Fun and Science at Home

(Learning Science at home through simple experiments)

Jyoti Bhansali
Prof. L.S. Kothari

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A-50, Institutional Area, Sector-62,
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Phones : 0120-2404430-35
Fax : 0120-2404437
E-mail : info@vigyanprasar.gov.in

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Fun & Science at Home
Learning Science at Home
Through Simple Experiments

Authored & Edited by : *Ms. Jyoti Bhansali*
Prof. L.S. Kothari

Illustrations : *Shri Virendra*

Cover Design : *Manoj Kumar*

Typesetting & pagemaking : *Ms. Sonu*

Production Supervision : *Sumita Sen*

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PREFACE

We are living in an age of science and technology. Knowledge of science is essential for all women and also for men, in order to be able to live in peace and harmony with Nature.

Science is the study of Nature. As the great French philosopher Henri Poincare said: "The scientist does not study Nature because it is useful, he studies it because he delights in it, and he delights in it because it is beautiful. If Nature were not beautiful, it would not be worth knowing, and if Nature were not worth knowing, life would not be worth living."

Nature is an open book. Even after centuries of investigations into its structure and functioning, scientists are of the opinion that we now know enough about Nature to be able to say that we do not understand Nature.

Science has to be learnt, it cannot be taught. Teachers can serve only as guides and help students to learn science on their own. And what is most important, science can be learnt not through textbooks, but by directly observing nature, asking questions and trying experiments with their own hands. Curiosity is what is needed to learn science and it is the greatest asset of all children. It should be encouraged and properly guided, rather than suppressed, as this is what elders often do.

For the progress of science in any country, its children have to be introduced to nature at an early age and guided to observe closely the marvel that is nature.

In this book we have tried to collect together some simple experiments which any child above the age of 10 years can perform at home, without the need for any complex or costly equipment. Basic facts about the experiments are also briefly mentioned at the end of most experiments. For those interested in more such activities, at the end of the book we have provided a short list of books for further reading.

We would like to render our heartfelt thanks to Shreya who helped us try out each experiment with utmost enthusiasm, who typed out major portions of the manuscript and who made all the rough sketches for us. Without her assistance, this book would have been a distant dream.

Jyoti Bhansali

L.S. Kothari

This book is dedicated to

Mrs. Indra Bhansali, Mrs. Sushila Kothari,
Sharad, Siddhant and Shreya —
the three generations which gave us their unflinching support
and continuous encouragement.

AIR

AIR

What is it that is around us all the time, and yet we cannot see it? It is air.

What is air?
Air is a mixture of gases, mainly nitrogen (78%) and oxygen (21%). It also contains some carbon dioxide, water vapour, hydrogen and the inert gases argon, neon, helium, krypton and xenon. Most gases exist in molecular form. The size of the molecule is extremely small. Under normal conditions, one litre of air contains 2.7×10^{22} (27000000000000000000000) molecules.

Each molecule moves with a tremendous speed and keeps colliding with the other molecules. The average speed is almost 500 metres per second (i.e. 1800 km/hr). When air is enclosed, in say a balloon, it is the collision of the tremendous number of particles on the surface of the balloon that keeps the rubber stretched.

To appreciate the large magnitude of the numbers involved, let us consider the following example:

Think of the last hundred breaths of the Buddha, and the atoms of argon in it. Each one of us, in every ten minutes, breathes in at least one atom of argon from those hundred breaths of the Buddha. We have chosen argon because it is an inert gas and does not undergo any chemical reactions under normal conditions. What is breathed in, is breathed out. Further, it forms about 1% of the atmosphere (0.93% to be more precise), whereas other inert gases like neon or helium constitute less than 0.002%.

How much does air weigh?
Under ordinary conditions a litre of air weighs about 1.3 grams. This may appear too small but consider the weight of air in a room of ordinary size- say 5m x 6m with 3 m height. The weight of air in this room will be nearly 100 kg!

We live at the bottom of an ocean of air. The air above us exerts tremendous pressure on the surface of the earth. On a square metre of area, the force exerted is equivalent to a weight of almost 10 tons. The surface area of a human being is about the same, nearly 1 sq. metre. Hence the air presses on our bodies with a force of about 10 tons- which is more than the weight of a heavy bus full of people. This force acts on all sides and luckily since we have the same air inside our bodies, the two forces balance exactly and we do not feel the pressure of the air.

You will be learning something about air in the following few experiments.

THE EXTINGUISHING FLAME

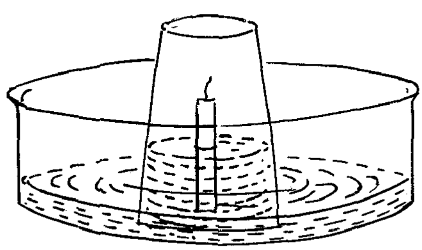
Things required:
A glass, a candle about less than half the length of the glass, a shallow bowl of water, a matchbox.

Method :

1. Before filling the bowl with water, fix the candle in the bowl.
2. Now fill the bowl with water.
3. Light the candle.
4. Put the glass over the lit candle and observe carefully.
5. You will notice that the candle flame gets weaker gradually and is ultimately extinguished.
6. You will also notice that as the flame gets extinguished, the level of water in the glass rises until it reaches 1/5th the length of the glass!

What actually happens:
You must have already realized that the flame gets extinguished because it gets only a very limited supply of oxygen and so the moment the oxygen gets exhausted, the candle gets extinguished.

The water in the glass rises because when the oxygen is consumed by the candle, the air pressure in the glass falls. Because of the low pressure, water in the glass rises.



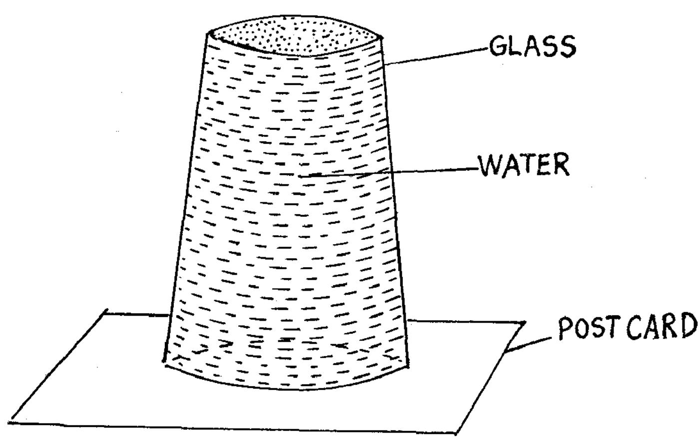
NOT A DROP TO SPILL

Things required:
A postcard or greeting card, a glass of water

Method :

1. Fill the glass up to the brim with water.
2. On the top of the filled glass place the card.
3. Now keep your hand on the card and press it down. Now turn the glass upside down. Remove your hand from the card—the water stays in the glass and the card remains where it is.

What actually happens:
The outside air exerts a pressure on the card. This pressure is about 1 kg per square centimetre. This is sufficient to hold the card against the glass.



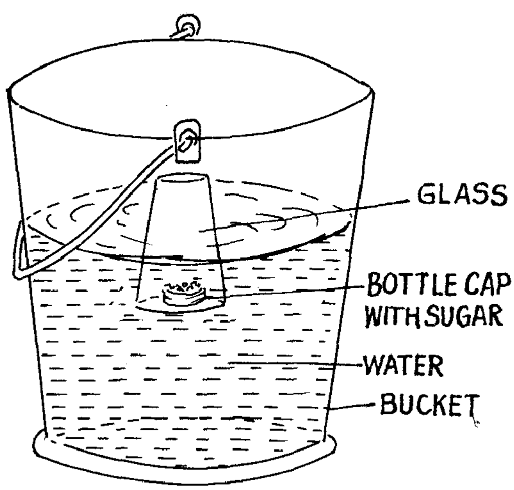
UNDER WATER AND STILL DRY

Things required:
A bucket of water, a glass, a small plastic bottle cap, a teaspoon of sugar.

Method:

1. Put the sugar in the bottle cap and let the cap float on the surface of the water.
2. Cover the cap with the glass.
3. Now push the glass straight down into the water.
4. No water enters the glass because the air in the glass doesn't let it. So the inside of the bottle cap and sugar will remain dry even though they are at the bottom of the bucket of water.

What actually happens:
Since air occupies space, it doesn't let in water inside the glass. So even though you took the glass to the bottom of the bucket, yet no water could get into the glass to wet the inside of the bottle cap.



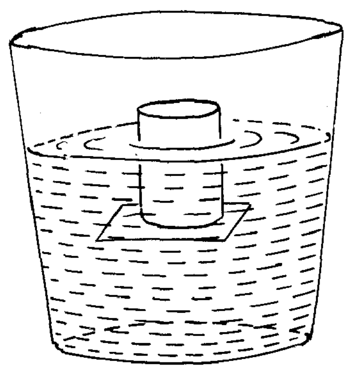
THE RUNAWAY

Things required:
An empty tin can open from both ends, a cardboard piece, scissors, a bucket of water, a glass

Method:

1. Place the can over the cardboard and cut out the cardboard so that it is larger than the bottom of the can.
2. Press this cutout under the can and push these two into the water in the bucket.
3. When the top of the can is near the surface of the water remove your hand from the cardboard.
4. No water enters the can since the cardboard acts as a tightly sealed bottom.
5. Now pour water slowly from the glass into the can.
6. When the level of water in the can becomes the same as the level in the bucket, then the cardboard bottom is pushed out and it sails to the bottom of the bucket.

What actually happens:
When the can is immersed in the bucket, the water exerts a force upwards on the cardboard so that the cardboard always stays pressed to the bottom of the can.



When you pour water inside the can, you create an opposite, downward force-which balances out the pressure of water in the bucket and hence the card-board moves away.

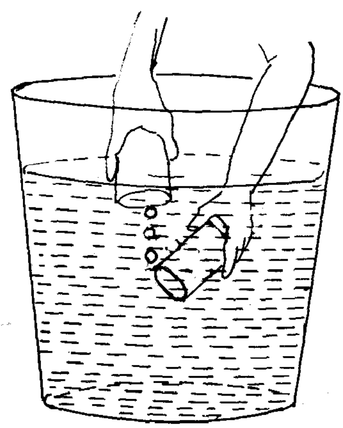
THE INVISIBLE TRANSFER

Things required:
Two glasses, a bucket of water

Method:

1. Take one glass, turn it upside down and then push it into the water in the bucket.
2. Because of the air trapped in the glass, about 2/3 of the glass remains dry.
3. Now bring the second glass in the water in a similar manner and keep it near the first one.
4. Tilt the first glass and let the air from that escape into the second glass.

Observation:
The first glass gets filled with water while in the second one, the volume of air increases.



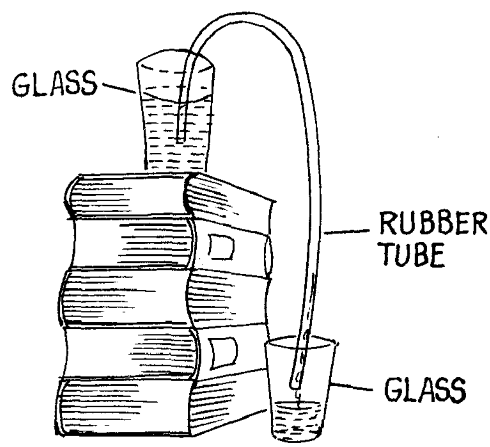
THE WATER SIPHON

Things required:
Two glasses, a thin flexible rubber tube of about 40 cm, a pile of books about 30 cm high.

Method:

1. Keep the two glasses on a table but at different levels. One glass should be placed on the pile of books and the other at the bottom.
2. The glass which is on the top should be filled completely with water.
3. Now hold one end of the rubber tube under a tap until the tube is completely filled with water.
4. Clamp both ends with your fingers and thumbs so that no water can escape.
5. Place one end in the glass of water and remove your finger and thumb, making sure that the end goes right to the bottom of the glass.
6. Place the other end of the tube into the empty glass and remove your thumb.
7. The water will flow from the upper glass to the lower one until the upper one is almost empty.

What actually happens:
As the water falls onto the lower glass from the tube, a vacuum is created in the tube. The air pressure against the water in the top glass pushes water into the tube and this goes up and then down the rubber tube and flows into the bottom glass. This downward flow of water continues until all the water flows down or if the flow of the water is interrupted by some air which gets into the tube.



AIR PRESSURE EXPERIMENT

Things Required:
A wooden 12 inch ruler, a newspaper

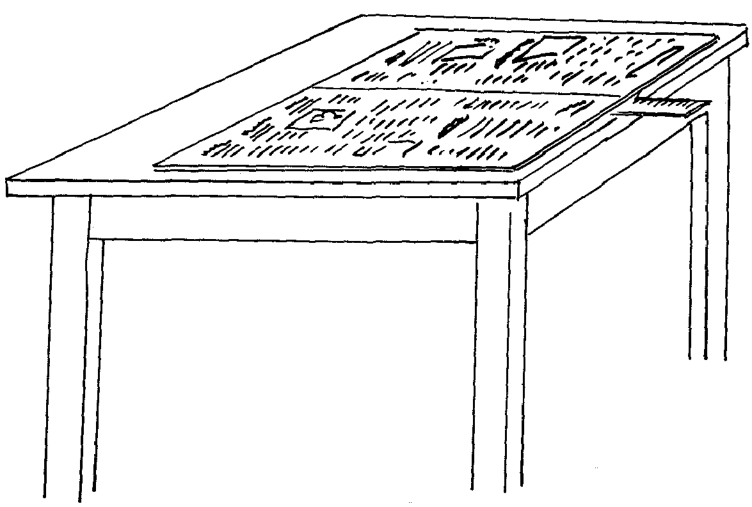
Method:

1. Place the ruler on the edge of a table with about 10 cm lying beyond the edge of the table and place an open newspaper over it on the table.
2. Carefully smoothen down the newspaper.
3. Now try to displace the paper by striking the projecting part of the ruler.

   (Be careful not to strike too hard on the ruler otherwise it will break.)
3. You will find that it is difficult to displace the paper because it appears as if there is a big load on the paper.

What actually happens:
With this experiment, you have demonstrated dramatically the tremendous weight of air.

When you strike the ruler, you find that instead of throwing the paper to the ceiling, the ruler acts as if it were nailed to the table. Because air is unable to get under the paper fast enough to balance the air above it, the air pressure on top of the paper may be momentarily as heavy as 5 tons.



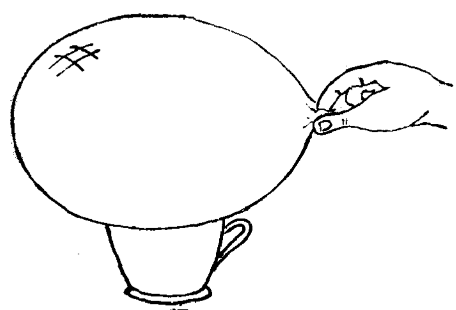
LIFTING A TEACUP

Things required:
A teacup, a strong round balloon

Method:

1. Keep the teacup on the table.
2. Hold the balloon a little above the cup and blow air into it until the balloon presses into the teacup.
3. Now close the mouth of the balloon with your finger and thumb.
4. Slowly lift the balloon. You will find that the teacup is lifted along with it.

What actually happens:
When you blew air into the balloon, it pushed the balloon inside the cup. Part of the air inside the cup was pushed out creating a partial vacuum, which forced the cup to stick to the balloon. If you remove the cup from the balloon, you will notice this.



BALLOON IN A BOTTLE

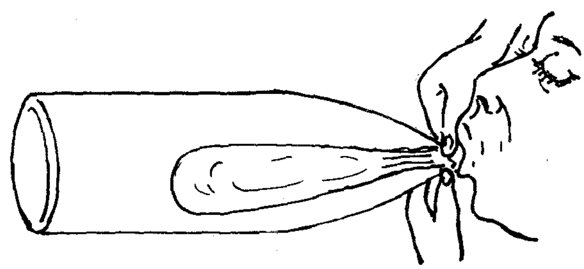
Things Required:
A bottle with a narrow opening (like a 300ml cold drink bottle), a balloon, your blowing ability

Method:

1. Inflate the balloon to make sure it isn't punctured.
2. Now push the balloon inside the bottle and stretch its ends over the mouth of the bottle.
3. Now try to inflate the balloon again.

   You won't be able to do that anymore!

What actually happens:
When you blow the balloon, it tends to expand and compress the air inside the bottle. But you cannot compress the air too much and hence are unable to inflate the balloon.



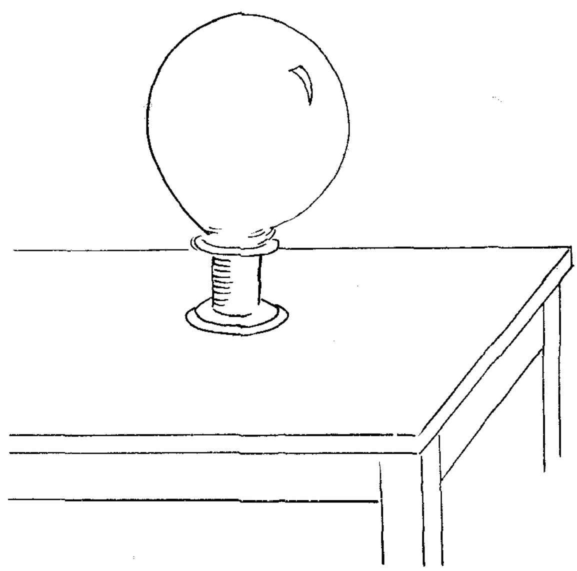
A HOVERCRAFT

Things Required:
A wooden spool from a reel of cotton thread, a large rubber balloon, slices from a pencil eraser, fine grade sandpaper

Method:

1. Take the wooden spool and make its bottom as smooth as you can by rubbing with the fine grade sandpaper.
2. Reduce the opening at the bottom to about half its original size by filling the hole with slices of rubber taken from the pencil eraser.
3. Slip the mouth of the rubber balloon over the other end of the spool and inflate it by blowing through the bottom of the spool.
4. Now place the spool on a smooth table or on top of a table with a glass top and give it a gentle push- it will glide along effortlessly.
5. *This should last as long as there is air in the balloon.*
6. If you find that the air flows out too quickly, then the hole will have to be made narrower by using more rubber slices. If, however, the hole becomes too narrow, it will be difficult to inflate the balloon. Find the correct size by trial and error.

What actually happens:
The spool moves effortlessly because it is supported on a cushion of air coming slowly out of the balloon.



THE MISCHIEVOUS STRAWS

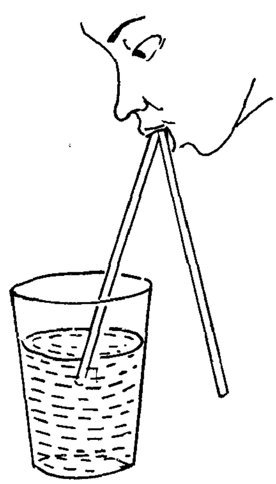
Things Required:
Two drinking straws, a glass of water

Method:

1. Put one straw in the glass and use it to drink some water.
2. Then keep the second straw together with the first and drink some water.
3. Now leave the first straw in the glass but take out the second one. Keep one end of this one in your mouth and the other outside the glass.
4. Now try to drink water with both the straws. You will find that you are unable to suck any more water from the glass.

What actually happens:
It is far easier to suck air than to suck water through a drinking straw. Hence when we use two straws-one sucking air and another sucking water, only air is sucked in, for, out of the two, it is the easier one to suck in.

(Also refer to the Experiment 'Ripping the Paper.')



PAPERS ATTRACT !

Things Required:
2 strips of paper, approximately 5 cm X 15 cm

Method:

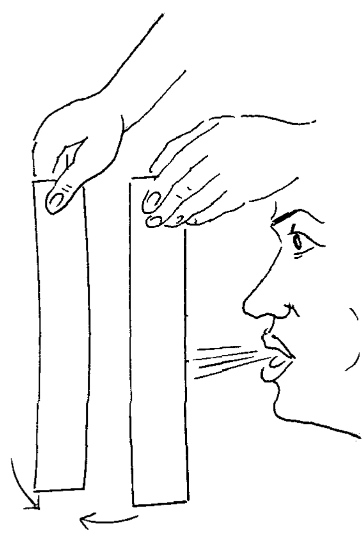
1. Hold the two strips of paper, one in each hand, near your mouth, such that the lower portion is closer to your lips and the strips are about 4-6 cm apart.
2. Now blow hard between the strips.
3. The strips move close to each other when the air is blown.

What actually happens:
We all know that the faster the speed of air, less will be the air pressure. When you blow between the strips of paper, the air pressure falls in that area. On the outer sides of the strips, air pressure remains normal and hence is greater in comparison to the reduced air pressure between the strips. This creates an imbalance between the air pressures and as a result the strips are pushed closer to fill the gap.

Bernoulli found out, about 200 years ago, that the pressure of air decreased according to the speed. At that time he never realized that he had discovered the law which would be the key to air travel.

Variation:
Hold a thin sheet of paper in front of your mouth—it hangs limp. Blow along the upper side of the paper.

Surprisingly, the paper rises into a horizontal position. This phenomenon can also be explained by Bernoulli's principle–when you blow across the paper, you create an area of low pressure above the paper. At the same time the pressure of air under the paper remains normal. Thus, because the pressure under the paper is greater than the pressure above, the paper gets pushed upwards into a horizontal position.



WATER

WATER

Water covers nearly 75% of the earth's surface. All life is based on water. Our bodies are almost 70% water.

What is there so special about water that all life is totally dependent on it? Water is a miracle material and scientists still do not understand why it behaves the way it does.

Most materials contract when we cool them, i.e. they become denser as temperature is reduced. Water behaves in the same way till its temperature reaches 4°C. If we cool water further, it begins to expand and when ice is formed at 0°C it is lighter than water and floats.

