SCIENCE IN ACTION

M. A. PARASNIS

BOOK 2

PREFACE

Doing an experiment is fun
And is the best way to learn

The series 'Science in Action' is written specially to help children in the age group eight to thirteen years to have first hand experience in science. It is designed so as to help the classroom teacher make the learning of science an enjoyable and rewarding experience for herself/himself as well as for her/his class. Interested parents could also easily use the series to help their children to do science at home. Enthusiastic children could even use it on their own at home and school.

The series consists of five books: Book I for class four (age 8-9 years), Book II for class five (age 9-10 years), Book III for class six (age 10-11 years), Book IV for class seven (age 11-12 years) and Book V for class eight (age 12-13 years). It is not designed to cover the syllabus of any particular school system or state but, rather, to uncover a little part of the fascinating world of science, taking into consideration the average mental and physical capabilities of the respective age groups.

Essentially these are books of science activities. These typical activities, selected from various areas of science, use *readily available* and *Inexpensive materials* like jam and milk bottles, coffee tins, paper cartons, thread, string, wire, paper clips and pins, rubber bands, balloons, drinking straws, etc. Many classic experiments, described in text books unchanged for generations, have been performed more interestingly and instructively. Many more have been added. Each activity has been tried and tested out, so to say, in the *field.* They all involve experimentation resulting in experience with important scientific principles. The involvement is qualitative and thus maintains a high level of interest.

These books are the culmination of a decade of involvement in school education (on the campus of the Indian Institute of Technology Kanpur) into which I was initiated and inducted by the Institute's first Director, Dr P K Kelkar. It was his faith in the tremendous potential of children and his keen insight into the way they learn which 1 made him start a school on the campus under IIT/K Administration. The School had complete freedom to try out new methods in teaching and learning. It was at the IIT/K Campus School that many of the seeds of the present series were sown. It was the encouraging response from children and teachers of that school that gave me the enthusiasm to complete the work.

Thanks are due to the Education Development Centre, IIT/K, funded by NCSE/NCERT, for grants which have supported this venture and have made it possible for each and every activity in this series to be actually tested out.

For books such as these good illustrations are essential. They save many words of description and are a special attraction for the children. I would like to record my appreciation for the patient and painstaking work done on illustrations by Mr. A C Joshi of the Department of Electrical Engineering, IIT, Kanpur.

My husband, Dr Arawind S Parasnis, Professor of Physics, IIT, Kanpur, has read the manuscript critically and made innumerable valuable suggestions. He and my sons, Kaushik and Gautam, have provided that understanding cooperation without which I could not have enjoyed writing the series. My sons were often the guinea pigs for testing out these activities.

The series is dedicated to children—the mini-scientists—and their teachers. If you have enjoyed the books, do let me know along with corrections and comments, if any.

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INTRODUCTION

Science today plays a significant and ever-increasing role in the social and economic life of ordinary man. The impact of scientific and technological progress not only has permeated urban and suburban life but also is fast penetrating into remote villages. New varieties of seeds, the tractor, the transistor radio and the antibiotics have reached the farthest corners of our country. Many villages have been electrified. Satellite Instruction Television Experiment (SITE) has already taken television to a number of villages. Training in science is essential to the improvement of health and living conditions of our people and to the promotion of agriculture and industry. It is, therefore, increasingly important for everybody to be literate in science. This need embraces all age-levels, alt socio-economic levels and all intelligence levels. However, it is for the children of today, the arbiters of our fate tomorrow, that the need is the greatest. Unless we give our children scientific schooling we cannot hope for a bright future for our country.

Till very recently, no one studied science unless one entered middle/high school. Some schools did teach a few lessons about birds and flowers. All that was available was a few books of nature stories and study.

Since Independence the field of science education has undergone a big change. Most of the changes stem from a dual attempt. First, there has been an increase in the quantity of subject matter taught. Second, there has been an attempt at re-establishing the class levels at which various topics would be taught: a part of what was done in high school is now sought to be done in the middle school and, in the same way, a part of what was done in the middle school is sought to be handed over to the primary school.

However, students are doing more reading in science. They are reading about science but not doing science. This is like attempting to teach a person to swim by having him read the best books on swimming rather than plunge into water.

In short, the science programme in our schools is still around the text books. Science is viewed by teachers (and consequently by children) as a body of facts and a set of answers, absolute and immutable, which explain the universe. Often these explanations come in the form of one word or phrase taught by the teacher and learnt by heart by the taught. When a phenomenon is demonstrated, the children simply associate the questions about the phenomenon with the word or phrase without understanding conceptually the interactions involved. Natural phenomena are used not as stimuli to regenerative thinking and to the spirit of discovery but merely as examples of or adjuncts to facts already presented. Thus a bug floating on water is an example of surface tension. A ship, though made of steel, floating on the sea is an example of Archimedes' principle. The horse pulling the cart and the cart pulling the horse is an example of Newton's law of reaction. Can we blame the child?

This inevitably helps erect a barrier between the child and science. This barrier must be broken. When such barriers are broken science becomes not only interesting but also a part of the child's thinking. This requires a child's active involvement in his own learning. Experimenting is an excellent chance to stimulate thinking. There is joy and excitement in working with one's own hands for man is basically a builder. Children need to work with their own hands and talk and argue about their work. They should get involved with science and discover its principles for themselves. As far as possible, even demonstrations by teachers should give place to investigations by children. Children should work like little scientists busy exploring the rich world around them. It was a very wise Chinese sage who said

I hear and I forget

I see and I remember

I do and I understand

Performing experiments and learning to make close observations requires some facilities. These are lacking in most of the schools of our country—especially at the primary and middle school levels. As a result, science teaching (if it is attempted at all) suffers from a severe handicap especially at these levels. It is often believed, though erroneously, that to introduce science experience even in primary and middle schools requires elaborate equipment made by commercial manufacturers and hence needs a big budget.

The series 'Science in Action' is an attempt to use simple, easily *available, low cost materials* to set up experiments which illustrate a large variety of sophisticated scientific principles. For example, experiments are so designed that the child does not need to use wooden planks, hammer and nails; the same work is done by cardboard, bark cork and drawing pins. The experiments are not hard to set up even if you have not done much experimentation before. The series is meant for classes' four to eight and consists of five books. These are essentially books of science activities written in a simple style so as to provide teachers, teachers-in-training and children with a variety of experiments that can be used as teacher-demonstrations, children's class room activities, demonstrations at science fairs, class projects or any related science study. The activities are interesting and instructive in practical and exciting ways.

From this year the 10 + 2 + 3 pattern of education is being introduced and science and work experience courses are compulsory up to class 10. The activities in these books involve both science and work experience. A good deal of the material needed has to be built with tins, cardboard and string. Screw driver, hammer, hacksaw, cork-borers, files and planers have to be used, depending upon the level. The contents of each book can be covered during a one year period by allotting special 'activity periods' during which children will work with their own hands to produce materials with which they will learn science. Book I has 25 very simple activities which could easily be handled by children of class 4 with two periods a week. This could be increased to four periods a week for classes 5 and 6 (Books II and III which have 30 and 40 activities respectively) and six periods a week for classes 7 and 8 (Books IV and V, having 45 and 50 activities respectively). Many concepts have been repeated from book to book so that a concept can grow to a greater degree of sophistication as a child goes to higher classes.

Each activity has five parts:

(i) An attractive title

(ii) Materials: the things and the equipment needed to perform the activity

(iii) Procedure: Step by step utilization of the materials. The expected observation is usually indicated as a part of the procedure

(iv) Drawings and diagrams: for ease of assembling

(v) The 'why' of the activities is given sequentially at the end of each book. This gives scope to the child to think for herself/himself. In case she/he needs help it is readily available. This also acts as a check.

Believing that the method of science should play a significant role in any modern educational scheme, this series is offered in the hope that it will assist science teachers and students in their co-operative quest for science.

FOREWORD

It is a matter of great pleasure and honour to have this opportunity of writing a Foreword to the rather unique series of books entitled 'Science in Action' meant for children below thirteen years of age written by (Mrs) Meera A Parasnis, The time of its publication could not have been more appropriate for there seems to be a new awareness in the country of the need to make science education meaningful from the earliest level of schooling right up to the tenth standard.

Modern technology is revolutionising our entire social structure in a variety of ways. The pace of change poses challenges in every direction. It is possible neither to go back nor to advance in a systematic manner without a proper understanding of the way technological forces affect society. It is necessary to appreciate that if the fruits of technology enter the lives of men; its roots are in science. In this context understanding of science and the scientific method is as necessary for those who are going to be professional scientists as for the rest.

The essential objective of the teaching of science to children must be not so much the imparting of scientific information as creating a lively interest in the scientific method and developing a scientific attitude of mind by actual involvement in "scientific activity". This is precisely what this series of five books makes possible.

In this approach the material expenses involved are very modest, but it draws heavily on the motivation of the teachers and the taught. To observe, to ask questions, to use Imagination, to make intelligent guesses about the possible answers, are all attributes of a lively scientific attitude of mind.

There is little doubt that, if children are exposed to these activities as detailed in these books over a sufficient period of time, they will not only be familiar with the scientific method but will develop a scientific attitude of mind. Children successfully taught in this fashion will in fact begin to show the scientific approach in all their learning.

Mrs Parasnis has taken enormous pains in writing these manuals based on ten years of her direct involvement with children in the age group of 8- 13 yrs, in exposing them to real scientific activity. The material incorporated has been as though tested 'in life' and that is perhaps its greatest merit. In my view, Mrs Parasnis not only deserves congratulations but our gratitude for this timely publication.

If the experiment involved in using these manuals succeeds, as it should, then no time may be lost in making these available in various Indian languages.

P K KELKAR

"Chhaya"

H R. Mahajani Marg

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1 Make a Spirometer and measure your Lung Capacity

Materials

Large glass jar, about 3 litres, with lid Cello tape

Flask 0.5 litre (say, milk bottle)

Glass marking pencil (lipstick or wax crayon works well)

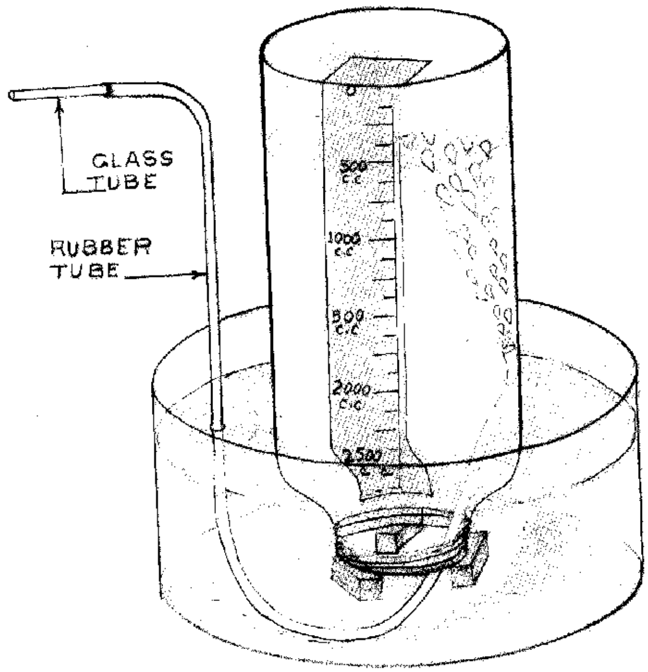
Large Basin (or trough)

Water

Three small wooden blocks

Long rubber tube (burner tubing)

Short glass tube, 8-10 cm in length, to fit in the rubber tube



SPIROMETER

FIGURE 1

TO MAKE THE SPIROMETER

Stick a strip of cello tape from the bottom to the top of a big glass jar on the outside. Using a 500 cc. (0.5 litre) flask, pour into the jar measures of water and mark lines (with glass marking pencil) across the strip to indicate 500 cc, 1000 cc, 1500 cc, etc, till the jar is completely filled with water. Screw the lid on tightly.

