DOCUMENT RESUME

ED 124 374 88 SE 018 326

AUTHOR Bullock, Bob; And Others
TITLE Introductory Minicourse, Career Oriented Pre-Technical Physics. Preliminary Edition.
INSTITUTION Dallas Independent School District, Tex.
SPONS AGENCY Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.
PUB DATE 74
NOTE 60p.; For related documents, see SE 018 322-333 and SE 019 605-616

EDRS PRICE MF-$0.83 HC-$3.50 Plus Postage.
DESCRIPTORS Individualized Instruction; *Instructional Materials; *Physics; Program Guides; *Science Activities; Science Careers; Science Education; Science Materials; Secondary Education; Secondary School Science; Technical Education
IDENTIFIERS Elementary Secondary Education Act Title III; ESEA Title III

ABSTRACT

This minicourse was prepared for use with secondary physics students in the Dallas Independent School District. This is an introductory minicourse aimed at acquainting the student with the realm of physics so that the student can pursue further study by selecting those minicourses most relevant to his career needs and interests. The minicourse was designed for independent student use with close teacher supervision and was developed as an ESEA Title III project. A rationale, behavioral objectives, student activities, and resource packages are included. Student activities and resource packages include paper puzzles, manipulative puzzles, paper glider construction, analog computer construction, and a number of physics "tricks." (GS)

CAREER ORIENTED PRE-TECHNICAL PHYSICS

INTRODUCTORY

Minicourse

1974

PRELIMINARY EDITION

dallas independent school district

CAREER ORIENTED PRE-TECHNICAL PHYSICS

INTRODUCTORY

Minicourse

ESEA Title III Project

1974

dallas independent school district

BOARD OF EDUCATION

Eugene S. Smith, Jr., *President*

Bill C. Hunter, *Vice-President*

Emmett J. Conrad, M.D.

James Jennings

Nancy Judy

Lawrence Herkimer

Kathlyn Gilliam

Sarah Haskins

Robert Medrano

ADMINISTRATIVE OFFICERS

Nolan Estes
General Superintendent

Rogers L. Barton
Associate Superintendent—Development

H. S. Griffin
Associate Superintendent—Operations

Frances Allen
Assistant Superintendent
Early Childhood Education

Larry Ascough
Assistant Superintendent—Communications

Otto M. Fridia, Jr.
Assistant Superintendent
Secondary Operations

Ruben Gallegos
Assistant Superintendent
Program Development

Carlton C. Moffett
Assistant to the General Superintendent

Ben Niedecken
Attorney

H. D. Pearson
Assistant Superintendent
Business

Joe M. Pitts
Assistant Superintendent
Elementary Operations

George Reid
Assistant Superintendent
Personnel Development

John J. Santillo
Assistant Superintendent
Personnel

B. J. Stamps
Assistant Superintendent
Career Education

Weldon Wells
Assistant Superintendent
Support Services

March 25, 1974

This Mini Course is a result of hard work, dedication, and a comprehensive program of testing and improvement by members of the staff, college professors, teachers, and others.

The Mini Course contains classroom activities designed for use in the regular teaching program in the Dallas Independent School District. Through Mini Course activities, students work independently with close teacher supervision and aid. This work is a fine example of the excellent efforts for which the Dallas Independent School District is known. May I commend all of those who had a part in designing, testing, and improving this Mini Course.

I commend it to your use.

Sincerely yours,

Nolan Estes

Nolan Estes
General Superintendent

mfs

CAREER ORIENTED PRE-TECHNICAL PHYSICS TITLE III ESEA PROJECT

Project Director: Jesse M. Harris
Assistant Director, Math-Science
Dallas Independent School District

Project Editor: Walt Elliott
Physics Department
California Polytechnic State University

Minicourse Authors: Bob Bullock
North Dallas High School

Perry Oldham
Lincoln High School

Helen Shafer
W. H. Adamson High School

Hollis Tapp
H. Grady Spruce High School

Physics Consultants: Ben Doughty
Physics Department
East Texas State University

Glenn Terrell
Physics Department
University of Texas at Arlington

CAREER ORIENTED PRE-TECHNICAL PHYSICS

INTRODUCTORY MINICOURSE

RATIONALE (What this minicourse is about):

This introductory minicourse is designed to acquaint you with the realm of physics. Physics is the study of <u>energy</u> and <u>matter</u>. Matter is the tangible stuff the universe is made of, like steers and stamps and stones. Energy is the prime mover of matter, like electrical energy causes lightning, heat energy causes thunder, and nuclear energy causes sun activity. Physics is the most basic science of all physical sciences, since matter and energy make up everything there is in the entire physical universe! . . . And technical physics is the study of harnessing this energy and matter as machines for mankind.

Because the realm of physics is so huge, this introductory course includes playing with things, constructing things, observing things and events, measuring things and events, and thinking about things and events. This way, you will become acquainted with some of the properties that make physics what it is.

When two things affect one another physics-wise, we call it <u>interaction</u>. For example, two automobiles interact when they collide. When something occurs in nature, the general physics term for this "happening" is <u>phenomenon</u>. For example, thunder is a sound phenomenon; and <u>event</u> is a word also used in physics to refer to a "happening." We could say that the two automobiles collided and that the interaction phenomenon was an event.

This minicourse will require about fifteen (15) hours of class time, doing mostly fun things. The physical phenomena related to the fun things you will do have their basis in physics and in the processes of science.

In addition to RATIONALE, this minicourse contains the following sections:

1) TERMINAL BEHAVIORAL OBJECTIVES (Specific things you are expected to learn from the minicourse)

2) ENABLING BEHAVIORAL OBJECTIVES (Learning "steps" which will enable you to eventually reach the terminal behavioral objectives)

3) ACTIVITIES (Specific <u>things</u> <u>to</u> <u>do</u> to help you learn)

4) RESOURCE PACKAGES (Specific instructions for performing the learning <u>Activities</u>, such as procedures, references, laboratory materials, etc.)

<u>TERMINAL BEHAVIORAL OBJECTIVE</u>

After completing this minicourse, you will demonstrate an increased interest in physics by selecting those minicourses for further study which you and your teacher consider to be most related to your career needs and interests.

<u>ENABLING BEHAVIORAL OBJECTIVE #1</u>	<u>ACTIVITY 1-1</u>	<u>RESOURCE PACKAGE 1-1</u>
Exhibit a familiarity with methods of puzzle-solving by demonstrating some puzzle solutions.	Complete Resource Packages 1-1 and 1-2.	"Paper Puzzles"
		<u>RESOURCE PACKAGE 1-2</u>
		"Manipulative Puzzles"

ENABLING BEHAVIORAL OBJECTIVE	ACTIVITY	RESOURCE PACKAGE
ENABLING BEHAVIORAL OBJECTIVE #2	ACTIVITY 2-1	RESOURCE PACKAGE 2-1
Distinguish between basic science (scientist) and technology (technologist), recognize the basic role science and technology play in society, recognize the need for career counsel and guidance and some sources of each, and become aware of the minicourse's structure and titles and rationales.	Read Resource Package 2-1.	"Career Oriented Pre-Technical Physics Minicourses"
ENABLING BEHAVIORAL OBJECTIVE #3	ACTIVITY 3-1	RESOURCE PACKAGE 3-1
Construct and fly at least two basic kinds of paper airplanes and recognize some basic aircraft and flight nomenclature.	Complete Resource Package 3-1.	"Some Aerodynamics of Paper Gliders"
ENABLING BEHAVIORAL OBJECTIVE #4	ACTIVITY 4-1	RESOURCE PACKAGE 4-1
Know the basic difference between an analog and a digital computer and construct some simple analog computers.	Complete Resource Package 4-1.	"Building A Super-Simple Analog Computer"
ENABLING BEHAVIORAL OBJECTIVE #5	ACTIVITY 5-1	RESOURCE PACKAGE 5-1
Demonstrate a variety of physics phenomena.	Complete Resource Package 5-1.	"Bag of Tricks"

RESOURCE PACKAGE 1-1

PAPER PUZZLES

The scientific process is based upon certain procedures:

1) A procedure for reasoning between what happens in nature (an effect) and what produces the "happening" (a cause). Because the determination of absolute truth may lie outside the realm of science, the scientist constructs mental models to account for cause and effect. The Bohr model (planetary model) of the atom, while naive and incorrect in modern physics, is a classic example of a useful model developed around the year 1900 to explain the cause of observed atomic effects.

2) A procedure for experimentally testing a model in the light of new scientific discoveries. If a model is found to contradict new findings, the model must be modified, abandoned, or restricted to limited use. The largest part of experimental physics is devoted to testing some model of how nature works for inconsistencies or errors.

3) A procedure for extending a model to encompass greater areas of physics, or for altering a model to accomodate new experimental findings. Extension or alteration requires deductive and inductive reasoning. Inductive reasoning frequently results from the genius of the "educated guesses" of such scientists as Einstein or Newton.

In these first Resource Packages, you will play with some puzzles. There are three basic ways to solve puzzles:

1) Reason through the entire puzzle (or through an entire sub-section of a puzzle) before attempting anything manipulative.

2) Attempt anything and everything manipulative in random fashion and hope to "luck out" on a solution.

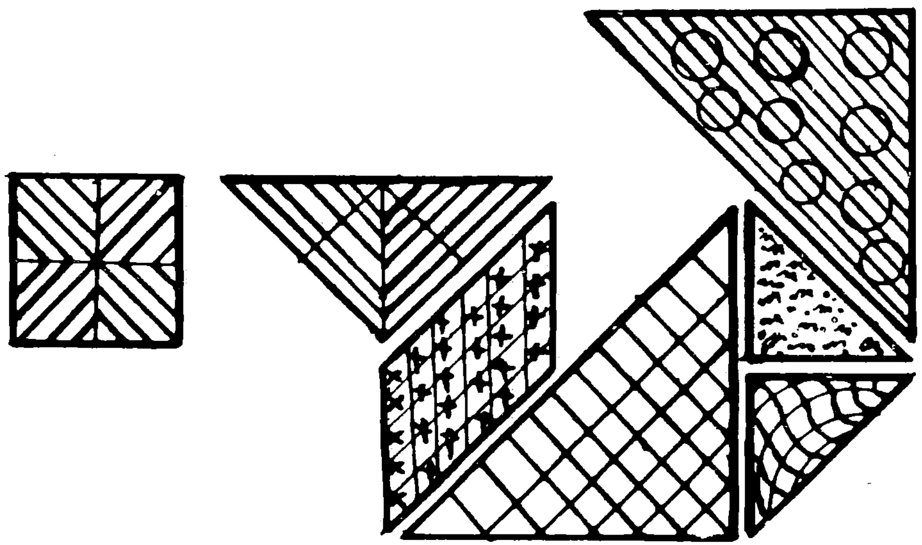
3) Reason through a few steps (perhaps even an occasional sub-section); manipulate to test this reasoning; and then either proceed if successful or go "back to the drawing board" if unsuccessful.

Most scientific achievements follow puzzle solution plan (3), where an idea for a solution and the testing of the idea are first reasoned through, and then a step-by-step testing takes place until a solution is reached.

Have fun with these paper puzzles, and with the subsequent three-dimensional tactile puzzles! Then, when you have completed Resource Packages 1-1 and 1-2, you will be asked to submit a brief in-your-own-words definition of <u>inductive</u> and <u>deductive</u> reasoning.

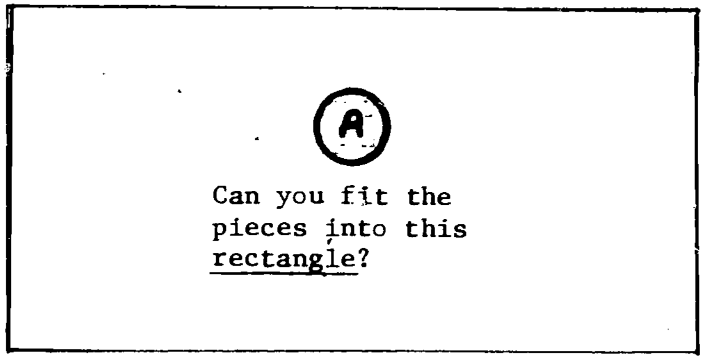
PUZZLE (a)

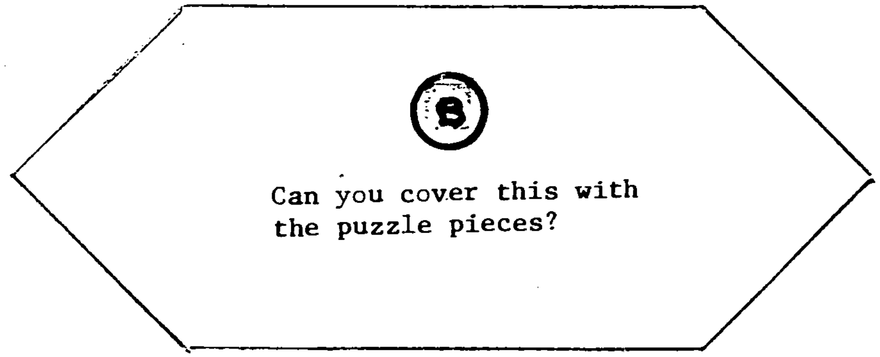
Cut out these seven puzzle pieces. Then, fit them into the five shapes indicated on the next page.

