ABSTRACT

Name: Donald Stanley Jarrad   Date of Degree: May 26, 1957

Institution: Oklahoma A. and M. College   Location: Stillwater, Oklahoma

Title of Study: SIMPLE SCIENCE EXPERIMENTS FOR DAILY HIGH SCHOOL CLASS DEMONSTRATION

Pages in Study: 71

Major Field: Natural Science

Scope of Study: A collection of simple experiments that may be used in high school science classes for demonstrating various physical and chemical principles. The experiments are of the sensational type that tend to glamorize science and instill inquisitiveness in students, but cannot be used as a replacement of classical laboratory experiments. In most cases, simple equipment, such as found in the house has been used. The experiments have been designed so as to require a minimum of time to prepare. The terminology used in each experiment is such that little scientific background is needed to follow and understand the results. Each experiment has been divided into three parts for ease in reading, namely; material, procedure, and discussion. To make the experiments useful, two indexes have been provided; one is a list of experiments and the other a list of physical or chemical properties demonstrated by these experiments. The report consists of eighty-nine experiments which have been divided into six chapters, namely: PRESSURE AND VACUUM, HEAT AND COLD, CHEMICAL MAGIC, PROPERTIES OF MATTER, ELECTRICITY AND MAGNETISM, and LIGHT AND SOUND.

Use of the Study: To supplement daily classroom discussions in science by the demonstrations of various experiments with inexpensive equipment.

ADVISER'S APPROVAL James H. Zant

SIMPLE SCIENCE EXPERIMENTS FOR DAILY HIGH SCHOOL CLASS DEMONSTRATIONS

By

DONALD S. JARRAD

Bachelor of Science

Michigan State University

East Lansing, Michigan

1947

Master of Arts

Arizona State University

Tempe, Arizona

1955

Submitted to the faculty of the Graduate School of
the Oklahoma Agricultural and Mechanical College
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
1957

SIMPLE SCIENCE EXPERIMENTS FOR DAILY HIGH

SCHOOL CLASS DEMONSTRATIONS

Report Approved:

James H. Zant

Report Adviser

Robert MacVicar

Dean of the Graduate School

ACKNOWLEDGEMENTS

The author wishes to express his gratutude to Dr. James H.Zant, report adviser; to the National Science Foundation, for making this possible; and to my wife, Jane Marie Jarrad, for giving me words of courage when I needed them most.

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CHAPTER I

INTRODUCTION

The author feels that too many times the science teacher tends to make his science classes dull, and uninteresting with only occasional stereotype laboratory experiments. It is of the opinion of the author that more science and better understanding of the principles of science could be taught, if first the students curiosity is aroused. Once you have the students interest there is theoretically no limit in the amount of subject matter you may present for his understanding.

However, to obtain best results this curiosity must be kept alive from day to day, by a "re-charging action" each day. It is for this purpose the author has compiled a series of simple experiments that may be preformed each class period, to demonstrate some principle being taught.

The author is well aware that the teacher does not have time to gather equipment and chemicals each day for experiments that are very elaborate and involved. Therefore, the experiments choosen require a minimum of material and very little time to set up.

The author also feels that many times the students cannot see the forest, because of the trees. This is a parable that is akin to the author's philosophy of teaching science. Simply stated, many students may not understand the basic principles being taught when the equipment is too expensive and elaborate. They may know what has happened and can write up a good laboratory report, but still lack that basic understanding as to how and why the experiment worked.

The author has divided the experiments into six different areas or chapters, to aid the searching of experiments. However, many experiments may be used to illustrate more than one principle. The author has therefore compiled not only an index of the experiments, but also an index of the science properties demonstrated by various experiments.

Some of the experiments may seem too simple at first glance, but have been retained because of the inability of a science teacher to remember all these experiments at the appropriate time for use.

A discussion follows each experiment to further explain what has happened and why it has happened. Occasionally a little historical background is given for that particular experiment.

The author wishes to make certain that it is understood these experiments are not to replace laboratory type experiments, but rather supplement them to aid in the understanding of science.

CHAPTER II

PRESSURE AND VACUUM

2.1 Streamlining Means Speed[1]

Material: Candle, flat cardboard, tear drop shape paper.

Procedure: 1. Hold a flat piece of card in front of a candle and blow towards the candle and card. The flame will blow towards you instead of away due to a created vacuum.

2. Replace the card with a tear shape card and repeat. Now the flame will blow away.

Discussion: It isn't the front end of a car or plane that slows speed; wind resistance is centered at the rear end, due to the created vacuum or drag on the car at the rear.

2.2 Water is Forced in a Glass[2]

Material: Shallow sauce pan, tumbler, piece of paper, matches, and a coin.

Procedure: 1. Place a coin in a shallow dish and ask if anyone can remove it without getting their hands wet.

2. Ignite some paper and place tumbler over it.

3. After the oxygen has burned, water will be sucked up in the tumbler, leaving the coin high and dry.

Discussion: Burned oxygen creates partial vacuum.

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[1] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), pp. 16-17

[2] "Challenge Your Friends", Popular Science, Vol. 147, (Aug. 1945), p. 185

2.3 Vacuum and it's Effects[3]

Material: Two drinking glasses, a piece of paper, match, a blotter (on both sides), and scissors.

Procedure: 1. Cut a collar out of the blotter paper to fit over the top of a glass.

2. Wet the blotter before placing it on top.

3. Light the paper and throw it in a glass, and at the same time place the other glass on top, mouth down.

Discussion: The two glasses will stick together due to a vacuum inside and a pressure on the outside.

2.4 Vapor Pressure[4]

Material: Flask, glass tube (with one end in the form of a jet), water (warm), and a test tube of ether.

Procedure: 1. Fill the flask one-half full of warm water.

2. Strap the test tube (one-half full of ether), to the glass tube.

3. Put a one hole stopper on the other end of the glass tube and insert it in the flask.

Discussion: Ether boils at 35°C and has a high vapor pressure at lower tempertures. If it is arranged as above, a fountain of water will appear due to the increased pressure inside the flask.

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[3] D.Herbert, "Mr. Wizard Science Secrets", Science Digest, Vol. 33, (Jan. 1953), pp. 71-4

[4] "Home Experiments Demonstrations", Popular Science, Vol. 146, (May 1945), pp. 202-3

2.5 Siphons[5]

Material: Two tumblers, short rubber hose.

Procedure: 1. Half fill two glasses of water.

2. Connect them with a rubber hose that has been filled with water.

3. Move the glasses up and down and the water will always seek it's level with the other glass.

Discussion: When you "suck up" water with a pump or "suck up" soda with a straw, you don't really suck up these things at all; the water and soda are actually pushed up the pipe or straw by the pressure of the atmosphere. When the water level in the two glasses are equal, the downward pressure of the water in the two legs of the tube is balanced and so opposes equally the upward force of air pressure. Lower one glass and the downward pressure in the leg in this glass increases because it's water column, measured from the water level to the top of the tube, has been lengthened. With relatively less water pressure to buck against, air pressure in the high glass forces water over to the low glass until balance is restored.

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[5] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 6

2.6 Pressure Exerted by Loose Packed Particles[6]

Material: Glass tube, napkin, rubber bands, dowel to fit inside the glass tube, salt or dirt.

Procedure: 1. Place the salt, or dirt, in the glass tube and place the paper napkin with rubber bands around one end of the tube.

2. Place the dowel inside the tube and exert pressure.

Discussion: Because of the sideways pressure, you can not force the napkin off by a steady force. This is why the earth supports itself above tunnels and subways and is also the reason why it can stop bullets.

2.7 Pascal's Law[7]

Material: Hot water bottle, hose, glass funnel.

Procedure: 1. Place a book or block which is slightly thinner than the bottle, on each side of the hot water bottle. Place a a board over this to stand on.

2. Fill the bottle one-half full with the hose and funnel.

3. Have a boy stand on the board across the water bottle.

4. Raise and fill the funnel until the person is raised.

Discussion: The water may only rise 3 or 4 feet for light weights. If the area of the tube is 0.05 square inches and the area of the bottle is 50 square inches, then the force at the tube opening is magnified 1000 times as great.

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[6] K.M.Swezey, Science Magic, New York: McGraw-Hill Book Company, (1952), p. 9

[7] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 24

2.8 Osmosis[8]

Material: Egg, short glass tube, a small glass, sealing wax.

Procedure: 1. Break a small patch on the shell at the end of an egg without breaking the membrane.