Pour some water into a large basin. Invert the jar of water and with the lid on insert the mouth of the jar *under* water. Unscrew the lid carefully and place the mouth on three wooden blocks.

Insert one end of a long rubber tube into the mouth of the jar. Attach the glass tube (mouthpiece) to the other end of the rubber tube.

The spirometer is now ready for use *(Fig I)*.

TO USE THE SPIROMETER

Exhale normally into the mouthpiece. The exhaled air bubbles through the water into the jar displacing an equal amount of water.

Why?

Read the tape marking of the water level and note it down.

This gives the amount of air exhaled with a normal breath.

NOW take a deep breath and exhale into the mouthpiece. Note the new level of water. The difference between the second and the first readings gives you the volume of air exhaled in a deep breath. Is it the same as that in a normal breath?

If not, why?

Compare the air exhaled by different children.

Compare the air exhaled before and after running.

Compare the air exhaled at the beginning of the year with that at the end of the year to check how much bigger your lungs have become.

2 Lift a Tumbler with a Balloon

Materials

Balloon

Tumbler (preferably transparent plastic)

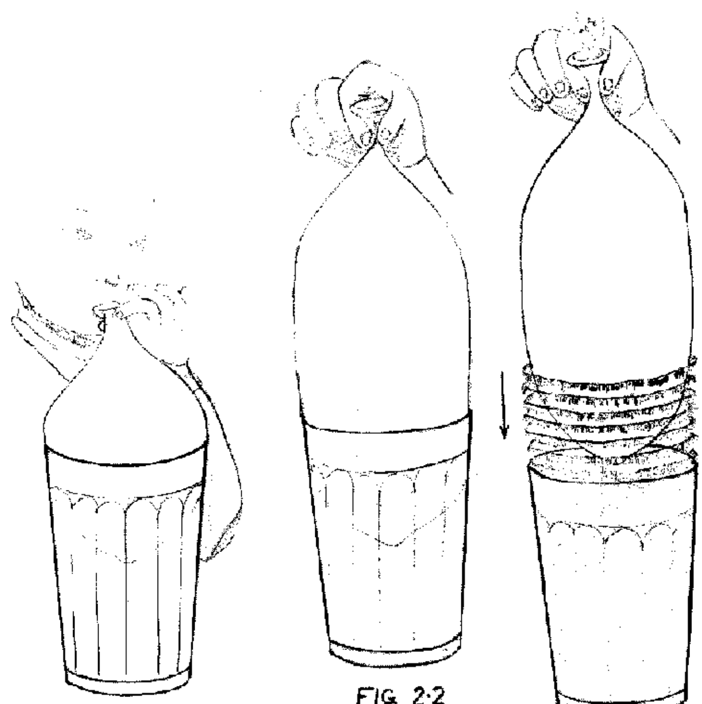


FIG 2·1 FIG 2·2 FIG 2·3

Hold a balloon inside a tumbler. Blow into it well *(Fig 2.1)* and pinch its neck between the thumb and the first finger so that the air does not escape.

Lift the balloon up.

What do you see?

The tumbler is also lifted *(Fig 2.2)*.

Why?

Allow the air to escape slowly.

What happens?

The tumbler falls off *(Fig 2.3)*.

Why?

3 Magic Finger stops Water Flow

Materials

Empty tin with lid (coffee, bournvita or similar)

Sharp thick needle

Water

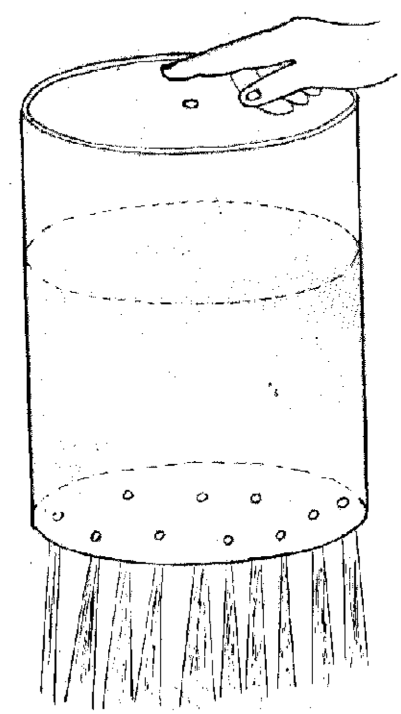


FIG 3·1

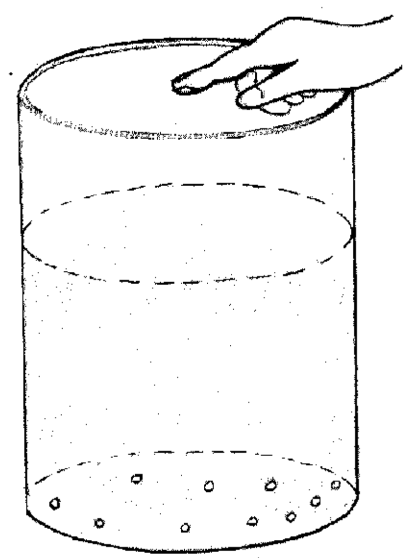


FIG 3·2

With a sharp thick needle, make one hole in the lid of a tin and a number of holes in the bottom of the tin.

Fill the tin with water and put the lid on it.

Hold the tin *up* with one hand.

Water flows out of the bottom holes *(Fig 3.1)*.

Close the hole in the lid *firmly* with the tip of your finger.

The water stops flowing out *(Fig 3.2)*.

Take away your 'magic finger' from the top hole. The water starts flowing out again *(Fig 3.1)*.

Bring your magic finger back on the lid-hole; the water stops flowing *(Fig 3.2)*.

You can control the flow of water by your finger.

Why?

Is there *magic* in your finger?

4 Water Fountain

Materials

Empty bottle (coco cola or squash)

Rubber stopper to fit the bottle

Glass tube

Water

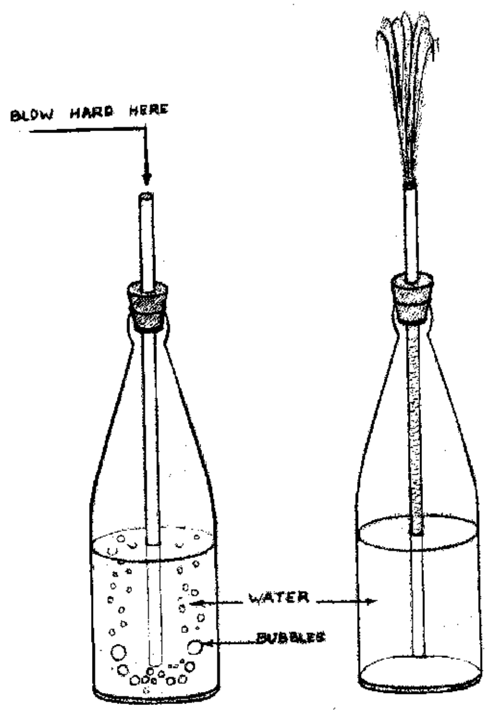


FIG 4·1 FIG 4·2

Take an empty bottle. Find a rubber stopper that fits the bottle well. Make a hole in the stopper so that the glass tube fits into it.

Fill the bottle about *half* with water.

Pass the glass tube through the hole in the rubber stopper and close the bottle *tightly* with the stopper.

Now blow *hard* into the tube. Bubbles of air come out of the bottom of the tube *(Ftg4.l)*.

Blow as hard as you can and move back.

What do you see?

Water shoots out of the tube like a fountain *(Fig 4.2)*.

Why?

Blow again, harder than before. The water now shoots higher.

Why?

5 Glue Tins together without Glue

Materials

Two tins (or glasses or bottles) of the same size

Drawing paper

Scissors

Water

Box of matches

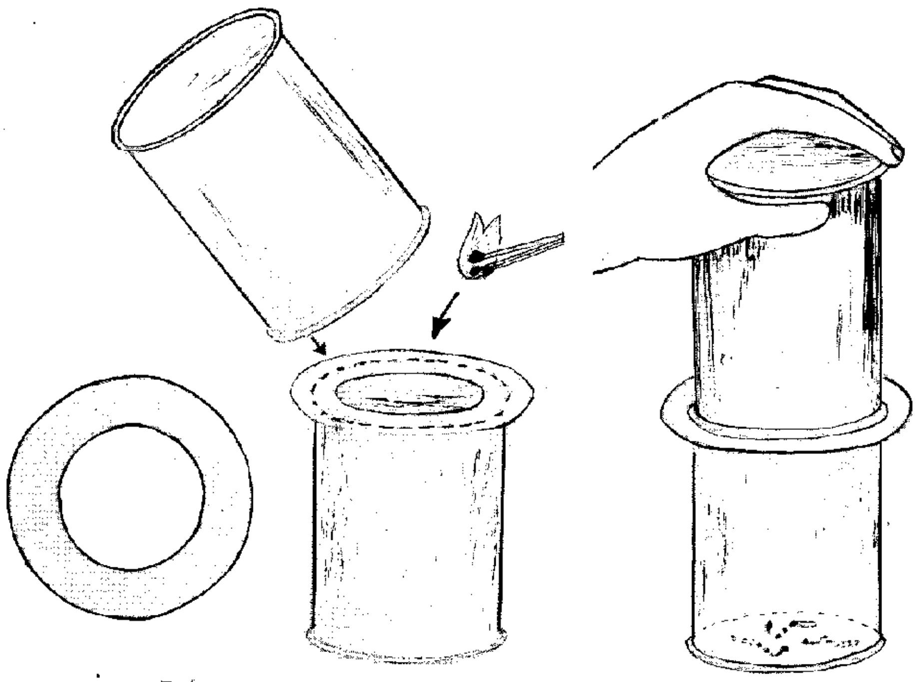


FIG 5·1

FIG 5·2

FIG 5·3

Take two tins of the same size.

Draw two concentric circles on a piece of drawing paper, one with a radius of about I cm greater and the other with a radius I cm smaller than the radius of the mouth of the tins. Cut along the circles *(Fig 5.1).*

Dip this piece in water so that it is nicely wet and place it on the top of one of the tins. Light two or three match sticks and put them inside the tin.

Quickly place the second tin on the first so that the mouths of the two tins are one *above the other* and the paper piece is in between the mouths *(Fig 5.2*).

Soon the matches burn out (stop burning). Now pick up the upper tin.

What do you see?

The lower tin lifts along with the upper! *(Fig* 5.3).

The two tins are *glued together without glue.*

Why?

6 Pin-Fan spins without Blowing

Materials

Metal foil (aluminium or tin) Pencil

Scissors (preferably tin-shears) Nail

Thick wire Candle Box of matches

Cut out from a metal foil a circle of radius 5-6 cm.

Make a small circle (5 mm) around the centre of the circle.

Divide the circle into eight equal parts.

