Ivar Utial

Colour Edition

101 +10 NEW SCIENCE EXPERIMENTS

A revolutionary approach to learning basic scientific facts by performing experiments with the help of **Tutorial CD Rom**

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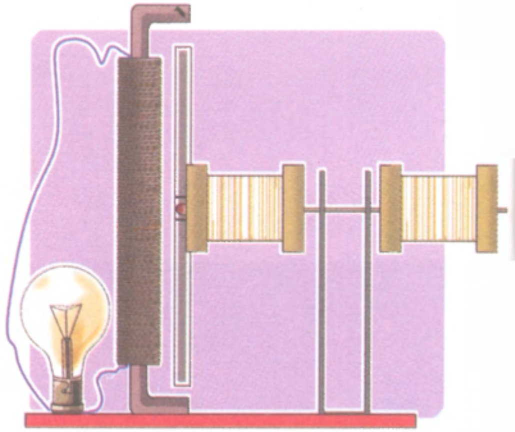
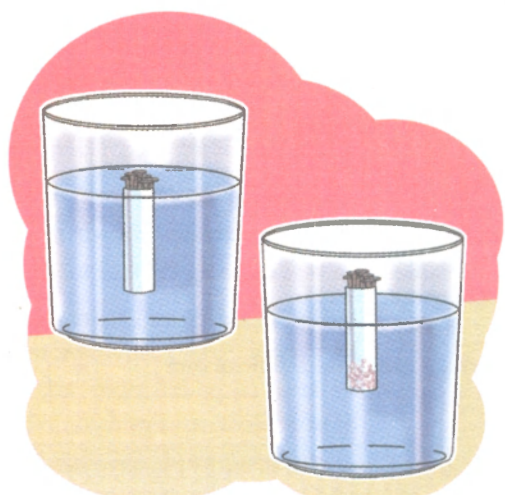


Coloured Edition

101 Science Experiments



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Preface

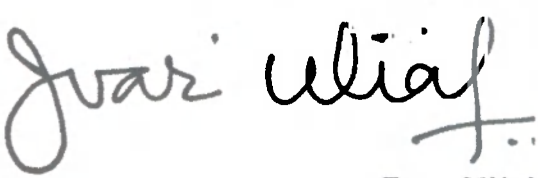
In this Age of Knowledge, a person who is indifferent to science and lacks a scientific temper will get left far behind in the race. Not only this, his casual attitude towards this vital might someday endanger his own life and those of others, for all around us are objects that reflect the bounty of science, but which can be very dangerous if mishandled. Imagine what would happen if the benefits of science are taken away from your day-to-day life. You would be transported in time to the Dark Ages, a time when human beings wallowed in superstition, ignorance, disease and misery. You wouldn't like to lead such a miserable life, would you?

Science is a very useful and fascinating subject, but its most amazing aspect is that despite its being very close to us in our day-to-day lives, many of us choose to keep ourselves ignorant about even its most basic principles. Given its crucial importance in understanding our technical world and our function within it, a closer study of science - and acquaintance with its basic principles and priorities - is unavoidable. Thus, what is required of you is that should get properly acquainted with it, and make sincere efforts to understand it.

On my part, I will do my best to write books for you that are interesting, attractive and instructive, so that whatever you absorb will stay with you throughout your life, and become a foundation for further growth.

This book teaches you how to do small experiments all by yourself, so that you can easily understand the basic principles involved. I have taken care to select only those experiments where the required apparatus or materials are easily available, having received many letters on this point in respect of the previous edition. While it was impossible for me to reply to all of them individually, I have responded in the desired manner by incorporating the suggestions. I again invite your views and suggestions for improving the book further in the next edition.

By being a good citizen of the country, may you progress successfully on the path of life and achieve distinction of worldwide renown for the country in the field of science. My sincere good wishes are always with you!



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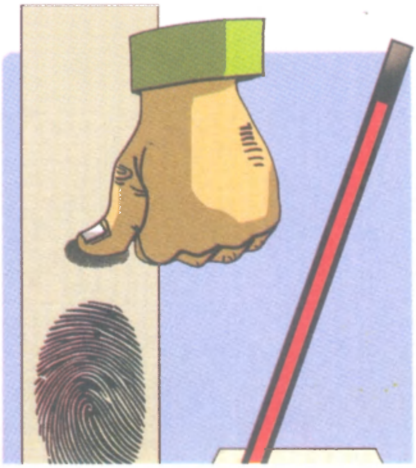
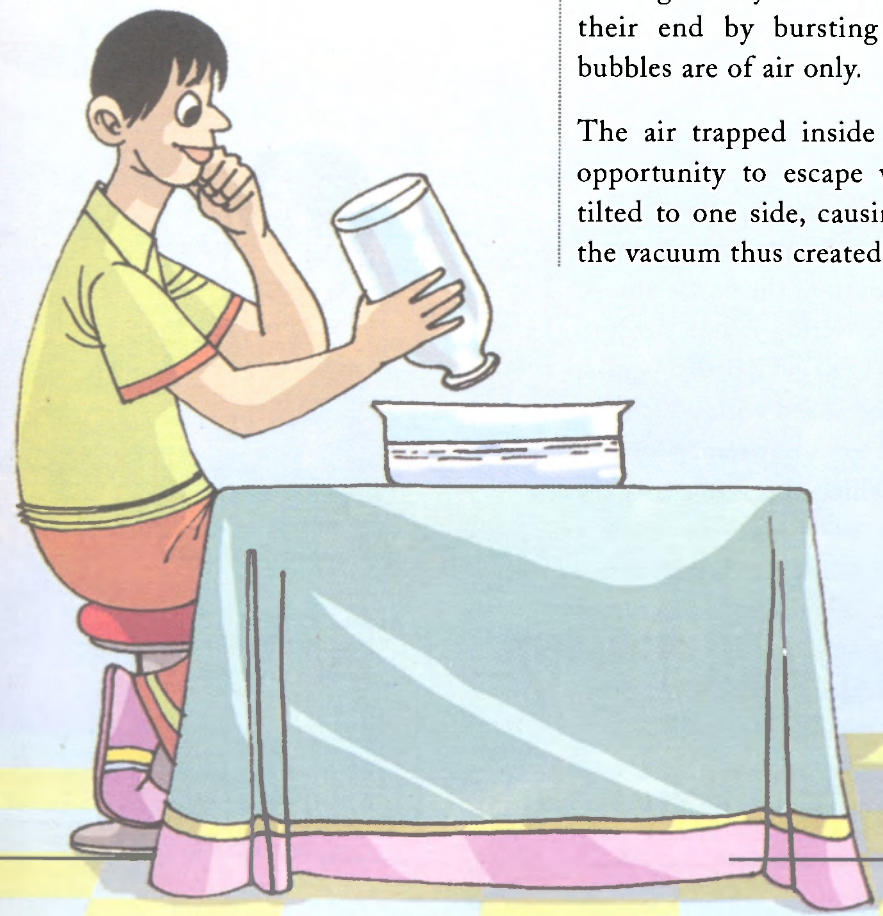


Is a visibly empty vessel really empty?

Take an empty glass bottle and remove its cap. Hold it upside down and immerse it into a vessel filled with water. Now watch the activity carefully. Water enters the bottle and rises up only upto a certain point. Now immerse the bottle deeper in the water. But, what is this? The level of water inside the bottle remains unchanged, while the level of water outside the bottle rises up gradually. Can you understand the reason? It is quite apparent from this experiment that there is definitely something inside the bottle which is preventing the water from entering it. What else can this invisible thing be except the air itself?

Now do one thing. Tilt the bottle a little to one side. Oh! What's this? The bubbles coming out of the mouth of the bottle are rushing noisily to the surface and meeting their end by bursting out there. These bubbles are of air only.

The air trapped inside the bottle gets an opportunity to escape when the bottle is tilted to one side, causing the water to fill the vacuum thus created by the exit of air.



Does air occupy space?

Keep a funnel on the mouth of a bottle and fill half of it with water. Now, while filling the remaining half of the bottle, raise the funnel, a little higher. Does the speed with which the water fills the bottle remain unchanged in both the cases?

When you keep the funnel on the mouth of the bottle and pour in water through the funnel, the speed with which the water enters the bottle is very slow. But the moment the funnel is raised a little higher, the water starts rushing in at a great speed. Do you know why this happens so? It is quite obvious. When water starts filling the bottle through the funnel, it exerts pressure on the air trapped inside the bottle, and as such, the air does not get an easy escape. Though the funnel is placed on the bottle in such a way that it covers the mouth of the bottle almost fully, yet, since the covering is not airtight, the air inside manages to get a little opening to escape. Hence, the speed with which the air inside the bottle goes out remains equal to the speed with which the water fills the bottle. Thus, when the funnel is raised a little higher, the air inside the bottle gets a free outlet to escape. It is through this outlet that water wades its way through the air in the bottle by pushing it out with great speed, quite unobtrusively.

Let us see, how much is the stamina of your lungs?

This experiment will not only determine the power of your lungs, but its regular practice will prove to be a good exercise to tone up your entire respiratory system.

Take a big shallow bowl and fill it with water to about 5 to 7 cm in height. Then take an open-mouthed big bottle or a jar, fill it fully with water and tighten its cover quite firmly. Now, hold the bottle upside down, immerse it in the water in the bowl and remove its cover. Mark the level of water inside the bottle and tilt the bottle to one side. You will need a hollow rubber tube whose one end should be inserted inside the inverted bottle, leaving the other end hanging freely outside the bowl.

Now, be ready yourself to measure the power of your lungs. Inhale as deeply as you can and then blow the air forcefully inside the free end of the tube by your mouth. Observe simultaneously the volume of water you can displace and fill in the air instead. Mark this level of water also. The difference between the two marks shall determine the capacity of your lungs. But be careful that while blowing the air inside the tube, you do not either break your breath or inhale.

If by its regular practice for a few days you find the difference between the two marks increasing, deem it that you are getting the due benefit from this exercise.

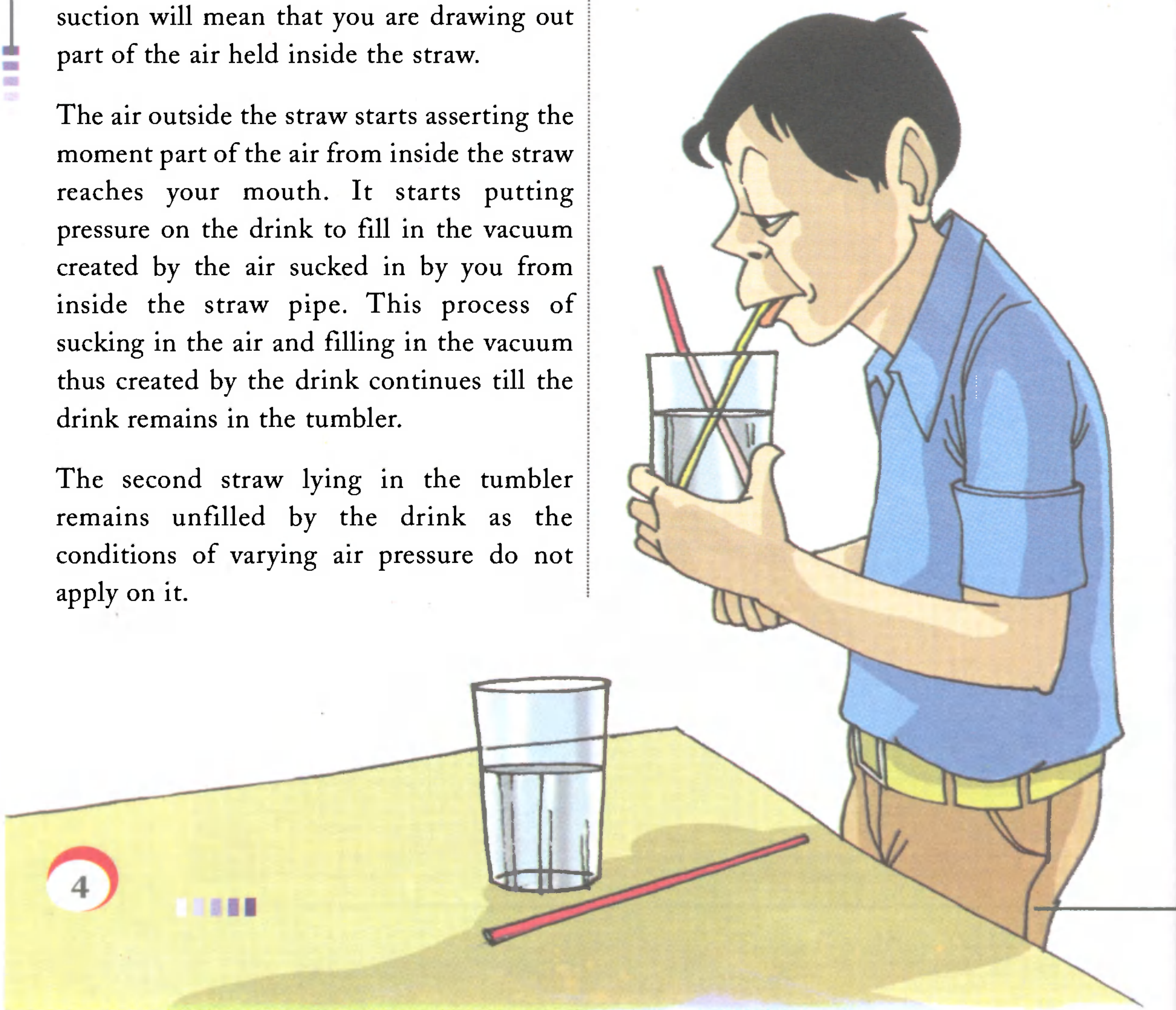
Importance of atmospheric air pressure

The atmospheric air pressure is extremely beneficial for us, for its absence would have made it impossible for us to drink anything through the straw.

Take some water or any other drink of your choice in a glass tumbler. Put two straws into it. Now hold one of the free upper ends of the straw by your mouth and suck in air from it. This suction will mean that you are drawing out part of the air held inside the straw.

The air outside the straw starts asserting the moment part of the air from inside the straw reaches your mouth. It starts putting pressure on the drink to fill in the vacuum created by the air sucked in by you from inside the straw pipe. This process of sucking in the air and filling in the vacuum thus created by the drink continues till the drink remains in the tumbler.

The second straw lying in the tumbler remains unfilled by the drink as the conditions of varying air pressure do not apply on it.



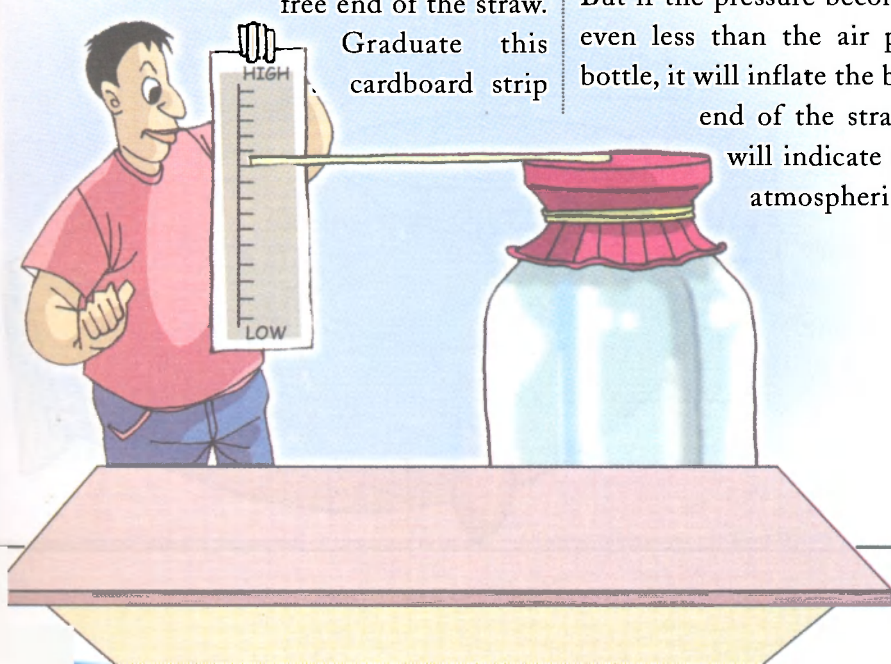
Making a barometer

The device used for measuring the atmospheric pressure is called a barometer. Why don't you make one yourself and see how it works and measures the atmospheric pressure?

Take a wide-mouthed bottle and stretch the neck of a balloon clamping it on its mouth. Bind it also with the help of a rubber band in such a way that the balloon is fully stretched on the mouth of the bottle. Now, take a drinking straw and attach one end of it on the centre of the stretched balloon with 'Quick-fix' (an adhesive agent). Then, continue to hold the straw in the same position till the 'Quick-fix' gets dry. After accomplishing this, you have to do only one more job — to set a white strip of cardboard by the side of the bottle in such a way that it remains standing upright, just behind the free end of the straw. Graduate this cardboard strip with the marks indicating 'high and low' degree signs.

Now, your **barometer** is ready. As you know, when the atmospheric pressure is high, it will exert a similar pressure in all the directions. So much so, that the pressure on all the sides of the bottle will be equal, causing slight deflation in the balloon towards the inside of the bottle. This in turn will put pressure on the attached end of the straw and its other end will rise higher to indicate the increase in the pressure.

On the contrary, if the atmospheric pressure decreases, the balloon will not be deflated. But if the pressure becomes so low as to be even less than the air pressure inside the bottle, it will inflate the balloon and the free end of the straw, quite obviously, will indicate the decrease in the atmospheric pressure.



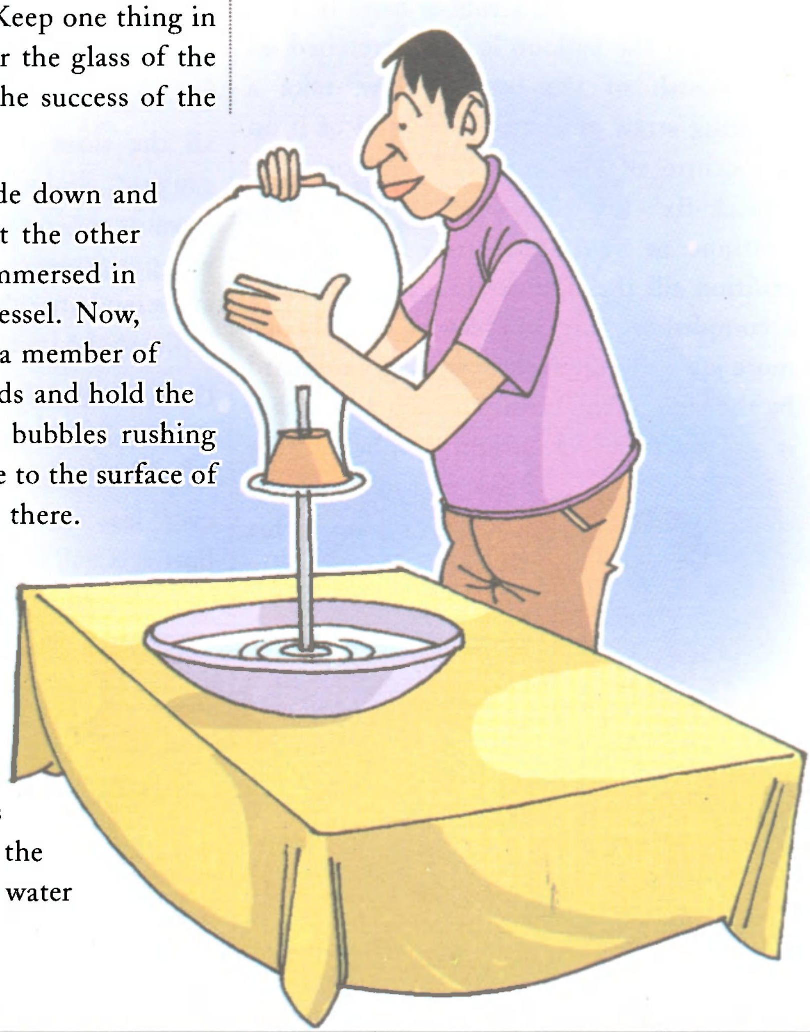
What is the effect of heat on air?

To conduct this experiment, you will need a flask type bottle with cork or rubber stopper and a slender tube. Drill a hole in the cork and insert the tube through the hole. Then fix the cork along with the tube tightly on the mouth of the bottle. Lac or grease can be used to make the joints air-tight. Keep one thing in your mind that the thinner the glass of the bottle, the better will be the success of the experiment.

Now, turn the bottle upside down and hold it in such a way that the other end of the tube remains immersed in the water kept in some vessel. Now, ask one of your friends or a member of your family to rub his hands and hold the bottle. You will see some bubbles rushing from the mouth of the tube to the surface of the water and bursting out there.

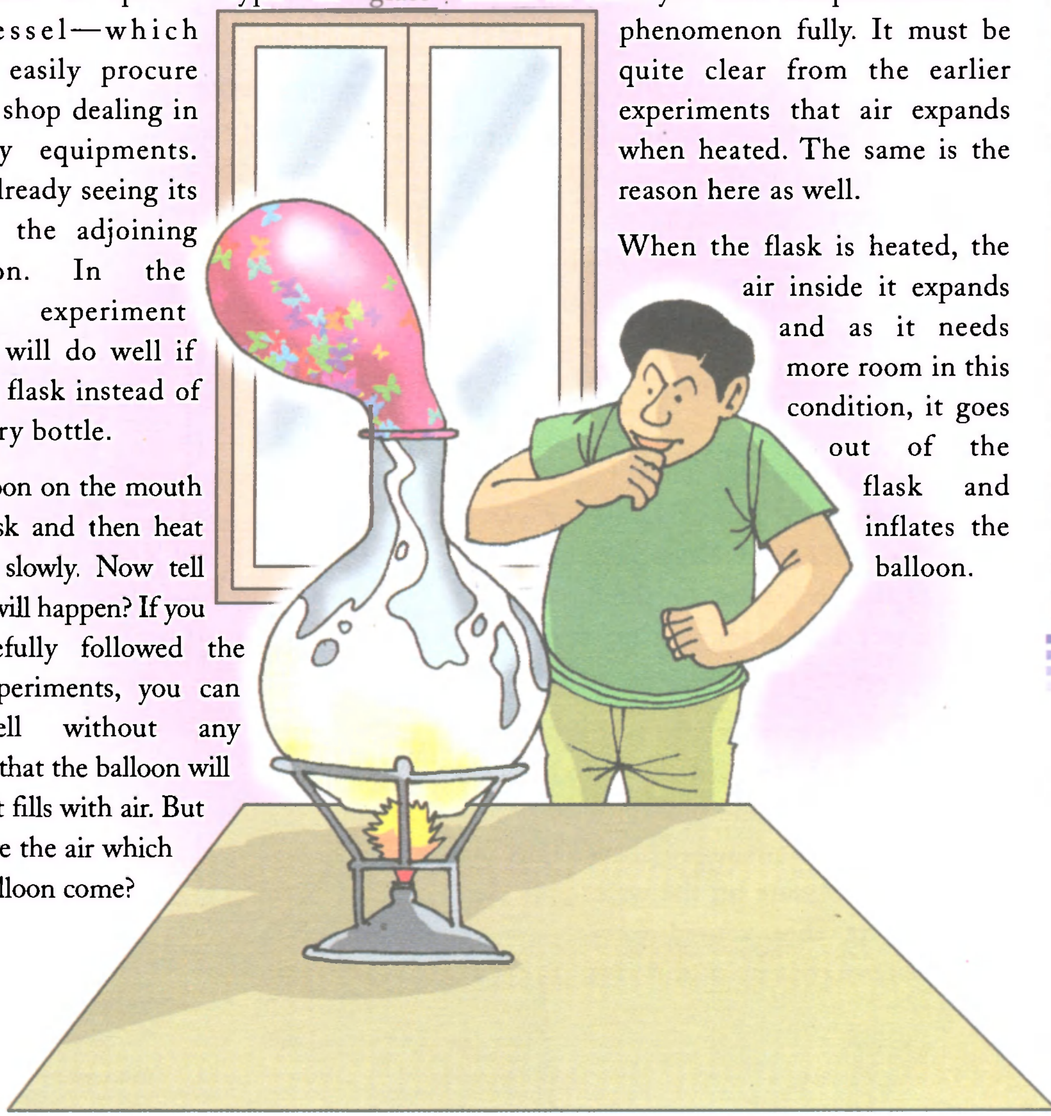
Now, do one thing more! Take a piece of cloth spread out in the sun and fold it to wrap it around the bottle. See, what happens? What do you say? Some more bubbles come from the mouth of the tube and appear on the water surface. Don't they?