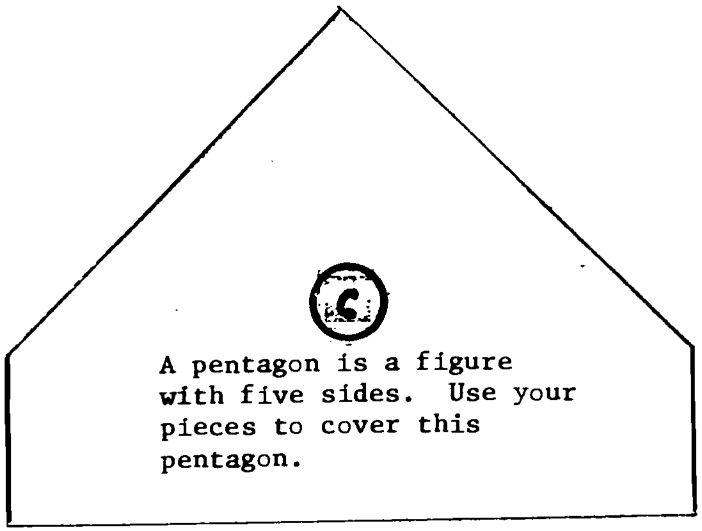


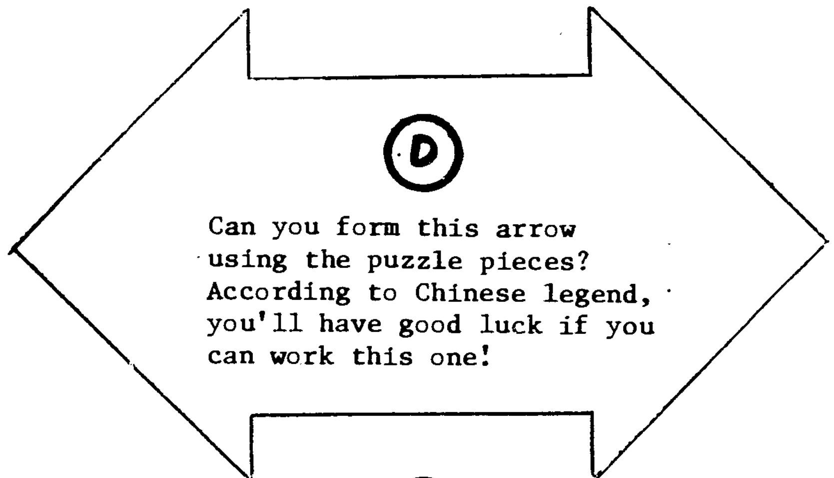
PUZZLE (b)

Fit the seven puzzle pieces into each shape. In technical physics, an arrangement or shape is frequently called a <u>configuration</u>. You should be able to arrange the seven pieces into these five configurations.







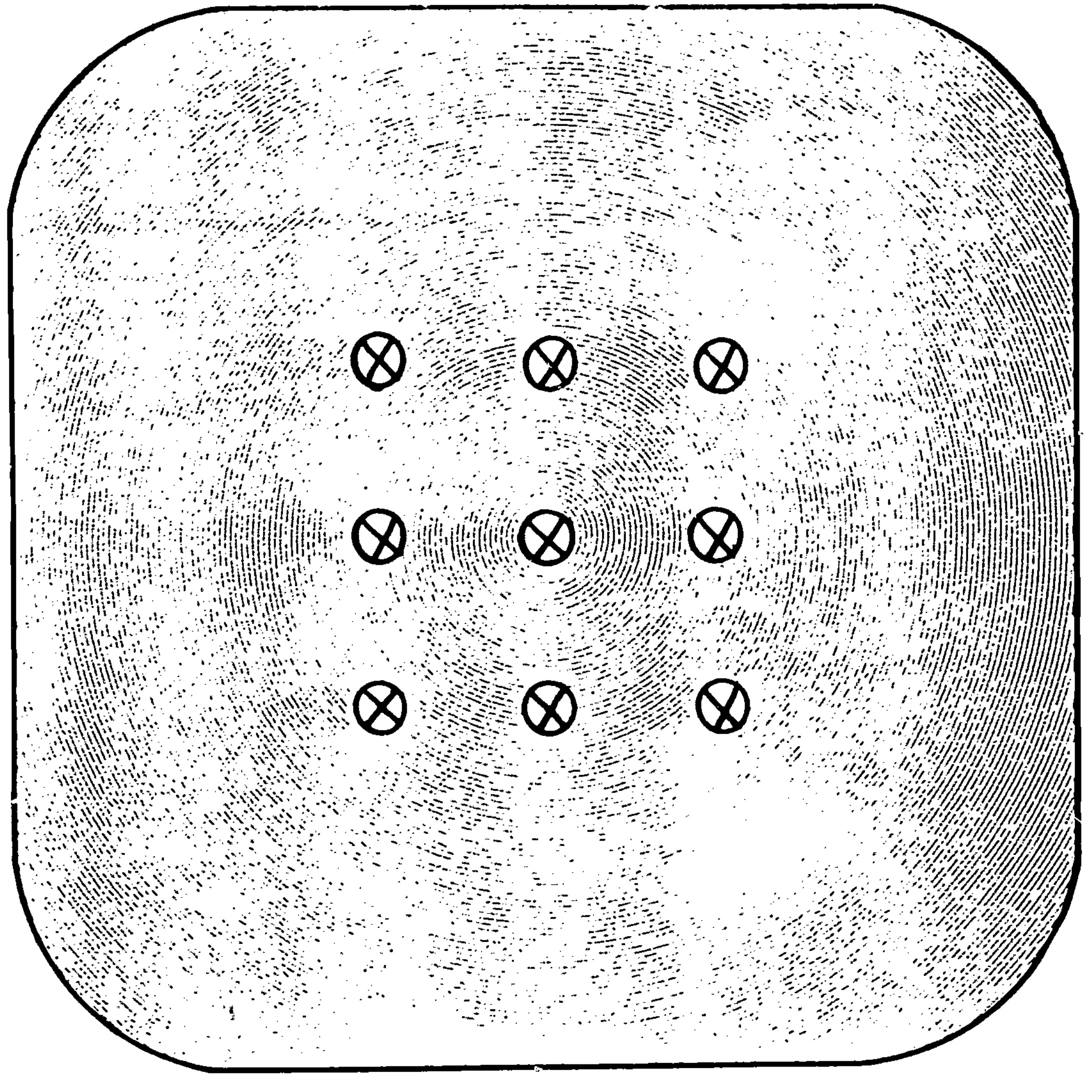


E

Form a square using the puzzles pieces.

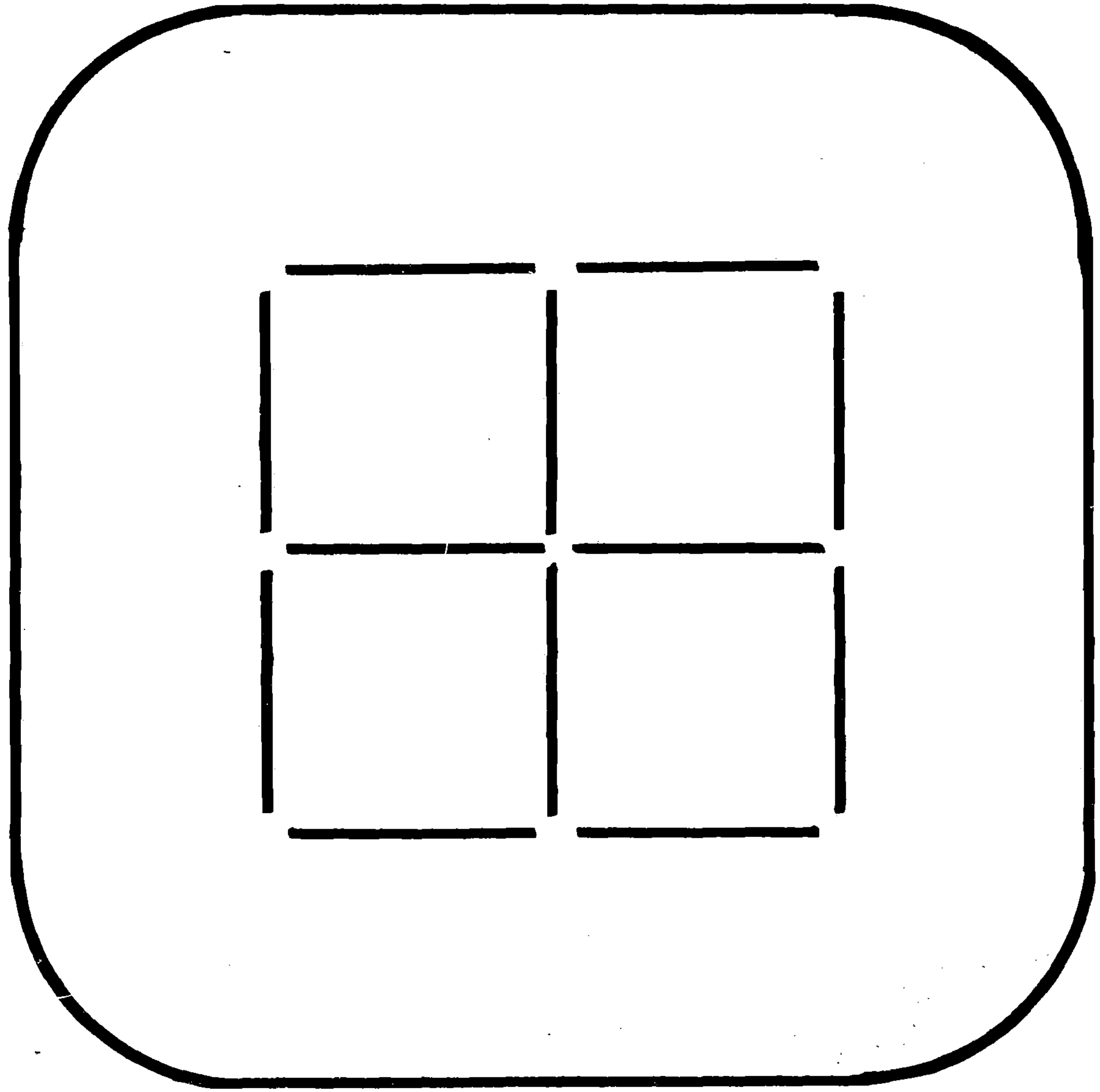
PUZZLE (c)

Connect all nine circles within the grey area to four straight lines without lifting your pencil.



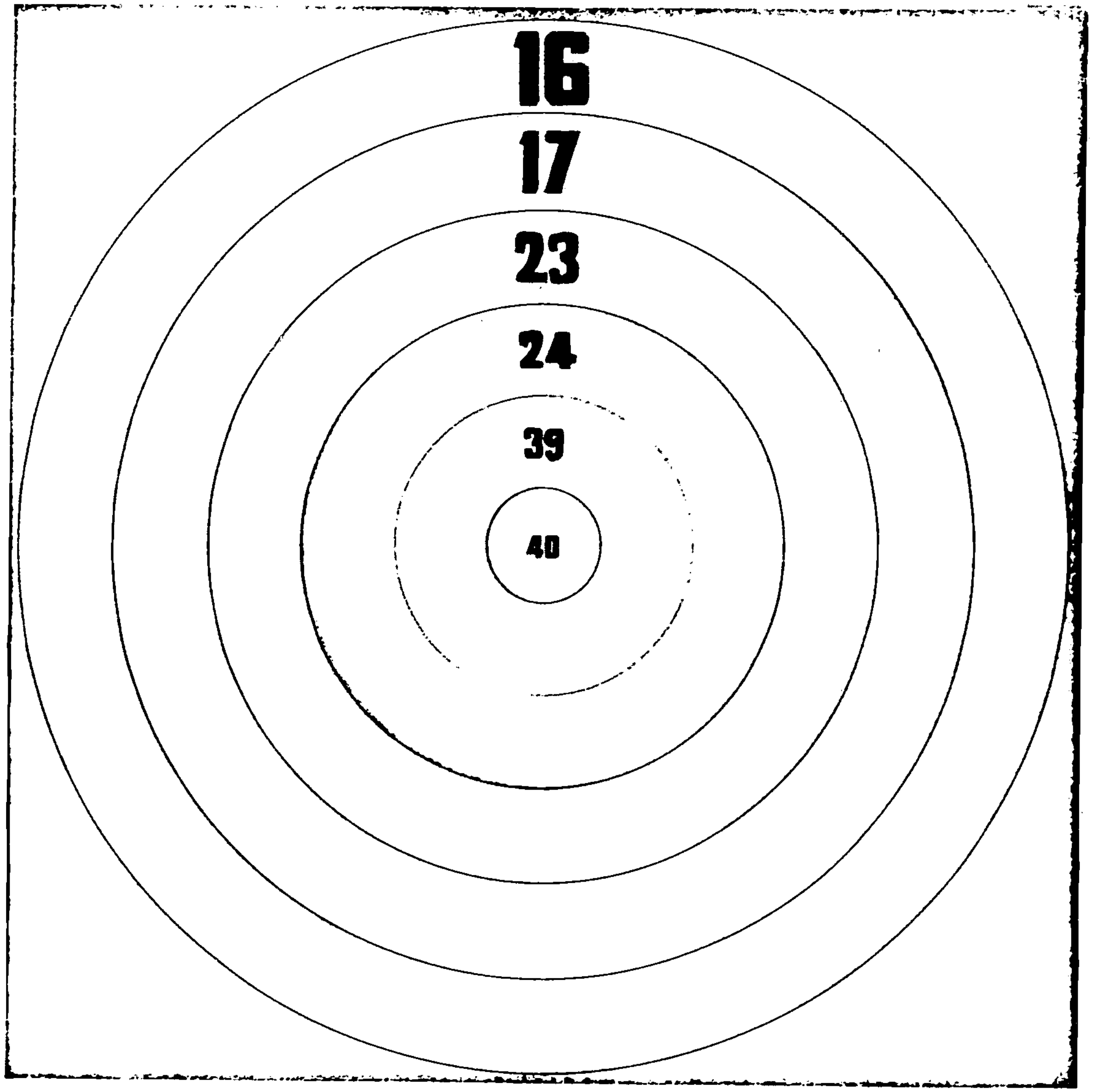
PUZZLE (d)

Notice the four squares inside the grey area. Can you make one less square by moving only 3 lines?