2. On the other end of the egg, break a small patch of shell and pierce the membrane.

3. Place a glass tube in the membrane and seal with wax.

4. Place the exposed membrane in a glass of water.

5. Within half an hour the eggs contents will push up through the glass tube.

Discussion: One theory is that the membrane lets small molecules of water pass through but prevents the large molecules like egg albumen from passing through. Osmosis occurs where two liquids containing different concentrations of dissolved matter are separated by a semi-permeable membrane. The movement of fluid is from the weaker to the more concentrated solution. The plants and trees extract their water and food from the soil by means of this same wonderful process.

Osmosis is the property of liquids and gases intermingling through the pores of a membrane. You may have noticed that hydrogen-filled balloons collapse after a time. This is due to the fact that small, fast-traveling molecules of hydrogen pass through the pores of the rubber balloon and disappear into the surrounding atmosphere faster than the oxygen and nitrogen molecules in the atmosphere can work in.

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[8] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 34

2.9 Hydrogen Peroxide Launches a Rocket[9]

Material: Two ounce bottle with a two hole stopper to fit it, eye dropper, manganese dioxide (MnO_2), match stick with a balsa head whittled for it, glass tube about one-eight inch in diameter (inside).

Procedure: 1. Put some MnO_2 in the small two ounce bottle.
2. Place the glass tube and eye dropper in the stopper.
3. Put a 30% solution of hydrogen peroxide in the eye dropper.
4. Fit the match with the whittled head of balsa in the glass tube.
5. Assemble and add two or more drops of hydrogen peroxide from the eye dropper and the rocket will shot up to the ceiling.

Discussion: The experiment can be done over again and again before recharging. The hydrogen peroxide breaks down into oxygen and water. This chemical can drive torpedoes, jets, or launch rockets. A 3% solution of hydrogen peroxide breaks up mildly giving off 10 volumes of oxygen and steam. A 90% solution of hydrogen peroxide breaks up violently into 4000 volumes of oxygen and steam. It was used in World War II to drive the Messerschmitts 163 (1 st. rocket), and the V-2 rockets. It was also used in the V-1 "Buzz Bombs", to give it a speed of 250 miles per hour.

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[9] K.M.Swezey, Science Magic, New York: McGraw-Hill Book Company, (1952), p. 6

2.10 Cut Ice Cube Remains Whole[10]

Material: Ice cube, fine wire, weights, support (bottle with a long neck will do).

Procedure: 1. Place the ice cube on top of the support.

2. Lay the fine wire over the top of the ice cube with the weights that are attached to both ends, hanging down.

3. It will take about 1 minute for it to cut through.

Discussion: The ice under the wire begins to melt because the pressure decreases the freezing point. Therefore the ice under pressure is not cold enough to be ice now and as a result melts, only to refreeze behind the wire when the pressure is released.

2.11 Cold Water Boils[11]

Material: Round bottom flask, water, thermometer, one-hole stopper.

Procedure: 1. Insert a thermometer in the one-hole stopper.

2. Boil a small amount of water until steam fills the flask.

3. Put the stopper and thermometer on tight and remove it from the flame immediately.

Discussion: As the flask cools, the water continues to boil because of decreased pressure resulting from the condensation of the steam formed inside the flask.

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[10] K.M.Swezey, Science Magic, New York: McGraw-Hill Book Company, (1952), p. 110

[11] "Home Experiments Demonstrations" Popular Science, Vol. 146, (May 1945), pp. 202-3

2.12 Bernoulli's Principle[12]

Material: Vacuum cleaner with hose attached to blower part, balloon with wire weight attached to it, table-tennis ball.

Procedure: 1. Attach the hose to the blower end of the sweeper and start it up.

2. Place the tennis-ball in the air stream and the balloon just above it in the air stream.

Discussion: They stay there and appear to float, because the air pressure holds them up and the low pressure area in the air stream causes them to stay there. This is an application of Bernoulli's Principle which states," When fluids such as gas or liquids move past a surface, the pressure against that surface is lowered."

2.13 Bernoulli's Principle[13]

Material: Glass funnel, rubber hose, marble, water faucet.

Procedure: 1. Hook the hose to the funnel and place a marble in the funnel.

2. Fasten the hose to a faucet and turn the water on.

3. After it has danced up and down, turn it upside down and it will still remain there.

Discussion: The harder the water is turned on the closer it will stick. See experiment 2.12 for more information.

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[12] D.Herbert, "Wizard Science Secrets" Science Digest, Vol. 33, (Jan. 1953), pp. 71-4

[13] "Home Experiments" Popular Science, Vol. 147, (Aug. 1945), pp. 185

2.14 Bernoulli's Principle[14]

Material: Stiff paper or a thin cardboard 4 inches by 8 inches (a filing card will do).

Procedure: 1. Fold the ends of the cardboard one inch over, at right angles to form a trough.

2. Place the trough on the table upside down and blow though it.

3. The harder you blow the tighter it sticks to the table.

Discussion: By blowing though the card you create an area of low pressure, (Bernoulli's Principle, see experiment 2.12). Therefore, the pressure on top of the card is greater than the pressure on the under side of the trough. This principle is used in airplane wing construction. The air on top of the wing travels further than the air on the bottom, creating a low pressure area. As a result, the air forces the wing up. This principle is also used in the modern carburator to suck the gas into the cylinders. Daniel Bernoulli was a famous Swiss mathematician, who formulated this law over 200 years ago.

When a tennis player hits the ball a glancing blow, he imparts to it a spinning motion. Then it travels along a curved path, and it takes a peculiar bound. A "sliced" or "hooked" golf ball is also an application of Bernouilli's principle.

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[14] D.Herbert, "Mr. Wizard Science Secrets", Science Digest, Vol. 32, (Dec. 1952), pp. 32-7

2.15 Why Curve Balls Curve[15]

Material: Small ball such as a ping-pong ball.

Procedure: 1. Fasten the ping-pong ball to about a yard of string.

2. Fasten the string to some support and swing it back and forth between two objects on the table. It will swing very straight.

3. Now twist the string about 50 times to the left, and try it again. It will spin clockwise and cause the ball to go to the right.

Discussion: This is also an application of the Bernoulli principle, explained in experiment 2.12. As the ball whirls, air is carried around with it. On one side of the ball this whirling air is moving with the air current produced by the forward motion of the ball; on the other side it is moving against the current. The result of such cooperation and opposition is that the air speed along one side of the ball is greater than the air speed along the other side. In consequence, the ball curves toward the side past which the air moves fastest. Screens have been set up with many threads, and the exact position of the baseball has been determined when a pitcher throws a curve. The maximum curve possible is in the order of six and one-half inches. It would be difficult to increase the curve of a baseball beyond this limit because of the inability of the pitcher's hand to spin the ball fast enough.

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[15] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Company, (1948), p. 12

2.16 Weight of Air Breaks Board[16]

Material: A thin piece of wood about 4 inches by 2 feet, two sheets of a newspaper.

Procedure: 1. Lay the strip of wood on a table so that 4 inches of the end projects over the edge.

2. Spread two whole double sheets of newspaper over the part of the wood that rests on the table.

3. Carefully smooth the paper down so it will hug the wood and table closely.

4. Strike the edge of the board with a swift, hard blow.

Discussion: Instead of throwing the paper to the ceiling, the wood snaps in two as if the other end was nailed to the table. Air is unable to get under the paper fast enough to balance the air above it; the air pressure on top of the paper may be momentarily as heavy as 5 tons. Scientists calculate that one-half of all our air lies below a height of 3½ miles, and 95% lies below a height of 13 miles. Scientists say there must be traces of air at least 600 miles above the earth.

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[16] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Company, (1948), p. 3

2.17 Weight of Cold Air Versus Hot Air[17]

Material: Two paper bags of the same size, scotch tape, string, a stick for balance, a candle.

Procedure: 1. Adjust the balance scales, consisting of the stick and paper bags hanging upside down, until it balances.

2. Hold one of the bags and heat the inside air with the candle.

3. Gently release the bag and it will rise because the air in the other bag is heavier.

Discussion: Gases expand very rapidly with an increase in temperture. A given amount of gas at 0°centigrade will expand 1/273 of its volume for each degree heated.

2.18 Atmosphere Pressure[18]

Material: One balloon, two cups.

Procedure: 1. Place a cup on either side of the balloon and hold it lightly.

2. Blow up the balloon until they fill up the space in the cups.

3. You can pick up the neck of the balloon and the cups will still cling to it because most of the air has been pushed out, between the balloon and the cup.

Discussion: Atmospheric pressure holds the cup in place and the rubber helps hold the cups by friction with such force that it will not let it skid past.

