LECTURE DEMONSTRATIONS FOR THE SMALL OR RURAL HIGH SCHOOL

By

CLAUDE W. GATEWOOD

Bachelor of Science

Stephen F. Austin State College

Nacogdoches, Texas

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Thesis Adviser

Dean of the Graduate School

TABLE OF CONTENTS

INTRODUCTION

A high school student, with no scientific background who enrolls in a chemistry class, quite often finds himself in a peculiar situation. All his life he has thought of weight as being pounds or tons and generally, there has been no emphasis on the fact that a pound is actually a unit of weight. He is told to learn a new "system of units of measure" in a few days and if he does not fully understand just what is involved he is forced to memorize blindly. This may be the fate of many of the new concepts involved in chemistry.

Especially in studying advanced chemistry, a knowledge of mathematics is essential. However, many students are lead to think of chemistry as something like a form of mathematics, in which one memorizes many formulas, tables and relationships. Then when confronted with a problem in chemistry, the student must rack his brain for the right thing to substitute in the right place. In any science there must be some of this sort of thing but the beginner should be well grounded in the concepts, be taught to see in his mind's eye what chemistry is and what it means. Then, confronted with a problem, he may well be challenged rather than frightened.

The compilation of this paper represents several goals. First: To isolate the most troublesome barbs in an introduction to chemistry on the high school level and where possible, deal with them so as to allow the student to understand through seeing and relating these new concepts to things in his every-day life. Second: To design teacher-demonstrations that can be done using equipment and material which is easily available. Third: To include a list of demonstrations and suggestions which may be used purely for "advertising" in schools where science is not taught.

The demonstrations are not intended for large high schools. Rather, they are written for the small rural or village school where chemistry may not even be taught every year. As science teachers in such schools may not have a major in chemistry, and quite often have little or none, the language will be such that a science teacher with a minimum background should be able to read and understand the directions. The chemicals needed may be purchased at almost any small drug store; the equipment well may be jelly glasses and fruit jars. Any special preparation will be thoroughly explained.

In schools not offering chemistry, this paper should prove useful in general science classes. In such cases, it is suggested that a certain portion of the semester be used to emphasize chemistry per se. After two or three years of this activity in, for example, a ninth grade science class, interest in the upper three grades may be increased to the point where a section of chemistry is possible.

ABOUT THE DEMONSTRATIONS

Many of these demonstrations will arouse the curiosity of the students and lead them to ask questions not pertaining to the subject at hand. Generally, it will be best to tell them that the answers can be found in their chemistry text. However, if chemistry is not offered, it may be wise to ask the student to try to find the answer himself and bring it to class in a few days to explain to the group.

In some instances, the same equipment and demonstration will be used in different sections to demonstrate different ideas. In such cases, any changes in procedure which must be made are indicated.

If satisfactory results are not obtained, very carefully vary the relative quantities of reagents to obtain the desired results. For example, in Section One, Number Four, best results may vary from two parts potassium permanganate and one glycerin to the opposite ratio.

Many materials, such as matches, butter, kerosene, balloons, etc., are not listed in the materials section because of the ease with which they may be purchased.

Do not consider the order in which subjects are taken as indicative of proper order. The first day, when most of the day will be used in issuing texts, etc., many teachers might prefer using Demonstration Eighteen, just to start with something interesting.

SECTION ONE

1. Drop a small piece of zinc about the size of a penny into a glass which is about half full of hydrochloric acid. If reaction is too violent, dilute the acid with 2 or 3 parts of water. The gas given off will be hydrogen, according to the reaction:

   Zinc + Hydrochloric Acid --- Zinc Chloride + Hydrogen

   $$Zn + 2\ HCl \text{ --- } ZnCl_2 + H_2$$

   A Pyrex glass would be best for use here due to the amount of heat given off when using concentrated acid. If no Pyrex glass is handy, use an ordinary clear glass and set it in a pie pan as a safety measure.

2. If some clean white sand can be procured, put one half inch of sand and an equal amount of sugar in the bottom of two glass jars or bottles. Cover with water and shake, dissolving the sugar. Ask the students if they know what the two substances are and if they can think of other substances which would act in the same way or if they know of a substance which would have been likely to have only half dissolved. This is more impressive if the sand and sugar look nearly the same.

3. Pass around or show from the desk, a piece of rusty iron, a piece of shiny iron, and a piece of aluminum. Ask if the students really know why the aluminum has not rusted and if they know what actually happened to the iron to make it rust.

4. From the drug store, procure a half ounce or so of potassium permanganate crystals and a small bottle of glycerin with an eyedropper. Fill a cigar box level full of sand. Place a metal thimble in the center with the open end up. Settle the thimble down about half way into the sand. Fill the thimble one-half full of potassium permanganate crystals and then gently squirt approximately the same amount of glycerin into the thimble on top of the crystals. Step back two or three feet and watch. In twenty or thirty seconds a beautiful flame should appear. The effects can be changed by using different amounts of each chemical or by using a slightly larger thimble.
5. Buy some ammonium bichromate from the drug store or from a photographer's shop. An ounce will do. Pour out a pile about the size of a pecan onto some unburnable surface. A soft brick with a place scooped out works fine. The effects are more dazzling if the surface is white or light-colored. Have the pile as pointed as possible and then light the top with a match. A bunsen burner works much better if you have one. If the entire pile burns it should increase in size and turn from orange to dark green while giving off sparks like a small volcano. Be sure that no-one tries to taste the ashes.
6. Take a quart of water to the drug store and tell the pharmacist that you want just enough iodine crystals to give the water a good color. If you wish, just pour as many drops as necessary of tincture of iodine into some water to color it. This will do nicely for iodine water. Next,

purchase an ounce of sodium thiosulfate. It is photographer's "hypo" in crystal form. You may experiment with varying amounts of each material. A crystal or two of hypo when dissolved in a small amount of the iodine water will clear the water, or a few drops of concentrated solution of hypo water will clear a fairly large volume of iodine water. Hypo can be used to clean iodine from clothes, too.

