The Compleat Chymical Demonstrator

About these files

Introduction

Chemistry is an experimental science. That is, it is not just an intellectual pursuit, but a hands-on (or should I say a "hands-in") science. Through chemistry we can create a wondrous range of substances and materials with unique colors, odors, and properties. None of the physical or natural sciences are as creative as chemistry.

Chemistry is full of abstract concepts and often requires some mathematics, thus, it is considered difficult to comprehend. To further compound chemistry's poor image, many instructors just talk about chemistry and chemical reactions, and the students have no concrete concepts of the phenomena being described. Pictures help, videos are better, but live demonstrations and hands-in activities make the longest lasting memories.

Unfortunately, when I tell people I am a chemistry teacher, I often get the same response as Count Dracula gets from potential victims in the movies. There are lots of stories about poorly taught and boring chemistry classes. Occasionally, I am told about the wonderful demonstrations remembered from class, sodium explosions in water, fires, smoke, and other explosions. Also, when I go to a school to do a chemistry presentation, I usually get the question "Are we going to have some explosions?" That is when I recoil in defense.

To all those individuals who think that fire, smoke, and explosions is chemistry, don't bother to read the material on this web site. You are not a chemistry teacher! Quit wasting your time surfing the web, and invest your money in some real chemistry and safety training along with a lot of liability insurance.

A word on safety. I have tried to give safety guidelines for each experiment or activity. The safety information is not exhaustive, as there is not sufficient space to discuss all aspects of chemical safety in each experiment/demonstration. Anyone who works with chemicals should have some safety handbook available for reference, even if it is only the Safety Section of the Flinn Scientific Company catalog. Of course, additional safety manuals are strongly recommended. Their costs are cheap compared to the alternatives. You should request that your employer purchase several safety manuals as essential information for your laboratory and that the school should bear the cost of these books, not your teaching budget. Safety references are every bit a necessary part of your science laboratory as the furniture in your classroom or laboratory. It is also the responsibility of every instructor or laboratory aid to practice safety at all times in the classroom and laboratory. Remember, a chemical professional working with hazardous materials in a chemical laboratory is safe, compared to someone working at home with household chemicals. That professional knows, in advance, what he or she is working with and

what to do in case of an accident, the home worker often does not know the same type of information.

Eye and face protection are essential. Rubber or insulated gloves, aprons, lab coats, safety shields, etc., are all important and should be considered for appropriate activities. In addition, all activities must be performed in the appropriate setting. Proper precautions must be taken with flames and flammable materials. Appropriate materials should be used to protect table tops, floors, and carpets. There must be adequate ventilation so smoke or fumes do not fill a room or set off smoke detectors. The audience must be warned of loud noises.

Limited disposal information is also included for most activities. Rules for disposal of chemicals varies with the locality, so there is no way to adequately cover disposal of all materials. The best advice I can give on disposal is work with small quantities of materials and use the least hazardous materials that will demonstrate the concept you are discussing and dispose of all materials according to your local regulations.

Some essential references for chemical safety and disposal are:

Flinn Scientific, Inc., *The Flinn Catalog*. Available from Flinn Scientific, Inc., P.O. Box 219, 700 N. Raddant Rd., Batavia, Ilb60510.

Flinn has dedicated a significant portion of their catalog to chemical safety, storage, and disposal. This is the lowest cost safety manual you can obtain, but it should not be your only one. Flinn also offers safety training workshops. In return for this service, you should order supplies from Flinn to support their safety efforts.

American Chemical Society, *Safety in the Academic Chemical Laboratory,* 6th Edition, ACS Books, 1995.

An essential 70 page book that should be in your laboratory. ACS will usually send one copy free to an academic institution. Normal price is $3.50 for 1 to 199 copies.

Committee on Prudent Practices for Handling, Storage, and Disposal of Chemicals in Laboratories, National Research Council, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*, 1st Edition, 1995.

This authoritative reference book costs $66.00, but it is a bargain, considering the information it contains.

As a chemistry educator, it is your professional responsibility to invest in yourself and your future by joining the appropriate professional societies and regularly attending chemistry and related science education conferences. If you are reimbursed for your expenses, that's great, if you are not, then you just have to budget for a conference. This is not about money, it is about lifelong learning and being a truly effective teacher. If you can get up the courage, present a paper or demonstration at one of those conferences,

it really is not difficult and you do have something to offer to others. I'll bet that boring science teacher you remember from your past probably did not do any professional development after he or she obtained tenure.