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[17] D.Herbert, "Mr. Wizard Science Secrets", Science Digest, Vol. 33, (Jan. 1953), pp. 71-4

[18] D.Herbert, "Mr. Wizard Science Secrets", Science Digest, Vol. 32, (Dec. 1952), pp. 32-7

2.19 <u>Potato Pistol</u>[19]

<u>Material:</u> Smooth tube of glass or metal 6 inches long, a wooden plunger that loosely fits inside the tube, slices of potato about 3/4 of an inch thick.

<u>Procedure:</u> 1. Seal up both ends of the tube by pressing the tube through a slice of potato as you would cut a cookie.

2. Push the back potato in a little with the plunger and then hit it hard.

3. The front potato will fly out like a bullet.

<u>Discussion:</u> This is the principle of the air rifle, and air hammer. You never touch the front seal, pressure forces it out.

2.20 <u>Does Air Have Weight</u>[20]

<u>Material:</u> Glass, piece of cardboard, some water.

<u>Procedure:</u> 1. Fill the glass completely full with water.

2. Place the cardboard or wax paper on top of the glass.

3. Invert the glass carefully and the cardboard will bold the water in the glass.

<u>Discussion:</u> Air pressure on the outside is greater than the weight of the water. We don't notice our shoes because we are used to them; the same is true of air and its weight on us. A postage stamp has about 15 pounds pressure on it when placed on a letter. A handkerchief can be used in this experiment instead of a card as the surface tension will keep water back.

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[19] Ibid.

[20] Ibid, (Nov. 1952), pp. 1-6

2.21 Ammonia Makes a Fountain[21]

Material: Two bottles, a one hole stopper that fits the bottle, glass tube, glass of water, small amount of ammonia.

Procedure: 1. Heat two ounces of ammonia in a bottle and fill the other bottle with the ammonia gas, by holding it mouth down over the source.

2. Remove the bottle and leave it inverted so as to keep the light gas in the bottle.

3. Put a piece of wet cotton on the glass tube near the stopper and insert this end in the bottle. Place the other end of the tube in some water.

4. Soon there will be a fountain of water inside the inverted bottle.

Discussion: The ammonia in the bottle is absorbed by the water, thus causing a partial vacuum in the bottle. This results in water being forced inside the bottle by greater atmospheric pressure on the outside. Ammonia gas has been used in this experiment because of its extreme solubility in water. At atmospheric pressure, one volume of water at 20° centigrade will dissolve about 700 volumes of ammonia.

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[21] K.M.Swezey, Science Magic, New York: McGraw-Hill Book Company, (1952), p. 54

2.22 Surface Tension Drives a Boat[22]

Material: Cardboard, piece of soap.

Procedure: 1. Cut out a boat from some cardboard and cut a "V" in the back of the boat.

2. Place a small piece of soap in the "V" part of the boat.

Discussion: The boat darts about because the surface tension at the rear of the boat is less than that at the front, hence the boat is pulled forward. Soap always lowers surface tension of a liquid. If the boat slows down put it in some fresh water and it will give the boat new life.

2.23 Surface Tension Makes a Perfect Circle[23]

Material: One tumbler, machine oil, piece of string.

Procedure: 1. Place the thread on the surface of the water in the form of a rough ring. However, the top edge of the string must not be submerged.

2. Add a little machine oil to the center of the ring.

Discussion: As the oil spreads, it lessens surface tension inside the ring. Therefore, the greater tension of the water on the outside of the ring will pull the thread into a nearly perfect circle.

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[22] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 32

[23] "Home Experiments", Popular Science, Vol. 147, (Aug. 1945), p. 186

2.24 Wetting Agent Causes Miniature Snowstorm[24]

Material: Powdered sulfur, wetting agent such as drene shampoo.

Procedure: 1. Sprinkle powdered sulfur on the surface of the water in the glass.

2. Add the wetting agent and sulfur sinks like a miniature snowstorm.

Discussion: The reason water resists wetting many things is due to surface tension. If a surface coming in contact with water has enough attraction for water to break this tension, the surface is wetted. If the surface is oily or otherwise water repellent, the water pours off it, as off a duck's back. This is a serious problem to an industrial chemist. For instance try and color feathers with a water dye, or try washing your hands with just water. A few agents now used in industry are so powerful that 1 part added to 100,000 parts of water will increase water's wetness by one-third.

2.25 Spherical Drops[25]

Material: Alcohol, some oil, water, small vial.

Procedure: 1. Fill the vial two-thirds full of alcohol.

2. Add a few drops of oil to this and enough water until the oil just floats in the middle.

Discussion: The drops are spherical because all the molecules are pulling inward. A sphere has the smallest surface exposed.

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[24] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 30

[25] K.M.Swezey, Science Magic, New York: McGraw-Hill Book Company, (1952), p. 36

2.26 <u>Surface Tension Tames a Cork</u>[26]

<u>Material:</u> Two glasses of water, two corks.

<u>Procedure:</u> 1. Fill one glass nearly full and float a cork on the water. It will go to one side.

2. Fill the other glass until slightly heaped over and then put the other cork on this. It will always go to the center.

<u>Discussion:</u> In the first case the water climbs up around the cork and at the edge of the glass, producing a concave surface between them. In trying to shorten this surface, surface tension lifts it. As the water in the raised portion is at less pressure than that of the rest, and as the water can never be raised to exactly the same level on all sides of the cork, air pressure pushes the cork toward the side where the surface is highest. When water is curved downward, pressures are balanced with the cork in the middle.

2.27 <u>Surface Tension Sinks a Cork</u>[27]

<u>Material:</u> Cork, short piece of wire, beaker.

<u>Procedure:</u> 1. Place the extended end of a horizonal wire loop in a cork.

2. Press the loop under water, and the surface tension will prevent it from breaking through. Touch the water with a piece of soap, which lowers the surface tension, and it will pop up again.

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[26] Ibid., p. 38

[27] "Home Experiments", <u>Popular Science</u>, Vol. 142, (May 1943), p. 172

2.28 Surface Tension Enables Iron to Float[28]

Material: Dish, soap, small piece of screen, needle, razor blade.

Procedure: 1. Gently place a square of screen, razor blade, or needle on the water surface of a pan.

2. The material will float due to surface tension.

3. Dip some soap in the water and the screen, razor blade or needle, will sink due to decreased surface tension.

Discussion: If the screen or razor blade is slightly oiled it will help keep it afloat if trouble is encountered. The screen is more than 7 times as heavy as water, but will float like a raft, due to the surface tension of the water. Flies, mosquitoes and other insects can walk on water without even getting their feet wet. Water tends to act like a stretched elastic membrane. When the water comes in contact with the air the molecules at the surface are attracted more strongly to the water beneath than to the air above. As a result the surface molecules become more tightly packed together than those in the interior. Surface tension is affected by temperature, and the liquid used. As the temperture rises, surface tension decreases; that is why hot water may leak through a small hole, but will not leak when the water is cold.

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[28] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 28

2.29 Cartesian Diver or Bottle Imp[29]

Material: Tall glass of water, a small vial.

Procedure: 1. Invert the unstoppered vial in the water, letting just enough water into it so that it barely floats in the upside down position.

2. Fill the glass almost to the brim.

3. Cover the glass completely with the palm of your hand.

4. Press down and the bottle will sink; release pressure and the bottle will rise.

Discussion: Rene Descartes, famous French philosopher, created the bottle imp, over 300 years ago. Air is easily compressible, but water can hardly be compressed. Therefore pressure on the water does not squeeze the water but does squeeze the air remaining in the vial. With more water and less air in the vial, it will sink. In commerical cartesian divers the water enters a hole in the foot or if a devil, through the tail. Submarines dive by letting in water in the same manner as the vial does, and rises similarly by expelling water.

[29] Ibid., p. 26

2.30 Capillary Action[30]

Material: Tin can, board to stand on, porous cardboard.

Procedure: 1. Fill the can with cut porous cardboard.

2. Stand on top of the can and have some one pour water in it.

3. A soapless detergent will help penitrate the pores.

4. You will raise several inches from the ground.

Discussion: Water not only rises in tubes but also exerts incredible pressure. Dry wood driven in rock holes when wet will split the rock. In 1586 a architect was about to give up mounting the obelisk in front of Saint Peters in Rome because the weight had streched the ropes so much that the base of it would not come high enough. Someone in the crowd said wet the ropes; and it slowly rose high enough to put it in place.

2.31 Why Liquids Rise in Plants[31]

Material: Two plate glasses, cellophane, piece of cardboard.

Procedure: 1. Take two plate glasses and fasten them together with cellophane on each side.