In cold countries, lakes often freeze during winter. If ice were heavier than water, it would settle down and gradually the entire lake would be frozen solid and all life would perish. Since ice floats, life in water survives.

Water has a very large specific heat, one has to supply more heat to raise the temperature through say 1°C, than that required by other substances. That helps nature in keeping our body temperature steady, in spite of changes in the surrounding temperature. Further, we use water in our hot water bottles for the same reason.

Water has a high latent heat, i.e. a given amount of water needs lot of energy to evaporate as compared to other substances. That is why we sweat during hot weather, so that its evaporation helps to cool us down. A man in a moderate climate secretes somewhere between 70-150 tons of sweat in a life span of 70 years. This is also the reason why plants get new leaves during summer- to keep the tree cool.

You must have seen water drops dripping from a leaking water tap. The drops, as they fall, are small balls- spheres. This is because water surface acts like a stretchable rubber membrane, and pulls the water close together, so that the surface area exposed is minimum. This property of water is called its surface tension. One result of water surface tension is that water can rise in narrow tubes and in trees.

WELL SHAPED

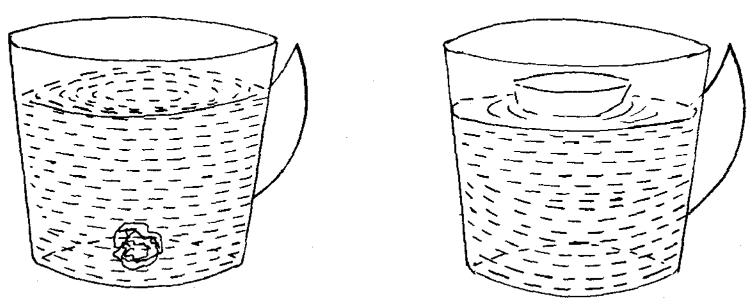
Things required:
Some plasticene, a mug of water

Method:

1. Make a neat ball with the plasticene and keep it on the surface of the water. It will sink immediately.
2. Now try to change the shape of the plasticene such that it floats on the water.
3. You will realize that the way to make it float is to flatten it out into a 'roti' shape and then curl up the ends to make it the shape of a ship or a craft.
4. Make sure that there is no water on the plasticene. This time the plasticene will float.

What actually happens:
When we place any object in water, it loses weight. The loss of weight is equal to the weight of the water displaced. When the plasticene is in the shape of a ball, it has the least volume and the loss of weight is also small. When we make a big craft out of it, it displaces lot of water and the loss of weight is larger. The craft begins to float when the loss of weight is balanced by the weight of plasticene.

Huge iron ships float in the sea because of this very principle.



THE FLOATING NEEDLE

Things Required:

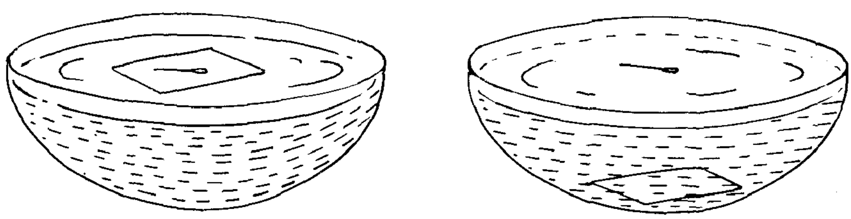
A thin sewing needle, small square piece of non starched cloth or paper, a bowl of water

Method:

1. Put the sewing needle on the square piece of cloth and place both of them gently on the surface of water in the bowl.
2. In a short while, the cloth will sink leaving the needle floating on the water (you can also, very gently, keep a razor blade flat on calm water and it may float). To make your work simpler, try coating the needle with a little oil before putting it on the cloth.

What actually happens:

The needle and the razor blade float on water because the surfaces of all liquids behave like stretched skins and are able to support denser objects provided the objects are not too heavy and can be placed on the surface without puncturing the skin.



FLOATING MATCHSTICKS

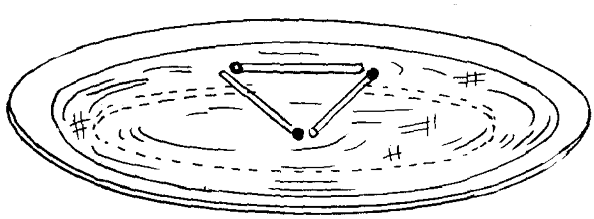
Things Required:
Three burnt matchsticks, water in a saucer, a small piece of soap

Method:

1. Take some clean water in the saucer and make the three burnt matchsticks float on the water so that they form a triangle(you may have to push them around with another matchstick to bring them into position).
2. Now take the small piece of soap and very gently make it touch the water somewhere within the triangle.

Observation:
You will find that the matchsticks fly apart instantly. (Before repeating the experiment be sure to use fresh water.)

What actually happens:
When the soap touches the water, a thin film of soap solution is formed on the surface. The surface tension of water being greater than that of soap solution, the soap film is pulled outwards in all directions causing it to spread. It is this spreading of the soap film which causes the matchsticks to fly apart.



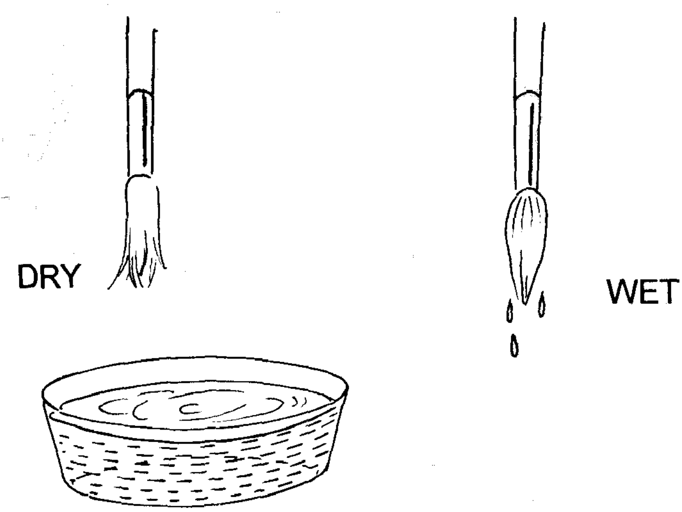
SURFACE TENSION

Things required:
A paint brush, some water in bowl

Method:

1. Look at the brush carefully. You will notice that the hair fluff out.
2. Now dip the brush in water. When you take the brush out of the water, its hair cling together.
3. Put the brush back in the water and notice that the hair under water do not cling together even though they are wet. Yet when the brush is taken out and as long as it is wet, the hair always stick together.

What actually happens:
This behaviour of the brush is best explained if we suppose that the surface of water acts like an elastic skin. It is this skin which holds the hair together whenever the brush is wet and outside water. The skin is absent when the brush is within water, and as a result the hair do not cling together under water. This property of an elastic skin is called the surface tension of the liquid.



THE INVISIBLE GARDENER

Things required:

A potted plant, a big container with a lot of water, a strip of old cotton cloth (about 5 cm wide and a metre long)

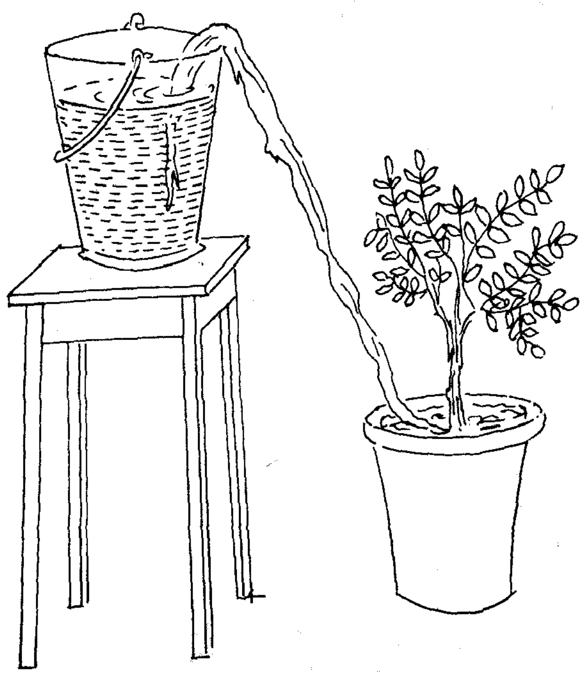
Method:

1. Keep the container of water at a level higher than the level of the pot but somewhere close to it.
2. Immerse the cotton strip in the water and then let it run all the way to the potted plant and push it just under the soil.
3. You will see that the water starts to move from the container via the strip to the plant. As long as the strip is immersed in the water the flow of the water will continue towards the pot and the plant will be able to survive. This method comes in handy if you need to go out on a vacation for a few days and have no one to take care of your plants.

What actually happens:

It is capillary action which makes the water move from the container to the plant and it is this that keeps the plant alive, for the water will keep flowing downwards to the plant as long as the strip is immersed in it.

In nature, capillary action plays a very important role for it is this capillary action which makes water rise upwards in plants against the pull of gravity. In trees water has to travel from the roots to each leaf (sometimes a distance of even 40-50 metres).



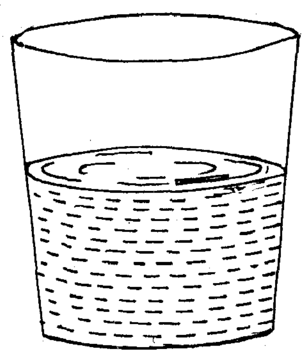
THE CALL OF THE CENTRE

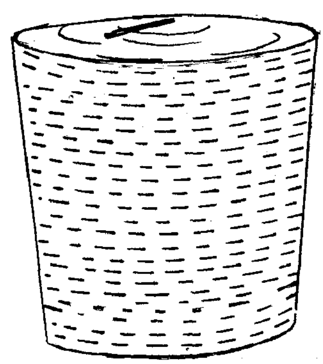
Things required:
Two glasses, water, a tiny piece of the lower end of a matchstick

Method:

1. Fill one of the glasses until the water level reaches near the top.
2. Put the matchstick piece in the centre of the glass on the water surface.
3. The matchstick will slowly move towards the edge of the glass.
4. Now fill some water in the second glass.
5. Pour water from this one into the first glass until the water level of the first one is above the rim of the first glass. (This is possible because of surface tension).
6. The matchstick will now slowly move to the centre and will stay there.
7. If you now pour out some of the water from the first glass then again the matchstick piece will move to the edge of the glass.

What actually happens:
Whenever there is water in a glass, the level of water is slightly higher at the walls than in the middle. So the matchstick piece floats to this higher point. Later on, when you poured water above the rim of the glass, at that time the shape of the water was different–it was higher in the centre. So the matchstick piece floated to this highest point which was in the centre of the glass.





MELTING ICE CUBES

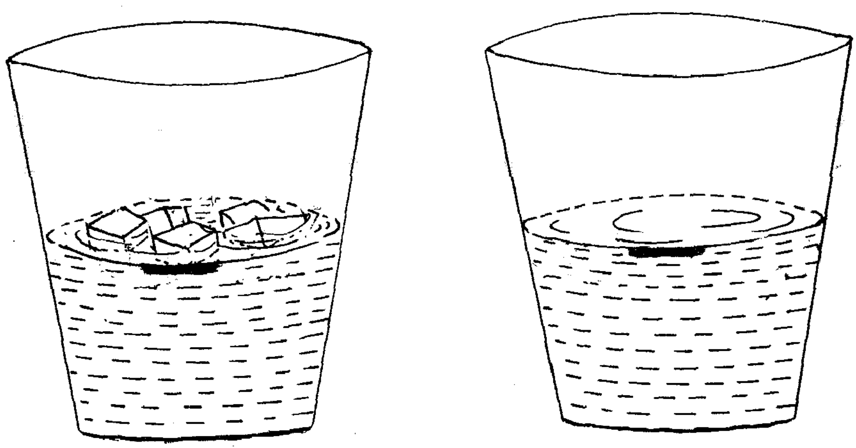
Things required:
A glass three fourths full of water, some ice cubes

Method:

1. Drop 2-3 ice cubes in the glass of water.
2. The level of water will rise.
3. Make a small mark to denote this level of water.
4. Now wait for the ice cubes to melt and then observe what happens to the water level.

What do you think will happen to the water level? Will it increase or remain the same?

What actually happens:
The water level remains the same. Though the ice seems to be jutting out of water and you may expect this much extra water when ice melts—yet it is not so. When ice melts, its volume decreases and the level of water remains the same.



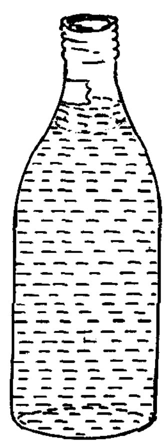
THE EXPANDING WATER

Things required:
A small bottle with a narrow neck, cellotape, some place in the freezer section of your refrigerator

Method:

1. Fill the bottle with water but leave some empty space on top.
2. With the cellotape mark the level of the water in the neck and then leave the water to freeze in the freezer. (Remember NOT to screw on the cap-If you screw the cap on, then the bottle may burst when the water freezes).
3. The bottle should be left standing for at least 24-30 hours.
4. When you go to see it next , you will find that the water has frozen completely and it has expanded even above the level marked by you with the cellotape.

What actually happens:
Water expands on cooling. When you fill the bottle with water and leave it in the freezer, the water slowly changes to ice and so it expands and takes up more space. So when you went to the bottle after 24-30 hours, you saw that the water had turned into a column of ice and was now occupying more space than earlier.



FASTER FREEZING

This simple experiment was the observation of a young boy and was reported recently in a scientific journal.

Things Required:

Two steel bowls (katoris) of water. Some space in your freezer

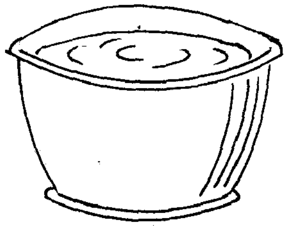
Method:

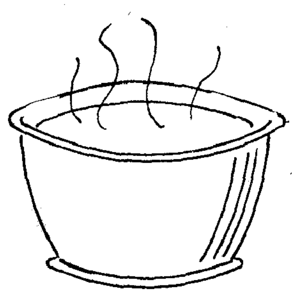
1. Make sure that the amount of water in the two bowls is the same.
2. Heat the water in one bowl. Make sure that the water is quite hot.
3. Now keep both the bowls in the freezer section of your fridge.
4. Leave them undisturbed for about 4-5 hours and then observe them after every half an hour interval.

You will observe that the bowl with the hot water freezes much before the water in the other bowl.

What happens:

What probably happens is that there are stronger convection currents in the bowl with hot water and this helps the water to freeze faster than the water which is at room temperature.





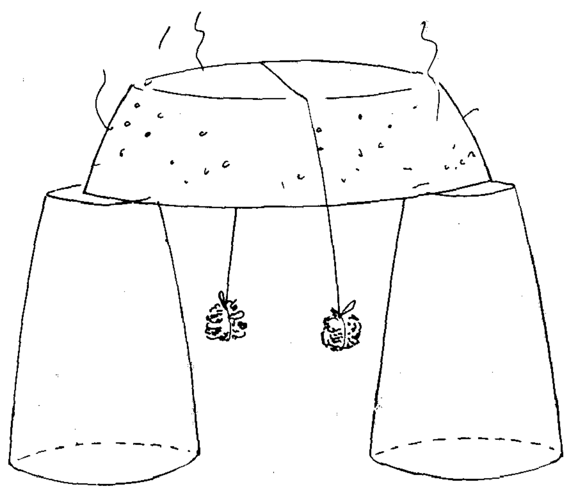
CUTTING ICE

Things Required:
Ice, a string about 30 cm long, two nearly similar stones, two tall glasses

Method:

1. Fill a small bowl with water and leave it to freeze in the freezer compartment of the refrigerator.
2. Tie the stones to the two ends of the string.
3. Place the glasses vertically and close to each other.
4. When the ice is well set, remove it from the bowl and place it between the two vertical glasses such that it acts as a bridge.
5. Now take the string with the weights and put it across the ice so that the string goes over the ice and the stones hang down.
6. Just observe what happens next.

Observation:
The string cuts through the ice and ultimately reaches its lower part and then falls down. The ice remains as it was.



What actually happens:
The melting point of ice is lowered under pressure. Where the string applies pressure, ice melts and the string moves down. However, when the pressure is removed, the water above the string again solidifies. People skate on ice because of this phenomenon.

IT'S EASY TO LOSE WEIGHT

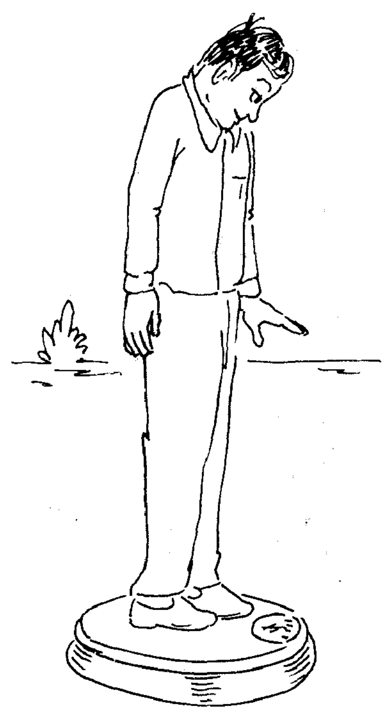
Things Required:
A weighing machine, preferably a hot day.

Method:

1. On a hot summer day take your weight on the weighing machine.
2. After that, go outside and play for about 45 minutes to an hour.
3. Don't come inside for a drink of water, even if you're thirsty.
4. After playing, when you come in and weigh yourself again, you will notice that you may have lost almost a kilogram.

What actually happens:
Most of the weight loss which you observe is due to water. While you were playing, you must have been sweating too. Your body produces this sweat to keep you cool because as the sweat evaporates into the air, it takes away excess heat from your body. So the weight loss which the weighing machine shows is actually due to the weight of the water which has evaporated.

This is why we drink more water in summer than in winter for we need to replace the water which has been lost through our skin in the form of sweat.



COOL DOWN

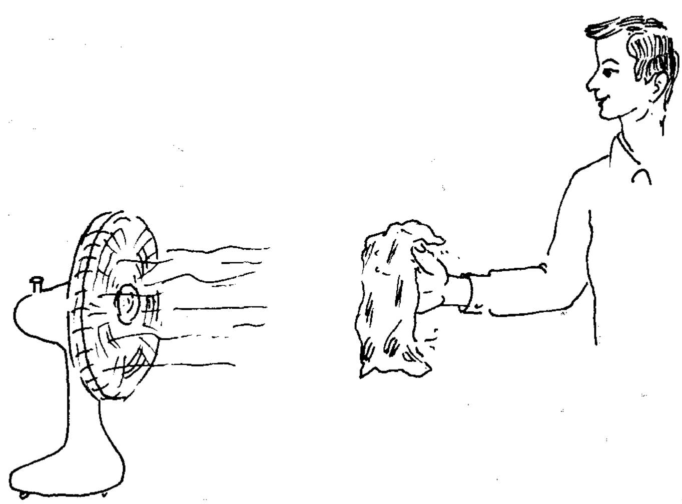
Things required:
A small piece of cloth or handkerchief, your time

Method:

1. Wet the cloth and then squeeze out any excess water.
2. Keep this on your arm and rest for sometime under a fan.
3. You will soon start feeling cool around the area of the handkerchief.

What actually happens:
Evaporation of water from the handkerchief produces this cooling effect on your arm. To evaporate, water takes latent heat from your body, and uses that to convert to water vapour. Hence the body feels cool.

Note:Since time immemorial, Indians have been using earthenware pots ('ghara'/'matka'/'surahi') to store water. These have tiny holes all over. Throughout the day water from these holes keeps evaporating and when doing so, it cools down the remaining water in the earthenware pot.



FEELING COLD ON A HOT DAY

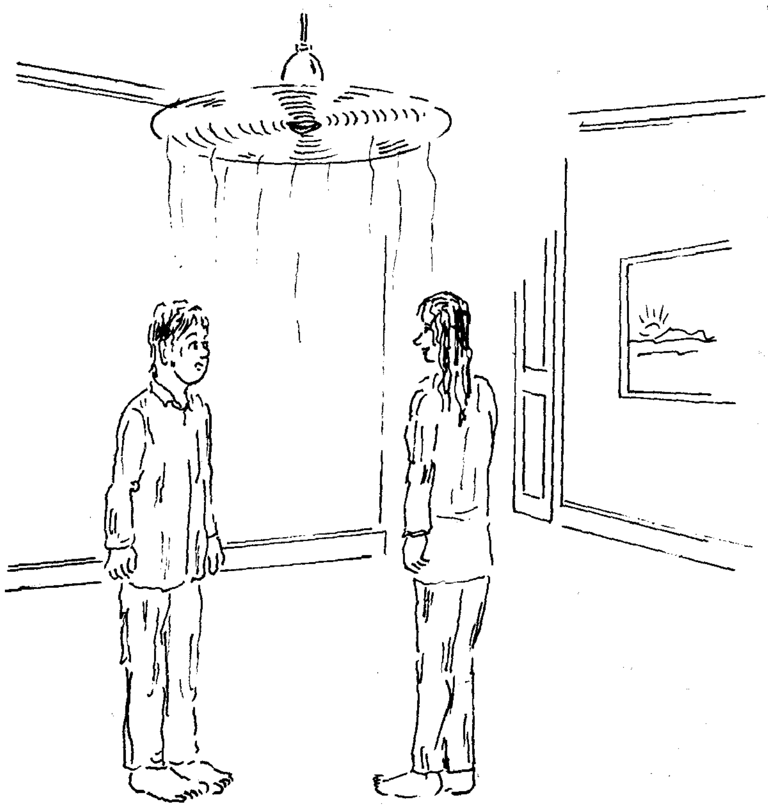
Things Required:
Some loose clothing (like a kurta pyjama for boys and a nightie for girls)

Method:

1. Take a bath and then without drying yourself with a towel, wear your loose clothing and go and stand under a ceiling fan.
2. At once you will start feeling very cold and may start shivering.

