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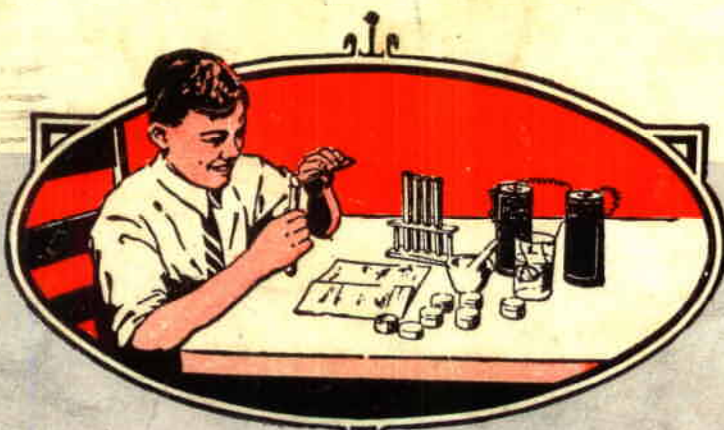

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Editor

Prof. Johnson has been associated with the Chemistry Department of Yale University since 1898. He received the degree of Ph.B. from the Sheffield Scientific School of Yale in 1898, and the Ph.D. degree from Yale Graduate School in 1901. Since this later date he has been continually engaged at Yale in the teaching of organic chemistry and in the promotion and development of advanced research in the field of organic chemistry and Biochemistry.

About 75 graduate students have received their Ph.D. degree for research done under his direction and these specially trained men now hold positions in universities and industrial organizations in this country. Prof. Johnson's publications in the field of organic chemistry number nearly 300 papers, and his pupils who have been granted the Ph.D. are constantly contributing to scientific and technical journals in various lines of activity.

Prof. Johnson is a member of the National Academy of Sciences, The National Research Council, The American Chemical Society, The American Institute of Chemists, The Connecticut Academy of Arts and Sciences and the American Society of Biological Chemists.

At the present time he is holder of the Sterling Chair of Organic Chemistry in the Graduate School of Yale University.

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ADVENTURES IN CHEMICAL RESEARCH

A PERSONAL MESSAGE FROM THE FOUNDER OF THE GILBERT HALL OF SCIENCE

You are now the owner of a Gilbert Chemistry Set. This means you are starting your chemical career with the right equipment—because more boys have won fame and big awards with Gilbert Chemistry Sets than any other kind made.

You are going to get a lot of fun out of your Gilbert Chemistry Set. Also, you have as good an opportunity as any other boy to win one of my Annual Awards described below. So here are a few tips on how to go about it.

First, read the manual that comes with your set and perform some of the simplest experiments exactly as described. This will give you valuable practice—and practice is just as essential in mastering chemistry as pole vaulting, football or anything else. Next try some of the more complicated experiments. These are usually more thrilling—and of course more fun.

By this time you are ready to undertake your own original experiments. Almost everything around you lends itself to chemical research: The clothing you wear—the food you eat—the water you drink—the clays, minerals and plant life where you live. Remember that aluminum was discovered in a clay and rubber in a plant.

There is no telling what exciting discoveries *you* may make. Some of your experiments may have important commercial value or lead to your becoming the Gilbert Boy Chemist of the Year. So be sure to keep a record of what you do—how you do it—and what the results are. This note book gives you a handy way to record your adventures in chemical research.

$200.00 ANNUAL AWARDS

To the boy doing what in my opinion is the most important research in Chemistry this coming year, I will award $100.00 in cash. To the ten boys doing the next most important research, I will award $10.00 each. Applicants must not be over 17 years old and must send me full description of their experiments by May 1st of each year.

A.C. Gilbert
Founder of the Gilbert Hall of Science

EXPERIMENT 1—How to make an explosive mixture

Mix thoroughly 1 measure of sulphur, 1 measure of powdered charcoal and 2 measures of potassium nitrate on glazed paper, but do not grind or rub the mixture. Then put the mixture on an old pan, and, standing off at a suitable distance, out of doors, being careful so as not to burn the hand or face, drop a lighted match on the mixture. Note the sudden flash and puff of smoke. Gunpowder is made from such a mixture, and is probably the longest known explosive. The potassium nitrate acts as an oxidizing agent, evolving oxygen on heating to burn the sulphur to sulphur dioxide and the powdered charcoal to carbon dioxide. *Do not attempt to perform this experiment with proportions of chemicals larger than those stated above.*

EXPERIMENT 2—A color change due to solution

Make a mixture of one measure of tannic acid and one measure of ferric ammonium sulphate on a piece of paper and notice that there is no evidence of reaction. Transfer this mixture to a clean, dry test tube and fill half full of water. Observe the formation of a black colored product showing that there was a chemical reaction due to the presence of water. The black product formed is iron tannate. This black substance is a basic constituent of many inks.