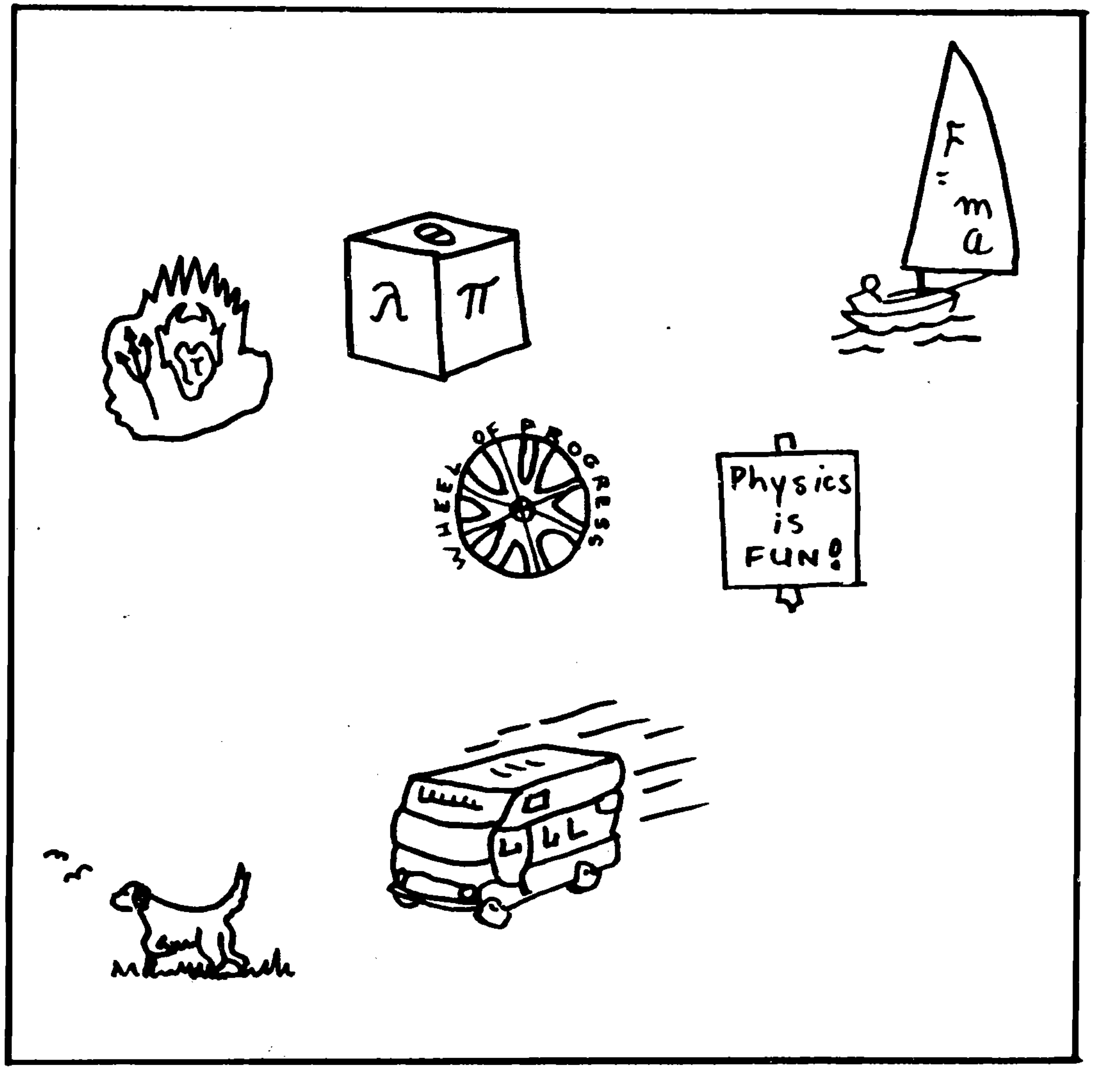
PUZZLE (e)

To score exactly one hundred, how many darts must you use?



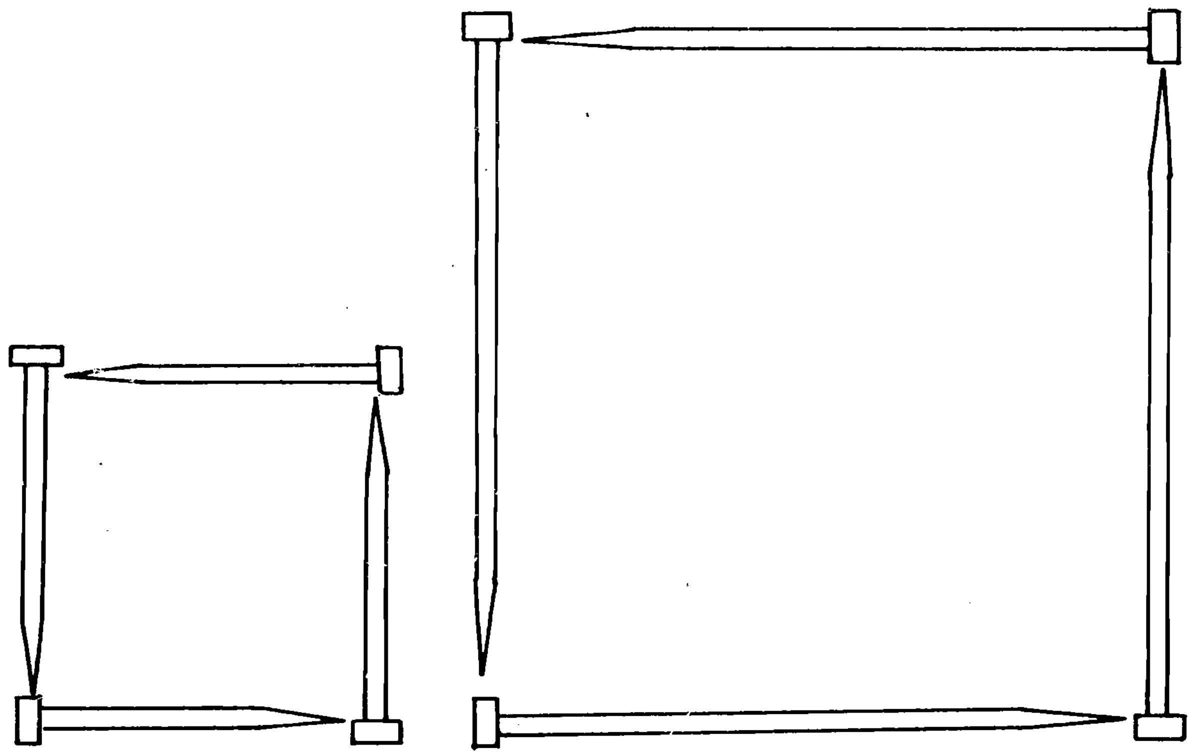
PUZZLE (f)

Try to enclose each figure in its own area by drawing <u>only</u> three straight lines.



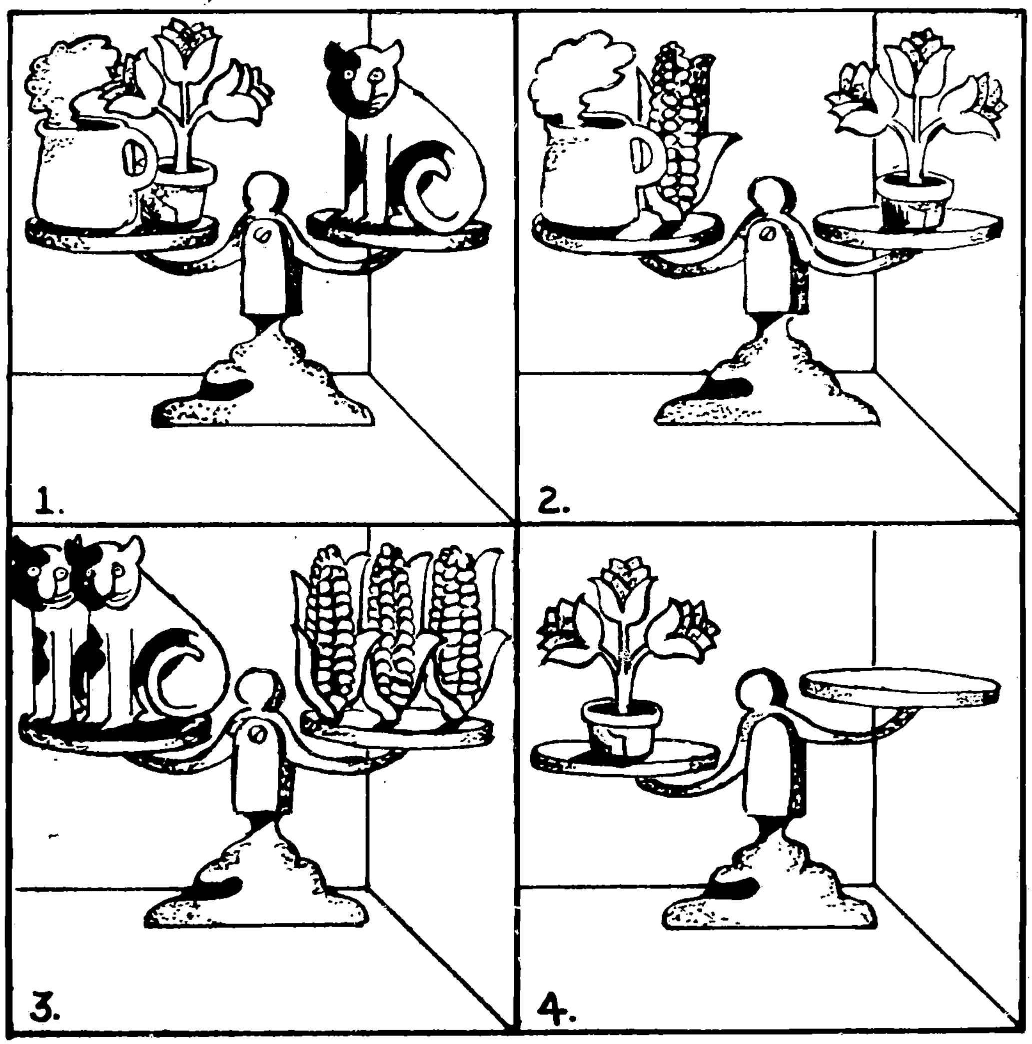
PUZZLE (g)

Arrange these eight nails to make three squares of equal size. No part of any nail may extend beyond the edge of any square.



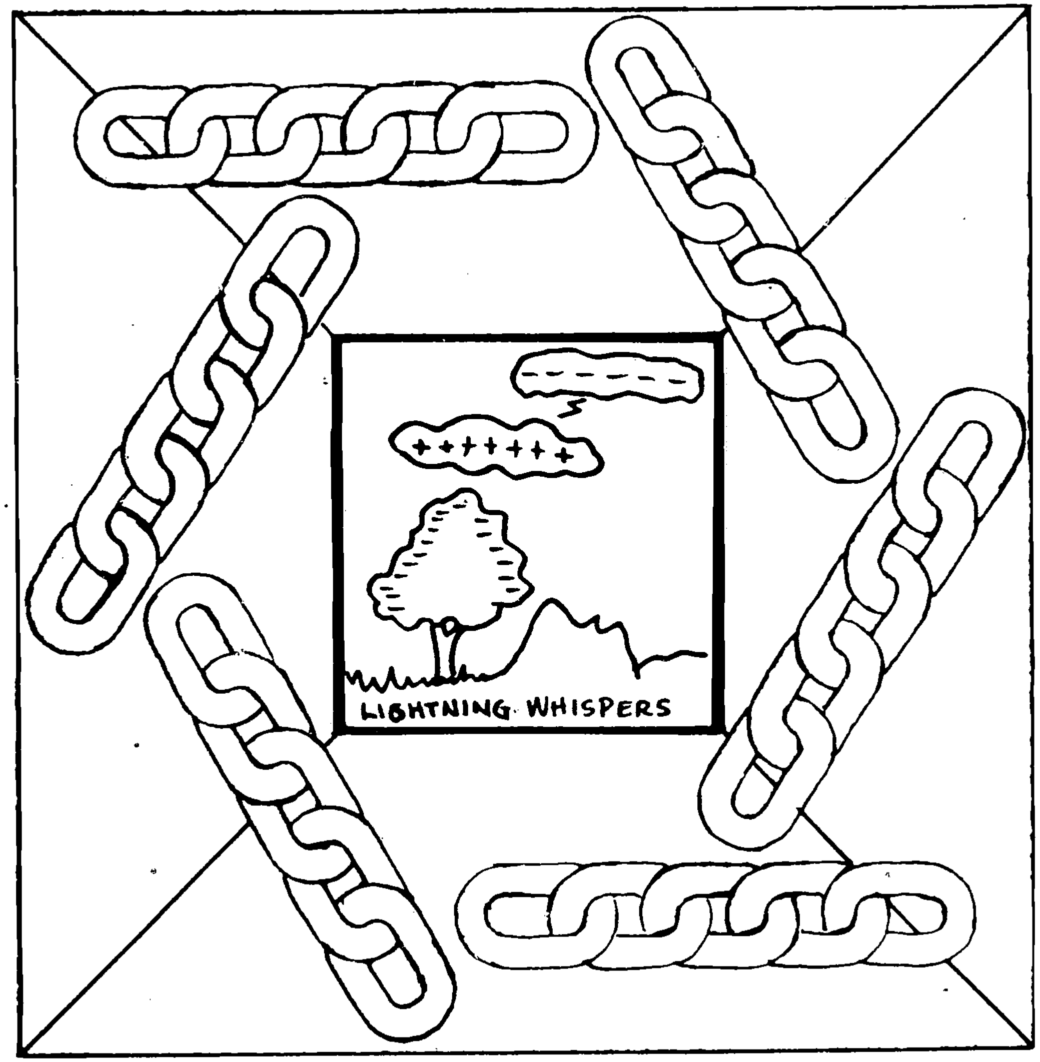
PUZZLE (h)

Study the pictures labeled 1, 2, and 3. Then, how many mugs will be needed to balance the flower pot in picture number 4?