It is so because the heat of the hands or the warmth piece of the cloth permeates through the air inside the bottle to cause it to expand. That part of the expanded air which cannot be contained in the bottle comes out through the tube and can be seen in the form of bubbles.



Air expands when heated

For this experiment, you will need a flask—a special type of glass vessel—which you can easily procure from any shop dealing in laboratory equipments. You are already seeing its shape in the adjoining illustration. In the previous experiment also, you will do well if you use a flask instead of an ordinary bottle.



Fix a balloon on the mouth of the flask and then heat the flask, slowly. Now tell me, what will happen? If you have carefully followed the earlier experiments, you can easily tell without any hesitation that the balloon will inflate as it fills with air. But from where the air which fills the balloon come?

The answer is very simple, isn't it? It always seems so when you have comprehended the phenomenon fully. It must be quite clear from the earlier experiments that air expands when heated. The same is the reason here as well.

When the flask is heated, the air inside it expands and as it needs more room in this condition, it goes out of the flask and inflates the balloon.

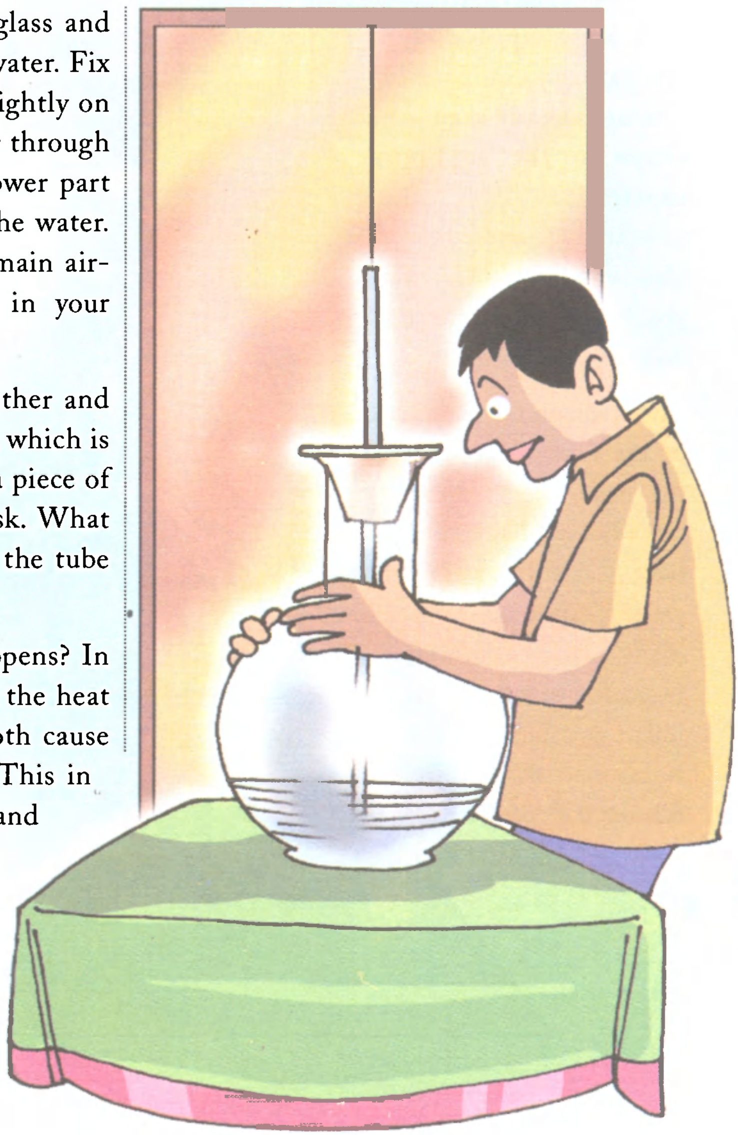
What happens when air is heated?

What happens when the air inside a flask, one-fourth filled with water and having a fixed rubber cork pierced through by a long glass tube whose lower end is lying sunken in the water, is heated?

Take a flask made of thin glass and fill one-fourth of it with water. Fix a rubber or cork-stopper tightly on its mouth with a glass tube passing through the stopper. Make sure that the lower part of the tube remains immersed in the water. All the joints of the flask must remain air-tight or else you won't succeed in your experiment.

Now, rub both of your hands together and place them on that part of the flask which is above the water-level. Next, place a piece of cloth heated in the sun on the flask. What do you see? The water rises up in the tube both the times on its own.

Can you understand why it so happens? In fact, as you have guessed correctly, the heat of your hands and the piece of cloth cause *expansion* of the air in the bottle. This in turn exerts pressure on the water and the pressure thus caused forces some water to rise up in the tube.



Does the air contract, as it cools, in the same way, as it expands when heated?

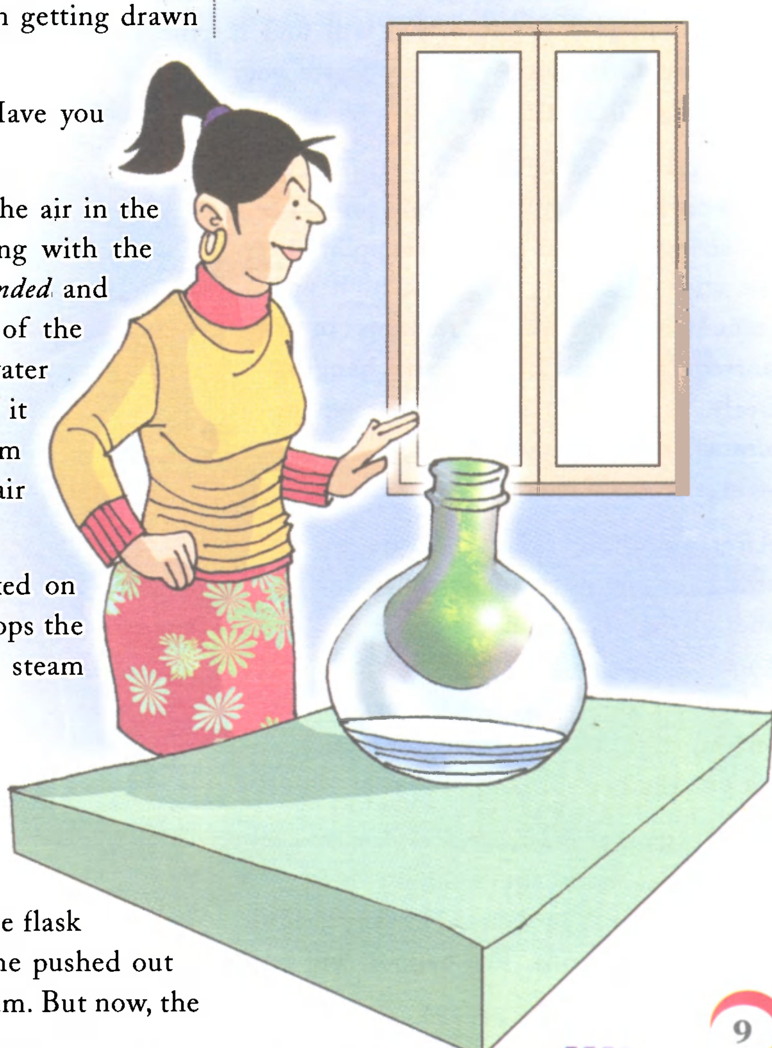
Take a little water in a flask and heat it. After sometime, when the water starts boiling, remove the flask away from the flame and fix a balloon on the mouth of the flask. Within a few moments, you will observe the balloon getting drawn to the flask, gradually.

Why does it happen so? Have you understood?

When the flask is heated, the air in the flask also becomes hot along with the water. So the air gets *expanded* and some part of its goes out of the flask. Similarly, when the water starts boiling, some part of it gets converted into steam which pushes some more air out of the flask.

Now, when a balloon is fixed on the mouth of the flask, it stops the passage of the air and the steam totally.

So, when you stop heating the flask, the steam present in it will become cool and will again get converted into water. The air inside the flask too will contract, causing the pushed out air to return to fill the vacuum. But now, the balloon is there to check it. Thus, only one option is left with the outside air—to come back to the flask and to push the balloon also along with it inside the flask. This is what precisely happens.



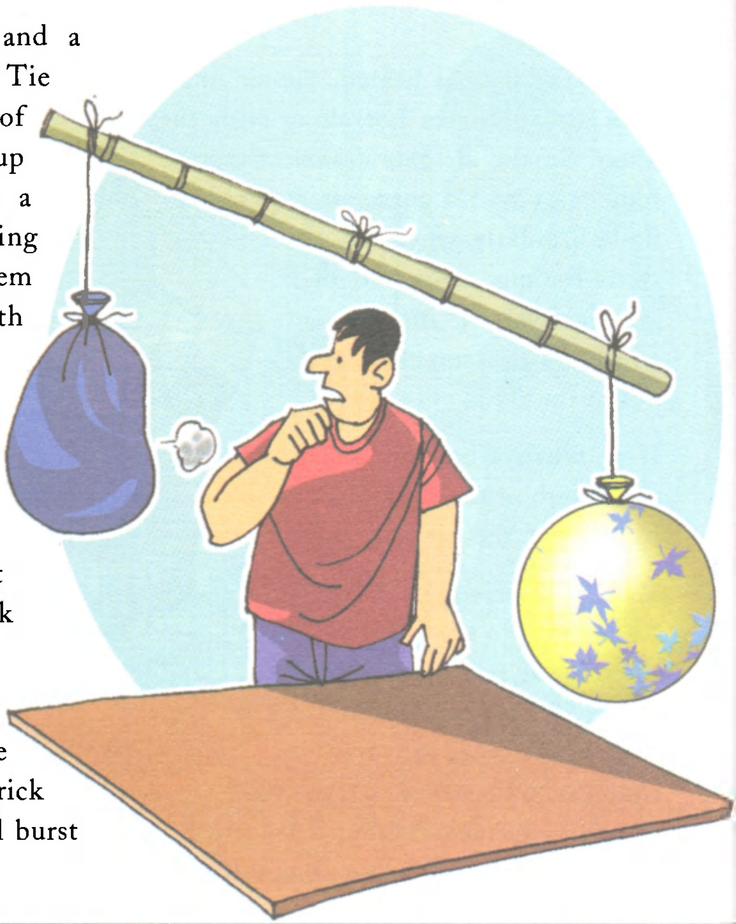
Has air any weight?

The air has weight—to prove this fact by an experiment may seem to you the most difficult task so far. Quite possibly it might prove to be the easiest one also, so easy that you may not even enquire about it! Because, it is such a type of an experiment, if once its basic concept enters your brain, you will find it very easy. Otherwise, you may waste your whole day ruminating over it.

First take two balloons, a string and a bamboo stick, about one metre long. Tie the string exactly at the middle point of the stick and hang the stick high up somewhere so that it remains in a horizontal position, when hanging freely. Take two balloons, inflate them almost equally and tie them with strings of equal length.

After you have done this, tie the strings of one of the balloons to one end of the stick and make a loose knot in the string of the other balloon, so that, by adjusting the knot on the stick, you can bring the stick back to the horizontal position.

The horizontal position of the stick shows that both the balloons have equal weight. Now take a pin and prick one of the balloons. The balloon will burst with a bang and the air in it will escape, causing the stick to tilt to one side. Thus, this proves that air has *weight*. As the air goes out of the balloon, that end of the stick having the inflated balloon tilts, as its weight is now not countered by the burst balloon. Nothing has changed except that the air of one of the balloons has gone out and so it is not contributing to keeping the stick balanced in a horizontal position.



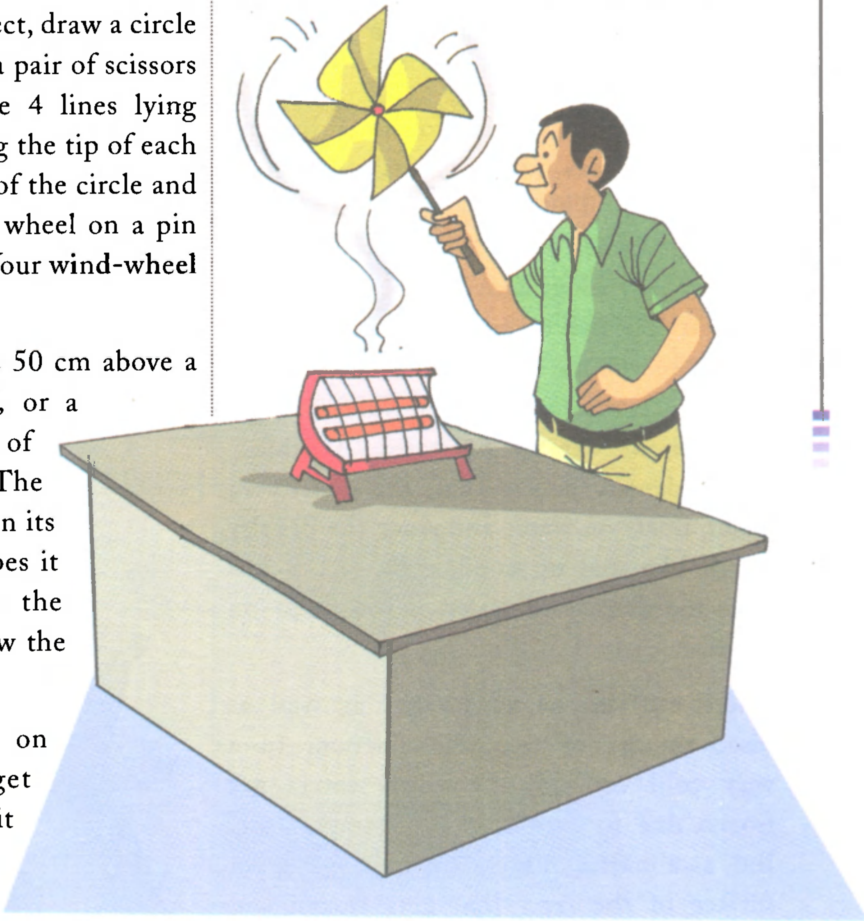
How does wind blow?

Everyone knows that the wind blows. But how? What is the reason of its motion?

To do this experiment, first of all, make a wind-wheel. Take a sheet of paper of the size, 30 cm × 30 cm and draw two lines joining the corners diagonally. Taking that point as centre where these two lines intersect, draw a circle of 10 cm radius. Then take a pair of scissors and cut the portion of the 4 lines lying outside the circle. Now bring the tip of each of the corners to the centre of the circle and stick them there. Pivot the wheel on a pin stuck into a piece of wood. Your wind-wheel is now ready to rotate.

Hold this wind-wheel some 50 cm above a burning furnace or *angithi*, or a heater or any other source of heat and see what happens. The wind-wheel starts rotating on its own, doesn't it? But why does it stop when removed from the source of heat? Do you know the reason?

When the air expands on heating, its molecules get dispersed by the heat and it becomes light. Whereas the portion of the air that does not come in contact with the heat, remains heavy and slides itself down by pushing the warm and light air, higher up. In this way, a cyclic motion is created which imparts speed to the air and also to the rotation of the wind-wheel.



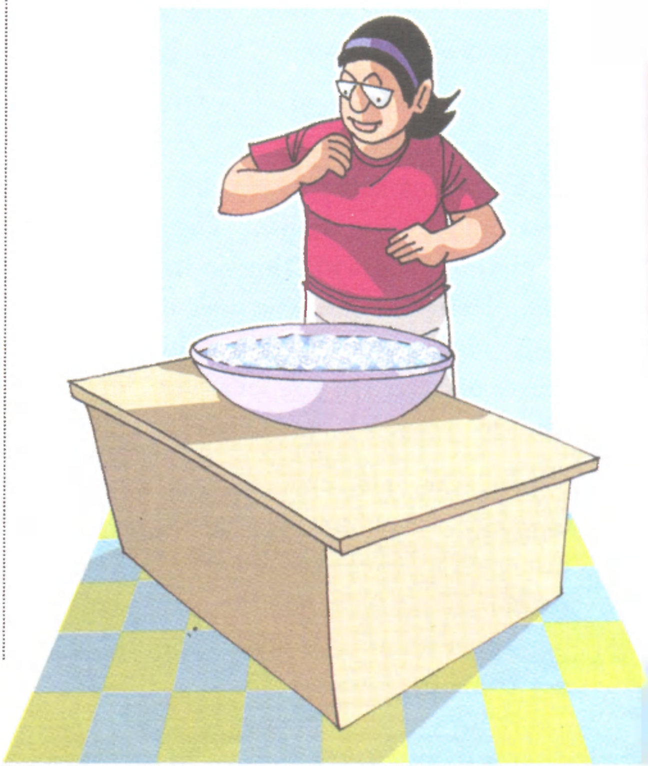
Why ice floats on water?

Cold water is heavy but ice, which is another form of cold water, floats on water despite being a solid—how does it happen?

As water gets colder, its volume decreases and it becomes heavier but this process continues only upto a certain temperature, which is 4°C. This is the temperature at which the density of water is maximum and the volume is minimum.

When water takes the form of ice, its volume increases, i.e., it covers more space in this form. The mass, however, remains unchanged when water is converted into ice. Neither anything added nor taken away from it. So the mass remains unchanged while the volume increases, which is quite apparent. It means that when water changes into ice, its density decreases. Anything, whose density is less than the density of water, floats on water and since the density of ice like that of wood, cork, etc. is less than the density of water, it too floats on water.

There are various advantages as well as disadvantages of this phenomenon. In a very cold country, the river waters get frozen due to extremely low temperature. But, as a matter of fact, it is only the upper surface of the river that gets frozen and becomes solid. The water beneath it remains in the liquid form and thus, the flora and fauna are saved from total annihilation. But on the other hand, those who travel by sea can alone tell you the grave dangers involved due to the large floating icebergs—the large chunks of ice—in the sea. These icebergs, whose larger parts are immersed in water, when come underneath the ship, act as sharp knives cutting and damaging the hull of the ship easily.



What is evaporation?

To understand this, do a minor and the most ordinary type of experiment. Take three identical saucers and keep them at a place, quite close to one another. Now pour one spoonful of water in one saucer, two spoonfuls in the second and three spoonfuls in the third one, and continue observing them at frequent intervals.

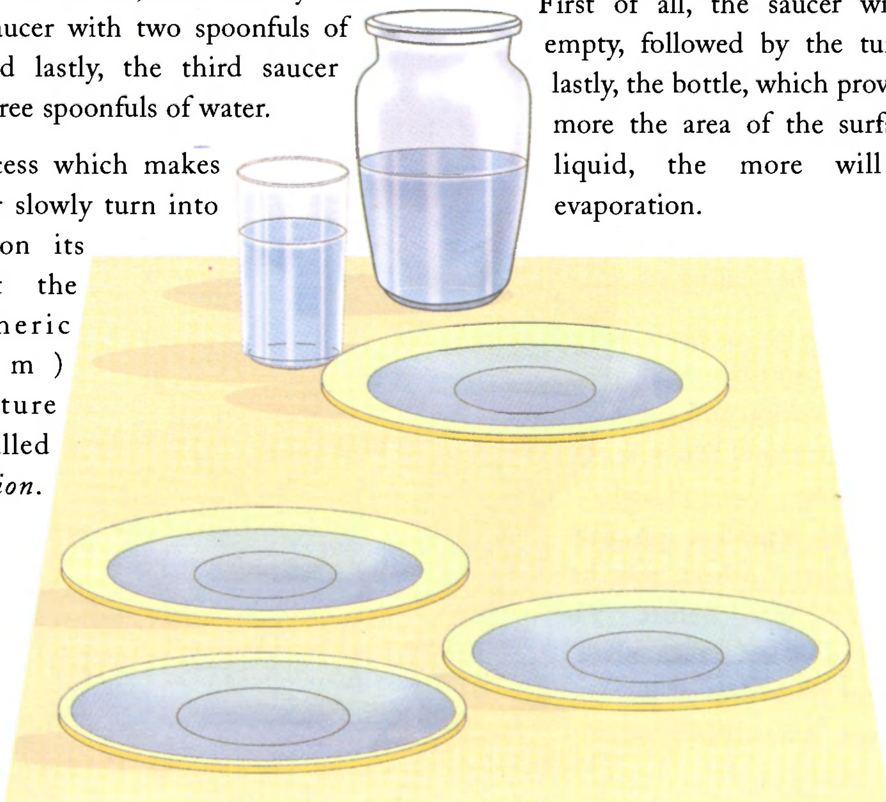
After sometime, you will observe that the saucer having one spoonful of water gets emptied first of all, followed by the second saucer with two spoonfuls of water and lastly, the third saucer having three spoonfuls of water.

The process which makes the water slowly turn into vapour, on its own, at the atmospheric (room) temperature is called *evaporation*.

However, this takes place only from the surface of the liquid. This fact can also be verified by an experiment.

For it, you require a saucer, a tumbler and an open-mouthed, narrow and long bottle. Pour two spoonfuls of water in each vessel and keep them together at a place. They all have equal quantity of water but do they get emptied together? No? Then keep on observing as to which one gets emptied first.

First of all, the saucer will become empty, followed by the tumbler and lastly, the bottle, which proves that the more the area of the surface of the liquid, the more will be the evaporation.