What actually happens:
When you stand under the fan without wiping yourself dry, there is water all over your body and some on your freshly worn clothes. Under the fan, the water starts to evaporate from your body and to do so it absorbs latent heat from your body. Hence the evaporation of the water produces the cooling effect.

In fact, this is what happens to us on a hot summer day. The sweat from our skin evaporates and goes into the air and our bodies are cooled.



SOUND

SOUND

Besides light, our other means of communicating with the outside world, is sound. Though sound is also waves, it is completely different from light waves. Light can travel in total vacuum but sound waves need a medium to travel. Sound travels through air and other solid and liquid objects.

The wavelength of sound is large (about 10 metres to a few centimetres) and hence can bend around corners. If we talk inside a room, people standing outside, though they might not be visible to us, may be able to hear us. On the moon, where there is no atmosphere, there is no sound.

Our brain and ears are sensitive to frequencies between 20 Hz and 20,000 Hz and this is called the audible range. Dogs can hear over a much wider frequency (15 Hz to 50,000 Hz). You may have heard of dog whistles, which when blown, we cannot hear but dogs can. Bats can hear up to 120,000 Hz and use these frequencies to guide them through forests and buildings in total darkness.

High frequency sounds (called ultrasonic sounds) are now used in medical diagnosis.

Like two eyes, we have two ears. These help us to locate the position of the source of sound.

HOW SOUND WAVES TRAVEL

Things required:
3 similar coins

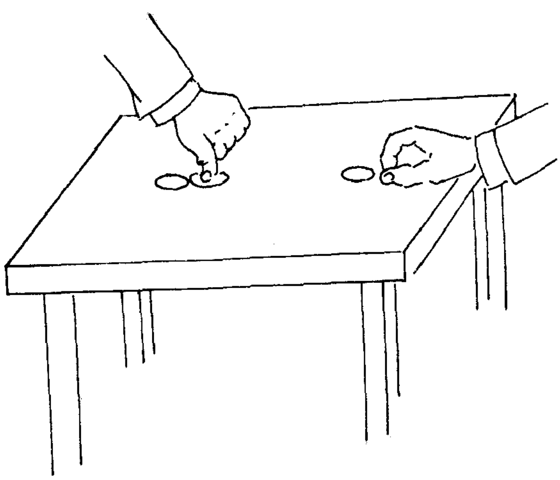
Method:

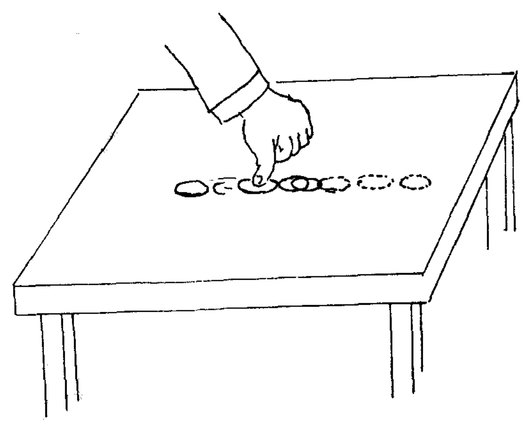
1. With one hand hold down one coin firmly on a table.
2. Place the second coin to its left, just touching it.
3. Snap the third coin so that it strikes sharply the opposite edge of the clamped one.
4. The second coin jumps smartly away.

What actually happens:
Although the clamped coin does not shift at all, yet the energy from the motion of the third coin is passed right through it. The edge of the fixed coin is first squeezed by the impact of the coin snapped against it. This impulse is then passed to the neighbouring particles; they pass it on too, until the particles at the opposite edge of the coin finally pass the impulse to the free coin.

It is by means of a similar game of pass-it-on between particles of air or any other substance, that sound gets from one place to another.

The source of sound is always some vibrating body.





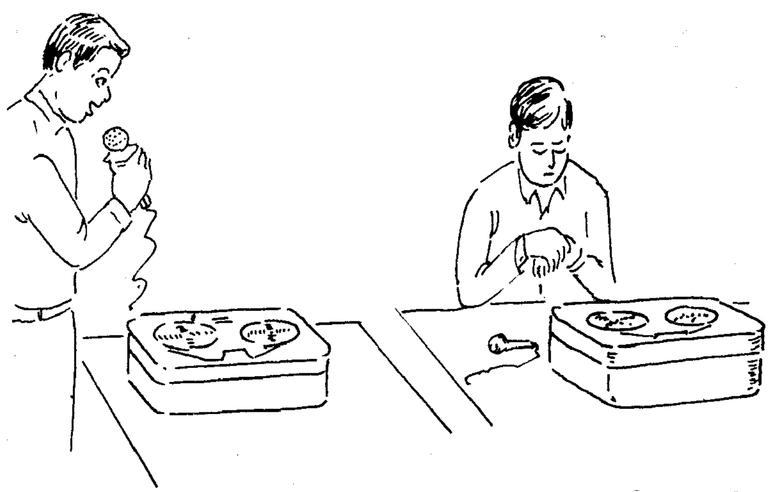
HEAR YOURSELF AS OTHERS HEAR YOU

Things required:
A tape recorder

Method:

1. Read out a short paragraph from any book and tape your voice while reading.
2. Now listen to the recorded version of your voice. It will sound very unusual and different to you when you will hear it but will sound quite fine to others!

What actually happens:
Throughout our lives we can never really hear ourselves as others hear us and so when we do listen to our recorded voice, it sounds as if it is not really ours! When we talk the sound reaches our ears through our internal structure and not so much through the air, as it reaches others.



A SIMPLE TELEPHONE

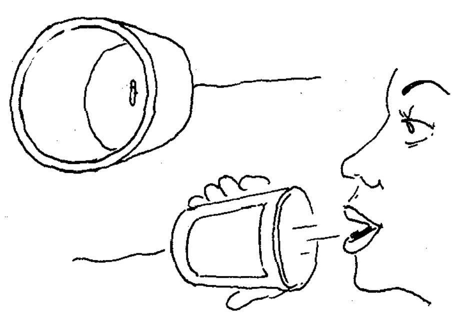
Things Required:
Two plastic or thermocol glasses or two tin cans, some long string (about 5-6 metres), two paper clips

Method:

1. Make a small hole in the base of each plastic glass.
2. Pass one end of the string through the hole of one glass from the outside of the glass to the inner side.
3. Keep a paper clip inside the glass and tie the string to it so that the string does not come out even if pulled.
4. Do the same for the second glass.
5. Your telephone is now ready.
6. Now give one end to a friend and ask him to keep it close to his ear while you talk into the other end. You must ensure that the string is fully stretched.
7. If your friend wants to talk then he should keep the open end of his glass close to his mouth and you should then keep your glass next to your ear.

What actually happens:

When you talk, your voice produces vibrations in the air in the glass. These vibrations travel through the taut string and produce similar vibrations at the other end (close to your friend's ear). The air in his glass vibrates and he hears exactly what you had whispered to him through your own mouthpiece.



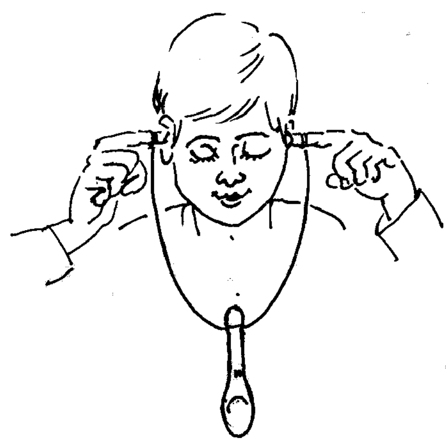
INVISIBLE BELLS

Things Required:
A heavy tablespoon, a piece of string about a meter long

Method:

1. Tie the spoon near the center of the string. Wrap the two ends of the string about your two little fingers so that the spoon hangs evenly.
2. Now close your ears with your little fingers and by moving your head back and forth, get the spoon to swing and hit something like the back of a chair or the edge of a table.
3. You will hear beautiful resonant notes as if a big bell were ringing.

What actually happens:
The sound which is rich in different frequencies is carried to your ears by the string through your fingers. Your fingers also plug out all other sounds and the sound from the spoon is heard loud and resonant. You can also try hanging a number of spoons and forks of different sizes.



SOUND MAGNIFIER

Things Required:
A balloon, a friend, a watch.

Method:

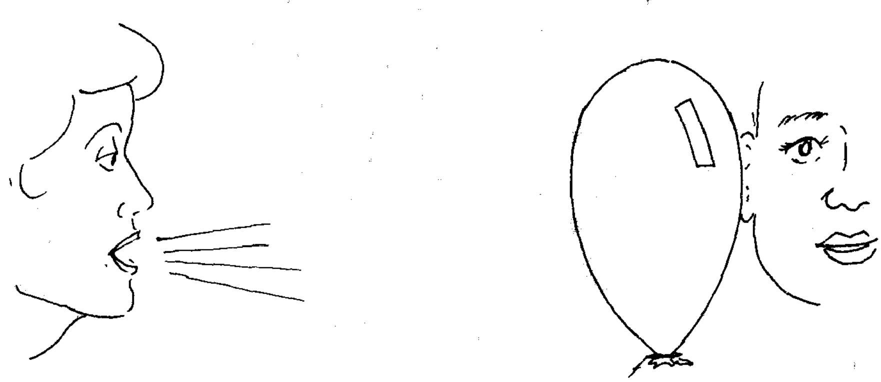
1. Blow up the balloon and tie it up.
2. Hold it close to your ear.
3. Ask your friend to stand at a distance and whisper something towards the balloon.
4. The sound of your friend's voice gets magnified very appreciably.

Variation:

1. Fill the balloon with water.
2. Then hold it to your ear with a ticking watch pressed to the other side.

What actually happens:

Sound vibrations travel better through liquids and solids than they do through air.



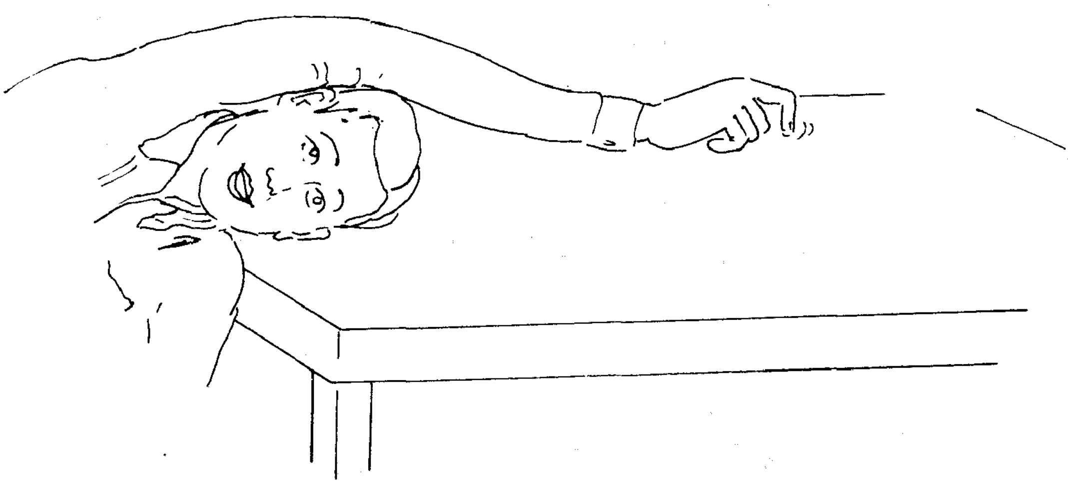
OH! THOSE EARS

Things Required:
Your ears, a table.

Method:

1. Keep one ear on the table and with your fingernail just softly tap the table.
2. You will be able to hear even the most soft tap which you normally may not even have heard if you did not have your ear to the table.

What actually happens:
Sound can only be heard when there is a vibration and this vibration reaches our ears.(Hence sound cannot travel through vacuum). It has to have some medium like air, water or even wood and other solid objects. This experiment shows that sound waves travel more easily through wood than through air.



SEA SOUNDS

Things required:
Few different sized glasses / bowls / 'katoris'

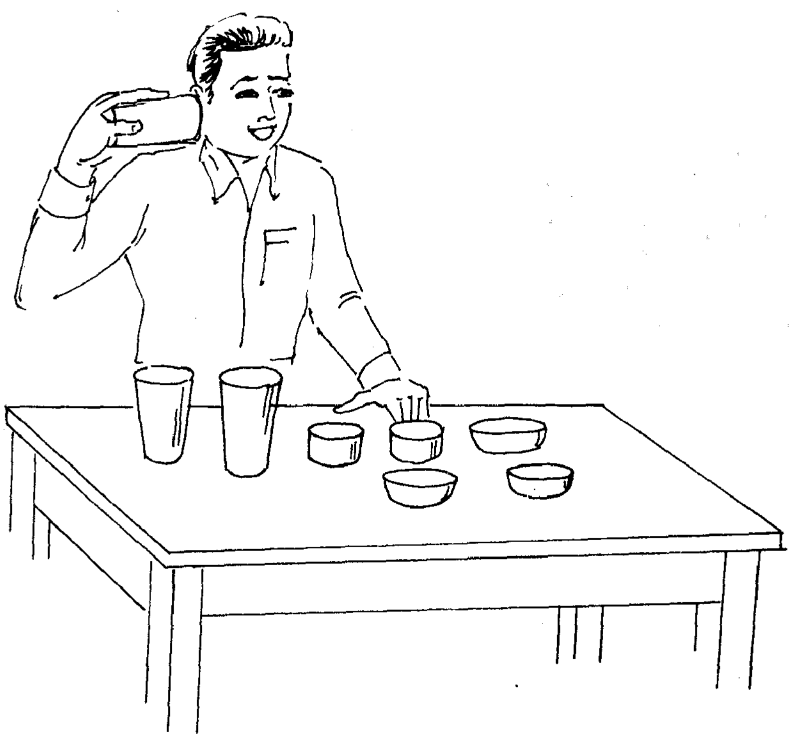
Method:

1. Keep each of these different glasses/bowls/katoris to your ear and listen. You will be able to hear the 'sound of the sea.'

What actually happens:
The air within any enclosed space of moderate size vibrates more easily at one definite pitch than another; the bigger the space, the lower the pitch, and vice versa.

The air around you is full of a mixture of sounds of different pitch.

When you put a glass to your ear, what you hear is merely an amplification of any sound from the hubbub that corresponds to the glass's own natural pitch.



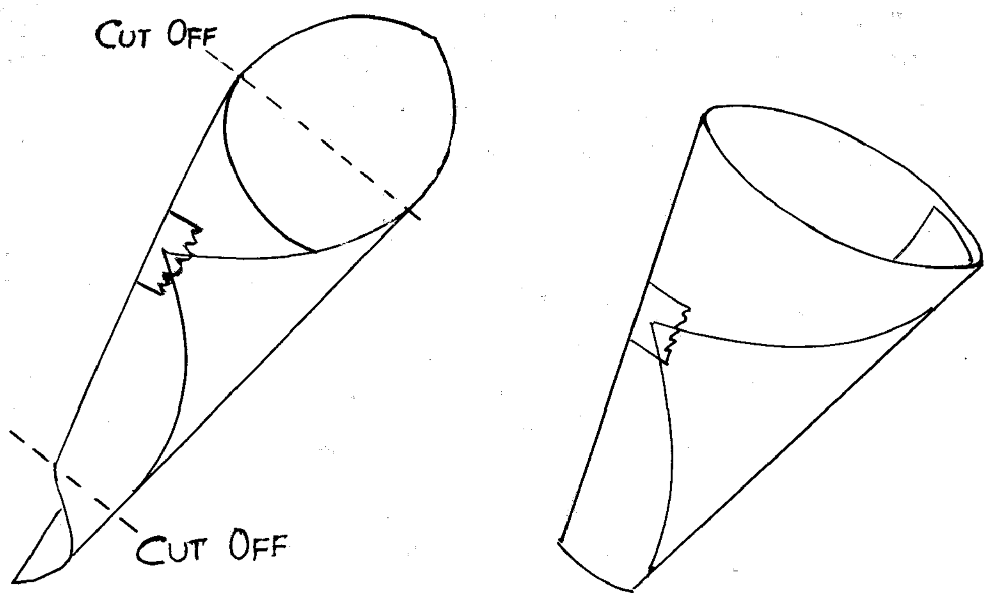
A MEGAPHONE

Things required:
A sheet of stiff paper or thin card, some cellotape

Method:

1. Roll up the paper and fix the end with tape as shown in figure A.
2. Then cut off the extra paper from the top and lower end.
3. Now you can talk into the lower end and your voice will be louder.

What actually happens:
The megaphone directs your voice and makes it louder.



A HOME-MADE GUITAR

Things required:
Any kind of box —a lunch box or plastic box or shoe box etc., several rubber bands of varying widths

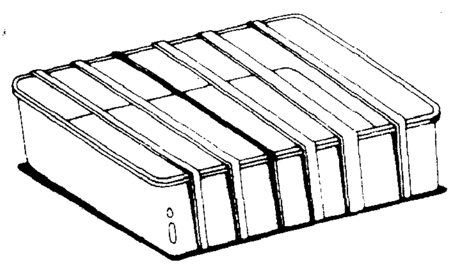
Method:

1. Remove the box top and stretch the rubber bands over the entire box.
2. The rubber bands should not be too close to each other.
3. Now pluck them to play the guitar.

   You will observe that the different widths of the rubber bands make different sounds.

What actually happens:
A guitar is a stringed instrument, and its sound is produced because of the plucking and strumming of its strings. When you pluck a guitar's strings, they vibrate. These vibrations cause the air molecules around the guitar to vibrate.

Similarly in the case of the box, when you pluck the rubber bands, they vibrate and hence produce the sounds.



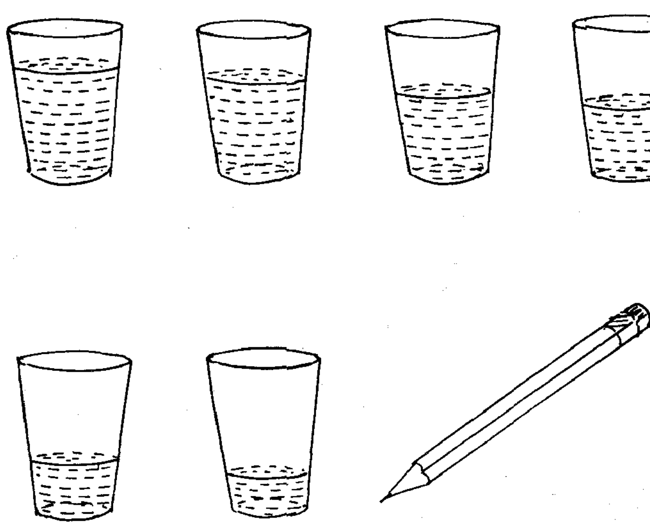
'JAL TARANG'

Things Required:
6 glasses/ bowls /'katoris', a pencil

Method:

1. Fill the 6 glasses with different quantities of water and arrange them in a line.
2. Tap the edge of each one with the pencil.
3. You will hear a different musical sound coming from each glass.

What actually happens:
Some particular sound frequencies resonate in the free volume above the water level and we hear these. In another glass with a different water level, the resonating frequencies will be different and we will have a different note.



STRAW FLUTES

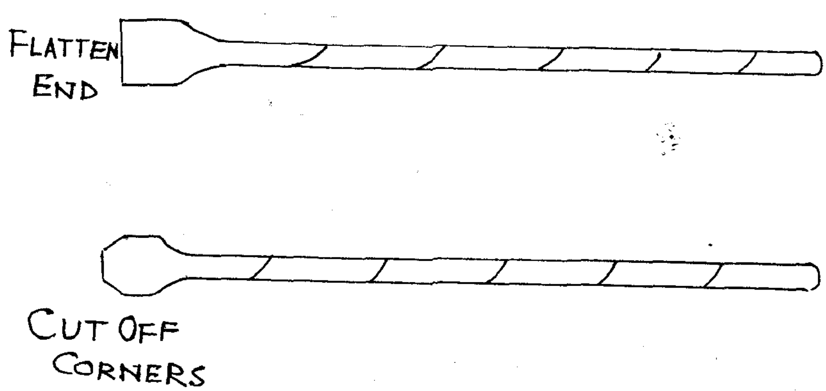
Things required:
Some straws, scissors

Method:

1. Flatten one end of the straw.
2. Carefully use the scissors to cut this flattened end so that it becomes pointed as shown in the diagram.
3. Hold the straw loosely in your mouth and gently blow into the straw.

   (Playing the flute on this is slightly difficult but once you practice a little, you will see that your flute produces beautiful music.)
4. Now try cutting the remaining straws to make flutes of different lengths.

What actually happens:
Some sound frequencies will resonate for a given length of the tube. You will hear only these notes. If you want to hear other notes, you will have to change the length of the straw.



LIGHT

LIGHT

We observe the world around us with our eyes. Light helps us in this. The sun is the main source of light for all life on earth. Apart from helping us to see the world, it sustains all plant life.

Light from the sun is composed of seven colours- red, orange, yellow, green, blue, indigo, violet. When light falls on an object it is scattered in all directions. Some of it reaches our eyes and the eye lens focuses it on a screen at the back of the eye ball, which we call the Retina. When an object, say, reflects only red light and absorbs all other colours, it will appear red. Leaves on the other hand reflect green light and absorb all other colours.

Why do we have two eyes? If you close one eye and see with only one eye, you will notice the difference. With one eye, everything looks flat. One cannot judge the distance of an object relative to another. With two eyes, two images are formed at slightly different angles and the brain combines these two images to present one three dimensional picture (a picture with depth).

Our eyes are a marvel of nature. A baby, before being born, is in the mother's womb, where there is total darkness. Eyes develop there, like all other organs and parts. When a baby is born, she opens her eyes and is able to see the world around. How did the cells inside the womb know that when the baby comes out there would be light outside of particular wavelengths to which its eyes are sensitive ?