EXPERIMENT 3—Testing for carbon dioxide

Make up a solution of lime water by adding half a measure of calcium oxide to half a test tube of water. Shake well and let settle for a few minutes. Add to a test tube of water which is to be tested a few drops of this clear lime water. If a white turbidity is formed the water contains carbon dioxide.

The presence of carbon dioxide in water causes it to effervesce and gives it a sparkling taste. Soda water and many bottled mineral waters contain carbon dioxide.

EXPERIMENT 4—Crystals of iron alum

Prepare a saturated solution of ferric ammonium sulphate in water and pour the clear liquid into a small beaker. Then set aside to cool slowly, after placing a piece of cardboard over the top of the beaker to avoid too rapid cooling. After the crystals have completely separated, then remove several of them and examine under your microscope.

EXPERIMENT 5—Clarifying water

Add one-half measure of aluminum sulphate to a test tube three-quarters full of muddy water prepared by adding a little clay to some muddy water and shaking. Then add one-half measure of sodium carbonate and shake again. Allow the tube to stand undisturbed for 15 minutes and for proof of the experiment prepare another test tube of muddy water in the same manner, but without adding aluminum sulphate and sodium carbonate and set it along side of the first tube.

After 15 or 20 minutes you will note that the water in the first tube to which the aluminum sulphate and sodium carbonate were added is clear, while the mud particles in the second tube remain suspended throughout the water. This is explained by the fact that aluminum sulphate reacted with sodium carbonate to form aluminum hydroxide—a gelatinous precipitate which settled to the bottom of the tube, carrying with it the suspended matter.

EXPERIMENT 6—Preparation of absorbent charcoal from white birch wood

Carbonize some small pieces of white birch wood in a copper oven. After this baking, then grind to a powder in a mortar. Test the efficiency of this powder as a decolorizing agent and absorbing agent.

EXPERIMENT 7—Preparation of absorbent charcoal from pine wood

Follow same directions as given for Experiment 6.

EXPERIMENT 8—Preparation of absorbent charcoal from maple wood

Follow same directions as given for Experiment 6.

EXPERIMENT 9—Preparation of absorbent charcoal from chestnut wood

Follow same directions as given for Experiment 6.

EXPERIMENT 10—Nickel carbonate

Dissolve one measure of nickel ammonium sulphate in a test tube half full of water. Dissolve one measure of sodium carbonate in another test tube ¼ full of water. Now add the sodium carbonate solution a little at a time to the solution of nickel ammonium sulphate and a thick light green precipitate of nickel carbonate will be formed.

EXPERIMENT 11—Aluminum carbonate

Dissolve one measure of sodium carbonate in a test tube ¼ full of water. Dissolve one measure of aluminum sulphate in another test tube ¼ full of water. Add the sodium carbonate solution to the aluminum sulphate solution a little at a time. Notice that at first an effervescence takes place and then a gelatinous precipitate of basic aluminum carbonate is formed.

EXPERIMENT 12—Testing for iron

To a test tube full of water add one measure of sodium ferrocyanide and shake until dissolved. If the water shows a blue tinge either at once, or after standing a while, iron is present.

EXPERIMENT 13—Making a tannic acid solution for burns

Dissolve about 2 measures of tannic acid in four test tubes of water. For small burns, saturate a small pad of cotton or gauze with this solution and hold it in place over the burn with a loose bandage. Very large and severe burns are treated by bathing in the tannin solution or by applying the solution as a spray.

EXPERIMENT 14—To make a color lake

Lakes are colored bodies made by precipitating a colloid which is a jelly-like substance in the presence of an organic dye, the dye being absorbed by the colloid and giving it color.

To make a purple lake, put two measures of logwood in a test tube half full of water and boil for several minutes. Add one and a half measures of aluminum sulphate and shake the mixture thoroughly. Allow the test tube to stand for several minutes and pour the clear red liquid into another test tube. Now add to this solution one measure of sodium carbonate and shake the mixture. Notice the formation of a deep purple precipitate. Collect this precipitate in a funnel with filter paper. This purple lake can be mixed with your water color vehicle to make a good water color paint.