2. First however, place a strip of cardboard on one of the sides, so the space between the plates will vary.

3. When placed in a pan of water, the water will rise at various heights.

Discussion: The closer together the glass is the higher the water will rise, just as in a plant, the finer the tubes or fibers of plants, the higher it will rise.

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[30] K.M.Swezey, Science Magic, New York: McGraw-Hill Book Company, (1952), p. 44

[31] Ibid., p. 43

2.32 Stream of Air Lifts Dime[32]

Material: Dime, dinner plate, table top.

Procedure: 1. Place a dime on the table two inches from the edge.

2. Place the dinner plate behind it with it's middle one foot from the edge.

3. Blow hard, with the lips one-fourth of an inch above the edge of the table in front of the dime, and blow over the dime toward a point about six inches above the middle of the plate.

4. The dime will rise up into the air stream and fly with it into the plate.

Discussion: This is another application of Bernoulli's principle, in which the rapid air stream produces low pressure above the dime. The atmospheric pressure on the under surface of the dime then lifts it into this low pressure area. The momentum of the dime shoots it up into the air stream and the air stream carries it toward the plate.

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[32] C.J.Lynde, Science Experiences With Home Equipment, New York: D.Van Nostrand Company, (1950), p. 50

2.33 Air Pressure Crushes a Can[33]

Material: Tin can, source of some heat, water.

Procedure: 1. Pour one-half inch of water in the bottom of a can.

2. Heat the can until the water boils.

3. After steam is produced, remove the can from the fire and screw the cap on tight.

4. Steam will condense and a partial vacuum result.

5. Air pressure will slowly crush the can.

Discussion: If our body were not composed chiefly of incompressible liquids and solids, and if air did not fill all the spaces between them, you would be crushed flatter than a pancake. This experiment shows the terrific pressure of air and is very dramatic if the can is allowed to cool slowly.

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[33] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 4

CHAPTER III

HEAT AND COLD

3.1 How Seeding Starts Snows and Rain[1]

Material: Sodium thiosulfate (hypo) crystals, spoon.

Procedure: 1. Melt a spoonful of hypo crystals and leave it in a stationary position. The liquid will be supercooled and remain a liquid if left undisturbed.

2. Scrape off any dirt that the liquid may contain, with some paper as this will prevent the liquid from supercooling.

3. Add crystals of hypo after it has cooled (small specks).

4. The liquid will freeze as a solid instantly.

Discussion: Tiny ice seeds by means of a similar triggering action, cause whole super-cooled clouds to turn into snow. Dry ice and silver iodide are also used to seed the clouds. In a real cloud a single cubic inch of dry ice could trigger at least 20,000 tons of snow. According to men who make rain and snow by seeding the clouds, raindrops and snowflakes begin as minute ice crystals in a cloud whose temperature is below freezing. Additional moisture freezes around these ice crystals and causes them to grow until they are heavy enough to fall. They reach the earth as snow or rain, depending on the temperature.

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[1] K.M.Swezey, Science Magic, New York: McGraw-Hill Book Company, (1952), p. 112

3.2 Heat of Evaporation[2]

Material: Test tube, glass elbow, ether.

Procedure: 1. Place a small amount of ether in the test tube and blow on it with the glass elbow tube inserted in the tube.

Discussion: The test tube frosts up because it takes heat from the air around to change the liquid to vapor, as ether boils at 35°centigrade. The same effect results when ether is rubbed on the arm.

3.3 The Unburnable Handkerchief[3]

Material: Alcohol, water, handkerchief, match.

Procedure: 1. Mix 2 parts rubbing alcohol to 1 part water.
2. Dip the handkerchief in this and squeeze it out.

Discussion: When ignited, only the alcohol will burn, the water keeps the cloth cool so that it will not ignite.

3.4 Conduction and Convection[4]

Material: Small tin cover, lighter fluid, match.

Procedure: 1. Pour some lighter fluid on top of the water filled cover. Ignite, and hold it with your fingers.

Discussion: Water is a very poor heat conductor. Heat is transfered by convection in the hot water heater.

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[2] "Home Experiments Demonstrations", Popular Science, Vol. 146, (May 1945), pp. 202-3

[3] K.M.Swezey, Science Magic, New York: Mc Graw-Hill Book Company, (1952), p. 95

[4] "Home Experiments", Popular Science, Vol. 147, (Aug. 1945), p. 186

3.5 Radiation of Black Objects Versus Light Ones[5]

Material: Tin can, light bulb (100 watt), candle.

Procedure: 1. Smoke half the can, inside and out, by holding it over a candle flame.

2. Suspend a 100 watt bulb in the can as near to the center as possible.

3. Cup your hands around the blackened and shinny sides of the can and you will discover that the black side radiates considerably more heat than does the bright side.

Discussion: Objects with dull or dark surfaces are best absorbers and radiators of both heat and light. Objects with shinny light surfaces reflect light and heat well, but absorb and radiate it poorly. Therefore, black pots heat fast and cool fast; shinny ones takes longer to heat and holds the heat longer after removed from the heat source. Five to ten percent more radiant heat can be obtained from radiators when coated with linseed-oil paint than they do when coated aluminum or bronze paint. From this experiment we can deduce that shinny roofs and light colored clothes are the coolest in the summer.

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[5] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 38

3.6 Infrared Heat[6]

Material: One infrared bulb, clear cellophane, embroidery hoop, unpopped popcorn.

Procedure: 1. Cut the cellophane in a circle like the hoop and place it on the bottom and top, with enough popcorn, placed in between to cover the bottom.

2. Hold over the infrared bulb and the corn will pop out.

Discussion: Infrared heat passes through the cellophane, but is turned to radiant heat when it hits the corn, because it can not pass through this. Corn pops because of the moisture in it expanding. As a novelty, the lamp may be hidden, as the light given off is invisible to the human eye.

3.7 Heat Feat[7]

Material: Asbestos sheet, one penny, heat source.

Procedure: 1. Place the penny on an asbestos sheet and heat.

2. Periodically touch the penny and asbestos sheet. The penny will seem hotter.

3. Check the temperature with a thermometer and both will be found to be the same.

Discussion: The difference is in conduction. Metal conducts heat rapidly to your fingers; asbestos conducts slowly. Metals, consequently, make good heat radiators and conductors; asbestos, good insulators.

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[6] D.Herbert, "Mr. Wizard Science Secrets", Science Digest, Vol. 33, (Jan. 1953), pp. 71-4

[7] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 41

3.8 Effects of Freezing Temperature[8]

Material: Dry ice, acetone, some solder, lead sheet, rubber band.

Procedure: 1. Put some dry ice in a cloth and crush it.

2. Place about 4 ounces of this dry ice in a tumbler along with two ounces of acetone.

3. Place some more dry ice in the solution after it has foamed until it is mushy in texture.

Discussion: The temperature of the above solution is about -110°F. Some interesting things happen to solids when froze at this temperature. Use some tongs and put a coil of solder into the solution and freeze it. It will now act like a spring. A lead sheet when frozen will sound like bronze when struck with an object. A rubber band will break into a million pieces when hit with a hammer.

3.9 Fire Without Oxygen[9]

Material: Iron filings, sulfur, hard-glass test tube.

Procedure: 1. Mix equal parts of powdered sulfur and iron filings and put one inch of the mixture in a hard glass test tube.

2. Heat, and presently the whole mass will glow.

Discussion: The fire produced is due to iron chemically combining with sulfur to form iron sulfide.

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[8] Ibid., p. 52

[9] K.M.Swezey, "Chemistry of Fire", Popular Science, Vol. 146, (Feb. 1945), pp. 198-99

3.10 Mystery Half Flame[10]

Material: Bell wire, flame.

Procedure: 1. Scrape off the insulation of some wire and make a little copper coil by winding 10 or 12 turns around a pencil.

2. Lower this coil over a candle flame and the flame will go out to the depth you lower the coil.

Discussion: The heat is being taken away faster then it can be generated, so the gas is below it's kindling temperature. As a result, the flame is extinquished to that depth.

3.11 Heat That Won't Burn[11]

Material: Handkerchief, coin, cigarette or incense stick.

Procedure: 1. Stretch the handkerchief across the coin and tighten by twisting it.

2. Touch this spot with the cigarette or incense stick and it will refuse to burn.

Discussion: The coin conducts heat to all parts of the coin; as a result the kindling temperature is kept below the burning point. For the doubting Thomas, burn a piece of the cloth to show that it will burn.

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[10] Ibid. pp. 200-1

[11] D.Herbert, "Mr. Wizards Science Secrets", Science Digest, Vol. 32, (Nov. 1952), pp. 1-6

3.12 Water Boiled in a Paper Card[12]

Material: Paper cup, source of heat, water.

