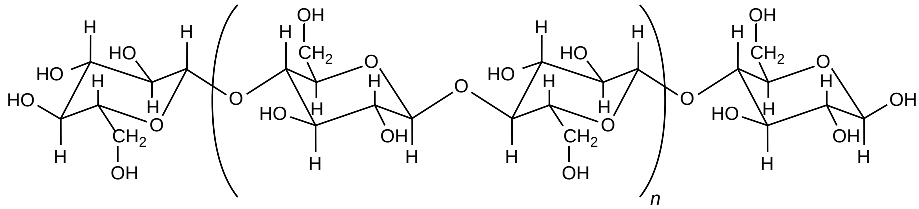
1. Chemical careers in brief. *http://www.chemistry.org/portal/a/c/s/1/acsdisplay.html?DOC=vc2%5C3wk%5Cwk3.html*
2. Sarquis, Jerry L.; Sarquis, Mickey; Williams, John P. *Teaching Chemistry with Toys: Activities for Grades K–9;* Terrific Science Press, Middletown, OH, 1995; pp 189–194 and pp 169–175.
3. Jacobsen Erica K. *J. Chem. Educ.* **2002,** *79,* 1162–1167 and references within.

The authors thank Robert G. Laughlin, a retired Procter & Gamble Co. researcher, for his contributions to this article. This Activity was funded by Grant #1R25RR16301-01A1 from the National Center for Research Resources, a component of the National Institutes of Health. Its contents are solely the responsibility of the authors and do not necessarily represent official views of NCRR or NIH.

JCE Classroom Activities **are edited by Erica K. Jacobsen and Julie Cunningham**

Colorful Lather Printing

Paper marbling has been popular for centuries. In a Japanese version called *sumi nagashi* (meaning "ink-floating"), hydrophobic, carbon-based inks are dropped onto water and blown across the surface to produce swirls like those seen in polished marble. Rice paper lifts the ink off the surface of the water. In this Activity, you will investigate the art and science of the creation of colorful marbled paper patterns using shaving cream and food color. Shaving cream contains soap, which consists of long ionic species that have a hydrophilic ("water loving") head and a hydrophobic ("water hating") tail. Paper contains cellulose, which is a polymer of glucose (see below), as well as other chemical substances.



cellulose

photo by R. Wildman and J. J. Jacobsen

Shaving cream and food color prepared for marbling.

Try This

You will need: aerosol shaving cream (standard white type); paper plate; scraper such as spatula or tongue depressor; toothpicks; food color; 3–4 small (~3 × 5 in.) pieces of non-glossy, sturdy paper such as index cards, card stock, or art paper; eye dropper; water; small transparent cup; and paper towels.

Be Safe! Shaving cream can become irritating if left on skin for too long. Wash your hands when you are done.

__1. Read the label on a can of aerosol shaving cream. Record the list of ingredients.

__2. Place a drop of food color on a clean piece of non-glossy, sturdy paper, such as an index card. Observe and record how the drop spreads.

__3. Fill a small, transparent cup half-full with room-temperature water. Without stirring, add a drop of food color to the water. Observe and record how the drop spreads.

__4. Spray a pile of shaving cream the size of your fist onto a paper plate. Use a scraper such as a spatula or tongue depressor to shape the pile so that the top surface is flat and slightly larger than the paper that you will marble. Apply only 4–6 drops of food color to the shaving cream surface, one drop at a time. Observe and record how the drops spread.

__5. Drag a toothpick through the shaving cream and food color to create colored patterns. Press a 3 × 5 in. piece of non-glossy, sturdy paper firmly on the shaving cream surface. What do you observe through the back of the paper?

__6. Lift the paper off of the shaving cream. Scrape off any excess shaving cream close to the paper with a spatula or side of a tongue depressor and return it to the original pile. Observe the front of the paper. What happened?

__7. Repeat steps 5–6 to marble additional papers with the remaining tinted shaving cream, or move on to step 8.

__8. Using a spatula or tongue depressor, mix the leftover pile of colored shaving cream until it is one uniform color. If most of the color has already been removed by paper, add 1–5 more drops of food color before mixing completely.

__9. Using an eye dropper, apply a drop of water to the tinted shaving cream. Observe and record what happens.

More Things To Try

Try the same marbling technique using foam pump soap or gel shaving cream as the base, or different artists' paints on standard white shaving cream. What factors influence your results?

Questions

1. Compare and contrast the spreading you observed when dropping food color onto clean paper, into water, and onto shaving cream. Explain your observations.
2. Based on your observations, what claims can you make about the polarity of the food color and the paper? Explain.
3. Using the chemical structure of cellulose, explain the claims you made regarding the polarity of paper in question 2.
4. Shaving cream is a lather, similar to a foam. A foam is a colloid consisting of a gas dispersed within a liquid. (The liquid in shaving cream is water and soap, with larger sized soap particles dispersed in water.) What other common products are foam or lather colloids?
5. Artists have created beautiful marble papers since the middle ages. How do you think an artist's understanding of materials influences his or her work? Explain your answer.

Information from the World Wide Web *(accessed Jan 2007)*

Paper decorating. *http://www.cbbag.ca/BookArtsWeb/PaperDecorating.html*

Shaving cream—background, raw materials, the manufacturing. *http://www.madehow.com/Volume-1/Shaving-Cream.html*

Consumer product chemistry careers. *http://www.chemistry.org/portal/a/c/s/1/acsdisplay.html?DOC=vc2\3wk\wk3_cpd.html*

More Than Meets the Eye: Nonvisual Observations in Chemistry

W

Background

This activity adapts an acid–base reaction that generates carbon dioxide gas to allow blind students to observe the results. It is based on the 2000 Pimentel Award Address by Jerry Bell (*1*). This activity is intended for sighted students, to show them that gathering all the information available will engage all of their senses in the chemistry laboratory. It may also serve to sensitize both students and instructors to the needs of blind students, showing how students with special needs can participate in the laboratory when simple modifications to standard experiments have been made.

Integrating the Activity into Your Curriculum

This activity is intended for use at the outset of a chemistry course to emphasize that students should use all of their senses in observing chemistry. The activity could also be used to demonstrate examples of acid–base reactions, reactions of carbonates, or endothermic reactions.

Caution: *Never* taste or eat anything in the laboratory. Use caution in noting odors or touching chemicals. Splash-proof goggles should be worn at all times in the laboratory.

About the Activity

All materials required for this activity can be obtained at a grocery store. It can be done in a classroom, laboratory, or as a take-home activity.

A small plastic bottle with a cap should be used for the water in Experiment 1 to minimize the mess if the bottle is dropped. A well-rinsed 8–16 oz. beverage container with squirt cap works well.

The chemistry involved in this activity is not described on the Student Side. Both reactions, A and B, involve the formation of carbon dioxide gas:

A. $NaHCO_3(aq) + KO_2CCH(OH)CH(OH)CO_2H(aq) \rightarrow CO_2(g) + H_2O(\ell) + KO_2CCH(OH)CH(OH)CO_2Na(aq)$

Sodium bicarbonate (baking soda, a weak base) plus potassium hydrogen tartrate (cream of tartar, a weak acid) yields carbon dioxide plus water plus potassium sodium tartrate. Note that no reaction occurs between the solids until they are dissolved in water. This reaction is done in Experiment 1 and Experiment 2.

B. $NaHCO_3(aq) + CH_3CO_2H(aq) \rightarrow CO_2(g) + H_2O(\ell) + CH_3CO_2Na(aq)$

Sodium bicarbonate (baking soda, a weak base) plus acetic acid (vinegar, a weak acid) yields carbon dioxide plus water plus sodium acetate. This reaction is done only in Experiment 2.

Experiment 1: The blindfolded investigator should hear fizzing and feel the bag inflate while the assistant sees bubbles or foam and the bag inflate. The investigator will feel a decrease in temperature that the assistant cannot observe.

Experiment 2: Students will observe that reaction B is much more vigorous than reaction A. Reaction B may overflow the cup. Both reactions are endothermic, but the temperature decrease for B may not be noticeable.

After observations are made, solutions that remain in the bag and cups can be poured down the drain. Unused baking soda and cream of tartar can be saved for use by other students. Plastic bags and cups can be rinsed with water and air-dried for reuse or can be placed in the trash. Be sure to open bags containing carbon dioxide to release the gas before placing them in the trash.

Answers to Questions

1 The investigator can observe by touch and hearing everything the assistant sees. In addition the investigator can feel the reaction mixture get cold. Sight, sound, and touch are all useful in describing the reaction. Sound and touch are sufficient, but sight alone is not.

2. Reaction A is slower and safer to do in a closed container. Observations are likely to be mostly visual in Experiment 2. Temperature change may not be noticed or may be more noticeable for reaction A. The blind student might learn more about the reaction by noticing the temperature change, something that the typical student could easily miss.

3. Answers will vary, but the investigator should have been successful without frustration. Possible modifications include use of safer chemicals, plastic equipment, and containers that allow the student to feel the chemicals, and a sighted lab partner or assistant. See references 1 and 2 for more ideas about adapting laboratory for students with special needs.

Additional Activities and Demonstrations

W A video of this experiment is available as supplemental material in this issue of *JCE Online*.

1. Bell, J. A. *J. Chem. Educ.* **2000**, *77*, 1098–1104.

2. Barrier Free Education Home Page. *http://barrier-free.arch.gatech.edu/* (accessed July 2000).

JCE Classroom Activities **are tested and edited by Nancy S. Gettys and Erica K. Jacobsen**

JCE Classroom Activity: #28 **Student Activity**

More Than Meets the Eye: Nonvisual Observations in Chemistry

Science is based on careful observations of nature using all five of your senses. In chemistry lab, however, most of your observations are visual, such as reading a scale or noting a color change. Have you ever wondered whether sight is essential to do chemistry experiments? Could a blind person use other senses to learn about chemicals and chemical processes? This activity will help you decide.

Try This

You need a chair and a clean desk or table; 3 sandwich-size zip-seal plastic bags; 2 plastic teaspoons; paper towels; marking pen; baking soda; cream of tartar; water; small (8–16 oz.) plastic bottle with squirt cap; 3 3-oz. paper or plastic cups; a blindfold; 2 8–10 oz. cups; and vinegar. The activity requires an **investigator** (who will be blindfolded and will do the experiment—all measuring and mixing of chemicals—and make observations) and an **assistant** (who will not be blindfolded and will set up materials, record the investigator's observations and actions, and watch what happens. Instructions for the **assistant** are in *italics*. Read all the steps carefully before beginning.

Caution: *Never* taste or eat anything in the laboratory. Use caution in noting odors or touching chemicals. Splash-proof goggles should be worn at all times in the laboratory.

Preparation: (Both partners may work on this step, without the blindfold.)

__1. Use a marking pen to label one of the plastic bags **baking soda**, then use a clean plastic spoon to place 3–4 spoonfuls of the baking soda in the bag, put the spoon inside the bag, and seal it. Label a second plastic bag **cream of tartar**, then use another clean plastic spoon to place 3–4 spoonfuls of cream of tartar in that bag, put the spoon inside the bag, and seal it. Label the bottle **water** and fill it about half full of water.

__2. The **investigator** should sit in a chair in front of a clean desk or table and put on the blindfold.

Experiment 1: (both partners work together, one is blindfolded)

After the investigator's blindfold is in place, the ***assistant*** *should arrange within reach on the table in front of the investigator in no particular order, the bags and bottle prepared in step 1 above along with an empty 3 oz. cup, an empty plastic bag, and a paper towel. Read aloud to the investigator the steps of Experiment 1, one step at a time. Read slowly and repeat instructions if the investigator asks. When the investigator completes a step, record her/his observations. Record your own* ***visual observations only*** *in a separate list. Do not help or advise the investigator in any way except to clean up any spills.*

__1. Locate and identify the 6 items on the table in front of you. Arrange them so that you can easily find each item.

__2. Examine the two bags containing spoons and solids. Do they feel the same? Can you tell by touch that the bags contain different solids?

__3. Get one spoonful of solid from each bag and place it in the empty plastic bag. You will use this bag in step 5.

__4. Pour water into an empty cup until the cup is about half full. You may need to touch the water in order to know when the cup is half full. If so, dry your fingers on the paper towel when you have finished measuring.

__5. Find the plastic bag from in step 3 and carefully place the cup inside it without spilling any water. Seal the bag.

__6. Tip the cup inside the bag so that the water flows from the cup into the solids. Gently shake the bag to mix the contents; describe what happens inside the bag. When your observations are complete, remove your blindfold.

Experiment 2: (partners work together, with no blindfold)

__1. Label one of the larger cups and one of the smaller cups **A**. Put one spoonful each of baking soda and cream of tartar into the larger cup. Fill the smaller cup half full of water.

__2. Label the remaining large and small cups **B**. Put one spoonful of baking soda into the larger cup. Fill the smaller cup half full of vinegar.

__3. Over a sink or table protected with paper towels, simultaneously pour the liquid from each smaller cup into the larger cup labeled with the same letter. Describe what happens.

Questions

__1. In Experiment 1 did the assistant see anything that the investigator was not able to observe? Did the investigator observe anything the assistant could not see? Which senses (sight, smell, sound, or touch) are useful in describing this chemical reaction?

__2. In a typical chemistry laboratory, students would probably do only the baking soda and vinegar reaction in Experiment 2. Compare the two reactions. Why do you think only the first reaction in Experiment 2 was done with a blindfold? How did your observations in Experiment 2 differ from those in Experiment 1? Would a blind student who did only Experiment 1 learn as much chemistry as a sighted student who did only the typical experiment?

__3. Describe any the problems or frustrations the investigator experienced in Experiment 1. Was the investigator able to successfully perform the experiment? What sort of adjustments might be needed for a blind student in a chemistry lab?

Activities:

Service Learning Opportunities

Service Learning Opportunities

Many students are interested in serving their communities in a meaningful way. Additionally, your school may require students to complete a minimum number of service hours as a requirement for graduation.

Your *ChemClub* could provide students with organized opportunities to perform public outreach activities. All of these projects could be done in conjunction with other school-based clubs, with your local ACS section, or with your area collegiate ACS Student Chapter.

Here are several ideas that incorporate service learning and promotion of chemistry:

- Conduct or assist in school-wide in recycling efforts.
- Work with local forestry officials to plant trees and ground cover to control erosion and help the environment.
- Provide academic tutoring
  - Tutor area elementary/middle school students with an after-school program.
  - Tutor other students within your school. This is an excellent opportunity to collaborate with another club/organization such as an academic honor society.
- Present a chemistry demonstration to elementary school children at a local library, elementary school, or other community gathering place. Available ACS resources for activities, explanations, and guidelines include:
  - Safety guidelines for conducting chemical activities and demonstrations are provided in this section of the handbook
  - Kids and Chemistry. Visit www.acs.org/kidsandchemistry. This features a set of tried and true activities contributed by Student Chapters. Contact kids@acs.org to contribute your own activity.
  - Science for Kids at www.acs.org/kids has 143 science activities you can do with kids. Ciencia para chicos is available at www.acs.org/chicos.

NCW and Community Activity
SAFETY GUIDELINES

These guidelines are based on the premise that all presenters care very much about the safety of their audiences and participants during demonstration shows and hands-on activities. Although these guidelines are primarily for the presenters of chemistry outreach programs, the responsibility for presenting safe chemistry programs falls on a much larger group of individuals. Local section leaders, community activity coordinators, volunteers, and even participants and their parents share the responsibility of ensuring safe environments for these programs and activities. The information presented in these guidelines will help in the selection and presentation of programs and activities to keep community activities safe.