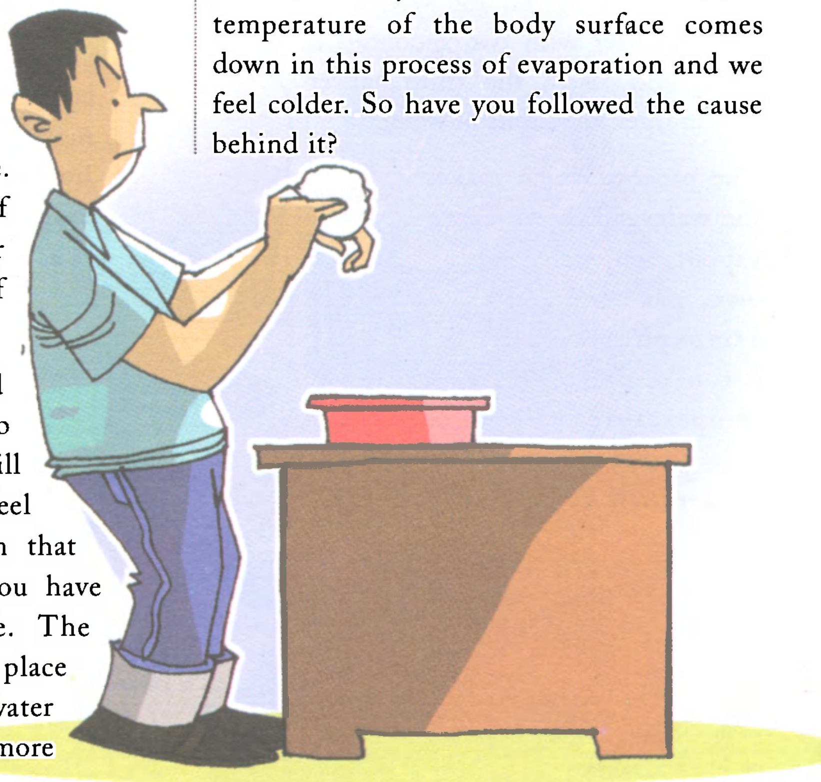
Reason to feel cold after bathing

Can you tell why we feel colder when air touches our body soon after taking a bath?

Take a small piece of cotton. Dip it in water and rub it gently over your palm. It will become wet. First of all, you will feel its wetness only, but after a few seconds, you will experience a cool sensation on that part of your hand. Do you know the reason? You already know that when evaporation takes place, the liquid derives heat from everything that comes in its contact. So it must be quite clear that the heat is being absorbed from that part of your hand where the evaporation is taking place. The resulting loss of temperature at that particular part will cause the feeling of coolness.

Now take some spirit instead of water in the cotton and dab it gently on your hand. You will feel the difference. You will feel a much cooler sensation on that part of your hand where you have applied spirit than before. The evaporation of spirit takes place much quicker than that of water and, therefore, it needs heat more quickly. This is why, the intensity of the feeling of cold is more profound than before.

Now, you must have understood why we feel colder after taking a bath. On a wet body, the evaporation takes place as usual, but owing to its contact with air, it takes place at a faster pace, resulting in more loss of heat from the body, with the result that the temperature of the body surface comes down in this process of evaporation and we feel colder. So have you followed the cause behind it?



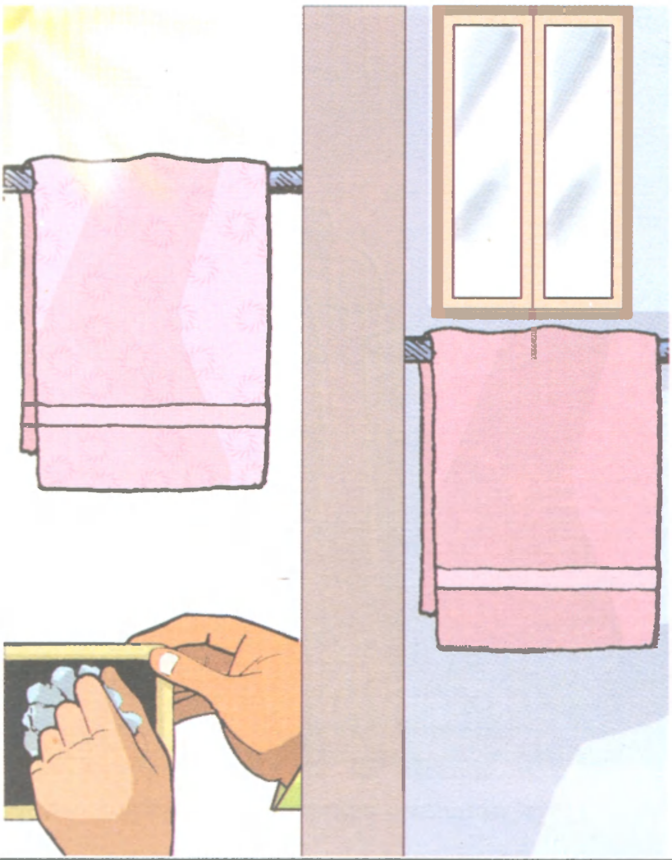
What is the effect of strong wind and heat on evaporation?

To see the effect of the strong wind on evaporation, conduct a small experiment. Moisten both sides of your slate with a wet cloth. Now continue to blow air from your mouth on one side of it, or, as an alterative, keep this side in front of a moving fan.

Which side do you think would get dry first? The side exposed to the continuous draught of air or the other one? Your answer will be correct if you say that the side exposed to the fan will dry first.

Strong wind or draught of air blows off the small particles of water or molecules—as they are called—and paves the way for the other molecules to rise higher up.

To find out the effect of heat on evaporation, take two towels of similar dimensions. Wet these two towels liberally with water so that both the towels absorb almost the same amount of water. Hang one of them in the sun and the other in the shade. For this experiment, choose a day when there is no fast moving wind. Now see, which towel dries first.



Surely, the towel lying in the sun will be the first to get dried. The molecules of water are taken away much sooner by the hot wind in comparison to that by the cool air because the molecules of hot air move faster than those of cool air.

What is condensation?

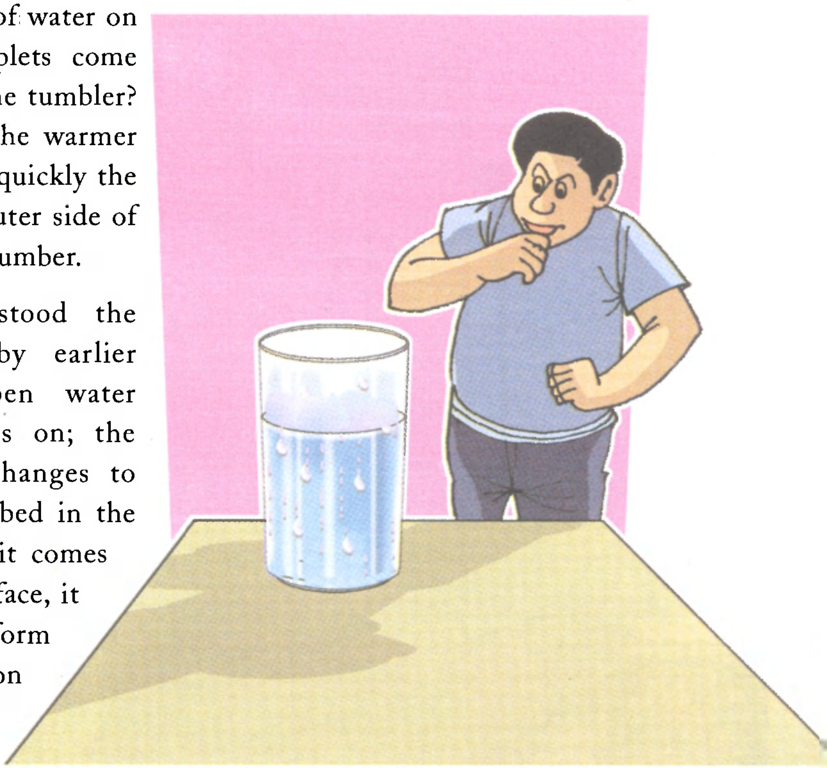
When you pour some cold (chilled) drink into a tumbler, you will find some droplets shining on the outer side of the tumbler, however, carefully you pour it. Do you know why it so happens?

Take a tumbler and fill half of it with water. Now put some ice-cubes into it and wait for sometime. The ice will melt and start cooling the water as well as the tumbler.

After a while, you will find that the outer wall of the tumbler—so far quite clean—has now some shining droplets of water on it. Where have these droplets come from on the outer wall of the tumbler? Also, you will notice that the warmer the surroundings, the more quickly the droplets will shine on the outer side of the tumbler and in greater number.

You have already understood the process of evaporation by earlier experiments. On all open water surfaces, this process goes on; the process in which water changes to vapour form and gets absorbed in the atmosphere. But whenever it comes into contact with a cool surface, it comes back into the liquid form like the droplets you saw on the tumbler. This subsequent process is known as condensation.

With the increase in temperature, the process of evaporation also speeds up. Similarly, the process of condensation is also faster if it takes place on a cooler surface.



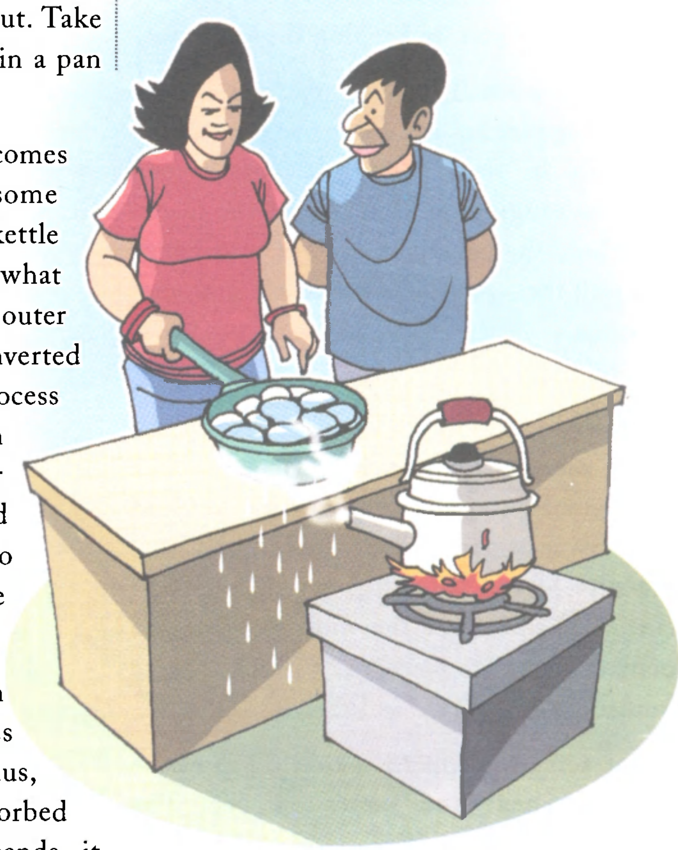
Natural process for evaporation and condensation

During rains, a lot of water falls from the sky. Sometimes, the rain continues for hours. Where does so much water come from?

For this experiment, it would be better if you could procure one aluminium kettle for boiling the water. Otherwise, any vessel can serve the purpose. Cover it with a lid in such a way that there remains a little gap between the lid and the vessel for the exit of the steam. Now boil the water till the steam starts coming out. Take some pieces of ice or chilled water in a pan with a handle.

Now see from where the rain water comes in the sky. Hold the pan at some distance from the nozzle of the kettle blowing out the steam and see what happens. The hot steam strikes the outer chilled wall of the pan and gets converted again into water drops, i.e., the process of **condensation** takes place. When many such drops combine together and become too heavy to withstand their own weight, they start falling to the ground. This precisely is the process by which the rain falls.

The heat emanating from the sun converts the water of the rivers, lakes and the seas into vapour and thus, water in the form of vapour gets absorbed in the atmosphere. As the air ascends, it becomes colder and the vapours present in it take the shape of tiny drops of water owing to the colder climate above. A large collection of such water drops forms the cloud. When the water drops in the cloud become too heavy to withstand their own weight, they start falling to the earth and thus, we get the delight of rains.



What is coalescing?

In extremely cold regions, the water in rivers, ponds, etc. gets frozen and changes into ice. On this ice, how is it possible for the people to slide with the help of a special type of footwear known as ice-skates? Can you explain the reason behind it?

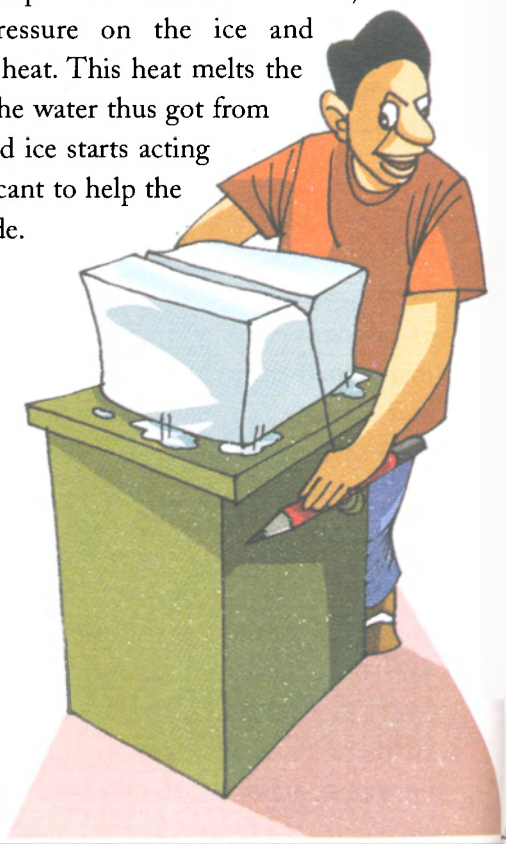
Take a 50cm long piece of metallic wire (it can be a fuse wire or any other wire of lesser gauge but quite sturdy). Tie one pencil each on both the ends. These will work as handles for you and will help you, in keeping the wire taut.

Now take a small wooden plank and place on it a big piece of ice. Place the wire on the ice-piece in such a way that one pencil remains hanging on each side of the plank. Now hold the pencils in each of your hands and pull them slowly downwards. See, what happens.

The wire starts cutting the ice and begins to go down, and after a while, goes across the whole piece of ice to reach its bottom. But surprisingly, the ice does not get divided into two separate parts. Though the pressure of the wire goes on melting and cutting the ice, yet the moment the wire penetrates the ice piece, the two parts of ice immediately coalesce and freeze.

What actually happens is that the pressure produces heat and melts the ice. The moment the pressure is removed, the heat dissipates and, hence, the coalescing of the separated ice blocks and their refreezing becomes possible.

In the game of ice-skating, the weight of the entire body of the skater gets concentrated on the iron strips fixed below the ice skates; which exerts pressure on the ice and produces heat. This heat melts the ice, and the water thus got from the melted ice starts acting as a lubricant to help the skates slide.

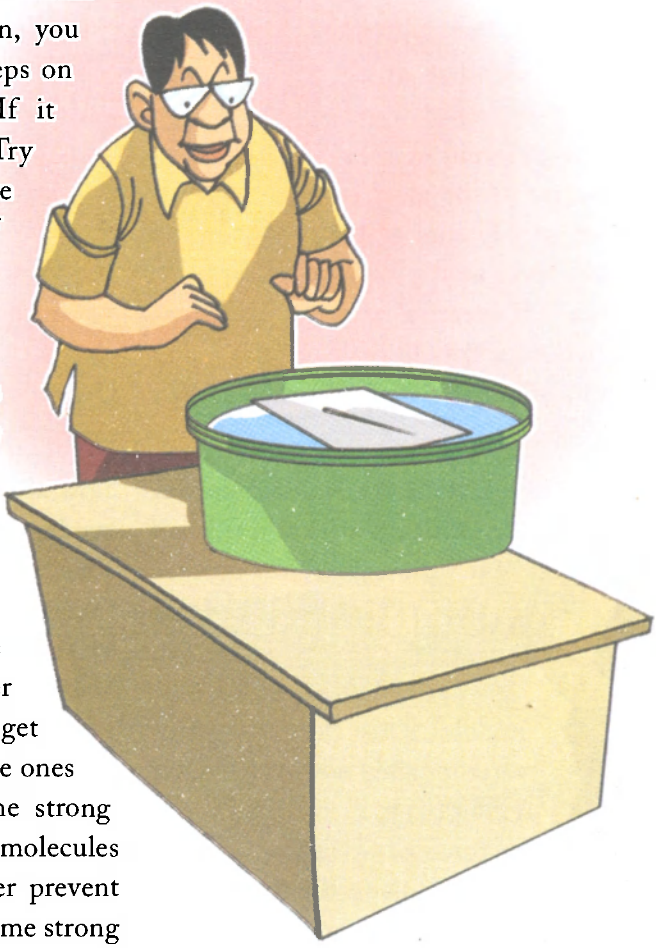


Water acts like a thin film

Some very small insects can be seen moving with great ease on the surface of water. How are they able to move on the surface of a liquid?

Place a big bowl on a table and fill it with water. When the water in it becomes still, place a needle horizontally on the water level, very carefully and watch the happening. If the needle has been placed with due caution, you will be surprised to see that it keeps on floating on the water surface. If it sinks, do not get disheartened. Try again. Now you can do one more thing. This time take a piece of tissue paper, float it on the water surface and then place the needle on it. The paper will sink automatically the moment it gets thoroughly soaked but the needle will continue to float.

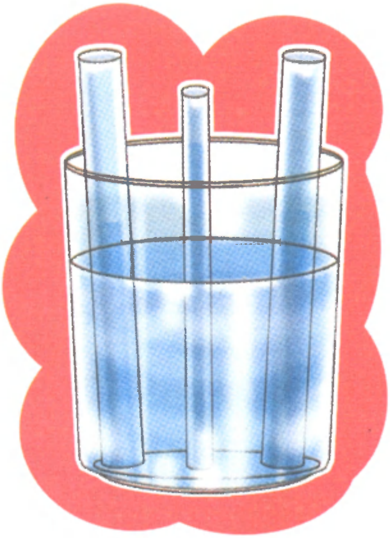
Do you know the reason why the needle floats? In fact, the surface of water acts as a thin film which is known as the *surface tension*. The molecules in water attract each other and the molecules on the surface get attracted closer in comparison to the ones below the surface. In this way, the strong forces of attraction among the molecules present on the surface of the water prevent the sinking of the needle. It is the same strong attraction which forms a sort of platform by creating a film-like effect on the water surface on which small insects can be observed sauntering with ease.

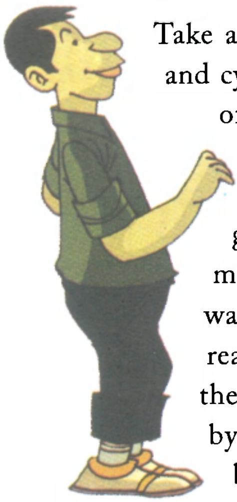


What is water level?

Put a plastic or glass tube in a glass full of water. The level of water in the glass tube rises higher than the level of water in the glass. Why?

To study its cause thoroughly, take three or four glasses or plastic tubes of different diameters and put them in a glass of water. You will be surprised to see that in all the tubes, the level of water has risen to different heights but the water in the glass is still quite steady and still. The water level in the tube of the least diameter is the highest whereas it is lowest in the tube of the maximum diameter. Why does it happen?





Take a test tube or a long, narrow and cylindrical bottle and fill half of it with water. Now observe the level carefully. It is highest at the sides and gets gradually concave in the middle! This curved level of water is called *meniscus* and the reason of its such formation is the force of attraction exerted by the walls of the tube or the bottle on some portion of water due to *adhesion*.

Normally, you can reckon this adhesion to be a force which raises the level of water on the sides of a tube. Actually, this action of raising the water level higher is called the *capillary action*. This capillary effect is strongest on the tube with the least diameter because in this condition, a large portion of the water remains in direct contact with the sides of the tube. Owing to the adhesive force, it remains in the fold of the attraction working on it.

Now see what happens if you apply grease inside the tube before filling it with water. This time the level of water instead of curving downwards would seem to be curving upwards. Why? It is so because the molecules of water do not get attracted as much by grease as by the plastic or glass. In this case, the mutual attraction of water molecules is more than the attraction caused by the grease, which is known as *cohesion* and not *adhesion*.

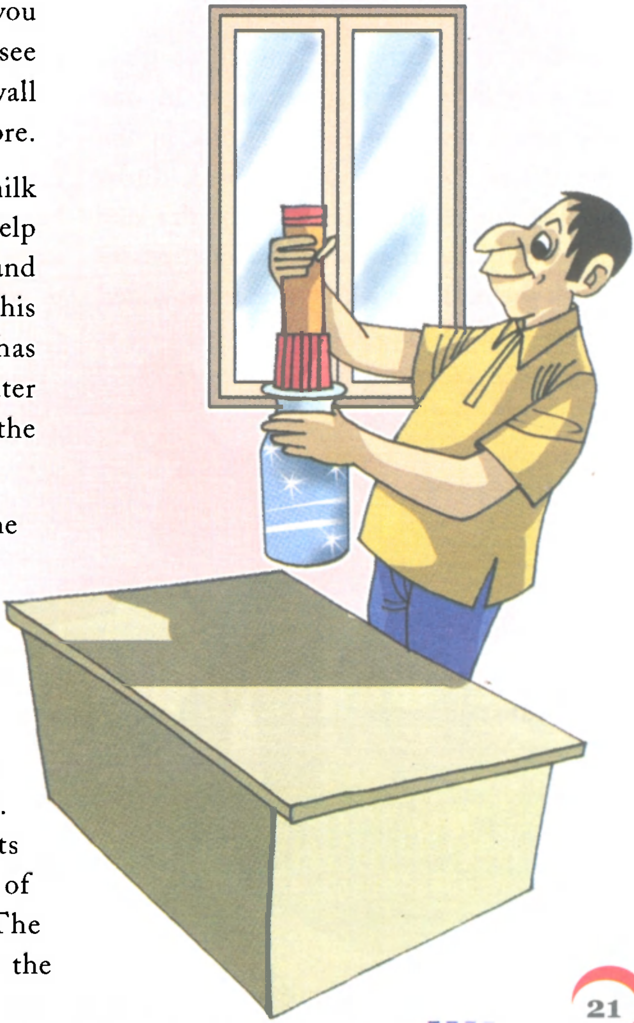
What is (total) reflection?

Why does water placed directly below a source of light start shining when a few drops of milk have fallen into it?

Take a wide-mouthed bottle or a glass jar and fill it with water. Place a torch of light above it in such a way that light falls straight into the water and not on the walls of the bottle. If you look from above, you will, no doubt, see some shine in the water but the outer wall of the bottle will look darker than before.

Now add two or three spoonfuls of milk in the water and mix it well with the help of a spoon. Throw light into it again and see the difference. You will find that this time, the shine inside the bottle has increased only a little but on the outer walls, it is so much brighter that the bottle glows like a milky bulb.

What actually happens is that when the torch is lighted, the angle of incidence of light is so acute that in conformity with the *law of total reflection*, the entire light remains confined inside the jar. But when some milk is mixed with water, the situation undergoes a total change. Light thrown from the torch gets reflected when it strikes the molecules of the milk floating in the water. The reflected light, coming out through the transparent wall of the jar creates a brightness inside the jar as it shines outside on it.