Procedure: 1. Pour a small amount of water in the cup.

2. Heat the cup over a small flame and the water will boil, but the cup will not burn.

Discussion: Water, at sea level, can not be heated more than 212°F. Any excess heat will be used in turning the water to steam. Therefore, heat will be taken from the cup to aid in converting the water to steam. In so doing it produces a cooling effect and does not allow the cup to attain a temperature higher than the water itself.

3.13 Convection of Liquids and Gases[13]

Material: Large container, small vial, some ink.

Procedure: 1. Fill the large glass 3/4 full of hot water.

2. Fill the small vial 2/3 full of hot water and the rest ink.

3. Place the vial at the bottom of the large container.

4. By convection, the ink mixed with the cold water just as gases mix in the air.

Discussion: First the ink will appear as a cloud over the vial and then sink as it gains density.

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[12] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 42

[13] K.M.Swezey, Science Magic, New York: McGraw-Hill Book Company, (1952), p. 20

3.14 Freezing With Hypo or Ammonium Nitrate[14]

Material: Hypo (sodium thiosulfate), ammonium nitrate, glass of water.

Procedure: 1. Half fill a tumbler with water and add an equal amount of hypo or ammonium nitrate to it.

2. Stir the solution until it is dissolved.

3. Check with a thermometer; if the water is cold to begin with you can freeze a tumbler to a cork coaster or a block of wood.

Discussion: This is one of the latest gadgets on the market to cool your beverage. Ammonium nitrate will lower the temperature even more than hypo. When they dissolve, their molecules are given greater freedom, just as when ice melts. To get this freedom, they absorb heat energy from their surroundings. If a solid produces heat when it dissolves, it is due to a chemical reaction that gives off more heat than is absorbed.

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[14] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 50

CHAPTER IV

CHEMICAL MAGIC

4.1 Burning Carbon Tetra-Chloride[1]

Material: Fine sand, zinc dust, carbon tetra-chloride.

Procedure: 1. Mix equal parts fine sand and zinc dust.

2. Put a small amount in a metal bottle cap and heat it over an open flame.

3. Add a few drops of carbon tetra-chloride, and fire will result with clouds of smoke.

Discussion: This is a smoke producing agent in warfare. The zinc combines with the carbon tetra-chloride to form zinc chloride and particles of carbon. Vaporized by heat, the zinc chloride then reacts with the moisture in the air to form white zinc oxide and this mixed with particles of black carbon, makes the dense smoke.

4.2 Smoke From No-Where[2]

Material: Two tumblers, hydrochloric acid, ammonia.

Procedure: 1. Rinse one glass with ammonia and the other one with hydrochloric acid; if kept apart they will appear empty.

2. Place them together, mouth to mouth, and smoke will appear inside the glasses in the form of ammonium chloride.

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[1] K.M.Swezey, "Chemistry of Fire", Popular Science, Vol. 146, (Feb. 1945), pp. 199-200

[2] "Chemical Magic", Popular Mechanics, Vol. 81, (Feb. 1944), p. 47

4.3 <u>Chemical Gardens</u>[3]

<u>Material:</u> One glass jar, sand, sodium silicate (water glass), colbalt and manganese chloride, heavy metal sulfates such as copper, nickel and iron.

<u>Procedure:</u> 1. Sprinkle one-fourth inch of sand on the bottom of the glass jar.

2. Fill the remainder of the jar with equal parts of water and sodium silicate.

3. Seed the jar with the salts of the heavy metals.

4. Crystals begin to send up shoots within seconds; within an hour or two, the garden should be completely grown.

<u>Discussion:</u> If all goes well you should have a forest of intricate and varicolored growth which suggests some undersea fairyland. After a day, you should carefully siphon off the sodium silicate solution and replace it with fresh water. Because the crystals of metallic silicates which make-up the structures are insoluble, the plants should last until they are broken by jarring.

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[3] Ibid., p. 46

4.4 Glass Rod Lights a Fire[4]

Material: One-half teaspoon of carbon disulfide, a dish, glass rod.

Procedure: 1. Pour one-half teaspoon of carbon disulfide into a small dish.

2. Hold a glass rod, that has been heated, over the dish and it will burst into flames.

Discussion: Carbon disulfide is very explosive in the gaseous state.

4.5 Mothball Ballet[5]

Material: One-half glass of water, one-half cup of vinegar, four moth balls, one teaspoon of sodium bicarbonate.

Procedure: 1. Mix the vinegar and water and add the four moth balls to it.

2. Add one teaspoon of sodium bicarbonate and stir it throughly.

3. The moth balls sink because they are too heavy to float, but soon they will start to rise and fall.

Discussion: Bubbles of carbon dioxide generated, cling to the moth ball until it is lighter than equal amount of water. It then rises to the top where the gas escapes that's on the top, causing it to turn over and let the gas escape from the bottom; it then sinks until more gas causes it to rise again, starting the cycle all over again.

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[4] K.M.Swezey, Science Magic, New York: McGraw-Hill Book Company, (1952), p. 94

[5] D.Herbert, "Mr. Wizard Science Secrets", Science Digest, Vol. 32, (Dec. 1952), pp. 32-7

4.6 Water Starts a Fire[6]

Material: Non-metallic container, powdered aluminum, iodine crystals, asbestos sheet.

Procedure: 1. In a non-metallic container, mix one-half a thimbleful of powdered aluminum and one-half thimbleful of iodine crystals. Iodine is very corrosive, don't get any on your hands.

2. Put this mixture on an asbestos sheet and add one drop of water.

3. Aluminum reacts with the iodine vapors and suddenly bursts into flame. Great volumes of dense smoke accompany the fire.

Discussion: The mixture is catalyzed by the water, starting the reaction in which aluminum joins chemically with the iodine.

4.7 A Magic Volcano[7]

Material: Ammonium bichromate, small strip of magnesium.

Procedure: 1. Place about one-half a teaspoonful of the ammonium bichromate crystals on the center of the mat.

2. Place the strip of magnesium in the mound and ignite it.

3. In place of a small mound you have a mountain of green powder.

Discussion: The fire has changed ammonium bichromate into chromium sesquioxide; a chromium oxide that is green. It is a permanent pigment used in paints and ceramics.

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[6] K.M.Swezey, Science Magic, New York: McGraw-Hill Book Company, (1952), p. 92

[7] Ibid., p. 98

4.8 Pharaoh's Serpent[8]

Material: Potassium nitrate, mucilage, glass dish, stirring rod, mercuric thiocyanate.

Procedure: 1. Dissolve a pinch of potassium nitrate and a few drops of mucilage in one-half ounce of water.

2. In a glass dish, and using a glass stirring rod, moisten the mercuric thiocyanate with this solution until you form a stiff paste.

3. Mold into cones about one-fourth inch in diameter and one-half inch high.

4. To "hatch" a serpent, set a cone on an asbestos pad or a raised can cover, and light the tip.

Discussion: The secret behind these modern serpents of Pharaoh is the mercuric thiocyanate, a chemical which on burning, leaves an ash more than 25 times its original volume. It will continue to grow, apparently from no-where, until it is several feet long.

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[8] Ibid., p. 96

4.9 Synthetic Invisible Inks[9]

Material:

Ink	Developer	Color
sulfuric acid, 10 drops to 1 ounce of water	heat	black
nitric acid	heat	black
cobalt chloride	gently heat	blue
copper nitrate	potassium ferrocyanide	brown
oxalic acid	cobalt nitrate	blue
potassium thiocyanate	ferric chloride	red

Procedure: Follow instructions above.

Discussion: A universal good developer for nearly all invisible inks is as follows; 4 grams of potassium iodide, 1/10 gram of iodine, 5 grams of sodium chloride, 4 grams aluminum chloride (not hydrous), 3 milliliters of glycerine, add water to make up 50 milliliters of solution. Apply sparingly with a wad of cotton.

[9] Ibid., pp. 170-1

4.10 Turn Wine to Water[10]

Material: Ink, glass of water, clorax in another glass.

Procedure: 1. Add a few drops of ink in the glass of water.

2. Add some clorax in the other glass.

3. Pour the two glasses together and it will appear colorless.

Discussion: The bleach contains chlorine which combines with the hydrogen of water, setting oxygen free to combine with the ink and change it to a colorless material. The oxygen does the bleaching, not the clorax.

4.11 Root Beer Changes to Water[11]

Material: Tincture of iodine, a small bottle with a cap, a few crystals of sodium thiosulfate (hypo).

Procedure: 1. Put a few drops of tincture of iodine in a small perfume bottle, and enough water to nearly fill the bottle. The solution will look like root beer.