Light travels as electromagnetic waves with a speed of $3x10^8$ m/s (299792458 m/s exact) in vacuum. In water or glass or any other transparent medium, the speed of light is less than this. The wavelength of visible light lies between $6.7x10^{-7}$ m for red and $4.5x10^{-7}$ m for violet. Electromagnetic waves of other wave lengths also exist. On the long wave length side we have infrared (heat) waves, microwaves and radio waves. Radio waves have a wavelength ranging from a few tens of metres to a few hundred metres. On the low wavelength side we have ultraviolet rays, X-rays and gamma rays.

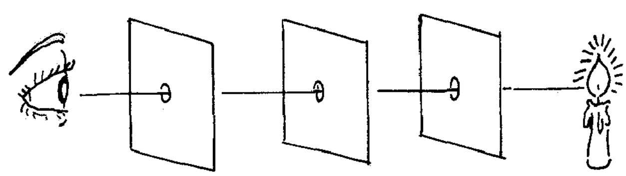
LIGHT TRAVELS IN STRAIGHT LINES

Things required:
Some cards, a lit candle

Method:

1. Make a tiny hole in each of the cards.
2. Arrange the cards in a line .
3. Behind the last card place the lit candle.
4. Now look through the hole in the first card. You will notice that it is possible for you to see the light of the candle only if all the holes are in a straight line.

What actually happens:
Since light travels in straight lines the candle at the end is visible only if the cards are precisely arranged such that the holes are in a straight line.



IMAGES OF IMAGES

Things Required:
Two plane mirrors, some cello tape, a candle, a matchbox

Method:

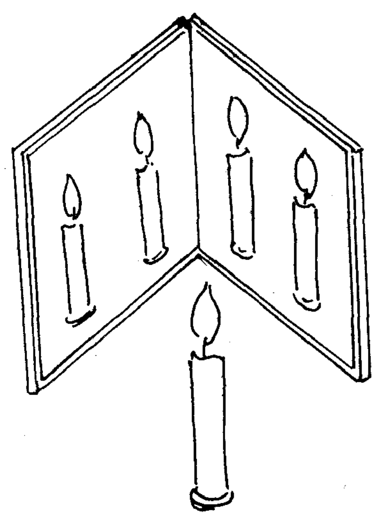
1. Place the two plane mirrors on a table and hinge them together with some cello tape.
2. Place the candle in the angle between them.

Observation:
Look into the mirrors and see how many images there are. Close the mirrors slightly and see what happens to the number of images.

As you keep making the angle between the mirrors smaller, the number of images keeps growing.

Now separate the mirrors, support then upright so that they exactly face each other and place the candle between them. If you look over the top of one mirror *into the other, you will see a row of candles stretching away from you. These are* images of images of the single candle.

What actually happens:
What actually we see are the successive reflections in the two mirrors and the number of images depends upon the angle between the mirrors. If the mirrors are parallel to each other the number of images formed, in principle, is infinity.



SEE YOURSELF AS OTHERS SEE YOU

Things required:
Two plane mirrors

Method:

1. Keep the two mirrors at right angles to each other.
2. Now look at your face in the two mirrors so that half of it appears in each mirror.
3. You will find that you do not look the same as you normally do when you see yourself in a mirror. You can now see yourself looking the way you do to others.

When you normally look at yourself in the mirror you will find that if you have your hair parting on the left, then in the mirror, the reflection has a parting on the right and vice versa.

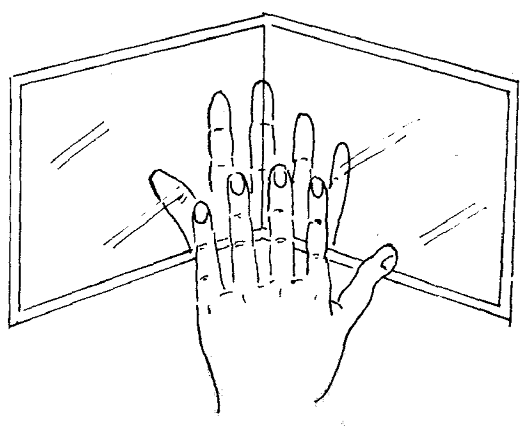
But when you look at your reflection in the two right-angled mirrors, then your hair parting remains on the same side as it actually is.

Try touching your left ear to make sure the image is the right way round.

Also hold a book page in front of the mirrors-instead of appearing backwards, as they would in a single mirror, the letters and words are lined up in their proper order.

What actually happens:
It sounds strange, but no part of the self that you see in the pair of mirrors comes originally from the single mirror in which it is seen. Remove either mirror, and you will have no image at all.

What actually happens is that the image on the left side of your face is caught by the left-hand mirror and is reflected over to the right-hand mirror, which in turn reflects it back to your eye. The same holds true for the image on the right side.



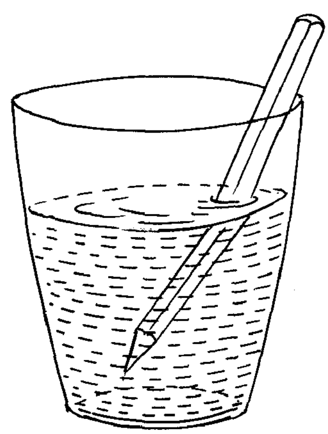
THE BENT PENCIL

Things required:
A pencil, a glass/bowl of water

Method :

1. Look intently at the pencil. It appears straight.
2. Now keep the pencil in the bowl of water such that only half of it is immersed in the water and then observe it.
3. It appears to be bent!
4. If you could manage to move the whole pencil into the water, then again it appears to be a normal straight pencil.

What actually happens:
When you put the pencil in the bowl of water and look at it from the side, it appears to be bent or broken at the water-air interface. This is due to the refraction of light at the water-air interface. The portion of the pencil in water appears raised and hence the pencil appears bent.



BENDING OF LIGHT

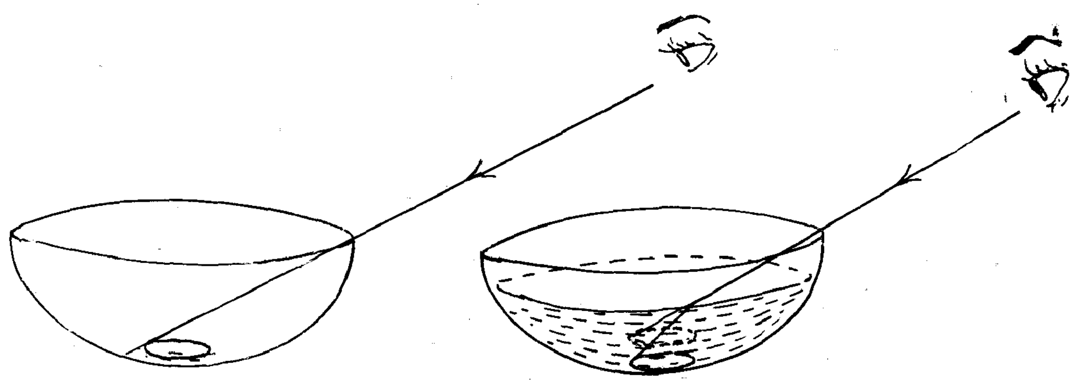
Things Required:
An empty bowl, water, a coin

Method:

1. Put the coin at the bottom of the empty bowl and place the bowl on a table.
2. Stand at a short distance from the table so that you can just see the coin over the edge of the bowl.
3. Move a little further so that the coin just goes out of view.
4. Now ask someone to pour water into the bowl.
5. Gradually the coin will come into view.

What actually happens:
When light rays travel from a denser to a rarer medium, they move away from the normal. The light coming from the coin bends when it travels from water into air and is able to reach your eyes. This bending of light when it travels from one medium to another is called refraction.

Though the rays of light from the coin bend when they travel out of the water into the air, yet to your eye they seem to have travelled in a straight line. So the coin and the bottom of the bowl appear to be raised.



A HOMEMADE MAGNIFYING LENS

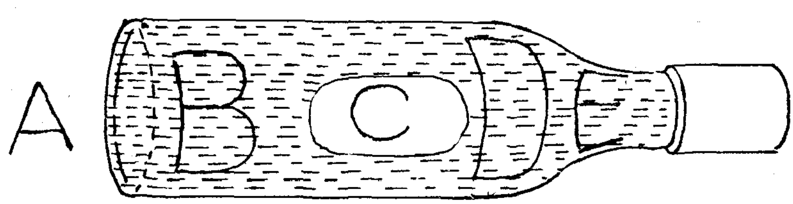
Things Required:
A clean, dry, clear (preferably narrow) glass bottle.

Method:

1. Fill water up to the brim and then screw on the bottle cap.
2. Let the bottle lie horizontally. Make sure no water leaks out.
3. In the horizontal position you will notice that a big air bubble can be seen which moves from left to right if the bottle is moved around.
4. Keep this bottle on any reading material with fine print (like a newspaper).
5. You will notice that every letter gets magnified many times.
6. Now look at the printed words through the air bubble. Every letter seems to shrink.
7. Also look at your palm through the water.

What actually happens:
The bottle, filled with water, acts as a convex (cylindrical) lens (thick in the middle). When it is held against the text, the words look bigger because the bottle lens bends the rays of light inward. Your eyes trace the light rays back in straight lines and 'see' a 'virtual' image that appears larger.

Variation
Take a card-maybe an old postcard. Punch a hole in it with a punching machine. Drop a drop of water in the hole. It will hang down. Now use this as a magnifying lens. The drop forms a convex lens of water.



OPAQUE WATER

Things required:
A coin, a deep bowl full of water, a small transparent glass

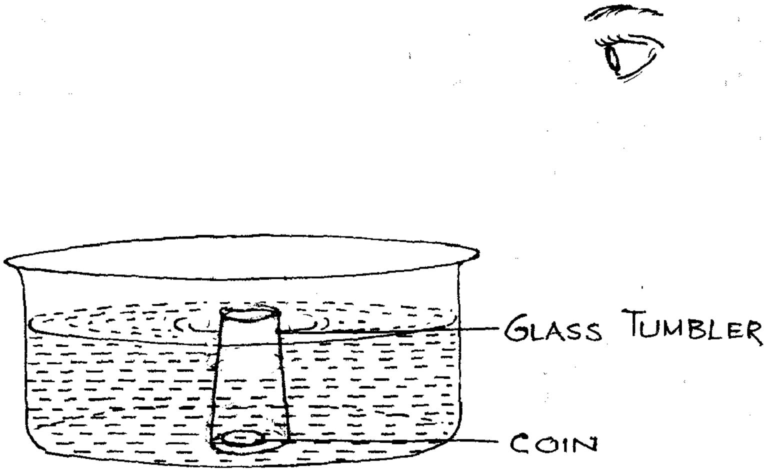
Method:

1. Place the coin at the bottom of the deep bowl which is half full of water.
2. Lower the inverted glass straight down, so that the air in it keeps out water.
3. Keep looking diagonally at the coin.
4. As the glass is lowered, the coin disappears!

   (If, of course, you look straight down through the glass, from there you will find that the coin is always visible.)

What actually happens:
The undersurface of the water becomes as opaque and as bright as a shining, silvered mirror. A trick of light, called total internal reflection, prevents the coin from being visible.

You know that when light rays travel from water to air, they deviate away from the normal. The greater the angle of deviation, the more they are bent. When the angle becomes 48 degrees (for water) the rays cannot get through the surface at all but are bent back into the water. Because of this phenomenon, a diver can see out of water only through a circle that extends about 48 degrees to each side of the vertical.



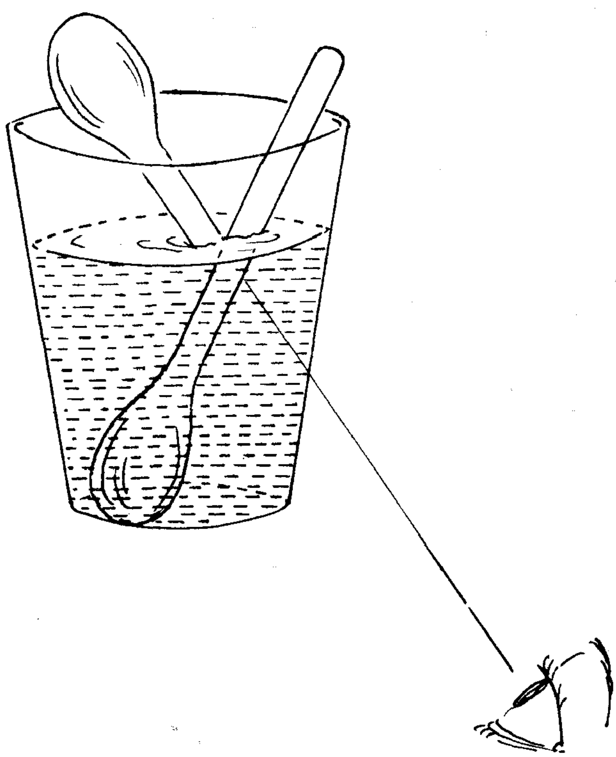
THE WATER MIRROR

Things Required:
A glass nearly filled with water, a spoon.

Method:

1. Place the spoon in the glass.
2. Hold the glass above the level of your eyes and look up inside the glass from the side.
3. The under surface of the water seems to be shining like a mirror.
4. The spoon gets reflected in this 'water mirror' and can be seen shining brilliantly at position A.

What actually happens:
As mentioned previously in 'Opaque water,' in this experiment too, the undersurface of the water becomes opaque and shines as if it were a bright and a shining, silvered mirror. The spoon in the water gets reflected in this shining undersurface and we see the reflection at position A.



RAINBOW COLOURS THROUGH A FEATHER

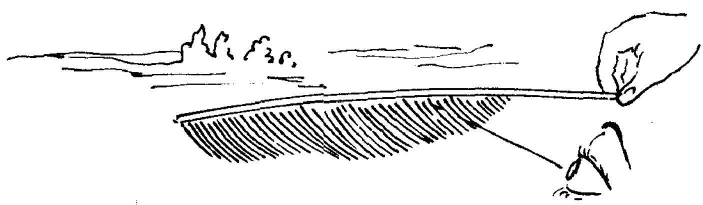
Things required:
A bird feather

Method:

1. Be careful not to disturb the natural combed look of the feather.
2. Very carefully look at a distant bright light through this naturally combed feather.

   (BE EXTREMELY CAUTIOUS AND NEVER LOOK AT THE SUN DIRECTLY.)

Observation:
The feather acts as a fine grating and so you will be able to see rainbow colours.



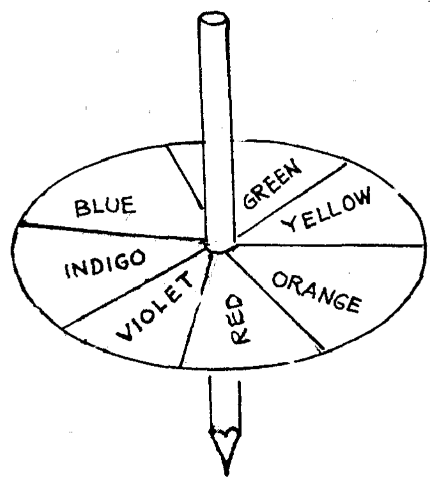
NEWTON'S DISC

Things Required:
A circular disc of cardboard about 10 cm in diameter, crayons, a pencil about 6-7 cm in length, a ruler

Method:

1. Take the disc and divide it into seven equal segments with the help of a pencil and ruler.
2. Colour these sections red, orange, yellow, green, blue, indigo, violet in this order.
3. Pierce a hole through the centre of the circle and push the pencil through it. You now have a top.
4. If you spin this fast, you will find the colours merging together and the card will appear grey.

What actually happens:
White light is made up of the seven colours of the rainbow and so when you were rotating the disc it should have appeared white. But because the colours of the crayons are not the pure colours of the spectrum, and also because they are not mixed in the right proportion, we do not see pure white when we rotate the disc.



SOLAR SPECTRUM

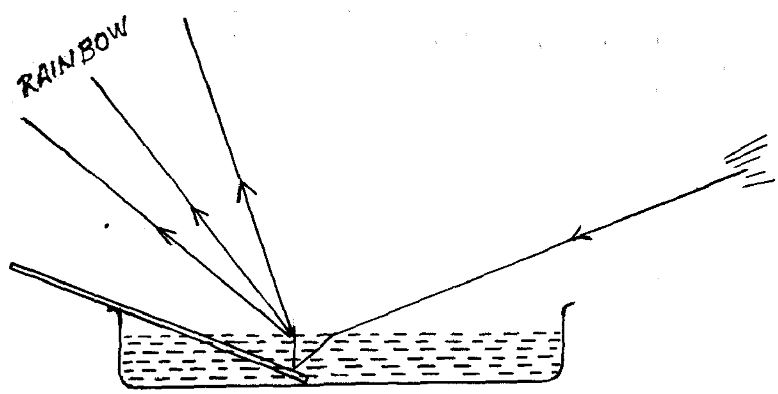
Things required:
A shallow container about 4 cm X 8 cm (preferably the usual lunch box) , a small mirror

Method:

1. Fill the container completely with water and around late morning or afternoon, place it inside a room where sunlight is falling, such that the sun rays fall on it.
2. Place the mirror at an angle (as shown in the figure). Adjust the angle of the mirror until you get a band of colours on the wall or ceiling.
3. You will see a white patch on top and a beautiful spectrum below it.

(If you disturb the surface of water in the container, the colours will mix together again to make white light)

What actually happens:
Sunlight is really a mixture of different colours. The arrangement above serves as a prism and splits the sunlight into its different components. (Raindrops bend some colours more than others and so they are separated out to make a rainbow.)



A COLOURED WORLD

Things required:
Some pieces of cellophane paper of different colours, a big birthday or greeting card, scissors

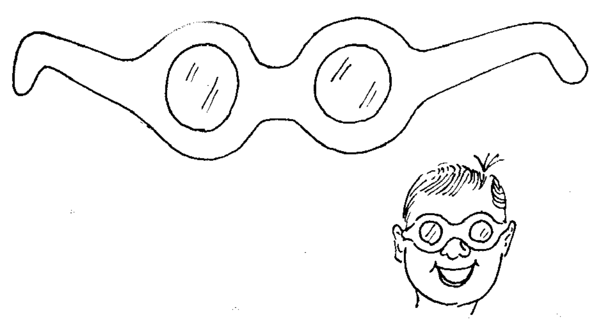
Method:

1. Draw out life sized spectacles on the card, as shown in the figure and then cut them out.
2. Also cut out the holes where you will keep the cellophane lenses.
3. Now cut out circular pieces of the cellophane and keep two pieces of the same colour in the holes of the spectacles and hold them firmly.
4. Now look at the world through your coloured glasses.
5. Keep changing the cellophane paper and see how the world appears then.
6. Try to confuse your brain by using a different coloured cellophane for each eye-try red and green or yellow and blue.

Variation 1
You can also wrap your cellophane pieces around a torch and hold them in place with a rubber band.

Now go to a darkened room, and using the coloured beam, direct the torch-light to different things in the room. You will be amazed at what you see.

Variation 2
Cover a torch with red cellophane. In the night, in a dark room, shine the torch on a white wall from about a metre. Ask someone to hold an object, say a book, in the light so that it casts a shadow on the wall. The shadow should appear greenish.



MAKE THIS ACCORDING TO YOUR SIZE

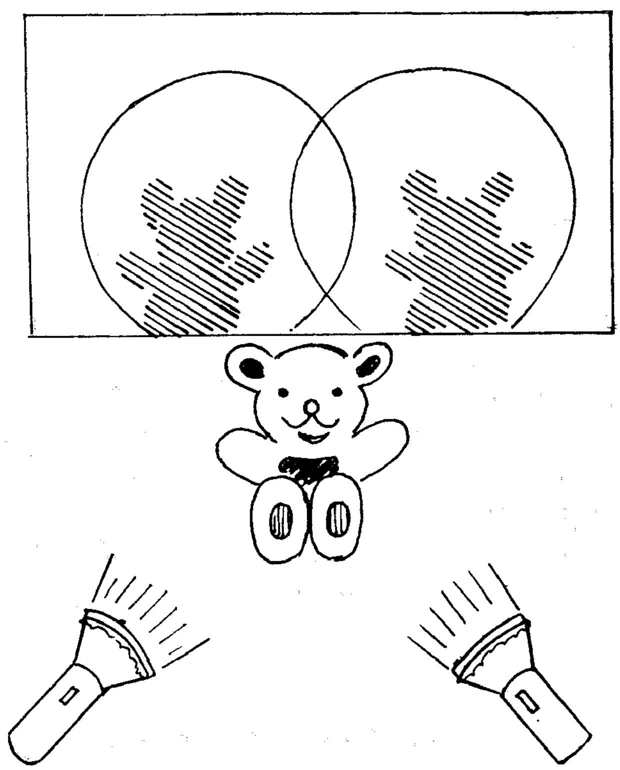
COLOURED SHADOWS

Things Required:
Two torches, two different coloured cellophane papers, say red or blue, any small objects, a white sheet of paper

Method:

1. Cover the front of the two torches with the two different coloured cellophane papers.
2. Keep any small object in front of the white sheet of paper and shine the two torches on it from two different directions.
3. Each torch will cast a shadow of the object on the paper. One shadow will be red, the other blue and the background will appear a shade of pink.
4. You can use other sets of colours and the torches may have to be placed at different distances from the object for best results.

What actually happens:
As long as the two shadows do not overlap, the region of each is illuminated by the light of only one colour, and therefore has that colour. The background receives light of both colours and therefore appears to be a mixture of the two–pink in the case considered.



(A) SEEING IS BELIEVING

Things required: Your eyes, a small hand mirror

Method:

1. Find a fairly dark place and look at your eyes in the mirror. (Look at the dark part in the centre-called the pupil-you will find it is quite large.)
2. Now go out in the sun for a few minutes and then look at the pupils in the mirror. They seem to have shrunk!