PUZZLE (i)

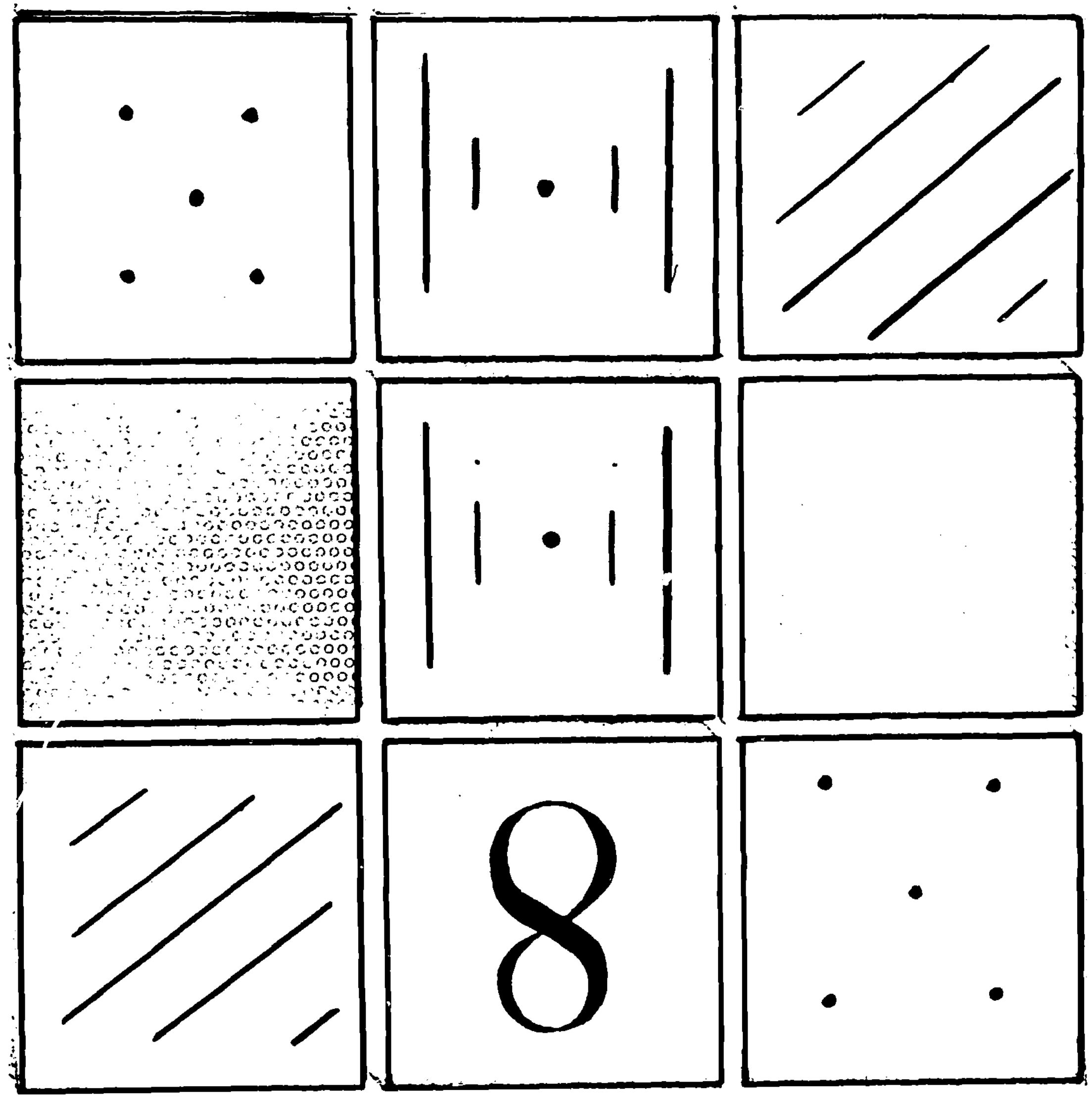
What is the least number of links you must cut open and then close to make an endless chain?



PUZZLE (j)

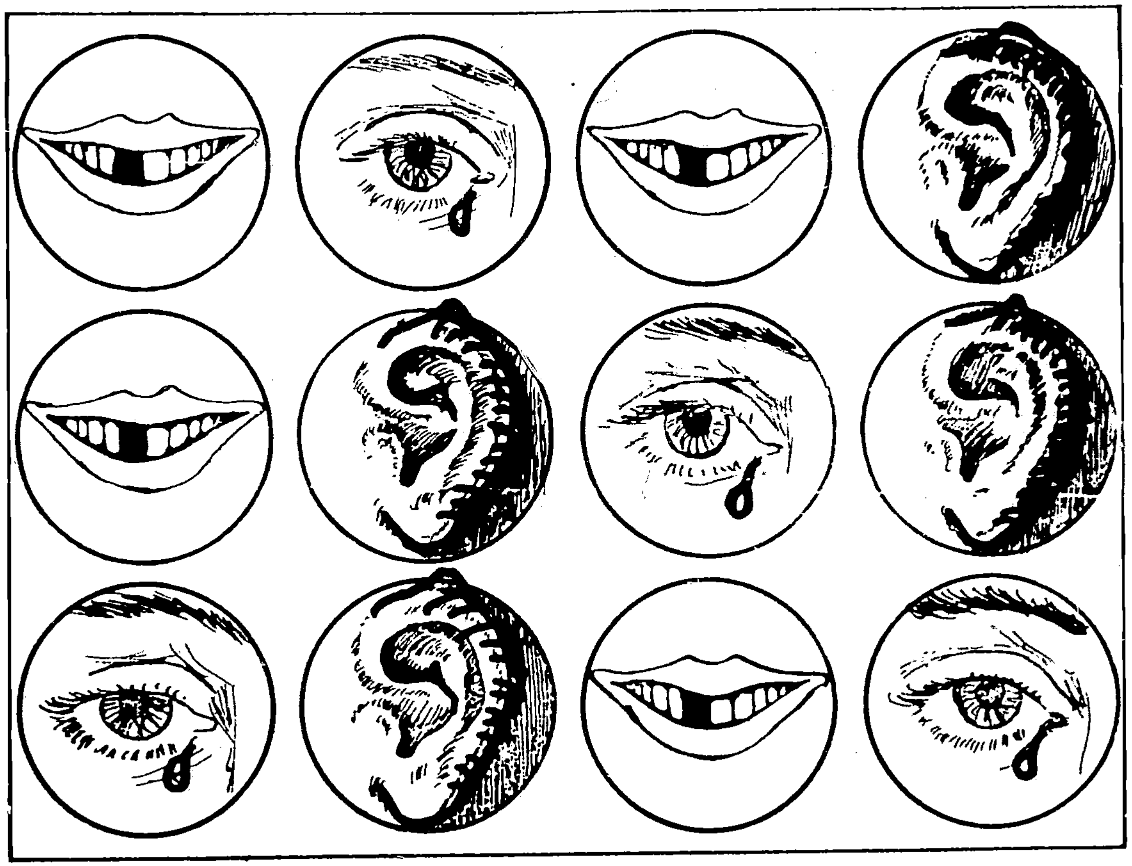
Number the remaining eight squares so that each row, column, and diagonal of any squares totals 15.

Do not use a number more than once.



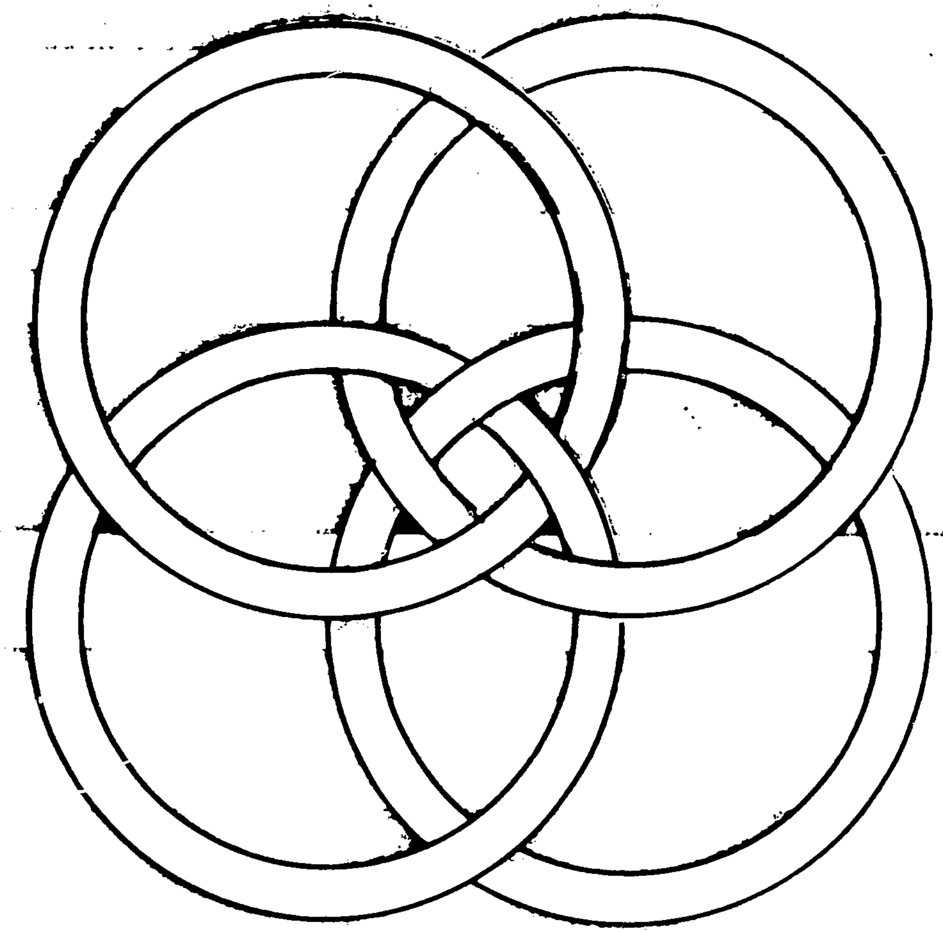
PUZZLE (k)

Can you divide the rectangle into four <u>equal</u> <u>and</u> <u>similarly</u> <u>shaped</u> portions so that each portion contains an eye, an ear and a mouth?



PUZZLE (1)

Which one of the four interlinked rings must be cut so all the rings will be free?



RESOURCE PACKAGE 1-1

MANIPULATIVE PUZZLES

Ask your teacher for the manipulative puzzles. You may wish to lend some of these yourself, if you have some at home. Some trade names for these 3D puzzles include:

"Instant Insanity"	"Hi-Q"
"Dovetail"	"Puzzables"
"Skill-it"	"VooDoo"
"Fool's Spool"	"One Way"
"8 Men on a Raft"	"Chinese Box"
"Nervous Breakdown"	"Gradual Despair"
"Add-M-Up"	"Thinker (series)"

When you have finished experimenting with these puzzles, submit the brief "in-your-own-words" definitions of <u>deductive</u> and <u>inductive</u> reasoning to your instructor for evaluation.

RESOURCE PACKAGE 2-1

CAREER ORIENTED PRE-TECHNICAL PHYSICS MINICOURSES

Technical physics is the study of energy and matter, and how they can be harnessed to serve mankind. The application of basic science to the development and production of machines and related devices is called technology.

Technicians are usually graduates of two-year colleges, of technical schools, or of on-the-job training, and they serve as the link between engineers and skilled craftspersons. Engineers have strong backgrounds in physics and they take the ideas of basic science and apply them to the design and production of machines and machines products. Craftspersons are skilled workers whose vocational (technical) training has prepared them to compete in a machine-age society. All these kinds of people, scientists and technicians and craftspersons, are essential in the development and production stages between basic science and the final products of machines.

Career opportunities for technical persons are greater than ever, and the future appears bright. The successful technician and craftsperson will be in a more competitive position if personal skills are well-developed and combined with an understanding of basic theory. Assuming a reasonable ability to communicate with people and to work with numbers, the next most valuable technical asset is likely an understanding of some basic concepts of physics. Because fewer than twenty per cent (20%) off all high school graduates have ever studied physics, think what a great competitive job advantage can by yours when you have completed this curriculum!

Now is a good time to become better acquainted with various technical career opportunities, or with the career field you may have already decided upon. In the minicourse which make up this technical physics curriculum, you will often be referred to an encyclopedia of careers and vocational guidance. While your counselor can refer you to many excellent career references, you are urged to carefully examine this encyclopedia (reference below). Remember, a career is usually much more than earning a living; it is a way of life! Can any study be much more important to you now than a study of possible career choices, or the opportunity to learn more about the career you have pretty much decided upon already? The career reference highly recommended by the minicourses authors is:

> The Encyclopedia of Careers and Vocational Guidance, Vols. 1 and 2, Revised Edition, Doubleday and Co., Inc., Garden City, New York, 1973.

Because career interests are varied among students, a number of minicourses have been developed. These minicourses concentrate upon a unified physics topic, but all contain sub-topics which overlap with the central topic and with the sub-topics of the other minicourses. This means that you and your teacher can jointly work out a technical physics course to approximate your individual career needs and interests. You are NOT expected to complete all of the minicourses; you and your teacher will decide upon those particular minicourses you are to complete during this physics course! The minicourse authors think that perhaps six to eight minicourses constitute "ball park" numbers for a complete curriculum.

Just because you don't complete all of the minicourses does not mean you have not learned as much physics as someone who has had a traditional physics course and "covered the entire textbook". Most of us learn by reading and by doing. These minicourses are filled with things to do; the reading is up to you, mostly, and the more you read about physics the more you will learn about physics.