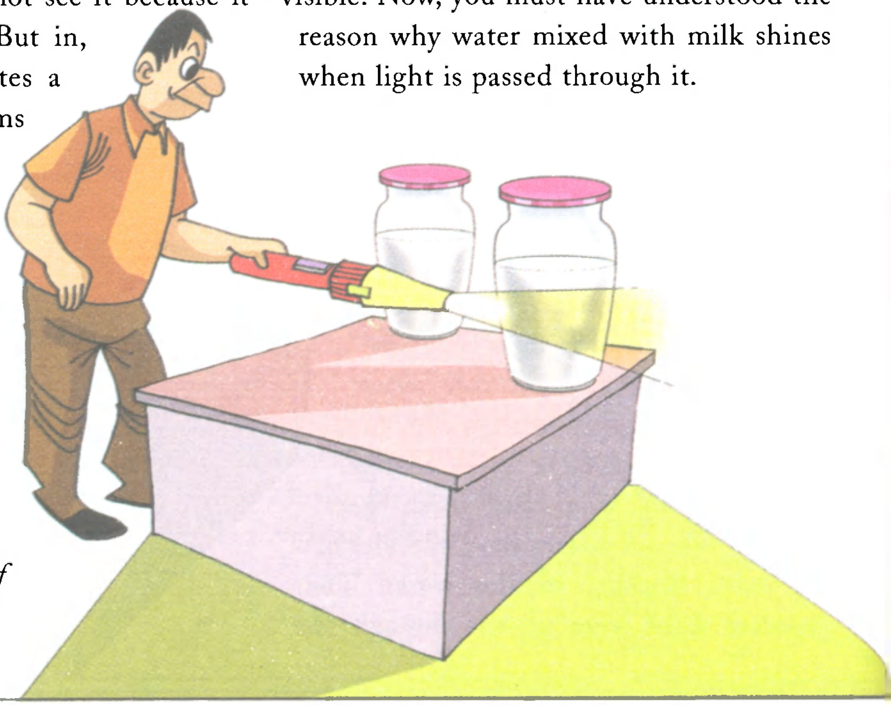


Translucence or opaqueness?

There is a state of translucence between transparence and opaqueness. Is there any such state between solubility and insolubility?

Take a piece of thick paper and fold it in the shape of a cone and then cut off its pointed end, a little. Now paste this cone on the front side of a torch or light with the help of an adhesive tape. Then take the bottles of colourless glass filled with water. Put some sugar in one bottle and a few spoonfuls of milk in the other. When the sugar is dissolved, throw light from the torch on both the bottles, one by one. What do you see? Light just passes through the bottle in which sugar was added and you may perhaps, not see it because it contains the solution. But in, other bottle, light creates a shine because milk forms a colloidal solution with water.

When a substance is mixed in some liquid (generally water), the entire substance or part of it gets dissolved in the liquid and disappears —this property is known as the *solubility of the liquid*. But if the substance does not get dissolved in the liquid, this property is called the *insolubility of the liquid*. In this case, the substance, after sometime, settles down at the bottom of the liquid. Apart from these two states, there is yet another state called the *colloidal suspension* in which the substance neither gets dissolved in the liquid nor does it settle down at the bottom, but its molecules remain in a state of suspension. These molecules are big enough to reflect the rays of light and make them visible. Now, you must have understood the reason why water mixed with milk shines when light is passed through it.



Speed and the 'cage of death'?

In circus, there is a game known as the 'cage of death'. In this game, a motorcyclist drives a motorcycle speedily on the inner walls of a spherical cage of iron. But he does not fall off the motorcycle even when he is upside down. Why?

Take a small bucket and fill one-third of it with water. Tie a rope, half a metre long, to the handle of the bucket. Now perch yourself atop a fixed stool or a raised platform in an open space and rotate the bucket speedily in a full circle with the help of the rope. While doing so, the mouth of the bucket should always be facing your hand gripping the rope and its bottom should be towards the outer side of the circle of movement. While making the full circle, there will arise a position of the bucket when its bottom is vertically upwards. But, surprisingly, even in this position, the water from the bucket will not fall down. The force which prevents the water in the bucket from falling down is called *the centrifugal force*. The chief property of this centrifugal force is to maintain the maximum distance between the object moving speedily in a circular path and the centre of the circle of rotation. The more the speed of the rotation, the more shall be the centrifugal force.

It is due to this centrifugal force that the motorcyclist remains glued to his seat while driving his motorcycle inside the cage.

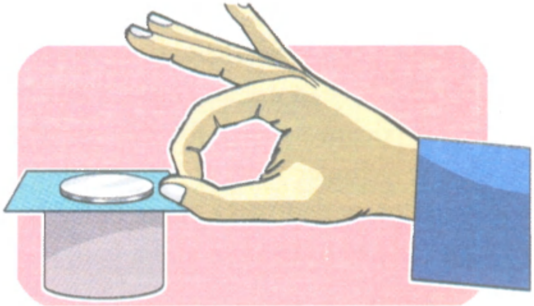
What is inertia?

Why does a person sitting in a fast moving vehicle bend forward with a jerk when the vehicle suddenly stops?

Stretch the palm of your hand fully and place on it five to six books, one above the other. Keep your hand a little forward and start walking fast. After a while, stop yourself abruptly. Do you know what will happen? Do this experiment not only once or twice, but many times, and you will see that you achieve the same result every time. The pile of books will tumble down and fall forward. It is similar to the bending forward with a jerk of a person sitting in a vehicle, when the vehicle stops suddenly. Here, *the law of inertia* will apply. According to this law, a moving object shall continue to move in the same direction unless some external force stops it.

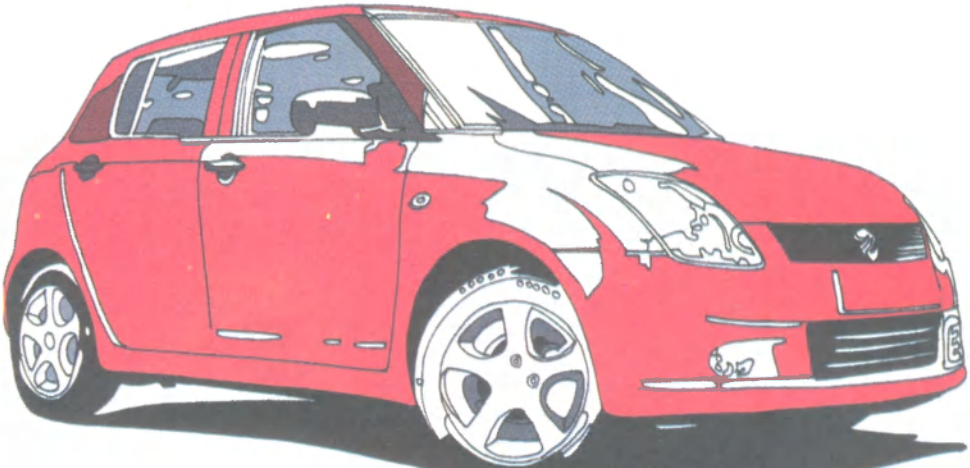
Practical inertia

Why does a person sitting in a stationary vehicle get pulled back when the vehicle starts moving suddenly?



In order to understand this phenomenon, perform an experiment. Cover the mouth of a glass tumbler with a piece of cardboard and place a coin on it. Now push the cardboard with your finger so that the cardboard is thrown off the tumbler. Do you know as to what will happen? Along with the cardboard, the coin would also fall off the glass. You should not worry and once again place the cardboard atop the glass along with the coin. Now flick the cardboard forcefully with your forefinger propelled with the help of your thumb and observe the consequence.

This time it will be quite different from what happened earlier. As soon as you strike the cardboard, it will be thrown off but the coin will drop in the glass tumbler. What actually happens is this: The cardboard is thrown off with such a force that the coin fails to accompany the cardboard and the cause of the failure of the coin to move together with the cardboard is the *law of inertia*. When a thing is stationary, it remains in that stage till an external force makes it move. This is what is known as the law of inertia.



Constructing a water dam at home

You might be knowing that the dams constructed on the rivers have their lower portion much broader than the upper portion. Can you tell why?

Take a cylindrical container made of tin. You can use an empty container of talcum powder for this purpose. Divide the cylinder from top to bottom in four equal parts and make three holes in it with the help of a hammer and a nail.

Now keep the tin, either in a tray or at any such place where there is no danger of anything getting spoiled by the spurt of water from the three holes. Then fill the tin fully with water.

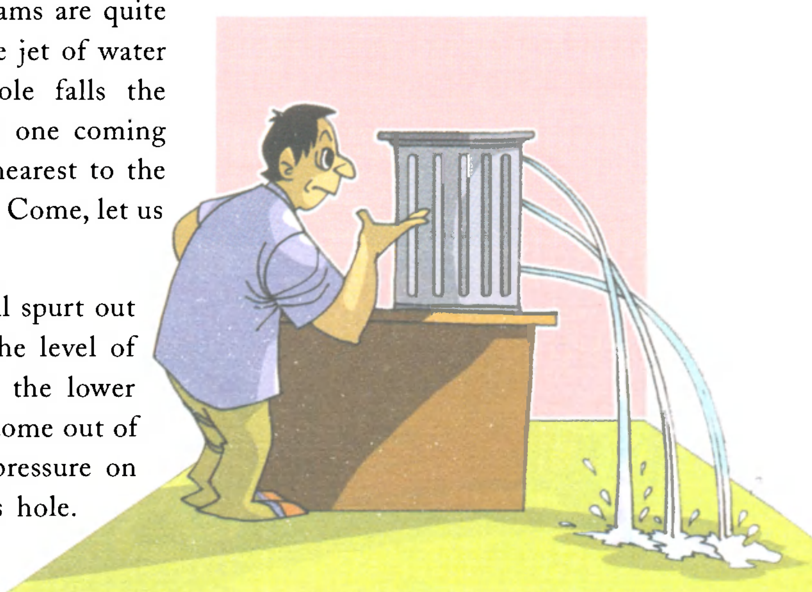
What do you see when you fill the tin with water? Three jets of water start spurting from the holes, don't they? But you will observe that all the three streams are quite different from each other. The jet of water spurting from the lowest hole falls the farthest from the tin and the one coming out of the top hole falls the nearest to the tin. Let me tell you the reason. Come, let us first consider the top hole.

Only that portion of water will spurt out of this hole which is above the level of this hole. Since the water in the lower portion of the tin has not yet come out of this hole, it won't exert any pressure on the water spurting out of this hole.

In the same way, when you consider the lowest hole you will observe that the entire water which is above the level of this hole exerts pressure on the jet spurting out of this hole. And that will definitely be far more than the pressure exerted on the water spurting from the top hole.

Thus, you have seen that in a vessel full of water, the pressure on the lower part is always more in comparison to the pressure felt on the higher part.

It is for this reason that the lower portions of the dams are made broader because the pressure decreases as you go upwards.



Detecting starch and fat in food

Besides other ingredients, our food contains starch and fat. Can their presence be detected by means of simple experiments?

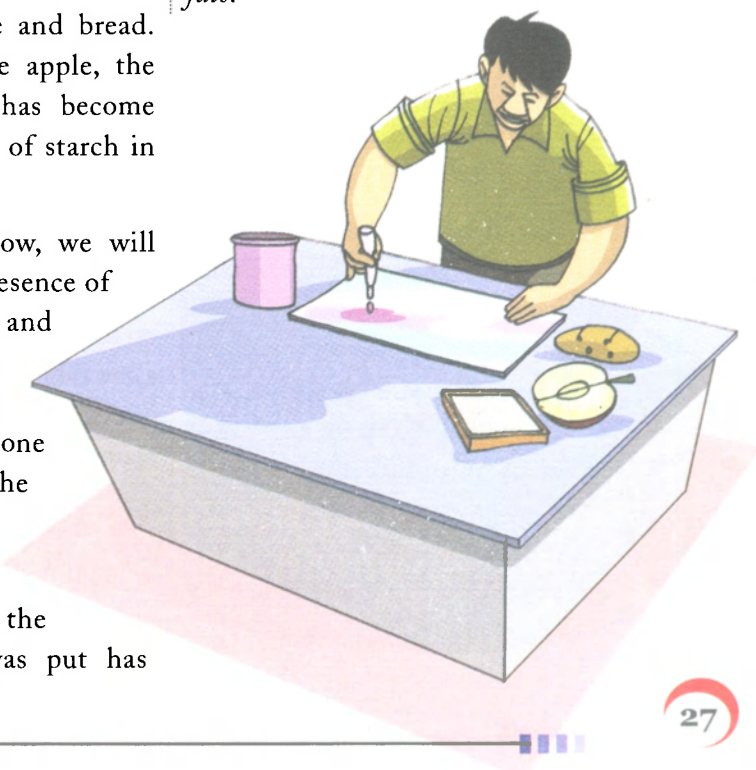
Put a little starch on a glass sheet and sprinkle some baking soda (sodium bicarbonate), a little away from it on the same glass sheet. Now put one drop of tincture of iodine on each of these substances with the help of a dropper. Notice the change in their colour.

Sodium bicarbonate will take the colour of iodine; while the colour of starch will turn purple to indicate the presence of starch.

Now put one drop of tincture of iodine each on the pieces of potato, apple and bread. You will find that barring the apple, the iodine on bread and potato has become purple, indicating the presence of starch in them.

This was regarding starch. Now, we will consider the detection of the presence of fat. Take a sheet of clean paper and draw two circles on it at some distance from each other. Put a few drops of lemon juice in one circle and *ghee* or butter in the other.

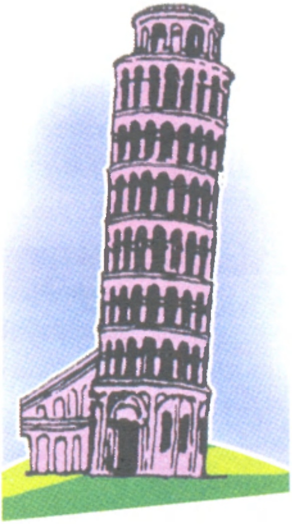
After an interval of 10 to 15 minutes, you will find that the portion where lemon juice was put has started to become dry without leaving any mark of it on the reverse side of the paper. But the marks made by the *ghee* or butter will be clearly visible, not only on the spot where it was put but even on the reverse side of the paper, and the marks have spread also in the meantime. The conclusion of this experiment is: The substances containing fat cannot only be seen on the reverse side of the paper, but their marks spread too, during the process. This test is called *spot test for fats*.



Law of gravity

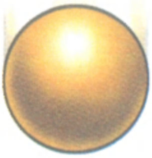
The renowned Italian scientist, Galileo had proved by dropping some pebbles from the leaning tower of Pisa that despite the difference in weight, all the pebbles reached the earth at the same time. But you don't believe it, do you?

If you don't believe in the conclusions derived by Galileo, let it be so. But you can yourself conduct some such experiments. And for this, you need not climb a tower. You can observe it all by yourself by doing a simple experiment at your home itself whether the objects of different weights dropped from the same height reach the ground at the same time or not.

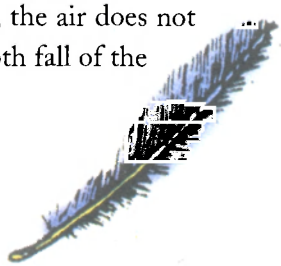


To do this experiment, you will need a long wooden plank—a metre long will do—and few coins of different weights. That's all.

Now make a row of coins along the length of the plank and hold the plank horizontally with both your hands, above your head. Tc increase the distance between the plank and the ground, you can stand on a stool or table. Now tilt the plank towards the ground so that all the coins slide down simultaneously. Before doing so, ask your friend well in advance to watch carefully whether all the coins touch the ground at the same time or not.



If you have tilted the plank in such a way that all the coins slide down at the same time, then they will definitely fall on the ground simultaneously owing to the effect of the gravitational pull of the earth which attracts everything towards it with the same speed. If the same experiment is conducted with a coin and a feather, the result will not conform to this principle. The coin will reach the ground earlier than the feather. Why? The reason behind it is the resistance created by the air in the way of the feather. But if the coin is placed on the feather, both will reach the ground at the same time, as in this case, the air does not directly obstruct the smooth fall of the feather.



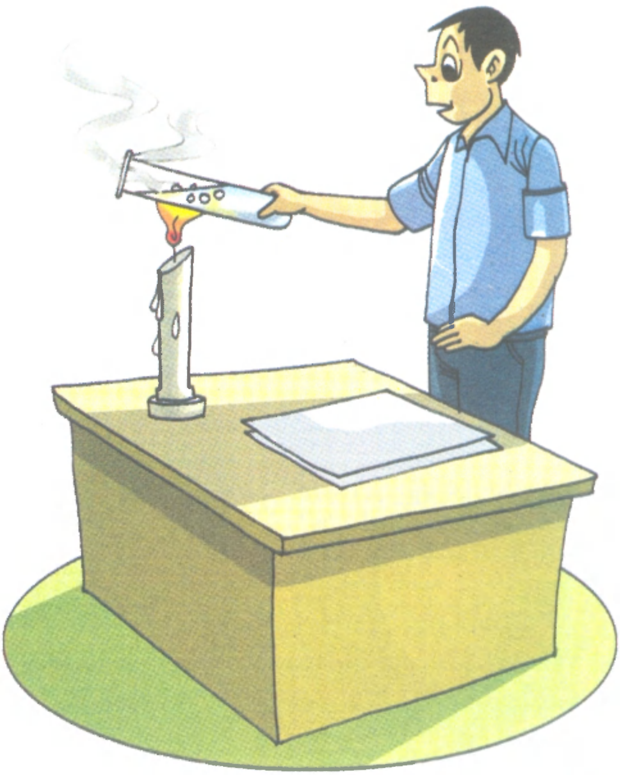
Is it possible that you hold a test tube in your hand in which water is being boiled?

Take a test tube and fill 3/4th of it with water. (but be sure that the test tube is heat proof). Now hold the test tube in an inclined position (as shown in the diagram), so that the flame of the candle starts heating the upper level of the water. After sometime, the water will start boiling and it will be visible rising up in the form of steam.

How exciting will it look that you are holding a test tube without difficulty in your hand, in which the water is being boiled! But don't imagine that you can continue holding the test tube in the same manner by its upper portion too, when the tube is being heated from the bottom side. There is a vast difference between the two situations. Do you know what?

We cannot hold the test tube from any place when it is heated from the bottom side because water becomes lighter on heating, and hence, it rises up to make room for the cold water. This process continues till the entire water starts boiling. Owing to their contact with hot water, the walls of the test tube also get heated. Hence in this condition, it is not possible to hold the test tube.

The situation is quite different when the water is heated from the upper portion of the tube. The question of water going down on heating does not arise as the water from this portion is lighter. It rather goes on getting converted into steam at the upper portion of the tube itself, and the water at the lower part remains unaffected by the heat. It is only then that you can remain holding the tube.

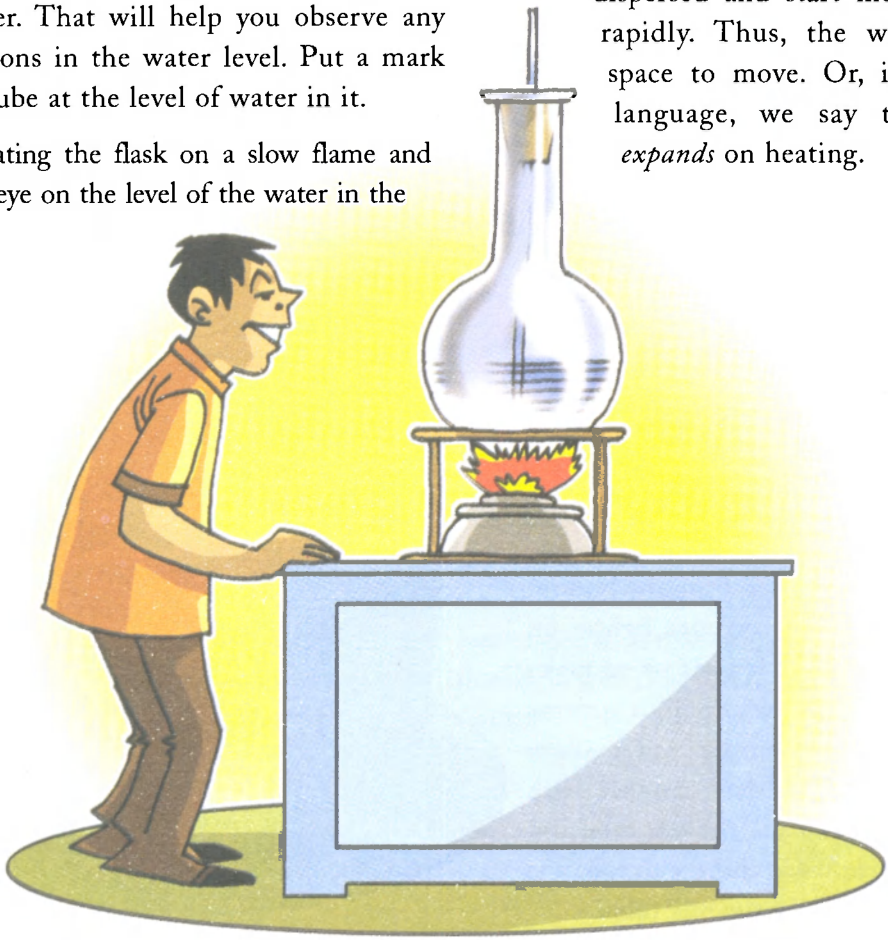


What is the effect of heat on the volume of water?

For this experiment, you need a flask, a cork and a glass tube. Make a hole in the cork and insert the tube through the cork. To make this joint airtight, you can apply grease or seal it with lac. Now fix the cork holding the tube tightly at the mouth of the flask. Put one or two drops of ink or any coloured liquid in the water. That will help you observe any fluctuations in the water level. Put a mark on the tube at the level of water in it.

Start heating the flask on a slow flame and keep an eye on the level of the water in the tube. What happens? Do you observe any change in the water level? Yes, you are right! With the heating of the water, the level of the water in the test tube starts rising up.

The experiment shows that on heating, the volume of the water increases. The molecules of water, on heating, get dispersed and start moving more rapidly. Thus, the water needs space to move. Or, in ordinary language, we say that water *expands* on heating.



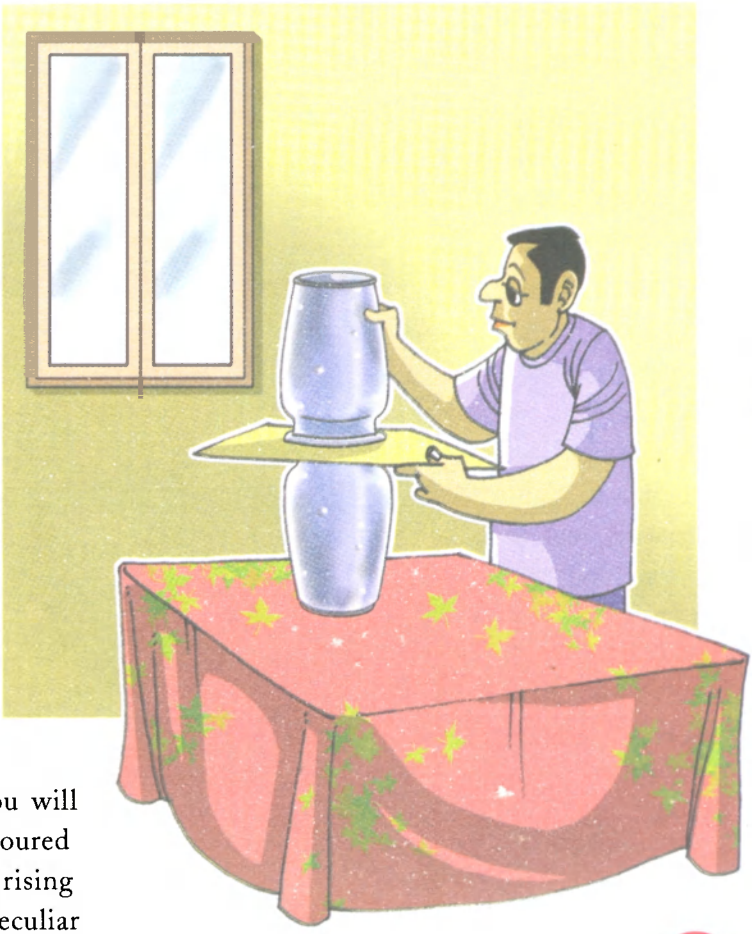
Does the weight of water undergo any change when heated?