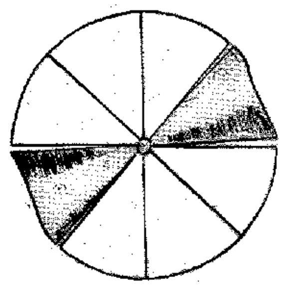


FIG 6·1

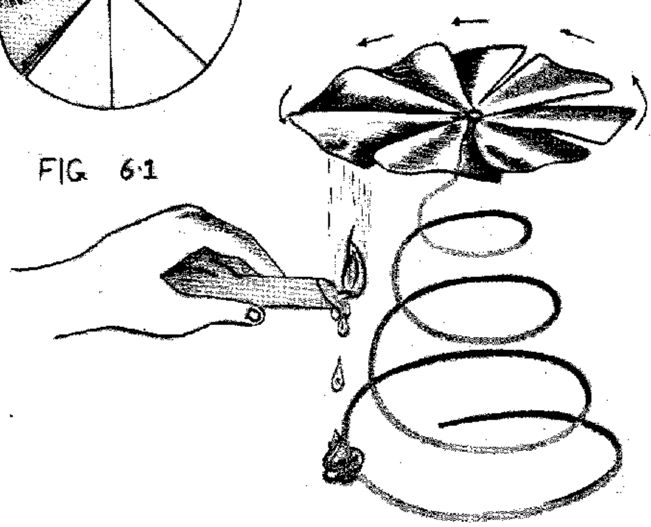


FIG 6·2

Cut along the eight radii from the outer edge to the inner circle. Bend upwards one long edge of each of the eight triangles *(Fig 6.1)*.

With a sharp nail (2.5 cm long) make a *light* dent *exactly* at the centre; do not pierce.

Bend a piece of wire into a spiral. Balance the metal circle on the upper end of the wire *(Fig 6.2*).

Your pin-fan is ready.

Bring a lighted candle under the pin-fan.

What do you see?

The fan *spins* round and round.

Why?

Inside cover of coffee or tea tin works well.

7 Bumping Balls

Materials

Two ping pong balls (or apples or oranges or round balloons)

String

Any horizontal support, e.g. a scale resting on the backs of two chairs

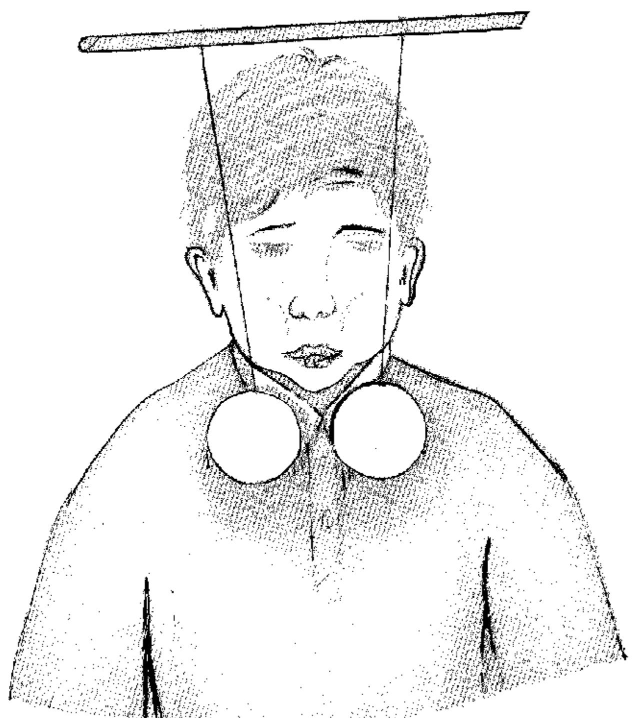


FIGURE 7

Hang by pieces of string the two baits of the same size from the horizontal support.

Adjust the strings so that the balls are at the same height and about 3-4 cm apart.

Blow *hard* between the balls.

What do you expect?

What do you see?

The balls do not move apart but *bump* together *(Fig 7).*

Are you surprised?

Blow harder than before.

The balls now bump with greater force.

Repeat a number of times.

Do you know the reason why this happens?

8 Autogyro

Materials

Piece of paper

Pair of scissors

Two paper clips

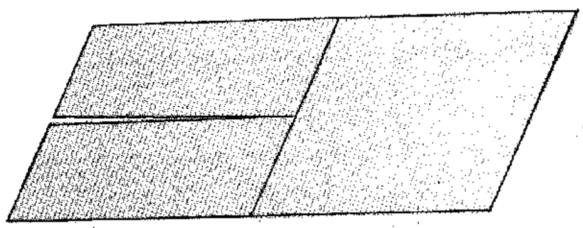


FIG 8·1

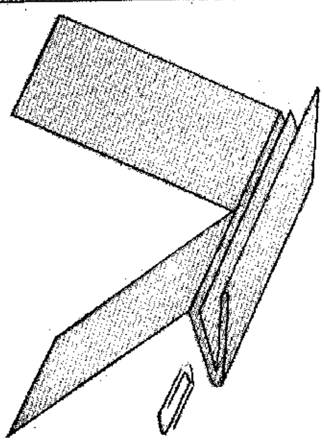


FIG 8·2

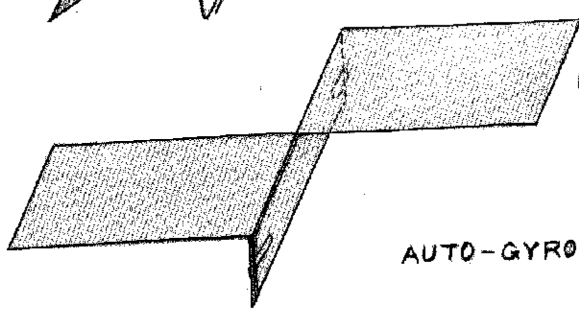


FIG 8·3

AUTO-GYRO

Take a piece of paper 10 cm x 20 cm. Cut the paper in half lengthwise up to 10 cm *(Fig 8.1)*. Fold the two flaps (wings) in opposite direction.

Make 3 or 4 folds in the uncut part and hold the folds together with a paper clip at each end *(Figs 8.2-3)*.

Autogyro is ready.

Stand as high as you can (preferably, in the balcony of a higher floor) and release the autogyro.

What do you observe?

It spins down to a soft landing.

Why?

9 Floating Candle

Materials

Candle

Pins (or nails)

Glass of water

Match box

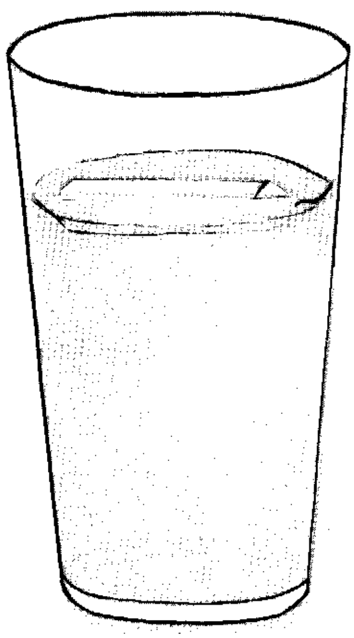


FIG 9.1

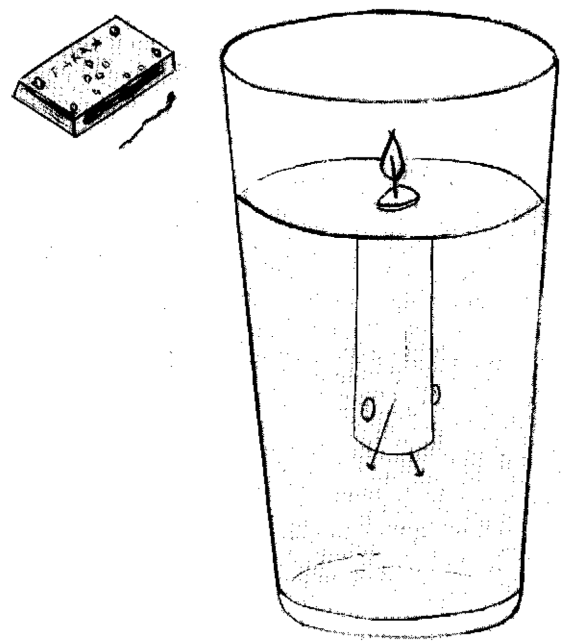


FIG 9.2

Place a candle on the surface of water and watch. The candle floats on its length *(Fig 9.1)*. Why?

Load the lower end of the candle with pins such that the candle will float in water with its top just above the surface of water.

Light the candle. Watch it *(Fig 9.2)*.

The candle continues to float and burn until it is nearly finished.

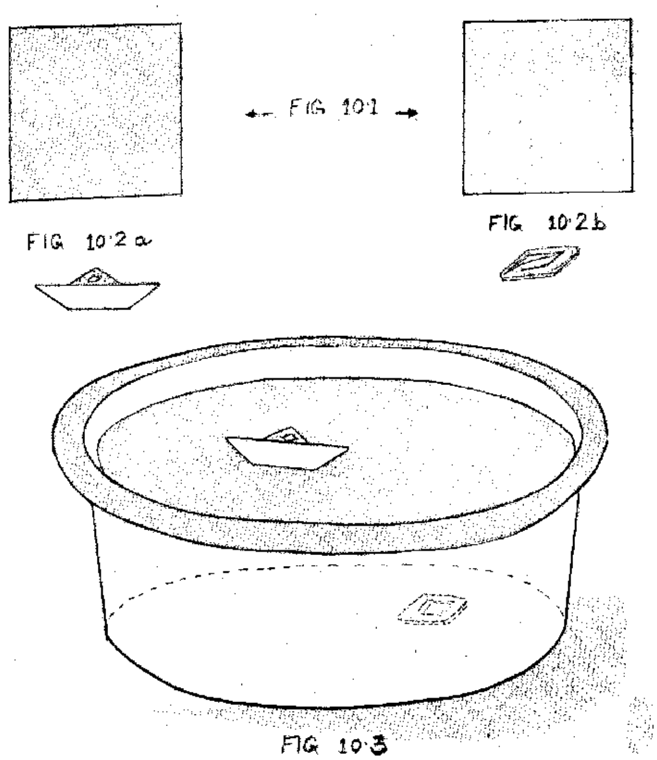
Why?

10 Why Boats Float

Materials

Thin metal foil (aluminium or tin)

Large vessel of water



Cut out two *equal squares* from aluminium foil *(Fig I0.I)*.

Make a boat out of one *(Fig I0.2a)*.

Carefully fold the other into a *tight* disc *(Fig I0.2b)*.

Place both in a large vessel of water.

The *boat floats,* the *disc sinks (Fig 10.3)*.

Why?

Do you now know why ships made of steel are able to float on the sea?