EXPERIMENT 15—Iron in your tonic

Pour one-quarter of a test tube of your spring tonic mixture into a test tube and add to it one-third a test tube of sodium ferrocyanide solution. The production of a blue color will prove that iron is present.

EXPERIMENT 16—Iron in blood

Repeat Experiment 15, using a few drops of animal blood. Mix with water and then add the sodium ferrocyanide solution.

EXPERIMENT 17—How to test for alum in baking powder

Make a solution of logwood by putting one measure of logwood in a test tube half full of water and heating the solution to boiling. Allow the liquid to cool, then pour the clear red liquid into another test tube.

Put three measures of baking powder in a test tube half full of water and add one-half measure of tartaric acid. Notice the violent effervescence due to the liberation of carbon dioxide gas. When the reaction has stopped add two or three drops of the red logwood solution. If the solution turns reddish-blue, alum is present in the baking powder. Apply this same test for detection of alum in bread, biscuits, doughnuts and loaf cake.

EXPERIMENT 18—How to test for copper sulphate in bread

Dissolve one-third measure of tartaric acid and one measure of sodium ferrocyanide in a test tube half full of water. Then put into the test tube three or four pieces of bread to be tested and allow the bread to stand in this solution for one or two hours. If the solution becomes reddish-brown the bread contains copper sulphate.

Copper sulphate is very seldom used as an adulterant in bread.

EXPERIMENT 19—How to mend blue chinaware

To mend broken pieces of blue chinaware make a paste, using one-half teaspoonful of water glass, four measures of sodium ferrocyanide and two measures of ferric ammonium sulphate. Now mend the pieces of china by painting with a brush the broken surfaces with this paste. The blue color is formed by the action of sodium ferrocyanide on ferric ammonium sulphate.

EXPERIMENT 20—How to make purple ink

Put three measures of logwood into a test tube one-third full of water and boil for several minutes until the solution is deeply colored. Then add 1 measure of aluminum sulphate and heat to boiling again. Notice the beautiful dark colored purple ink which is formed. Write with the ink, using a clean pen. By repeating this experiment and adding one measure of sodium bisulphate in addition to the other compounds, it is possible to make a red ink. Write with an ink made in this way, using a clean pen.

EXPERIMENT 21—How to make a commercial blue-black ink

Put one measure of ferric ammonium sulphate and one measure of tannic acid into a test tube one-third full of water and shake well. In another test tube one-quarter full of water add one measure of sodium ferrocyanide and one measure of ferric ammonium sulphate and shake thoroughly. Mix the two solutions and notice the bluish-black ink produced. Write with this ink, using a clean pen. Notice that the writing is blue. After two or three days the writing will turn black.

EXPERIMENT 22—How to make printer's ink

Put a spoonful of water glass (sodium silicate) in a test tube and add two measures of powdered charcoal or, better, lampblack. By means of the stirring rod, stir the mixture until it is quite uniform. Then fill the test tube one-third full of water and shake thoroughly.

Now add one measure of ferric ammonium sulphate and one measure of tannic acid. Shake thoroughly for several minutes and notice the heavy dark black liquid produced.

Printer's ink is made similar to this. Writing done with this ink will last for a long time and is very difficult to remove. This is because the charcoal or lampblack gets into the pores of the paper, where it is held fast.

EXPERIMENT 23—A commercial ink powder

Mix together on a sheet of paper three measures of tannic acid, six measures of ferric ammonium sulphate, and six measures of sodium ferrocyanide. Place this mixture in a small dry bottle and whenever you wish to make a good blue-black ink add water to the bottle and shake thoroughly.

EXPERIMENT 24—Ink powder

Mix together one measure of tannic acid and one measure of ferric ammonium sulphate. Place the powder thus formed in a small bottle, and when you need ink simply add some of this powder to a little water.

EXPERIMENT 25—Detecting finger prints

Obtain a smooth piece of white paper, breathe on one of your fingers a few times and press it on the paper. Prepare a mixture of one measure of sulphur and one measure of powdered charcoal. Put this mixture on the paper which you have touched with your finger and tap the underneath side of the paper gently so that the powder will be spread over the part of the paper where you have pressed your finger. Shake the excess powder off the paper and you will find that the finger prints instead of being invisible are now plainly seen.