During my career, I have attended many demonstration sessions at many conferences, particularly, American Chemical Society national and regional meetings, Two-Year College Chemistry Conferences, International Conferences on Chemical Education, Biennial Conferences on Chemical Education, ChemEd Conferences, National Science Teacher Association national and regional meetings, state chemistry and science teacher association meetings, and local conferences and workshops. Not only do I compare notes and ideas with others from around the world, I usually walk away from these conferences with at least one new demonstration or activity or an idea for a demonstration. In addition, I have over 200 books with science activities and demonstrations in my personal library. (A list of demonstration and activity books is given in a separate file.) Most demonstrations and activities are not "new", they have been taken from many sources, shared between colleagues, and modified or re-engineered. In some cases, I can remember where I first saw a demonstration or activity or who presented it, but in many cases I can not. I have tried to acknowledge those individuals or the conference where I first saw a demonstration at the end of each activity. For those activities where no acknowledgement is given, I would like to thank those unnamed individuals for their contributions or for sparking an idea in my mind.

David A. Katz

Files on this web site

The files on this web site are PDF files and require the latest version of Acrobat Reader. Get Adobe Acrobat Reader for free at www.adobe.com

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(As files are continually added to this site, the following list may not be up-to-date with all the files on the web site.)

Reference and background information:

- The Art of Effective Demonstrations – tips on preparation and storage
- The First Day – make that first day special
- Science Demonstrations, Experiments, and Resources: A Reference List for Elementary through College Teachers Emphasizing Chemistry with some Physics and Life Science
- Common Chemicals and Supplies in and Around Your Home

Scientific Method, Investigations and Elements:

- Hypothesis and Experiment – an introduction to the scientific method
- Pouring water between two glasses – an easy interactive activity
- The M&M's Lab – an introduction to graphing
- Iron for Breakfast – do you know what's in your food?
- An Experiment in Alchemy: Copper to Silver to Gold
- Earth Science
- The Magnesium Fire Starter

Density, Volume and Heat:

- Coke and Diet Coke – a density experiment
- Hot and Cold – separate water by density
- Conservation of Volume
- Conservation of Volume, Solution to the Problem
- Energy of a Peanut – an experiment in calorimetry

Mixtures:

- Chalk Chromatography: A Method to Separate a Mixture
- Spin Chromatography

Chemical Reactions:

- Investigating the Chemistry of Color Changing Markers
- Chemical Reactions: A Microscale Experiment
- Preparation of Zinc Iodide – tracking a chemical change
- The Thermite Reaction

Gases and Oxidation:

- The Preparation of Oxygen
- Oxidation: Does Iron Burn?
- The Magnesium Fire Starter
- Pouring Out a Candle
- Gases and Pressure: Experiments with a 140-mL Syringe
- How Do We Affect the Quality of Our Atmosphere

Solids:

- Grow an Alum Crystal

Light and Spectra:

- Visualizing the Electromagnetic Spectrum
- Build a radio transmitter
- Colors and Elements – a safe way to demonstrate flame colors
- Build a Hand-Held Spectroscope
- Build an Overhead Projector spectroscope
- Phosphorescence
- Red Sunset – “red sky at night…”

Intermolecular Forces:

- Decrease in Volume – mixing two polar substances
- Increase in Volume – reaction of an acid with a base yields…
- Forces of Attraction: Drops of Water on a Coin
- Which Will Evaporate First? – visual vapor pressure
- Intermolecular Forces

Entropy – order ↔ disorder

Kinetics and Equilibrium:

Colorful Catalysis – observe an activated complex

Chemical Equilibrium Simulation

Electrochemistry:

Batteries

Build a Microscale Fuel Cell

DNA Isolation – using household products

Non-Intuitive Demos and Activities to Make Students Think

Chemistry in the Toy Store (a separate web page) consists of:

Chemistry in the Toy Store Notes (my current version**)**

Encyclopedia Britannica Article (scanned from the 1988 Yearbook of Science and the Future)

Expanded Toy Articles

Preparations and extended investigations with toys based on materials developed from 1982 to the present. As this section becomes updated, this list will be changing.