11 Salt Water is more buoyant than Fresh Water

Materials

Two glasses (or wide mouthed jars)

Water

Salt

Pencil

Plasticine

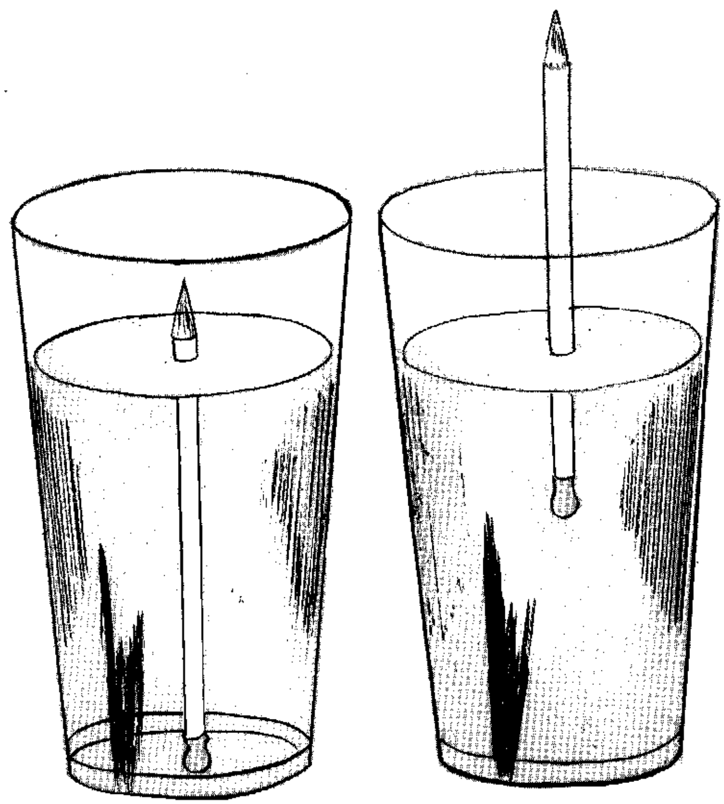


FIG 11·1 FIG 11·2

Fill two glasses about three fourths full with tap water.

Add two or three spoonfuls of salt to one glass and stir so that the salt dissolves completely.

Place a pencil in the glass containing ordinary water. Load the pencil at the bottom with plasticine so that it just sinks vertically *(Fig 11.1)*.

Now shift it to the glass of salt water.

What do you observe?

The pencil *floats* in *salt* water *(Fig 11.2)*.

Why?

Can you now guess why you float more easily in sea-water than in river water?

12 Find Centre of Gravity by trial and error

12 Find Centre of Gravity by trial and error

Materials

Cardboard

Pin (or needle)

Pencil

Stick of soft wood

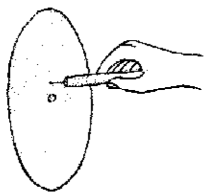


FIG 12·2

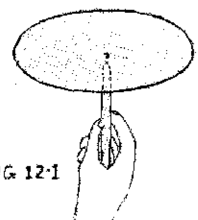


FIG 12·1

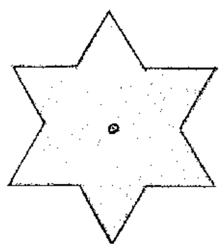


FIG 12·4

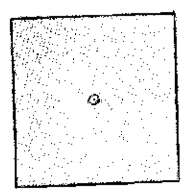


FIG 12·3

FIG 12·6

FIG 12·5

Cut out a circle from a piece of cardboard. Attach a pin to a stick of soft wood.

By *trial and error* find the point at which you can balance this circular disc on a pencil point. This point will be at or near the centre of the circle.

Pass the pin through this point and spin the disc *(Fig 12.1).*

Observe how it turns.

The disc spins *without a jerk* and stops in *any position.*

Why?

Now pass the pin through the cardboard circle 2-3 cm away from the point *(Fig 12.2),*

Spin the disc again. What do you see?

The disc *does not spin* as nicely and stops *always* in the some *position* with the point *directly below* the pin.

Why?

Repeat for a square *(Fig 12.3)*.

a cardboard star *(Fig 12.4)*.

a cardboard car *(Fig 12.5)*.

a cardboard child *(Fig 12.6)*.

The point about which a flat object spins without a jerk is called the centre of gravity of the object.

13 Centre of Gravity remains nearest to the Earth

Materials

Scale

Circular disc (cardboard or metal)

Pencil

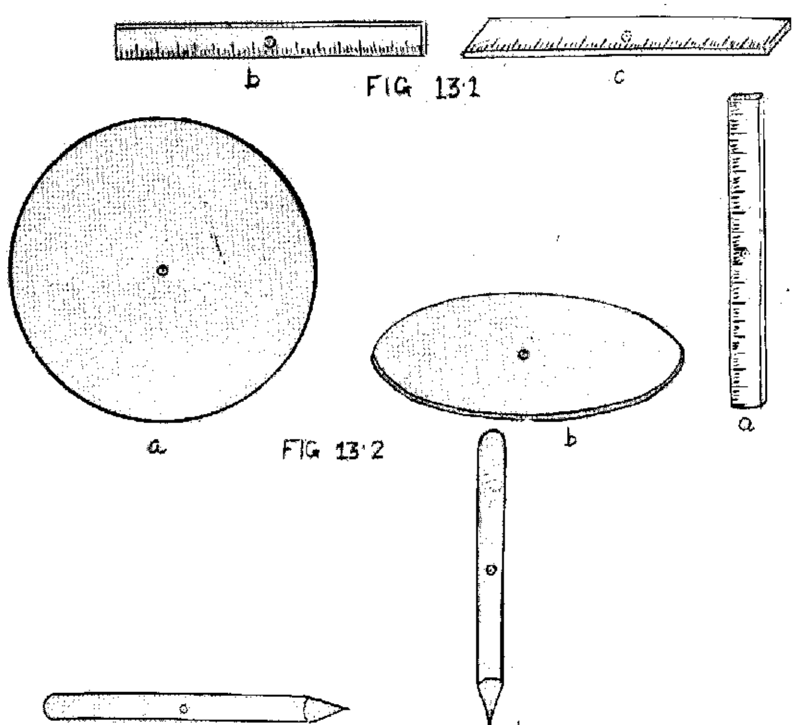


FIG 13·1

FIG 13·2

FIG 13·3

Throw a scale into the air.

How does it usually come to rest on the floor?

Mostly as in *Fig 13.1 c.*

Rarely as in *Fig I3.lb,* but hardly as in *Fig 13.1 a.*

Why?

Drop a circular disc. How does it come to rest on the floor? As in fig/3.2a or /3.2b? As in the latter, does it not?

Why?

Throw a pencil. How does it land? As in Fig *I3.3a* or *13.3b*?

Why?

14 Do Equally Heavy Things fall equally fast in Air?

Material

Aluminium or tin sheet

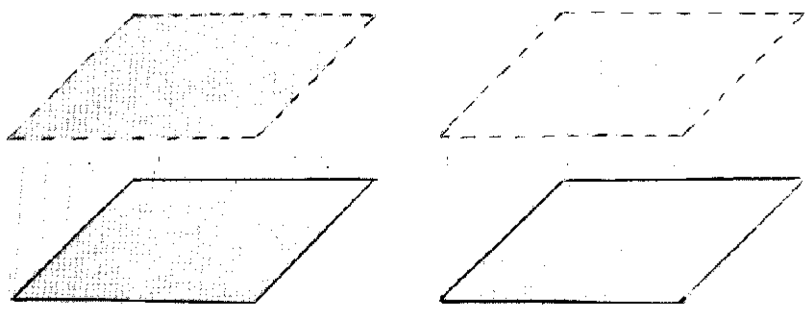


FIG 14.1

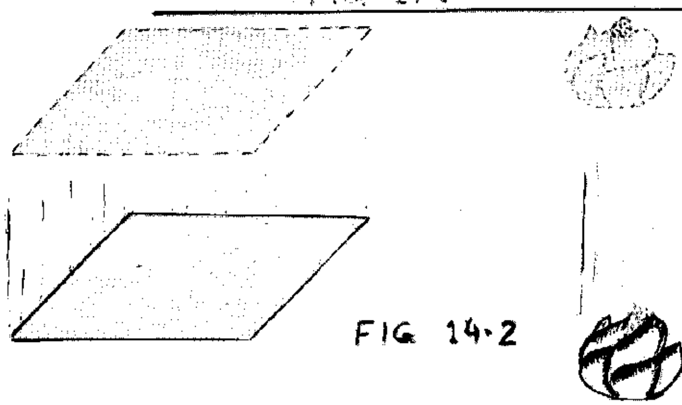


FIG 14.2

Cut out two squares of the same size from aluminium sheet.

Hold the two squares at the same *level* and as *high* as you can. Drop them at the some *time.*

Watch when they hit the ground. Both will hit the ground at almost the same time (Fig *14.1).*

Now, roll one of the squares into a small ball. Leave the other square as it is. Now hold the two at the same *level* and as *high* as possible. Drop them as before *(Fig 14.2*).

Again watch them when they hit the ground.

What do you find?

The small ball hits the ground first.

Why?

Repeat several times.

15 Straw Balance

Materials

Staples

*Empty bottle (or tin)**

Cello tape

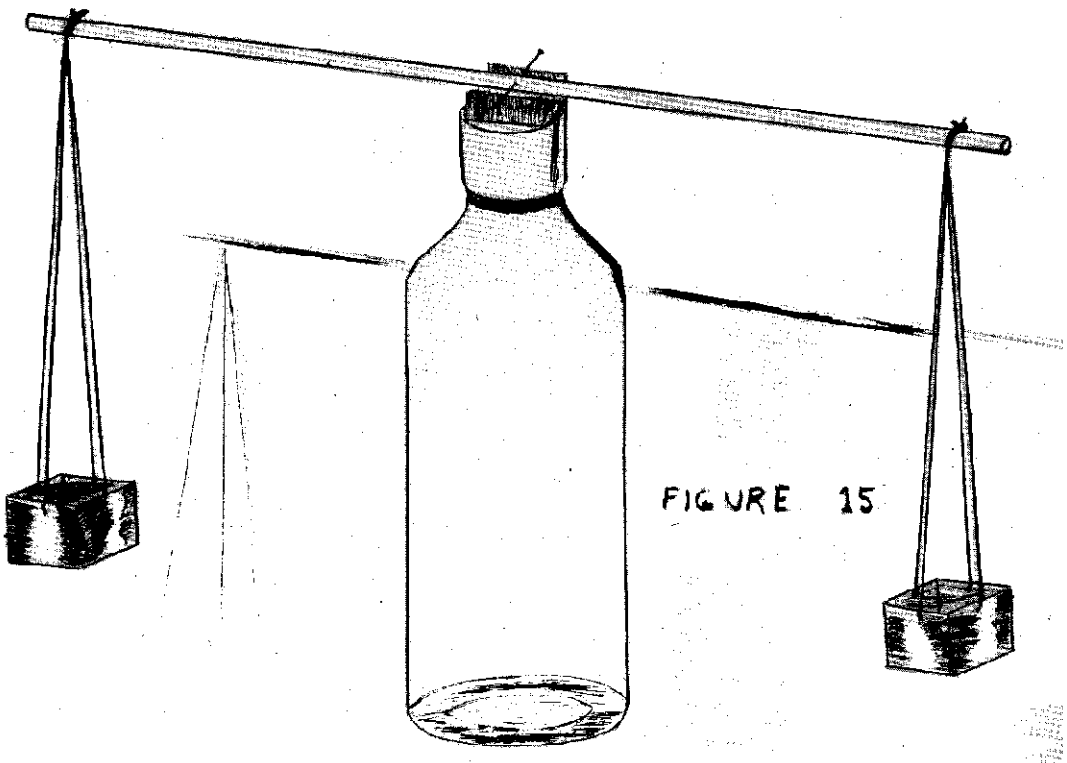
Pin

Drinking straw

Aluminium foil

Sewing thread

Plasticine



Take 10-15 staples that are stuck together. With cello tape, fix the staples on the top of the cap of a bottle.

Pass a pin through the centre of a drinking straw. Place the straw on the staples *(Fig 15)*.