With the help of an experiment, it can be easily known that cold water is heavier in comparison to hot water, or in other words, water becomes lighter when heated.

Take two identical bottles. Fill one bottle fully with hot water and the other with cold water. Mix a few drops of ink or any other coloured liquid to the hot water to make it coloured too.

Now keep a piece of thick paper on the mouth of the bottle with cold water, and keeping this paper pressed properly with the fingers, turn it over and place it on the other bottle. When the mouths of the two bottles are fully aligned, pull out the piece of paper pressed in between them.

The water in the lower bottle is hot and coloured too, while in the upper one, it is cold. You will see that after sometime, the coloured water in the lower bottle starts rising towards the upper bottle in a peculiar manner. This clearly shows that the cold water in the upper bottle being heavy and in an effort to come down, starts pushing the hot water in the bottle below, towards the upper side.

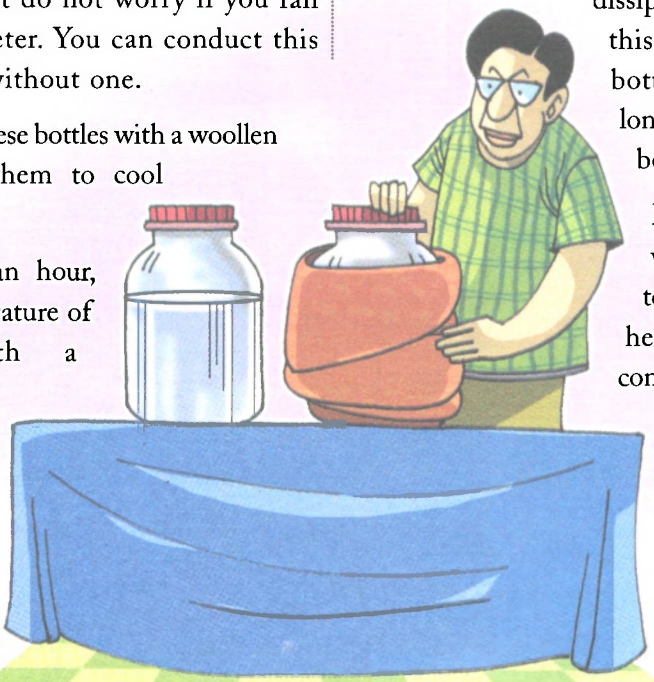


In winter, we are protected from cold when we wear woollen clothes. Why is it so?

Take two identical jars or bottles. Boil water in a vessel and fill the two bottles or jars with this hot water. Close them tightly with their covers. It will be better if you can manage to arrange a thermometer to measure the temperature, because only then you will be able to get the exact results instead of doing the guesswork. But do not worry if you fail to get a thermometer. You can conduct this experiment even without one.

Now cover one of these bottles with a woollen cloth and allow them to cool simultaneously.

After about half an hour, measure the temperature of the bottle with a thermometer, if you have one, otherwise, feel it by touching the bottles. Which is the hotter one now? The one covered with the woollen cloth, isn't it?. Do you know the reason? The bottle not covered by the woollen cloth comes in direct contact with the air and in this way, its heat gets dissipated in the atmosphere. But the second bottle covered with the woollen cloth does not come in contact with the open air. Owing to the wool being a bad conductor of heat, it prevents the heat of the bottle from dissipation. It is due to this reason that this bottle remains hot longer than the other bottle.



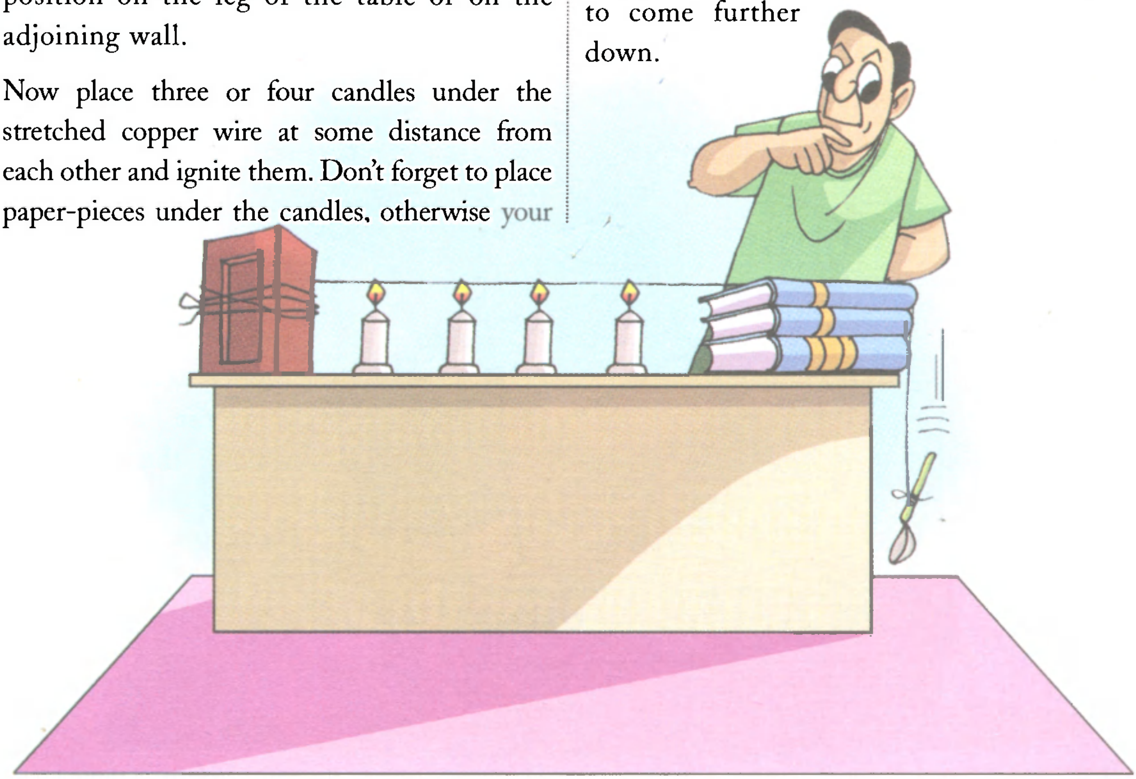
During winter, we wear woollen clothes to *insulate* our body-heat and keep it confined to our body. In this way, we prevent the heat from going out of our body and getting absorbed in the cold atmosphere outside.

Do the metals expand on heating?

Take one metre long copper wire and tie its one end with some heavy object placed on a table, about 60 cm away from one end of the table. Suspend the other end of the wire from the other side of the table, passing over a small pile of books kept on that side of the table. Now tie some small but heavy object with the suspended end of the wire, so that the wire remains fully taut. When this weight tied with the wire becomes stationary, mark its position on the leg of the table or on the adjoining wall.

Now place three or four candles under the stretched copper wire at some distance from each other and ignite them. Don't forget to place paper-pieces under the candles, otherwise your mummy might scold you for ruining the table.

Heat the piece of the wire thoroughly by changing the position of the candles under it. After about 5 to 7 minutes, mark the position of the weight tied with the suspended end of the wire again. You will observe that the second mark is at a lower point than the earlier one. This extension of the wire proves that the wire has grown longer on heating and thus, causing the weight tied to the suspended end of the wire to come further down.

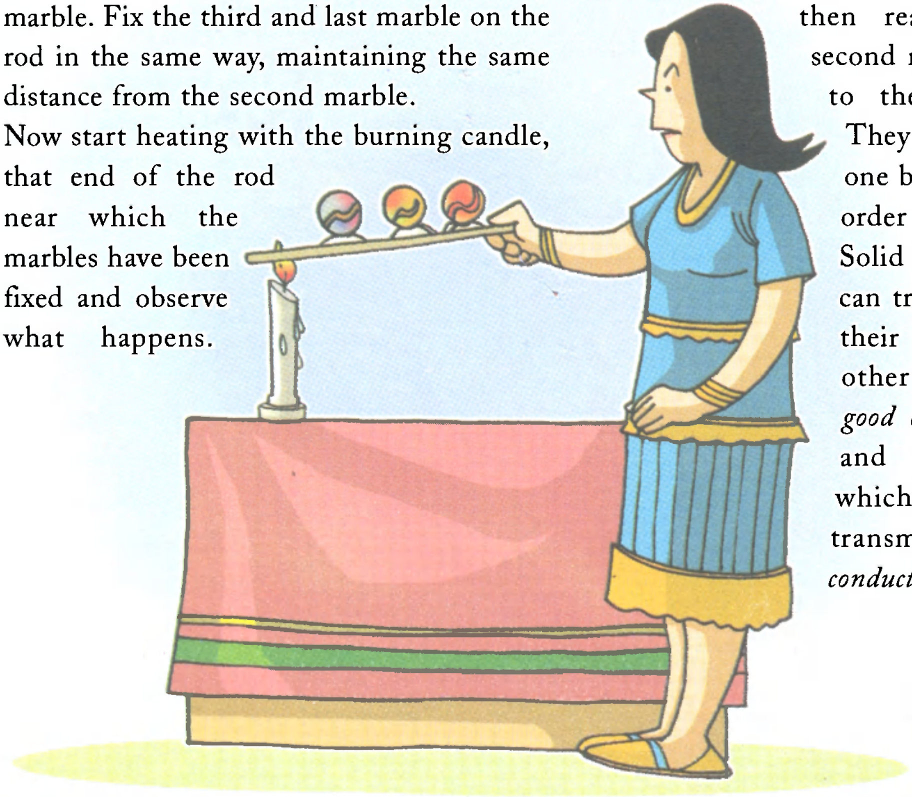


Can solid objects transmit heat?

Take a 30 cm long metal rod, a candle and three big round marbles. Now lit the candle and let a few drops of the wax fall on the rod, about 5 cm away from one end of the rod. Take one marble and fix it on the molten wax and press it hard before the wax dries. The marble will stick to the rod when the wax dries.

Similarly, fix another marble on the rod at a point about 3 to 4 cm away from the first marble. Fix the third and last marble on the rod in the same way, maintaining the same distance from the second marble.

Now start heating with the burning candle, that end of the rod near which the marbles have been fixed and observe what happens.



Does the heating of the rod not affect the marble at all? Or, do all the marbles drop down at the same time or in a particular order?

If you fail to answer these questions, this experiment will demonstrate how solid objects transmit heat. It is owing to this reason that the wax holding the marble nearest to the end of the rod being heated will melt first and hence, that marble will be first to fall down. Heat will then reach up to the second marble and lastly, to the third marble. They will fall too, but one by one and in that order only.

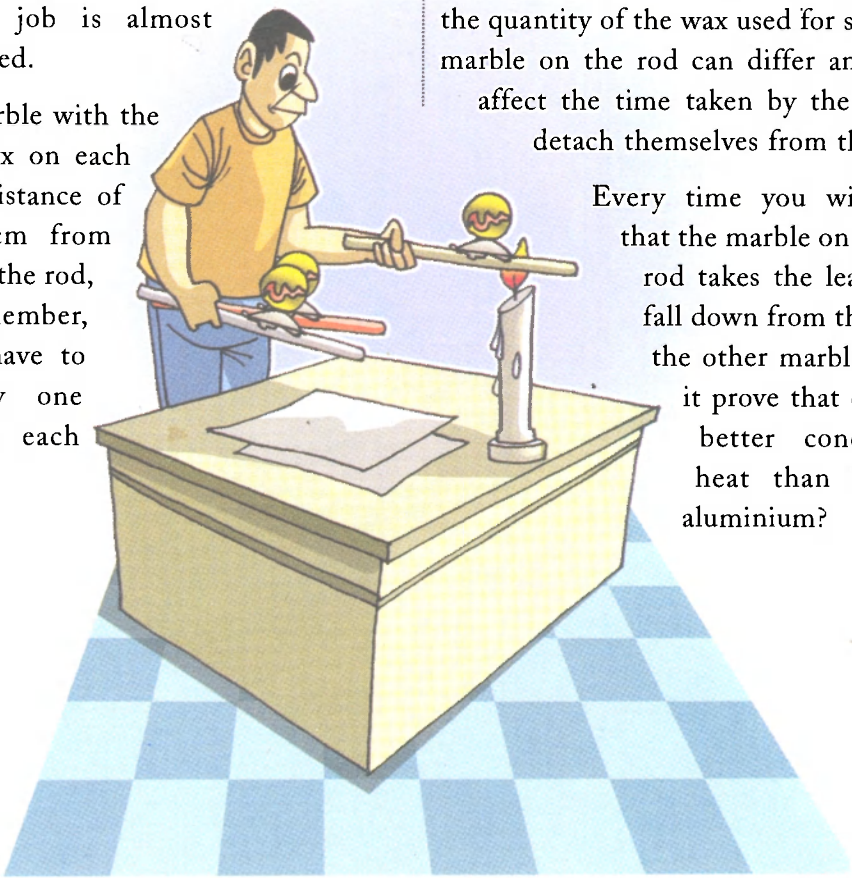
Solid substances which can transmit heat from their one end to the other are known as *good conductors of heat* and the manner in which the heat is transmitted is called *conduction*.

Is copper a good conductor of heat?

Metals are good conductors of heat but is copper, a better conductor than brass and aluminium?

The only problem in proving this statement by experiment is to procure three metal rods of the same length and thickness. The moment you get these three identical rods of copper, brass and aluminium, deem it that your job is almost accomplished.

Stick a marble with the help of wax on each rod at a distance of about 5 cm from one end of the rod, but remember, that you have to stick only one marble on each rod.



Now heat all the three rods one by one, as you did in the previous experiment, and note down the time taken by each marble in getting itself detached from the rod. It will be better if you repeat the experiment more than once because despite your best effort, the quantity of the wax used for sticking the marble on the rod can differ and this can affect the time taken by the marble to detach themselves from the rods.

Every time you will observe that the marble on the copper rod takes the least time to fall down from the rod than the other marbles. Doesn't it prove that copper is a better conductor of heat than brass and aluminium?

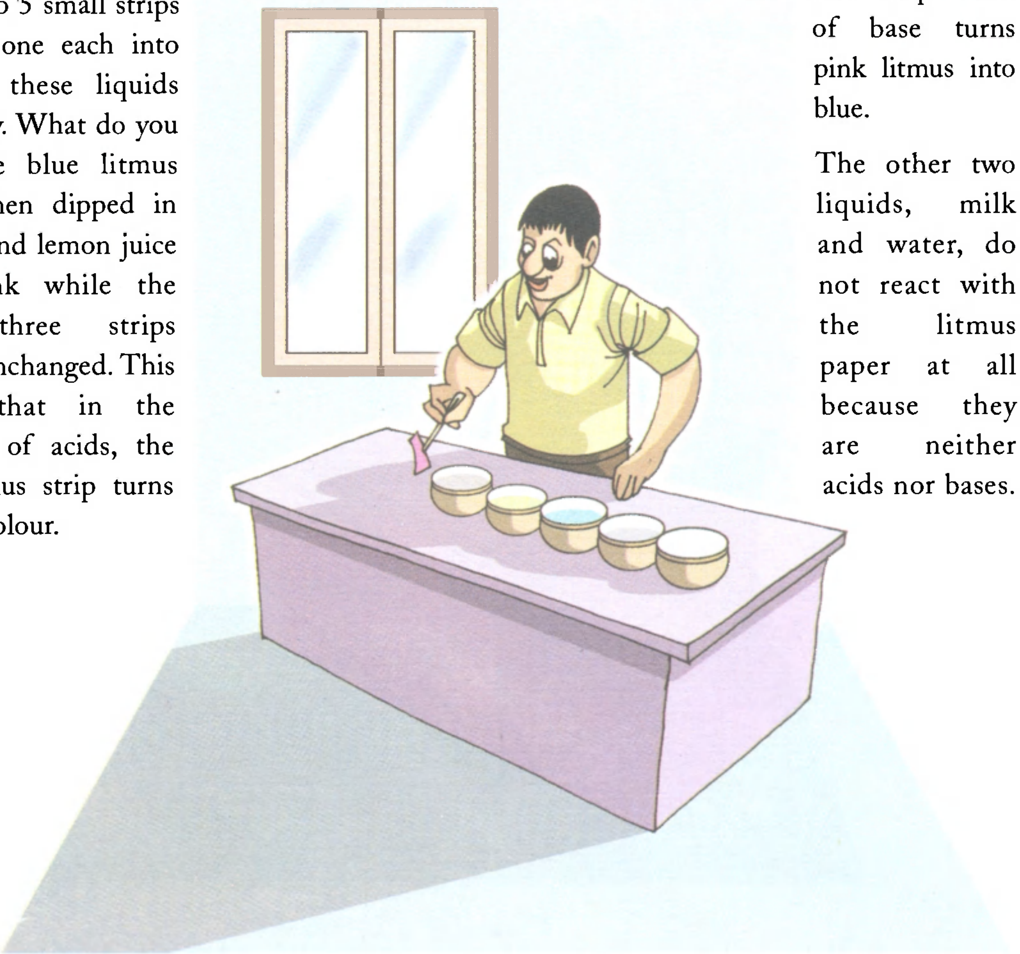
How can acids and bases be identified?

To do this experiment, you need a thing called litmus paper which can be easily procured from a shop dealing in laboratory items.

To conduct this experiment, take five glass bowls and fill them with vinegar, water, milk, soap solution and lemon juice respectively. Now cut the blue litmus paper into 5 small strips and dip one each into each of these liquids separately. What do you see? The blue litmus strips when dipped in vinegar and lemon juice turn pink while the other three strips remain unchanged. This means that in the presence of acids, the blue litmus strip turns pink in colour.

Similarly, cut the pink litmus paper into five small strips and dip one each in the same five different liquids. What do you see this time? Out of the five strips, only one changes its colour. Isn't it? The strip which you dipped in the soap solution changed its colour and turned blue—why does it so happen? It is because the soap solution is a base and the presence of base turns pink litmus into blue.

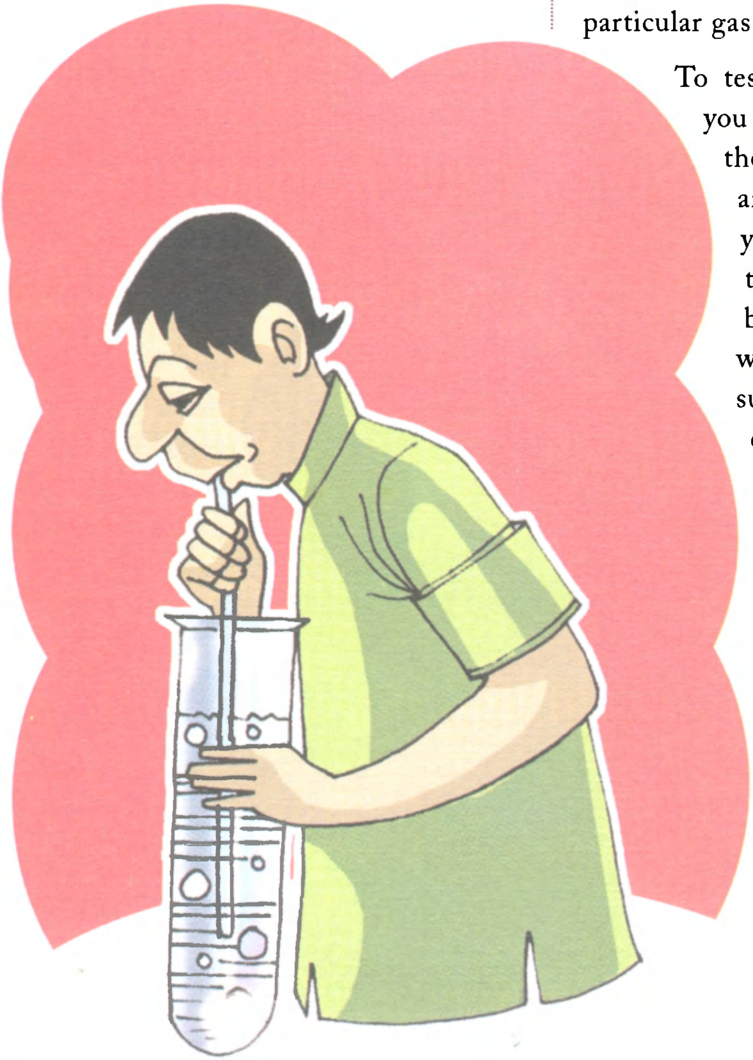
The other two liquids, milk and water, do not react with the litmus paper at all because they are neither acids nor bases.



How can it be known that the air we exhale contains carbon dioxide gas?

To verify this statement, what you need is a test tube, a straw pipe and a little lime water. The lime water is required because when it reacts with carbon dioxide, its colour changes into milky white.

Lime water is the best and cheapest test to identify carbon dioxide's presence in a particular gas.



To test the carbon dioxide which you exhale, fill three-fourths of the test tube with lime water and put a straw pipe in it. As you start blowing air through the pipe, you will see that the bubbles rising in the lime water burst themselves at the surface of the water and disappear in the atmosphere.

But at the same time, the colour of the transparent water will turn milky-white, which proves the presence of carbon dioxide in the air you exhaled while blowing the air in the straw pipe.

Does carbon dioxide really help in putting out fire?

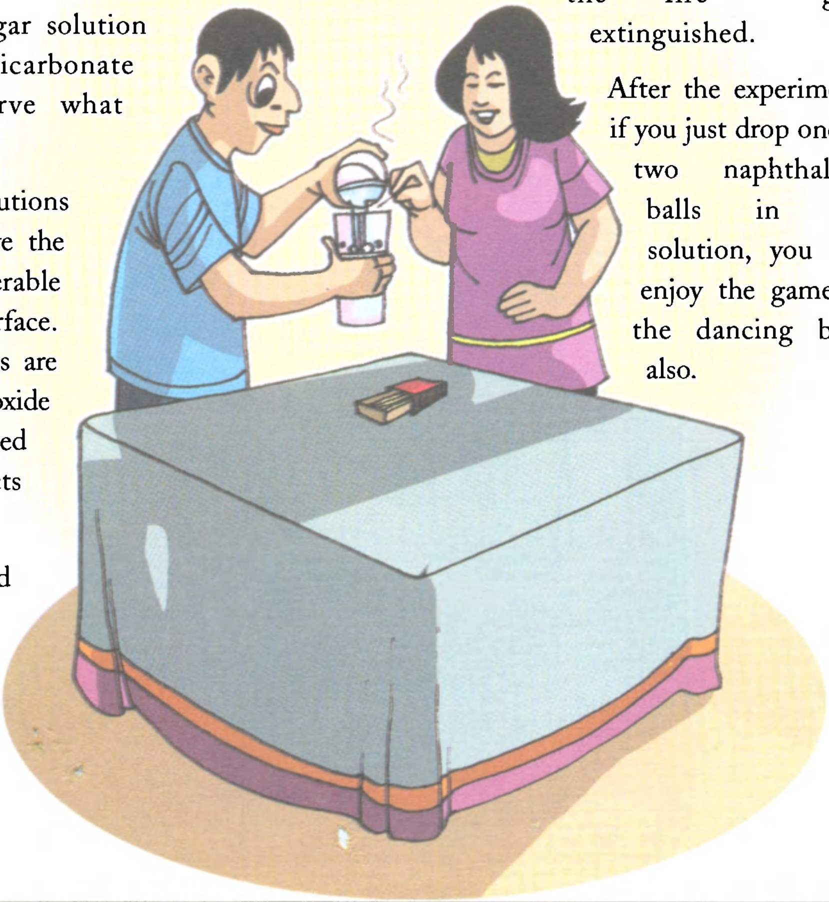
To conduct this experiment, first of all you must learn how to produce carbon dioxide at home. Come, let us learn this process first.