For the purpose of these guidelines, a chemical is defined as any material used during the course of a demonstration or a hands-on activity. Material Safety Data Sheets (MSDS) should be available for all chemicals used in demonstrations and hands-on activities. Because these activities involve "doing science," presenters and participants will be required to do what scientists do—wear appropriate personal protective equipment that includes, at a minimum, chemical splash (cover) goggles that conform to the American National Standard Institute (ANSI) Z87.1 standard, types G or H.

The guidelines presented here are divided into four sections, two for types of facilities and two for types of activities.

1. Guidelines for Presentations and Activities at Scientifically Equipped Facilities
2. Guidelines for Presentations and Activities at Non-scientifically Equipped Facilities
3. Guidelines for Hands-On Activities
4. Guidelines for Chemical Demonstrations (ACS Division of Chemical Education)

Follow all guidelines appropriate for both *site and type* of activity. For example, a hands-on activity at a shopping mall would need to follow both the guidelines from Section 2 and those from Section 3, always using the more stringent rules of the two guidelines.

If you observe any activity that puts the audience at risk, we encourage you to take action. If the situation is deemed immediately hazardous, take appropriate measures to stop the activity. If such action is taken, report the circumstances of the activity to the community activities coordinator and the local section executive committee. If you have concerns about other issues related to safety, address them to the presenter in a timely manner.

Presentations and Activities at Scientifically Equipped Facilities

Scientifically equipped facilities include:

- science facilities at colleges, universities, secondary schools, and science museums;
- research and manufacturing facilities; and
- any other type of facility that has laboratories.

It is assumed that these facilities generally have:

- extensive emergency equipment, including fire extinguishers;
- chemical supplies;
- adequate ventilation and air circulation;
- disposal procedures for chemical waste; and
- rules concerning personal safety of visitors and employees during community activities.

1. Secure pre-approval for use of the facilities.
Secure pre-approval of all hands-on activities and demonstrations from the laboratory safety director or other management official. Make facility security/safety officers aware of the planned activity.

2. Prepare supplies in an appropriate area.
Carry out demonstration and activity preparations in an area designed for working with chemicals. Put controls in place to ensure that the types and quantities of chemicals brought into the area are appropriate and kept to a minimum. Make certain that all chemicals are appropriately labeled including appropriate safety hazard warnings. Make MSDS available for all chemicals in the activity area.

3. Pretest demonstrations and activities.
Pretest programs, if possible, in the area in which they are to be performed. The pre-testing will help identify potential safety hazards.

4. Carefully review activities that produce loud noises.
Consider moving these activities outside. If they are carried out inside, be certain to notify management and security. In all cases, alert the audience to expect a loud noise and to cover (protect) their ears.

5. Identify issues related to chemical waste.
Establish in advance the types of chemical waste that will be produced and the procedure for waste disposal. Be certain to follow the federal, state, and local regulations for waste disposal.

6. For demonstrations, provide adequate shielding for the audience and the demonstrator.
The safety of the audience is paramount. It must not be assumed that the members of the audience are protected by distance. Protection could be achieved by shielding the audience and by the demonstrator wearing chemical splash (cover) goggles (ANSI Z87.1) types G or H. Alternately, chemical splash (cover) goggles could be worn by all participants (demonstrator and audience). Have a goggle sanitation plan for goggles used by multiple persons. One possible method of sanitation is to immerse the goggles in diluted household laundry bleach (1 part bleach to 9 parts water), followed by thorough rinsing and drying. Know the location of the nearest eye wash fountain and safety shower and ensure in advance that the eyewash and safety shower are working properly. Discuss safety precautions with the audience as well as the locations of the nearest restrooms.

7. If the activity is hands-on, provide adequate personal protective equipment for the participants, the leader(s), and any assistants.
The safety of all persons involved is paramount. All participants, helpers, and presenters must wear eye protection in the form of chemical splash (cover) goggles (ANSI Z87.1) types G or H. Prepare and execute a goggle sanitation plan for goggles used by multiple persons. One possible method of sanitation is to immerse the goggles in diluted household laundry bleach (1 part bleach to 9 parts water), followed by thorough rinsing and drying. If the activity is likely to be messy, consider providing disposable laboratory aprons and gloves. If aprons are to be reused, be certain to label the front of the apron. Never reuse disposable gloves. Prior to the activity, discuss safety precautions with the audience as well as the locations of the nearest restrooms.

8. Perform programs in areas with adequate ventilation.
Make certain the facility being used for the activity or demonstration has adequate ventilation for the chemicals being used.

9. Make plans in advance for adequate crowd control.
Make advance plans and provide personnel to ensure that the audience size is maintained at a predetermined level for the activities. This includes control over the entrances to limit the number of persons admitted to the area. Make certain that the number of volunteers is appropriate for the activities and for the expected size of the audience. For hands-on activities, it is very important to control the number of persons having access to the area of the activity.

10. Plan exit routes.
Make certain that there is easy access to and exit from the area of the demonstration or activity. Include an explanation of exit procedures and have adequate personnel to supervise evacuation in case of an emergency. Be aware of all on-site fire regulations regarding audience size and emergency evacuations.

11. Do not allow consumption of food or drink in the demonstration/activity area.

12. Have spill kits available that are appropriate for the chemicals to be used.

13. Ensure that fire protection is readily available in the immediate area.

14. Distribute handouts complete with safety recommendations.
If the description of the activity is distributed, make sure that the procedure is well tested and details all safety related concerns. All ACS materials have undergone safety review and contain appropriate guidelines.

Presentations and Activities at Non-scientifically Equipped Facilities

Non-scientifically equipped facilities include

- elementary schools
- exhibit halls
- hospitals
- museums
- libraries
- senior citizen centers
- shopping malls
- sports facilities
- theaters

These facilities generally lack

- extensive emergency equipment, including fire extinguishers;
- chemical supplies;
- adequate ventilation and air circulation;
- disposal procedures for chemical waste; and
- rules concerning personal safety of visitors and employees during community activities.

1. Secure approval in writing for use of the facility from its management.
Make management fully aware of the specific demonstrations and activities that are planned, any inherent hazards, and the precautions being taken to mitigate those hazards. Make facility security/safety officers aware of the planned activity.

2. Inspect the facility to ensure its adequacy.
Make no assumptions about the facility that will be used. Prepare a checklist of items necessary for the activities to be carried out, including basics such as water and electricity. Keep in mind that non-scientific facilities have inadequate ventilation and air exchange compared with scientific facilities. Make certain an appropriate fire extinguisher is available in the immediate area even if you must supply one.

3. Be aware of audience size limitations set by local fire regulations. Fire regulations may also determine what materials can be brought into the facility.

4. Use care in selecting the demonstrations/activities to be done in this type of facility.
For example, avoid reactions that produce loud noises, flames, smoke, and fumes.

5. Pretest demonstrations and activities.
Because it may not be possible to pre-test the demonstrations and activities in the facility to be used, pre-test them with an age-appropriate helper in a similar area. During the pre-testing process, identify and correct potential safety problems. Pre-testing will also ensure that the planned activity produces the expected results.

6. Minimize on-site reagent preparation.
For example, pre-weigh samples in bottles to which water may be added on-site to prepare solutions. This eliminates the need to bring large quantities of solution to the facility.

7. Consider the time length of demonstrations and activities.
In a facility that has a large turnover of people, consider the use of brief demonstrations and activities. This is important for crowd control.

8. Do not take flammables or combustibles [as defined by the National Fire Protection Association (NFPA); www.nfpa.org] into a non-scientifically equipped facility.

9. Do not use flames of any type.
Caution must also be exercised when using hotplates. Never use a hotplate to heat flammable materials.

10. Carefully review activities that produce loud noises.
Consider moving these activities outside. If they are carried out inside, be certain to notify management and security. In all cases, alert the audience to expect a loud noise and to cover their ears.

11. Use plastic, non-breakable containers and supplies.
Keep use of glass to a minimum. Use glass only when necessary and with appropriate safety precautions.

12. Consider issues related to the transport of chemicals and removal of waste.
The transport of chemicals to the event site and removal of waste afterwards present potential problems, including legal problems, to those in charge of the programs.

A. To minimize the potential problems associated with the transport of chemicals to the facility, give careful consideration to the planned activities and demonstrations. You should strongly consider developing demonstrations and activities that use chemicals that may be purchased at local stores such as hardware, grocery, and discount stores. Be aware that there could be potential problems associated with transporting these chemicals to the facility, although some of these chemicals (e.g., drain cleaner, muriatic acid) would not be appropriate for use in community activities. Make certain that all chemicals are appropriately labeled. Include any hazard and handling information. When practical, make MSDS available for all materials used.
B. If possible, develop demonstrations and activities that "neutralize" the wastes that are produced. Depending on the nature of the liquid wastes, it may be possible to dispose of some or all of the wastes on-site through the sanitary sewage system, provided permission to do so has been obtained from local sewer/sanitation authorities. This must not be done unless you have previously secured management approval. If the waste is transported off-site, it is important to observe all federal, state, and local regulations governing such transport.
C. Label all waste and dispose of it in accordance with EPA or equivalent local regulations.
D. Follow the rule "if you take it in, you must take it out" as much as possible and always for any hazardous and potentially hazardous substances.

13. For demonstrations, provide adequate shielding for the audience and the demonstrator.
The safety of the audience is paramount. The audience must be kept a minimum distance from demonstrations; a minimum of five feet is recommended. It must not be assumed that the members of the audience are protected by distance. Protection could be achieved by shielding the audience and by the demonstrator wearing chemical splash (cover) goggles (ANSI Z87.1) types G or H. Alternately, chemical splash (cover) goggles could be worn by all participants (demonstrator and audience). Have a goggle sanitation plan for goggles used by multiple persons. One possible method of sanitation is to immerse the goggles in diluted household laundry bleach (1 part bleach to 9 parts water), followed by thorough rinsing and drying. Know the location of the nearest eye wash fountain and safety shower and ensure in advance that the eyewash and safety shower are working properly. Discuss safety precautions with the audience as well as the locations of the nearest restrooms.

14. If the activity is hands-on, provide adequate personal protective equipment for the participants, the leader(s), and any assistants.
The safety of all persons involved is paramount. All participants, helpers, and presenters must wear eye protection in the form of chemical splash (cover) goggles (ANSI Z87.1) types G or H. Prepare and execute a goggle sanitation plan for goggles used by multiple persons. One possible method of sanitation is to immerse the goggles in diluted household laundry bleach (1 part bleach to 9 parts water), followed by thorough rinsing and drying. If the activity is likely to be messy, consider providing disposable laboratory aprons and gloves. If aprons are to be reused, be certain to label the front of the apron. Never reuse disposable gloves. There should be a discussion with the audience of the safety precautions being taken as well as the locations of the nearest restrooms.

15. Make plans in advance for adequate crowd control.
Make advance plans and provide personnel to ensure that the audience size is maintained at a predetermined level for the activities. This includes control over the entrances to limit the number of persons admitted to the area. Make certain that the number of volunteers is appropriate for the activities and for the expected size of the audience. For hands-on activities, it is very important to control the number of persons having access to the area of the activity.

16. Plan exit routes.
Make certain that there is easy access to and exit from the area of the demonstration or activity. Include an explanation of exit procedures and have adequate personnel to supervise evacuation in case of an emergency.
Be aware of all on-site fire regulations regarding audience size and emergency evacuations.

17. Do not allow consumption of food or drink in the demonstration/activity areas.

18. Have spill kits available that are appropriate for the chemicals to be used.

19. Distribute handouts complete with safety recommendations.
If the description of the activity is distributed, make sure that the procedure is well tested and details all safety related concerns. All ACS materials have undergone safety review and contain appropriate guidelines.

Guidelines for Hands-on Activities

When hands-on activities are planned, regardless of the location, certain precautions must be taken to protect the participants and those directing and assisting with the activity. The protection is necessary regardless of the nature of the activity, even if the "safest of chemicals" are being used. These guidelines must be used in conjunction with one of the two facility guidelines.

1. Pretest all planned activities to ensure that they work and to identify and eliminate any safety problems.

2. Select chemicals that carry a minimum of risk for use in hands-on activities.
Keep in mind common allergies such as those to different varieties of nuts, latex, and sulfites.

3. Explain the procedures clearly to ensure that all participants understand and agree to follow the procedures before beginning the activity.

4. Make provisions to ensure that adequate experienced help is available to carefully oversee the experimenters carrying out the hands-on activities.

5. Supervise participants.
Do not allow unsupervised activity. Do not allow any extension of the planned activity unless approved by the presenters. Prior to starting any activity, discuss safety precautions with the audience as well as the locations of the nearest restrooms.

6. All participants, helpers, and presenters must wear appropriate personal protective equipment.
The safety of all persons involved is paramount. All participants, helpers, and presenters must wear eye protection in the form of chemical splash (cover) goggles (ANSI Z87.1) types G or H. Have a goggle sanitation plan for goggles used by multiple persons. One possible method of sanitation is to immerse the goggles in diluted household laundry bleach (1 part bleach to 9 parts water), followed by thorough rinsing and drying. If the activity is likely to be messy, consider providing disposable laboratory aprons and gloves. If aprons are to be reused, be certain to label the front of the apron. Never reuse disposable gloves.

7. Make all participants aware of all safety precautions.
Do not allow anyone to participate in any activity if they have missed procedural and safety instructions.

8. Exercise caution with flames.
Never use alcohol burners in any type of activity. It is inappropriate to use a flame in a non-scientific facility. If burners are used in a laboratory setting, make certain that the experimenters are old enough to understand the use and dangers involved. Be careful of loose-fitting clothing, and make certain that long hair is tied back or otherwise prevented from hanging down when using burners. Caution must also be exercised when using hotplates. Never use a hotplate to heat flammable materials.

9. Carefully control activities using the sense of smell.
Prepare in advance any activity that involves smelling any substances. Allow only safe, commercially available substances to be smelled. Additionally, these should be at minimal concentrations even if dilution is required. Teach participants about the dangers of smelling chemicals and instruct them in the proper technique—wafting a small amount of vapor from the container to the nose rather than placing the nose directly over the container. Use professional discretion in selecting substances for these types of activities being particularly aware of chemical sensitivities (allergies).

10. Do not perform activities that involve tasting.
This guideline is consistent with the earlier guideline that prohibits the consumption of food or drink in the demonstration areas. In keeping with standard, safe chemical practice, chemists do not taste substances used in their activities.

11. Instruct all participants to wash their hands immediately upon completion of the activity and before leaving the facility in which the activity takes place.

Guidelines for Chemical Demonstrations

When demonstrations are planned, regardless of the location, certain precautions must be taken to protect the presenters, participants, and audience. Protection is necessary regardless of the nature of the activity, even if the "safest of chemicals" are being used. It is recommended that highly hazardous, highly flammable, or carcinogenic substances, such as benzene, carbon tetrachloride, carbon disulfide, and formaldehyde, not be used in any demonstration activity.

These guidelines must be used in conjunction with one of the two facility guidelines.

Minimum Safety Guidelines for Chemical Demonstrations
ACS Division of Chemical Education

Chemical Demonstrators Must:

1. Know the properties of the chemicals and the chemical reactions involved in all demonstrations presented.

2. Comply with all local rules and regulations.

3. Wear appropriate eye protection for all chemical demonstrations.

4. Warn members of the audience to cover their ears whenever a loud noise is anticipated.

5. Plan the demonstration so that harmful quantities of noxious gases (e.g., $N0_2$, $S0_2$, H_2S) do not enter the local air supply.

6. Provide safety shield protection wherever there is the slightest possibility that a container, its fragments or its contents could be propelled with sufficient force to cause personal injury.

7. Arrange to have a fire extinguisher at hand whenever the slightest possibility for fire exists.

8. Not taste or encourage spectators to taste any nonfood substance.

9. Not use demonstrations in which parts of the human body are placed in danger (such as placing dry ice in the mouth or dipping hands into liquid nitrogen).