Use cello tape to make two small open boxes from aluminium foil. Tie with strands of thread these two boxes near the ends of the straw.

If necessary, use plasticine to get exact balance. Your straw balance is ready. It is a very *sensitive* balance. Use it often.

Use your straw balance to find the fraction of water in leaves by weighing a number of leaves before and after drying. You can use staples as your weights.

Fraction of water = $(n_1 — n_2) / n_1$, where n_1 is the number of staples required to balance the leaves before drying and n_2 is the number required after drying.

* Bottle or tin with high neck *e.g.* oil bottle, powder tin, etc.

16 Heat expands Metals

Materials

Two supports

Two hooks (or eyes) with screw ends

Copper (or steel) wire

Weight (e.g. pen-knife, nut, bolt, etc.)

Candle

Box of matches.

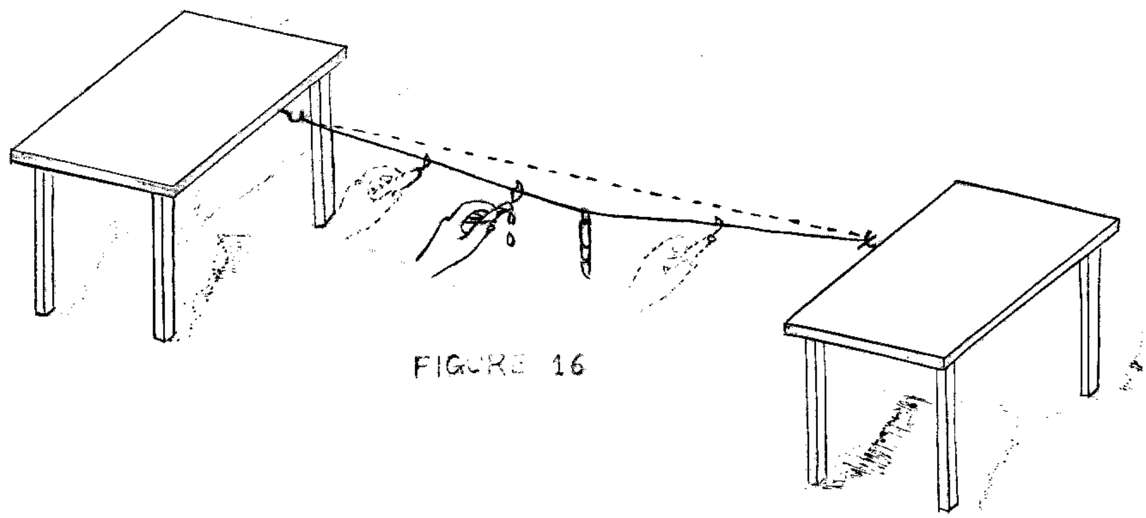


FIGURE 16

Take any two similar sturdy supports (tables, chairs, etc.). Screw in two hooks one to each support.

Take a wire about a metre long and stretch it between the two hooks.

Make sure the wire is taut i.e. tightly stretched.

You may have to load the supports so that they do not topple.

Attach a weight; say a pen-knife, to the mid-point of the wire. Measure the distance of the tip of the pen-knife from the floor.

Move a lighted candle along the wire so as to heat the wire. Do this for a couple of minutes.

What do you observe?

The wire *sags* in the middle *(Fig 16).*

Measure the distance of the tip from the floor again.

What do you find?

The distance is smaller than before.

Why?

Allow the wire to cool. The sag disappears. The wire becomes straight again and the weight rises to the original position.

Why?

17 Warm Air weighs less

Materials

Metre scale (or long strip of wood)

Thread

Hook

Two empty tins

Plasticine

Candle

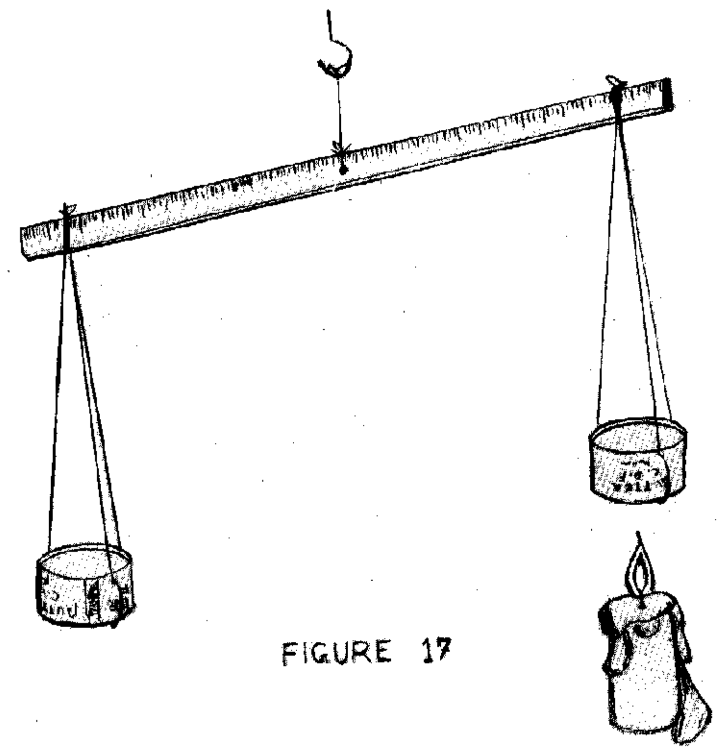


FIGURE 17

Balance a metre scale on your finger. It will balance near or at the 50 cm mark.

Make a hole at this point. Pass a piece of thread through the hole. You can now support the scale from a hook by the thread.

Make two holes one near each end and at the same distance from it. Hang an inverted tin from each end. *

Use plasticine to adjust till the whole thing balances.

Hold a lighted candle below one of the tins.

What do you see?

The tin over the candle goes up *(Fig 17)*.

Why?

Move the candle to be below the other tin. Now this one goes up, as surely you expected.

Remove the candle. In a few seconds the tins again gain balance. Why?

*You could use your Straw Balance made in Activity 15.Invert the aluminium foil boxes.

18 Hear through Wood

Material

Metre scale (or wooden rod)

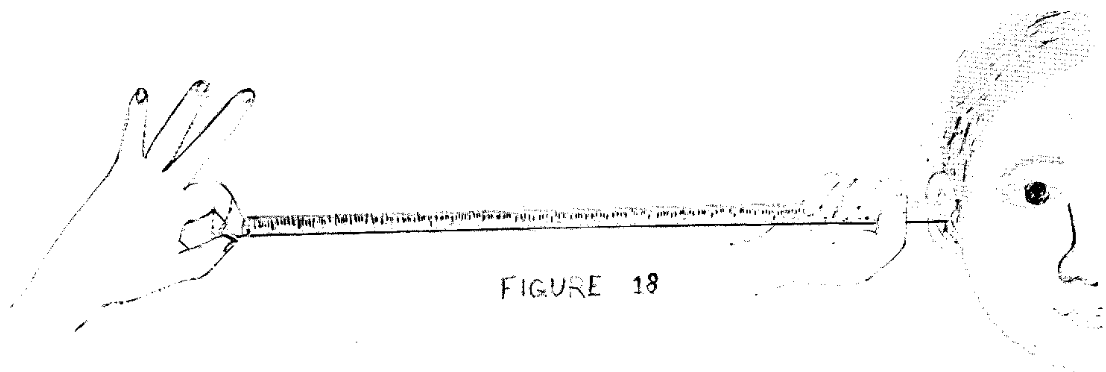


FIGURE 18

Hold a metre scale *close* to the opening of your ear.

Let a friend *strike* with his finger at the other end of the scale *(Fig 18)*.

You can hear the click very clearly.

Repeat with the scale at various distances from the ear.

What do you find?

Whenever the scale is *close* to the ear, the sound is heard *clearly*. The farther away the scale is from the ear the less audible is the sound heard by you. At a few cm the sound is not heard at all.

Why?

You could try scratching with a pin instead of striking.

You could hold a watch in contact with the scale and you will hear the 'tick-tick' clearly.

19 Sympathetic Bottles

Material

Two identical bottles (milk, jam etc.)

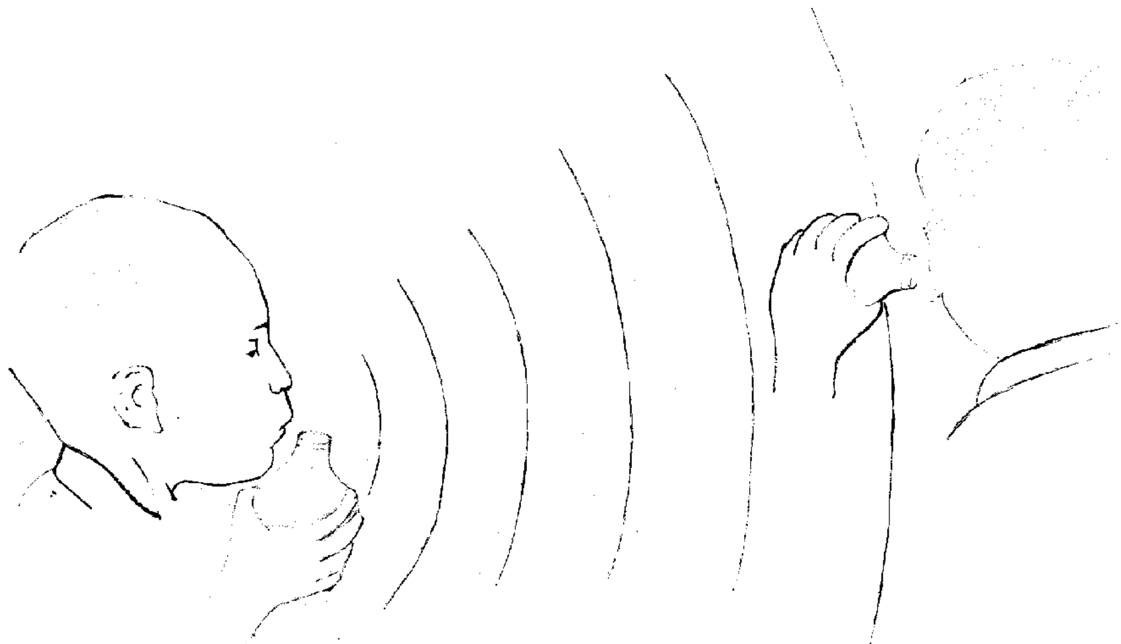


FIGURE 19

Take two *identical* milk bottles.

Let a friend hold the mouth of one milk bottle close to his ear without obstructing the opening.

Blow strongly across the mouth of the other milk bottle until you produce a strong *clear note.*

Your friend will hear the note clearly *(Fig 19).*

Now let your friend take the bottle *away* from his ear.

Blow across your bottle again.

Can your friend hear the sound now?

He does, but it is not as strong.

What does the second bottle do?

Try the experiment with two bottles of different sizes. Do you get the same results?