Take a little vinegar and baking soda (sodium bicarbonate) in two separate tumblers and mix half a cup of water in each of them. Bring a burning matchstick to the mouth of the two tumblers. You will see that the matchstick continues burning.

Now pour the vinegar solution into the sodium bicarbonate solution and observe what happens.

As soon as the solutions react, you will observe the rising of innumerable bubbles to the surface. Actually, these bubbles are nothing but carbon dioxide gas which is produced when the soda reacts with vinegar.

Now we have to find out whether this gas actually puts out fires or not. For this, again bring a burning matchstick above the mixed solution. What happens? The matchstick is extinguished, isn't it? Try again with another matchstick. This also is extinguished. What does it show? This shows that carbon dioxide puts out the fire. Actually, what happens is that this gas being heavier than air creates a sort of wall around the flame which prevents oxygen from reaching the fire. As oxygen is essential for any burning, the fire gets extinguished.



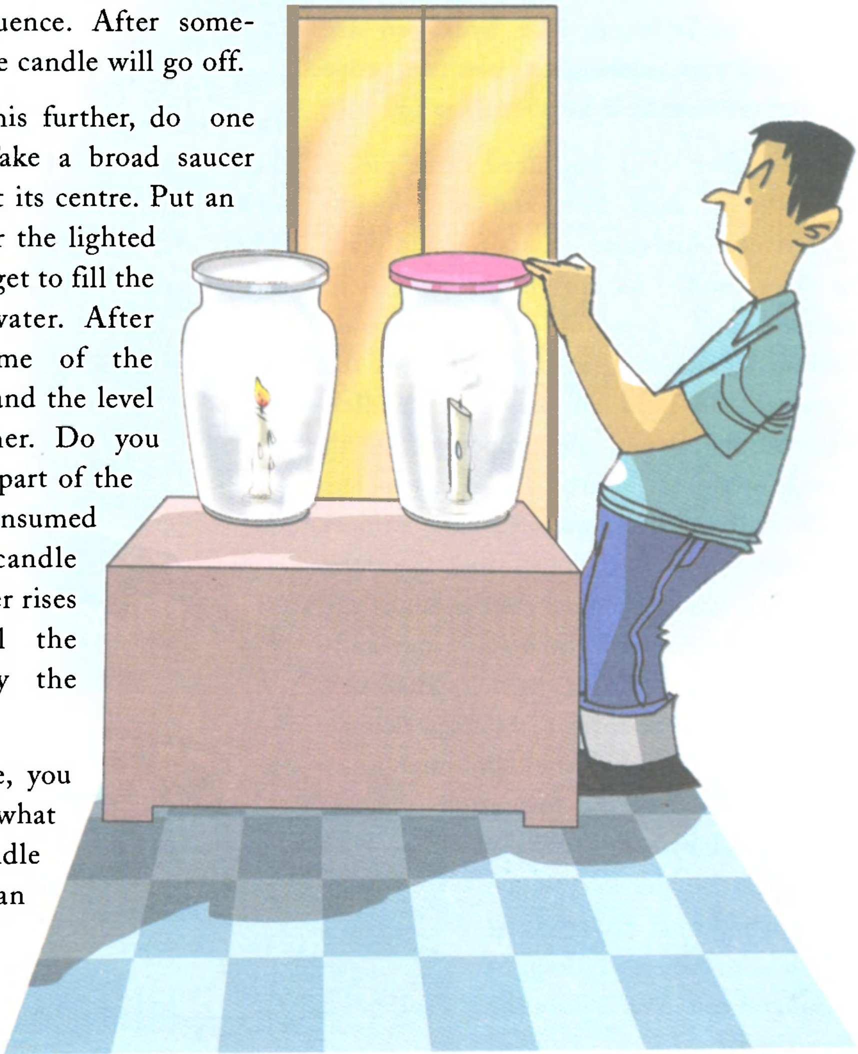
After the experiment, if you just drop one or two naphthalene balls in the solution, you can enjoy the game of the dancing balls also.

What happens when a lighted candle is kept inside a closed vessel?

Take a wide-mouthed jar or a bottle and keep a lighted candle in it. Take a piece of cardboard and keep it on the mouth of the jar to cover it. Now observe the consequence. After sometime, the flame of the candle will go off.

In order to prove this further, do one more experiment. Take a broad saucer and place a candle at its centre. Put an upside-down jar over the lighted candle. But don't forget to fill the saucer first with water. After sometime, the flame of the candle extinguishes and the level of water rises higher. Do you know the reason? A part of the air in the bottle is consumed in keeping the candle burning and the water rises higher up to fill the vacuum created by the consumed air.

Well, whatever it be, you have come to know what happens when a candle is lighted in an enclosure!

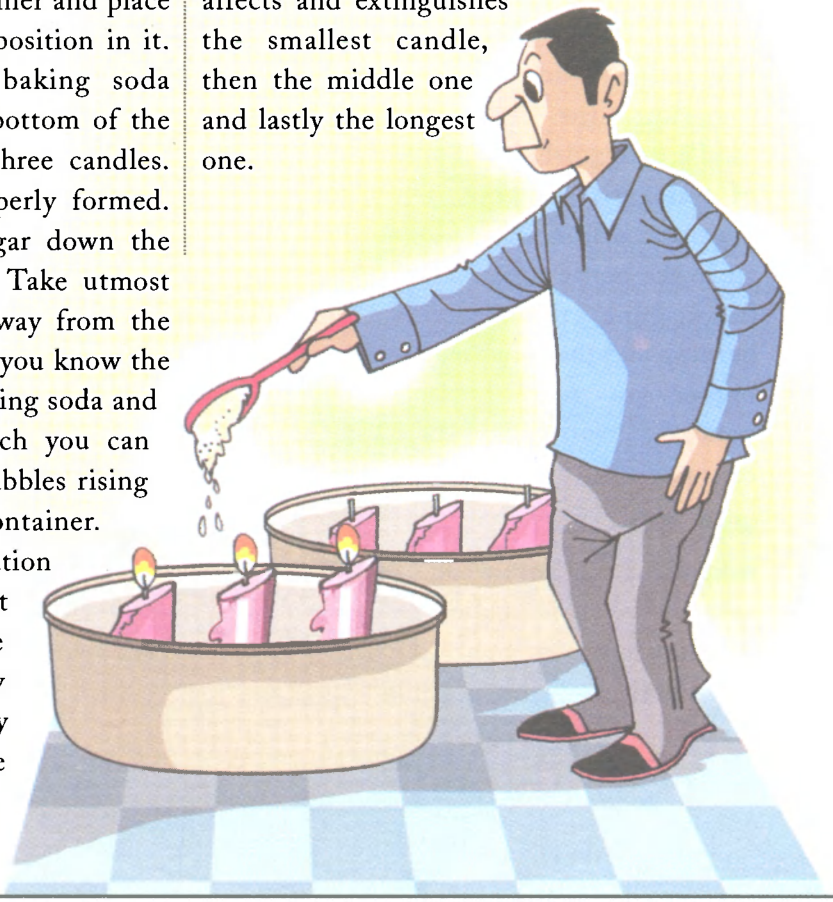


Is there any easier method to prove that carbon dioxide is heavier than air?

The air we breathe is a mixture of various gases like oxygen, nitrogen, carbon dioxide, hydrogen, etc. Some gases like carbon dioxide are heavier than air while some like hydrogen are lighter. By this experiment, you can prove that carbon dioxide is heavier than air.

For this experiment, you need three pieces of candle of 2cm, 5cm and 8cm length respectively. Now take a container and place the three candles in upright position in it. Sprinkle one spoonful of baking soda (sodium bicarbonate) at the bottom of the container and light all the three candles. Wait till the flames are properly formed. Now slowly pour some vinegar down the inside wall of the container. Take utmost care that the vinegar stays away from the flame. See, what happens? As you know the vinegar will react with the baking soda and produce carbon dioxide, which you can yourself see in the form of bubbles rising from the bottom of the container. After sometime of the formation of the bubbles, the smallest candle will be the first to be extinguished by it, followed by the middle one, and then by the longest one. What does the blowing off of the candles, one by one, indicate? Can you understand anything?

The reaction of soda and vinegar causes the formation of carbon dioxide at the bottom, which due to its heaviness pushes out the air from the bottom of the container and gets itself collected there. As the quantity of the thus formed gas increases, its level goes higher up. Hence, it first affects and extinguishes the smallest candle, then the middle one and lastly the longest one.



Effect of rusting

How does the process of rusting affect the atmosphere?

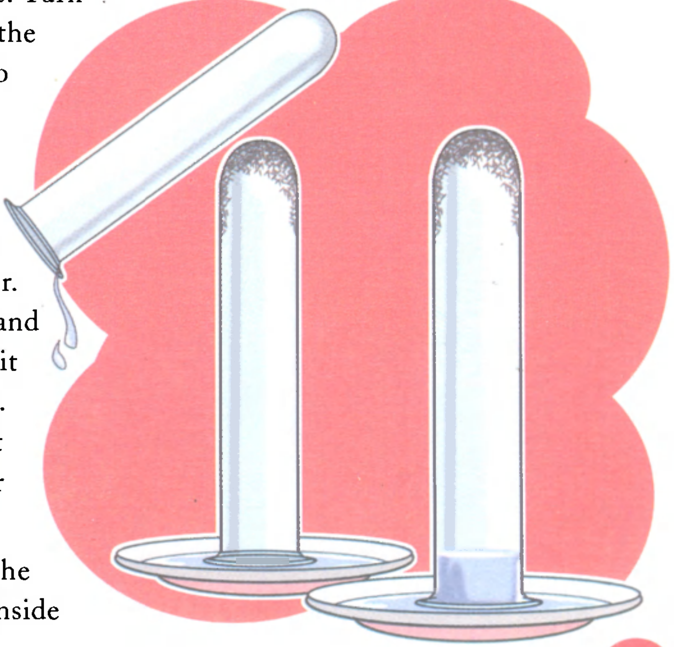
When an iron object comes in contact with water and air, a reddish-brown coating is formed on its surface. This coating is called rust. Through this simple experiment, you can easily understand how this rusting process affects our atmosphere.

Take a test tube and fill it with water. Then turn it turtle to empty it of water. This will leave the tube wet inside. Now put a small quantity of iron filings into the tube and shake it well. Do you know what will happen? The small particles of iron will stick on the wet wall of the test tube. Turn the tube turtle once again so that all the particles of iron filings, not glued to the wall due to wetness, may come out.

Now take a saucer, fill it with water and make the test tube stand upside down at the centre of the saucer. Upside down means bottom up and mouth down—followed? Now leave it there as it is for at least two days. After two days, you will see that some of the water from the saucer has risen up in the test tube.

From this, you can derive the conclusion that due to some action inside the tube, some part of the air inside has been consumed, causing the rise in water level in the tube to fill the vacuum thus created.

In one of your earlier experiments, you had placed a lighted candle inside a bottle and water had risen up in the bottle in a similar manner. The part of the air which gets consumed in the process of burning and rusting is known as oxygen. So it can be said that rusting is a process similar to the process of slow burning which uses up one-fifth part of air, which is of oxygen.

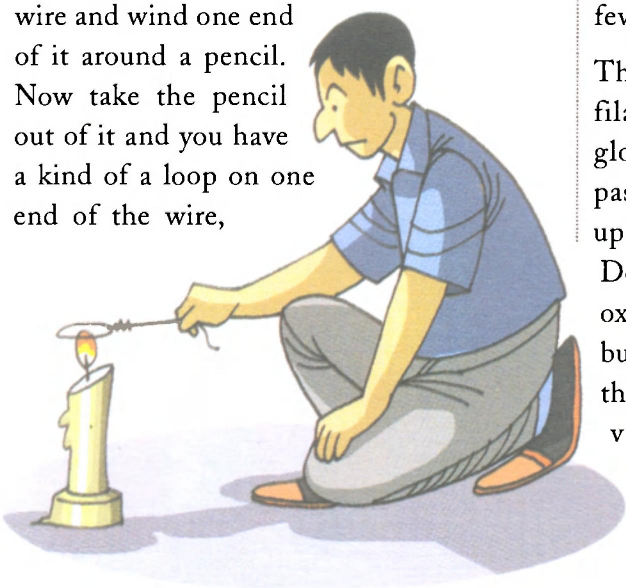


Speciality of a electric bulb

An electric bulb continues to give light for many hours, yet its filament does not get burnt up. Why?

Look at the electric bulb in your house. All you have to do is to press the switch on and the bulb emits light around. In ordinary language, you say that the bulb is lighted (or in Hindi parlance 'the bulb is burning'). But tell me one thing. Normally, the things end their entity by changing their form when they burn. Then how is it possible for a bulb to continue functioning, as it is, not only for hours and days, but for months?

Come, let us first conduct an experiment. Take a 15 cm long fuse wire and wind one end of it around a pencil. Now take the pencil out of it and you have a kind of a loop on one end of the wire, don't you?



Heat this loop by putting it on the flame of a candle. After sometime, the loop will become red hot. If you heat it more, a stage will come when the loop starts emitting white light for a few moments and then burns itself out.

The wire inside an electric bulb (known as filament) becomes very hot and starts glowing because of the electric current passing through it. But it does not get burnt up like the loop you saw in your experiment. Do you know, why it happens so? Because oxygen is not allowed to remain inside the bulb and it is only oxygen which helps a thing in getting burnt-up. There is either vacuum in the bulb or such gases, other than oxygen, which do not help at all in the process of burning.

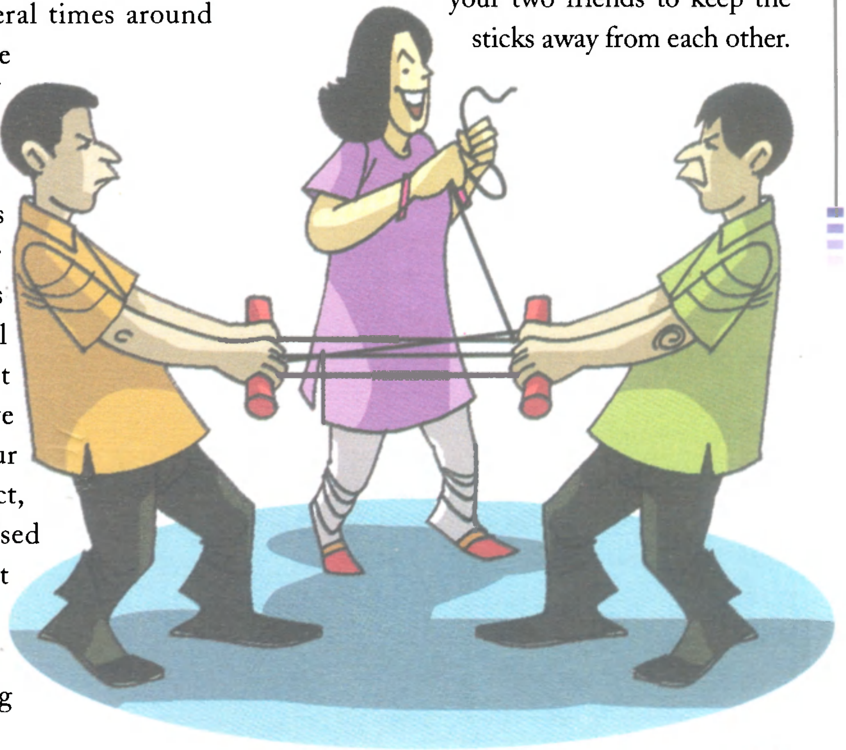
How are pulleys useful?

How is it that a heavy load, which you fail to lift with all your strength, gets lifted quite easily with the help of pulleys?

Come, let us teach you a game based on this principle. Ask two of your friends, stronger than you to join you in this game. In addition, you will be needing two sticks and a six-metre long smooth and strong string of cotton.

Ask your friends to hold one stick each with their both hands and stand about one metre apart. Now tie one end of the string to one stick and then wrap it several times around the sticks, as shown in the diagram. The other end of the string is not to be tied. It will remain in your hands. Start pulling this end and challenge your friends to pull the sticks towards themselves with all their strength. But eventually, they would have to accept defeat against your strength. As a matter of fact, they will rather be surprised to see that despite their best efforts to check, you can bring both the sticks close to each other by applying very little power.

But don't start pondering over this mighty source of strength in you. Because, in this demonstration, your physical strength has a very small role to play. The real work gets accomplished by the power of the pulleys. By wrapping the string on the sticks, you have made exactly the same arrangement as is manifested in a system of pulleys. Here, instead of the weight, you have the strength applied by your two friends to keep the sticks away from each other.

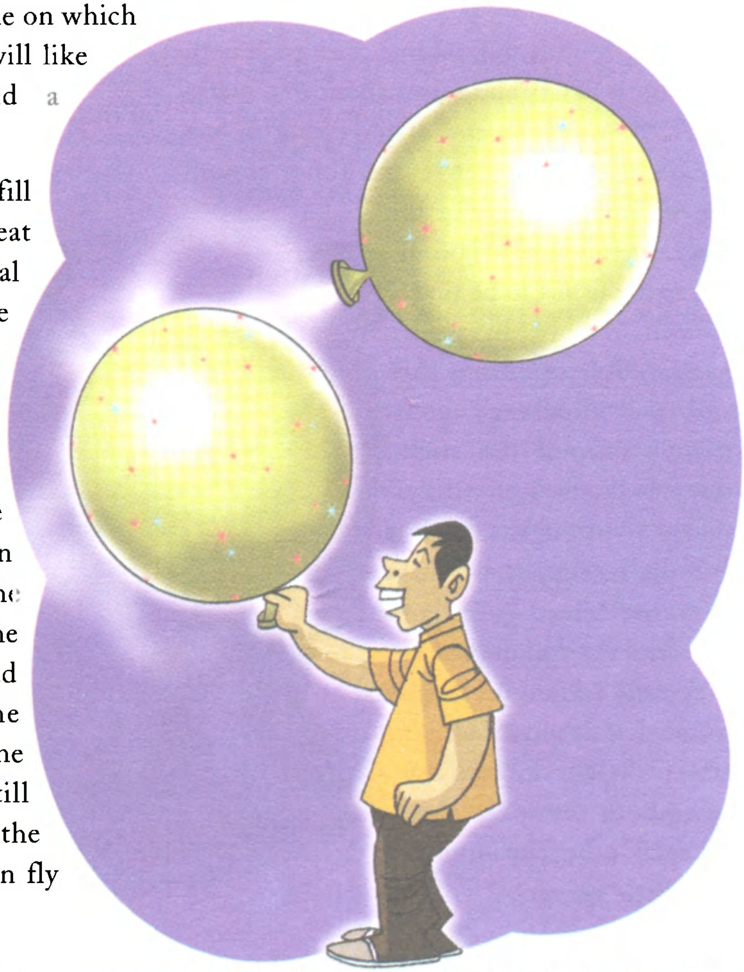


What are jet aircrafts and what is the principle they operate on?

Take a balloon, inflate it fully by your breath and keep the air trapped in the balloon by holding its neck securely. You will notice that the balloon remains inflated. Now if you release its neck, you will observe the air escaping out of it and the balloon moving forward. In simple words, this is the principle on which a jet operates. But surely, you will like to know the reason behind a balloon's forward motion.

To inflate a balloon means you fill it with lot of air at a very great pressure. This air exerts equal pressure on the walls of the balloon and extends its walls away in every direction. As long as the neck of the balloon remains securely clamped in your hand, the air inside the balloon exerts equal pressure on the walls from all sides and the balloon remains stationary. The moment you release the neck and allow the air to escape, the pressure from the opening of the balloon gets released. But still there is air pressure from inside the balloon which makes the balloon fly in the other direction. And this action continues till the entire air trapped in the balloon escapes and pushes the balloon in the direction opposite to that of the exit of the air.

Modern jet aircrafts too operate on this principle.



How does an aircraft fly?

The answer apparently looks very simple: that it can do so because of its powerful engine. But then, how does a glider fly which has no engine. Now you don't have any explanation, have you?

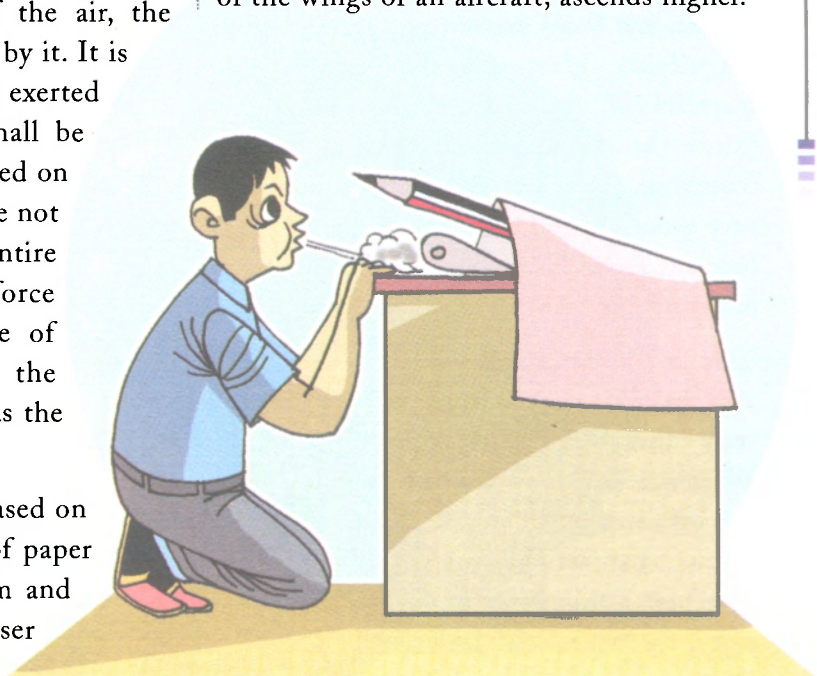
Well! the aircraft actually flies not on the power of its engine but owing to the shape of its wings. This peculiar structure of the wings is called an aerofoil and has a special quality which enables air to flow faster above its surface than the air passing below its surface and to meet simultaneously at the tail of the aerofoil.

The higher the velocity of the air, the lower is the pressure exerted by it. It is obvious that the air pressure exerted on the top of the wings shall be lower than the pressure exerted on their surface, which will force not only the wings but the entire aircraft to ascend. The force generated by this difference of the air pressure forcing the aircraft to ascend is known as the *lift force*.

To conduct an experiment based on this principle, take a sheet of paper approximately 30 cm × 5 cm and hold from the side of the lesser width with both your hands.

Now blow air into it with great force. What do you notice? The paper is lifting up. Reason? The same one, that when you blow air with force, the speed of the air above the surface of the paper is more in comparison to the speed of the air below the surface, causing the generation of the lift force.

Now join both the sides having 5 cm width and insert a pencil in between as shown in the figure. Place it on one end of a table and blow air again above its surface. You will observe that owing to the generation of the lift force, your model, resembling the shape of the wings of an aircraft, ascends higher.



What is combustion?