10. Not use open containers of volatile, toxic substances (e.g., benzene, CCl_4, CS_2, formaldehyde) without adequate ventilation as provided by fume hoods.

11. Provide written procedure, hazard, and disposal information for each demonstration whenever the audience is encouraged to repeat the demonstration.

12. Arrange for appropriate waste containers for and subsequent disposal of materials harmful to the environment.

Revised 4/1/95

Adopt-A-Stream Program Overview

The Adopt-A-Stream program is a "hands-on" way for groups to get involved in improving the water quality of local streams! Organizations register with the "environmental protection" office of their state or local government to clean-up and keep clean a section of a stream or aquifer. In addition to clean-up efforts, volunteers may be asked to monitor water quality and/or pollution sources. Responsibilities vary slightly from one municipality to the next.

Keys to Success

Adopt-a-Stream programs are most successful in areas of the country where people have strong ties to surrounding ecosystems. Because groups are asked to monitor and clean up relatively large geographical areas as part of the program, several volunteers may be needed to successfully implement an Adopt-a-Stream program effectively. Depending on the scope of work to be done, it may be necessary to identify corporate sponsors or other ACS groups (your Local Section and/or area Student Chapters) to help with supplies and/or equipment.

Steps to Identify or Create an Adopt-a-Stream Program

1. Conduct an Internet search to see what kinds of programs are currently available in your area.
2. Find your preferred geographical area.
3. Recognize resources that can be provided – supplies (trash bags, testing materials), tools (rakes, shovels, bow saws, and other gardening equipment) and/or time (a few hours or a few days).
4. Ascertain desired commitment (once a week, once a month, once a year, special event, etc.) and week/time preference.
5. Find a volunteer coordinator to facilitate the project.
6. Create a plan (include goals, benefits of the program, volunteers and sponsoring organizations, and specific volunteer roles).
7. Promote your efforts via your school newspaper, website, posters, flyers, local media.
8. Schedule and hold an orientation meeting for members and volunteers. Members should become familiar with their responsibilities, the ecosystem involved, and the overall scope of the plan.
9. Initiate program.
10. Evaluate the program. (What was successful? What can be improved? Were goals met?)
11. Celebrate what has been accomplished with the members, volunteers, corporate sponsors, your local section and the public.

Benefits from Involvement

By participating in the Adopt-a-Stream program, you are benefiting your local environment. Participation will increase the visibility of chemistry, any sponsors you may have, and your club. Students and teachers involved in the program will grow in their understanding of chemistry and its many contributions to our environment. Sponsors can realize tax-savings through their monetary donations and volunteers will gain from their sense of accomplishment and teamwork.

Adopt-A-Stream Talking Points

- Increases public awareness of water quality issues.
- Conveys concerns for water quality and the environment to the next generation.
- Encourages individuals to take personal responsibility for the quality of local waterways.
- This program provides citizens with the tools and training to evaluate and protect their local waterways.
- This program encourages partnerships between citizens and their local government.
- Our quality of life is directly related to the quality of the rivers, streams and wetlands around us.
- Regular monitoring provides specific information about the health of our local streams and other water bodies, as the water we have now is all the water we'll ever have (Water Cycle).

Publicity Timeline

6 months before program begins:

1. Determine site for project
2. Take "before" pictures. What did the site look like before the program?
3. Determine the scope of the project (e.g. outreach, education, partnerships, service)
4. Determine how to promote the project (school newspaper, school website, community bulletin board, local media)
5. Prepare materials (posters, flyers, signs, invitations, t-shirts)

2 weeks before program begins:

1. Gather sample data from site to use when looking for volunteers/sponsors.
2. Inform your audience through media outlets (email, website, school newspaper, local television and radio stations, local newspaper).

After the Event:

1. Send notes of appreciation to participants and organizers.
2. Send summary of event and photos to school and local newspapers, school website, and hschemclubs@acs.org.

Blood Drive

Convenience, for many people, turns out to be the deciding factor for whether they give blood or not. The American Red Cross works closely with companies, community groups, military bases, churches and synagogues, colleges, universities and high schools to organize blood drives at places most convenient for donors – the places where they live, work, worship, and play. In fact, 80% of blood donations made through the Red Cross occur at blood drives rather than fixed donor centers.

Blood drives need sponsors – organizations that can provide the appropriate physical space and a coordinator to educate, motivate, and recruit donors.

Why do organizations sponsor drives? It is both a simple and a powerful way to serve your community and allow employees/colleagues, students and/or members to get involved. Whether your club is large or small, you can make a difference!

Notes to know

- Donors should be 17 or older. Those students aged 16, may be able to participate with parent consent.
- Contact your local Red Cross Bloodmobile organizer as early as possible. They will let you know if they can accommodate your proposed dates. Some Red Cross locations may need 6 months to a year advance notice.
    - The Red Cross may be able to prepare a mini blood drive in less time. A mini blood drive has about 20 donors.
- Red Cross may need to visit ahead of time to assess the location you are planning to use.

Keys to Success

Your club:

- Offers a suitable location
- Publicizes the drive
- Helps recruit donors within the organization
- Schedules donors for their appointments

The Red Cross does the rest:

- Works with you every step of the way to plan and organize the blood drive
- Helps you determine how many donors to expect and how to recruit them
- Brings equipment/supplies to you, sets everything up and breaks everything down at the end
- Confidentially screens donors and collects the donations safely and professionally
- Schedules or helps you schedule volunteers to greet donors and serve refreshments

Where to start?

If your club is interested in hosting a Blood Drive, call 1-800-GIVE-LIFE (1-800-448-3543) for details, or register online at www.redcrossblood.org/hosting-blood-drive.

Checklist

Here are some simple tips from the Student Chapters that will help you be successful.

1. See the American Red Cross website for a complete checklist.
2. Have planning meetings.
3. Get your ACS Local Section involved. Ask them to assist in promoting and volunteering to help make your Blood Drive a success.
4. Start a publicity campaign: Consider placing an article or announcement in your school newspaper, on your school's website, and on your ACS local section's website. Place an ad in your local newspaper, or post an announcement on a community bulletin board. Send e-mails and/or post to a social networking site, like Facebook.
5. Begin active recruitment of donors. Start to schedule appointments on first contact to increase donor accountability. You will receive the best results through person-to-person contact, phone calls and sign-up tables.
6. Contact your representative at the American Red Cross, as needed, for an update or to ask for assistance.
7. Communicate with the American Red Cross again one week before the drive with your donor sign-up sheet. The American Red Cross representative will work out the details for the day of the drive with you (arrival time, etc.).
8. Send reminder cards or emails to donors. Reminder phone calls really help make sure everyone participates.
9. Remember to thank your donors, student affiliates, local section and other volunteers.

Additional Resources

American Red Cross – www.redcrossblood.org

American Chemical Society – www.acs.org

Blood Facts and Statistics – www.redcrossblood.org/learn-about-blood/blood-facts-and-statistics

Donating 101 for students – www.redcrossblood.org/students/donating-101

Blood Drive Talking Points

- People feel great about saving lives, so blood drives can boost morale, support team-building, and demonstrate that your organization cares about the community.
- One out of three people will use blood products at one time in their life. In that instance, you, your family, and your friends will need the support of volunteer blood donors.
- By hosting blood drives, you can make blood donation convenient, provide essential support to patients in your community, and help the organization become more civically minded.

***Chemistry** is crucial in numerous aspects of blood collection and preservation.*

- The collection bags and tubing are made of plastics – a product of chemical synthesis.
- Blood is separated into fractions. Specific chemicals are added to each fraction of blood for preservation and/or to prevent coagulation. The chemicals are designed to preserve the fraction while not interfering with subsequent test done on that fraction.
- The tourniquet and gloves used for collection are normally made of latex, a naturally occurring chemical. Non-latex synthetic chemical tourniquets and nitrile gloves are manufactured for those who have latex sensitivity.
- Disinfecting chemicals are used on the puncture site. Isopropyl alcohol is used followed by betadine (an iodine containing liquid).

Publicity Timeline

6 months before:

1. Contact the Red Cross to determine the site and date for a Blood Mobile.
2. Determine the who you will be recruiting (student body, teachers, and/or local residents)
3. Prepare materials (poster, flyers, sign-up sheets)

2 weeks before:

Inform the school and/or public through media outlets (school newspaper, website, announcements; local newspaper, television and radio stations).

After the Blood Drive:

1. Send notes of appreciation to participants and Red Cross.
2. Send summary of event and photos to school and local newspapers, school website, and hschemclubs@acs.org.

Lava Lamp

Contributed by the Chi Epsilon Mu (XEM) Chemistry Club at Austin Peay State University

Main Science Idea for Kids

The main idea for kids is the concept of density, in particular, the idea that things that are more dense than a liquid sink and things that are less dense than a liquid float. This activity is interesting because gas is added to and taken away from big drops of water which changes their density and causes them to float or sink in oil. Kids love watching this version of a lava lamp because of the colorful blobs that are moving around. What better way to teach kids about chemistry than to show them something that will captivate them!

Grade Level

We have done this activity with second through fifth graders.

How We Introduce this Activity

The way we introduce this activity is to ask the kids if they know what a lava lamp is, and if they do, how it works. We'll also ask them other questions about density, gas, and surface tension. These questions get the kids interested and their minds active. It gets them to think without them knowing that they're doing it because we're making it fun. Once we get some good guesses and answers, we demonstrate the lava lamp along with explanations as each phenomenon occurs.

Materials

- Alka-Seltzer® or generic effervescent-antacid-and-pain-relieving tablet
- Vegetable oil
- Water
- Tall clear plastic container (1 or 2 liter bottle)
- Food coloring (neon colors work well)

Procedure

1. Fill the bottle about 2/3 full with oil.
2. Add food coloring for color. You want it to be fairly dark but not too dark.
3. Fill the rest of the bottle with water, but don't fill it to the brim.
4. Add a half or quarter of an Alka-Seltzer tablet to the bottle. Watch what happens!

The Chemistry Explanation

Before the Alka-Seltzer is dropped in the bottle, the oil floats on the colored water. Oil floats because it is less dense than water. Oil and water don't mix because water molecules are not attracted to oil molecules.

When the Alka-Selzer tablet is dropped in the oil and water, it sinks to the bottom because it is more dense than oil and more dense than the water. In the water layer, the tablet begins to dissolve and the chemicals in the tablet react with each other creating bubbles of carbon dioxide gas. When enough gas enters an area of water, the water-and-gas combination in this spot becomes less dense than the water around it, so it floats up through the water. If this water-and-gas mixture is less dense than the oil, it floats up through the oil too. Since the water is so attracted to itself and not to the oil, the water-and-gas mixture moves through the oil in a ball-shape. Once a ball of water-and-gas gets to the surface, some bubbles of carbon dioxide gas pop, releasing the gas into the air. When enough bubbles pop, the water-and-remaining gas becomes more dense than the oil. So the ball of water sinks down through the oil and joins the rest of the water.

Changes in density as gas is added to or taken away from water cause it to float up and sink down through the oil. Thus the lava lamp is created!

Why We Like this Activity

This activity is simple and provides a great demonstration for kids. This experiment allows the kids to see what is happening as you explain what and how it is occurring. The kids understand these concepts easier if they can see what is happening. This provides a great learning experience and makes chemistry fun.

Chi Epsilon Mu (XEM)Chemistry Club
Austin Peay State University
Clarksville TN

About Us

We perform various demonstrations for local elementary school students to get them interested in chemistry. We answer their questions about science and help them understand what is going on. We are restarting a program to help elementary students with their science projects.

Bruno the Elephant's Toothpaste

Contributed by the Elizabethtown College Student Affiliates of the American Chemical Society

Main Science Idea for Kids

In this activity, students will see that new substances are created during chemical reactions. In this case, students will notice that a gas is produced and responsible for the foamy "toothpaste". Students will be introduced to the idea that scientists can use special chemicals called *catalysts* to help make reactions happen a little bit faster than they normally do.

Grade Level

We have done this activity with 1st through 5th graders.

How We Introduce this Activity

We begin by introducing our chapter's pet elephant, Bruno. We explain to the students while Bruno is still asleep, we have to make his toothpaste. He doesn't like to wait for it to be made. Usually, it takes a long time to make elephant toothpaste. They are big animals with big teeth so they need a lot of toothpaste! We then tell the students that we have found a new way to make a lot of elephant toothpaste a lot faster. We show the ingredients to them and let them choose the color stripes they would like Bruno's toothpaste to have. While we add dish soap to make the visualization of the reaction more exciting, we tell the students that the dish soap is really what will clean Bruno's teeth.

Materials

- 20 ounce soda bottles for each student or group
- Dishpan for each student or group
- 3% hydrogen peroxide (grocery store strength)
  About 120 mL per trial
- Yeast (fast-rising works best)
  Expect 8-12 reactions per ¼ oz. yeast packet
- Dawn dish detergent
- Food coloring
- 3 ounce Dixie cups
- Safety glasses

Procedure

1. Fill a Dixie cup about ¾ of the way with warm water (warm water is important!).
2. Add ⅛ teaspoon of yeast and stir. Allow the yeast to dissolve in the warm water for at least 5 minutes.
3. Place a clean, empty soda bottle in a dishpan.
4. Add about 100 mL of hydrogen peroxide to the soda bottle. This should fill about $^{1}/_{5}$ of the soda bottle.
5. Add in a few drops of the food coloring of choice. You can get creative here--make stripes down the sides of the bottle, mix colors, or color all of the toothpaste the same color!
6. Add a big squirt of the dish detergent to the soda bottle.
7. Add the contents of the Dixie cup of the yeast solution to the soda bottle. Don't get too close to the bottle!

The Chemistry Explanation

The main concept this activity introduces is how chemists use catalysts in reactions. Sometimes reactions will happen very quickly without any outside encouragement, but other times the reactions need a little boost. If this is the case, chemists will try to find a good catalyst. Catalysts help the starting materials, or reactants, find a better pathway to make the products. Better paths usually need less energy to follow.

In yeast, there are enzymes present whose job is to catalyze a variety of reactions. In this demonstration, the enzyme called "peroxidase" has the job of breaking hydrogen peroxide down into water and oxygen. Peroxidase in the yeast makes the reaction happen a lot faster than if we just left the hydrogen peroxide sitting in the room.

This activity also shows that gases can be a product of a reaction. We usually can't see gases being produced, but the dish soap we add to our container traps oxygen as it is released from hydrogen peroxide. The dish soap is responsible for the "wow" factor we see. The students can make predictions of how the reaction will change with different conditions (more yeast, less peroxide, etc.).

Why We Like this Activity

We really like telling the story to the kids. Some of them get really excited at the prospect of us having a pet elephant whose teeth need brushing! We are also able to do this activity as a demonstration (using reagents from our stock room) or as a hands-on activity (using household chemicals). This is the kind of activity that can really get kids excited about science; they love to see things that change colors or seem to "explode." This reaction produces a lot of colored foam that seems to come out of nowhere. Their reactions are always really fun to watch! It's also a pretty inexpensive demo for us to do multiple times with the students.

Elizabethtown College Student Affiliates of the American Chemical Society Elizabethtown PA

About Us

We participate in our campus-wide day of service called "Into the Streets." The Activities Fun Fair is a part of that day of service. Each child selects 4 or 5 activities in different disciplines (i.e. music, dance, art, science, business). In the past, we have also hosted guest speakers whose presentations were open to the public. We also celebrate NCW and Earth Day in the campus community each year.

ACTIVITY

How to make slime!

To make a great variety of slime, use the following procedure. The slime forms because of cross-linking between the protein molecules of white glue and the borate ions of borax.