Balloons
Rubber: Make a Rubber Ball
Chromatography: The following are two forms of chromatography using apparatus or materials available in toy stores.
- Chalk Chromatography
- Spin Chromatography

The Chemistry of Color Changing Pens and An Investigation of Color Changing Pens
Disappearing Ink (Includes information on Hollywood Hair Barbie)
Flash Screen A phosphorescent screen to freeze your shadow or write on it with light.
Hopper Popper Make a popper to demonstrate how a ball bounces
Shrinky Dinks
Silly Putty
Slime:
- Slime
- Polyvinyl alcohol Slime

Glow Slime
A Bag of Slime
GAK (Includes a procedure for making glow-in-the-dark Gak)
Ooze Ball
Magic Tree Experiment with a commercial Magic Tree
Magic Tree, An Explanation The chemistry of the Magic Tree
Grow You Own Crystal Tree or Crystal Garden
Magic Sand
Play Dough (Monster Flesh)
Smart/Stupid Balls
Superabsorbant Material:
Instant Glop
Magic Egg

Recipe Lists

Want to make some of these toys using mostly household materials? Two sets of recipes are provided. For more complete recipes and investigations, go to the individual files listed above. Please observe all safety precautions.

Toy Store Recipes are formatted to fit on letter size paper.

Recipes 2005 – legal size are formatted to fit on a single sheet of legal size paper

Magic Into Science (Some Chemical Magic) a separate web page

Magic into Science, by David A. Katz, was originally presented at ChemEd '93 at Butler University in Indianapolis, IN. It has since been presented many times internationally.

References for Magic into Science

The Burning Book – a way to light up your first class or a presentation

A Chemical Genie – a fun way to start out a program (don't forget the chemistry)

Cut and Heal

The Preparation of Oxygen

Pouring Out a Candle

The Fireproof Balloon

The Non-burning Paper

Disappearing Water

Silver Flask

Turning Phenolphthalein Red with Acid

Red Sunset

Cooking With Chemistry – a separate web page

Cooking with Chemistry was first presented as a one-day hands-on workshop for teachers at ChemEd 97, held at the University of Minnesota, Minneapolis, MN, August 3-7, 1997.

Click on one of the titles below to read some experiments and activities from Cooking with Chemistry, a work in progress, by David A. Katz:

These are PDF files and require Acrobat Reader

Beef Jerky - A Method to Preserve Food Without Refrigeration
Butter:
- Butter in a Bottle
- Blender Butter

Candy Making:
- Partial Thermal Degradation of Mixed Saccharides With Protein Inclusions
- Partial Thermal Degradation of Mixed Saccharides With Protein Inclusions - Teacher Notes
- Taffy: Partial Thermal Degradation of a Mixed Saccharides Triol Solution
- Taffy: Partial Thermal Degradation of a Mixed Saccharides Triol Solution - Teacher Notes
- Lollipops

Cheese Making:
- Easy Cheese
- Mozzarella

Chromatography of Food Colors
- Chromatography: The extraction and identification of artificial food colors by paper chromatography
- Chromatography: The extraction and identification of artificial food colors by paper chromatography teacher notes

Dry Ice Root Beer
Energy of a Peanut
- Energy of a Peanut - An Experiment in Calorimetry
- Energy of a Peanut - An Experiment in Calorimetry teacher notes

Glue from Milk
Ice Cream:
- Effect of Freezing Point Depression on Mixed Saccharides-Protein Solutions
- Effect of Freezing Point Depression on Mixed Saccharides-Protein Solutions – Teacher notes
- Liquid Nitrogen Ice Cream

Iron From Cereal
- Iron from cereal

- Iron from cereal teacher notes
- General Mills letter

Make Your Own Orange Drink: An Experiment in Determining How Additives Affect Our Food
Map Your Microwave
MOLasses Cookies
Peanut and Nut Butters
Pickling:
- Zip-Lock pickles
- Corned beef

Popcorn:
- Popcorn
- Microwave popcorn

Potato Chips:
- Potato chips
- Potato Chip Tasting
- Determination of Fat in Potato Chips

Titration of Stomach Antacids:
- Titration: Standardization of a Base and Analysis of Stomach Antacid Tablets
- Titration: Standardization of a Base and Analysis of Stomach Antacid Tablets teacher notes

Water testing:
- Testing the Waters: How Good is That Bottled Water and How Effective is Your Water Filter
- Testing the Waters: How Good is That Bottled Water and How Effective is Your Water Filter - Teacher Notes

Yeast:
- How yeast works
- Philadelphia soft pretzels
- Root beer/Birch beer
- Ginger ale

Food Additives: What They Do
Measurement Equivalents for Science Activities
Mass-Volume Equivalents of Common Chemical Solids
Grades of Purity of Chemicals
Temperature