20 Multiply your Money

Materials

Two plane mirrors (e.g. pocket mirrors without frame)

Cello tape (any gummed tape)

Table

Sheet of white paper

Coin (say, 25 paise)

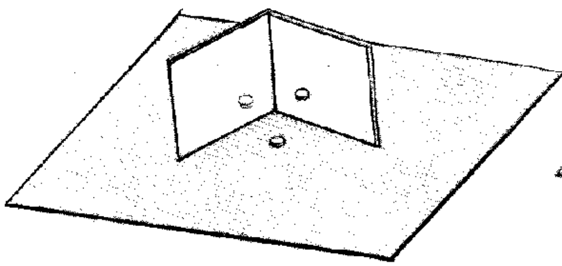


FIG 20·1

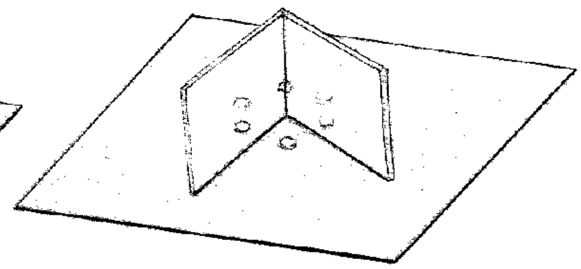


FIG 20·3

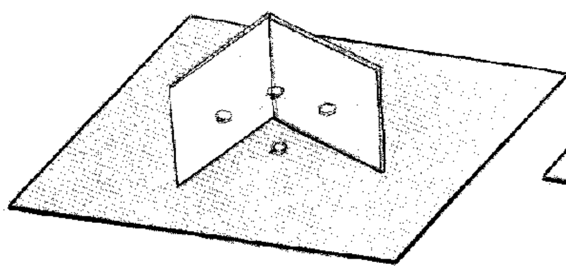


FIG 20·2

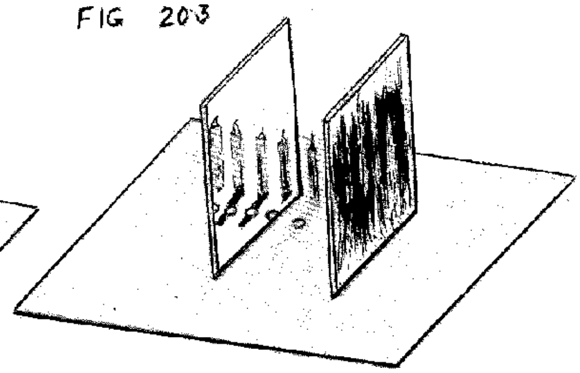


FIG 20·4

Place two plane mirrors edge to edge, with the mirrored surfaces away from you. With cello tape join the two adjoining edges. The two mirrors are now joined together with the tape acting as a hinge and the angle between the mirrors can be changed at will.

Have a fairly large angle between the mirrors and place them on a sheet of white paper on the table.

Place a coin between the mirrors.

You will be able to see not only the original coin but some more coins also.

Slowly bring the free ends of the mirrors close together, thus decreasing the angle between them.

What do you see?

More coins appear!

The *smaller* the *angle* between the mirrors, the *larger* the number of ‘coins’ (images) you see. Your money is multiplied!

Next, place the hinged mirrors so that the angle between them is 120°, and count the number of coins.

You will have three coins (the original one and two images) *(Fig 20.1)*. Repeat for 90°:   you will see four coins (three images) *(Fig 20.2*);

For 60°:   you will see six coins (five images) *(Fig 20.3)*.

And now remove the tape and place the mirrors parallel. You have a *parade of coins* (a very large number of images) *(Fig* 20.4).

Place a candle between the parallel mirrors and you have a *festival of lights*.

Can you tell how this happens?

Can you use your fortune?

Surely you have seen this before: in the barber shop when you had a haircut.

21 Cage a Lion

Materials

Card board

Plain white paper

Pencil

Glue

Twine (or rubber band)

Water colours (or crayons)

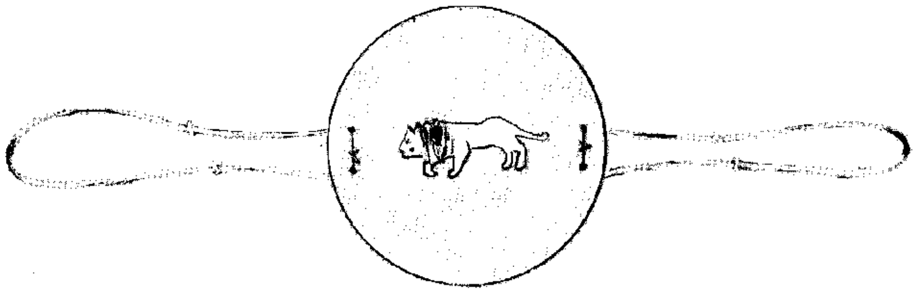


FIG 21·1

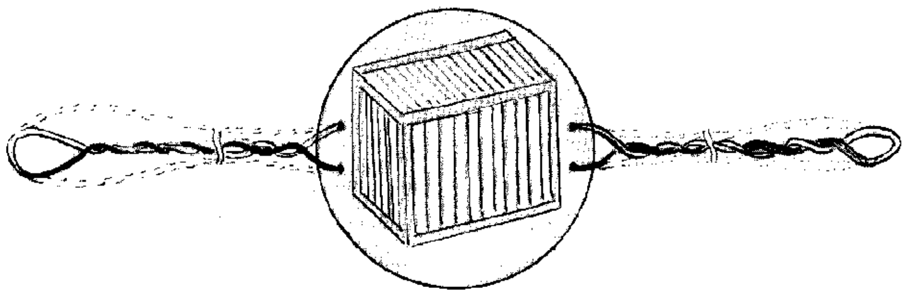


FIG 21·2

Cut out from cardboard a circle of radius about 5 cm. Cut out from plain white paper two circles of the same radius. Use glue to paste the two paper circles on the two sides of the cardboard circle.

Take two lengths of twine and tie them as loops near the opposite ends of a diameter of the circular disc *(Fig 21.1)*.

Draw a picture of a lion on one side and that of a cage on the other and colour them. They should be of proper size and the top of one should be behind the bottom of the other.

Hold the two twine loops between the thumb and index finger of your hand, one loop in each hand. Turn the disc round and round *winding* up the twine *(Fig 21.2)*.

Now steady your hands and stretch the twine loops.

The twine unwinds and the disc turns round and round rapidly.

And the lion gets into the cage.

Can you tell why?

You could similarly get a fish into a bowl or a sparrow into a nest.

22 Boat runs on Magnetic Power

Materials

Toy tin-boat (or soft wood and drawing pins)
Large dish (glass or plastic)
Wooden blocks
Water
Magnet (horseshoe or bar)

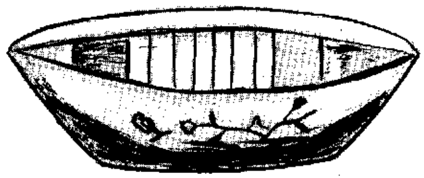


FIG 22·1

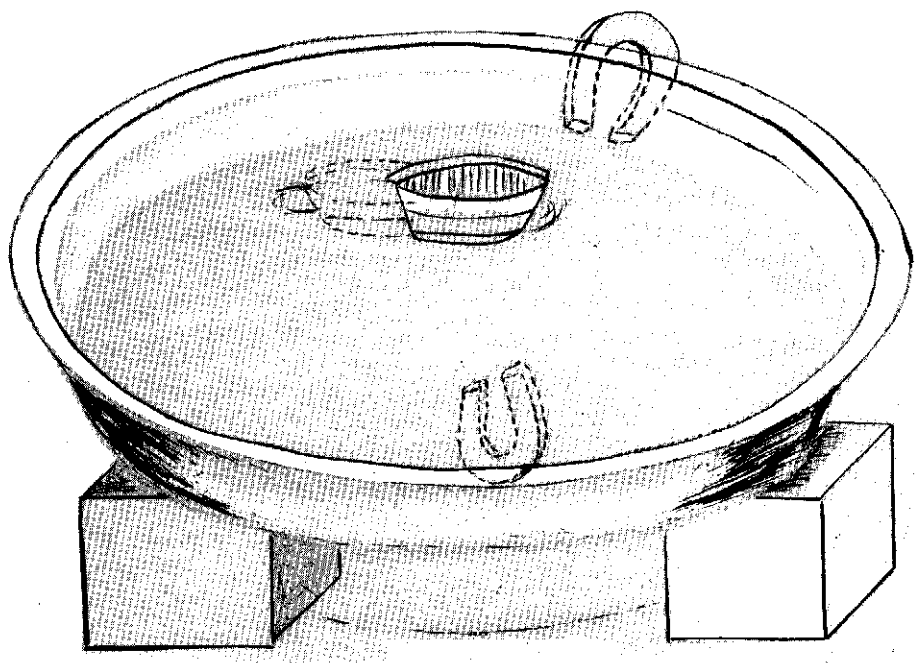


FIG 22·2

Take a toy tin-boat *(Fig 22.1).* Or

Carve out a boat from soft wood and fix a number of drawing pins on the sides and bottom of the boat.

Keep a large glass dish of water on three or four wooden blocks so that your hand can freely move under it.

Float the boat on the surface of water.

Hold a magnet *under* the dish and *near* to the floating boat and move the magnet *slowly*.

What happens?

Move the magnet around the sides of the dish and close to the boat *(Fig 22.2)*.

What do you see?

The boat follows the movement of the magnet.

Why?

23 Control a Car from a Distance

Materials

Two toy cars

Two bar (or horseshoe) magnets

Cello tape

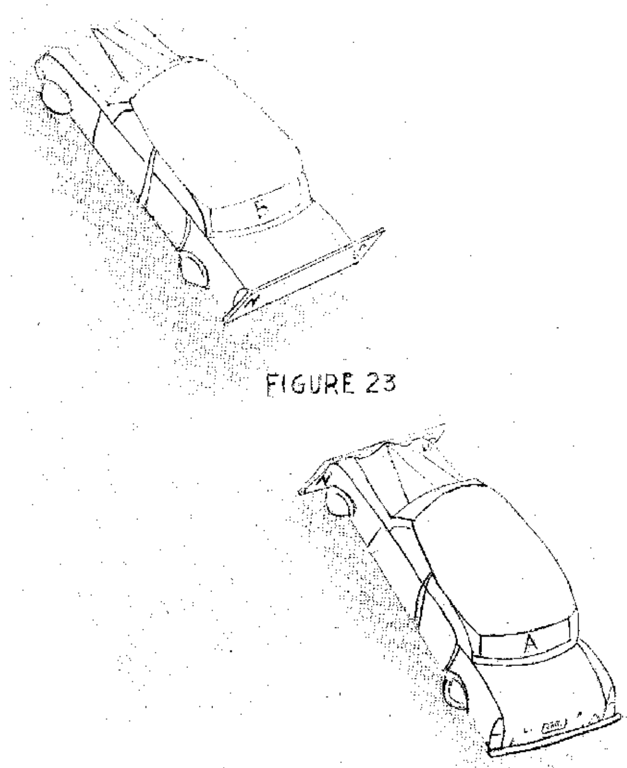


FIGURE 23

Take two toy cars, say A and B.

Tape two bar magnets one to the front of car A, and the other to the back of car B such that the North Pole (N) of the two magnets is on the same side *(Fig 23)*.

Bring car A *slowly* towards car B. Let it come closer and closer. What do you observe?

Even when car A is not actually touching car B, the latter runs away from the former.

Why?

Turn one of the magnets end-to-end (the North Pole now takes the place of the South Pole).

Observe again.

What difference do you see?

Now before the car A touches the car B the car B jumps towards the car A.

Why?