1. Make a saturated borax solution by adding 1 g of borax to 25 mL of water. Stir thoroughly until the borax has completely dissolved.
2. In a disposable plastic cup, add 50 mL of white glue and 50 mL of water. Stir thoroughly. (You may use more or less glue, as long as you maintain a 50:50 ratio between the glue and water.)
3. If desired, add a few drops of food coloring and stir thoroughly.
4. Using an eyedropper, add the borax solution a few drops at a time to the glue–water mixture and stir thoroughly with a stirring rod. The slime will collect on the stirring rod. Continue adding the borax solution until most of the glue–water mixture has turned into slime. Be careful not to add too much borax solution, or the slime will become too stiff. A good rule of thumb is to quit adding the borax solution when there is still a little glue–water mixture left in the bottom of the cup. This way, you will not add too much borax.
5. Remove the slime from the stirring rod with your fingers and work it with your hands until it is no longer sticky. The more you work it with your hands, the nicer its consistency. Store it in a Ziploc bag.
6. The excess borax solution can be poured down the drain and the cups disposed of in the trash.

Try a variation! To make fluorescent slime that will fluoresce brilliantly under a black light, prepare some fluorescent water to use in place of the ordinary water that is added to the glue. Prepare the fluorescent water by removing the tip from a fluorescent highlighter and placing it in a beaker containing up to 500 mL of water. After a few minutes, the water will be highly fluorescent. When this water is used to make slime, the slime will be highly fluorescent under a black light.

MIKE CIESIELSKI

Brian Rohrig is a chemistry teacher at Jonathan Alder High School in Plain City, OH. His newest book: *Pure Slime—50 Incredible Ways to Make Slime Using Household Substances*, can be purchased at www.fizzbangscience.com.

Pop Rockets

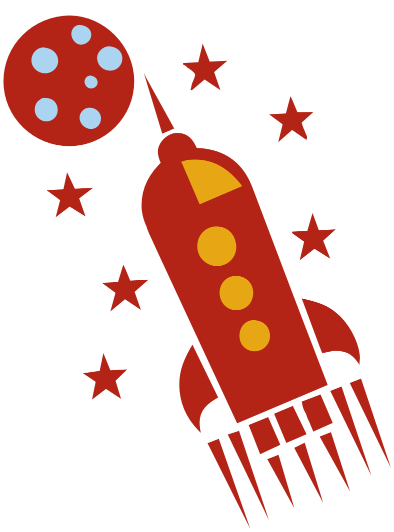
One important characteristic of gas is pressure. Increasing the amount of gas in a container can raise the pressure of a gas. In this activity, you will use the build-up of gas pressure to launch a film-canister rocket.

Materials

File folder or card stock
Blunt-end scissors
Glue
Empty film canister
Double-sided tape
Half of an effervescent antacid tablet
Water
Stopwatch

NOTE: This activity can be messy and should be conducted outside.

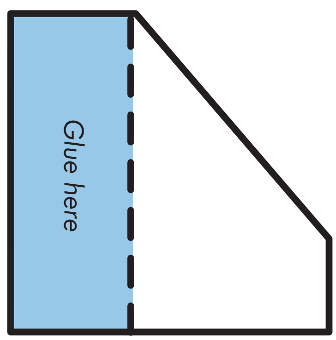
SAFETY! *SAFETY: Be sure to follow Milli's Safety Tips and do this activity only with adult supervision! Do not eat or drink the water used in this activity! Eye protection must be worn by everyone present in the launch area!*



Procedure

Build the Rocket

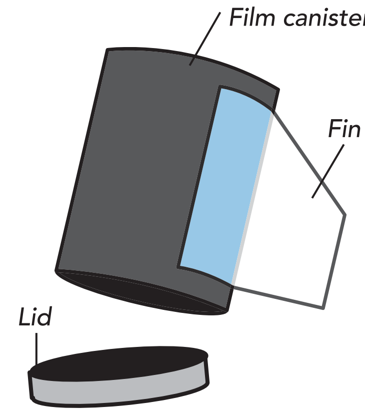
1. To make fins for the rocket, trace the pattern below (four times) onto a file folder, or a piece of card stock.
2. Cut along the solid lines so that you make four fins.
3. Fold the fins along the dotted lines.
4. Place glue on each of the fins in the area marked "Glue here" in the picture above, and attach each of the fins to the film canister. Be sure to have the point of the triangle towards the closed end of the canister and to leave enough room to put the lid on the open end of the canister.
5. Fold the fins so they stick straight out from the canister.



Make 4 of these

Fuel the Rocket

1. Ask your adult partner to help you select an appropriate area outside for the launch of your rocket.
2. Fill the canister half full of water.
3. Tape the half tablet of the effervescent antacid inside the lid of the canister using a piece of double-sided tape.
4. Close the canister, quickly place it on the launch area with the lid at the bottom, and take at least three big steps backwards.
5. The tablet should produce enough gas in the canister to pop off its lid, which will propel the rocket into the air.
6. Dissolve any unreacted pieces of the effervescent tablets by placing them in a bowl of water. Thoroughly clean the work area and wash your hands.
7. Record your experimental data in the "What Did You Observe?" section.



Where's the Chemistry?

Effervescent antacid tablets contain an acid and a base, similar to baking powder. When the acid and base are dry, they do not react, but when they dissolve in the water, they react to produce carbon dioxide gas. As the gas is formed, pressure builds up until, finally, the cap is blown off the canister and your rocket is launched.

What Did You Observe?

How many seconds did it take for the rocket to launch after it was sealed?

_____ seconds

About how high did the rocket go into the air?

_____ meters

The American Chemical Society develops materials for elementary school age children to spark their interest in science and teach developmentally appropriate chemistry concepts. The *Activities for Children* collection includes hands-on activities, articles, puzzles, and games on topics related to children's everyday experiences.

The collection can be used to supplement the science curriculum, celebrate National Chemistry Week, develop Chemists Celebrate Earth Day events, invite children to give science a try at a large event, or to explore just for fun at home.

Find more activities, articles, puzzles and games at www.acs.org/kids.

Safety Tips

This activity is intended for elementary school children under the direct supervision of an adult. The American Chemical Society cannot be responsible for any accidents or injuries that may result from conducting the activities without proper supervision, from not specifically following directions, or from ignoring the cautions contained in the text.

Always:

- Work with an adult.
- Read and follow all directions for the activity.
- Read all warning labels on all materials being used.
- Wear eye protection.
- Follow safety warnings or precautions, such as wearing gloves or tying back long hair.
- Use all materials carefully, following the directions given.
- Be sure to clean up and dispose of materials properly when you are finished with an activity.
- Wash your hands well after every activity.

Never eat or drink while conducting an experiment, and be careful to keep all of the materials used away from your mouth, nose, and eyes!

Never experiment on your own!

For more detailed information on safety go to www.acs.org/education and click on "Safety Guidelines".

Milli's Safety Tips

from **Celebrating Chemistry**

Always:

- Work with an adult.
- Read and follow all directions for the activity.
- Read all warning labels on all materials being used.
- Wear eye protection.
- Follow safety warnings or precautions, such as wearing gloves or tying back long hair.
- Use all materials carefully, following the directions given.
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Never experiment on your own!

For more detailed information on safety go to www.acs.org/education and click on "Safety Guidelines".

Education/Career Planning

Education and Career Planning

Your students may have an interest in learning more about collegiate study in chemistry or careers in chemistry. The following are suggestions for activities related to post-secondary education in chemistry and career planning. Keep in mind that members of Local Sections and Student Chapters are great resources for more information about education and careers pertaining to chemistry.

Education

- Invite members from a Student Chapter to speak with students about chemistry and chemistry-related courses of study as potential majors.
- Arrange a visit to an area college or university to sit in on a chemistry class and/or visit the laboratory.
- Provide information on colleges and universities with ACS Approved Chemistry Programs. To find the ACS-approved program go to www.acs.org/education and follow the path Students>High School>College Planning>Find an ACS Approved Chemistry Program.
- If possible, maintain a bulletin board advertising summer activities relevant to chemistry and the physical sciences (internships, jobs, classes).

Career Planning

- Invite a scientist to speak with students about their work.
- Some students may be interested in shadowing a chemist for a day to observe the profession first hand.
- Arrange a visit to a local industry or chemistry-related government agency (i.e. water treatment plant).
- Maintain a bulletin board and/or binder profiling different careers in the chemical field on a monthly basis. A starter group of career profiles can be found later in this section. You can find more career profiles by going to www.acs.org and follow the path Careers>What Chemists Do.

Inviting Speakers

Local Sections and Student Chapters are great resources for speakers. Students can form meaningful connections with these ACS members who have chosen to study chemistry and/or pursue chemistry as a career.

To locate a speaker in your local section or local Student Chapter, see the information provided in the "ACS Resources" document located under the American Chemical Society Section or visit www.acs.org. Also, consider contacting the community outreach office of a local company to locate interesting speakers.

When inviting speakers, you may want to consider the following:

- Have the publicity committee make eye-catching posters, ads in the student newspaper, and announcements over the public address system announcing this event.
- Share the opportunity with other science teachers. Encourage them to attend and to invite their students to attend.
- Coordinate with another school club to plan and execute the event.
- Inform the speaker of the audience and its interest/level of chemical understanding. This may help him/her create a presentation that will address the needs of your students more effectively. Determine the speaker's presentation/equipment needs.
- Have students send a thank-you letter to the speaker for giving his/her time and resources.

Visiting Off-Campus Sites

Local Sections are an abundant source for industry and government scientists willing to provide plant/laboratory tours. Similarly, your local Student Chapter may be willing to host your chemistry club for a day on campus. Also, consider contacting area industry directly to arrange tours and/or trips.

When planning an off-campus activity, you may want to consider the following:

- Review your school regulations to determine protocol for taking students off-campus and for arranging transportation.
- Arrange your tour/trip well in advance
- Establish the appropriate dress code for the site (e.g., no shorts or open-toed shoes)
- Have students send thank-you letters to the appropriate individual(s).

Biotechnologists

… Improve natural and synthetic materials

Biotechnology is the application of biological organisms, systems, or processes to alter and improve both natural and synthetic materials. Biotechnology aims to improve the value of materials and organisms such as pharmaceuticals, crops, and livestock. It is a relatively new and fast-developing field that integrates knowledge from several traditional sciences: biochemistry, chemistry, microbiology, and chemical engineering.

Biotechnology has more to do with chemistry than was ever imagined. It depends on the ability to manipulate chemical structures. The field looks promising for innovations made to medicine ranging from improving the diagnosis and treatment of hereditary diseases, to safer drugs, to more environmentally friendly herbicides and pesticides, to microbial processes that clean up the environment. Making such promise a reality requires rethinking some fundamental assumptions.

Biotechnology companies are integrating the sciences, bringing new perspectives from various fields such as chemistry, biochemistry, and genetics to tackle biomedical questions. The biotechnology industry has realized that it needs a better understanding of both biology and chemistry to discover new products, and now, more companies are hiring chemists than ever before.

Chemists who work on biotechnology drug development use biological products like peptides, DNA, and amino acids to develop a molecule that will bind to receptors in the human body. Once companies achieve this result, they can begin to produce a new drug.

… Combine teamwork, scientific skills, and interests

Success in biotechnology requires years of work and almost constant interaction among scientists, including peptide chemists, crystallographers, and molecular modeling specialists. Everything is a team project, and it is unusual to work alone. Therefore, chemists in biotechnology must be able to work with others. Although a team brings together specialists, individuals must be well-rounded with a variety of skills. The more skills you have, the more valuable you are to a company.

Because biotechnology requires a grasp of many different scientific disciplines, chemists suggest starting in high school with courses in biology, chemistry, and genetics. In college, you can gain a sense of whether this area is for you by taking a good molecular biology course.

In this business, one must also be highly motivated. A research scientist must be a good chemist with good laboratory skills and must enjoy studying biotechnology.

… Have many career possibilities

Opportunities are opening up for chemists across the biotechnology industry, offering the chance to work on the cutting edge of a dynamic and still largely developing field. Although each company is structured differently, most biotechnology firms operate with a hierarchy of senior scientists, scientists, and research assistants. In general, each advance to a more senior position requires an additional academic degree. One can reach the level of scientist in a biotechnology lab with a bachelor's degree, but it takes hard work and great creativity.

Experience shows that a scientist must have a Ph.D. to advance in this field. A lot of ambitious research assistants work one year and then go back to graduate school. Scientists with Ph.D.s follow a more creative career path in which the work they do is not much different from that of a scientist in an academic environment. In fact, many biotechnology companies were founded by academic scientists who took their projects out of universities and into a commercial environment.

In a commercial company, one is often surrounded by dedicated, intellectual, and motivated people. Some scientists feel that for all the advantages of academe, it can be isolating. In industry, a scientist has more opportunity to interact with other people.

However, a career in industry may mean making a decision early on about whether your career will follow a research or a more administrative track. On a research track, a scientist spends more time at the bench, advancing to higher levels of scientific research. A managerial track can involve job functions from running the laboratory to developing the company's overall business and marketing plans. Opportunities vary considerably depending on the company and, perhaps more often, on the personality and goals of the individual scientist.

American Chemical Society, Education Division,
1155 Sixteenth Street, NW, Washington, DC 20036; 800-227-5558; chemistry.org

Originally produced with funding from the Alfred P. Sloan Foundation as part of its Science Career Cornerstone Series.

FACT FILE: Biotechnologists

WORK DESCRIPTION ► Biotechnology, in the broadest sense, involves the use of living organisms or cell processes to make useful products. To date, the major thrusts of the biotechnology industry have been in drug development, human and animal nutrition, agricultural chemicals, and environmental protection. The cloning of insulin used to treat diabetics was one of the earliest biotechnology breakthroughs in human health care. In the future, it is hoped that biotechnology will have solutions for treating, if not curing, genetic disorders. In the field of agricultural chemicals, biotech scientists are focusing on developing plants that produce their own insecticides. If this goal is achieved, it may be possible to save many plants from destruction. In another area, biotechnologists are using selective breeding processes to develop fruits, vegetables, and grains with such favorable attributes as higher yields, longer shelf life, and better taste.

WORK ENVIRONMENT ► Chemists in biotechnology generally work in a laboratory atmosphere not unlike an academic environment. The laboratory may be involved in 5–10 projects, and the scientists may have varying degrees of responsibility for each project. Teamwork is a vital part of the biotechnology industry, and it is unusual to work alone. Most chemists in biotechnology say they work more than 40 hours a week, although they add that this is largely an individual choice and not necessarily required.

PLACES OF EMPLOYMENT ► Most biotechnologists work for small, innovative biotechnology companies that were founded relatively recently by scientists. However, as the field has developed, many major drug companies have added biotechnology divisions. Chemical companies with large agricultural chemical businesses also have substantial biotechnology labs. Biotechnology companies are generally located near universities. The business to date has been regional, although this is changing as more pharmaceutical and agricultural chemical companies across the country start up biotechnology divisions. Still, biotechnology firms are largely located in six to seven major cities. These include San Francisco and Boston (the traditional homes of biotechnology firms), Chicago, Denver/Boulder, San Diego, Seattle, and Research Triangle Park, NC.

PERSONAL CHARACTERISTICS ► A chemistry student interested in entering this field should keep in mind the interdisciplinary nature of biotechnology. While it is important to have a strong background in your own discipline, scientists must have the mental flexibility to pick up and incorporate other approaches. Most work is done in teams, making strong communication and interpersonal skills vital to success in this field.

EDUCATION AND TRAINING ► Although individuals have advanced in biotechnology with only a bachelor's degree, most scientists say it is necessary to have a Ph.D. to be given the responsibility to do creative work. Many bachelor’s degree candidates work at a biotechnology firm as a research assistant for one to two years before pursuing an advanced degree.

