SAFETY FIRST

If you accept the stereotypical image of a chemist as portrayed in the movies, then you probably have the notion that the chemistry laboratory is a dangerous place. Reality is completely contrary to the mad scientist stereotype as long as common sense prevails and proper precautions are taken. As a matter of fact, the chemical industry has one of the best records for days lost at work due to accidents.[1,2] Since you are now taking organic chemistry, you have already had experience in the chemistry laboratory but it is worth repeating the common rules. Additionally, the organic lab has new areas of concern that need to be addressed. Unlike general chemistry where almost all of your reactions were run in aqueous solution, most organic reactions use highly flammable organic liquids such as ether, hexane, 2-propanol or toluene as solvents (why are flammable organic solvents used rather than water). These solvents have low flash points and therefore should never be heated with a flame. In fact, unless the instructor gives a specific recommendation to use a flame, the use of flames in the organic laboratory should be totally avoided. Heating should be done with a steam bath, heating mantle or oil bath. Recognize that even these heating methods can cause dangerous accidents. Steam or hot oil can cause very severe burns. If instructions are carefully read and followed and you use common sense, you will experience an accident free, fun learning experience.

1. Wear goggles or appropriate legal eye protection at all times when performing experiments or in the vicinity of experiments being performed.

2. Know the locations and operating instructions for the fire extinguisher, eyewash, safety shower and fire blanket and know where the laboratory exits are.

3. Do not use flames at any time unless authorized by the instructor.

4. Follow instructions carefully and **do not perform unauthorized experiments**. If you have an idea for a modification to an experiment, do not hesitate to discuss it with your instructor. If your idea has merit, the instructor might enable you to carry it out.

5. Keep table tops clean. Clean up acid and base spills promptly.

6. Do not take food into the laboratory. Don't taste or eat anything in the laboratory.

7. When working with toxic gases or volatile toxic substances, work in a well-operating hood.

8. When working in a hood, keep the glass door down as far as possible.

9. Report all accidents, no matter how minor, to the instructor.

10. Never return chemicals to bottles of their origin. If you have taken an excess of a chemical, give it to another student, or if necessary, properly dispose of it. It's better to waste a small amount of the chemical than to risk contaminating the entire contents of the bottle.

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[1] http://www.bls.gov/iif/oshwc/osh/os/ostb1244.pdf

[2] http://www.bls.gov/iif/oshwc/osh/os/ostb1246.pdf

11. Don't stick objects such as pencils or eyedroppers into reagent bottles and don't lay reagent bottle stoppers down in any way that the part which goes into the bottle comes in contact with any surface. If you need a few drops of a liquid, pour a little into a beaker and then take what you need from the beaker. If a solid has packed hard in a bottle, slap the side of the bottle to loosen it. If this doesn't loosen some solid, ask the instructor to help you. Most reagent bottles for solids have hollow caps. If you need a small amount of the solid, with the cap still in the bottle, shake a little into the cap and take what you need from the cap. These techniques help to prevent introduction of contamination.

12. Switching reagent bottle stoppers will invariably contaminate the reagent. To avoid this, never have more than one bottle unstoppered at a time. If the stopper is the penny-head type, hold it between the fingers of the hand you are pouring with while pouring. If you do this, you can be certain you are not mixing up stoppers or contaminating the reagent.

13. Wear a lab apron to protect your skin and clothing whenever you are working with hot or corrosive liquids.

14. Never work alone in the laboratory.

15. Always read the label twice before using a chemical reagent. Be sure the concentration, as well as the name of the reagent, is correct.

16. If you spill a chemical on your skin, flush the skin area ***immediately*** with plenty of water, then wash the area with soap and water.

17. Smoking is not permitted in the laboratory and is bad for your health anywhere.

18. Leather shoes are preferred and canvas or open-toed shoes might not be allowed.

19. Paper items should be disposed of in the waste basket, not in crocks!

20. Do not dispose of insoluble compounds, used metal squares or marble chips in sinks. Dispose of them in designated containers.

SAFETY EXERCISE

A Smithsonian Museum display in Wash., D.C., showing Ira Remsen and Constantin Fahlberg in a chemistry laboratory.

About 100 years ago, the Chairperson of the Chemistry Department at Johns Hopkins University, and in large part, the founder of chemical education in America, Ira Remsen, (see ***Experiment 17*** for more information about Ira Remsen) wrote the following:[3]

While reading a textbook of chemistry, I came upon the statement "nitric acid acts upon copper." I was getting tired of reading such absurd stuff and I determined to see what this meant. Copper was more or less familiar to me, for copper cents were then in use. I had seen a bottle marked "nitric acid" on a table in the doctor's office where I was then "doing time!" I did not know its peculiarities, but I was getting on and likely to learn. The spirit of adventure was upon me. Having nitric acid and copper, I had only to learn what the words "act upon" meant. Then the statement, "nitric acid acts upon copper," would be something more than mere words.

All was still. In the interest of knowledge I was even willing to sacrifice one of the few copper cents then in my possession. I put one of them on the table; opened the bottle marked "nitric acid;" poured some of the liquid on the copper; and prepared to make an observation.

But what was this wonderful thing which I beheld? The cent was already changed, and it was no small change either. A greenish-blue liquid foamed and fumed over the cent and over the table. The air in the neighborhood of the performance became dark red. A great colored cloud arose. This was disagreeable and suffocating - how should I stop this? I tried to get rid of the objectionable mess by picking it up and throwing it out of the window, which I had meanwhile opened. I learned another fact - nitric acid not only acts upon copper but it acts upon fingers. The pain led to another unpremeditated experiment. I drew my fingers across my trousers and another fact was discovered. Nitric acid also acts upon trousers. Taking everything into consideration, that was the most impressive experiment, and, relatively, probably the most costly experiment I have ever performed. I tell of it even now with interest. It was a revelation to me. It resulted in a desire on my part to learn more about that remarkable kind of action. Plainly the only way to learn about it was to see its results, to experiment, to work in a laboratory.

The description above is very amusing and expresses an enthusiasm for chemistry that we all should strive for. Ira Remsen also recognized the vital importance of the laboratory experience in chemistry. However, he was very fortunate that this particular experiment did not have dire consequences. Experiments should never be conducted using the methods described. List all the violations of good safety practice in the experiment described by Ira Remsen and suggest some safer approaches to finding out what was meant by the words "acts upon."

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[3]Getman, F. H., *The Life of Ira Remsen*, Journal of Chem. Ed., Easton, PA, 1940, p 9 (reprinted in Cobb, C., Goldwhite, H., *Creations of Fire: Chemistry's Lively History from Alchemy to the Atomic Age*, Plenum, N.Y. 1995, p. 255).