EXPERIMENT 26—How to make black writing ink

Dissolve one measure of tannic acid in a test tube one-third full of water. Then in another test tube one-third full of water dissolve one measure of ferric ammonium sulphate. Now mix the two solutions and notice the intense dark black color formed by the reaction of the two substances. The black color and precipitate is due to the formation of iron tannate. Try writing with this ink, using a clean pen.

EXPERIMENT 27—How to make blue ink

Prussian blue ink may be made by dissolving two measures of ferric ammonium sulphate in a test tube one-third full of water and adding this solution to a solution of sodium ferrocyanide made by dissolving two measures of sodium ferrocyanide in a test tube one-quarter full of water. The blue precipitate formed in the reaction is a compound of ferro-ferricyanide. Write with the ink.

EXPERIMENT 28—Violet ink

Put two measures of logwood in a test tube one-quarter full of water. Warm to extract color and then add one-half measure of aluminum sulphate to the hot solution.

EXPERIMENT 29—Red ink

Put two measures of logwood in a test tube and fill tube one-quarter full of water. Warm to extract color and add one-half measure of aluminum sulphate and one-half measure of sodium bisulphate.

EXPERIMENT 30—Safety ink

Put one spoonful of water glass in a mortar or cup and stir in one measure of powdered charcoal. Stir for some time to properly mix. Keep bottled up in a tight stoppered bottle if it is desired to keep for any length of time. Writing done with this ink is very hard to remove.

EXPERIMENT 31—Using an aniline dye with a mordant

Aniline dyes are now supplied ready for household use, and the beginner will find these very interesting to experiment with. You will undoubtedly find some on hand in the home laundry.

Dye one of your patches of cloth in one of these dyes, following the directions on the package. Are all the kinds of textile fiber in the patch dyed alike?

Dissolve five measures of tannic acid in one test tube of water in a glass. Soak a patch of cloth in this solution for an hour or more. Squeeze it out and dry it. Now dye this patch with the same aniline dye. When the dyed cloth has dried, compare it with the previous dyeing. How has the tannic acid influenced the intensity of color on each fiber? The tannic acid acts as a mordant.

EXPERIMENT 32—Dyeing with a natural vegetable dyestuff

Dissolve three measures of ferric ammonium sulphate in one test tube of water and soak one of your cloth squares in this solution. Remove the cloth, press it between layers of paper towel to remove excess liquid, and allow it to dry.

Next dissolve two measures of tannic acid in one test tube of water and soak the cloth in this solution. Press out the cloth and dry it again.

Finally put three measures of logwood into one test tube of water and boil it in your beaker until it is a bright red. Put the cloth into this solution and continue to boil it a short time. Remove the cloth, wash it well in water, and dry it. What color have you produced? Are all the fibers dyed equally well?

EXPERIMENT 33—How to make a black sulphur dye

Mix together on a piece of paper one measure of tannic acid, one measure of sodium carbonate and one measure of sulphur. Put this mixture in a clean, dry test tube and heat the tube over an alcohol or gas flame for four or five minutes.

Now remove the tube from the flame and after it is cool fill the test tube half full of water and allow the test tube to stand for half an hour. Now shake the contents of the tube thoroughly and then pour it into a glass three-quarters full of water. If any dye remains in the test tube add a little more water, shake again and pour it into the glass. Notice the dark black color of the water produced by this dye.

EXPERIMENT 34—How to make black logwood dye

Dissolve one measure of ferric ammonium sulphate in a test tube one-third full of water.

In another test tube half full of water put two measures of logwood and boil for four or five minutes until the solution is colored a bright red. Pour this solution into the test tube containing the solution of ferric ammonium sulphate and notice the black colored solution which is formed.

EXPERIMENT 35—Changing red logwood solution yellow, then blue

Boil two measures of logwood in a test tube half full of water for four or five minutes. Then pour this solution into a test tube containing one measure of sodium bisulphate. Notice that the solution turns from red to yellow in the presence of an acid.

Now add to this solution two or three measures of sodium carbonate and notice on shaking the color changes from yellow to reddish-blue or purple. Red logwood solution is yellow in the presence of an acid and blue in the presence of an alkali.

EXPERIMENT 36—How to dye silk gray

Dissolve two measures of sodium bisulphate in a test tube half full of water. In another test tube put two measures of logwood and boil the solution until it is colored bright red. Pour this red solution into the solution of sodium bisulphate.

Now place a small piece of white silk to be dyed in this solution and heat the solution to boiling. Remove the silk and notice that it is dyed gray.

NOTES