24 Paper Clip hangs in Mid-Air

Materials

Books (or wooden blocks)

Magnet (bar or horseshoe)

Cello tape

Paper clip

Thread

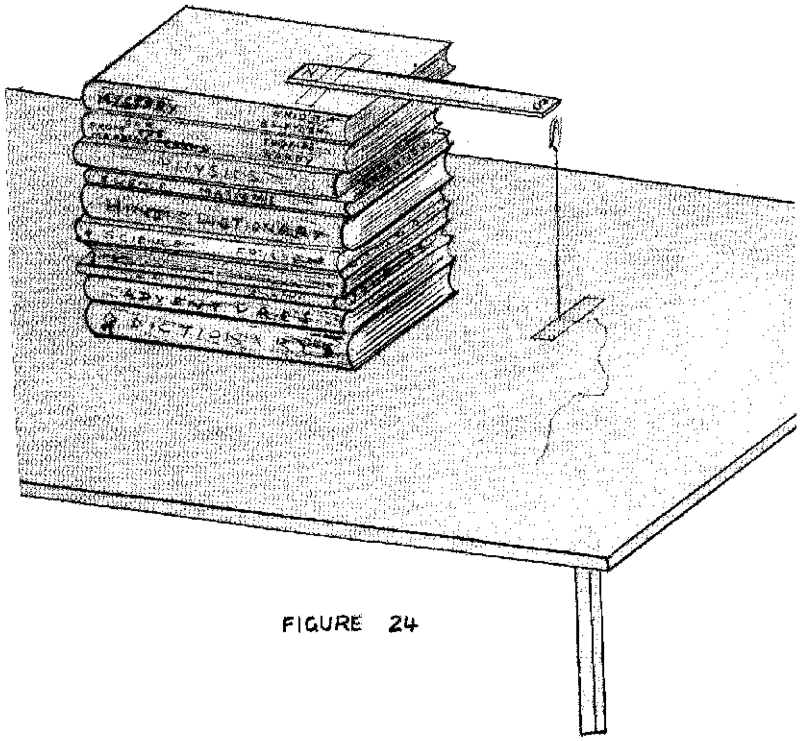


FIGURE 24

Pile a number of books about 25 cm high.

Rest a bar magnet on this pile such that one end of it projects over the edge of the pile. Tape it to top book *(Fig 24)*.

Tie a paper clip to one end of a piece of thread. Hold the thread vertical so that the paper clip is *close* to the projecting pole of the magnet but does not touch ft. Tape the thread to the table top and leave the clip to itself.

What do you see?

The paper clip stands up *against gravity.*

Why?

Reduce the length of the thread and find out at which point the clip refuses to stand up.

25 Dancing Paper Dolls*

Materials

Four bricks

Cardboard

Piece of window glass (or thin sheet of plastic)

Tissue paper Handkerchief (or piece of paper)

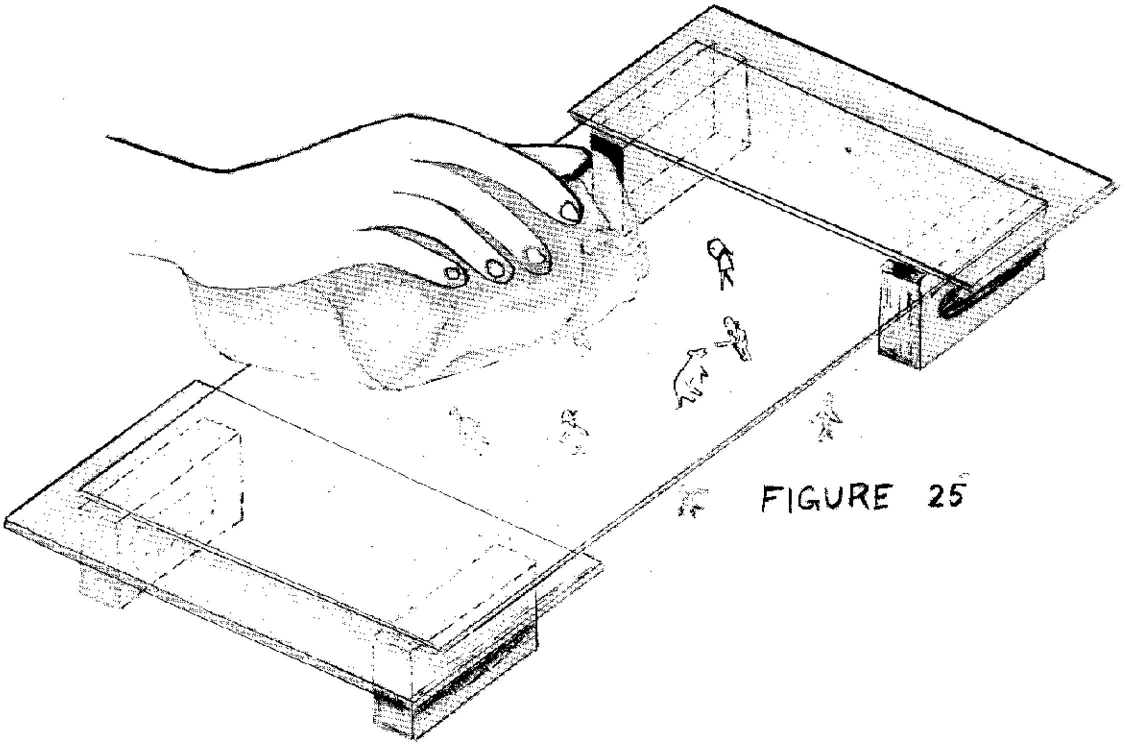


FIGURE 25

Arrange four bricks and a sheet of glass as in *Fig* 25. In order not to scratch the glass or break it, place pieces of cardboard under the ends of the glass sheet.

Cut dolls out of tissue paper and place them on the table under the glass sheet.

Rub the glass *briskly* with a *dry* handkerchief or crumpled piece of paper *(Fig* 25).

What do you see?

The dolls dance. Some may attach themselves to the glass.

Do you know why?

*The experiment works well only on a cool and dry day.

26 Electricity attracts Water*

Materials

Water tap

Rubber comb

Hair on your head (or a plastic bag)

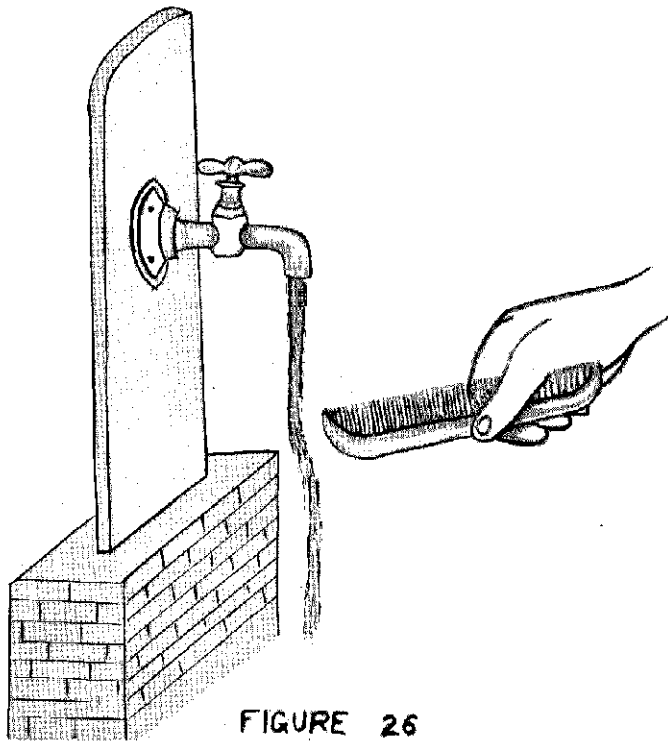


FIGURE 26

Open a water tap so as to get a thin and steady stream of water.

Comb you hair *vigorously* with a rubber comb (or rub a rubber comb vigorously against an ordinary plastic bag).

Hold the comb near the stream of water.

What happens?

The stream of water bends towards the comb *(Fig 26)*.

Why?

*Do this activity on a cold dry day.

27 The Siphon

Materials

Two large bottles

Long rubber (or plastic) tube

Water

Table (or stool)

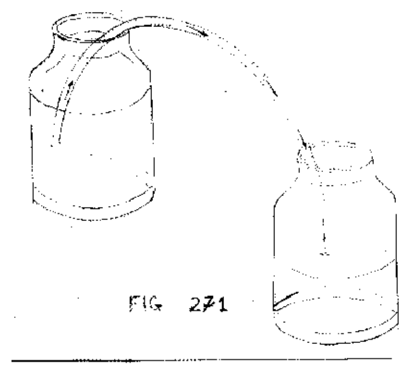


FIG 27.1

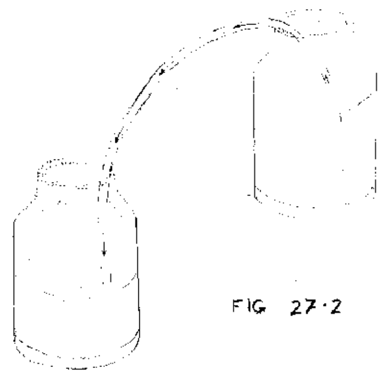


FIG 27.2

Fill a large bottle with water and keep it on a table. Keep an empty bottle on the floor.

Take a rubber tube about 100 cm long and fill it with water. Pinch one end of the tube tightly with the thumb and index finger of the right hand and put the tip of the index finger of the left hand on the other end. Put the left end of the tube into the water in the full bottle and the right one into the empty bottle and take your hands off.

What do you see?

Water flows *from* the *full bottle to the empty bottle (Fig 27.1)*.

You have *siphoned* the water from one bottle to the other bottle.

Raise the bottle on the floor higher than the bottle on the table.

What do you find?

Water now flows the other way round *(Fig 27.2)*.

Find out how you can stop the flow of water.

Can you think of some practical uses of the siphon?

28 Why Roofs are corrugated

Materials

Paper

Two books Coins

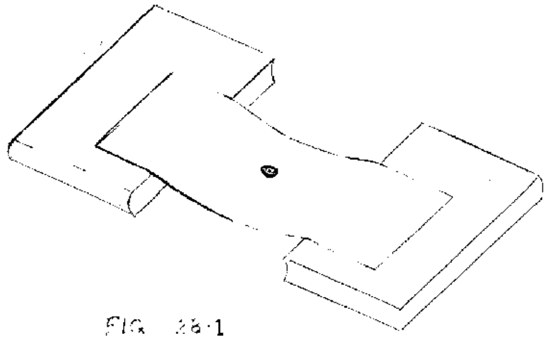


FIG 28·1

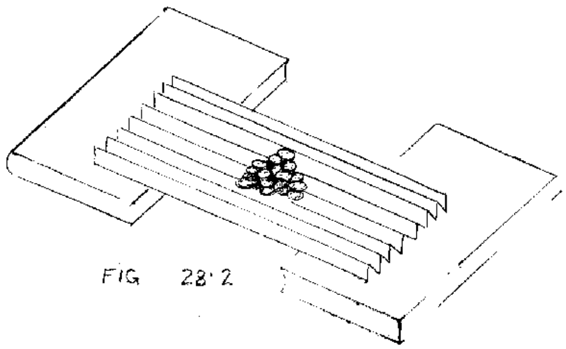


FIG 28·2

Place a rectangular piece of paper across two books *(Fig 28.1)*. Find the number of coins required to make the paper sag.

Usually one single coin will be enough. The paper may even sag due to its own weight.

Now make a fan out of an identical piece of paper. Spread the fan out a little and lay it across the two books *(Fig 28.2)*.