SALARY RANGE ► Starting salaries are in the mid $40,000-per-year range for candidates with a bachelor's degree. Individuals with a master's degree generally start at about $50,000 per year, and those with doctorates begin at $80,000 to $100,000 per year. The median salary for individuals with a Ph.D. and about 10 years experience is approximately $95,000 per year.

JOB OUTLOOK ► Opportunities for chemists in biotechnology are undoubtedly growing as the field matures and branches outside molecular biology. Although jobs in biotechnology will probably never be as plentiful as they were in the past 10 years, the employment outlook is still considered very good. As more entrepreneurs begin new businesses and more existing companies advance in the biotechnology field, the demand for biotechnologists will increase. In addition, as more biotechnology products now in development reach the phase when they are ready for market, there will be increasing demand for chemical engineers to work on some of the production and scale-up problems encountered in making biotechnology products in bulk. There is also growing demand for bachelor's chemists in sales and marketing.

FOR MORE INFORMATION

The Biotechnology Industry Organization
1625 K Street NW, Ste. 1100
Washington, DC 20006-1621
202-857-0244
www.bio.org

WHAT YOU CAN DO NOW ► Get as much background in biology, chemistry, and genetics as you can. All these disciplines are critical in biotechnology, and being well-rounded only works to your benefit. Lab experience is also important. Most companies have summer student programs and students profit from this experience by finding out if this is a field they might enjoy. The earlier you participate in this type of experience, the more advantages you will reap.

Chemical Engineers

. . . Take chemistry out of the lab and into the world

Chemical engineers apply the principles of chemistry, math, and physics to the design and operation of large-scale chemical manufacturing processes. They translate processes developed in the lab into practical applications for the production of products such as plastics, medicines, detergents, and fuels; design plants to maximize productivity and minimize costs; and evaluate plant operations for performance and product quality.

Chemical engineers are employed by almost all companies in the chemical process industry. Their work also extends to processes in nuclear energy, materials science, food production, the development of new sources of energy, and even medicine. In addition to process and product development and design, chemical engineers work in areas such as production, research, environmental studies, market analysis, data processing, sales, and management. They affect or control at some stage the materials or production of almost every article manufactured on an industrial scale.

. . . Focus on kinetics

Chemical engineering is broader in scope than the other branches of engineering because it draws on the three main engineering foundations: math, physics, and chemistry—whereas the other branches are based on only the first two. A specific interest in chemistry combined with an aptitude for math and science attracts individuals to the profession. The curriculum of study for chemical engineering is similar to that for chemistry but includes course work in engineering-related areas such as thermodynamics, fluid dynamics, process design, and control and electronics.

A chemical engineer's work involves applying chemists' findings to large-scale production. They take what a chemist does—synthesizing a small amount of a material—and scale it up to make several hundred tons per day. This process includes determining how to separate the desired product from its impurities. Chemical engineers focus more on kinetics and are concerned with things such as fluid flow and heat transfer on a large scale. These are things that a chemist does not necessarily have to worry about with smaller reactions in beakers, and a chemical engineer must design equipment that will accommodate these concerns.

Once processes and equipment are designed, chemical engineers remain on hand at a production facility to solve problems that occur as the processes continue. When changes occur that upset a running system, chemical engineers analyze samples from the system, looking at parameters such as temperatures, pressures, and flow rates to determine where the problem exists. They also work on expanding projects, evaluating new equipment, and improving existing equipment and processes. Meeting safety, health, and environmental regulations is also a large part of a chemical engineer's work life.

. . . Receive education on the job

Chemical engineers say that work experience is an extension of their education in the field. In school, one learns about the theory, but on the job, one learns real-world applications. At work, a chemical engineer must focus on manufacturing and the problems that arise, the real nuts and bolts of engineering. A degree is the key to starting a career in chemical engineering, but on-the-job training is what makes one good at it.

Gaining experience while still in school helps many individuals decide on their career paths. Many chemical engineers have held internships with their present employers that led them to a career in their respective areas. Undergraduate work experience helps students decide which areas they are most interested in.

Experienced chemical engineers might typically analyze new processes from a firm's research and development department. They would examine the economics of the project, and make suggestions about the process or recommend whether the new process should be developed. A chemical engineer who previously obtained experience working as a co-op student for the company, however, might gain the background and experience to obtain such a position more quickly than someone lacking that edge.

. . . Have a satisfying career

Chemical engineers enjoy considerable variety in their work. Projects vary greatly by type and through different stages of development. They can include performing bench-top experiments, writing reports, making technical presentations, or turning out production-scale trial batches. Someone who focuses on reaction engineering, for example, transfers new or improved chemical processes from bench-scale to commercial-scale equipment. Chemical engineers enjoy the satisfaction of developing an idea from it's initial laboratory stages to a full-fledged commercial process.

Originally produced with funding from the Alfred P. Sloan Foundation as part of its Science Career Cornerstone Series.

FACT FILE: Chemical Engineers

WORK DESCRIPTION ► Chemical engineers design and operate plants and processes for large-scale production of chemical products. They use chemistry, physics, and mathematical equations to solve real problems and design ways to produce products safely and economically.

WORKING CONDITIONS ► Chemical engineers typically work in manufacturing plants, research laboratories, or pilot plant facilities. They work around large-scale production equipment that is housed both indoors and outdoors. Often they are required to wear protective safety equipment, such as hard hats, goggles, gloves, and steel-toed shoes. Workdays may involve moving from place to place within a facility. Chemical engineers also work in business and management offices. These positions, however, often require visiting research and production facilities. Interaction with other people who are part of a team is critical to the success of projects.

PLACES OF EMPLOYMENT ► Chemical engineers are employed by almost every type of company in the chemical process industry; they work in a variety of settings, such as research, design, process control, sales, economic analysis, and management. Petroleum refineries and the pharmaceutical, biotechnology, and service industries also employ them. Approximately three-quarters of all chemical engineers are working in manufacturing industries; the balance are employed by government or academia or are self-employed.

PERSONAL CHARACTERISTICS ► A strong interest in chemistry, math, and physics is vital to success in this field because chemical engineering draws on all three disciplines. Chemical engineers are trained to apply lab processes to large-scale production, monitor processes, and understand highly technical material. As a result, thinking analytically, solving problems, and being creative are essential. Because projects often involve complex processes and problems that require teamwork and the preparation of reports, good interpersonal, oral, and written communication skills are highly desirable.

EDUCATION AND TRAINING ► To enter the field, professionals must have at least a four-year bachelor's degree in chemical engineering that includes course work in physics, math (through differential equations), and computers. A chemical engineer's curriculum is similar to that of a chemist, but also includes course work in engineering-related areas such as heat and mass transfer, thermodynamics, fluid dynamics, process design and control, and electronics. Economics, psychology, and political science help chemical engineers to understand the impact of technology on society. Chemical engineers say that although they learn a lot of theory in the classroom, most of their knowledge of real-world applications is derived from on-the-job training.

JOB OUTLOOK ► The demand of the past few years for chemical engineers at major chemical and pharmaceutical companies is expected to continue. As the biotechnology industry continues to grow, opportunities for chemical engineers will expand. Chemical engineering research jobs are becoming increasingly important as a result of the development and large-scale implementation of new energy sources designed as substitutes for the world's diminishing supplies of petroleum and natural gas.

SALARY RANGE ► Traditionally, few chemical engineers go on for graduate degrees. For more than a decade, the starting salaries for those with a B.S. degree in chemical engineering have topped the engineering and science fields. In 2004, the median yearly salary for industrial chemical engineers with 10 years of experience was $60,000 with a B.S. degree, $85,000 with a master's degree, and $100,000 with a Ph.D. Academic salaries for a chemical engineer with a Ph.D. range from $80,000 to over $100,000.

FOR MORE INFORMATION

American Institute of Chemical Engineers (AIChE)
3 Park Avenue
New York, NY 10016-5991
1-800-242-4363
www.aiche.org
AIChE has also produced career materials as part of the Sloan Career Cornerstone Series.

WHAT YOU CAN DO NOW ► Find a mentor and/or summer work experience in the process industry. This helps you determine your areas of interest. Consider a variety of industries when planning for a career in the field—pharmaceutical companies, oil companies, and the government—not only chemical companies. Develop written and oral communication skills. Participate in activities that call for teamwork, require analytical skills, and offer opportunities to interact with others.

Environmental Chemists

... Are concerned with environmental impact

What happens to the chemicals in an industrial cleaner after you pour it into the sink? When you see black smoke pouring out of the chimney at an industrial complex, what impact is it having on the atmosphere? These are the types of questions environmental chemists seek to answer.

The fate of chemicals in the environment and their effects are matters of increasing concern to specialists in environmental management. "Fate" involves studying where chemicals show up in streams, rivers, and air. Such pollution contains molecules that have not been removed in water treatment plants, caught by the filters in industrial smokestacks, disposed of properly, or successfully sealed in containers.

As concerns about geochemistry and the natural environment increase, environmental chemists also study the processes that affect chemicals in the environment. Gases emitted by a pine forest may create a mist when mixed with car exhaust, for example. In other instances, the environment may have effects on chemicals that can be toxic. Environmental chemists examine the ways both chemicals and the environment are changed by interacting.

... Manage our environment

Until about 20 years ago, those studying environmental contamination focused almost exclusively on the fate and effects of chemicals because the technology to measure the damage did not exist. As the technology for measuring leakage from landfills was developed, for example, industry recognized the potential for chemicals to negatively impact the environment—and the attendant social, political, and economic ramifications. As a result of these new data, chemists were able to help design pollution abatement systems that minimize the unwanted elements escaping into the environment. They also applied their knowledge to develop remediation systems to clean up contaminated areas.

As industry takes an increasingly proactive approach to environmental management, chemistry's role should continue to grow. For many chemical companies, this may involve redeveloping a chemical product to come up with functional groups or compounds that are more compatible with the environment. For example, one major corporation has used catalysts to develop a new production process for methylisocyanate, a highly flammable and hazardous material that is dangerous to transport. The new production process allows the chemical to be manufactured at the site where it is used, avoiding the risks of shipping and storing.

As waste disposal has become increasingly expensive, industry also has grown more interested in finding ways to solve waste problems. Many solutions involve making industrial processes more efficient, which cuts costs. In addition, environmental chemists study the effects of chemicals other than pollutants on the environment.

... Work in a broad-based discipline

Because our environment is so complex, environmental chemists always underscore the interdisciplinary nature of their field. Environmental chemists must be able to understand and use the terminology of a range of other disciplines, including biology, geology, ecology, sedimentology, mineralogy, genetics, soil and water chemistry, math, and engineering. They may be involved in analytical testing, new product development in the lab, fieldwork with users of chemicals, and safety and regulatory issues. Many opportunities exist to move into different areas of expertise, often outside the lab. Many chemists return to school to study public policy, law, or business—applying their chemistry know-how in new ways. For example, knowledge of chemical processes is often vital for an individual who works in a corporation's regulatory affairs department and must ensure compliance with government regulations.

Environmental management is becoming a popular career track. Students who hold degrees in environmental sciences are finding jobs throughout the chemical industry, often working alongside geologists, biologists, and chemists.

Most environmental chemists emphasize that a solid foundation in chemistry is important to this work. Chemistry students interested in applying their training to an environmentally oriented job are encouraged to take courses in environmental studies. Potential employers look favorably on this as an indication of interest and ability to think in an interdisciplinary manner.

American Chemical Society, Education and International Activities Division,
1155 Sixteenth Street, NW, Washington, DC 20036; 800-227-5558; chemistry.org

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FACT FILE: Environmental Chemists

WORK DESCRIPTION ► "Environmental chemist" is a general term. In fact, most chemists in the field would probably describe themselves more specifically by the work they do. This work may focus on collecting and analyzing samples, developing remediation programs, changing production processes to yield a more environmentally friendly product, providing expert advice on safety and emergency response, or dealing with government regulations and compliance issues.

WORKING CONDITIONS ► Work is often done in an indoor lab environment. However, when studying chemicals in the environment, a riverbed or stream may become the lab. Some companies have sophisticated indoor ecosystems in which they test their products. Others collect data outdoors and miles away from their own production sites.

PLACES OF EMPLOYMENT ► The chemical industry employs a huge number of environmental chemists to ensure that a given company is in compliance with government regulations. Government agencies such as the U.S. Departments of Agriculture and Defense and the U.S. Environmental Protection Agency hire chemists for environmental work. In addition, waste management companies and consulting firms employ such chemists to do consulting or remediation work. Colleges and universities are hiring more environmental chemists as they establish programs in environmental chemistry.

PERSONAL CHARACTERISTICS ► Because environmental chemistry is so interdisciplinary, it requires excellent interpersonal and communication skills along with the ability to express ideas efficiently to a nonscientific audience. The importance of the latter becomes apparent when chemists deal with regulations or with a company's sales and marketing staff. As the field of environmental management expands globally, chemists who speak other languages may experience additional success.

EDUCATION AND TRAINING ► Environmental chemists come from various backgrounds, and there is no one path into the field. However, your college or university may have an ACS-Approved Chemistry Program with an Option in Environmental Chemistry, which is a good starting point. Experienced professionals emphasize the competitive advantage of obtaining advanced degrees. However, because the field is growing so rapidly, opportunities exist for individuals with an associate's degree. Also, students are encouraged to take courses outside the traditional chemistry curriculum, such as advanced math and engineering courses.

Companies often hire graduates from schools with well-established programs. Employers also look for candidates who demonstrate the ability to broaden their skills and think in an interdisciplinary manner. Course work in subjects such as biology, geology, hydrology, or toxicology would be indications of such abilities.

JOB OUTLOOK ► Because of increased government regulations, job opportunities for environmental chemists continue to grow. Despite downsizing, companies are placing greater emphasis on compliance and environmental processes. Opportunities exist for chemists to move into various areas of expertise outside a traditional job in the lab. For those also studying law, business, or public policy, opportunities can be found in the regulatory area as well as in health and safety.

The field is expanding to include nontraditional employers. Opportunities are expected to grow in contract labs and consulting, because businesses are increasingly outsourcing this work.

SALARY RANGE ► The starting salary for a Ph.D. chemist is in the $70,000-per-year range in industry. For master's chemists, $40,000–$50,000 is an average starting salary. Bachelor's chemists can earn from the mid-$30,000s to the low $40,000s.

An individual going into the regulatory side of environmental chemistry is likely to start at a higher salary and continue to be paid more because these jobs are more high-profile and require taking responsibility for a company's liability. Although the work an analytical chemist does to reduce contamination is important, the chemist–regulator who negotiates a company out of trouble will receive more recognition and better compensation.

FOR MORE INFORMATION

American Chemical Society
Division of Environmental Chemistry
1155 16th Street, NW
Washington, DC 20036
800-227-5558
www.envirofacs.org

U.S. Environmental Protection Agency Regional Offices
(Check the government section in your local telephone book.)

WHAT YOU CAN DO NOW ► Because career choices abound, students should think about the type of work that interests them and what discipline, besides chemistry, they want to emphasize in school. Since many colleges have environmental sciences or environmental engineering programs, students can investigate potential employment areas before entering the job market. Environmental chemists in industry also suggest reading environmental journals such as the American Chemical Society's *Environmental Science & Technology* and taking courses in industrial chemistry and chemical engineering.

Forensic Chemists

… Apply scientific disciplines to physical evidence

A forensic chemist is a professional chemist who analyzes evidence that is brought in from crime scenes and reaches a conclusion based on tests run on that piece of evidence. A forensic chemist's job is to identify and characterize the evidence as part of the larger process of solving a crime. Forensic chemists rarely conduct any investigative work; they handle the evidence collected from the crime scene. Evidence may include hair samples, paint chips, glass fragments, or blood stains. Understanding the evidence requires tools from many disciplines, including chemistry, biology, materials science, and genetics. The prevalence of DNA analysis is making knowledge of genetics increasingly important in this field.