What actually happens:
The pupil of the eye is the part which lets in the light. Our eyes have a way of *opening to let in more light when we are in a dimly lit place and of closing up if* the light is bright. Hence the pupils dilate or contract according to the amount of light present at that point of time.

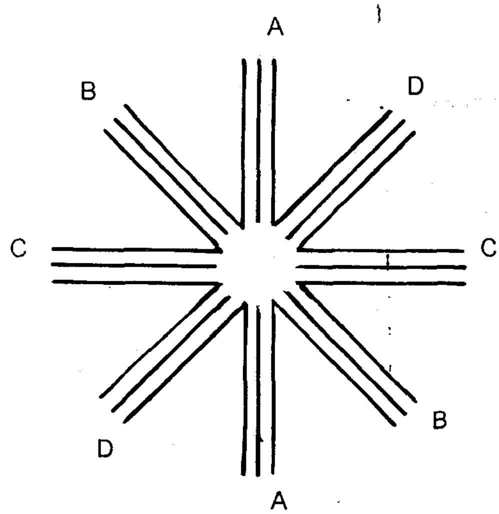
Some people think that owls and cats can see in complete darkness, but they cannot. They have special eyes which work better in very dim light than do those of most animals, but there must be some light.

There is another feature of our eyes which you may not have noticed. In bright light we can see and distinguish different colours. In dim light we cannot distinguish colours and everything appears a shade of grey.

Try this in your room, either very early in the morning or a little late in the evening when the light in the room is very dim.

(B) ARE YOU ASTIGMATIC?

This will let you know whether you are astigmatic or not.



Things required:
Your eyes, the figure given on this page

Method:

1. Take off your spectacles if you use them.
2. Shut one eye and look closely at this figure.
3. Do you see any difference in the darkness of the different lines AA, BB, CC and DD or do they appear to be equally dark?
4. Now shut this eye and open the other one. Try the same with this eye. If all the lines appear equally dark, your eyes are fine. But if some lines appear less dark than others, then you suffer from astigmatism! This just means that your eye lens is not truly spherical but also slightly cylindrical. This can be corrected by a cylindrical lens.

GHOST FINGER

Things Required:
Patience and determination, your time and your fingers.

Method:

1. Hold both hands about 15cm in front of your eyes with the forefingers touching each other.
2. While looking far beyond the fingers, just separate them slowly. You will be able to see a ghost finger hanging in the air with a nail on either side.
3. If you focus your eyes on it, it disappears, but appears again when you look far.

What actually happens:
This phenomenon is due to binocular vision. The two eyes do not form exactly identical images. Each one has its own field of vision differing slightly in angle from the other. When you are looking far, the images of the ends of the two fingers are not coincident and you get two separate images.

If you continue to pull the two fingers apart you will find the ghost finger shortening and finally it disappears when the distance between the two fingers is about 3-4 cm.

Variation:
Draw a tiny dot on a sheet of paper and place in on a table. Now take a pencil and with one eye closed bring the pencil on the dot. You will find that it is not as easy as it looks.

A HOLE IN YOUR HAND

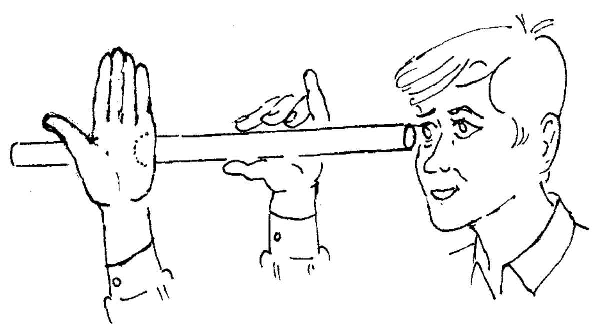
Things required:
A sheet of paper, your hand

Method:

1. Roll up the sheet of paper and hold it against one eye.
2. Keep the other hand, palm open, about 15 cm from your nose and touching the rolled up sheet.
3. Keep both eyes open and look straight ahead.
4. You will see a hole in the palm of your hand.

What actually happens:
Normally when you see things, both your eyes look at the same object. When the brain receives the messages from both the eyes it combines the messages and enables you to see the object as it really is.

In the above experiment, one eye sees the palm and the other looks at objects through the rolled–up sheet. The brain uses this mixed-up information from the eyes and makes it appear to you as if you have a hole in your hand!



A ONE – EYED VIEW

Things required:
Your two index (pointer) fingers

Method:

1. Shut one eye, and keeping your hands about a foot away, point the two index fingers at each other.
2. Now bring the hands close together and try to touch the tips of the index fingers together.

   The results may surprise you !
3. To try again, drop your arms out of position between each try.

What actually happens:
This simple exercise becomes hard because we owe our ability to judge depth, or the distance of any object away from us, to the fact that we use two eyes, which view the object from slightly different angles.

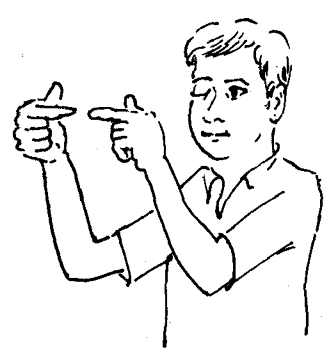


IMAGE FORMATION IN THE EYE

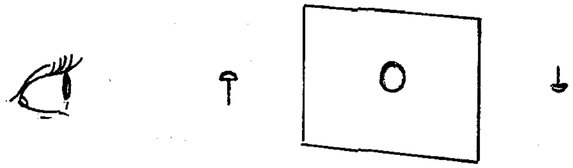
Things Required:
A postcard or visiting card, a pin

Method:

1. Make a pin hole in the postcard and hold it against a bright window or a lamp, about 10 cm from your right eye. Shut your left eye.
2. Take the pin and bring its head between the card and your eye, such that its head is opposite the hole.
3. It will appear as if the pin is beyond the hole and what is more important is that the pin will appear upside down.
4. Move the pin to the right, and the pin will appear to move to the left.
5. Repeat this with the pin beyond the hole in the card and observe again.

What actually happens:
When we look at the outside world, the image formed on the screen (retina) of the eye is inverted, as with a convex lens. Our brain inverts this again and presents an upright view. In the case of the pin, the image formed is erect and the brain, according to its habit, presents us with an inverted view.

This inversion phenomena which you have just seen using only the eye as the lens is the same principle which is used in a pinhole camera in which an inverted image of an object appears on the screen.



THE FISH IN THE WATER

Things required:

Half of a regular greeting card, a pencil, some cello tape,

Method:

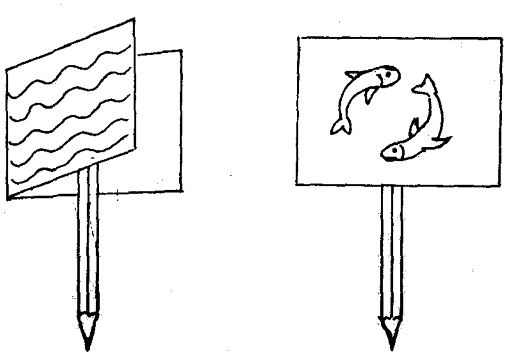
1. Fold the card into a neat half such that the blank portion is on the top and the bottom.
2. Now draw two related pictures-one on the top and the other on the other blank side. Make sure the pictures make sense together-so draw a bird and a tree/ a ship and the sea/ a table and a bowl of fruit or a fish and water etc.
3. Tape the pencil to the middle of the inside of one side and fold the other half over and tape both the opens ends together so that the pencil is sandwiched between the two portions.
4. Now put the pencil between the palms of your hands and quickly twirl it.

   You will see that the two separate images you drew merge together into one image.

What actually happens:

Whatever we see leaves an impact on our eyes for around 1/16th of a second. Because of this property of the eye, while the image of the fish left an impact on our eyes, the water was made visible to us and vice versa. Hence, because we saw the pictures in quick succession they appeared to be one entity and the fish appeared to be inside the water.

Motion pictures that you see in movie halls are based on this property of the eye.



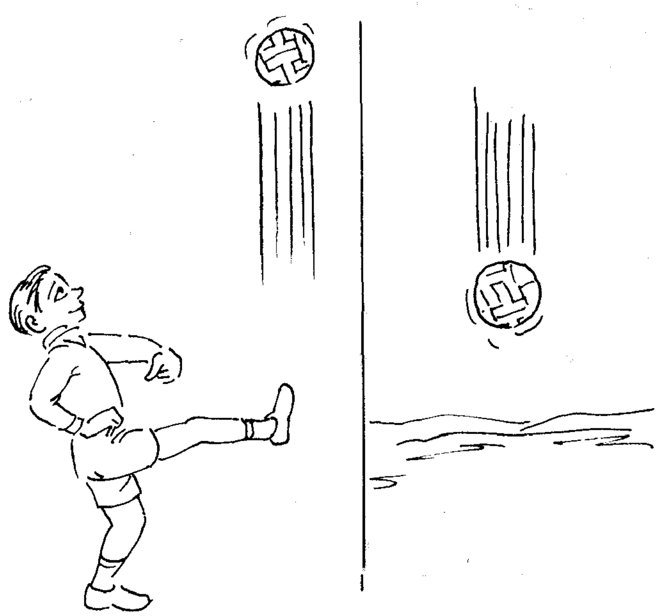
FORCES

FORCES

There are three forces in nature which act on a big scale: gravitational, electrical and magnetic.

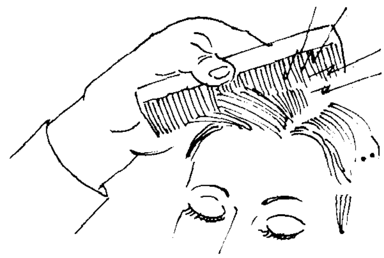
(A) Gravitational force:

We exist on the surface of the earth because of gravitational force. If we drop any object, it falls towards the surface of the earth. Even a football kicked high up, soon comes down. Newton for the first time gave a proper form to this law of attraction between any two bodies in the universe. It was for the first time that man learnt that laws discovered by him on the earth could also be applied to the heavens- the stars, the sun, the moon. It was a great revolution in human thinking.



All bodies, whether inanimate or living, fall to the earth's surface along a line joining the centre of the earth to the body. Once they are on the surface of the earth, all bodies rest in some particular position. You can stand comfortably on two legs but not many can stand on one leg for long. A chair cannot stand on one leg or even two legs without your support. What determines which is a proper equilibrium position? A line drawn straight vertically down through the centre of gravity of the body, must lie within the support system of the body.

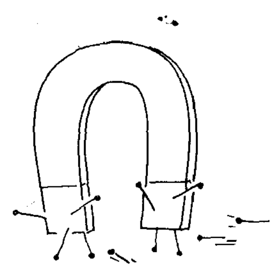
(B) Electrical force:



After combing dry non-oiled hair with a plastic comb, if you take it near tiny pieces of paper, you will observe that the comb attracts these pieces of paper. If you comb your hair in a dark room at night, when the air is dry, you should be able to see tiny sparks between the hair and the comb. A rubber balloon rubbed on woollen cloth will get 'charged' and stick to a wall. These are a few examples of a new kind of force which we call electrical force.

We find that there are two types of charges, one we call positive and another we call negative. Like charges repel and unlike charges attract. Now that we know something about the structure of matter, we have learnt that all matter is composed mostly of charged particles (some electrically neutral particles also exist and they are an important constituent of matter). Present day society is dependent on electric current and electric motors. The lightning you observe or hear during the rainy season is also electric in nature.

(C) Magnetic force



You may have seen or handled magnets. The Earth is a huge magnet. Magnets also have two 'poles'-one is called north and the other south. Like poles repel and unlike poles attract. In the generation of electric current magnets play a big role.

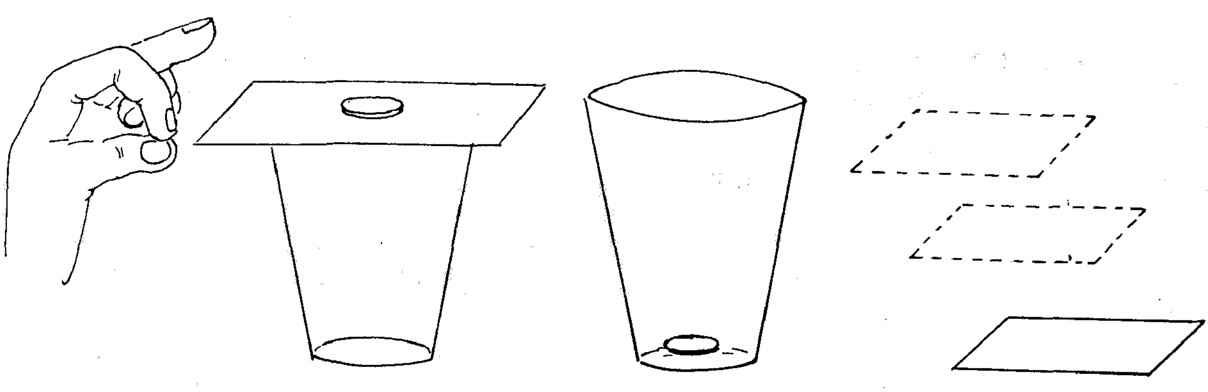
INERTIA

Things Required:
A glass, one playing card or postcard, a one rupee coin

Method:

1. Place the glass on a table and cover its mouth with the postcard or playing card and place the one rupee coin over the card.
2. Ask your friend, whether without lifting the card, he can make the coin fall into the glass.
3. If he fails. flick the card away sharply with your fingers, and watch the coin drop into the glass.
4. If you replace the card and the coin and pull the card away gently, you will find that the coin goes with the card and no longer drops into the glass.

What actually happens:
When the card is flicked away fast enough, the coin does not go with the card but stays behind, obeying the law of inertia, and with nothing to support it, falls into the glass. When the card is pulled away gently, the force due to inertia is small and less than the force of friction between the coin and the card- the coin therefore moves with the card.



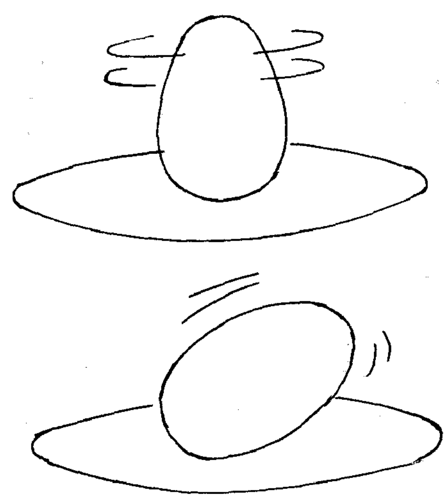
BOILED EGG VERSUS RAW EGG

Things Required:
One boiled egg (with shell), one raw egg (with shell), two plates

Method:

1. Keep the two eggs together and then interchange their positions a few times.
2. Now try to find out which one is boiled and which is raw.
3. To do this, just rotate each egg in a separate plate.
4. The boiled egg will spin steadily for quite a while. The raw egg will just take a shaky spin or two and will then stop altogether.
5. Now spin them again, this time stopping each egg with your hand in the midst of its spinning. Curiously, the boiled egg remains still when you release it, while the raw one starts spinning again on its own.

What actually happens:
The reason for this strange action on the part of the raw egg is internal friction. The initial motion of the egg shell being so fast, the inner layers of the egg slip on the outer layers and change part of the energy of rotation into heat. Hence the egg cannot spin for long.



But, when the egg is stopped from spinning, the liquid interior continues to revolve. This starts the shell spinning again when it is released.

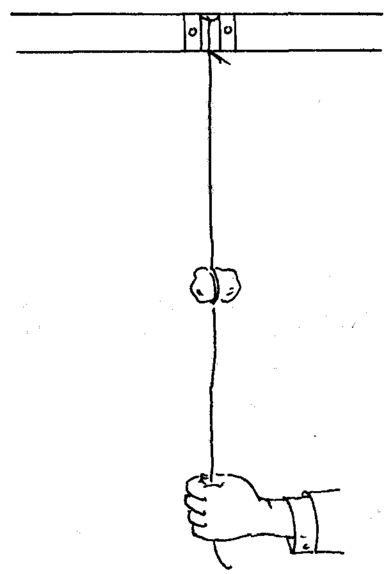
THE MAGIC STRING

Things Required:
A stone, 2 pieces of weak string—each a metre long (the string should not be very strong)

Method:

1. Tie the stone around the middle of the string.
2. Tie one end of the string to a rod or some suitable object so that the stone and string hang freely.
3. Now pull the lower string steadily downwards. You will find that the upper part of the string breaks.
4. Repeat steps 1 and 2 and then give the lower string a sharp downward jerk. This time it is the lower string which will break.

What actually happens:
When you gave the lower string a steady downward pull, the upper string had to support the weight of the stone in addition to this pull and so it broke first. When you gave a jerk, the inertia of the stone prevented the full force of the tug from being communicated instantaneously to the upper string and so it was the lower string which broke first.



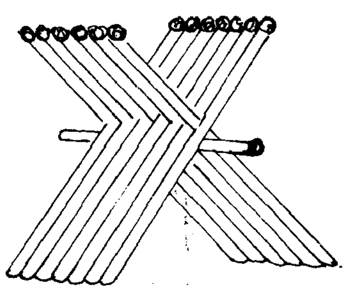
SUSPENDED MATCHSTICKS

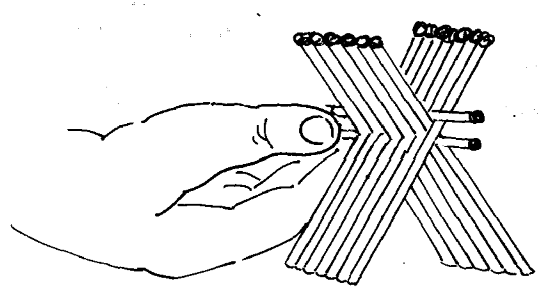
Things Required:
16 wooden matchsticks.

Ask a friend if he can lift 14 matchsticks with the help of just two matchsticks. If he gives up, try as follows-

Method:

1. Put 1 matchstick on the table.
2. Crisscross 14 other matches on the first match like in the picture.
3. Put the 16th match right on top of the first one but along the angle formed by the crisscrossed matches.
4. Now lift up all the matches, just by holding on to the 1st match
5. All the matches assume an oblique position and remain suspended between the 1st and the last matches.





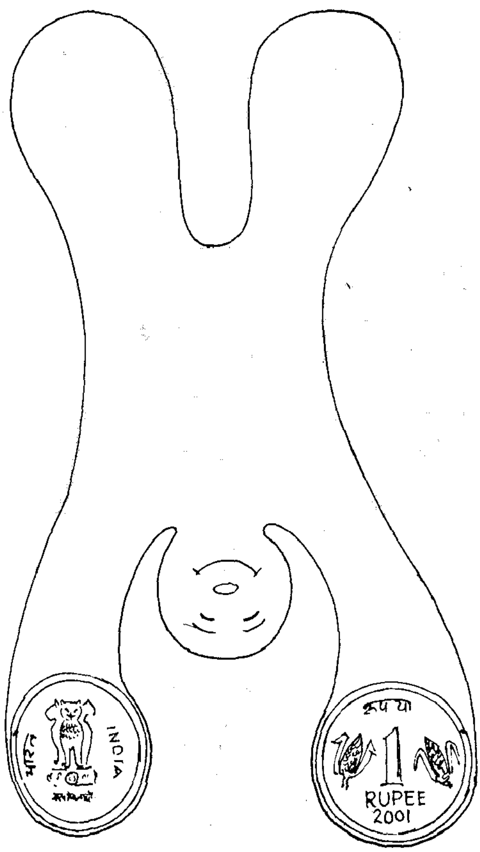
THE BALANCING ACT

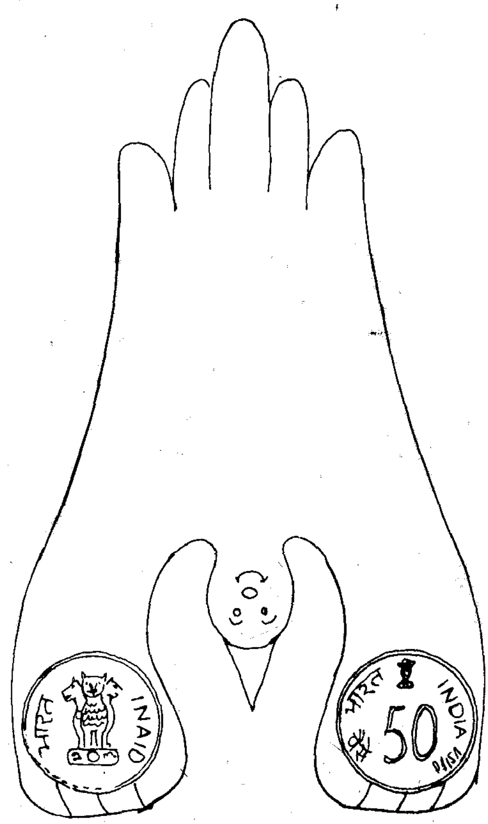
Things required:
A 15 cm X 15 cm piece of thin cardboard or a greeting card or a postcard, two similar one rupee or 50 paise coins, a pencil, some scotch tape or glue

Method:

1. Cut out the cardboard in the symmetrical shape of the bird or the clown shown below.
2. Paste a coin on each side.
3. Now you will be able to balance the figure on one finger.

What actually happens:
When the coins were pasted symmetrically on the two sides of the figure, then the centre of gravity of the figure fell on top of the head. Hence it could be balanced steadily on the finger.