Listed below are the minicourses from which you can choose (Everyone starts off with the Introductory Minicourse):

- Basic Machines - The "Nuts and Bolts" of Technical Physics
- Ballistics, Bullets and Blood
- Climatizing the Home
- Automobile Ignition System
- Metric System and Slide Rule
- Photography
- Physics of Communication
- Physics of Musical Instruments
- Physics of Sports
- Physics of Toys
- Science and Superstition

To help you decide upon which minicourses to select to best tailor this physics curriculum to your individual needs and interests, read the Rationale section on the first page of each minicourse. This section explains what the minicourse is all about.

If you want to know more about the mathematics of a particular physics topic, and particularly how to solve a problem in mathematical physics, usually the clearest explanation can be found in Daniel Schaum's COLLEGE PHYSICS, Schaum's Outline Series, Theory and Problems, 6th Edition. Do NOT let the title College Physics frighten you. Your teacher can get one of these for classroom use free, by writing on official stationery to Dept. C, McGraw-Hill Book Co., 1221 Avenue of The Americas, New York, New York, 10020. It is best to state that the book will stay in the classroom or library and will be used as a recommended reference book for the physics classes.

Physics can be fun, although it isn't all play. It is sometimes hard work, but it can be very interesting work. We, the authors, hope you have a fun and interesting trip through the minicourses!

RESOURCE PACKAGE 1-3

SOME AERODYNAMICS OF PAPER GLIDERS

The earth itself is nothing more than a huge spaceship. Further, the earth and everything associated with it must obey the laws of physics, for physics is the most fundamental and universal of <u>all</u> of the physical sciences.

All aircraft must also obey the laws of physics. The science of flight is called <u>aerodynamics</u>, and most of the basics of flight and flight control of aircraft can be observed in paper gliders.

The history of flight reveals that experiments with <u>gliders</u> led eventually to the Wright brothers' success at Kitty Hawk. So you will first build and fly simple paper gliders in this minicourse. Then you will build and fly more sophisticated paper gliders, all the while observing the basic principles of flight and of flight control. Finally, the minicourse terminates your aerodynamics study with a paper glider contest.

You will need some or all of these materials, depending upon the kinds of gliders you build:

- some 8½" x 11" bond paper
- Scotch tape (or equivalent)
- Paste (glue)
- some paper clips
- straight edge (ruler will do)
- scissors
- coloring materials (optional)
- stapler
- some hair pins; brads; gummed-paper hole reinforcements (optional)

Fluids. In technical physics the term fluid applies to a liquid or to a gas. Your paper gliders will be designed to fly in the fluid we call our atmosphere or simply the air. Air has certain properties relevant to glider design, and air exhibits certain behaviors when an object moves through it. These properties and behaviors will be mentioned as they arise in your investigations.

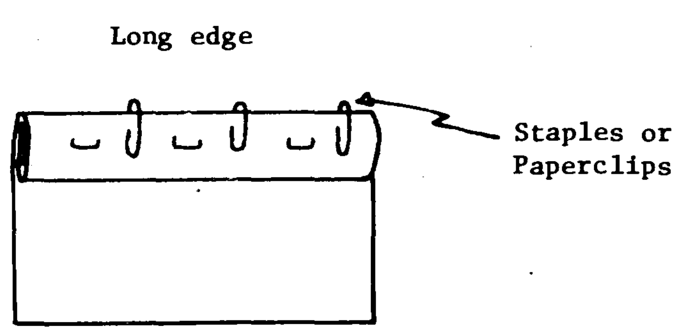
Inertia and Stability. The inertia property of the air is its resistance to being pushed aside. When you run fast, the air pushes on your face and body as it resists being shoved aside. If you suddenly stick your hand outside the window of a fast moving automobile this resistance is sufficient to hurl your hand backward with great force. The faster something moves in a fluid, the greater this resistance force (drag) normally becomes.

1) Hold a piece of paper in a horizontal position. Drop it; observe that the paper is not able to overcome the air's inertia and fall straight down to the floor. An aerodynamicist would say that the paper sheet was unstable in flight because of its erratic and unpredictable pattern of flight.

2) Crumple the paper into a wad. Drop it. Observe the comparative stability of the paper wad and the comparative ease with which it overcomes air resistance.

3) Cut a piece of 8½" x 11" paper in half. Shape it into a cone and secure it with a paper clip or staple. Drop it and observe its comparative stability and response to air resistance.

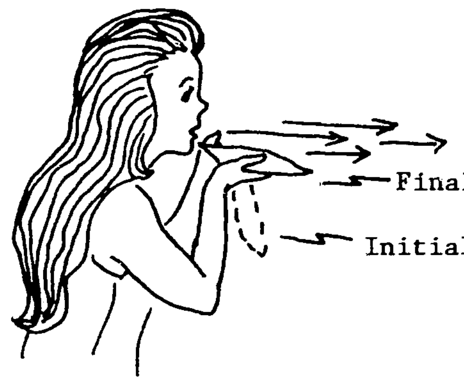
4) Let's really overcome air resistance by first creasing the long edge of the paper all the way across and about a half inch from its end. Continue to fold and crease (wind) the paper about a half dozen times. Secure the fold with staples or paper clips placed symmetrically as shown. This even spacing insures a more uniform weight distribution.



SIMPLE WING

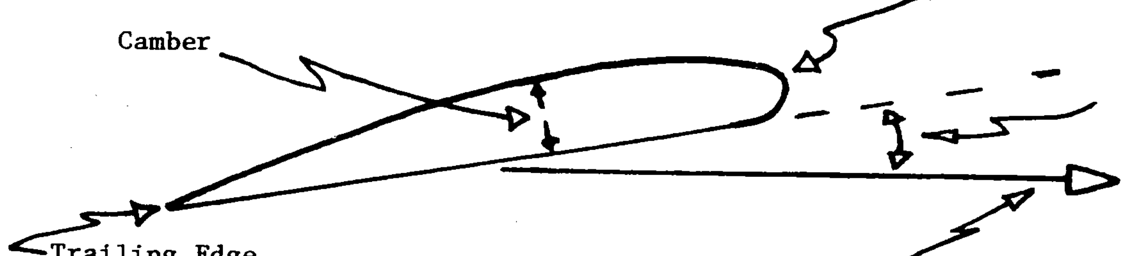
You have constructed a simple wing. Drop it and test it for stability and drag. SAVE THIS WING FOR LATER USE.

Lift. One reason a glider stays airborne is the upward force on its wing surfaces; such surfaces are called airfoils. The upward forces on airfoils are called lift. Lift results from a difference in air pressure on the top and bottom surfaces of an airfoil, and this pressure difference arises from a difference in the speed of the air rushing over the top and bottom wing surfaces. This lift is an example of Bernoulli's Principle. You can demonstrate the Bernoulli Principle by holding one edge of a piece of paper against your mouth, while letting the paper hang vertically. Then blow across the top of the edge of the paper; the harder you blow, the stronger will be the lift on the airfoil, as shown below.



BERNOULLI LIFT

In addition to Bernoulli lift, the primary lift in aircraft is produced by the push (reaction force) of the air against an airfoil attempting to move through it. The size of this reaction (lift) force depends upon such things as angle of attack, airfoil surface, relative speed of airfoil and air, etc. (See the sketch below).



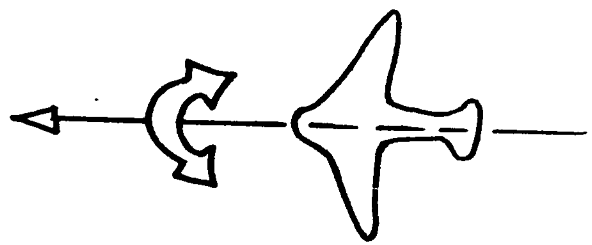
LIFT FACTORS

Camber is related to the curvature of an airfoil; camber affects the pressure differences between the top and bottom surfaces of an airfoil and the resultant Bernoulli lift.

Control Surfaces. A good aircraft must be stable in three _modes_ (three ways):

1) It must be _roll_ stable.

ROLL

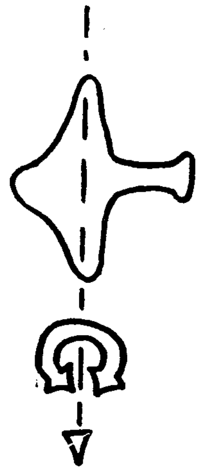


2) It must be _yaw_ stable.

YAW

3) It must be pitch stable.

PITCH

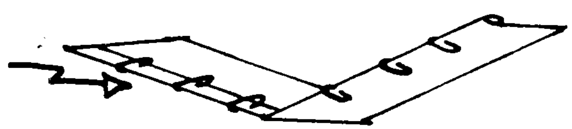


Ailerons are the control surfaces for roll; elevators control pitch; and rudders control yaw.

TO DO: Now you are to examine some properties of control surfaces.

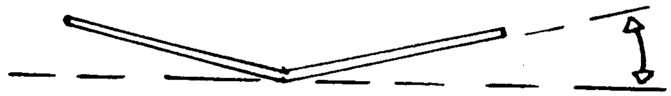
1) Take the wing you saved; try flying it. Observe its problems in terms of roll, pitch, and yaw stability.

2) Now bend this wing in half, to form two wings as shown.



TWO WINGS FROM ONE!

3) Look "head on" at the double wing you have formed.

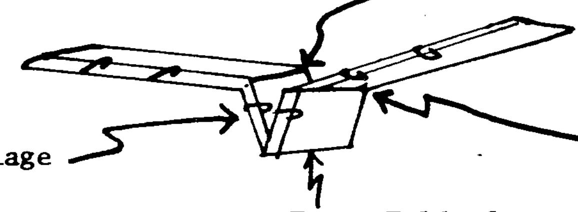


DIHEDRAL INCREASES ROLL STABILITY

The angle formed between the wing in the original flat position and in the now-angled position is called the dihedral. The dihedral helps a plane to resist roll.

4) Try flying the folded wing and observe its stability characteristics.

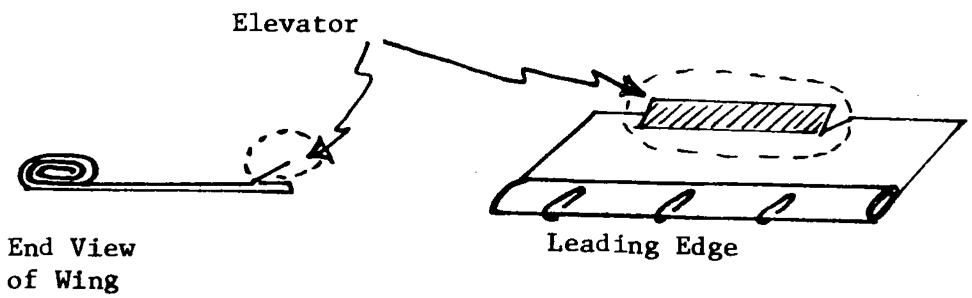
5) You can now fold each wing one more time, and build a keel or fuselage for your glider, as shown.



GULL GLIDER

Your gull-shaped glider should again be flown and observed for stability in terms of yaw, pitch, and roll.

6) Now make two scissors slits in the trailing edge of each wing, and crease a set of elevators into place.



ELEVATOR CONSTRUCTION

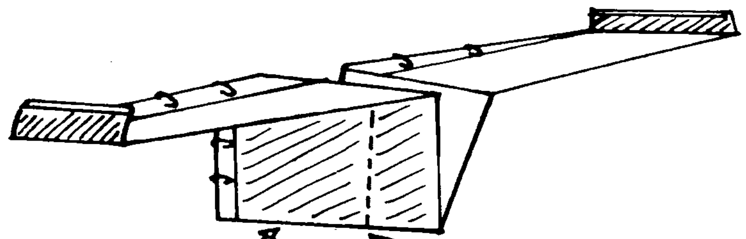
Try flying the craft. To increase its stability, experiment with adding and removing paper clips (weight distribution) and by changing the crease angle of the elevators.

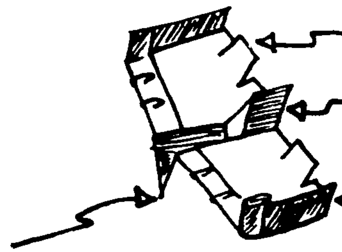
7) Now crease two control surfaces on the outside edge of each wing tip, similar to those of step (6), to form wing rudders.

RUDDER CONSTRUCTION

Fly the glider again and observe its stability. Experiment with different control surface configurations (different position angles of elevators and rudders).

8) A further modification is to scissor-cut forward of the trailing edge of the keel, reverse the first (center) crease, and form an empennage (tail assembly).





TAIL ASSEMBLY CONSTRUCTION

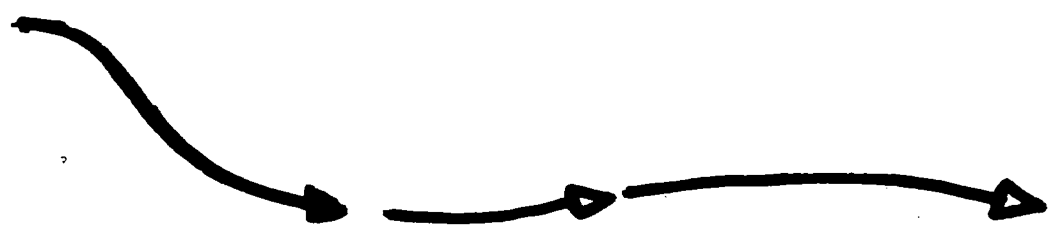
Building and Launching A Better Glider. Now you can build another glider similar to this own. You will have the advantage of your observations and experience to guide you. If you prefer, you may use the glider you just completed. After building your improved glider, try these glider launching tips:

1) Launch the glider into a gentle glide. Trim the ship for a smooth glide by changing control surface angles and weight distributions.