7. If an ounce or two of "Argyrol" (brown) or weak silver nitrate solution (clear) is mixed with a small bit of Clorox, either will turn chalky white. Argyrol and silver nitrate solution may be obtained from a drug store. Clorox is carried by any grocery store. Salty water may be used instead of Clorox.

8. Obtain some good, clear, distilled vinegar from a grocery store. Get a handful of oyster shell from a feed store. Pour 2 cupfuls of vinegar in a jar and one cupful of oyster chips. They will give off carbon dioxide gas for a long time. If this is done in a large bottle, a balloon placed over the neck will be filled with CO_2 gas. Do not stopper the bottle or it will explode. If this is done in a wide-mouthed container, in a still room, the carbon dioxide will fill the container. Then, if a burning match is lowered into it, the flame will be extinguished.

SECTION TWO

A meter stick should be shown to the class if one is available. A chart of the metric system would be particularly helpful at this time for an hour's discussion and explanation.

SECTION THREE

1. Powder an Alka-Seltzer tablet as a demonstration of a physical change. Then drop the powder into a glass of water to demonstrate chemical change. Also drop a whole tablet into another glass to show that powdering was not necessary to allow a chemical change.
2. Light a candle with a fairly large diameter and allow it to burn for 20-30 seconds. Point out that the solid wax is changing to a liquid. This physical change can be shown by tilting the candle to show that the liquid wax will drop off. Next point out that the liquid wax must undergo a physical change and become a gas before it will burn. The burning, of course, is a physical change. You can prove that the gaseous wax is burning by blowing the flame out and then quickly holding a match about one inch above the wick. The gases, being hot, will be rising and will usually re-ignite the candle. Here is an example of a physical change that must occur before a certain chemical change can take place. The wax must be changed into the gaseous form before it will burn.

SECTION FOUR

It may be difficult for some students to grasp the abstract ideas in this section. If students seem totally lost, the following demonstration might help. First tell the students not to worry about the abstract ideas that are confusing them, but to concentrate on the demonstration.

1. Show the students a dime, a nickel, a penny, a quarter, and a half dollar. Explain that you do not know anything about these objects but that you need to work with them anyway.

2. Tell the students that you are too lazy to write any more than you have to, so you are going to abbreviate in this way:

Unit	Symbol
Dime	D
Nickel	N
Quarter	Q
Penny (Cent)	Ce
Half dollar	Ha

Write these names and symbols on the board just as if you were making them up as you go. Next, compare all the coins and announce that since the dime is lightest, you will say that it weighs one. Compare the weight of one penny in one hand with the weight of three dimes in the other hand as though you were weighing them. Announce that since three dimes weigh exactly as much as one penny, you will say that the weight of a penny is three. Repeat this with four dimes and a nickel to establish the weight of a nickel as

4. In the same manner, assign weights of 2.5 to a quarter (it weighs two and a half times as much as a dime) and 5 to the half dollar. As each weight is determined, add it to the previous chart as a new column, "Weight." Call this "Coin Weight." Now you have all the information needed:

Material	Symbol	Coin Weight
Dime	D	1
Nickel	N	4
Quarter	Q	2.5
Penny (Cent)	Ce	3
Half dollar	Ha	5

Now say that you want to work with some groups of coins which you will call "stacks." Make a stack of three dimes, one penny, and one nickel. Write on the board that you could now indicate this "stack" as D_3CeN. Point out that this "stack weight" would be (3 x 1) plus (1 x 3) plus (1 x 4) equals 10. That is, a stack weight of this combination would be 10. You may give a name such as "gloop" to this particular combination and then put several more combinations on the board and ask the students to compute the stack weights.

		Formula	Stack Weight
1.	Gloop	D_3CeN	10
2.	Gleep	Ce_3N_2Ha	22
3.	Glop	$N_3(Ce_2D)_4$	40

$N_3(Ce_2D)_4$ means N ≠ N ≠ N ≠ 4(Ce ≠ Ce ≠ D)

Point out that stack weight means the same as molecular weight; coin weight means the same as atomic weight, etc. This comparison can be carried through any phase of this section and quite often a period may be well spent on this since it is so basic to the type of thinking ability the science student must acquire. This system seems foolish at first, but is has shown many students that they were trying to make the subject of atomic and molecular weights harder than it actually is.

SECTION FIVE

1. Do Demonstration Two under Section Three and point out the changes of state from solid to liquid to gas. You can prove that gaseous water is one of the combustion products by inverting a cool test tube or bottle neck over just the tip of the flame for two or three seconds. A film of moisture should collect on the inside of the container.
2. Demonstration Number One under Section One may be used here to show the reaction of a solid and a liquid to form, among other things, a gas.
3. An Alka-Seltzer tablet dropped into a glass of water is another example of a gas being formed from a solid and a liquid.
4. If, in Demonstration Seven in Section One, a clear solution of silver nitrate is used with Clorox, an insoluble precipitate is formed. This can be coagulated by allowing it to stand for a few hours. This settling may be hurried by adding a pinch of powdered alum and stirring. Here is a solid being formed by two liquids.