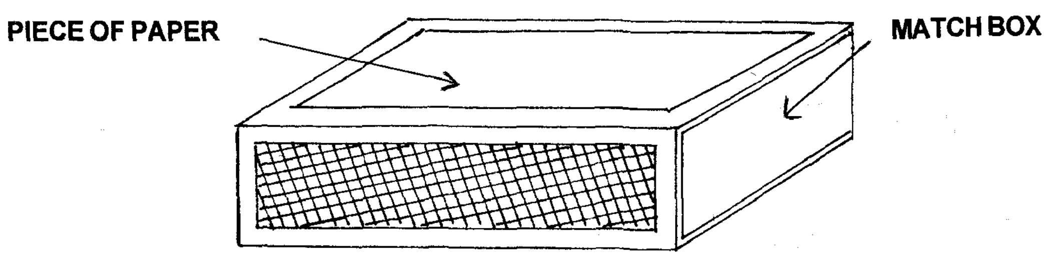
FALLING OBJECTS

Things Required:
A rectangular piece of paper 1x2 cm, an empty matchbox

Method:

1. Hold the matchbox in one hand and the paper in the other and release them together.
2. The matchbox hits the floor first. Does this mean that heavy objects fall faster than light ones?
3. To see that this is not so, place the paper on top of the matchbox and release the matchbox. Now both fall and hit the floor together.

What actually happens:
The reason why the paper falls more slowly in the first case is that because of its larger surface area in relation to its weight, it is affected more by air resistance. In the second case, the matchbox acts as a shield and so the paper does not experience any air resistance and it falls as fast as the matchbox.



FALLING COINS

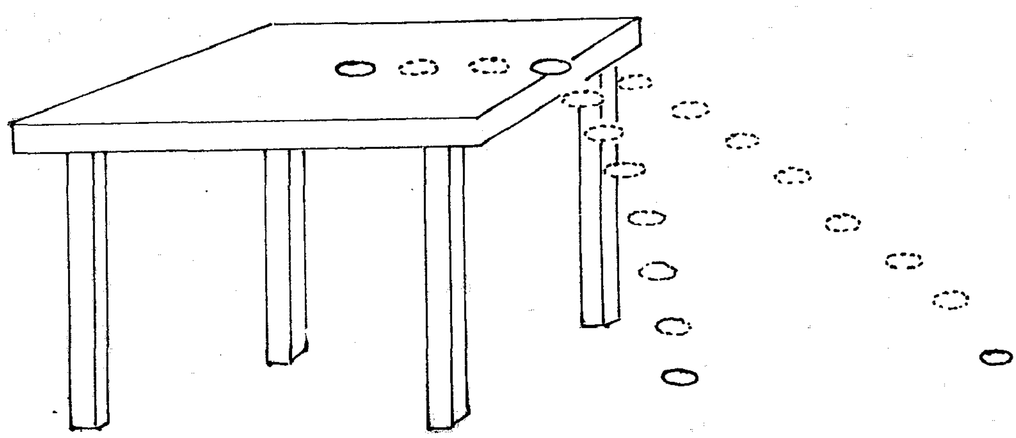
Things Required:
2 coins

Method:

1. Balance the coin on the edge of the table and flick another coin along the table like a carrom striker so that it just touches the balancing coin and both fall over.
2. Listen for the sound of the coins hitting the floor. Do you hear them at practically the same instant?

What actually happens:
Since gravity acts only in the vertical direction, the difference in the horizontal velocities of the two coins as they go over the table does not affect their vertical motion. Having the same initial zero velocity in the vertical direction, they fall at the same rate and hit the floor at the same time.

So, if a coin is dropped from the height of the barrel of a gun at the same time as a bullet is fired horizontally from it, both the coin and the bullet will hit the ground at practically the same time, even though the bullet may hit the ground over a mile away from where it was fired (the effect of curvature of the earth's surface is neglected in this case).



INSTANT SEE-SAW

Things Required:
One long candle which can burn at both ends, one long nail, 2 glasses.

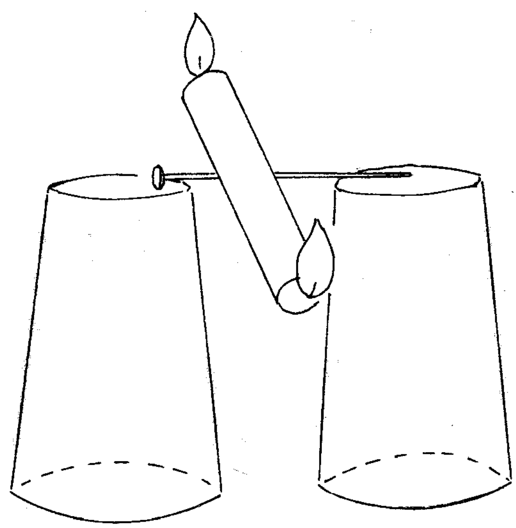
Method:

1. Push the nail through the centre of the candle and place the nail on the two glasses.
2. Light the two ends of the candle. The candle behaves like a see-saw.

What actually happens:
When the wax melts and drops off from one side, that side becomes lighter and rises upwards.

The heavier side now has more wax which is in contact with the flame because of the downward tilt of the candle. So more wax melts on this side and falls off, making it lighter now, so it rises up.

Thus, the candle behaves like a see-saw.



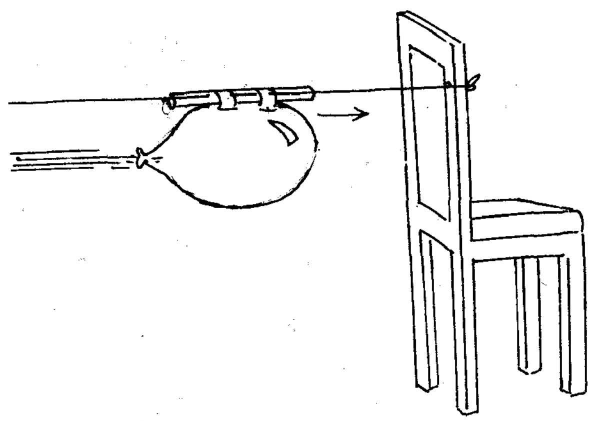
THE FLY AWAY BALLOON

Experiment A
Things required:
A balloon, your ability to blow a balloon

Method:
1. Blow the balloon as much as you can.
2. Release it.
3. It flies off in all directions.

Experiment B:
Things required:
3 metres of string, a balloon, a drinking straw, cellotape

Method:
1. Tie the string to the back of a chair or to any other stationary object.
2. Thread the drinking straw onto the string.
3. Blow up the balloon and pinch its mouth with your fingers and thumb so that no air escapes.
4. Tape the balloon to the side of the straw such that its mouth faces away from the chair.



5. Keep the string well stretched and taut and then let the balloon go.

It will shoot along the string like a rocket!

If you keep two strings parallel to each other, you can have balloon rocket races with your friends.

What actually happens:
When air is blown out of the mouth of the balloon, it forces it to move in the opposite direction.

This is the principle on which rockets and jet planes work.

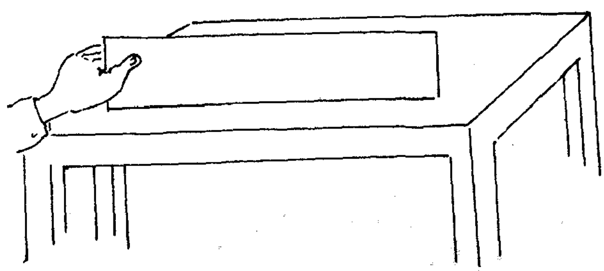
MUSCULAR PAPER

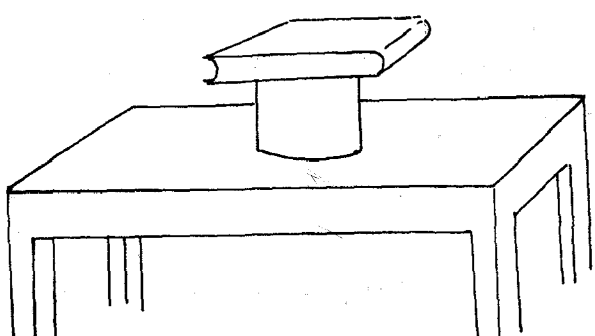
Things Required:
A strip of paper 15 cm wide and about 30 cm long

Method:

1. Hold the strip up on a table as shown. Can it support your text book?
2. Now roll it into a cylinder and place your text book on it. It will now be able to support your book.

What actually happens:
A tubular shape is stronger than an object which has been placed in a flat position. It is for this reason that pillars are often used to give support to the main structure of buildings.





WHICH WAY WILL THE STICK FALL?

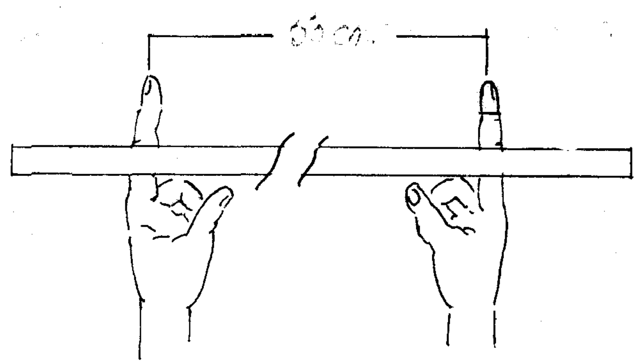
Things Required:
A long stick or a broomstick

Method:

1. Over the outstretched forefingers of both your hands, place the stick or the broomstick so that the two hands are stretched out as far as possible.
2. Now if you attempt to bring your hands slowly together, which way will the stick fall?

Observation:
You would expect the stick to fall on the side from which it is sticking out more. But as you bring you hands slowly together, something quite different happens. The stick does not fall at all but remains in equilibrium. And as your fingers meet, the stick rests exactly at its centre, balanced on both your fingers. Try it as many times as you want, but the same thing always happens.

What actually happens:
The behaviour is explained by friction. The end which sticks out further, presses with greater force on the finger than the shorter end. The greater force causes greater friction, so that there is no sliding at this spot for the moment. The stick only slides at the place with less pressure and less frictional force and this is the finger at the shorter end. This continues till both fingers join near the centre of gravity of the rod. This experiment will work even if you attached a weight on one end of the rod or even if the rod is not uniform. Try the experiment with a walking stick.



Friction is the force that resists the sliding of one body over another. The effects of friction are both bad and good. In automobiles and in all kinds of machinery, friction wastes energy by turning it into useless heat. It also wears away the parts that slide over each other. On the other hand, without friction between tyres and the road, vehicles wouldn't move, we wouldn't be able to walk.

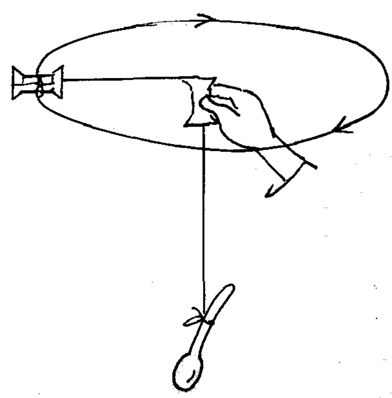
THE MOVING SPOON

Things required:
A teaspoon, some string about one and a half metres long, two wooden spools of thread.

Method:

1. Tie one end of the string to the spoon.
2. Slip the other end through one spool and then tie it to the second spool.
3. Hold on to the spool in the middle and then move your hand in circles so that the tied spool starts to swing in circles.
4. As you increase the speed of the swinging of your hand, the spoon will rise.

What actually happens:
As the spool at one end of the string is rotating, it exerts a centrifugal force on the attached spoon. The centrifugal force pulls the spoon upwards.



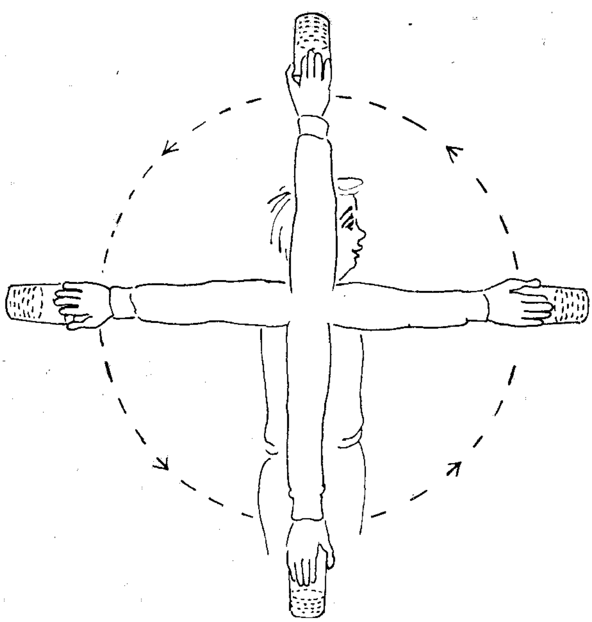
THE WHIRLING GLASS

Things Required:
A glass (preferably of steel), some water

Method:

1. Half fill the glass with water.
2. Now hold the glass in your hand keeping the elbow and wrist as stiff as possible.
3. Carefully study the diagram which tells you how to hold the glass when it is being swung.
4. Swing your arm from the shoulder as fast as you can, much like a bowler in cricket. With a bit of practice you should be able to do this without spilling any water from the glass even though at the top of your swing the glass is upside down and its mouth is open.

What actually happens:
Although the glass is upside down at the top of the swing, the pull of gravity is counter balanced by what is called the centrifugal force, so that no water spills.



THE GLUED COIN

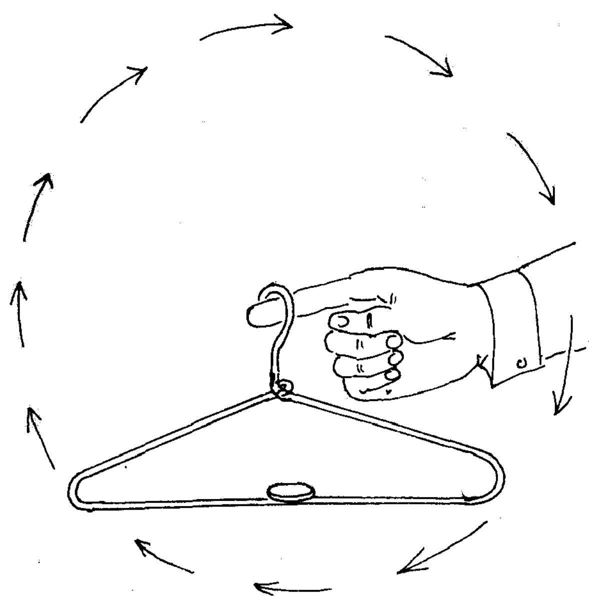
Things required
A coin, a wooden hanger

Method:

1. Put your forefinger (pointer finger) through the hook of the hanger.
2. Balance the coin in the middle of the crossbar as shown.
3. Swing the hanger gently at first and then increase the momentum until the hanger makes complete circles around your finger.
4. The coin does not fall off the crossbar even when the hanger is up-side down.
5. If you are able to gently bring the hanger to a complete standstill, the coin will still not fall off.

(Practice this a little before you show it to a friend.)

What actually happens:
The coin does not fall off because of the centrifugal force being applied to it.



RIPPING THE PAPER

Things Required:
A sheet of paper, scissors

Method:

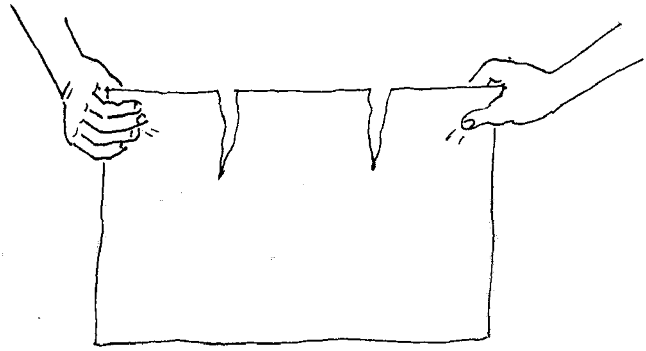
1. With the scissors make two equal slits on the same side in the sheet of paper.
2. Now hold the paper at the upper edges.
3. Pull the paper outwards to try to obtain 3 separate pieces of the paper. *(Try as hard as you can, you will always get only two pieces.)*

What actually happens:
Though the slits in the paper look equal to all extents and purposes, yet one side will always be stronger than the other. As you apply the outward force, the weaker side starts to tear first. After that all the force which you apply is concentrated and directed only to that spot until the paper is torn completely. The other side with the stronger slit remains unaffected.

It is this phenomenon which our bodies observe when we are inhaling and exhaling. At any point of time, the air we breathe in, is inhaled only from one nostril- both nostrils never take in air together.

To find out which nostril is active at any given time, just keep a finger under each nostril separately. You will easily be able to figure out which is the active nostril.

If you try again after some time you may find that the second nostril has now taken over the job of inhaling and exhaling.



OUR ADJUSTABLE BODY

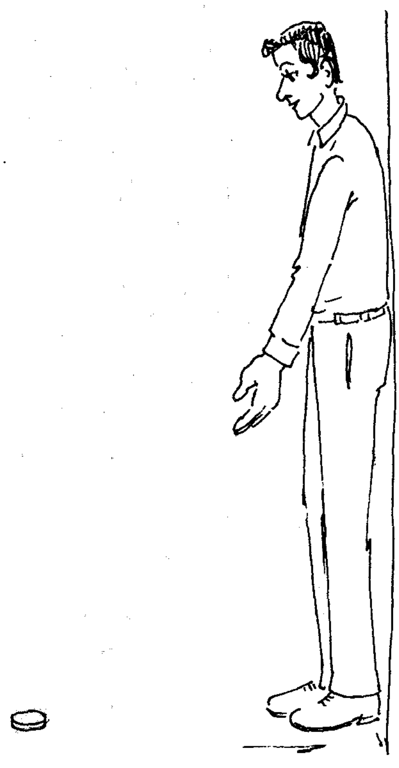
Things Required:
A coin

Method:

1. Drop a coin on the floor in front of you. Lift it with one of your hands. You can do it with ease.
2. Next, stand straight against a wall with your back and feet touching it. Again, by bending over (but without bending your knees) try to lift the coin which has been dropped in front of you.

   Can you do it?

Observation:
You will notice that it is not possible to bend over and pick up the coin.



What actually happens:
While bending over, you are moving your centre of gravity forward and as soon as the line drawn vertically through the centre of gravity falls beyond your feet, you will topple over. When there is no wall at the back and you bend over, your hips are pushed backward and the centre of gravity does not shift much. This automatic adjustment is due to coordinated nervous and muscular activity.

BEND TO STAND

Things Required:
A chair

Method:

1. Sit comfortably on any chair and hold hands in front.
2. Now try to stand up without bending forward or taking help of your hands.

You will find that to get up from any chair at any time, you have to bend forward before you straighten up.

Variation:
Try to stand on the side by a wall with both feet together. You will find that to accomplish this feat is an impossible task.

What actually happens:
For any object to be stable when standing on the ground, the essential condition is that its centre of gravity must lie within its support.

When we sit on a chair our centre of gravity is near our stomach whereas our support when we want to stand will be our feet, which are far away from the line of centre of gravity. Hence we cannot stand without first bending forward and bringing our centre of gravity above our feet.

In the second case, if we press the second foot close to the first, the centre of gravity will fall outside the support.

BENDING WATER

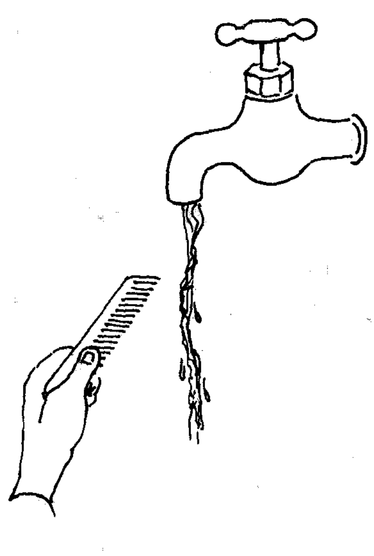
Things Required:
Your plastic comb, a tap.

Method:

1. Turn on the tap to allow only a very narrow slow stream of water to come through.
2. Take your plastic comb and comb your hair with it. (Your hair should be dry and without oil).
3. Now when you place this comb close to the water stream, you will see that the water bends towards the comb.

What actually happens:
When you comb your hair, static electrical charges accumulate on the teeth of the comb. These charges attract the stream of water. This then makes the stream bend towards the comb.

During winters, when the weather is dry, take a newspaper sheet and hold it against a wall. Rub the entire surface with the palm of your other hand rather briskly. You will find that the newspaper sticks to the wall. When we rub the newspaper surface with our dry palm, the paper gets charged and sticks onto the wall.



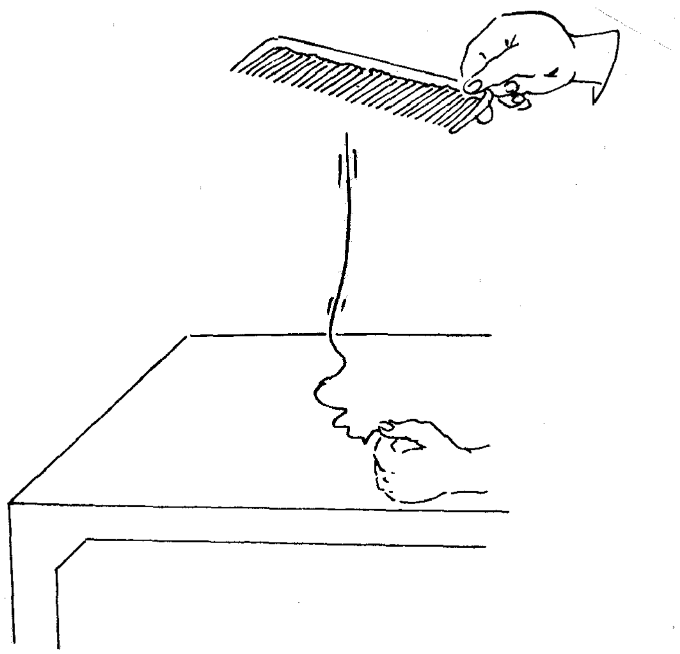
THE STANDING THREAD

Things Required:
Your plastic comb, very light thread (about 20 cm), a woollen sock.