2) Launch the glider with a greater speed than used in Step (1). If it noses up and stalls immediately after launch, the launch speed was too great.

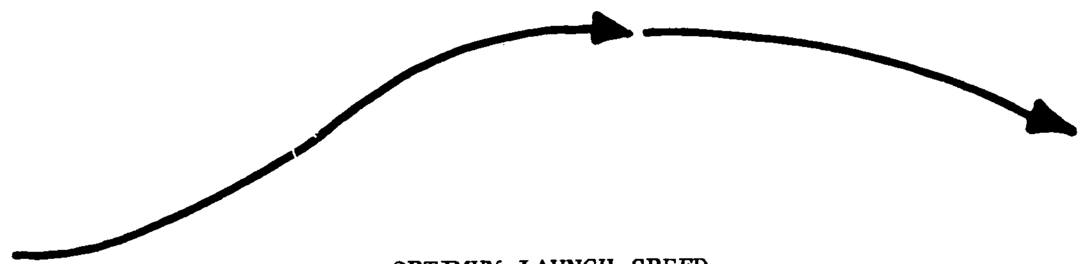
LAUNCH SPEED TOO GREAT

On the other hand, if the glider falls rather quickly below launch level, launch speed was too slow.



LAUNCH SPEED TOO SLOW

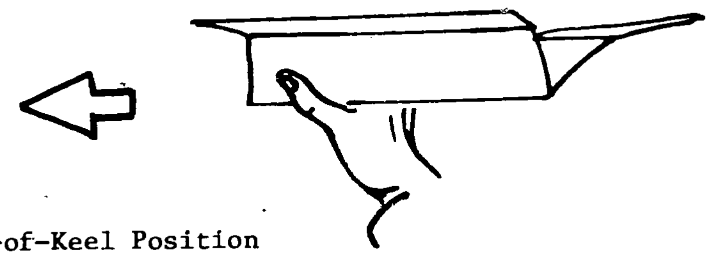
For best long distance launch, the speed should result in a launch <u>trajectory</u> (path) like this:



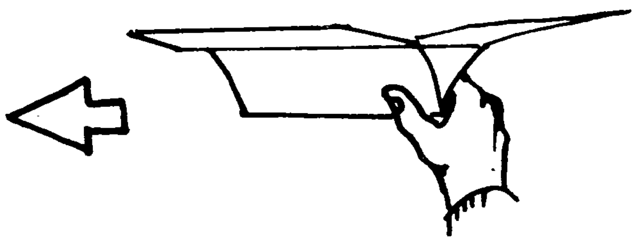
OPTIMUM LAUNCH SPEED

Below are shown several hand positions for launching:

1) Front-of-Keel Position

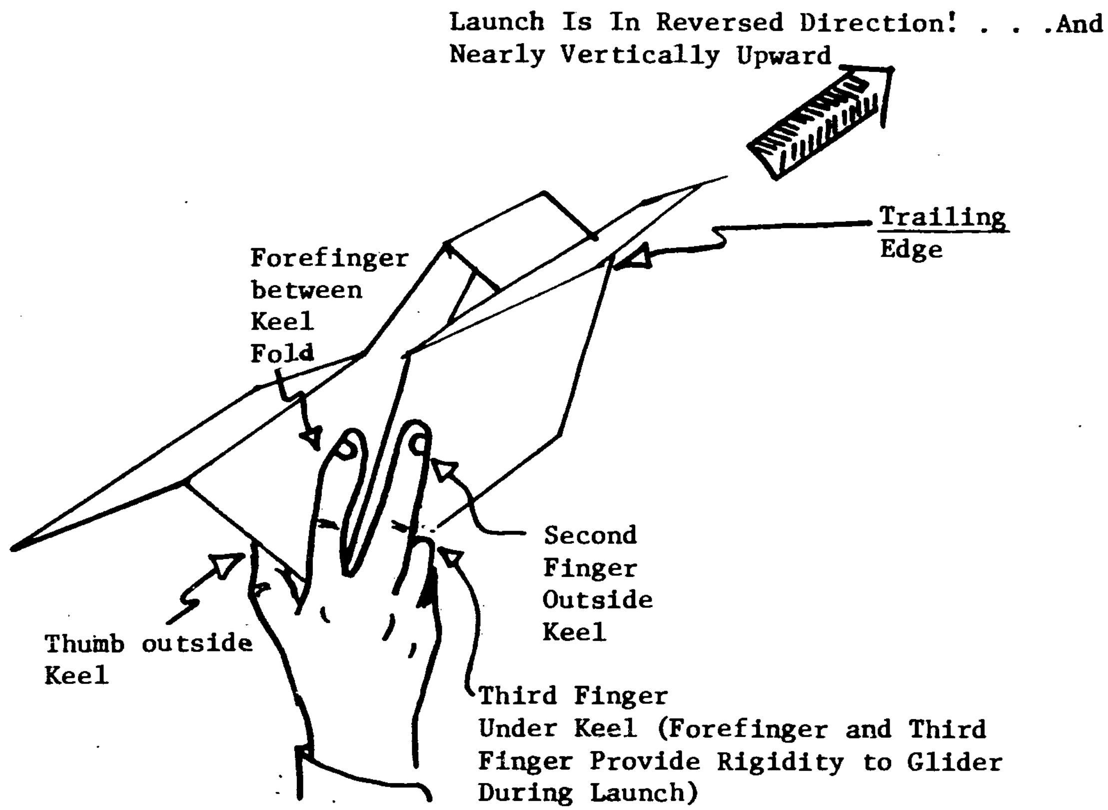


2) Rear-of-Keel Position



3) Center-of-keel Position (obvious from examples (1) and (2), above)

4) Reversed Leading-Edge Position



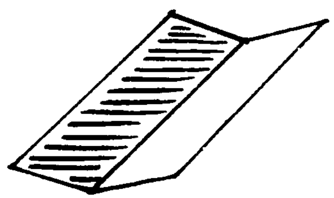
<u>Dart Gliders</u>. Someone in class can show you how to make a "dart" glider. There are many variations of these pointed gliders, whose flight path is more often than not more like that of a rock with wings or of an arrow in flight.

TO DO: Try improving upon a simple dart glider by

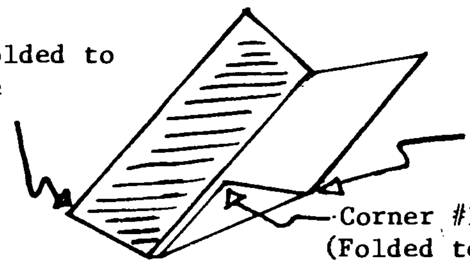
1) adding control surfaces

2) trying varied weight distributions.

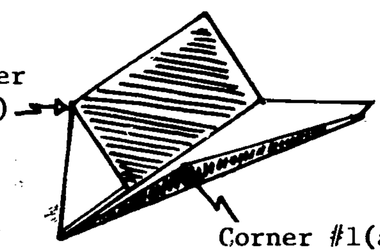
One kind of simple dart glider's construction is shown below.



Step #1
Crease the paper lengthwise

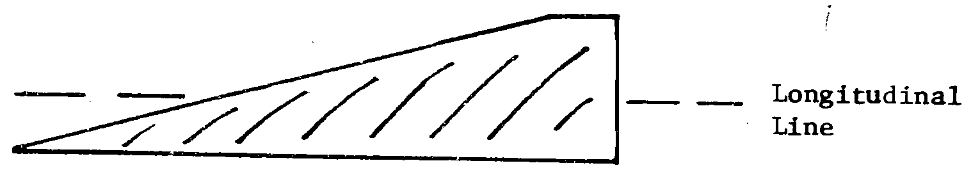


Step #2
Fold two corners into the center line

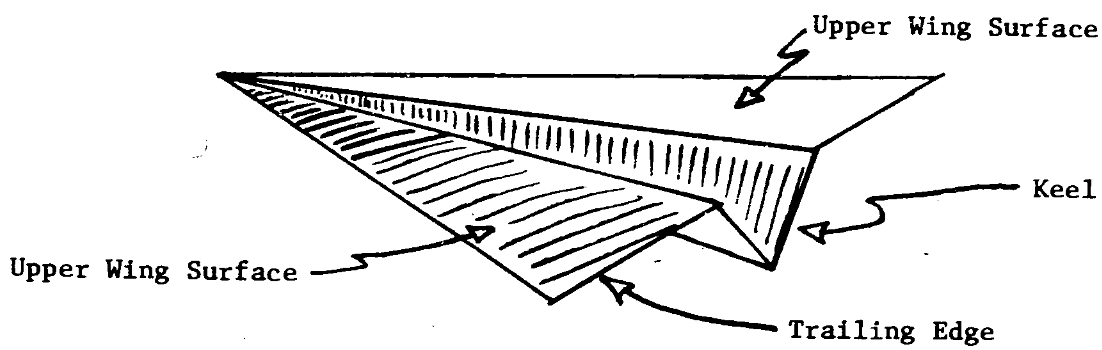


Step #3
Fold the newly-formed corners #1(a) and #2(a) into the center line

The dart glider now looks like this from the side:



Step #4
Fold each wing
along a longitudinal
line (as shown above) to
form the keel and two wings



DART GLIDER

Other Glider Designs. There are numerous kinds and styles of paper gliders. An excellent source of paper glider construction is the paperback by Barnaby, How To Make And Fly Paper Airplanes, Scholastic Book Services - Scholastic Magazines, Inc., New York, New York, 1969 (60¢). Other references are Olson's The Executive Manual On the Construction of Paper Projectiles, or, How To Build Paper Airplanes At the Office, Pisani Press, 485 Brannan Street, San Francisco, California, 1966, and Edmund Scientific Company's book based upon Scientific American Magazine's international paper airplane competition. This last paperback includes construction plans of all the winning entries, time-aloft records, photos, technical data, commentaries, and twenty (20) unusual designs on perforated pages for tear-out and easy construction ($2.95, post paid, Edmund Scientific Company, 300 EDSCORD Building, Barrington, New Jersey, 08007).

Finale. This Resource Package ends with paper airplane competition projects. The prizes and/or Honorable Mentions are to be arranged by your instructor. Here are some suggestions for classes of competition:

1) Farthest distance

2) Longest time aloft

3) Acrobatics

   a) Contestant declares in advance the intended manuever: loop, circle, double circle, S-turn, etc.

4) Cross Country

   a) A course is laid out.

   b) Course "airports" are circles drawn at each landing site and laid out in a designated sequence.

c) A contestant "flies" the course sequentially, landing the glider <u>inside</u> the first-sequenced circle (airport) before proceeding to the next circle. Contestants <u>may</u> make as many flights as necessary between circles, but must launch the plane each time from its previous landing site.

d) The winner is the contestant who "flies" the course with the least number of launches.

5) Most Unusual Design

6) Greatest Number Of Different Designs By One Contestant

7) Most Esthetic Design

a) Color

b) Paint

c) Pilots, wheels, etc.

d) Other "fancy stuff"

RESOURCE PACKAGE 1-4

BUILDING A SUPER-SIMPLE ANALOG COMPUTER

There exists an aura (a cloud) of mystery about the giant mechanical brains called computers. Some people even fear that computers will eventually dominate mankind, take over the earth, and make Homo sapiens their slaves.

Most of the mystery of computers comes from the roles given them in motion pictures, television releases, and science fiction articles. And a part of this mystery arises from the erroneous belief that only a genius can build and operate a computer; therefore, only a genius can understand how one works.

Tools of Mankind. Computer are not "brains." If anything they are "zombies" doing exactly what they are told to do. Computers are fast. They can perform in seconds or minutes calculations which would take mathematicians years and years to complete. But computers can only do the very same calculations a person could do with pencil and paper, if the person were willing to take long enough (or could live long enough!).

Why Use Computers? Computers make it possible to solve problems which before were impractical because of the staggering calculating time and/or expense required for their solutions. While computers cost more per hour than do workers (up to $700 per hour as compared to, say, $5.00 per hour) they cost very much less per calculation. A calculation which would cost one dollar on a high speed computer might cost several thousand dollars if done manually.

As in any technical application, the right machine must be used for the right job. You don't use a bulldozer to plant petunias. Computers range in size from simple fifty-cent slide rules to giant sophisticated calculating machines costing up to $10,000,000.

Some Types of Computers. The analog computer performs a calculation by measuring a physical process which is analogous to ("likened to") the mathematical process of the calculation being performed. For example, if we want to know how fast a motor shaft is turning we could count the number of turns in a given time interval and then divide the number of turns by the time for that interval; or we could indirectly read the shaft speed by the analogy of measuring the voltage from a small generator attached to the shaft, since the voltage generated is proportional to the shaft speed.

The digital computer performs calculations by representing digits ("single" numbers) in some physical manner such as a position on a wheel, the "on" or "off" of a certain light or switch, and then combining these numbers through mechanical, electrical, or electronic circuits. Consider how a digital computer would handle the previous example of a turning shaft. We would number the cogs on a wheel and connect it (gear it) to the shaft; the cogged wheel would be connected to a timing device. After a given time interval, the number on the final cog would show the number of turns in that time interval, or the speed of the shaft.

Which computer is better, analog or digital? Actually, there is a great deal of overlap in capabilities of these two computer types, so one will serve just as well as the other for many applications. Naturally, the particular job to be done must be considered. Usually an analog is faster but less precise than a digital machine of the same size. The digital computer can usually be used for a wider variety of calculations, while the analog computer tends to be used for special purposes. Sometimes analog and digital computers are linked to form a hybrid computer, thus providing the advantages of both types in a single installation.