5. Section Three, Experiment Two can be used to show a liquid, water, being formed by the chemical reaction of a gas, oxygen in the air, and a gas, the vaporized wax.
6. The electrolysis of water from Section Four is an excellent way to demonstrate the situation in which a substance normally a liquid is made of, and can be decomposed into, two substances which are gases.
7. Calcium carbide, which may be purchased from a hardware store as "Carbide," will react with water to form a gas, acetylene. Calcium carbide looks very much like a rock but when dropped into water, reacts to release acetylene which is a combustible gas. If a jar of acetylene gas is left open for about ten seconds, then ignited, it will burn and give off thick clouds of black smoke. The black soot is pure carbon. Care should be taken not to burn acetylene in a closed or narrow-necked bottle since it might explode. Also, moist Carbide, if sealed, may generate enough gas to explode the container, so <u>keep it dry</u>.

SECTION SIX

1. Demonstrate an emulsion by violently shaking a mixture of equal volumes of kerosene or oil and water. If an electric mixer or blender is available, a very good emulsion can be obtained.
2. Make an emulsion of oil and water. Divide it into two equal parts. Put a very little detergent, preferably sudsless, into one and then shake both vigorously. This

should prove that a detergent helps in the formation of an emulsion. This is how oil is removed from clothes, by breaking it up into small particles that will be carried away by the water.

3. Procure some clean white sand, some sugar and some salt, so that they closely resemble each other. Fill each of three test tubes with sand, salt and sugar to a depth of about one-third of the total depth. Cover each substance with water. Hold the three together and shake with equal vigor. After a short period of shaking them, show the class that although the three substances looked very much alike, the first did not dissolve at all, the second, about fifty per cent, and the third dissolved completely, or nearly so. Ask if they can guess what was in each container.

SECTION SEVEN

No demonstrations

SECTION EIGHT

1. Obtain some $CaCO_3$ (oyster shell or limestone will do). Have two beakers or glasses each containing about one-fourth inch of $CaCO_3$. In one container, have lumps about like peas but in the other have a powder or very fine grains. Explain to the students that both contain the same substance, the only difference being the size of the

particles. Now pour into each container about three or four inches of diluted hydrochloric acid. Strong vinegar will do, but not as well. The powder will react quickly, foaming up in a froth. The granules, however, will react much more slowly but their reaction will continue longer. This shows that reaction speed is dependent on, among other things, the amount of surface of one reagent exposed to the other reagent. The gas evolved is carbon dioxide. This may be shown by lowering a burning match into the container and extinguishing the flame. CO_2 will accumulate in the container after a time because it is heavier than air. The above reaction is:

$$CaCO_3 + 2HCl \text{ --- } CaCl_2 + H_2O + CO_2$$

2. The above demonstration may be repeated using very diluted nitric acid and copper. In one container, place a large copper lump and in the other one an equal amount of copper filings. The gas formed will be hydrogen: the blue color of copper nitrate will appear as it is formed by the reaction.

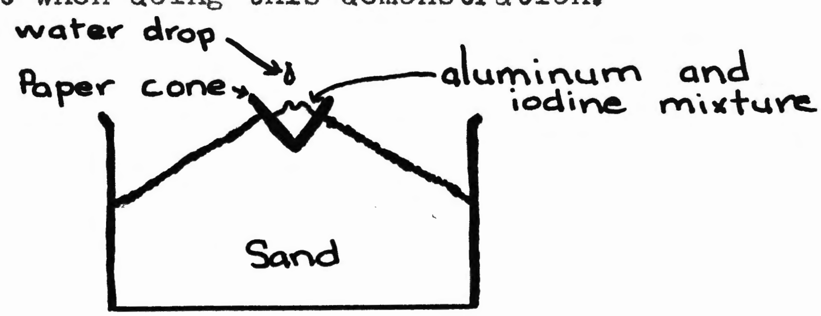
$$2\ Cu + 2H(NO_3) \text{ --- } Cu(NO_3)_2 + H_2$$

3. Demonstration Two in Section Nine may be used to show that cold copper has no catalytic action, but hot copper does in that demonstration.

SECTION NINE

1. Obtain some aluminum powder or fresh filings. Mix this

about half and half by volume with some iodine crystals. The iodine should be as finely divided as is practical. This may be done by punching it before mixing with a dry glass rod while it is spread out on a dry glass surface. Pour the mixture in a small container or roll of paper as shown. Use only about one or two thimblefuls. This amount may be increased slightly if there is excellent ventillation. Drop one or two drops of water on the mixture and **STAND BACK.** If both aluminum and iodine are finely divided and mixed, about twenty seconds after the addition of the water appears an orange flame with much purple vapor. The water catalyzes the reaction. There is probably no need to mention that dry hands are very important when doing this demonstration.