Method:

1. Take the woollen sock and rub it quickly over your plastic comb.
2. Hold one end of the thread on a table.
3. Bring the comb near the free end of the thread and let it touch the thread. The thread will stand straight up in the air.

What actually happens:
By rubbing the sock over the comb you were able to electrically charge the comb. This charge attracted the thread and when you raised the comb, the thread moved up with it.

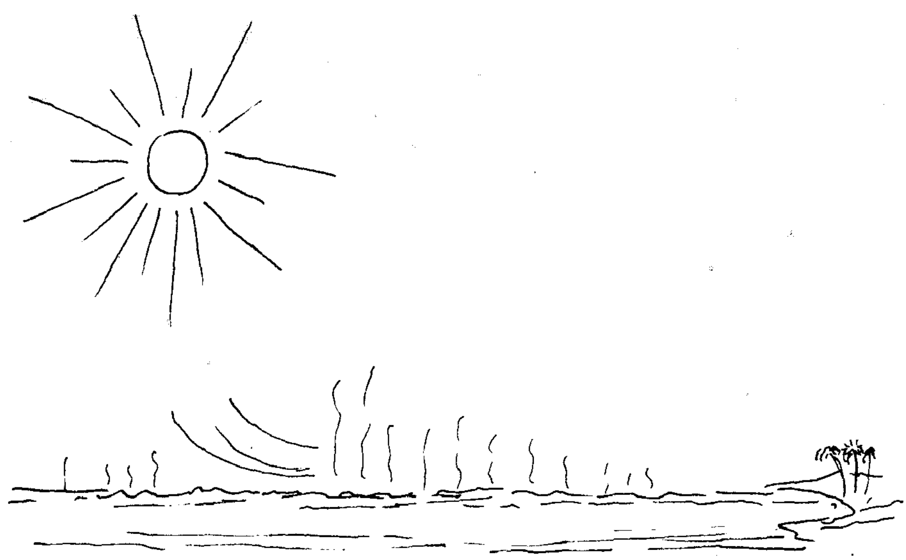


HEAT

HEAT

We know of different forms of energy, and heat is one of them. When some forms of energy, for example kinetic energy or electrical energy, seem to decrease, they partly change into heat. Heat is carried by three different ways- conduction, convection and radiation. We get most of our energy from the sun in the form of radiation. Heat radiation is basically of the same form as light- it is of longer wavelength.

All our cooking is done with heat. But fire can also be dangerous if we are not very careful. Therefore we have given only a few experiments in this area and also strongly suggest that the activities marked 'To be done under adult supervision' should be done very carefully and under the guidance and supervision of some elder family member.



HOT! HOT!

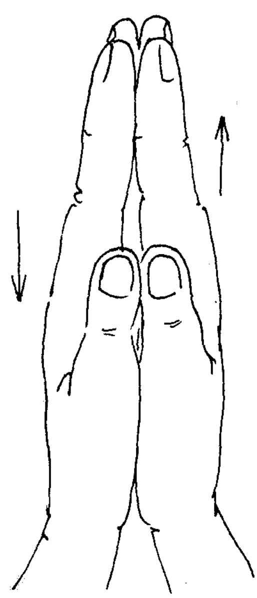
Things Required:
Your 2 hands, your time.

Method:

1. Stand as if you were doing 'namaste' to someone in front of you.
2. Now rub your hands together making them slide forwards and backwards until you feel that your hands have become warm.

What actually happens:
When you rub your hands together you create friction between them. It is this friction which creates heat.

On a cold winter day you must have noticed that if your hands are really cold and you need to warm them up, then the best and simplest method is to rub them together quickly for a minute or two.



ABSORPTION OF HEAT

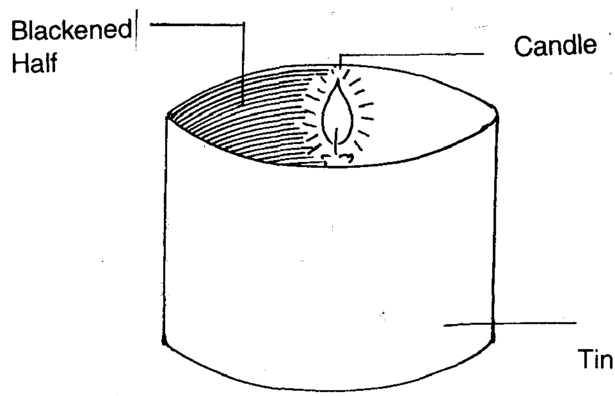
(To be done under adult supervision)

Things Required:
An empty tin can, a small candle about 5-6 cm in height

Method:

1. Take the tin can and on the inside blacken one half (with the burning candle) and leave the other half shiny.
2. Fix the candle inside the can near the centre.
3. Feel the difference in temperature of the two halves of the can as it gets heated up.

Observation:
The blackened half feels hotter than the shiny one.



What actually happens:
Black objects absorb all the radiation falling on them while everything else absorbs only partially. Objects with dull, dark surfaces are the best absorbers and radiators of both light and heat; objects with shiny, light surfaces reflect heat and light well, but absorb and radiate it poorly.

You must have noticed the same phenomenon in your daily life. One feels very uncomfortable wearing dark clothes in summer but not so in winter. The explanation is simple. Black clothes absorb all the radiation falling on them while light coloured clothes reflect it and thus keep us cool during the hot summer months.

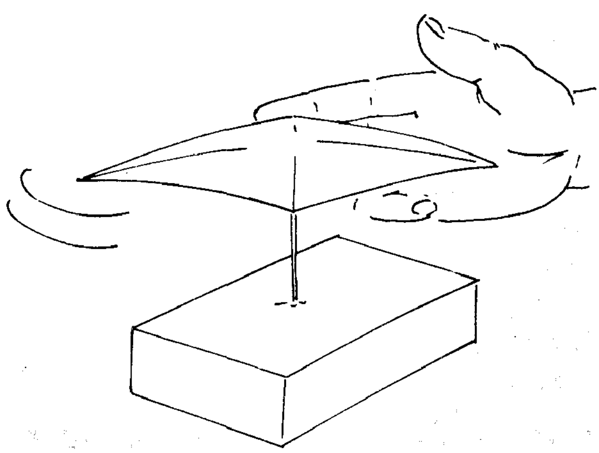
YOUR MAGIC HAND

Things required:
A thin piece of paper 3 cm X 3 cm, a pin

Method:

1. Fold the paper diagonally twice. Both the diagonals will cross at the centre.
2. Push the pin through some support like an eraser or cloth or plasticene so that it is upright and steady.
3. Place the paper on the point of the needle so that the centre of the paper is at the tip of the pin.
4. The paper will balance on the pin.
5. Now bring one hand close to the paper as shown in the diagram.
6. The paper will start rotating!

What actually happens:
When you bring your hand close to the paper, your hand heats the air near the paper. This air, now being warm, rises upwards and this makes the paper rotate.



CONFUSING TEMPERATURES

Things Required:
Three glasses-one with warm water, another with ice cold water, the third with water at room temperature

Method:

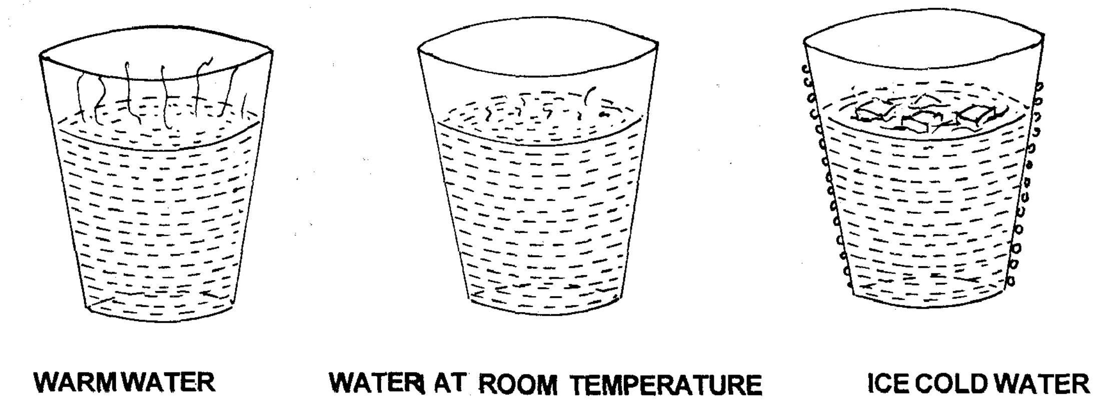
1. Immerse the fingers of your right hand in the glass with warm water and the fingers of your left hand in the glass with ice cold water.
2. Keep them in this position for nearly a minute.
3. Now put them both in the glass with water at room temperature.

   What do you feel?

Observation:
Your left hand fingers report that the water is warm, and the right hand fingers report that the water is cold. The truth, of course, is that the water in the glass is neither hot nor cold- it is at room temperature.

What actually happens:
The spots for the sensation of temperature in our skin are not sensitive to cold and warmth as such, but to changes in temperature.

The hand kept in warm water is adapted to warmth, and it loses heat in the third glass. But the hand kept in cold water gains heat from the water at room temperature and therefore you get the feeling of warmth.



BREATH: HOT OR COLD?

Things required:
Your breathing ability, your hand

Method:

1. Blow on your hand as if you were blowing out a candle.

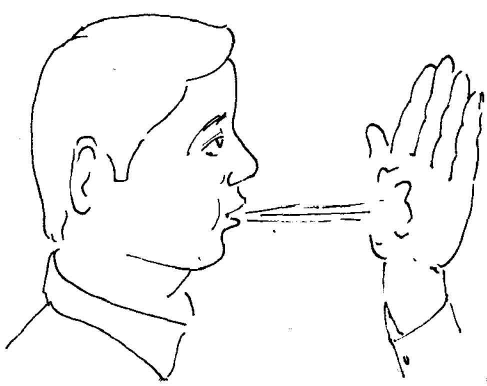
   Your breath feels cool.

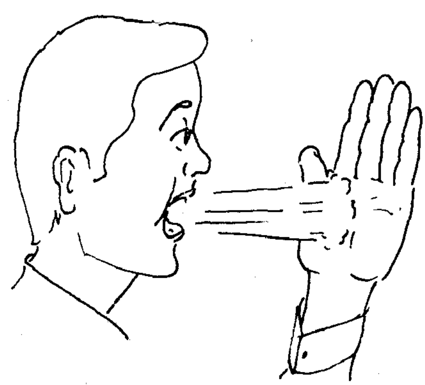
2. Now open your mouth quite wide and blow out on the hand again.

   This time the breath feels quite warm.

What actually happens:
In the second case when you open your mouth wide and blow the air, it is the air from your lungs which is at body temperature and feels warm-the surface of the hands being near the room temperature.

When you blow with your mouth only slightly open, it is not normal air which comes out but is forced out with speed and behaves differently.





THE ROTATING SNAKE

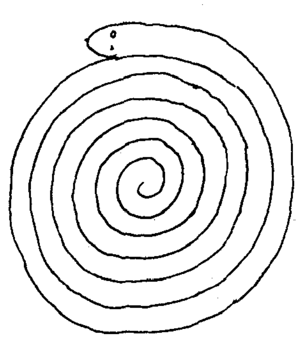
(To be done under adult supervision)

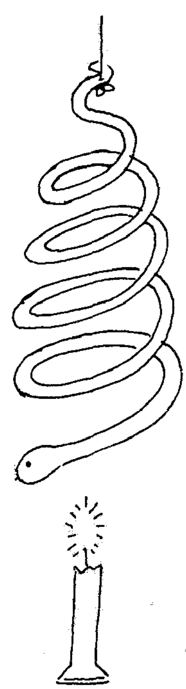
Things Required:
A greeting card, a 30 cm piece of string, a candle, a box of matches.

Method:

1. Draw a snake on the card as shown in the picture.
2. Cut out the spiral and tie the string to the end of the snake's tail.
3. Hold the other end of the string so that the snake is like a dangling spiral.
4. Light the candle and hold the snake about 30 cm above the candle.
5. The snake will start to rotate with considerable speed.

What actually happens:
The candle heats the air around it, which becomes lighter and rises, making the spiral spin like a top.





DANCING DROPS

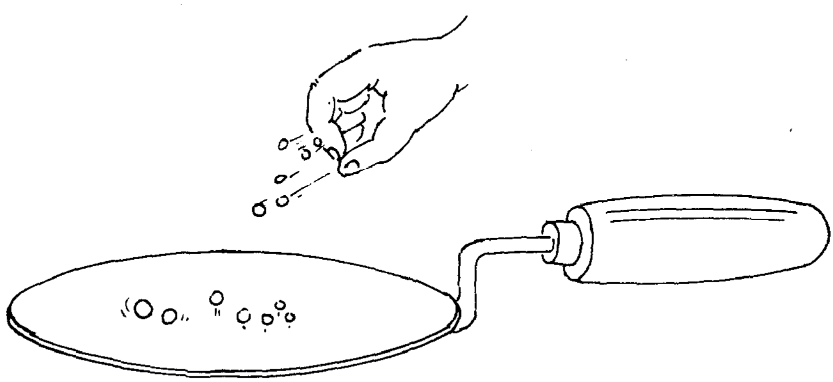
(To be done under adult supervision)

Things Required:
A very hot 'tava' (frying pan), some water

Method:

1. Heat the 'tava' to make it very hot.
2. Moisten your fingers with the water and shake your wet fingers over the 'tava'.
3. You will see that the drops of water which fall on the 'tava' are in the shape of small spheres and these dance on the 'tava'.

What actually happens:
The moment the water drops fall on the 'tava', a layer of steam forms around each one. The steam acts like a cushion and the drops are thrown up. The surface tension of the water holds each drop as a sphere until the drop disappears when its water changes to steam because of the hot 'tava'.



THE INSIDE STORY

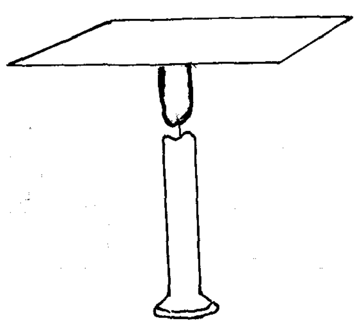
(To be done under adult supervision)

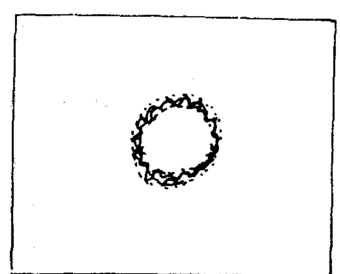
Things Required:
A candle, a sheet of thick paper (ensure that the sheet is thick, for thin paper gets totally burnt)

Method:

1. Light the candle.
2. Place the sheet of paper over the candle such that about half the flame is pressed down by the sheet.
3. Keep the paper over the flame for only a second or so.
4. Remove the sheet and observe it.
5. You will notice a black burnt ring which surrounds an almost untouched central portion.

What actually happens:
Whenever a candle burns, its flame is not uniformly hot – the inside of the flame is always cooler than the outside.





PAPER DOESN'T BURN

(To be done under adult supervision)

Things Required:

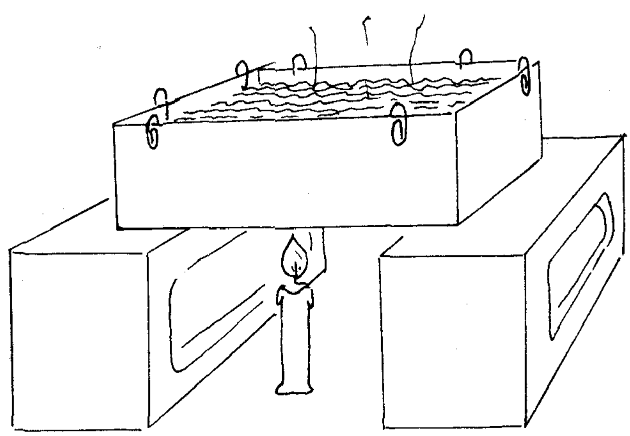
A sheet of thick paper, some paper clips, a candle, 2 bricks or any other blocks, some water.

Method:

1. Make an open box with the sheet of paper, using paper clips to hold the edges in place.
2. Fill it ¾ with water.
3. Place it carefully over the two bricks as shown below.
4. Now place the candle under the paper box and light it. Let it burn till you see the water boiling.

What actually happens:

Even when the water starts boiling, the paper doesn't get burnt. This is because the heat from the candle is taken away by the water before the paper reaches its burning point. We all know that water boils at 100°C and then changes into steam. Since the ignition point of the paper is much higher than 100°C, the paper box doesn't get burnt.



GENERAL ACTIVITIES

DELICIOUS HOME-MADE 'MISHRI' (ROCK CANDY)

(To be done under adult supervision)

Things Required:

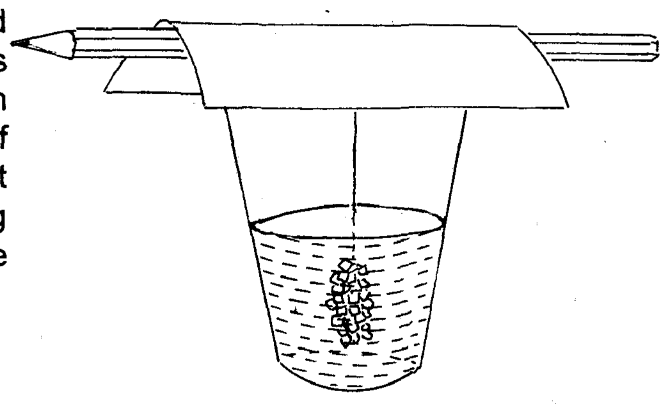
1½ cups sugar, a glass filled with ½ cup hot water, some string(15-20 cm), a pencil.

Method:

1. Take the pencil and tie the string around its middle such that if the pencil were placed on the glass, the lower end of the string would be about 2 cm above the base of the glass. Moisten this string with water and roll it in sugar. Keep this aside.
2. Keep adding sugar to the hot water till all the sugar dissolves, thus creating a saturated solution. (In case the sugar doesn't dissolve, then just heat the water a little.)
3. Now gently keep the pencil (with the dangling string) on the glass such that the string hangs in the middle of the sugar solution.
4. Cover the glass with a handkerchief or any cloth and leave it undisturbed for a day or two.
5. You will see shiny 'mishri' forming on the string. This 'mishri' is safe to eat.

What actually happens:

This 'mishri' is actually small crystals. Crystals are solid materials in which the atoms or molecules are arranged in an orderly pattern. This pattern is repeated over and over again throughout the crystal. The atoms of crystals are like building blocks. It takes billions of these 'building blocks' to make a crystal large enough to see.



THE SMELLING PATH

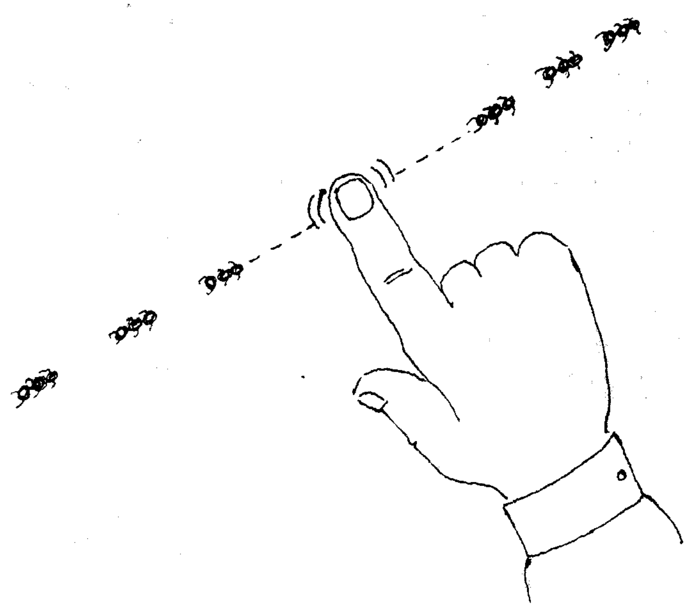
Things Required:
A procession of ants

Method:

1. For this experiment you must first find a procession of ants on the wall or on the floor.
2. At some spot where there seems to be a gap in the line, rub your finger gently on the invisible track and watch.

Observation:
You will notice that the incoming ants get confused, as though a bridge has been blown up. These ants move in all directions and by chance may touch upon the other end of the gap. When slowly, the onward journey is resumed, it is as if the bridge were repaired.

What actually happens:
All ants secrete an acid (formic acid) which is applied to the surface as they walk and thus lay a smelling path. This is the track that they all follow. Our rubbing disturbs the track and the ants get confused.



THE HOT CHILI POWDER

Recent research has just shown that some Indian chili powders are the hottest in the world! Here is an experiment to show just how hot they can really be.

Things required:

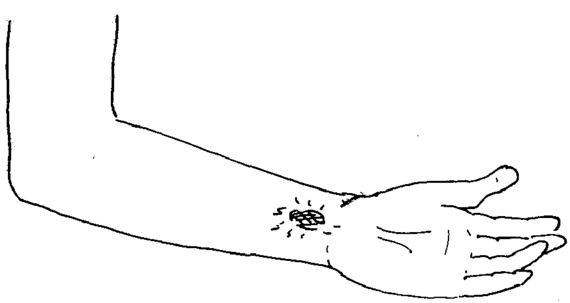
1 teaspoon of red chili powder, 3 teaspoons of warm water

Method:

1. Mix the chili powder in the warm water and let the mixture stand for about half an hour.
2. Now dip a finger in this mixture and taste it. It feels HOT!
3. Now again dip the finger in the mixture and put a drop on your wrist. You will experience the same hot sensation as you did on your tongue!

What actually happens:

Red chili powder contains a chemical which produces this hot sensation. Our skin is sensitive to this chemical as is our tongue. Hence you get this hot feeling when the chemical touches you.