Super-Simple Analog Computer. There are many, many types of calculations where extreme accuracy and precision are just not important, but where hand calculation requires an excessive amount of time. For example, if we wish to estimate the floor area of a room and our only measuring instrument is a piece of wood one foot long (no inch markings), we could precisely measure how many whole wood lengths exist in any of the room dimensions but we would have to guess (estimate) the fraction of a foot necessary to complete a measurement (unless the room dimension turned out to be precisely measurable in whole feet, with no inches required). Then we would multiply these numbers together to get the area. Assume that one side measured 12 feet, plus a "guessed" ¼-foot additional; and, assume another measured 11 feet, plus a "guessed" ½-foot added on. To find the area we would multiply 12.25 ft by 11.50 ft and obtain 140.975 square feet, which is significant as 141 squares whose sides consist of foot-long wood lengths.

Now if we have a whole building full of rooms to estimate, it would be a big job to calculate these room areas. But it is relatively easy to use a slide rule to multiply the two numbers necessary for area. In our previous room example it would be easy to get a slide rule accuracy of 141 square feet, which is just about as good (precision-wise) as if we multiplied longhand and it certainly takes a lot less time!

In such cases as our room example, the use of the slide rule is justified for estimating the area. Remember that a slide rule will give a fast approximate answer. We have sacrificed precision for speed and in many, many practical cases this is not only justifiable, it is preferable!

The slide rule is a super-simple analog computer. We use marks on the rule to represent the length and width of a room.

<u>To Do</u>: Take two yard sticks and arrange them so that the "zero inch" end of one stick is opposite the 13-inch mark of the other. Then opposite the 15-inch mark of the first, read 28 inches on the second. Hey! You have performed the calculation of 13 plus 15 equals 28, by simply adding lengths of two rulers. You have made a <u>linear</u> slide rule, a simple-minded analog computer.

With the inch scales on the yard sticks, you can add any numbers whose total is 36 inches or less. This slide rule (one rule <u>slides</u> alongside the other for addition) is really no great achievement, since it is easier to add 13 and 15 in your head than it is to lay out the yard sticks. So you can readily see why <u>adding</u> slide rules are not in common use.

Multiplication and division are not as easily done in most heads, so let's see if you can make a slide rule to multiply numbers. The easy way to do this is to change to another set of number scales. Put three equally spaced marks on one stick, and then put three equally spaced marks on another stick (Use paper, if you don't have sticks). Label the first mark 1, the second 10, and the third 100; then see that if 1 on the first stick is placed opposite 10 on the second stick, the <u>10 on the first</u> is opposite <u>100 on the second</u>. You have successfully calculated "10 x 10 = 100" by adding the lengths of these scales. It is possible, but a whole lot of work, to fill in the other numbers from 1 to 100 on each scale so you can multiply any of the numbers together by adding lengths. This is a multiplying slide rule and it can be used for obtaining approximate answers.

If, instead of <u>adding</u> two lengths together to multiply, you <u>subtract</u> one length from the other you will perform a division operation. Division is done with the same scales as multiplication.

Now construct an honest-to-goodness, ordinary, everyday garden-variety kind of slide rule. Such slide rules do not use <u>linear</u> scales, they use <u>logarithmic</u> scales. Unlike a linear scale having equal distances between each unit mark, logarithmic scales have different distances between unit marks. In other words, the scale distance between the 1 and 2-unit marks is <u>much</u> greater than the distance between the 8 and 9-unit marks.

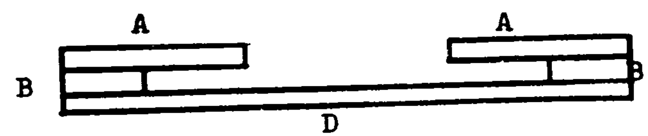
A) Assemble these materials:

8" x 11" piece of cardboard
Sheet of 4 cycle semi-log graph paper

B) Examine the sample components furnished your instructor. Then from the piece of cardboard cut the following pieces; you can refer to your instructor's sample pieces as guides:

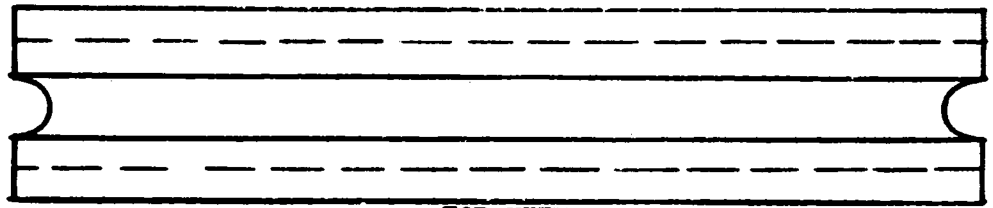
2 pieces 1" x 11" - designated "A"
2 pieces ½" x 11" - designated "B"
1 piece 2" x 11" - designated "C"
1 piece 3" x 11" - designated "D"

C) Assemble pieces "A", "B" and "D" as shown in the sketch below. Preferably, fasten the pieces together with glue, although a stapler can be used.



END VIEW

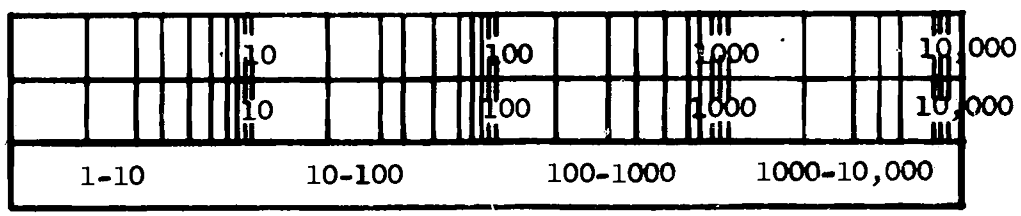
Cut a circular section out of each end of Piece "D".



TOP VIEW

D) Piece "C" now fits into the slots formed by Pieces "A", "B" and "D".

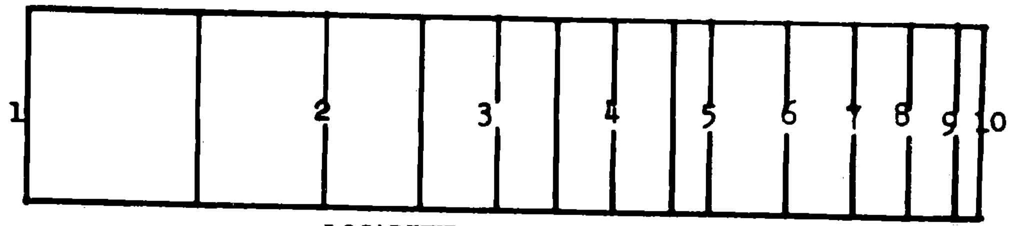
E) Refer to your instructor's sample components. Then, from the semi-log paper, cut one strip 1" wide and glue it to one of the pieces designated "A". Cut another strip 2" wide from the semi-log paper and glue to Piece "C". The assembled slide rule should appear like this (after you have placed numbers on in pen or pencil):



NUMBER SCALES
(Super-Simple Analog Computer)

F) To complete your rule, use a pen or pencil to put on the numerical subdivisions desired. Your teacher will furnish professional slide rules for your examination and guidance. One semi-log paper section is designated below as a guide. Each section is to be numbered in a similar fashion.

Each successive subdivision represents a multiplication by ten over the preceding section; i.e., 3 in the first subdivision represents 3; 3 in the second subdivision represents 30; 3 in the fourth subdivision represents 3,000. These are logarithmic scales!



LOGARITHMIC SCALE

G) Ask your instructor to demonstrate simple multiplication and division for you. Practice a little, just for the fun of it. If you get to taking all this seriously, "hang loose" for now and then sign up later for the "Metric System and Slide Rule Minicourse."

RESOURCE PACKAGE 1-5

BAG OF TRICKS

Ask your instructor to show you his bag of physics tricks! These tricks will likely be spread out over several days, and you may be assigned activities related to them.

In addition to the teacher's bag of tricks, here are some just for you. You can add these to your own bag of physics tricks, which will startle your friends, make you much in demand at parties, and likely change your social life forever and ever!! Each trick will be briefly described and/or sketched. Choose those which appeal to you; obtain the necessary materials from your instructor; and start "tricking."

<u>Keep a record</u> of the physics tricks you try; submit this record to your teacher at the close of this introductory minicourse. The record should include your observations, sketches, and related comments; and be sure to let your instructor know your perceptions of each trick in terms of:

1) Didn't work well

2) "Fun" trick

3) "Bummer" trick (Dirty trick?)

4) Too difficult

The tricks are as follows:

1) <u>The Burning-Glass Trick</u>:

A) Take a coverging lens into the sunlight and focus it. Record its focal length. Use a background of white paper and look for sunspots in the image focused on the paper. DON'T LOOK UP INTO THE SUN!

Paint a dark spot on a piece of paper. Focus the lens to a point, and time the interval between first focus and first smoke! Do the same for a white spot. Compare these time intervals.

Focus the lens so that you can see an image of some object. Describe this image.

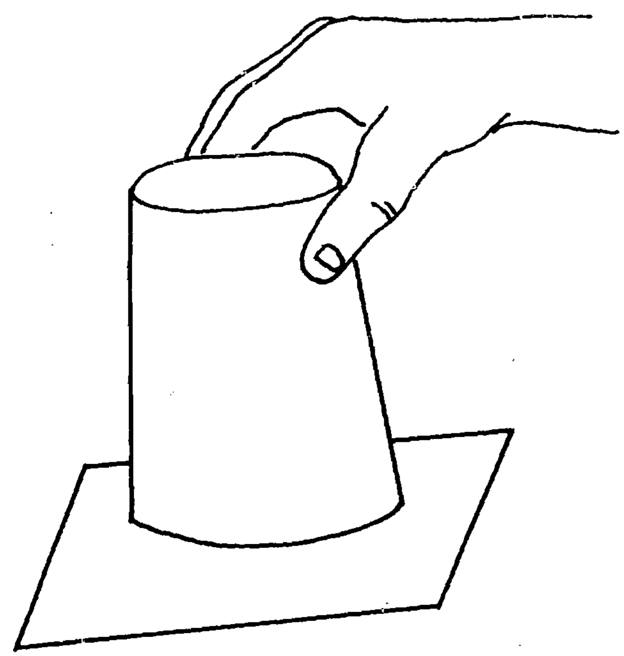
#2) The Old Boiling-Water-In-A-Paper-Cup Trick:

Fill a paper cup with water. Place it over a flame (Bunsen burner, etc.). Keep the flame fairly low; the water will boil and the cup will not burn!

#3) The Air-Pressure-Is-Incredible Trick:

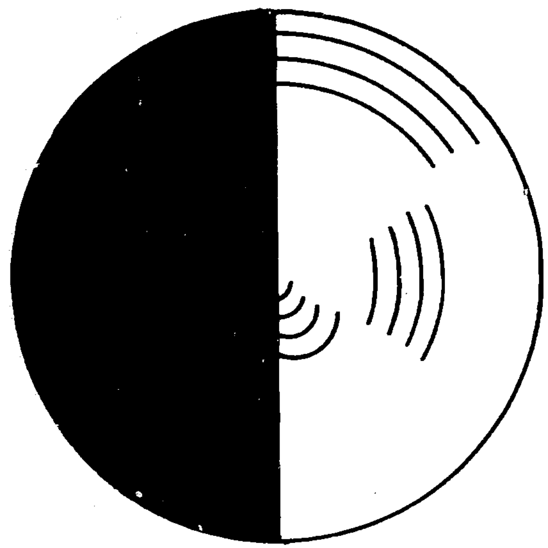
Fill a glass with water. Cover the glass with a thin piece of cardboard. Hold the assembly over a sink and turn it upside down. Remove the hand holding the cardboard.

With a little practice and proper materials, the water will not spill from the glass:



#4) <u>The Magic-Color-Wheel Trick:</u>

Trace the drawing below onto a cardboard or wooden sheet. Cut out the circular pattern and mount it on something which will spin. If you can't come up with a "spinner" device, simply stick a nail or large pin through its center and then spin it by hand.



First, spin the color wheel clockwise and look at its rim area, then its middle area, then its central area.

Which color predominates in each area?

Next, spin the wheel counter-clockwise and determine which color predominates in each of the three areas.

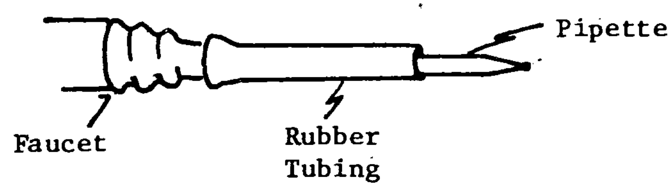
#5) <u>The Electric Attraction-Repulsion Trick:</u>

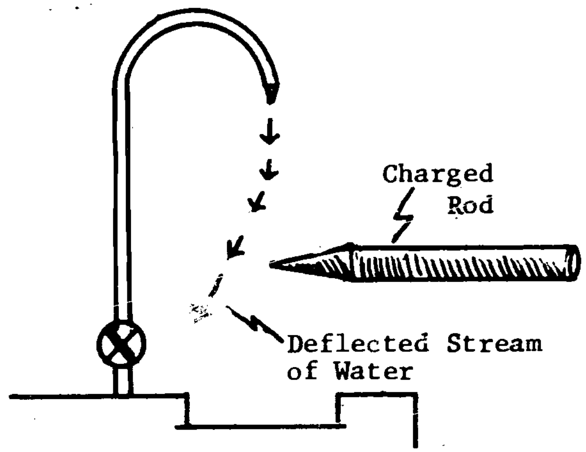
This one works best on a cold, dry day (It may not even work on a hot, humid day!). Adjust a laboratory faucet until a small, continuous stream of water flows into the sink. If necessary, attach a piece of rubber tubing and a pipette (or other small-bore nozzle) onto the faucet outlet.

Briskly rub a glass rod with a silk cloth and bring its tip quickly near the tiny water jet.

Next, repeat the process with a rubber rod and fur.