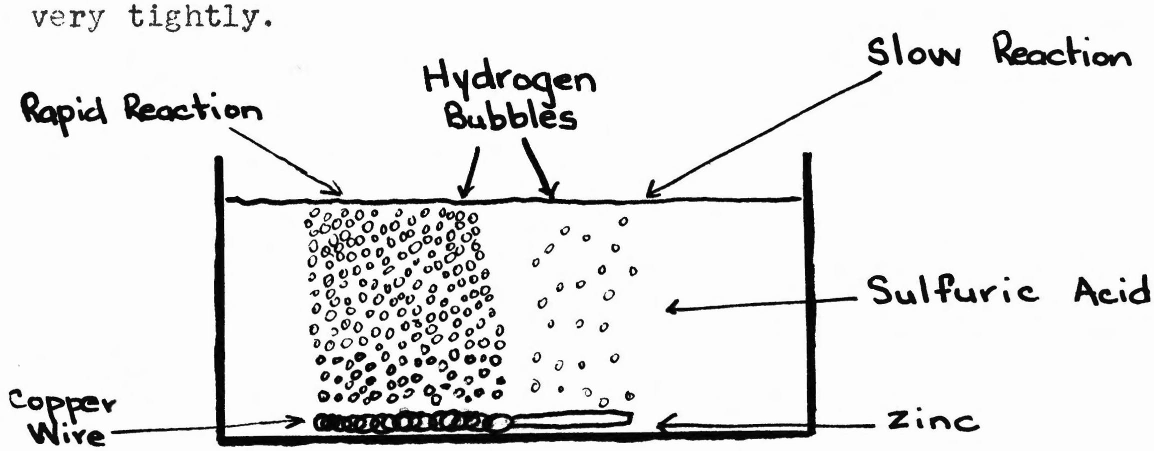


2. Roll some copper wire into a coil about the same size as shown with a foot long handle.

Use fairly heavy copper wire about as large as pencil lead. Pour a test tube or similar container with a wide mouth about one-tenth full of methyl alcohol. Warm the alcohol with the hand to insure alcohol vapor filling the container. The odor may then be easily detected. Heat the copper coil and thrust it into the vapor just above the liquid. Do not touch the liquid or heat the coil hot enough to ignite the alcohol. Hold the coil in the vapor for four or five seconds. Withdraw it and smell the test tube. You should be able to detect the new, pungent odor of formaldehyde. The hot copper catalyzed its formation from the methyl alcohol. Ordinarily only a fraction of the alcohol vapor would be thus converted and it would be so small that it would be impossible to detect. The copper coil, however, catalyzes this reaction and makes its speed hundreds of times greater so that detectable amounts of formaldehyde are formed from the alcohol vapors.

3. Either buy a piece of zinc about three inches long and the size of a pencil or make one by removing the zinc sheeting from a flashlight battery. This may then be rolled tightly and wrapped with copper wire as shown in the diagram. If a solid piece of zinc is used, one end must still be wrapped in copper wire. The wire should be about the size of large thread. Prepare about 100 cc of two or three normal sulfuric acid. This may be done by diluting concentrated acid or by mixing standard solute acid about fifty-fifty with water. When a piece of zinc is dropped into the acid it should just barely react. If the reaction is too fast, add a little more water. When the copper-wrapped zinc is dropped into the acid, one may plainly see that the copper catalyzes the action of the acid

on the metal. The copper does not react itself since, if it did, the solution would turn blue because of the presence of copper sulfate. Some copper sulfate may be exhibited to show its blue color. The copper wire should fit very tightly.



SECTION TEN

1. Obtain a small coil spring and show it to the class. Compress and stretch it, discussing the energy release involved.

2. Place a 250 cc glass container, preferably one made of Pyrex, in a pan large enough so that if the glass breaks, no liquid will be spilled. A water glass may be used. Fill the glass one-third full of water, about 100 cc. Very slowly pour ten cc of concentrated sulfuric acid into the water. It might be wise to hold a book between you and the top of the glass, in case of spattering. After the acid is added, stir for a few seconds to assure adequate mixing. Let some of the students feel the glass of water before the acid is added to show that it is cool. After the acid has been added, let the same

students feel the glass. The temperature should be about the same as water from a hot water faucet. Be careful not to spill it because hot acid is especially dangerous. Quite often when diluting sulfuric acid for laboratory use, several hours are required to keep from boiling the water. Explain that a certain amount of heat must be used (put into the acid) to concentrate dilute sulfuric acid and make the concentrated form. It is only natural (the Law of Conservation of Energy) that the same quantity of heat must be liberated when the process is reversed; that is, when concentrated sulfuric acid is diluted. This is an excellent demonstration of the action of the Law of Conservation of Energy.

SECTION ELEVEN

The electrolysis of water as demonstrated in Section Fourteen will serve nicely as a demonstration of the fact that two volumes of hydrogen react with one volume of oxygen to form water. If the water is thought of as also being in the gaseous state, steam, then it can be seen that two volumes of hydrogen react with one volume of oxygen to form, not three, but two volumes of water, steam.

SECTION TWELVE

No demonstrations

SECTION THIRTEEN

1. Obtain about one-fourth cup of copper sulfate. The blue crystals which you will have are actually hydrated copper sulfate: $CuSO_4 : 5\ H_2O$. Each molecule of copper sulfate has with it five molecules of water. This is what causes the blue color. If a few crystals of the blue stone are heated over a burner, the water of hydration will be driven off, leaving white "anhydrous" copper sulfate, $CuSO_4$. When water is added, the dehydrated white powder will again pick up molecules of water and turn blue. If some of the dehydrated white powder is put in water, it is surprising to the uninformed student to see the water turn blue.
2. Concentrated sulfuric acid is actually a dehydrated liquid. This explains why heat is liberated when the concentrated acid is added to water. Do Demonstration Two under Section Ten, and use it here as an example of an anhydrous liquid "hydrating" with accompanying release of heat. Repeat the explanation used with the demonstration, also.
3. Get a cupful of cheap rock salt from a grocery store. Use the kind that is in large lumps about the size of peas. Hold a spoonful over a burner and the lumps will pop, explode and crack. This is called decrepitation. It is caused by a small amount of water in the salt crystals which turns to steam and makes a minature bomb of

the lump. Sodium chloride (table salt) does not have any water of hydration. However, some of the impurities in the cheap rock salt do have water of hydration and it is this which causes rock salt to decrepitate.