…Explain and defend results

Forensic chemists agree that public speaking skills and being comfortable with what you do are important personal characteristics for this career. As seen on *Court TV,* forensic chemists are often called upon to explain what was found and how they arrived at their conclusions.

Not all cases go to trial, but when one does, giving expert testimony in court is a significant piece of a forensic chemist's job. Some employers require their forensic chemists to go through several months of mock courtroom testimony training along with their regular training. Forensic chemists must be able to give an impartial explanation to the jury that will assist in a final judgment—forensic chemists analyze the evidence but do not determine the verdict.

… Have various opportunities

The career path for most forensic chemists is through federal, state, or county labs associated with the medical examiner's office. However, there are different types of careers available, including those in other fields of forensic science, academe, or administration. Chemists can also move up within a particular organization, changing responsibilities along the way. For example, the director of a crime lab may supervise other forensic scientists rather than being involved in day-to-day analysis. A director may also be responsible for case review and general lab management. Some forensic chemists also use their technical training to pursue a career in patent law.

FACT FILE: Forensic Chemists

WORK DESCRIPTION ► Forensic chemists apply knowledge from diverse disciplines such as chemistry, biology, materials science, and genetics to the analysis of evidence found at crime scenes or on/in the bodies of crime suspects. The field is a combination of criminalistics and analytical toxicology. Criminalistics is the qualitative examination of evidence using methods such as microscopy and spot testing, whereas analytical toxicology looks for evidence in body fluids through a range of instrumental techniques from optical methods (UV, infrared, X-ray) to separations analyses (gas chromatography, HPLC, and thin-layer chromatography). Mass spectrometry is also frequently used since it provides the strongest evidence in court. Most often, forensic chemists do not know the nature of the sample before they analyze it. The results of their work are used in police investigations and court trials, at which they may be called upon to provide expert testimony and explain their findings to a jury.

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WORKING CONDITIONS ► Forensic chemists generally work in government labs, which can be small, understaffed, and underfunded. They spend time preparing and giving testimony in court. Formerly under the jurisdiction of police departments, forensics has traditionally been totally male dominated. However, over the last 15 years, the field has opened up to women, who are moving up in its ranks.

PLACES OF EMPLOYMENT ► Most labs are associated with a federal, state, or local police department, medical examiner's office, forensic services lab, or branch of the Federal Bureau of Investigation. There are some private labs that carry out forensic analyses.

PERSONAL CHARACTERISTICS ► Versatility and patience are the most often cited qualities of a forensic chemist. Forensic chemists must be able to spend hours rigorously applying analytical techniques to evidence and then defending their work in a court of law. They must be able to clearly and concisely answer challenges to their findings. Integrity is also an important characteristic, because it is not unusual for the different interests in a case to try to sway the forensic chemist's position.

EDUCATION AND TRAINING ► A strong background in chemistry and instrumental analysis as well as a good grounding in criminalistics is vital. A forensic science degree at both the undergraduate and graduate level is recommended. Those interested in working with trace evidence, such as glass, hair, and paper, should focus on instrumentation skills and take courses in geology, soil chemistry, and materials science. If forensic biology and DNA analysis are preferred, take microbiology, genetics, and biochemistry courses. Those interested in the toxicological aspects of this work should study physiology, biochemistry, and chemistry.

JOB OUTLOOK ► The forensic science field is guardedly optimistic about job prospects for the future. Greater interest in the use of DNA analysis is expected to create more jobs. Those interested in DNA work should keep up with the rapidly changing technology and develop skills that distinguish them from the pack.

SALARY RANGE ► For forensic chemists with a B.S. degree, incomes start in the high $30,000s per year. The median salary is $50,000. Chemists at the high end are paid more than $60,000 per year. Scientists involved with fingerprint analysis are on the lower end of the pay scale.

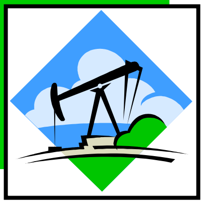
FOR MORE INFORMATION

American Academy of Forensic Science
P.O. Box 669
Colorado Springs, CO 80901-0669
719-636-1100
www.aafs.org

Forensic Science Society (United Kingdom)
Clarke Hose
18A Mount Parade
Harrogate
North Yorkshire HG1 1BX
United Kingdom
www.forensicsciencesociety.co.uk

You can also contact schools with academic programs in forensic science. University of New Haven (CT), George Washington University (DC), and John Jay College of Criminal Justice of the City University of New York all have graduate programs. Michigan State University has programs on the graduate and undergraduate level.

WHAT YOU CAN DO NOW ► Contact local forensics labs and find out when a forensic chemist will be testifying in court. Attending courtroom testimony will give you a sense of whether this aspect of the work is right for you. Hands-on technical experience is more difficult to get. Most labs do not have internships but may take on volunteers. Academic requirements are tightening. Give some thought to graduate work and research projects that show you are capable of problem solving. To prepare for court presentations, scientists recommend participation in the debate team and school theater.



Oil and Petroleum Chemists

… Work in a high-pressure environment

The oil and petroleum business is a high-pressure, high-stakes field that offers a broad range of career opportunities for chemists. Because even small decisions can mean financial gains or losses for one's employer, the business offers a dynamic combination of excitement and responsibility.

It's also a setting quite unlike the academic world, and one that for many young chemists requires a major shift in thinking. In school, a graduate student can focus on a paper as the end product; but in the oil and petroleum industry, chemists succeed only when their ideas are put into practice. And, although many universities are moving in this direction, the oil and petroleum industry places increasing emphasis on work accomplished by teams rather than by individuals. With a focus on profitability, companies can be ideal places for people who like to see their ideas become reality.

… Apply knowledge of chemistry in many ways

The oil and petroleum industry offers chemists and chemical engineers a broad range of work opportunities over a wide area of chemistry. For example, specialists in chemometrics rely on statistical and computer expertise to put lab instruments online at a refinery. Working with delicate machines can be a challenging assignment anywhere, but in a refinery they must operate under hostile conditions—including temperature extremes, vibrations from surrounding equipment, continuous operation, and locations that make monitoring difficult.

With crude oil being the raw material for polymer production, there are positions for polymer chemists throughout the field. Since these positions are also defined by the demands of a business environment, most polymer chemists work on projects with real-world applications rather than do "research for its own sake." Many in the industry view polymers as a growing field in which many questions are unanswered and many areas still untested.

Exploration and production are major areas of effort in the petroleum industry (often referred to as the "upstream" part). Companies operating in these fields, as well as in the "downstream" areas of refining and marketing, employ people trained in chemical engineering, physical chemistry, computer technology, geochemistry, and tracer chemistry (to name a few areas). Biochemistry is also important in the production of oil since bacteria can change the quality of oil over time, creating interference with production, downstream corrosion problems, and toxic hazards. The chemistry of catalysts is also very important to the industry. Inorganic chemists, organic chemists, analytical chemists, and chemical engineers all have a role in catalyst technology for the petroleum and petrochemical industries.

… Increasingly rely on computer skills

Although their chief mission is to make products, oil and petroleum companies also do research. In recent years, however, this research has become more applied and product-focused. Chemists in oil and petroleum companies increasingly use computers and computational chemistry to reduce the cost and time of research. They also use computer modeling to target the most promising areas for exploration, aid in decision-making, and control field and transportation functions.

… Interact in a business-focused environment

Oil and petroleum businesses tend to feature fast-paced, collaborative environments. As result, many find that while their technical knowledge and skills are critical to obtaining a position, their effectiveness on the job relies just as much on skills such as time management, communication, and cooperation.

Cooperation also extends outside one's company. Complying with environmental regulations is more important in industry than ever before, and scientists must always be mindful of how a process or petroleum product will affect the environment.

There is a widespread public perception that oil and petroleum are bad for the environment, and the public tends to forget that oil and petroleum products are used every day to heat houses, power cars, and produce a range of synthetic materials. Because of these challenges, new career options have arisen, including jobs in corporate government relations, public outreach and risk communication, and government agencies that ensure compliance with environmental regulations. Research to replace existing refinery processes and products with cleaner, safer, and more energy-efficient ones has also expanded career opportunities.

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FACT FILE: Oil and Petroleum Chemists

WORK DESCRIPTION ► Chemists in the oil and petroleum industry work with crude oil and the products derived from it, including petroleum for automotive or aviation fuel as well as petrochemical feedstocks, which are used in a range of polymer products. Chemists in the field have a similarly broad spectrum of jobs: from "fingerprinting" oil leaked in a spill to process control at the refinery, and from developing catalysts used in the refining process to creating new polymers for fibers and resins.

WORKING CONDITIONS ► Oil and petroleum chemists work mostly in the lab. Some have jobs that take them into the refinery, but usually on a short-term basis. Others may work temporarily in the field, collecting samples. Chemists work in groups and often with chemical engineers. Communication skills are vital—not just with other scientists, but also with marketing managers and with the media. The field has been traditionally male-dominated, but many companies are making efforts to attract a more diverse group of workers in terms of gender, ethnicity, and other factors.

PLACES OF EMPLOYMENT ► Most chemists in this field work for large oil companies. Others work with independent companies that develop processes for the oil industry, such as fluid-cracking catalysis, or that make chemicals used to aid drilling and refining. Many chemists work at companies that supply chemicals for petroleum companies and provide technical support for handling environmental systems.

PERSONAL CHARACTERISTICS ► Chemists in the oil industry describe themselves as practical people who are interested in solving problems. Some say they are more interested in the development of scientific products than in pure science. Most underscore the importance of liking lab work, being able to work on a team, and communicating with chemical engineers, product managers, and customers. Because the industry is product-focused, an interest in business and a flair for sales can also be helpful.

EDUCATION AND TRAINING ► A Ph.D. is generally necessary if you want a research position in the oil and petroleum industry. Postdoctoral work is not considered necessary, though it may give you an edge in getting a job. There is a range of chemist and chemical engineering positions for people with bachelors' and master's degrees. Scientists whose backgrounds include chemical engineering may be better prepared for work in this industry, with its emphasis on essential business considerations such as cost/benefit analysis. A solid foundation in organic and physical chemistry is vital, and analytical chemistry skills are extremely important. Technical skills, communication skills, teamwork, and leadership are also crucial.

JOB OUTLOOK ► The oil and petroleum industry is hiring fewer chemists now as companies downsize because of budget constraints and a drop-off in profits since the 1990s. There have been layoffs across the industry, and the job market right now is highly competitive. Basic research has also declined. Whereas long-term research projects once spanned 10–15 years, they now are much shorter and are typically more focused on solving immediate problems.

SALARY RANGE ► Petroleum chemists beginning their career in industry can expect starting annual salaries in the mid-$40,000s at the B.S. level and in the low- to mid-$80,000s at the doctorate level. After about 10 years in the field, the B.S. petroleum chemist earns about $60,000 per year, and the petroleum chemist with a doctorate earns about $95,000 per year.

FOR MORE INFORMATION

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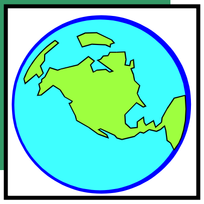
1155 16th St., NW
Washington, DC 20036
800-227-5558
membership.acs.org/P/PETR

American Petroleum Institute
1220 L St., NW
Washington, DC 20005
202-682-8000
www.api.org

WHAT YOU CAN DO NOW ► The oil and petroleum industry is a corporate environment. To find out whether this atmosphere would suit you, try to get experience through summer internships or by participating in a university–industry technology transfer. While you are in school, it is important to develop a strong foundation in organic chemistry, but you will be a more attractive candidate if you broaden your skills with courses in industrial chemistry and business. Course work in statistical design is also strongly recommended.



Químicos Ambientales

....Están preocupados por el impacto del medio ambiente

¿Qué pasa con las sustancias químicas en un producto limpiador industrial cuando lo echas por el desagüe? ¿Qué impacto está teniendo sobre la atmósfera el humo negro que ves saliendo de una chimenea de un complejo industrial,? Estas son el tipo de preguntas que los químicos ambientales están tratando de contestar.

Lo que sucede con las sustancias químicas en el medio ambiente, y sus efectos, son las cosas que más están preocupando a los especialistas en el manejo del medio ambiente. El "destino" involucra el estudiar a donde se van las sustancias químicas en los riachuelos, los ríos y en el aire. Esta contaminación contiene moléculas que no han sido removidas en las plantas de tratamiento de agua, o que no se atraparon en los filtros de las chimeneas industriales, que no se han desechaolo debidamente, o que no han sido bien selladas en un recipiente.

Así como van aumentando las preocupaciones acerca de la geoquímica y el medio ambiente natural, los químicos ambientales también estudian los procesos que afectan las sustancias químicas en el medio ambiente. Por ejemplo, los gases que son emitidos por un bosque de pinos pueden crear un neblina cuando son mezclados con la emision de gases de los carros. En otras palabras, el medio ambiente puede tener efectos sobre las sustancias químicas que pueden ser tóxicos. Los químicos ambientales examinan la manera en que las sustancias químicas y el medio ambiente pueden cambiar por alguna interacción.

....Manejan el medio ambiente

Hasta hace 20 años los que estaban estudiando la contaminación del medio ambiente estaban enfocados casi exclusivamente, en el destino y el efecto de las sustancias químicas porque la tecnología para medir los daños no existía. Por ejemplo, así como la tecnología para medir los escapes de los basureros se desarrolló, la industria reconoció el potencial que tienen las sustancias químicas para afectar negativamente el medio ambiente—y las repercuciones políticas, sociales, y económicas. Como resultado de esos nuevos datos, los químicos pudieron ayudar a desarrollar sistemas para la disminución de la contaminación que minimicen los elementos no necesarios que se escapan al medio ambiente. También aplicaron su conocimiento para desarrollar sistemas de remediación que ayuden a limpiar las áreas contaminadas.

Así como la industria toma un papel proactivo en el manejo del medio ambiente, el papel de la química debe continuar creciendo. Para muchas compañías químicas ésto puede involucrar el redesarrollo de un producto químico que presenten diferentes grupos funcionales o compuestos que sean más compatibles con el medio ambiente. Por ejemplo, una corporación grande ha utilizado catalíticos para desarrollar un nuevo proceso de producción para metilisocianato, (methylisocyanate) un material altamente combustible y peligroso de transportar. El nuevo proceso de producción permite que la sustancia química sea manufacturada en el mismo sitio donde se utiliza, evitando los riesgos de transporte y de almacenaje.

Ya que el manejo de desperdicios se ha vuelto cada vez más costoso, la industria se ha interesado más en encontrar las formas de resolver los problemas de la disposición de desperdicios. Muchas soluciones involucran el hacer los procesos industriales más eficientes, lo cual disminuye los costos. También, los químicos ambientales estudian los efectos de sustancias químicas que no son contaminantes del medio ambiente.

....Trabajan en extensas disciplinas

Ya que nuestro medio ambiente es tan complejo, los químicos ambientales siempre hacen un énfasis sobre la naturaleza interdisciplinaria de su área. Los químicos ambientales deben de entender Y usar la terminología de muchas otras disciplinas, incluyendo la biología, geología, ecología, sedimentología, mineralogía, genética, química de aire y tierra, matemáticas, e ingeniería. Es posible que sean involucrados en pruebas analíticas, desarrollo de productos nuevos en el laboratorio, trabajo en el campo de los consumidores de las sustancias químicas, y cuestiones de regulación, y de seguridad. En ocasiones, existen muchas oportunidades para moverse dentro de varias áreas de especialidad, fuera del laboratorio. Muchos químicos regresan a la escuela a estudiar la política pública, leyes, o negocios, aplicando su sabiduría quimica en diferentes maneras. Por ejemplo, el conocimiento de procesos químicos es vital para un individuo que trabaja en una corporación en los departamentos de regulación y que tiene que asegurar el cumplimiento de las regulaciones gubernamentales.