2. Glue a few crystals of hypo to the under side of the bottle cap.

3. Shake the solution and it becomes clear.

Discussion: Iodine is the easiest smear to remove- just wipe with hypo and the stain becomes colorless. It can then be wiped off with water and a rag. The reaction of the thiosulfate ion with iodine in acid or neutral solutions is given by the equation, $2S_2O_3^{=} + I_2 \longrightarrow S_4O_6^{=} + 2I^-$. In simple words, the iodine has been reduced.

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[10] D.Herbert, "Mr. Wizards Science Secrets", Science Digest, Vol. 32, (Nov. 1952), pp. 1-6

[11] K.M. Swezey, Science Magic, New York: McGraw-Hill Book Company, (1952), p. 162

4.12 Water Turns to Three Colors[12]

Material: Four- one ounce eye dropping bottles, potassium thiocyanate, silver nitrate, potassium ferrocyanide, ferric chloride, three glasses, one pitcher.

Procedure: 1. Mix the following solutions in the bottles:

No.#1 --- $\frac{1}{4}$ ounce potassium thiocyanate and fill with water.

No.#2 --- $\frac{1}{4}$ ounce of silver nitrate and fill with water.

No.#3 --- $\frac{1}{4}$ ounce of potassium ferrocyanide and fill with water.

No.#4 --- $\frac{1}{4}$ ounce of ferric chloride, and fill with water.

2. Line up the three glasses and add to each one:

7 drops of #1 in the first glass

7 drops of #2 in the second glass

2 drops of #3 in the third glass

3. Put three glasses of water in a pitcher and add 30 drops of #4 to it.

4. Pour into the three different glasses, and three different colors will result in each glass, namely red, white, and blue.

Discussion: The red and blue color are due to the ferric iron which is the test for them. The white color is the test for a chemical containing silver or chlorine.

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[12] Ibid., p. 166

4.13 Water to Ink[13]

Material: Potassium iodate (not iodide), sodium sulfite, corn starch, concentrated sulfuric acid, three beakers.

Procedure: 1. Dissolve 1/2 teaspoon of potassium iodate in 32 ounces of water.

2. Make a second solution by stirring 1/4 teaspoon of sodium sulfite and 1/8 teaspoon of corn starch in 8 ounces of boiling water; add cold water to make up 32 ounces.

3. When cool, and while stirring, add 20 drops of concentrated sulfuric acid. More acid will speed up the reaction; while less will slow it down. At first it may be milky, but this will clear as excess starch settles.

4. While constantly stirring, pour some of the first solution in a beaker and an equal amount of the other solution in this beaker.

5. Annouce you will turn it's color at your command.

Discussion: Most chemical changes occur at the instant two substances are mixed. This baffling change, due to a series of complex chemical reactions which first must take place, occurs seconds or minutes later. This type of reaction is commonly called a "clock reaction". By careful timing, you can make the startling transformation seem to occur at your command.

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[13] Ibid., p. 165

4.14 Red Cabbage Turns Green[14]

Material: Red cabbage juice, vinegar, ammonia.

Procedure: 1. Add several drops of vinegar to some red cabbage juice and it will turn red.

2. Add ammonia drop by drop while stirring and it will turn purple, then change to blue.

3. If more ammonia is added to the above solution, an extra yellow pigment is conjured up, which combines with the blue to form a dark green.

Discussion: Due to a natural indicator in cabbage common to beets, purple plums, and blue grapes, it will produce the color changes above due to the degree of acidity or alkalinity. The name of the indicator is anthocyanius.

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[14] Ibid., p. 161

CHAPTER V

PROPERTIES OF MATTER

5.1 Volume Change[1]

Material: Glass of water, salt or sugar, stirring rod.

Procedure: 1. Fill a glass with water to the brim, but don't round it over.

2. Add sugar or salt slowly and stir.

3. The volume will be only slightly more with salt, and hardly any change with sugar.

Discussion: Evidently there are spaces between the molecules of the solvent, in which under favorable conditions the molecules of the dissolved substance can fit. The amount of shrinkage is erratic and varies with the different substances. A few substances will actually increase the total volume when dissolved.

5.2 See Your Self As Others See You[2]

Material: Two mirrors.

Procedure: 1. Place two mirrors at right angles to one another and stand in front of the mirrors.

2. Things appear as they really are now, as seen by your eyes.

Discussion: The images are reversed by reflecting from one mirror to the other and then back to your eyes.

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[1] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 33

[2] Ibid., p. 97

5.3 Mirror Magic[3]

Material: Flower, some books, concave mirror, vase.

Procedure: 1. Attach some flowers, bottom side up, to a book.

2. Rest this book on top of two other books placed at right angles to one another.

3. On a level a little higher than the flowers are, place a concave mirror about 1 or 2 feet from the books , depending on the focal length of the mirror.

4. By placing a small vase on top of the book that the flowers are attached to, you can make it look like the flowers are in the vase even though the students can not see them.

Discussion: It is a mere phantom, projected by a concave mirror into space above the vase, much as moving pictures are thrown on a screen. Like a lens, a mirror of this type can project a real image. Pictures can actually be taken of an object such as this. When the flowers are at a distance equal to the center of curvature, the image is real, inverted, the same size as the flowers, and located at the center of curvature. This is the type of mirror used for shaving, but is held close to the face so that the image formed is virtual, erect, enlarged, and situated behind the mirror.

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[3] Ibid., pp. 98-9

5.4 Doll in a Glass[4]

Material: Plate of glass, small doll, tumbler.

Procedure: 1. Place a small doll or some object in front of a plain piece of glass standing on edge.

2. By maneuvering a tumbler behind the glass you can make it appear as if the doll is in the tumbler.

Discussion: Although you can't find the reflected image of an object by looking behind a mirror, the position of this image is apparently fixed in space. No matter where the doll has been placed, you will discover that the image is just as far behind the mirror as the doll is in front, in a line perpendicular to the plane of the glass.

5.5 Mysterious Roll Back Toy[5]

Material: Coffee can and cover, stout rubber band, string, a weight.

Procedure: 1. Punch two holes in the top and bottom of a can.

2. Run a rubber band through and tie on each end.

3. Tie a weight to the center of the band, inside the can.

4. Put the cover on tight and roll it on the floor; the toy will return almost to the exact spot it started.

Discussion: The reason is because the weight does not turn with the can, and thus causes the rubber band to wind up; returning the toy to it's original position. This is an excellent example of the conservation of energy.

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[4] Ibid., pp. 74-5

[5] D.Herbert, "Mr. Wizard Science Secrets", Science Digest, Vol. 32, (Nov. 1952), pp. 1-6

5.6 Pendulum Clock[6]

Material: String, a couple of marbles.

Procedure: 1. Tie the marble on a string that is 39 inches long. It will take about 1 second per swing, at this length.

2. Tie the other marble on a string so that it will be 1/4 as long, or about 10 inches. It will take about 1/2 second per swing, at this length.

3. If you tie a marble on a string that is 4 times as long as the one that takes 1 second, it will take about 2 seconds per per swing. This would be about 156 inches long.

Discussion: In 1583 while Galileo was praying in the cathedral at Pisa, his attention was caught by the movement of a great lamp which had been left swinging after it had been lighted. Galileo began to time it's oscillations by the beat of his own pulse. To his astonishment, the time taken for the lamp to make each swing was precisely the same at the moment it began as at the moment before it stopped. Experiments made later proved to him that the time of a pendulum's swing has nothing to do with it's weight or material, but is proportional to the square root of it's length. The split second timing of the pendulum is due to the constant acceleration given it by gravity.

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[6] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 62

5.7 Liquid Does Not Seek It's Own Level[7]

Material: Carbon tetrachloride, few iodine crystals, potassium permanganate, few grains of sodium bisulfite, one U-tube.

Procedure: 1. Color the carbon tetrachloride by adding a few iodine crystals.

2. The water is also colored the same by adding enough potassium permanganate to match it.

3. Pour these separate solutions in the separate ends of a U-tube. They will not mix.

Discussion: The water side will be higher in the U-tube, due to the heavier liquid on the other side. Although the total weights on each side will be the same, their heights will vary, due to their density difference. A few grains of sodium bisulfite dropped in, will decolorize the potassium permanganate, showing there are two liquids.

5.8 Cohesion and Adhesion Effects[8]

Material: Shallow pan, eye dropper, lycopodium powder, zinc stearate dusting powder.

Procedure: 1. Have a drop of water fall on a plate and notice how it splatters out.