Again find the number of coins required for the fanned paper to sag.

What do you find?

Many more coins will be needed to make the fanned paper sag.

Why?

Use identical coins and find out how much stronger fanned (i.e. corrugated) paper is than plane paper.

Repeat for different types of paper like drawing paper, chart paper, blotting paper, etc.

Do you now know why roofs are corrugated?

29 Rolling reduces Friction

Materials

String

Rubber band

Heavy book

Three or four round pencils

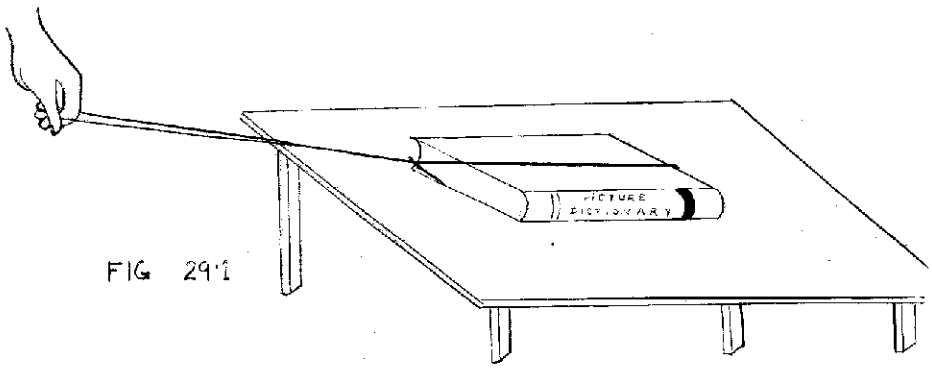


FIG 29·1

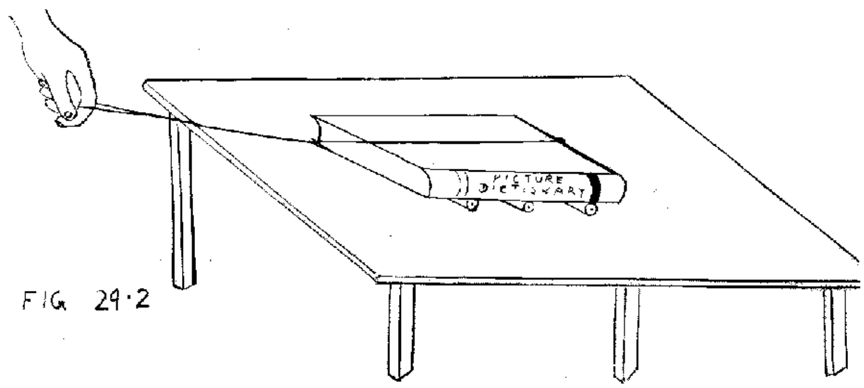


FIG 29·2

Take a thin rubber band and pass a piece of string through it. Tie the string around a heavy book. Place the book on a table.

Put your index finger into the rubber band and try to move the book along the table *(Fig 29.1*).

What do you see and feel?

The rubber band stretches and it is not easy to pull the book.

Why?

Now put three or four round pencils under the book.

Again pull on the rubber band *(Fig 29.2).*

What do you find?

The rubber band does not stretch as much as it did before, and it is much easier to pull the book.

Why?

30 Respiration Model*

Materials

Large bell jar (or any large glass or transparent plastic jar with an open bottom)

Rubber cork to fit the mouth of the jar

Y-tube (glass, plastic or metal)

Two balloons

Polythene bag

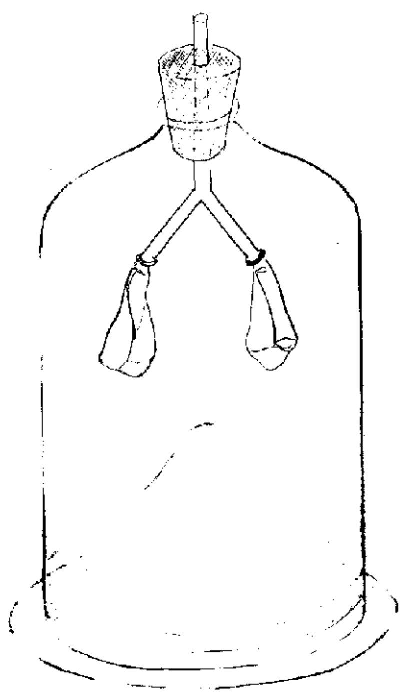


FIG 30·1

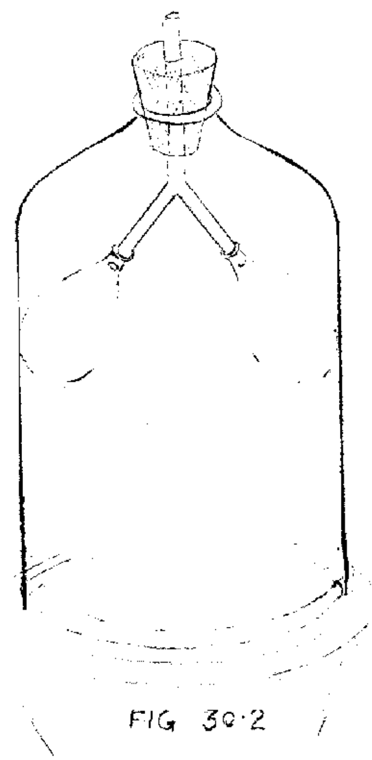


FIG 30·2

Take a large bell jar and assemble the Respiration Model as shown in *Fig 30.1.*

Use rubber balloons for lungs, Y-tube for the wind pipe, the open bottom of the jar for the thoracic cavity and the polythene bag for the diaphragm at the bottom that separates the chest from the abdomen.

Push the polythene bag into the jar and tie the open end of the bag to the open end of the jar.

Pull out the polythene bag, the balloons *blow up (Fig 30.2)*.

Push in the polythene bag, the balloons *collapse (Fig 30.1)*.

Can you tell why?

Repeat several times.

*How lungs work

Explanations of Activities

1 Breath is real and needs space. When you breathe out into the tube an equal amount of water has to come out of the jar so that the gases of the breath can take that space.

2 The compressed air presses the skin of the balloon against the sides of the tumbler and the friction between the two stops the tumbler from falling off. This is just like pressing a book against a wall so as to stop it from falling.

3 When your finger closes the top hole, air pressure from below holds the water back in the tin. When the finger is taken away, air can enter the tin through the upper hole and the water is pulled down by the force of gravity.

4 By blowing into the tube the air above the water is compressed. When Wowing is stopped, the compressed air pushes the water out through the tube.

5 The burning matches use up a good deal of oxygen in the air inside the tins. The pressure of air inside is thus reduced. The wet paper acts as a seal and does not allow the outside air to enter the tins. The outside air tries to get in and keeps the tins glued together.

6 The warm air rising from the candle flame makes the fan spin.

7 Blowing causes a fast moving stream of air to pass between the balls. The pressure of this moving air is smaller than that of air at rest. The outside air pressure is thus greater and the balls are pressed together.

8 The wings make an autogyro spin. The potential energy of the gyro is used in spinning and pushing away the air through which it falls. It, therefore, lands softly on the ground.

9 Wax is lighter than water. Hence a wax candle floats on water. It floats flat because that position is more stable. By loading the candle with pins, the

density of the candle-pins-combination is effectively increased. You can make it float with the wick as close to the surface as you may wish by increasing the number of pins. Pins, being denser than wax, help in making the candle stand erect. As its weight decreases on burning it comes up and up all the time.

10 Though the weights of the boat and the disc are the same the volume of water displaced by the boat is much greater and hence the upward push (thrust) is also greater. The boat is thus able to float.

For the same reason, ships made of steel are able to float on the sea.

11 The denser the liquid, the greater the buoyancy (upward push). Thus, salt water is more buoyant than fresh water. Hence the pencil which sinks in plain water floats in salt water.

This is also the reason why it is easier to float in sea water than in river water. For the same reason, a ship rides higher in ocean water than in fresh water.

12 Any flat object spins without a jerk about its centre of gravity. Spinning is an experimental way of finding the C G of fiat objects. Objects such as circles, triangles, squares etc., have their C G located at or near their geometric centre.

13 The centre of gravity always tries to be as near to the ground (earth) as possible because then the object is more stable.

14 The two pieces have the same weight and the earth puffs them with the same force. However, the flat piece has much more air to push out of its way while the rolled piece has less air to push. So the rolled one falls faster and hits the ground first. A parachute works on the same idea (Activity 6 Book I).

15 The wire is made of metal. Metals expand when heated and contract when cooled. Its length increases when heated by the candle but the distance between the ends is the same as before. So it sags.

16 The air in the tin above the candle is heated. It expands and becomes lighter. The tin, therefore, weighs less than the other tin. So the tin with hot air goes up.

17 Wood carries sound better than does air. The spreading of sound energy is much less in wood.

18 Every time you blow and produce a clear note, sympathetic vibrations are set up in the second bottle because the two bottles are identical. The

rattling sounds in a bus are due to sympathetic vibrations of loose bus parts caused by the engine at particular speeds (Resonance).

19 Each mirror forms an image of the coin and also forms images of the images in the other mirror. The smaller the angle between the mirrors the greater is the number of images.

20 The images of the lion and the cage alternate *rapidly* on the retina of the eye. Vision lasts for a short time (about 1/16th sec) in the eye even *after* the object goes away from view. This small persistence of vision makes us feel as if the lion is in the cage. Without it movies will be impossible to see.

21 The magnetic field of the magnet penetrates through the glass dish and water attracts the tin boat. Therefore it can control the movement of the boat.

A 'tin' boat is really made of steel sheet and coated on the outside with tin to avoid rusting. Tin itself is not magnetic. In case of the wooden boat it is the steel of the pins that is attracted.

If the dish were also made of steel sheet, it would shield the boat from the magnetism of the magnet. Try to do the experiment with such a dish.

22 Around every magnet is its magnetic field, though we cannot see it. The fields of the two magnets influence each other. Like magnetic poles repel, unlike magnetic poles attract one another.

23 A magnet can attract a magnetic substance without touching it because of its magnetic field. Gravity pulls the clip down and the magnet pulls it up. When the two pulls are equal the clip hangs in mid-air.

24 Static electricity is produced by rubbing on glass. Rubbing can remove electrons from glass which thus becomes positively charged, and attracts the neutral paper dolls. Under the combined action of electric force and gravity the dolls dance up and down.

25 The comb is electrified by rubbing and gets a negative charge. Running water has a positive charge. Unlike charges attract.

26 Water stops flowing when the level of water in the two bottles is the same.

A siphon can be useful in emptying large heavy vessels like water tanks, aquaria, etc.

27 When a material is given a suitable shape, it can bear much greater load than when it is flat. This is the reason why roofs of houses and sheds are made of corrugated steel or corrugated cement asbestos sheets.

28 Pencils act as rollers and make it easier to pull the book. Rolling friction is less than sliding friction. This is the principle used in ball bearings and roller bearings. Your bicycle has ball bearings. Find out where they are. More than 2000 years ago the Egyptians, while building pyramids, used round big logs of wood under huge boulders to drag the boulders where the pyramids were being built.

29 When you pull the polythene bag out the air pressure in the jar decreases and the outside air rushes in through the tube and the balloons fill up (Inhalation). When you push the polythene bag in, the air pressure in the jar increases and the air in the balloons rushes out (Exhalation).

END