4. Chemical dehydration is not so simple as the above physical dehydration but can be easily demonstrated.

   a. Pour a few drops of concentrated sulfuric acid on a paper towel or newspaper. The paper will immediately turn black and seem to disappear. This is due to the fact that concentrated sulfuric acid has such a terrific affinity ("chemical desire" is the term which may be used) that when it is put on a substance composed of hydrogen, oxygen, and carbon, such as paper, it chemically removes the hydrogen and oxygen in the form of water, leaving the black carbon.

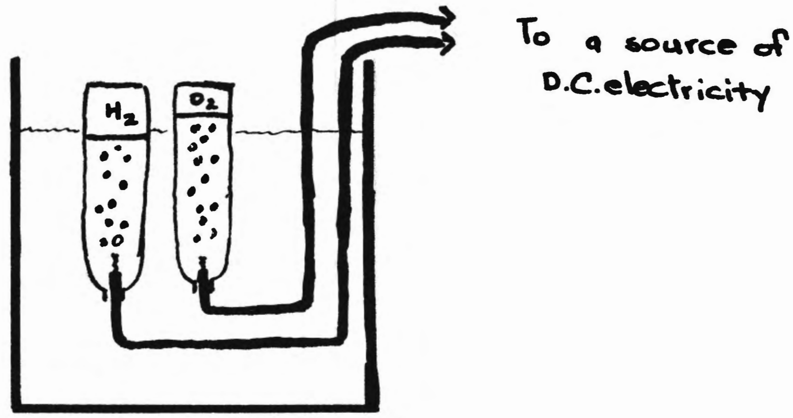
   b. Another way to demonstrate this chemical dehydration of a compound made of hydrogen, oxygen, and carbon is to put about one inch of sucrose (common cane sugar) whose formula is $C_{12}H_{22}O_{11}$ into a straight-sided water glass. Pour just enough concentrated sulfuric acid on it to soak all the way down and just barely cover the surface. In about two or three minutes, the acid will begin to chemically extract water from the sugar and a column of black carbon will rise up from the container. Use care in disposing of the residue as it is covered with strong, hot acid.

SECTION FOURTEEN

Electrolysis of water will be difficult to demonstrate unless a fairly strong direct current is available. At least 40-60 volts should be used and preferably 80-120 volts. If a rectifier is not available to change the alternating current to direct current, one may be made from almost any AC-DC radio that is worn out, providing the selenium rectifier is undamaged. There are so many different types of radio rectifiers in use that it would be best to ask advice of a local radio repairman. Once a source of D.C. is available, procure two copper wires about the size of small pencil leads. If possible, get wire that has a tight plastic coating. Prepare an arrangement such as the one shown. If you have graduated cylinders, they may be used or you may use upturned fruit jars. The important thing is to show a two to one ratio between the volumes of hydrogen and oxygen to prove the reaction:

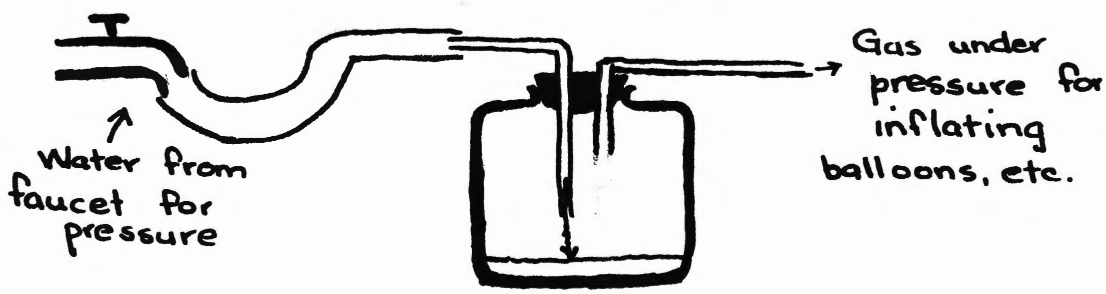
$$2\ H_2 + O_2 \text{ --- } 2\ H_2O$$

The upturned containers must be completely filled with water in the beginning so that only the hydrogen and oxygen from the decomposed water will rise and displace the water. This assures reasonable purity.



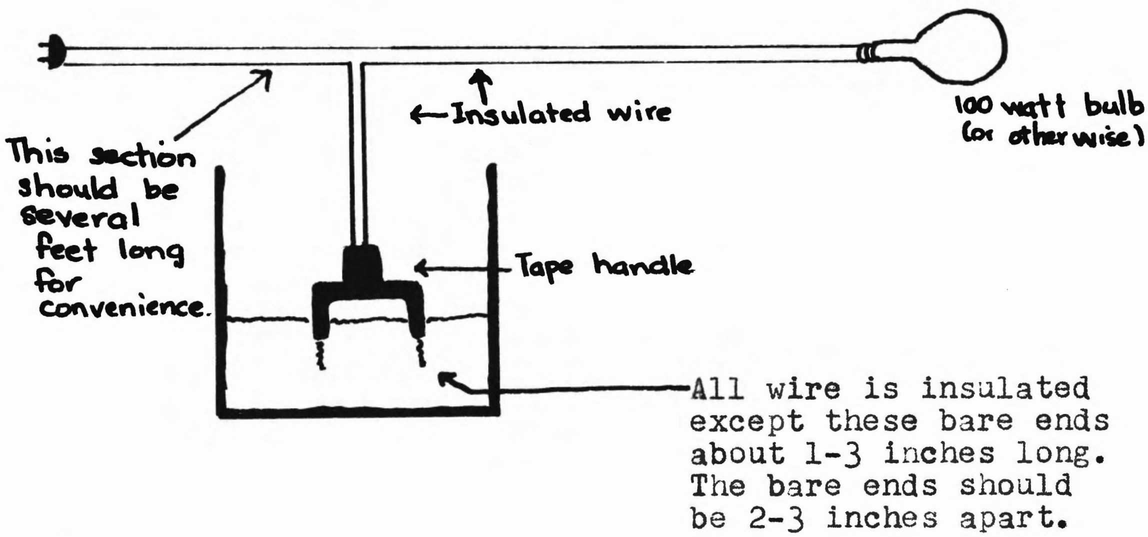
Note: The wires are stripped only for about one inch within the gas containers. Otherwise, gas would be evolved all along the wires. A very small amount of acid must be added because pure water will not conduct.