2. Apply a thin coat of powder on the bottom of the pan and repeat. The drop will retain it's shape now.

Discussion: Water attraction is greater than that for lycopodium.

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[7] "Home Experiments", Popular Science, Vol. 142, (May 1943), p. 173

[8] "Home Experiments", Popular Science, Vol. 147, (Aug. 1945), p. 185

5.9 Faster Than Gravity[9]

Material: Ruler, coin.

Procedure: 1. Place a coin on one end of a ruler.

2. Hold the ruler by both ends, parallel to a table top and about seven inches above.

3. Release the end of the ruler holding the coin and let the other end rotate freely on your finger.

4. By observation or by listening, you will note that the ruler hits the table first.

Discussion: This would seem a paradox of physics, but can be explained on the basis of a compound pendulum. When it is supported at one end, the ruler acts as a compound pendulum, whose center of percussion, a point one-third of the way from the free end, falls with the acceleration of gravity. Parts nearer the free end fall faster; parts toward the supported end move slower.

5.10 Friction Varies With Pressure[10]

Material: One yardstick.

Procedure: 1. Rest the yardstick horizonally on two fingers.

2. Regardless where you hold the yardstick on your fingers, they will meet at the center, when moved towards one another.

Discussion: It is all a matter of weight governing friction. The amount each finger can slide under the stick depends upon the proportion of the stick's weight that bears down upon it.

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[9] K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 61

[10] Ibid., p. 66

5.11 Problem of Balance[11]

Material: One rod (curtain rod will do), wire to wrap around the rod for weight.

Procedure: 1. Wrap a good length of wire on the end of the rod, to act as a sliding weight.

2. Balance the rod on a finger with the weight in different positions.

Discussion: Ask the students whether it will be easier to balance the rod vertically on the tip of your finger, when the weighted end is on the top or on the bottom. If they say the bottom, they are wrong. The base of the rod is so small and finger so unsteady that the rod will try to fall whether the center of gravity is high or low. When it is high, however, the rod takes longer to topple due to inertia of the weight to resist change; hence you have more time to check the fall.

5.12 Circular Motion and Pendulum the Same[12]

Material: String, weight.

Procedure: 1. Make a pendulum with a cord and weight, and find the time it takes the pendulum to make a complete swing.

2. Find the time it takes to make a complete circular motion, and you will find they are the same. (Average 10 swings).

Discussion: This is a good experiment to show how the simple harmonic equations tie in with a pendulum and circular motion.

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[11] Ibid., p. 59

[12] C.J.Lynde, Science Experiences With Home Equipment, New York: D.Van Nostrand Company, (1950),p. 93

5.13 Center of Oscillation or Percussion[13]

Material: Baseball bat, string, marble.

Procedure: 1. To find the center of oscillation or percussion of a bat, hold the bat between your fingers where you would gripe it and set it swinging.

2. At the same time set a marble pendulum swinging and shorten the string until they are swinging together.

3. When they are in step, the point on the bat opposite the marble is the center of oscillation.

Discussion: The bat is a compound pendulum; it acts as if it were a series of simple pendulums strung end to end. If a baseball bat were uniformly thick, it's center of percussion would be two thirds of the distance from the grip end. Because it tapers, the center is nearer the striking end. Strike the bat at this point with a hammer, stick, or ball, and you will feel no vibration. Strike it anywhere else and due to it's inability to oscillate uniformly, the bat shudders, stings, and perhaps cracks. This same law applies to machinery and to hand tools such as the hammer and ax. For instance, if an ax handle is too long, the center of percussion may be in the handle instead of the head. Such an ax shudders, and may cause the handle to break.

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[13]K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 63

5.14 Mysterious Light Bulb[14]

Material: Small light bulb (flash light bulb will do), wire, beaker of cold water, beaker of hot water.

Procedure: 1. Wrap enough wire around the base of the bulb so it will just float in cold water.

2. When the weight is just right you will find it will float in cold water first and then sink. If placed in hot water it will sink first and then float.

Discussion: When you put the bulb in the cold water it floats, until the wire contracts on cooling, whereupon it sinks. If placed in the hot water it will expand and then rise to the top, due to the buoyancy effect of water on a larger mass.

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[14]"Home Experiments", Popular Science, Vol. 142, (June 1943), p. 252

CHAPTER VI

ELECTRICITY AND MAGNETISM

6.1 Static Electricity[1]

Material: Vinylite record, puffed cereal grains, water glasses, cake pan.

Procedure: 1. Place three water glass supports around a tin of cereal and lay the record on top of these supports.

2. Briskly, rub the record with wool cloth.

3. The cereal grains underneath will cling to the bottom of the record, standing on end.

Discussion: Static electricity means stationary electricity. It is different from ordinary electricity for it doesn't move; it is an excess or deficiency of electrons. Sandpaper is made by coating paper with adhesive and then by static electricity, sand is shot towards it and stands on end, making it better and longer lived. Attractive imitations of embroidery are made by a similar process, the cloth has adhesive put on the design sought, and the short pieces of the fiber are attracted to it. A static charge may be produced by streching a rubber band. Constant flexing of the inter-tube causes static noise on the car radio. By placing a wire mess pan around an electroscope it will not charge. This is why sky-scrapers are lined with steel.

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[1]K.M.Swezey, Science Magic, New York: McGraw-Hill Book Company, (1952), pp. 78-81

6.2 Substances Producing Static Electricity[2]

Material: photo film
polished glass
wool
nylon
cotton
silk
lucite
sealing wax
polystyrene
hard rubber
vinylite

Procedure: 1. By using the substances above, you can produce a plus or a minus charge. The substances highest on the list will be positive and the lower one will be a negative charge. For example, photo film rubbed with cotton will give you a positive charge on the photo film and a negative charge on the cotton.

Discussion: Whenever unlike substances are pressed or rubbed together, the one with the weakess attraction loses electrons; the other one gains them.

6.3 Which Rod is Magnetized[3]

Material: Two steel rods that look the same, but one is magnetized and the other is not.

Procedure: 1. Ask someone to find out which one is magnetized. Both of the rods will pull on each other.

Discussion: Take a rod and place it's end near the center of the other rod; if it is attracted, then the rod in your hand is the magnet, for the force of a magnet is at it's ends.

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[2] Ibid., pp. 74-5

[3] Ibid., p. 86

6.4 Electric Motors and Their Current Drawn[4]

Material: Light bulb, socket with screw connections on the side, small motor to test.

Procedure: Wire the bulb in series with the motor.

2. As the motor starts up the bulb will glow; as speed picks up it will dim.

3. Grasp the shaft to slow down the motor and the light will glow brightly, showing more current is being drawn.

Discussion: The reason for this is because an armature spinning in a magnetic field acts secondarily as a generator, creating a voltage in it's windings that is always opposite in direction to the electro-motive-force impressed upon the motor. Large motors must be started with a variable resistance in the ciruit.

6.5 AC and DC Difference[5]

Material: 15 to 25 volt direct current source, 6 to 12 volt alternating current source, cloth, a solution of water, starch, and potassium iodide, pie tin.

Procedure: 1. Place a wet cloth that has been soaked in the solution above on a pie tin turned upside down.

2. Attach the negative pole to the tin and draw the positive lead across the cloth.

Discussion: Direct current will cause a solid line because the steady current releases free iodine which reacts with the starch. Alternating current leaves a dotted line.

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[4] "Electrical Effects Shown By Home Experiments", Popular Science, Vol. 147, (Dec. 1945), p. 190

[5] Ibid., p. 191

6.6 Clean Your Silverware by Electrolysis[6]

Material: Silverware, aluminum pan, salt, sodium bicarbonate.

Procedure: 1. Add one teaspoonful of sodium bicarbonate and another of salt to each quart of water.

2. Place the silverware in an aluminum pan and cover it with the boiling solution.

3. After several minutes, remove the silver, rinse, and polish with a soft cloth.

Discussion: The silver touching the aluminum and surrounded by the electrolyte, forms one plate of an electric cell. By the action of this cell the tarnish of silver sulfide is first dissolved, then the sulfur is separated and the silver redeposited. As a result, less silver is removed by this type of cleaning than by ordinary rubbing with commerical compounds. This method should not be used on so called "french finish" silver however, as it may clean out the gray toned depressions as well as the surface.

K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 151

6.7 Mercury Heart[7]

Material: Wood handle, support and clamp, needle, sulfuric acid, mercury, watch glass.

Procedure: 1. Place one cubic centimeter of mercury in a watch glass.

2. Cover the mercury with sulfuric acid and water in a ratio of one to five.

3. Place the needle in the wooden holder and dip it into the solution, but just touching the mercury.

4. The mercury will be in constant motion, first moving forward to touch the needle and then drawing away from it. Hence, the mercury appears to throb like a heart.