El manejo del medio ambiente se ha vuelto un camino de carrera bastante popular. Los estudiantes que tienen títulos en las ciencias ambientales están encontrando carreras a través de la industria química, a veces trabajando junto con geólogos, biólogos, y químicos.

Casi todos los químicos ambientales enfatizan que una fundación sólida y en la química es importante para este trabajo. A los estudiantes de química que están interesados en aplicar su adiestramiento a un trabajo orientado hacia el medio ambiente se les recomienda tomar cursos en estudios del medio ambiente. Los empleadores potenciales patronos ven favorablemente ésto, ya que indica un interés y una habilidad de poder pensar de una manera interdisciplinaria.

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ARCHIVO DE HECHOS: Químicos ambientales

DESCRIPCIÓN DE TRABAJO ► El término químico ambiental es un termino general. Es mas, casi todos los químicos en el campo probablemente se describirían específicamente por el trabajo que hacen. Este trabajo se puede enfocar en recolectar y analizar muestras, desarrollar trabajos de remediación, cambiar los procesos de producción para rendir un producto que es más compatible con el medio ambiente, dar asesoría experta sobre la seguridad y las respuestas a las emergencias, o lidiando con las regulaciones gubernamentales y hechos de conformidad.

CONDICIONES DE TRABAJO ► El trabajo normalmente se hace en un laboratorio. Sin embargo, cuando están estudiando las sustancias químicas en el medio ambiente, por ejemplo; en un riachuelo, el laboratorio puede estar a las orillas de un rió o de un riachuelo. Algunas compañías tienen ecosistemas sofisticados en los laboratorios en los cuales investigan sus productos. Otros recolectan datos fuera del laboratorio y en ocasiones en millas distantes a los sitios de producción.

LUGARES DE EMPLEO ► La industria química emplea gran cantidad de técnicos ambientales para asegurar que la compañía está cumpliendo con las leyes y regulaciones gubernamentales. Agencias del gobierno, tales como el Departamento de Agricultura, de Defensa, y la Agencia de Protección del Medio Ambiente de los Estados Unidos, emplean a químicos para el trabajo en el medio ambiente. También, las compañías que manejan desperdicios y compañías consultoras emplean químicos para que hagan asesorías o trabajo de remediación. Los colegios y universidades están empleando más químicos ambientales ya que están estableciendo programas de química ambiental.

CARACTERÍSTICAS PERSONALES ► Ya que la química ambiental es tan interdisciplinaria requiere excelentes destrezas interpersonales y de comunicación. Es importante tener la destreza de expresar ideas eficazmente a una audiencia que no es científica. Esto se vuelve aparente cuando los químicos se involucran con regulaciones o con el personal de mercadería y de ventas. Así como el área de manejo del medio ambiente se expande globalmente, los químicos que hablan otros idiomas probablemente van a ser más exitosos.

EDUCACIÓN Y ADIESTRAMIENTO ► Los químicos ambientales proceden de distintos tipos de formación profesional y no hay un solo camino para llegar a ese campo. Sin embargo tu colegio o universidad puede tener un programa químico aprobado por la Sociedad Americana de Química (ACS) con una opción en química ambiental, lo cual es un buen lugar para comenzar. Los profesionales con experiencia hacen un énfasis acerca de la ventaja competitiva al obtener títulos avanzados. Sin embargo, porque esta área está creciendo tan rápido hay oportunidades que existen para individuos con un título asociado. A los estudiantes también se les recomienda tomar cursos que son fuera de lo tradicional en el área de química, tales como matemáticas avanzadas y cursos de ingeniería.

Las compañías, con frecuencia, emplean personas graduadas de escuelas con programas bien establecidos. Los empleadores también buscan a candidatos que demuestran la habilidad para aumentar sus destrezas y para pensar en una manera interdisciplinaria. Cursos en biología, geología, hidrológica o toxicología serían una indicación de tales destezas.

PERSPECTIVAS DE EMPLEO ► Dado el aumento en las regulaciones gubernamentales que existen, las oportunidades para los químicos ambientales continúa creciendo. Las compañías están en continua reducción de empleados, pero están poniendo mas énfasis en el cumplimiento y en los procesos ambientales. Las oportunidades existen para que los químicos se muevan a varias áreas de experiencia fuera de las tradicionales en los laboratorios. Para los que están estudiando leyes, negocios, o política pública, pueden encontrar oportunidades en el área de regulaciones tanto en la de salud como en la de seguridad.

El área se está expandiendo a incluir empleadores que no son tradicionales. Se espera que las oportunidades crezcan en contratos de laboratorios y en asesoría, porque los negocios están enviando este trabajo afuera.

ESCALA DE SUELDOS ► El sueldo, para empezar, para un químico con doctorado es alrededor de 70,000 dólares por año en la industria. Para un químico con una maestría un sueldo de 40,000 a 50,000 dólares por año es el sueldo promedio para comenzar. Los químicos con un bachillerato pueden ganar entre los 30,000 dólares a los bajos 40,000.

Un individuo que va a entrar en el área de las regulaciones de la química ambiental probablemente va a empezar con un salario más alto y va a continuar a ganar más porque estos trabajos son de alta visibilidad y requieren el tomar responsabilidad por el riesgo de una compañía. Aunque el trabajo que hace un químico analítico para reducir la contaminación es importante, el químico-regulador que negocia para sacar a una compañía de problemas recibirá más reconocimiento y mejor compensación.

PARA MAS INFORMACIÓN:

American Chemical Society
Division of Environmental Chemistry
1155 16th Street, NW
Washington, D.C. 20036
800-227-5558
www.envirofacs.org

U.S. Environmental Protection Agency Regional Offices
(Checa la sección del gobierno de tu directorio local.)

QUE PUEDES HACER AHORA ► Ya que las opciones de carreras existen son diversas, los estudiantes deberían de pensar en el tipo de trabajo que les interesa y en qué disciplinas, aparte de la química, para ésto deben ponerle énfasis a la escuela. Ya que muchos colegios tienen programas de ciencia del medio ambiente o ingeniería del medio ambiente, los estudiantes deben investigar las áreas potenciales de empleo antes de entrar al mercado de empleos. Los químicos ambientales en la industria sugieren que lean revistas del medio ambiente tales como la de la Sociedad Americana de Químicaa "Environmental Science and Technology" y que tomen cursos en química industrial y en ingeniería química.

Químico Forense

.... Aplica disciplinas científicas a la evidencia física

Un químico forense es un químico profesional que analiza la evidencia que se obtiene de una escena de crimen y llega a una conclusión basada en las pruebas e investigaciones que hace con los pedazos de evidencia. El trabajo de un químico forense es el de identificar y de caracterizar la evidencia como parte del proceso más grande para resolver un crimen. Los químicos forenses casi nunca realizan un trabajo de investigación del crimen, más bien están a cargo de la evidencia que se colecciona de la escena del crimen. La evidencia puede incluir muestras de cabello, pedazos de pintura, pedazos de vidrio o manchas de sangre. El entender la evidencia requiere como herramienta el conocimiento sobre muchas disciplinas incluyendo química, biología, ciencia de materiales y genética. La fecuencia del uso del análisis del DNA está haciendo que el conocimiento sobre la genética aumente en importancia en este campo.

....Explica y defiende sus resultados

Los químicos forenses están de acuerdo que el poder hablar en publico y el sentirse cómodo con lo que hacen son características personales muy importantes para esta carrera. Como se puede ver en "Court TV" los químicos forenses frecuentemente son llamados a explicar qué fue lo que aprendieron y cómo llegaron a sus conclusiones.

No todos los casos acaban en un juicio pero, cuando uno si lo hace, el dar el testimonio experto en la corte es una parte muy significativa del trabajo del químico forense. Algunos patronos requieren que sus químicos forenses tengan varios meses de práctica simulada en corte junto con su adiestramiento normal. Los químicos forenses deben de tener la habilidad de dar explicaciones imparciales a un jurado, lo cual asistirá al jurado con un juzgado final—los químicos forenses analizan la evidencia pero no determinan el veredicto.

....Tiene varias oportunidades

La carrera para los químicos forenses es a través de laboratorios federales, estatales, o municipales asociados con la oficina del medico examinador. Sin embargo hay diferentes tipos de carreras incluyendo las de otras campos de la química forense, academia, o administración. Los químicos también pueden subir dentro de una organización, cambiando de responsabilidades en su trayecto. Por ejemplo, el director de un laboratorio de crimen puede supervisar otros científicos forenses en lugar de estar involucrado en los análisis de día en día. Un director también puede ser responsable de la revisión de casos y del manejo general del laboratorio. Algunos químicos forenses usan su adiestramiento técnico para seguir una carrera en el área de leyes, muchas veces especializándose en patentes.

American Chemical Society, Education Division,
1155 Sixteenth Street, NW, Washington, DC 20036; 800-227-5558; chemistry.org

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ARCHIVO DE HECHOS: *Químicos Forenses*

DESCRIPCIÓN DE TRABAJO ► Los químicos forenses aplican su conocimiento de diversas disciplinas tales como la química, biología, ciencia de materiales y genética al análisis de la evidencia que se encuentra en las escenas de crimen o en los cuerpos de los criminales sospechosos. El campo es una combinación de criminalistica y de análisis de toxicología. La criminalistica es la examinación cualitativa de la evidencia usando métodos tales como la microscopía y la prueba e investigación de manchas, mientras que la toxicología analítica busca evidencia en los líquidos del cuerpo a través de un alcance de técnicas instrumentales desde métodos ópticos (UV, infrarrojo, Rayos X) análisis de separación (cromatografía de gases, HPLC y cromatografía de capas delgadas) La cromatografía de masa es frecuentemente usada ya que provee la más sólida evidencia en la corte. Casi siempre los químicos forenses no saben la naturaleza de la muestra antes de analizarla. Los resultados de sus exámenes se usan para investigaciones de la policía y en juicios de la corte en los cuales es posible que los llamen a dar testimonio experto y a explicar sus resultados al jurado.

CONDICIONES DE TRABAJO ► Los químicos forenses normalmente trabajan en laboratorios del gobierno los cuales pueden ser pequeños, sin suficiente personal, y sin suficientes fondos. Pasan el tiempo preparando y dando testimonio en la corte. Antes bajo la jurisdicción de los departamentos de la policía, la ciencia forense tradicionalmente ha sido dominada por los hombres, sin embargo en los últimos 15 años esta área se ha abierto para las mujeres, las cuales han subido rapidamente de posición.

LUGARES DE EMPLEO ► Casi todos los laboratorios están asociados con los departamentos federales, estatales, o de la policía local, la oficina del medico examinador, laboratorios de servicios forenses, o una sección del departamento del FBI. Hay algunos laboratorios privados que llevan a cabo análisis forenses.

CARACTERÍSTICAS PERSONALES ► La versatilidad y la paciencia son las cualidades más necesarias de un químico forense. Los químicos forenses deben poder pasar horas rigorosamente aplicando técnicas analíticas a la evidencia y entonces defender sus resultados en una corte de ley. Tienen que poder responder clara, y concisamente a los retos de sus resultados. La integridad es una característica muy importante porque no es inusual que los diferentes intereses en un caso traten de cambiar la posición del químico forense.

EDUCACIÓN Y ENTRENAMIENTO► Un conocimiento profundo y abarcador en química y en análisis instrumental tanto como un conocimiento de criminología son vitales. Un título de ciencia forense a ambos niveles de estudios subgraduado y a nivel graduado es recomendado. Los que están interesados en trabajar con evidencia de elementos trazadores, tales como vidrio, cabello y papel, deberían de enfocarse con habilidades de instrumentación y tomar cursos en geología, química de tierra, y ciencia de materiales. Si la biología forense y el análisis del DNA son preferidos, debe tomar cursos en microbiología, genética y en bioquímica. Los que están interesados en los aspectos toxicólogos de esta área deberían de estudiar fisiologia, bioquímica y química.

PERSPECTIVAS DE EMPLEO► El campo de la ciencia forense está algo optimista acerca de los prospectos de trabajo en el futuro. Dado a que hay más interés en el uso de los análisis de DNA, se espera que se creen más empleos. Los que están interesados en trabajar con DNA deben de poder seguir los cambios rápidos en la tecnología y desarrollar técnicas que los distinguen de los demás.

ESCALA DE SUELDOS ► Para los químicos forenses con titulo de BS. Los sueldos empiezan en los altos 30,000 dólares por año. Los químicos en los niveles altos reciben más de 60,000 dólares por año. Los científicos que están involucrados con las huellas digitales son los que reciben menos sueldo.

PARA MAS INFORMACIÓN

American Academy of Forensic Science
P. O. Box 669
Colorado Springs, CO 80901-0669
719-636-1100
www.aafs.org

Forensic Science Society (United Kingdom)
Clarke Hose
18ª Mount Parade
Arrógate
North Yorkshire HG1 1BX
United Kingdom
www.forensicsciencesociety.co.uk

También puedes ponerte en contacto con las escuelas que tienen programas académicos en la ciencia forense. University of New Haven (CT, George Washington University (DC), y John Jay College of Criminal Justice of the City University of New York tienen programas graduados. Michigan State University también tiene programas al nivel subgraduado y graduado.

QUE PUEDES HACER AHORA ► Ponte en contacto con laboratorios forenses locales y averigua cuando va a dar testimonio en la corte, un químico forense. El atender un juicio te va a dar el sentido si este aspecto del trabajo es para ti. El conseguir experiencia técnica es más difícil. Casi todos los laboratorios no tienen internados pero a veces toman voluntarios. Los requisitos académicos se están poniendo más fuertes. Piensa en trabajo de graduado y en proyectos de investigación que demuestren que tú eres capaz de resolver problemas. Para prepararte a dar presentaciones en la corte los científicos recomiendan que participes en el teatro de tu escuela, y en los equipos de debate.

Químicos Del Petróleo Y Derivados

....Trabajan en un ambiente de alta presión

El negocio del aceite y del petróleo es de mucha presión, de mucho interés y ofrece una gran variedad de oportunidades de empleo para los químicos. Dado a que aun pequeñas decisiones pueden afectar las ganancias o perdidas del patrono, esta industria ofrece una combinación dinámica de entusiasmo y de responsabilidad.

También es una escena muy diferente a la del mundo académico, y una que para muchos químicos jóvenes requiere un gran cambio en la forma de pensar. En la escuela, un estudiante graduado puede enfocarse en una publicación como producto final de su investigación, pero en la industria del petróleo crudo y del petróleo, los químicos triunfan sólo cuando sus ideas se ponen en la práctica. Y aunque muchas universidades están moviéndose en esta dirección, la industria petrolera pone mas énfasis en el trabajo hecho por equipos que por individuos. Con su enfoque en las ganancias las compañías pueden ser lugares ideales para las personas que les gusta ver que sus ideas o sueños se vuelvan realidad.

....Aplican su conocimiento de la química de varias maneras

La industria del aceite y del petróleo ofrece a los químicos y a los ingenieros químicos, una gran variedad de oportunidades de trabajo en un campo muy abarcador de la química. Por ejemplo, los especialistas en quimométrica se apoyan en su conocimiento de computación para conectar en redes los instrumentos de laboratorio utilizados en una refinería. El trabajar con maquinas delicadas puede ser una tarea con muchos retos, en donde sea, pero en una refinería deben de operar bajo condiciones hostiles, incluyendo temperaturas extremas, vibraciones causadas por el equipo a su alrededor, operación continua, y locales que hacen más difícil el llevar a cabo examinaciones continuas de las mismas

Siendo el aceite crudo la materia prima para la producción de polímeros, hay posiciones para químicos polimericos en todo ese campo. Ya que esas posiciones son definidas por las demandas del ambiente de negocios, los químicos polimericos trabajan en proyectos con aplicaciones al mundo real en lugar de hacer investigaciones por solo hacerlas. En la industria, muchos ven los polímeros como un área que está creciendo, por lo cual muchas preguntas no tienen aun respuestas y muchas áreas aún no han sido exploradas.