The following apparatus may be used to force any hydrogen or any gas into other containers, or even into a balloon.



SECTION FIFTEEN

1. Devise an apparatus such as is shown. Be sure to remember the bare wires when you plug it in.



When the plug is connected, the bulb will glow only when the two bare ends are dipped in a solution which will conduct electricity. The brightness of the bulb will depend upon two things, the length of wire immersed and the number of ions in the solution. The length of wire may easily be kept constant by stripping only the last inch of each wire, or by painting the last inch with fingernail polish. This should be done if the insulation does not fit tightly. Then the apparatus may be used to determine relative ionic strength of various solutions of electrolytes. A larger (500 watt) bulb may be used to get a more noticeable difference between solutions.

2. Distilled water purchased from a drug or grocery store should not show any indication of conductance. Compare this with water from the faucet, salty water and water with any acid mixed in in varying proportions. For weaker responses, the bare wire ends may be kept closer to-

gether.

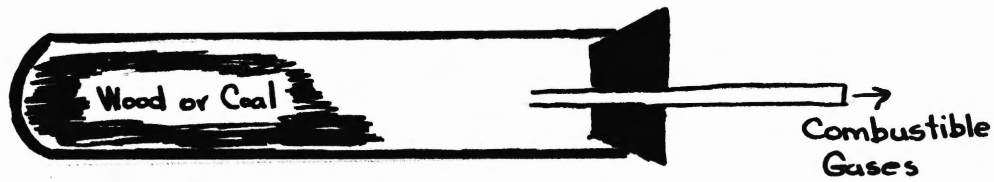
SECTION SIXTEEN

1. Demonstration Three under Section Six or any variation may be used to indicate that after shaking, all three solutions are saturated, that is, if some sugar is still left. The difference is that more sugar is required to saturate a given amount of water than is salt. A still smaller portion of sand would saturate the water. Point out that the water above the sand is saturated with dissolved sand, even if it might be only a millionth of a gram.
2. The solution should be in a clear glass for easy observation. This solution (clear, with no crystals) should be cooled to room temperature. The cooled solution is supersaturated. This can be shown by tying a piece of thread around a crystal of hypo and lowering it into the solution for a few seconds. The crystal will grow in size. If any small bits break off, the solution will solidify except for the amount of water which was originally used.

SECTION SEVENTEEN

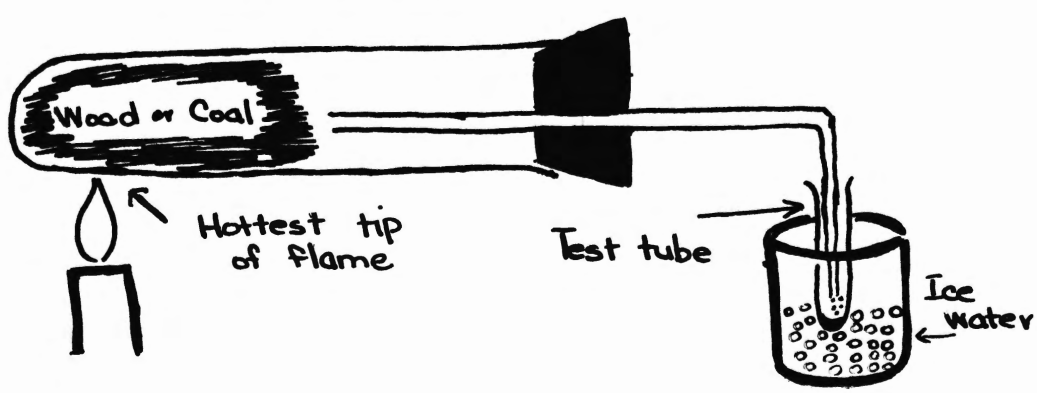
1. A Pyrex glass test tube and a bunsen burner (or gas burner of any blue-flame type) should be used in this demonstration. A standard test tube is likely to melt. Pack

a test tube full of either wood or soft coal. Tooth picks may be used or small splinters. Stopper the test tube in the manner shown, leaving as the only opening, a piece of glass tubing.



The burner should be kept continuously under the test tube. It may be moved from end to end to char all the contents. Do not get too near the stopper or you will burn it. As no air can get in to burn the wood, it merely seems to char. All the oils and flammable materials are vaporized and under heat-induced expansion, driven out. At higher temperatures of continued heating with a bunsen burner, the long, complex molecules of wood or coal will "crack" to form simpler molecules of oil or gas. The exhaust tube may be lighted to demonstrate that the gases given off will burn.

2. The apparatus shown in Number One may be changed to condense the heavier oils produced.



3. The altered apparatus shown in Number Two may be used to recover some oil from apparently dry sand. Pour a little oil on dry sand and mix well. Use only a small amount so that the sand may look dirty, but not greasy. It would require a very expensive and powerful press to compress the sand enough to squeeze out the oil but the apparatus will do it nicely. Check all connections for tightness to prevent your igniting the hot oil vapors.
4. The altered apparatus may also be used to remove oil from peanuts. Two distinct layers of oil and water will be found in the cooling test tube.