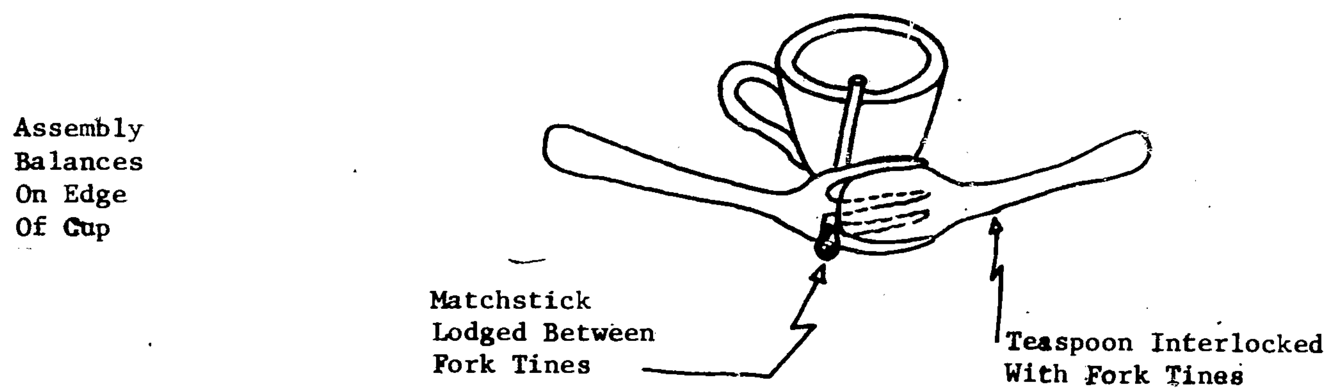
Experiment with other materials, especially plastics.



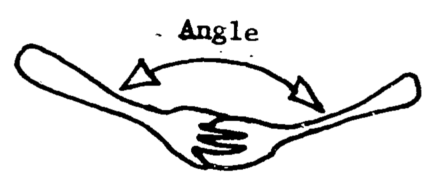


#6) <u>The Great-Balance (Equilibrium) Trick:</u>

Arrange a fork, a teaspoon, and a wooden matchstick (or equivalent) as shown. This is a tricky looking, stable configuration which appears to <u>defy gravity</u>. Actually, the gravity effect is what makes it so stable!

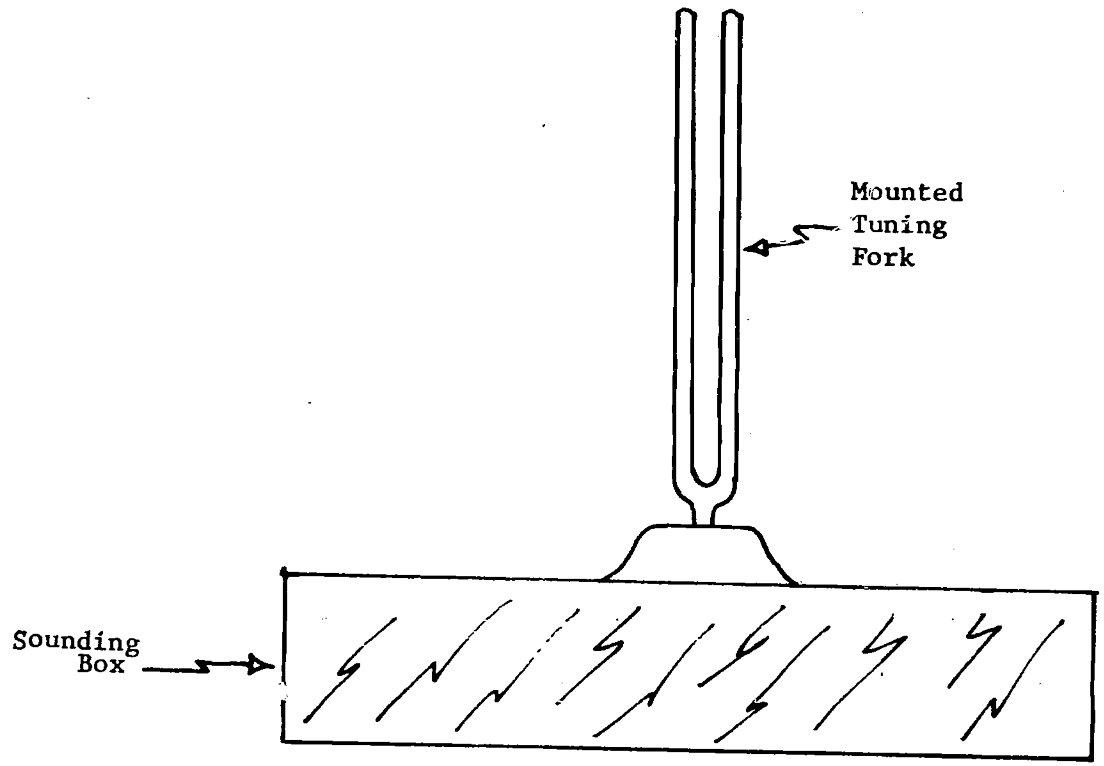


The angle between the fork and spoon affects the balance properties; the same applies for the length and angle of the matchstick.



#7) <u>Tuning Fork Tricks</u>:

Sound a tuning fork with sounding box, by striking it with the rubber hammer called a <u>sounding mallet</u>. With the fork sounding, walk at a constant pace toward a flat, smooth wall. Listen for changes in <u>intensity</u> (loudness). Can you detect a marked increase in loudness at certain intervals?



Select two tuning forks of slightly different frequencies. Sound them, and simultaneously hold one near each ear. Then repeat this procedure exactly, except this time hold both forks near the same ear. You should be able to hear louder, pulsating sounds at regular intervals. These are called <u>beats</u>.

Sound a tuning fork and place its tip on the surface of some water. Can you see that sound is generated by a vibrating body (The tuning fork emitted no sound when it was at rest before being struck)?

Sound the fork and sounding box. Strobe the tuning fork. Are you convinced that it is a vibrating body?

#8) The Old How-The-Rainmaker-Seeds-Clouds Trick:

Get it together as follows:

salt and water solution
atomizer
glass microscope slide
microscope

Spray some solution onto the slide. The water will evaporate and small salt crystals will be left on the glass. You can speed up this evaporation by heating and/or placing the slide in a moving stream of dry air.

Place the slide under a microscope and locate some small crystals.

Blow a cloud onto these crystals by

a) leaving the slide untouched

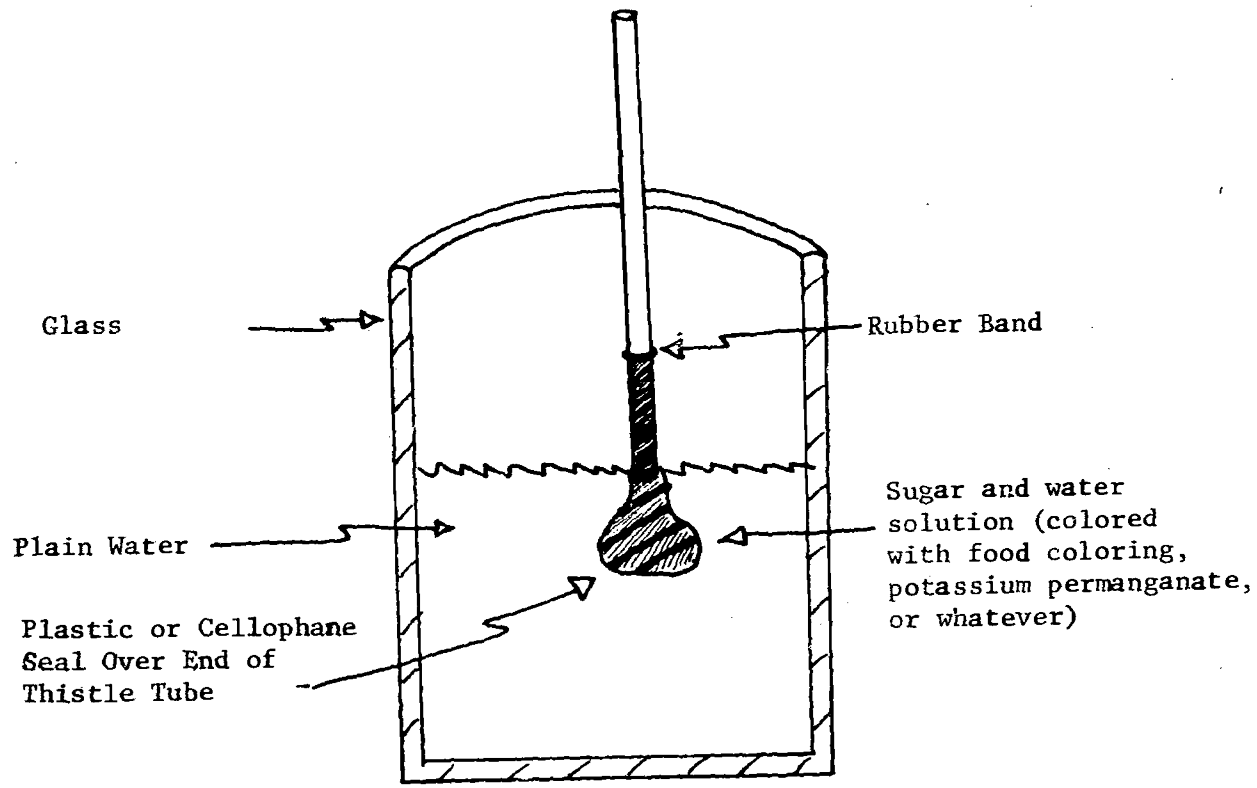
b) using the warm, moist air exhaled as your breath (you are not full of hot air, you're full of hot, moist air!)

Look through the microscope and watch for water molecules condensing on the salt crystals. You should be able to see the drops grow in size.

You have observed the principle of cloud seeding, where iodine crystals (silver iodide) are dispensed into clouds and these crystals serve as condensation nuclei (centers) for rain drop growth.

#9) Sweet Tricks:

Arrange a thistle tube and glass vessel as shown. A colored sugar-and-water solution is contained inside the thistle tube by means of a cellophane or plastic wrapping (semi-permeable membrane). A rubber band marks the level of sugar-and-water solution initially in the thistle tube.



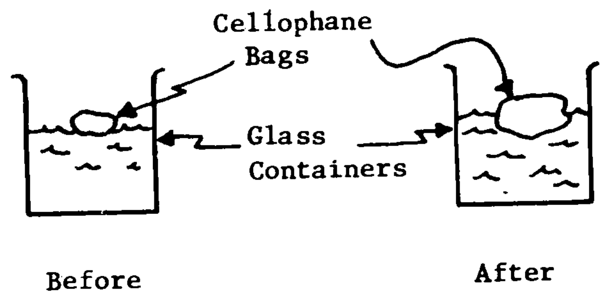
Periodically examine the fluid level in the thistle tube. If the level rises, one must conclude that the water molecules somehow move in one direction; namely, from outside the cellophane seal into the thistle tube. This phenomenon is called <u>osmosis</u>.

Now partially fill a cellophane bag (certain plastic bags will do) with a non-colored sugar-and-water solution.

Place the partially-filled bag into a glass container. Add plain water to the container. Periodically check the appearance of the bag.

The bag should grow in size. Again, osmosis is the phenomenon responsible for this trick!

Repeat the above procedure, except this time use a salt-and-water solution. Are the results comparable?



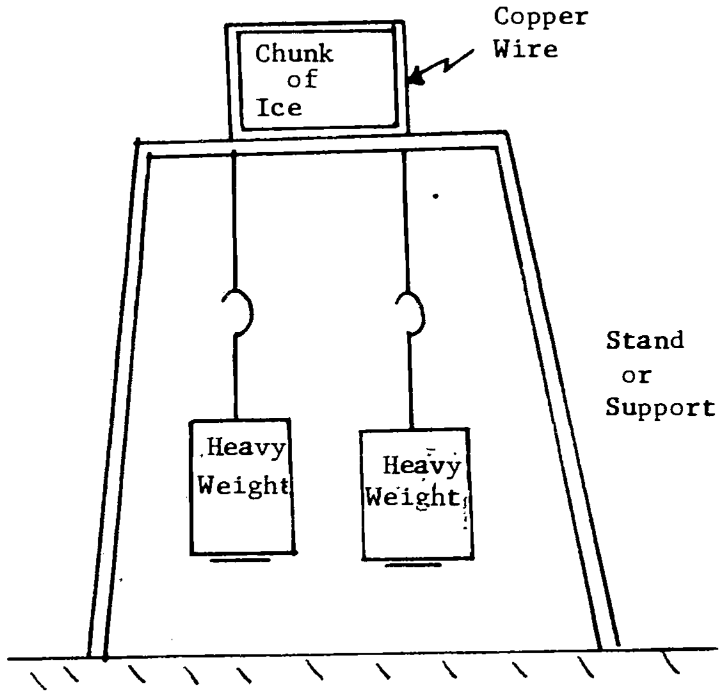
#10) The Old I'm-Cutting-An-Ice-Cube-In-Half-To-Get-One-Cube Trick:

This one works best in a large refrigerator, a walk-in cold box, or outdoors on a cold day. It will also work indoors most anytime; but if melting ice is messy, then this one gets messy.

Arrange the equipment as shown. Use a larger block of ice indoors; you can get by with smaller chunks wherever melting is no problem.

The copper wire will cut completely through the ice, yet the ice will not be in two pieces (It will re-freeze behind the wire!).

Be sure to use copper wire, preferably of small diameter. You can reduce melting by insulating with sawdust, cloths, etc.



This phenomenon of melting under pressure is called <u>regelation</u>. It is responsible for the molecules of liquid water on which ice skaters glide! Yes, the knife edge of a skate instantly melts the ice as the skate passes; the ice instantly re-freezes once the pressure is removed.

Congratulations! You have completed this introductory course. Please turn in your notes and sketches to your instructor, so that you two can discuss them. At the same time, you should decide upon a tentative selection of minicourses which will constitute your physics study for the year.