Discussion: The sulfuric acid slowly dissolves the needle, giving it a charge. At the same time the action on the mercury is to give an opposite charge. This causes the mercury to be attracted to the needle where both the charges are lost , and the action begins all over again.

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[7] J.O.Frank, G.J.Barlow, Mystery Experiments, Wisconsin: J.O.Frank Company, (1949), p. 56

6.8 Magnetic Field[8]

Material: One alnico magnet, clear light bulb, shaving mirror, white piece of paper.

Procedure: 1. Adjust the mirror in back of the bulb until you get a clear image of the filament on the paper.

2. Bring the magnet near the filament and it will begin to vibrate.

3. The closer the magnet approaches the stronger the vibration.

Discussion: The explanation is that as the field reverses it's polarity, the filament is alternately attracted and repelled.

6.9 Lightning Produced[9]

Material: Flame, powdered rosin.

Procedure: 1. Place the powdered rosin that has been ground very fine, in a salt shaker.

2. Shake this over a flame; preferably in the dark.

3. You will see bright flashes of light resembling lightning.

Discussion: Each rosin particle burns rapidly with a long flame and this long flame gives the appearance of lightning.

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[8]"Home Experiments", Popular Science, Vol. 148, (May 1946), pp. 198-205

[9]C.J.Lynde, Science Experiences With Home Equipment, New York: D.Van Nostrand Company, (1950), p. 115

CHAPTER VII

LIGHT AND SOUND

7.1 Fluorescent Lighting[1]

Material: Small argon bulb, quinine sulfate, diluted sulfuric acid.

Procedure: 1. Fluorescent paint can be made by mixing a paste of quinine sulfate and dilute sulfuric acid.

2. Coat half the tube and allow it to dry.

3. The coated side gives off more light because it is being bombarded by ultra-violet rays from the plates in the tubes; giving off visible rays of great intensity.

Discussion: In a commercial tube the coating is on the inside, so as to protect it and at the same time utilize those ultra-violet rays that cannot pass through the glass. Mercury and argon vapor are the two gases used most often in fluorescent lights. The electric current is started by the low pressure argon present, but later most of the ultra-violet light is changed into visible light by the phosphor powders on the walls of the glass.

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[1]"Home Experiments", Popular Science, Vol. 142, (Apr. 1943), p. 109

7.2 Producing a Blue Print[2]

Material: Ferric ammonium citrate, potassium ferricyanide.

Procedure: 1. Mix and store the following in a dark room until ready for use: (a) 10 grams of ferric ammonium citrate to 50 milliliters of water, (b) 10 grams of potassium ferricyanide. It is best to store them in a separate container until ready for use.

2. Filter the solution and store in the dark room.

3. Paint the solution on the paper or slowly draw it over a pan that contains the solution, being careful to wet only the bottom side.

4. Hand up the sensitized paper in the dark room to dry.

5. Place the design you wish to blueprint on top of the paper, and expose it to the sunlight for 5 or more minutes, depending on the intensity of sunlight.

6. Wash the print in water and hang it up to dry.

Discussion: Light causes the formation of turnbull, $Fe_3(Fe(CN)_6)_2$ which is insoluble in water. Where light has not struck the paper, prussion blue, $Fe_4(Fe(CN)_6)_3$ remains, which is soluble in water and will wash out.

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[2] W.Lemkin, Graphic Survey of Chemistry, New York: Oxford Book Company, (1956), p. 287

7.3 Famous Lissajous Curves[3]

Material: String, paper cup that is cone shaped, salt.

Procedure: 1. Cut a string six feet long and tie both ends about a foot apart, to a horizonal support.

2. Tie a string to the paper cup and fasten it to the other string to form a "y".

3. Fill the cup with salt and after cutting a small hole in the bottom of the cup, start it swinging.

4. By substituting this two way pendulum for a tuning fork, and salt for the light rays, you can see a beautiful pattern, which is similar to the tuning fork waves.

Discussion: These patterns of sound waves were first discovered by a French scientist, Lissajous. He attached tiny mirrors to tuning forks arranged at right angles to each other. Then he shot a ray of light onto one mirror so that it was reflected to the other and from there onto a screen. When the forks were set vibrating, their combined motion caused the ray of light to trace out a simple or intricate pattern on the screen. These Lissajous curves are not only beautiful and fascinating, but the patterns are clues to the exact relationship between the pitch and other qualities of waves from two tuning forks.

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[3] K.M.Swezey, Science Magic, New York: McGraw-Hill Book Company, (1952), p. 72

7.4 Sound Cannot Travel in a Vacuum[4]

Material: One small pyrex flask, one pencil, one small bell.

Procedure: 1. Tie the bell loosely to one end of the pencil by means of a rubber band.

2. Push the other end of the pencil through a one hole-stopper that fits snugly on the flask.

3. Add a little water to the flask and boil until all air has been expelled.

4. Remove from the flame and put the stopper on instantly.

5. After the steam has condensed, a partial vacuum results, which makes the bell almost inaudible when the flask is shook.

Discussion: In 1660 Robert Boyle first proved that sound couldn't penetrate a vacuum in an experiment very similar to that above. It will be more dramatic if the flask is shook at different intervals as the steam is condensing. Sound has its origin in a vibrating body and is transmitted to the ear through some medium. Solids are the best media for sound transmission; liquids and gases follow in the order named, but sound will not travel in a vacuum. The velocity of sound in air at 0 degrees centigrade is 1090 feet per second. The velocity increases 2 feet per second for every 1 degree centigrade rise in temperature.

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[4]K.M.Swezey, After Dinner Science, New York: McGraw-Hill Book Company, (1948), p. 78

7.5 Resonance Gives Sound of Sea[5]

Material: Containers of various sizes.

Procedure: 1. Hold each container to your ear and you will hear the "sound of the sea".

Discussion: The reason for the sound and it's pitch is resonance. The air within any enclosed space of moderate size vibrates more easily at one definite pitch than another; the bigger the space, the lower the pitch, and visa-versa. The air around us is full of a mixture of sounds of different pitch. When we press the container to our ear we merely hear an amplification of any sound that corresponds to the shell's own natural pitch. Auto industries take advantage of this when test running a car for noises. the car is driven very close to a wall where any noise is picked up and amplified. Resonance is defined as the reinforcement of one sound wave by another.

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[5] Ibid., p. 84

7.6 Sound Lens Made from a Gas Balloon[6]

Material: One balloon, one watch or clock, source of carbon dioxide.

Procedure: 1. Fill a balloon with carbon dioxide. This can be done by putting the balloon over a coke bottle that has had dry ice and water added to it.

2. Hold the carbon dioxide filled balloon between a ticking watch and your ear.

3. By maneuvering it around you will find a position in which the ticks sound louder.

Discussion: Because sound waves travel more slowly through heavy carbon dioxide gas than they do through air, a "lens" can be made to focus sound, much as light waves can be focused with a lens of glass. Although a spherical balloon does not form a perfect lens, the effect is nevertherless pronounced.

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[6] Ibid., p. 79

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APPENDIX

APPENDIX A

INDEX OF EXPERIMENTS

APPENDIX B

INDEX OF CHEMICALS AND SCIENCE PROPERTIES

DEMONSTRATED BY THE EXPERIMENTS

VITA

Donald Stanley Jarrad

Candidate for the Degree of

Master of Science

Report: SIMPLE SCIENCE EXPERIMENTS FOR DAILY HIGH SCHOOL CLASS DEMONSTRATIONS

Major Field: Natural Science

Biographical:

Personal data: Born near Morrice, Michigan, December 10, 1921, son of Stanley C. and Adah Jarrad.

Education: Attended grade school in the Baldwin Country School, near Morrice, Michigan; graduated from Morrice High School in 1940; received the Bachelor of Science degree from Michigan State University, with a major in Agricultural Engineering, in June 1947; received the Master of Arts degree from Arizona State University, with a major in Audio-Visual Aids, in May, 1955; completed requirements for the Master Science degree in May, 1957.

Professional experience: Entered the teaching profession in 1951 as a high school science and mathematics instructor; taught general mathematics, geometry, chemistry and physics in Safford, Arizona, 1951-1953; taught algebra, biology, general science, chemistry and physics in Clarkdale, Arizona, 1953-1955; taught advanced algebra, geometry, chemistry, and physics in Buckeye, Arizona, 1955-1956; attended the Oklahoma Agricultural and Mechanical College for one year in graduate study under the scholarship grant of the National Science Foundation; member of the Arizona Mathematics Club.