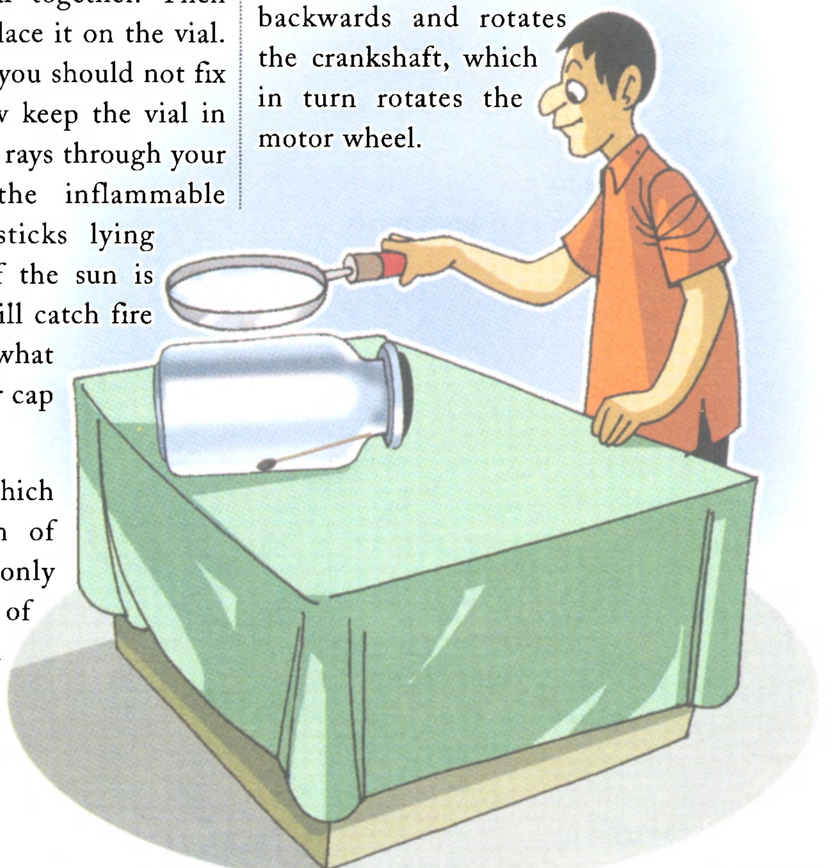
You get your car's tank filled up with petrol and can drive wherever you wish to. But are you aware of the principle on the basis of which you are able to do so?

To get an idea of it, it will be better to conduct a small experiment to make things quite clear to you automatically.

Take an empty injection vial with the rubber cap. Now take two matchsticks and put the front portion of the matchsticks containing the inflammable material together. Then wet the rubber cap and place it on the vial. You must remember that you should not fix the cap very tightly. Now keep the vial in the sun and focus the sun rays through your magnifying glass on the inflammable material of the matchsticks lying inside the closed vial. If the sun is scorching, the material will catch fire very soon. Do you know what happens then? The rubber cap blows off the vial.

This is the principle which acts behind the motion of your motorcar. The only difference is that instead of the inflammable material of the matchstick, you have here a thin spray of petrol thrown in with air.

For ignition, in place of a magnifying glass, you have a special part called 'spark plug' used for this purpose. It generates fine sparks of fire to ignite the mixture of petrol and air. The moment the combustion takes place, the fuel (petrol and air) expands with a loud bang and pushes the piston. The connecting rod of the piston moves backwards and rotates the crankshaft, which in turn rotates the motor wheel.



What happens when elements are burned?

You must have seen the flames coming out of burning wood. These flames are quite colourful. Sometimes they are red, sometimes, yellow, blue or green. But have you ever thought where these colours come from?

First do one thing. Collect certain things which are easily available in your house. For example salt, caustic soda, baking soda, alum, lime, etc.

Now take a shining coin and holding it with the pliers, dip it in water and then insert it into a heap of salt, so that some salt particles to the coin. When you heat the coin on a spirit lamp, you will see a shining yellow flame. Continue keeping the coin on the flame till this yellow colour is no more visible. In a similar way, conduct this test on all other materials you have collected, one by one, and note down the colours of the flame against each material. It is quite possible that in some cases, the colour of the flame might not change but in majority of the cases, it will. For example, take the case of borax. It will emit a green-coloured flame on heating.

It has already been proved by scientists that every element gives out its own peculiar light on heating. For example sodium, when heated upto a certain temperature, emits yellow light. This is the reason why salt (its chemical name is sodium chloride) gave a yellow flame when heated—similarly, boron (found both in borax and boric acid) emits green light.

I hope, now, you will not be surprised to see the variegated colours in the flames emitted by different combustive elements present in the wood.

How does a camera clicks photos?

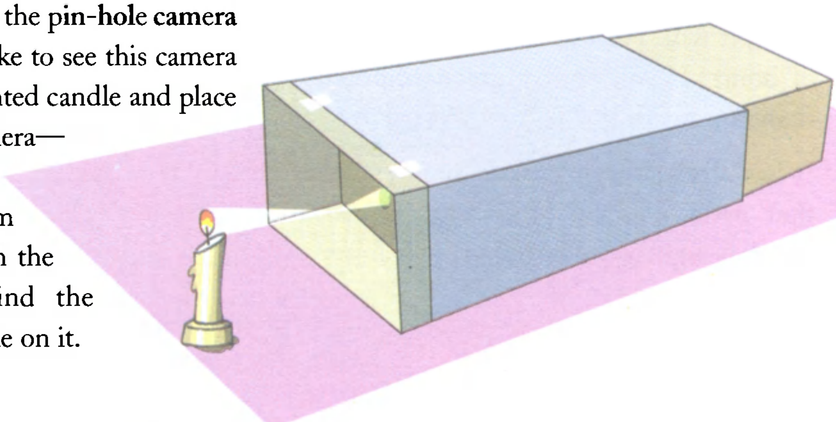
That light travels in a straight line is a fact we quite frequently utilise. One of its practical uses is the camera, whose function is basically dependent on this principle. Let us see!

Take two cardboard sheets, one of them should be a little bigger than the other. Now fold the sheet and make a box. For adhesion, any sticky tape will do. These two boxes, with one side open, should be of such dimensions that one may slide easily into the other. Cut the two slots facing each other in the smaller box about 5 cm away from the edge of it so that a strip of wax paper of the same breadth may be inserted through. Now insert this strip through the slots and then stretching it fully, fix it with an adhesive tape. If wax paper is not available, a milky glass sheet or even a piece of thick tracing paper can serve the purpose.

Now fix a metal foil on one side of the other box and make a minute hole in this foil. After doing this, just slide the smaller box into the bigger one and your camera, known as the **pin-hole camera** is ready. Now, would you like to see this camera working? Okay! Take a lighted candle and place it a little away from the camera—facing the metal foil with the hole. If you see in it from the other side, i.e., through the milky glass, you will find the inverted image of the candle on it.

Now by looking at the given diagram, you must have understood how the image is formed. Light travels in a straight line. And here also the light from each point of the candle is travelling in a straight line through the minute hole to the wax paper or tracing paper. Thus, all the light rays coming from the candle combine together to form its image.

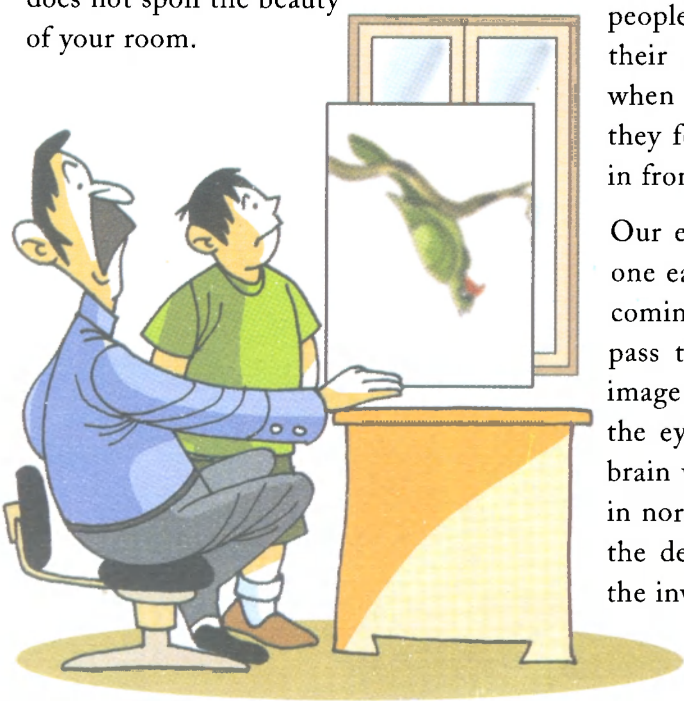
This was the reference of the pin-hole camera to make you understand the principle behind it. But a common camera has a lens instead of a pin-hole. If you make a larger hole instead of a pin-hole and fit magnifying lens in it, you will get a sharper and clearer image. But for this, you will have to slide one box backward and forward in the bigger box to get a clearer and sharper image in a particular position.



Our eyes see every object upside down—this statement is as amusing as it is true. But how?

To verify this statement, you will need a convex lens. Convex means curved outwards. For this, a magnifying glass will be most suitable because it is such a lens that it is easily available at any stationary shop.

Close the doors and windows of your room and make it as dark as possible. Now find out if there is any hole or opening in any of the windows or the doors through which you can peep outside. If none, do not worry. Just scratch a small portion of the paint on one of the window-panes. Be careful that it does not spoil the beauty of your room.



Hold your lens in one hand in front of the hole and a sheet of white paper in the other. Bring the sheet in front of the lens and start moving your hand till the blurred images start appearing on the sheet.

Go on moving this sheet backwards and forwards to adjust the sheet's distance from the lens till you get a well defined image on it.

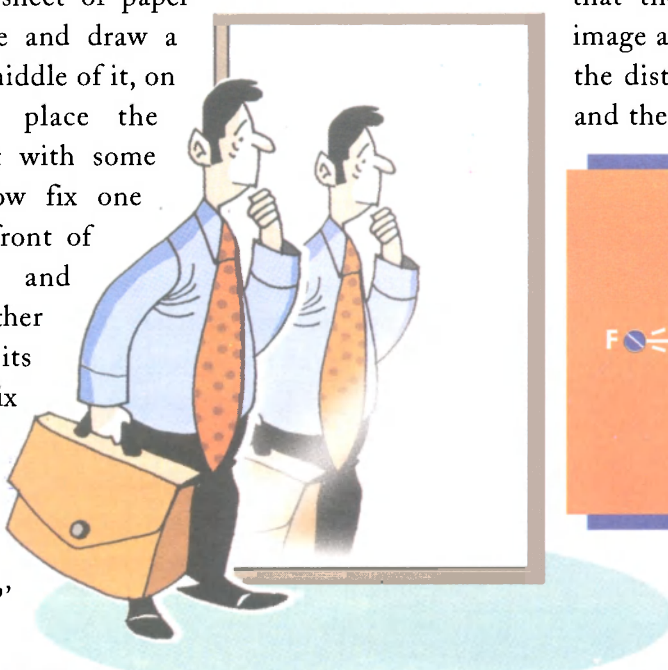
Now watch minutely, whose image is this? Oh! It is the scene of the outer surrounding only, but upside down! That is, the sky is below and the earth above. The feet of the people walking on the road are upwards and their heads downwards. It is so because when the rays pass through a convex lens, they form an inverted image of the objects in front of it.

Our eyes too consist of two such lenses—one each in the two eyes. The rays of light coming from the objects enter the eye and pass though the lens to form an inverted image of the object at the back portion of the eye-ball, known as retina. Thank your brain which helps you in seeing the objects in normal and correct shape on the basis of the details supplied by the optic nerve, of the inverted image formed on the retina.

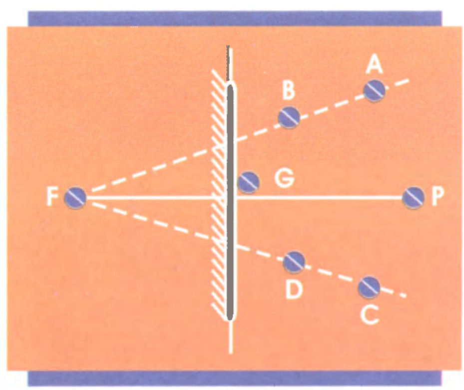
Is it true that the distance between the image and the mirror is equal to the distance between the object and the mirror?

If you stand facing a big mirror, you will see your image. Not only this, if you get closer to the mirror, you will feel that your image too has come closer to the mirror. If you move away from the mirror, you will clearly observe that the distance between you and your image in the mirror has also increased. To understand this phenomenon all by yourself, conduct an experiment. For this experiment, you will need a sheet of blank paper, a plane mirror, some pins, a pencil and a scale.

Spread the sheet of paper on the table and draw a line in the middle of it, on which you place the mirror erect with some support. Now fix one pin, 'P' in front of the mirror and then fix another pin, 'A' on its right side. Fix one more pin, 'B' on the line joining the image, 'P' with 'A' in the same line. Now come to the left hand side. On this side also fix two pins, 'C' and 'D' in the manner as described above.



Now remove the mirror and draw lines joining the marks of the pins as shown in the diagram. Join the point, 'A' with 'B', and 'C' with 'D' and extend these lines to get a point, 'F'. Now join 'P' and 'F'. This line will cut the mirror-line at 'G'. On measuring, you will find that the distance between 'G'-'P' and 'G'-'F' is exactly equal. This proves that the distance between the image and the mirror is equal to the distance between the object and the mirror.



Reflection changes with distance

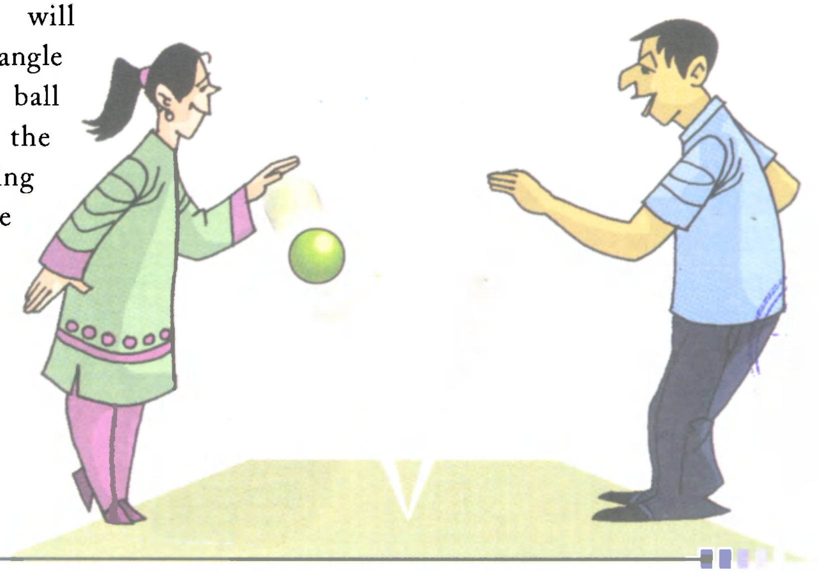
Why is it that you can see your image in the mirror only when you are just in front of it, whereas you see scores of other things which are not in front of the mirror!

Do you know how an object is seen by you? You can see an object only when rays from a source of light reach your eyes after striking the object. The deviation in the direction suffered by the light rays after striking an object is called ***reflection***.

Take a rubber ball and throw it vertically on the ground. It will bounce back to you. If you observe carefully, you will notice that the ball follows the same path as it went by. Now aim it at a point on the ground slightly away from you. It won't come back to you this time. Instead, it will bounce to the other side. By repeating this game a number of times, you will observe that the angle the path of the ball makes with the ground on striking it, is equal to the angle its path makes with the ground when it bounces back.

Now hold a lighted torch in front of the mirror. The entire beam of light returns on the same path. If you tilt the torch a little, the path of the beam of light will deviate to the other side but at the same angle from the mirror.

You can see your image in the mirror only when the rays of light from you strike the mirror in a perpendicular direction. And this is possible only when you stand just in front of the mirror. But even when you are not in front of the mirror, you can still see in the mirror, the images of all those things from which the light rays are striking the mirror and reaching your eyes.



What is a telescope?

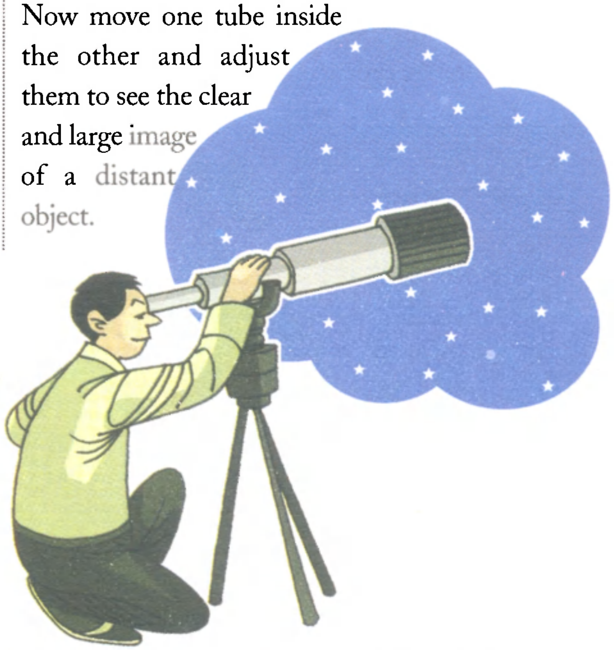
We study the celestial bodies with the help of a telescope. But what, after all, is this telescope and on what principle does it work?

A **telescope** is an instrument with the help of which we can see distant objects closer and larger. If you wish to derive pleasure by seeing through a telescope made by yourself, you will need just two magnifying glasses of different powers. To find out the difference between the powers of the two magnifying glasses, take an open book and keep these glasses side by side but a few centimetres away from the book.

What do you see? In comparison to the one, the print size of the book will appear slightly bigger or smaller, when seen through both the lenses. The lens which shows the print bigger has definitely more power than the other. Now take the glass with lesser power and keep it about 5 cm away from your eyes. Then hold the more powerful glass in front of it. Arrange both the glasses in such a way that you can see a clear image of a distant object. You will see that the image is not only larger and closer but upside down also. Ask your friend to measure the distance between the two glasses. (As you already know, the magnifying glass is a convex lens).

Now you know how to make a small working model of the telescope from the above mentioned arrangement of the glasses. Roll two sheets of stiff paper to make two tubes whose diameters should almost be equal to the diameters of the magnifying glasses. Wrap some extra paper on the tube having smaller diameter so that it can slide easily inside the bigger tube.

You must take precaution that the length of the tube should be at least 5 cm more than the distance between the two lenses. The length of the other tube should be less than the first one. Now move one tube inside the other and adjust them to see the clear and large image of a distant object.

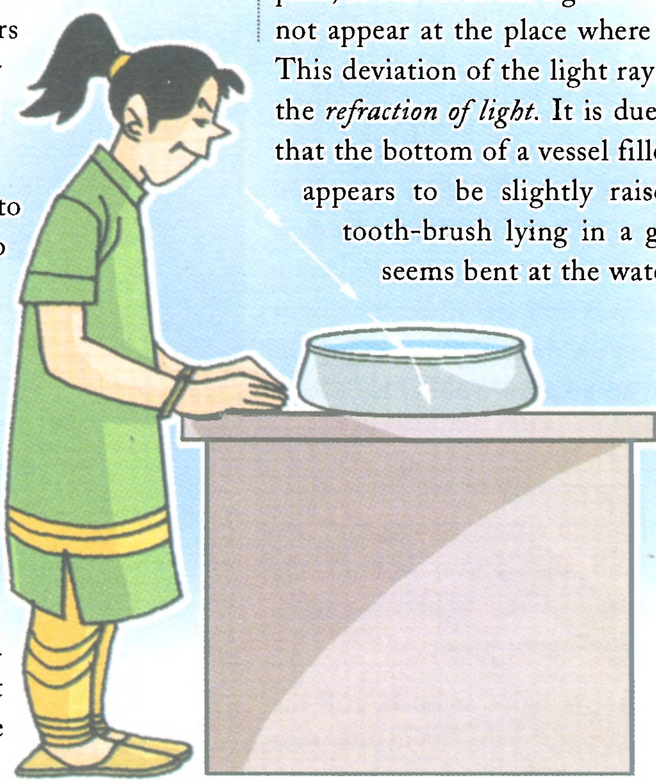


What is refraction?

The apparent depth of the bottom of a vessel filled with water appears less than its actual depth when viewed from a higher position. Why?

Take a shallow or less deep bowl and place a coin at the bottom of the bowl. Keep this bowl on a table. First look at the coin from a higher position and lower your head slowly till your head reaches to a position from which the coin becomes invisible—totally hidden by the wall of the bowl. The moment it disappears from your view, just stay still and remain in that position.

Now ask your friend to pour water carefully into the bowl along its walls so that the coin does not get displaced at all. The moment a little water reaches the bottom of the bowl, you will start seeing the coin once again without changing either the position of your head or that of the coin. But how are you able to see the coin which was invisible to your sight, a little while ago?



To understand this, you must first know—how you see an object. It is only when the light rays coming from the source of the light reach the object and from the object to your eyes, you see the object. When the light rays enter from one medium to another, they deviate from their original path, as shown in the figure. The object does not appear at the place where it actually is. This deviation of the light rays is caused by the *refraction of light*. It is due to refraction that the bottom of a vessel filled with water appears to be slightly raised up and a tooth-brush lying in a glass of water seems bent at the water surface.

Properties of light

You see an object only when the light reflected from that object reaches your eyes. It means that everything reflects light. Why does not then everything have the properties of a mirror?

Shut all the doors and windows of a room and make it completely dark. Put a table near one of the walls of the room and place a mirror on it. Now light a torch and throw its light on the mirror. What do you see?

The beam of light coming out of the torch gets reflected from the surface of the mirror and you can clearly see the reflected beam of light making the same angle with the mirror.

Now remove the mirror and place a white sheet of paper there. When you throw the torch-light on the sheet of paper, you will merely see a glow on the paper. You will not see the reflected beam of light this time as you saw when the mirror was there. In fact, the sheet of paper reflects the rays of light in an irregular manner because of its uneven surface.