SECTION EIGHTEEN

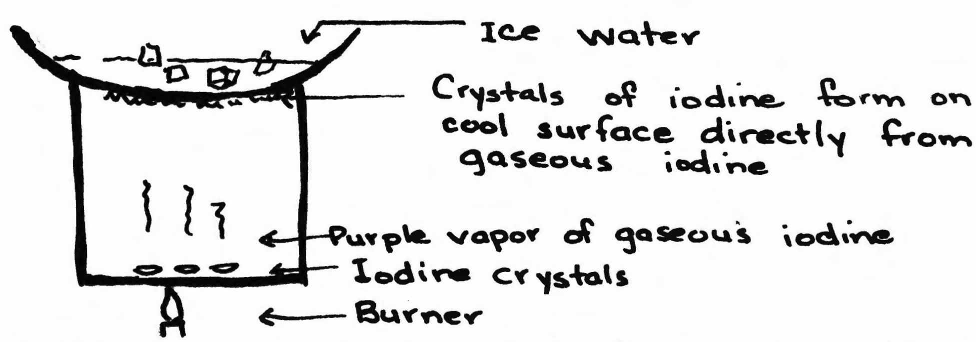
This demonstration does not perform a useful function in that it does not demonstrate any chemical phenomena. However, in many beginning science or chemistry classes it is wise to start the class on scientific reasoning which will show them the type of mental gymnastics needed to appreciate any science.

Place a board taken from a packing crate on the edge of the desk so that it protrudes about a third of its length. The board should be three or four inches wide and not so strong that it could not be broken over the knee. Have the board placed so that if you threaten to hit the protruding end with a hammer, the students will think the board will fly into the class. Pretend that you are going to hit the board. Just as the students duck, stop and ask: "What would happen if I did hit the board?" Most students will say: "It would hit us."

Then place three sheets of newspaper across the board, covering it all the way up to the edge of the desk. Repeat the above question. Best results are obtained if the bell rings now. Many students will go home and try it themselves. Leaving a puzzling question such as this dangling in a student's mind may be the best start toward teaching that student the scientific attitude, particularly if he is made curious enough to want to find the answer and to be willing to work for it.

SECTION NINETEEN

Place two or three grams of iodine cyrstals (about one-third thimbleful) in a Pyrex container as shown.



Cover the top with a watch glass full of ice water. If no watch glass is available, use any glass container which will cover the top of the bottom container. This should be a tight fit, but not air tight. When the iodine is heated with a burner, it will not melt, but will sublime; i.e., it will go directly from a solid to a gas. This gas, on contact with the cold glass at the top, will form beautiful crystals of iodine. This is a convincing demonstration of sublimation.

SECTION TWENTY

Many of the demonstrations described in previous sections will serve admirably for pure advertisement. In general, you should first use the quantities prescribed and then, for use in this section, take several times that amount. Be sure that any deviation is done carefully before hand to assure proper use. These demonstrations are recommended for use as advertisement:

Section I--Demonstrations 4, 5, 6, 7
Section V--Demonstration 7 (See information below)
Section IX--Demonstration 1
Section X--Demonstration 2 (For small groups)
Section XVI--Demonstration 2
Section XVII--Demonstration 1

To use Section V, Demonstration 7, for larger groups or classes, pour one-half cupful water into a gallon bucket and drop in 6-8 pieces of carbide (calcium carbide). Lay the lid <u>loosely</u> on top for 9-10 seconds, then <u>remove lid</u> and <u>then</u>, with a match on a two-foot stick, quickly light the gas in the bucket. A small explosion and a large black cloud should result. Vary the time a few seconds for best results. Variation in timing will allow optimum mixture of acetylene and air.

CHEMICALS AND MATERIALS

Acid, Acetic-----5% acetic acid can be purchased as white distilled vinegar. Five per cent vinegar is called "Fifty Point" vinegar.

Acid, Hydrochloric--Can be purchased at a drug store as muriatic acid in concentrated form.

Acid, Nitric-----Can be purchased at a drug store in concentrated form.

Acid, Sulfuric---Can be obtained at either a battery shop or drug store in concentrated form. To dilute, always add acid cautiously to water, very slowly, to prevent boiling or spattering.

Acid, Tartaric---Can be purchased at a drug store.

Alcohol, Methyl--(Poison) May be purchased from a drug store as wood alcohol.

Alka-Seltzer-----Tablets, whole.

Alum-------------Lump or powdered as is needed may be purchased at a drug store or grocery store.

Aluminum---------Metal strips; may be cut from old pans, etc.

Aluminum---------Powdered or finely granulated; may be purchased from a paint store, automotive paint shop, or plumbing shop.

Ammonium Bichromate--Generally carried by photographer's shops or drug stores.

Argyrol----------See SILVER NITRATE

Battery, Dry Cell--Large, heavy duty type (1.5 volts); weight, approximately 1-2 pounds. The type used in rural telephones will serve for the electrolysis experiment.

Calcium Carbide--May be purchased from hardware stores as "Carbide."

Calcium Carbonate--Lump, granulated, or powdered may be obtained by breaking up oyster shell, limestone, or mussel shells. Drug stores also carry this.

Candle, Parrafin--About one-half by six or eight inches.

Carbon Tetrachloride--Drug stores carry this liquid as such or as "Carbona," a cleaning fluid.

Clorox-----------May be purchased at any grocery store.

Coal, Soft-------May be picked up around a train station or boiler house, or bought from a fuel company.