La exploración y la producción son las áreas más grandes de esfuerzo en la industria petrolera, que se refiere a la parte de mayor crecimiento. Las compañías que operan en esa área al igual que las de menor crecimiento como lo son las refinerías y de mercadeo, emplean personas que son adiestradas en la ingeniería química, química física, tecnología de computación, geoquímica, y química de rastreo. La bioquímica también es importante en la producción de aceite ya que las bacterias pueden cambiar la calidad del aceite a través del tiempo, creando interferencia con la producción, problemas de corrosión, y desperdicios tóxicos. La química de catálisis también es muy importante para esta industria. Los químicos inorgánicos, químicos orgánicos, químicos analíticos e ingenieros químicos, todos tienen una función muy importante en la tecnología de catalíticos y en las industrias petroquímicas.

....Mas y más se apoyan en las destrezas de computación

Aunque su misión primaria es el hacer productos, las compañías de aceite y de petróleo también hacen investigaciones. En años recientes, sin embargo, estas investigaciones se han vuelto más aplicadas y orientadas hacia los productos. Los químicos en las compañías de aceite y de petróleo usan cada vez más computadoras y química computacional para reducir los costos y el tiempo de investigación. También usan modelos de computadora para señalar las áreas más prometedoras para la exploración, ayudan en la toma de decisiones, y controlan el área y las funciones de transportación.

....Interaccionan en un ambiente enfocado en negocios

Los negocios del aceite y del petróleo tienden a ser ambientes de mucho movimiento y de colaboración. Como resultado, muchos encuentran que mientras su conocimiento técnico y destrezas son criticas para obtener una posición, su eficiencia en los trabajos depende de de igual manera de sus destrezas tales como comunicación, el manejo de tiempo, y su cooperación.

La cooperación se extiende fuera de la compañía de uno. Ahora el obedecer las regulaciones del medio ambiente es más importante en la industria que nunca antes y los científicos deben siempre tener presente cómo un proceso o un producto petrolero afectará al medio ambiente.

Hay una amplia percepción pública que el aceite y el petróleo es malo para el medio ambiente, y el publico tiende a olvidar que los productos del aceite y del petroleo se usan todos los días para calentar casas, darle energía a los carros, y producen una gran variedad de productos sintéticos. Por esos retos, nuevas carreras han surgido, incluyendo empleos en relaciones en corporaciones gubernamentales, el comunicarse con el público y el poder comunicarle acerca de los riesgos, y agencias del gobierno que se aseguran que se cumplen con las regulaciones del medio ambiente. Hoy en día se llevan a cabo investigaciones para reemplazar los procesos y productos de las refinerías, con unos que son más limpios, más seguros, y más eficientes en usar energía, también, éstos han hecho crecer las oportunidades de empleo en esta carrera.

American Chemical Society, Education Division,
1155 Sixteenth Street, NW, Washington, DC 20036; 800-227-5558; chemistry.org

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ARCHIVO DE HECHOS: Químicos de petróleo y de aceite

DESCRIPCIÓN DE TRABAJO ► Los químicos en las industrias petroleras trabajan con el petróleo crudo y los productos que son derivados del mismo, incluyendo el petróleo para los automóviles o aeroplanos, como también los abastecimientos petroquímicos que son utilizados en una gran variedad de productos polímeros. Los químicos en esta área tienen una gran variedad de trabajos desde detectar rastros de aceite en un derrame hasta controlar procesos en una refinería, también, desarrollar catalizadores que se usan en el proceso de refinamiento y hasta crear nuevos polimeros para fibras y resinas.

CONDICIONES DE TRABAJO ► Los químicos petroleros casi siempre trabajan en laboratorios. Algunos tienen trabajo que los lleva a las refinerías pero usualmente por plazos cortos. Algunos trabajan, temporalmente, en el campo coleccionando muestras. Los químicos usualmente trabajan en equipos y frecuentemente con ingenieros químicos. Es vital tener una buena habilidad para comunicarse, no solo con otros científicos si no también con los supervisores de ventas y a través de los medios de comunicación. Este campo ha sido, tradicionalmente, dominado por los hombres pero las compañías están haciendo un gran esfuerzo para atraer trabajadores que sean más diversos en términos del genero, de la pertenencia técnica, y de otros factores.

LUGARES DE EMPLEO ► La mayoría de los químicos trabajan para compañías petroleras grandes. Otros trabajan en compañías independientes que desarrollan los procesos para la industria del petróleo, tales como: la catálisis para la fragmentación del crudo del petróleo, o que producen las sustancias químicas que se usan para fragmentar y para refinar el petróleo. También, muchos químicos trabajan en las compañías que suplen los productos químicos para las compañías del petróleo y proporcionan la ayuda técnica para manejar los sistemas ambientales.

CARACTERÍSTICAS PERSONALES ► Los químicos en la industria de petróleo se describen como gente práctica que está interesada en solucionar problemas. Algunos están más interesados en el desarrollo de productos científicos que en la ciencia pura. La mayoría subrayan la importancia de que le agrade el trabajo de laboratorio, al igual que el poder trabajar en un equipo, y de comunicarse con los ingenieros químicos, con los encargados de producto, y con los clientes. Debido a que la industria es enfocada en los productos, un interés en los negocios y un instinto para las ventas también son provechosos.

EDUCACIÓN Y ENTRENAMIENTO ► Un doctorado (Ph.D.) es, generalmente, necesario si usted desea una posición de investigación en la industria petrolera. El trabajo post-doctorado no se considera necesario aunque puede darle una ventaja para conseguir un trabajo. Hay una gama de posiciones para químicos e ingenieros químicos con títulos de 4 años (bachelors') y de maestría. Los científicos cuya preparación académica es ingeniería química están mejor preparados para el trabajo en la industria, y se recomienda tener un conocimiento sobre consideraciones básicas en negocios, tales como el análisis de costos y de beneficios. Una base académica sólida en química orgánica y en física es vital, y las habilidades de la química analítica son extremadamente importantes. También , son importantes las destrezas técnicas, destrezas de comunicación, el poder trabajar en equipo y dar direcciones.

PERSPECTIVAS DE EMPLEO ► La industria petrolera ahora está empleando a pocos químicos ya que las compañías están disminuyendo su tamaño debido a la bajada desde los años 90 en el presupuesto, en las ganacias y en los beneficios. Ha habido despidos a través de la industria y el mercado de trabajo ahora es altamente competitivo. La investigación básica también ha declinado, mientras que los proyectos de investigación a largo plazo tardaban de 10 a 15 años ahora son mucho más cortos y se centran, típicamente, mas en solucionar los problemas inmediatos.

ESCALA DE SUELDOS ► Los químicos petroleros que comienzan su carrera en la industria pueden contar el empezar con un sueldo anual en los medios 40,000 dólares por año con un nivel de bachillerato (B.S)., y en alrededor de 80,000 dólares por año con un nivel de doctorado. En el campo de químico petrolero con un B.S. y luego de diez años de experienci puede ganar cerca de 60,000 dólares por año y el químico petrolero con un doctorado gana cerca de 95,000 dólares por año.

PARA MAS INFORMACIÓN

American Chemical Society
División of Petroleum Chemistry
1155 16th St., N.W.
Washington, D.C. 20036
800-227-5558
membership.acs.org/P/PETR

American Petroleum Institute
1220 L St., N.W.
Washington, D.C. 20005
202-682-8000
www.api.org

QUE PUEDES HACER AHORA ► La industria petrolera es un ambiente corporativo. Para descubrir si este campo de la química le agradaría, intente conseguir experiencia participando en internados de verano o participe en programas de transferencia de tecnología de la universidad-industria. Mientras que esté estudiando es importante el adquirir una base académica muy fuerte en química orgánica y en cursos de mercadeo. También es altamente recomendable el tomar cursos en diseño estadístico.

Appendix

Association with ACS – Important Notice

Association of High School Chemistry Clubs with ACS

ChemClub is a program of the American Chemical Society, administered through the Office of High School Chemistry in the Education Division. This program is designed to provide support in the way of resources, organizational information and networking opportunities for teachers and their students interested in chemistry and the chemical sciences. While recognized as an activity of ACS, High School Chemistry Clubs (*ChemClub*) are not official units of the American Chemical Society. As such, activities and members of the clubs are not covered under the ACS general liability policy. Verify with your school administration the terms of coverage associated with extracurricular activities.

ACS Logo and Name

Usage agreement

Logos provided by ACS are intended for the use of ACS local sections, technical divisions, student chapters, regional meeting planners, and anyone else, member or non-member, who has rightful reason to promote ACS programs, products, or services.

The ACS logo is a registered trademark of the Society and its use is under the control of the ACS. Because of its trademarked status, maintaining the integrity of the logo is critical to the Society. Tampering with or misusing the logo could result in the ACS losing this logo as a trademark. Board Regulation X, 2, "Use of SOCIETY Name and Insignia" is the official statement of this subject. Please note that any request for use of the ACS name and insignia by any non-ACS organization must be referred to the Board of Directors, the only body with authority to grant such permission. Although the Society encourages sub-units of ACS to use the ACS logo, some rules for its use must be observed:

- The logo should not be modified or incorporated into another logo, cut apart or have any of its elements changed or rearranged.
- The Society logo should be as big as or bigger than other logos when used together.

- Local sections can use their logos, but please remember to use the guidelines above. We suggest that local section logos be placed prominently in the top right hand corner of materials, opposite the ACS logo and tagline.
- Along with the logo and the tagline, it is important to use the words “American Chemical Society” somewhere on the item of communication.
- The Society name/logo/tagline should not be used in circumstances that might be construed as an endorsement of a commercial product or service.

All requests to use the name/logo/tagline by non-ACS organizations should be referred to the ACS Office of the Secretary at (202) 872-4464 or email secretary@acs.org.

Investigations and Activities

The activities, included in this handbook and those you will receive in the future, are intended for use by high school students under the direct supervision of a qualified chemistry teacher. The investigations described may involve substances that may be harmful if they are misused or if the procedures described are not followed. Other substances are mentioned for educational purposes only and should not be used by students unless the instructions specifically indicate.

The materials, safety guidelines, and laboratory procedures contained in this handbook are believed to be reliable. This information and these procedures should serve only as a starting point for good laboratory practices, and they do not purport to specify minimum legal standards or to represent the policy of the American Chemical Society. No warranty, guarantee, or representation is made by the ACS as to the accuracy or specificity of the information contained herein, and the ACS assumes no responsibility in connection therewith. The added safety information is intended to provide basic guidelines for safe practices. It can not be assumed that all necessary warnings and precautionary measures are contained in the document or that other additional information and measures may not be required.

ChemClub Laboratory Safety Agreement Form

The following safety pointers apply to all laboratory activities. For your personal safety and that of your classmates, make following these guidelines second nature in the laboratory. Your *ChemClub* faculty advisor will point out any special safety guidelines that apply to each activity.

Rules of Laboratory Conduct

1. Perform laboratory work only when your *ChemClub* faculty sponsor is present. Unauthorized or unsupervised laboratory experimenting is not allowed.
2. Your concern for safety should begin even before the first activity. Always read and think about the details of the laboratory activities.
3. Know the location and use of all safety equipment in your laboratory. These should include the safety shower, eye wash, first-aid kit, fire extinguisher, fire blanket, exits, and evacuation routes.
4. Wear a laboratory coat or apron and impact/splash-proof goggles for all laboratory work. Wear closed shoes (rather than sandals or open-toed shoes) preferably constructed of leather or similar water-impervious material. Tie back long and loose hair. Shorts or short skirts must not be worn.
5. Clear your workspace of all unnecessary material such as books and clothing before starting.
6. Check chemical labels twice to make sure you have the correct substance and the correct concentration of a solution. Some chemical formulas and names may differ by only a letter or a number.
7. You may be asked to transfer some laboratory chemicals from a common bottle or jar to your own container. Do not return any excess material to its original container unless authorized by your *ChemClub* faculty sponsor, as you may contaminate the common bottle.
8. Avoid unnecessary movement and talk in the laboratory.
9. Never taste laboratory materials. Do not bring gum, food, or drinks into the laboratory. Do not put fingers, pens or pencils in your mouth while in the laboratory.
10. If you are instructed to smell something, do so by fanning some of the vapor toward your nose. Do not place your nose near the opening of the container. Your *ChemClub* faculty advisor will show the correct technique.
11. Never look directly down into a test tube; do view the contents from the side. Never point the open end of a test tube toward yourself or your neighbor. Never heat a test tube directly in a Bunsen burner flame.
12. Any laboratory accident, however small, should be reported immediately to your *ChemClub* faculty advisor.
13. In case of a chemical spill on your skin or clothing rinse the affected area with plenty of water. If the eyes are affected, rinsing with water must begin immediately and continue for at least 10 to 15 minutes. Medical assistance must be obtained.

14. Minor skin burns should be placed under cold, running water.
15. When discarding or disposing of used materials, carefully follow the instructions specified by your *ChemClub* faculty sponsor. Waste chemicals are not generally permitted in the sewer system.
16. Return equipment, chemicals, aprons and protective goggles to their designated locations.
17. Before leaving the laboratory, make sure that gas lines and water faucets are shut off.
18. Wash your hands before leaving the laboratory.
19. If you are unclear or confused about the proper safety procedures, ask your *ChemClub* faculty advisor for clarification. If in doubt, ask!

Students exhibiting misconduct or disregard for safety during a *ChemClub* laboratory activity may be asked to leave the laboratory.

By signing below, the student and parent or guardian indicate that they have read and agreed to follow these "Rules of Laboratory Conduct." The student is expected to follow these rules as well as any additional printed or verbal safety instructions given by the *ChemClub* faculty advisor. This slip is to be returned by ____. If a parent or guardian has any questions, please feel free to telephone ____ at ____________________________________.

I, ____ have read and agreed to follow the "Rules of Laboratory Conduct and any additional printed or verbal safety instructions given by the *ChemClub* faculty sponsor.

____

STUDENT SIGNATURE DATE

____

PARENT SIGNATURE DATE

ACS *ChemClub*
Education Division
1155 Sixteenth Street, NW
Washington, DC 20036
(202) 776-8296
Fax (202) 833-7732
hschemclubs@acs.org
www.acs.org/chemclub

PHOTO RELEASE FORM

PARENT OR GUARDIAN:

I hereby give permission for my son's or daughter's, ____,

photo taken during ChemClub activities to be used in publication produced and distributed by the Education Division of the American Chemical Society. This photo release is for the __________________ school year.

Parent or Guardian Name ____

Parent of Guardian Signature____ Date______________

Student Name____

Student Signature____ Date______________

Student Address____

Student Phone Number____

With our signatures on this page, we hereby transfer to the American Chemical Society (ACS) all copyright and other interests in photographs taken of the aforementioned student at ChemClub activities during the ______________ school year to use in publications produced and distributed by the Education and International Activities Division of ACS. Likewise, we hereby grant royalty-free permission, including nonexclusive world rights in all languages to reproduce these photos in all formats including but not limited to print (magazines, newsletters, books, posters, catalogs, promotional brochures), electronic (Web sites, online newsletters), and digital images (CD ROM, DVD, PowerPoint). We understand that ACS will not share the photos with any third parties without first obtaining our additional permission.