BEING NOSEY

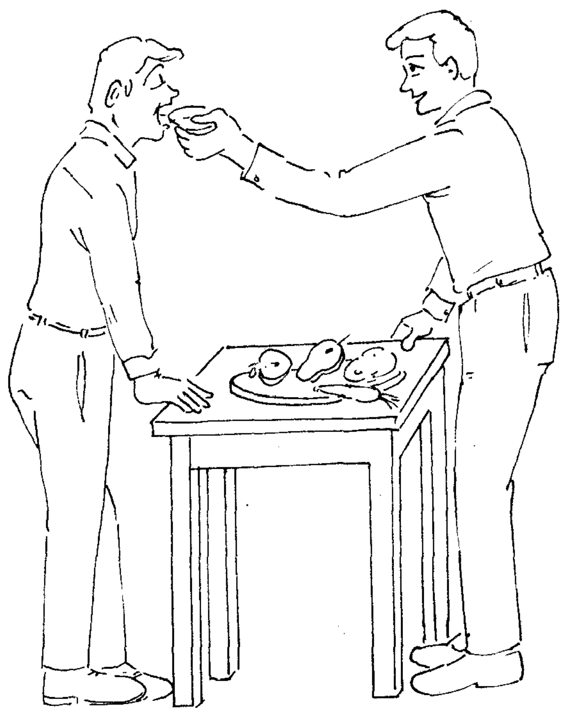
Things required:
A friend, pieces of different fruits and raw vegetables

Method:

1. Shut your eyes and pinch your nose closed.
2. Ask your friend to select any piece of the fruit or vegetable and put it in your mouth.
3. Try and tell him what fruit / vegetable he had just served you.

   (Chances are, you won't be able to. A raw potato and an apple feel the same in your mouth because both have the same texture.)
4. Try this a few more times.
5. Now switch places with your friend and then try this experiment on him.

What actually happens:
You may have observed that when you have a bad cold and your nose is stuffed up, food doesn't have the same appeal. This is because it isn't only your tongue that does most of the tasting; it's also your nose!



Noses are made for smelling and they help out the tongue when it comes to tasting. That's because a lot of what we call taste is actually a smell. Simply put, food tastes so good because it smells so good.

POWERFUL 'RAJMAH'

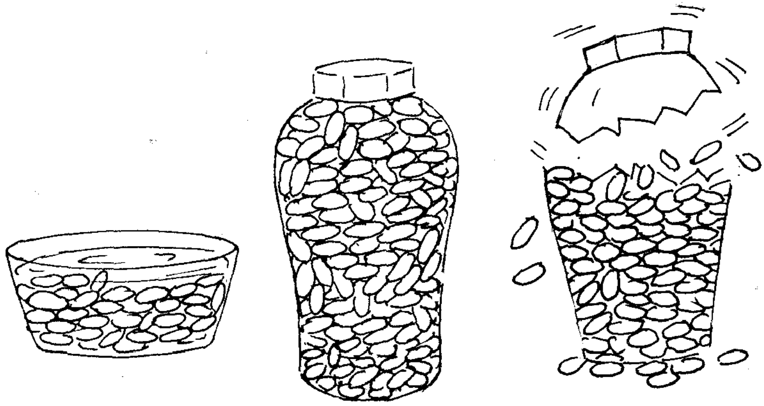
Things Required:
½ a 'katori' of 'rajmah', a small plastic bottle.

Method:

1. Soak the 'rajmah' overnight in plenty of water.
2. The next morning, take out the swollen 'rajmah' and put it in the plastic bottle, making sure that the bottle is completely stuffed with 'rajmah'.
3. Now close the cap of the bottle firmly.
4. Leave it undisturbed for about a day.
5. At the end of about 24 hours you will find that the 'rajmah' has managed to break the bottle.

What actually happens:
The 'rajmah' needs water in order to germinate or begin to grow. Water is absorbed by the 'rajmah' causing it to swell and crack open its tough seed coat, allowing the seed embryo to grow roots and stem.

The germinating 'rajmah' needs more space than that which is available in the closed bottle and so the bottle is cracked open by the 'rajmah' so that its growth remains unhampered.



GRAPES SHRINK AND RAISINS BURST

Things Required:

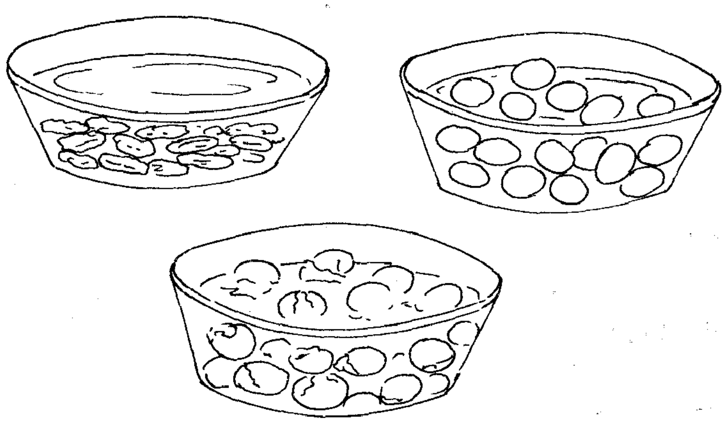
10-12 raisins, grapes, water, sugar syrup or honey

Method:

1. Place 5-6 raisins in water.
2. In a few hours, you will notice that the raisins have begun swelling. Their wrinkled surface has become even and distended.
3. If kept for a longer time the outer coat of the raisins bursts at some point, as though it was overinflated.
4. Next, try putting the remaining raisins in thick sugar syrup or honey.
5. Similarly, try putting fresh grapes in thick sugar syrup. They shrink showing that something has flown out.

What actually happens:

These changes are on account of osmosis. If two solutions of different concentrations are separated by a suitable membrane (called a semi permeable membrane), such as the skin of grapes, the wall of the urinary bladder etc., the water from the thinner solution flows towards the thicker solution. This flow tends to continue till the concentration on the two sides equalizes, and in this lies the answer to the swelling and bursting of the raisins kept in water.



INVOLUNTARY ACTIONS

Things Required:
A child volunteer, your hand

Method:

1. Make the child sit on a chair with his legs freely hanging and fully relaxed.
2. Now strike gently with the lower edge of your stretched hand just below the knee cap.
3. Try it several times by shifting slightly the place where you hit.

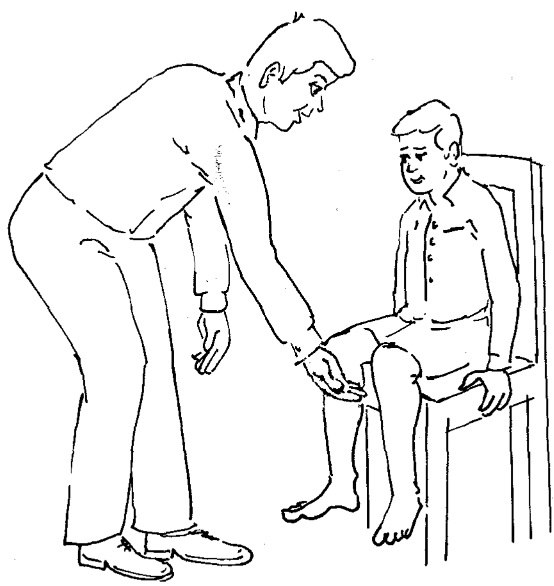
Observation:

When you find the correct spot, the part of the leg below the knee, suddenly kicks forward.

What actually happens:

This is called the knee reflex. This particular response is not under the control of the person. Doctors very often test this reflex by using a triangular rubber hammer.

The human body has numerous reflexes. If you direct torch light into someone's eye, his pupil contracts. In very dim light, as in a darkroom, the pupil dilates.



A SIMPLE MACHINE-THE PINWHEEL

Things required:

An 8"X 8" piece of paper, scissors, tape, drinking straw,12" thread, paper clip, a coin, a ballpoint pen

Method:

1. Fold and crease the paper along the dotted lines as shown in Figure 1.
2. Place a coin at the centre of the paper where the two folds cross each other and draw the outline of the coin.
3. Remove the coin and punch a hole with the ball point pen in the centre of the circle.
4. Then punch holes at Positions A, B, C and D as shown.
5. Next, cut along the folds but stop just before you reach the circle made by the coin.

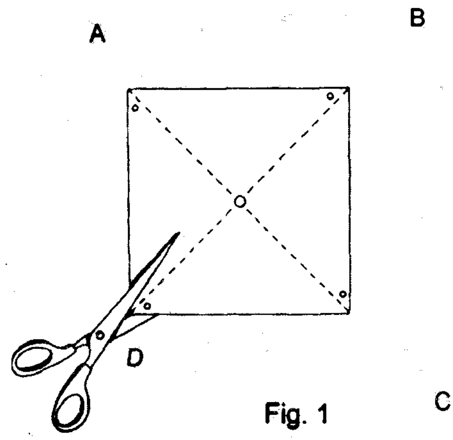


Fig. 1

6. Now fold each of the four corners containing the holes into the centre, aligning all the holes.
7. Insert the straw through the holes in the pinwheel and push the pinwheel halfway down the straw. Figure 2
8. Wrap some tape on the straw on either side of the pinwheel to prevent too much movement of the pinwheel.
9. Tape one end of the string to the straw and attach the paper clip to the other end.

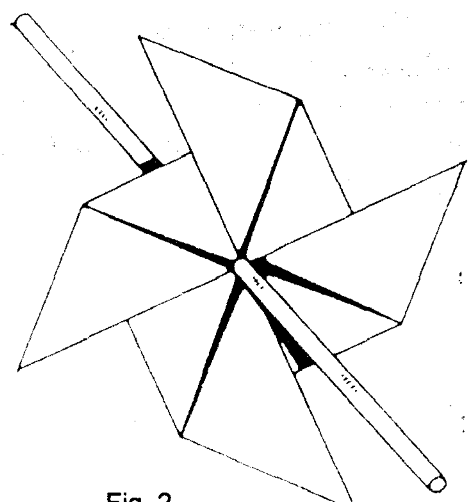


Fig. 2

10. You can now put your wheel and axle machine to work hauling the paper clip up and down.

11. Hold the straw loosely as shown in Figure 3.

12. Then blow on the pinwheel or stand with it under a fan.

13. As the pinwheel turns, it turns the straw axle *which in turn causes the thread to wind up*, hauling up the paper clip.

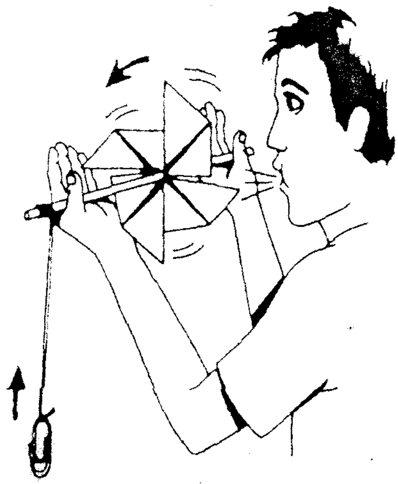


Fig. 3

What actually happens:

The pinwheel is an example of a simple machine-a wheel and axle machine. Its two parts-the wheel and axle are combined in such a way that when one part turns, the other does as well.

The most common example of a wheel and axle is the steering wheel of a car.

COUNT YOUR HEART BEATS

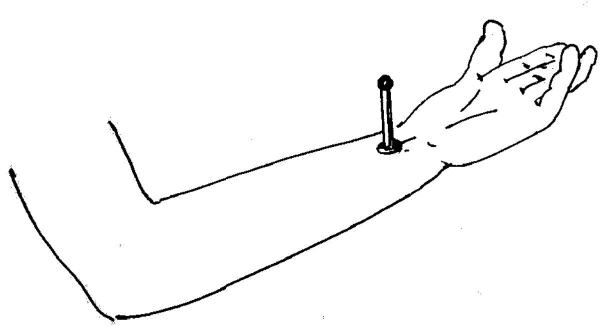
Things Required:
A matchstick, a thumb pin.

Method:

1. Push the lower portion of the matchstick into the point of the thumb pin until it is firmly placed there.
2. Now keep these two on your wrist and move them around until you can find the place where you normally feel your pulse.
3. When the thumb pin is placed on the correct spot, it starts swaying like a tiny pendulum according to the heart beat.
4. If you count the number of swings of the matchstick per minute, it will give you an estimate of the number of your heart beats per minute.

What actually happens:
Doctors are able to measure your pulse while holding your wrist because in that region, there are some veins which are close to the surface of the wrist and hence it is easy to measure the pulse from there.

The normal count for children is between 90-120 beats per minute. As you will grow older, the beats will come down to 80 per minute.



CHAINED UP

Things required:
A few sheets of paper, scissors

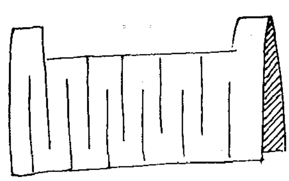
Introduction:
Take a sheet of paper and ask a friend to try and cut in it a hole large enough for her to pass through.

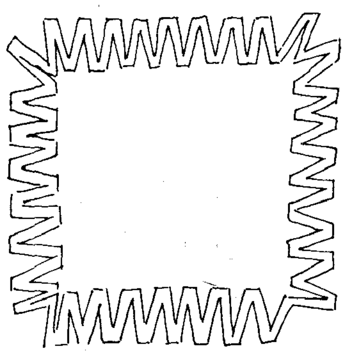
Is it possible for her to do this?

In case your friend finds this an impossible task, you can show her how to do it.

Method:

1. Fold the sheet into half and cut out a strip from the folded portion as shown.
2. Make several slits on this side as shown in the diagram.
3. Now make slits on the other side too.
4. Expand the paper.
5. You now have a loop long enough for your friend to pass through.





ELLIPSE

Your teachers must have often talked to you about the elliptical orbit of the earth and the other planets around the sun. Here are two easy ways of demonstrating what an ellipse really looks like:

Experiment A:

Things required:
A glass of water

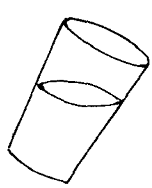
Method:

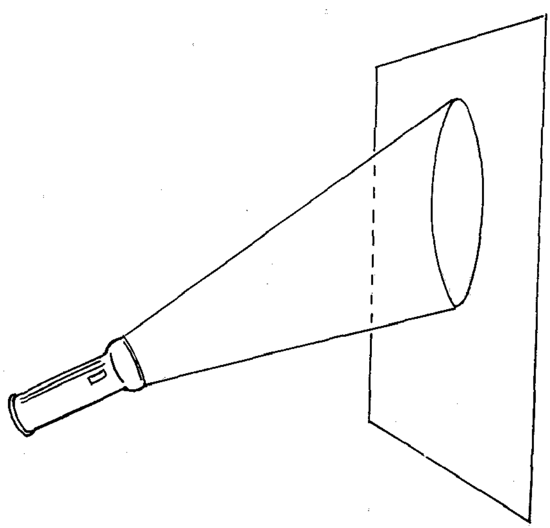
Take a glass half full of water and tilt it slightly. The surface of the water shows an ellipse.

Experiment B:

Things required:
A torch

Method:
Take the lit torch near the wall of a darkened room and hold it perpendicular to the wall. The light of the torch makes a circle on the wall. Now tilt the torch slightly –the edge of the light on the wall shows what an ellipse looks like.





MOIRÉ PATTERNS

Things Required:
A comb with uniformly spaced teeth, a mirror

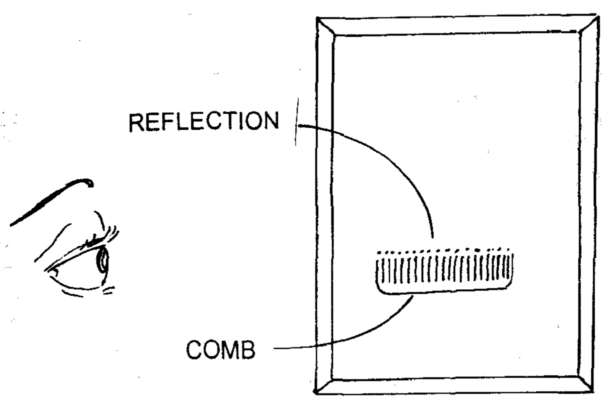
Method:

1. Hold the comb at eye level in front of the mirror (at a distance of about 3-4 cm from the mirror) so that the image of the teeth overlaps with the teeth themselves.
2. You should now be able to see dark , vertical stripes.
3. If you move the comb away from the mirror, the spacing between the dark bands is seen to decrease rapidly.

The separation of the bands is an indication of how far the comb is from the mirror.

OBSERVATION
These patterns, which are known as Moiré Patterns, can be used to measure very small changes in angle or position.

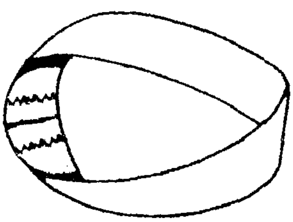
If you have had a chance to observe one wire netting through another, you must have seen complicated patterns of light and shade . These patterns change as you move your head, and disappear if one netting is removed.



MOBIUS STRIP

Things Required:
Some strips of paper 5 cm wide and 50-60 cm long, a pair of scissors, some glue

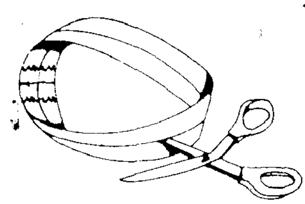
Introduction:
An ordinary sheet of paper is said to possess two surfaces. A way of seeing this is to make a dot on one face of the strip and another on the opposite face. Now whatever you do you cannot join the two dots by drawing a continuous line without crossing an edge of the paper. It is possible , however, for things to have only one surface, that is whichever two points you choose on such an object they can be joined by a continuous line without crossing any edge. An example is the Mobius Strip.



Method:
1. Take another strip of paper, give it a single twist and paste the two ends together to form a ring known as the Mobius Strip.
2. Make a dot on the strip and mark another dot on the other side of the paper directly under the first.
3. Now you will find that it is possible to join the two dots by drawing a line along the length of the strip.

Another interesting property of the Mobius Strip is that if you try to cut it length-wise in the middle to make two rings of half the width, you will find that you will end up with one ring of half the width and twice the circumference. This ring will not be a Mobius Strip.

Again if you try and cut the ring lengthwise at a third of the width from the edge, you will end up with two interlocked rings, one twice the length of the other. The shorter one will be a Mobius Strip and the longer one will not be.



SOME OPTICAL ILLUSIONS

An optical illusion is an effect where sometimes our eyes deceive us. What appears to us to be true may not be true at all or it may seem to change as we look at it.

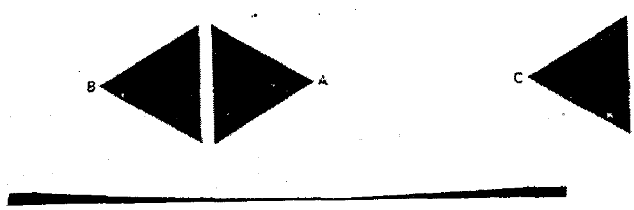
Here are some optical illusions for you to enjoy.

A. An angel in the house

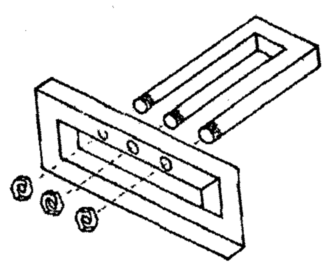
Method:

1. Keep this book about 25-30cms. from your eyes.
2. Concentrate on the angel's face and stare hard at it.
3. Wait for about half a minute by counting up to 30.
4. Now quickly look into the floral archway of the house.
5. After a few seconds, the angel turns white and is seen in the arch-way.

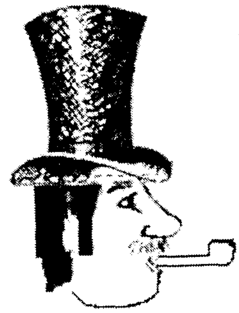
B. Which is the greater distance AB or AC?



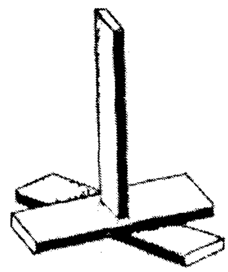
C. What do you see here?



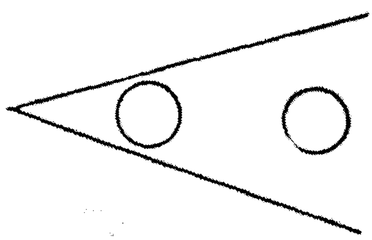
D. In the hat worn by this man the height seems to be more than its width, but both of them are equal.



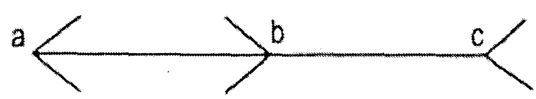
E. The height of the vertical plank seems to be more than the other two horizontal ones.



F. The circle on the right seems to be smaller than the one on the left.



G. The segments bc and ab are equal though it doesn't appear so.



List of books for further reading:

1. Ormond McGill, Science Magic- 101 Experiments You Can Do
2. Kenneth Swezey, Science Tricks for Fun
3. Albert James, Active Science
4. Leonard de Vries, 101 Amazing Experiments
5. Ivar Utial, 101 Science Games

The Buddha spoke thus:

"Believe nothing merely because you have been told it or because it is traditional or because you yourself have imagined it. Do not believe what your teacher tells you merely out of respect for the teacher. But whatever after due examination and analysis you find to be conducive to the good, the benefit, the welfare of all beings, that doctrine believe and cling to, and take it as your guide."

Einstein said:

"Bear in mind that the wonderful things you learn in your schools are the work of many generations, produced by enthusiastic effort and infinite labour in every country in the world. All this is put into your hands as your inheritance in order that you may receive it, honour it, add to it and one day faithfully hand it on to your children. Thus do we mortals achieve immortality in the permanent things which we create in common."

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