Copper Filings---These may be filed from copper or made by cutting small wire up in very short pieces.

Copper Metal-----Small slugs about like a penny.

Copper Sulfate---"Blue Stone;" can be purchased from drug store. Also called "Blue Vitriol."

Copper Wire------Wire of about the same diameter as a small broom straw (bell wire).

Ferrous Oxalate--May be purchased from a drug store.

Ferrous Sulfate--May be purchased at drug store as "Monsel's Powder."

Glycerin---------May be purchased at any drug store.

Iodine Crystals--May be purchased from a drug store and should be finely granulated.

Iodine, Tincture of--Either 5% or 10% will do.

Iron, Metal Slugs--Small new nails will do for Section XII.

Iron Filings-----May be made or purchased. Should be free of rust and corrosion. A good emery wheel will produce a large supply very quickly.

Napthalene-------Moth balls from a variety store are almost pure napthalene.

Phenolphthalein Indicator--Can be obtained from most drug stores. You may want the druggist to prepare it for you. Add one gram dry powder to 50 ml ethyl alcohol and then add 50 ml of water.

Potassium Permanganate--May be purchased in the crystalline form from a drug store.

Silicon Dioxide, Granulated--Clean white sand.

Silver Nitrate---May be purchased as a two per cent solution from a druggist. A slightly stronger solution reacts more noticeably in Demonstration Seven in Section One.

Sodium Bichromate--Baking soda.

Sodium Chloride--Lumps, ice cream salt.

Sodium Chloride, Granulated--Table salt.

Sodium Thiosulfate--"Hypo;" can be obtained from a photographer's shop or from some drug stores in crystalline form.

Sugar, Granulated--Common cane or beet sugar.

Sulfur------------Obtain powdered sulfur from a drug or feed store.

Tincture of Iodine--See IODINE

Wood Splints-----Small splints of dry wood from the size of toothpicks and six inches long up to five times that size.

Zinc Metal, Sheets--May be obtained in high purity by cutting open an old flashlight battery and peeling the soft gray metal off the outside. It resembles hard lead; must be cleaned thoroughly.

BIBLIOGRAPHY

Bogert, L. Jean, _Fundamentals of Chemistry_. London: W. B. Saunders Co., 1947.

Brownlee, Raymond B., _et al._, _Elements of Chemistry_. New York: Allyn and Bacon, 1954.

———, _First Principles of Chemistry_. New York: Allyn and Bacon, 1937.

Carleton, Robert H., Floyd F. Carpenter, and W. R. Teeters, _Chemistry for the New Age_. New York: J. B. Lippincott Co., 1949.

Cavelti, John E., _Introductory General Chemistry_. New York: Blakiston Co., 1952.

Davis, Tenney L., _Chemistry of Powder and Explosives_. New York: John Wiley and Sons, Inc., 1941, Vol. I.

Dull, Charles E., William O. Brooks, and H. Clark Metcalfe, _Modern Chemistry_. New York: Henry Holt and Co., 1954.

Frank, J. O., _Mystery Experiments and Problems_. Oskosh, Wisconsin: J. O. Frank, 1945.

Heiss, Elwood, Ellsworth Osburn, and Wesley Hoffman, _Modern Methods and Materials for Teaching Science_. New York: Macmillan Co., 1940.

Hopkins, B. Smith, _et al._, _Chemistry and You_. Chicago, Ill.: Lyons and Carnahan, 1949.

Jaffe, Bernard, _New World of Chemistry_. New York: Silver Burdett Co., 1955.

Lange, Norbert A., and Gordon M. Forker, _Handbook of Chemistry_. Sandusky, Ohio: Handbook Publishers, Inc., 1949.

Lynde, Carleton John, _Science Experiences with Home Equipment_. Scranton, Pa.: International Textbook Co., 1937.

Morgan, Alfred, _First Chemistry Book for Boys and Girls_. New York: Charles Scribner's Sons, 1950.

Smith, Alexander, _General Chemistry for Colleges_. New York: Century Co., 1918.

Weaver, Elbert C., and Laurence S. Foster, _Chemistry for Our Times_. New York: McGraw-Hill Book Co., Inc., 1954.

Wood, George C., and Harry A. Carpenter, _Our Environment: How We Use and Control It_. New York: Allyn and Bacon, 1948.

VITA

Claude West Gatewood

Candidate for the Degree of

Master of Science

Thesis: LECTURE DEMONSTRATIONS FOR THE SMALL OR RURAL HIGH SCHOOL

Major Field: Natural Science

Biographical:

Personal data: Born in Nacogdoches, Texas, June 10, 1926, the son of Claude Walker and Grace West Gatewood.

Education: Attended grade school in Nacogdoches and Abilene, Texas, and Muscogee, Oklahoma; graduated from Nacogdoches High School in 1943; received the Bachelor of Science degree from Stephen F. Austin State College, Nacogdoches, Texas, with majors in Business Administration and Chemistry in June, 1952; did graduate work at University of Houston, Massachusetts Institute of Technology, and Colorado College; completed requirements for the Master of Science degree at Oklahoma A. and M. College in May, 1957.

Professional experience: Worked for Reconstruction Finance Corporation, Washington, D.C., in 1943-1944; entered U.S. Navy in 1944 and, except for five months employment with Northern Indiana Brass Company, served until 1949; entered Stephen F. Austin State College in 1949, and upon receiving degree, was employed by National Lead Company as Field Service Engineer; taught high school science from 1953 to 1956; member of National Science Teachers Association, Texas State Teachers Association, and Houston Council of Teachers; holds the Administrator Certificate and the Life Professional Certificate for work in elementary and high schools in Texas.