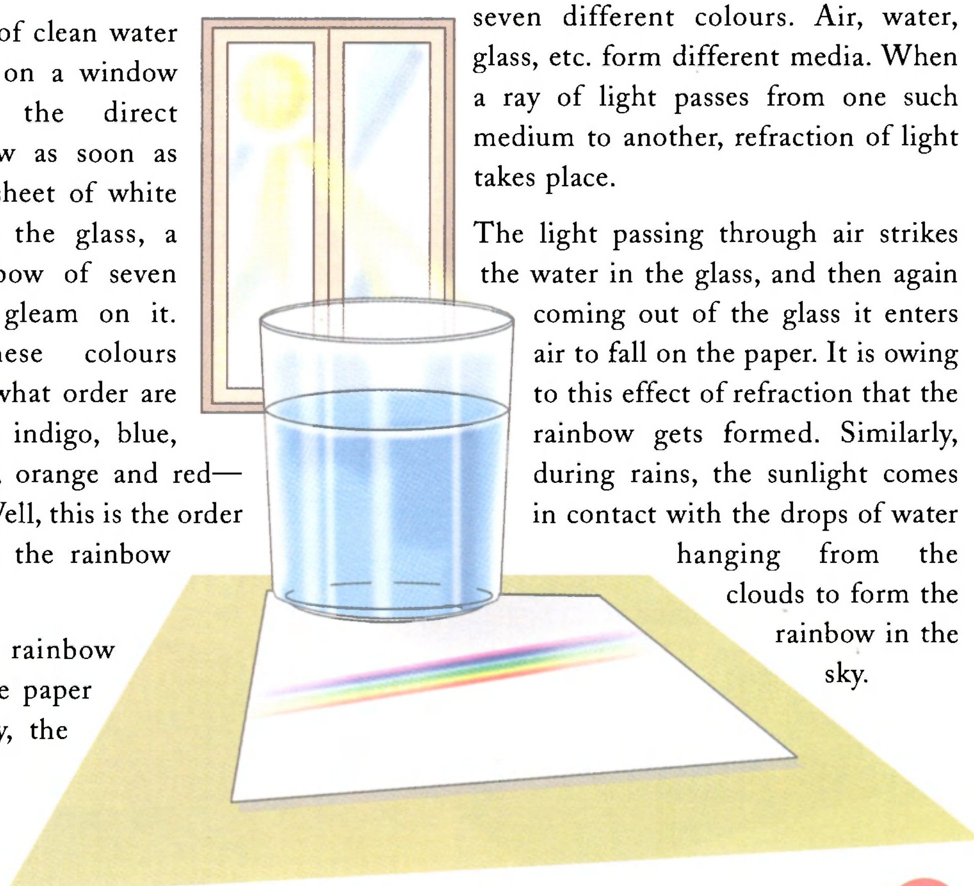
If you get an opportunity to see the surface of the paper through a microscope, you will easily understand the reason behind the irregular spreading of the light rays, when they strike the surface of paper.

Even if the paper is quite smooth, still the tiniest unevenness on its surface will appear to be a chasm for the rays of light. Since the surface of a mirror is extremely smooth, the light falling on it gets reflected uniformly without going astray. Hence, the image formed on it is sharp and clear. In case of other objects where irregular reflections make light rays go astray, the image cannot be formed.

The sunlight is a combination of seven colours–how far is this statement true?

You must have heard that sunlight is a combination of seven colours—it is a truth but not the whole truth because there are seven specific colours and these too, are in a definite order. You may see them yourself as to what exactly these seven colours are and in what order they are arranged.

Take a glass of clean water and place it on a window sill facing the direct sunlight. Now as soon as you place a sheet of white paper under the glass, a shining rainbow of seven colours will gleam on it. Observe these colours carefully. In what order are they? Violet, indigo, blue, green, yellow, orange and red—aren't they? Well, this is the order of colours in the rainbow too!

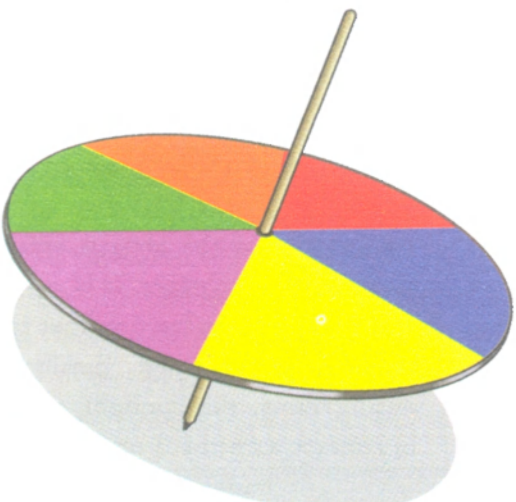


Whether a rainbow gleams on the paper or in the sky, the principle behind its formation is the same—the principle of *refraction of light*, i.e., when light passes through one medium to another, it deviates a little from its original path. At the moment of refraction, the different colours present in the light deviate differently according to their basic tendencies and thus light gets split into seven different colours. Air, water, glass, etc. form different media. When a ray of light passes from one such medium to another, refraction of light takes place.

The light passing through air strikes the water in the glass, and then again coming out of the glass it enters air to fall on the paper. It is owing to this effect of refraction that the rainbow gets formed. Similarly, during rains, the sunlight comes in contact with the drops of water hanging from the clouds to form the rainbow in the sky.

Have you ever seen a circular disc which appears colourful if stationary but totally white when rotating?

If you haven't already seen such a disc, don't worry. Make one yourself today. Cut out a cardboard sheet into a circular disc of about 10 cm in diameter. Divide its surface into six equal parts. For dividing it equally, keep on drawing arcs equal to that of its radius on its circumference and join all the points to the centre. Colour these parts with six different water colours, each part in a different



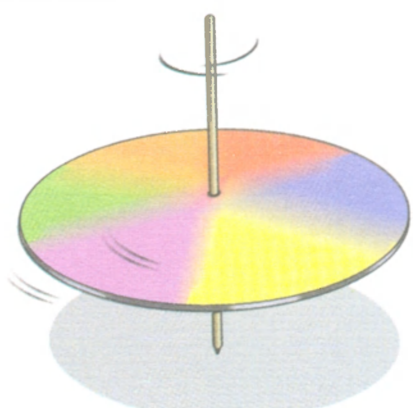
colour. Keep in your mind that these colours should be in the following order: red, orange, yellow, green, blue and violet.

When the colours have dried up, make a small hole in the centre of the disc and insert through it a 5 cm long pencil or handle of a discarded painting brush.

Now the disc is ready for the experiment. Hold the handle of the disc and rotate it rapidly—and then leave it free. The disc will move around the pencil point. But what a change! You had rotated the coloured disc but how come this disc has become colourless or white?

Actually, what happens is this: when the disc rotates rapidly, it is not possible for our eyes to identify the colours separately. We see only their combined effect because these colours happen to be those colours that lay hidden in the sunlight. Hence, their resultant visual effect is the same, like that of sunlight, colourless or totally white.

So you have seen the disc which, though colourful, looks totally white when rotated round its axis.



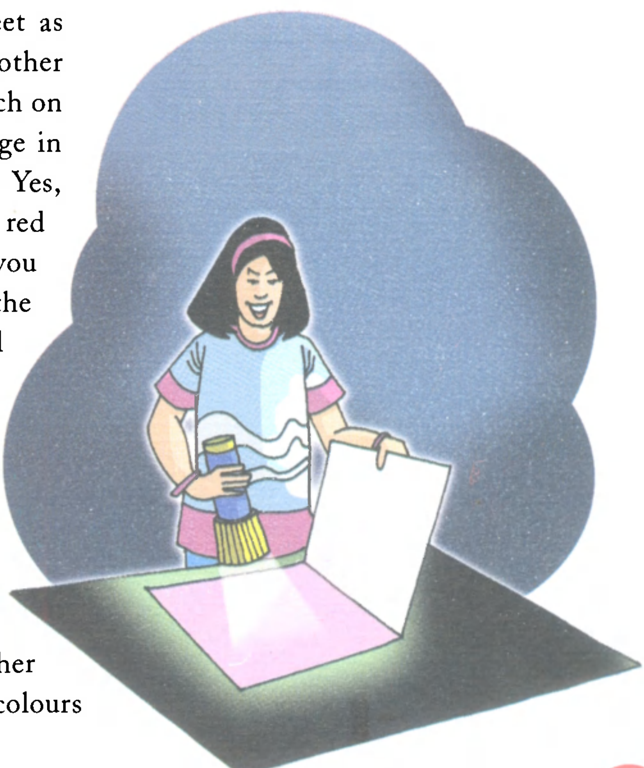
How do we see different colours?

The world around us is full of so many colourful things. But have you ever thought how they appear colourful to you?

To understand this phenomenon properly, conduct a small experiment for which you will need a torch, some sheets of smooth paper of different colours and a white sheet of paper. That's all.

First of all, make your room totally dark. Then spread the red paper on a table and hold the white paper at a slightly inclined position to one edge of the red sheet as shown in the diagram. From the other side, throw a beam of light by the torch on the red sheet. Do you find any change in the appearance of the white paper? Yes, that's right. That is the shade of the red paper spread below, whose red glow you see on the white paper. Now replace the red sheet by the green sheet. You will see a green glow on the white paper. Similarly, by spreading the sheets of different coloured papers, you can conclude that every paper is reflecting its own colour. It means that an object withholds all other colours present in the light except its own colour which it reflects. In other words, it can be said that all other colours are absorbed by the object itself.

The grass looks green because prior to its reflecting the light rays, all colours are absorbed by it except the green colour. And thus, after reflection, it is only the green colour which reaches your eyes to make the grass look green. This is also the secret of an apple looking red and an orange yellow. Isn't it an amazing fact?



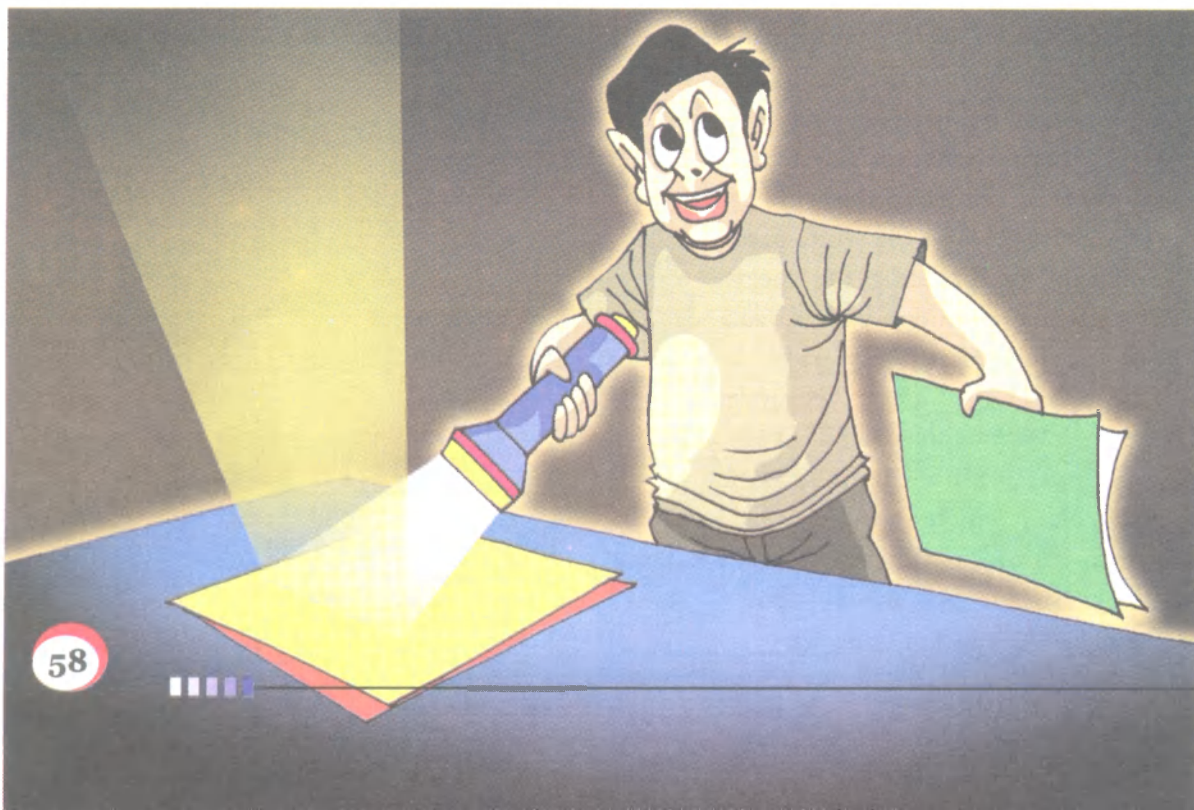
Is there any relation between the colours and reflection of light?

Take two sheets of paper, one black and the other white, each measuring 15 cm × 15 cm. Besides these, you will need a battery torch. Now select a room which can be made totally dark and have these three objects there with you.

Now spread the black paper sheet on a table. Throw a beam of light from the torch on it and observe to what extent your room gets illuminated by it. Similarly, now spread the white paper sheet, throw light on it and assess whether the room is better illuminated than before. You will see that there is a great difference between the lights which illuminated the room on both the occasions, to make you understand that white paper reflects more light.

Do this experiment with sheets of other colours also. In addition, repeat this experiment on rough and smooth surfaces as well and observe the results.

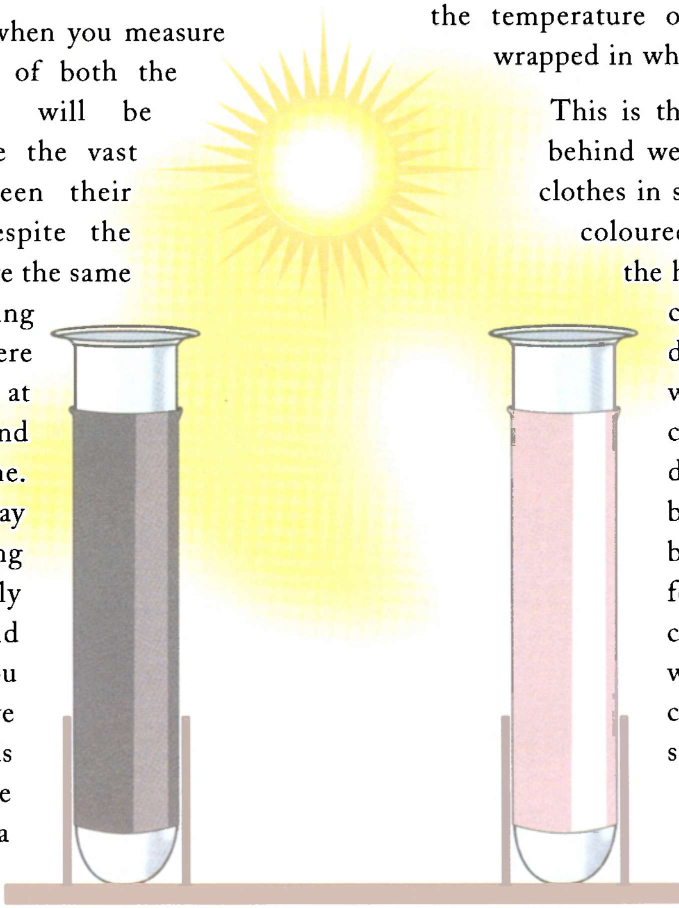
You will see that a smooth and light-coloured surface reflects more light in comparison to rough and dark-coloured surfaces.



Why do we like to wear clothes of light shade in summer?

Take two identical test tubes and fill them with cold water. Note down the temperature of the cold water. Now cover one of the test-tubes with white and the other with black paper. Then keep them side by side in the sun, at least for an hour.

After one hour when you measure the temperature of both the test-tubes, you will be surprised to see the vast difference between their temperatures despite the fact that they were the same in the beginning and both were placed in the sun at the same place and for the same time. The difference lay in only wrapping them separately with black and white paper—you must not have thought that this minor difference will create such a big effect.



Most of the sunlight falling on the white paper gets reflected whereas the black paper absorbs the major part of the sunlight falling on it. It is due to this reason that the heat brought in by the sunlight increases the temperature of the tube covered with the black paper much more in comparison to the temperature of the other tube wrapped in white paper.

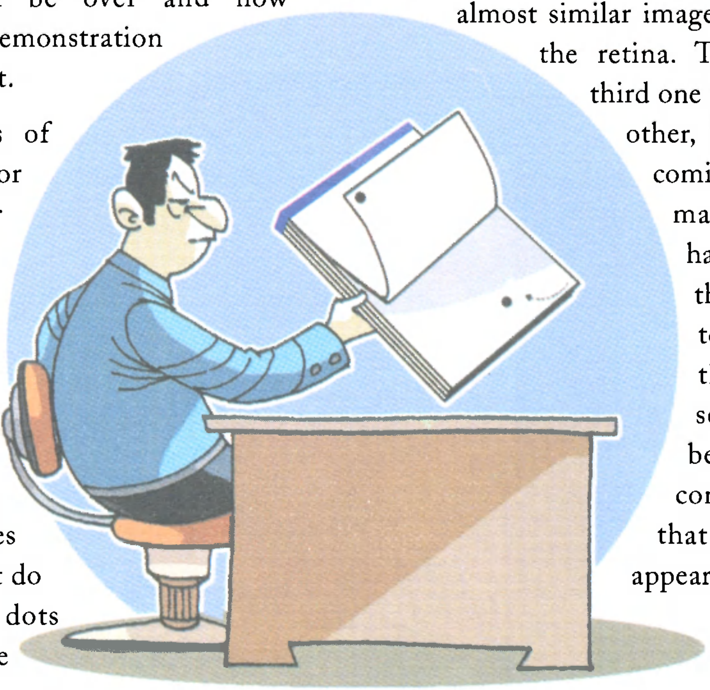
This is the scientific reason behind wearing light-shaded clothes in summer. The dark-coloured clothes absorb the heat of the sun and create uneasiness during summer whereas the light-coloured clothes dissipate the heat by reflecting it back. Hence, we feel cool and comfortable by wearing light-coloured clothes in summers.

How do the pictures on the cinema screen appear to be dancing, jumping and moving?

Take a blank pad or a notebook. With the help of a pen, make a big dot at the right bottom side of its last page. Now turn the leaf and make a similar dot again, not exactly at the same position, but slightly towards the left of the dot on the previous page. Now go on making similar dots on each leaf keeping in mind that each dot should be slightly more towards the left than the dot on the previous page. Thus when you reach the first page of the book, your preparation for the experiment will be over and now commences the demonstration of the experiment.

Hold the pages of the notebook or pad with your right hand in such a way that your thumb keeps pressing the middle part of its pages. Now rapidly release the pages one by one. What do you see? The dots marked on the pages do not look separate from each other. Instead, you see only one dot which appears to be moving from right to left.

When we look at some object, its image gets formed on the screen of our eyes called the retina. The effect of this image lasts on our retina for 1/10th of a second even when we shift our eyes from the object. Taking advantage of this peculiar quality of our eyes, the scientists were able to make the dancing and jumping pictures. Before the effect of the first image is wiped off completely, another almost similar image gets formed on the retina. Then comes the third one and one after the other, images continue coming in the same manner. All this happens so quickly that our eyes fail to distinguish these images separately. It is because of their combined effect that the pictures appear to be moving.



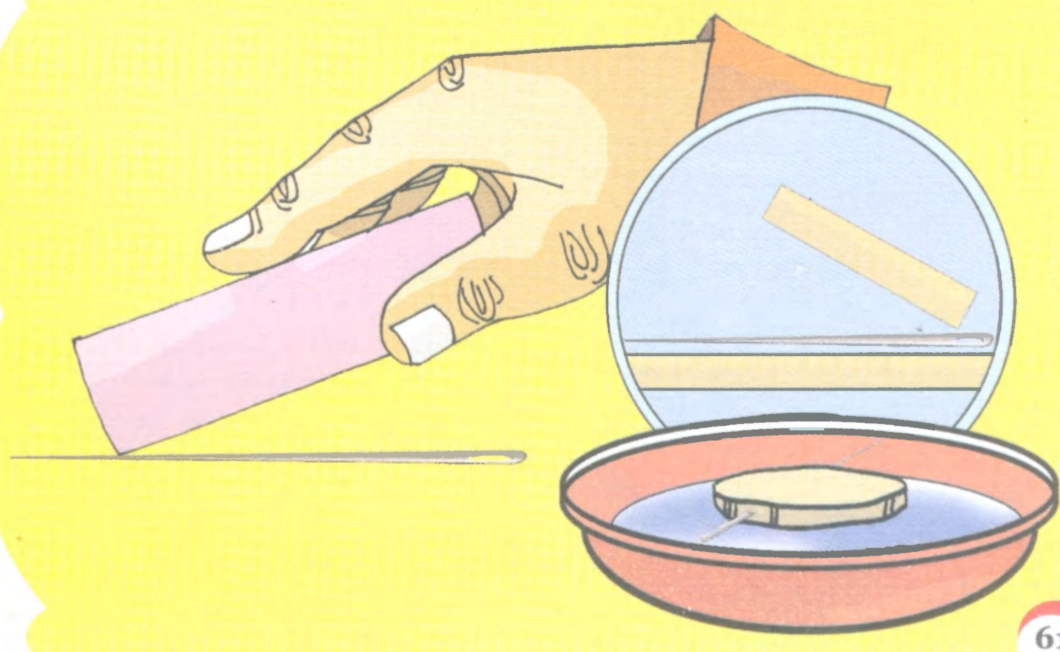
Can the properties of a magnet be produced in an ordinary needle?

To conduct this experiment, you will need an ordinary needle and a magnet. Now hold the needle in one hand and the magnet in the other. Keep one end of the magnet on one end of the needle and rub the magnet over it from end to end. Now lift the magnet and bring it back to its initial position. Repeat the process not only twice or thrice but 70 to 75 times according to the requirement and that too in one direction only. And every time from the same end of the magnet—please be careful about this precaution.

To test whether the qualities of magnetism have been induced in the needle or not, bring a pin near it. It does get attracted towards the needle! So, your purpose is served.

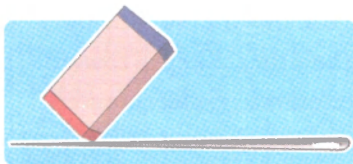
You can make a compass with the help of this needle. Do you want to know, how? Oh, nothing can be easier than this!

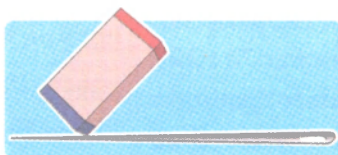
Take a cork and allow it to float on water. Pierce the needle through this cork in such a way that the two ends of the needle remain projected from this cork. Got it? So, your small **compass** is ready!



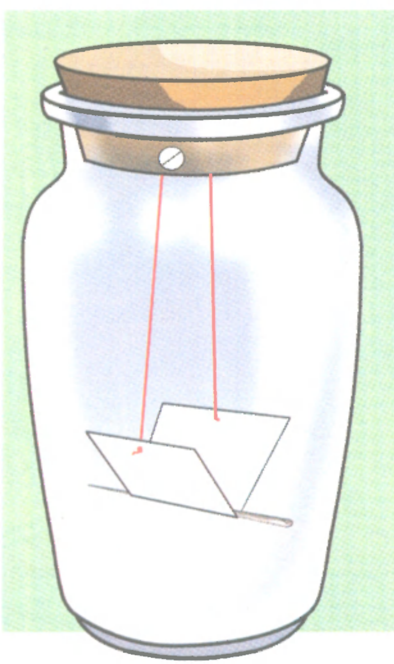
Making a magnetic compass

There is a device called compass which is used for determining the directions. Let us make it and see how it works!





To make this instrument, your requirement will be of one long needle and a bar magnet to magnetise the needle. Start rubbing it with the north pole end of the bar magnet from its middle point to its eye. Lift the magnet and rub again in the same manner. Repeat the process for about 50 times or more. Now keep the south pole end of the bar magnet in the middle of the needle and rub upto its pointed end. But whether rubbing the needle by the magnet's north pole or south pole, you must bear in mind that every time you have to lift the magnet sufficiently high to start again the rubbing from the middle of the needle. Only then will the needle be perfectly magnetised.



When you have done this, take a corked bottle and take out its cork. With the help of this cork, suspend a swing by folding a paper, and arranging the threads and the drawing pins as shown in the picture. Place the needle carefully on the paper-swing—along the crease of the paper—and suspend this whole apparatus in the bottle. Fix the cork tightly on the mouth of the bottle. Do you know the advantage of suspending it in a bottle? The wind will not be able to disturb your **magnetic needle** and, by rotating freely, it will indicate the North-South direction.

What all does a magnet attract?

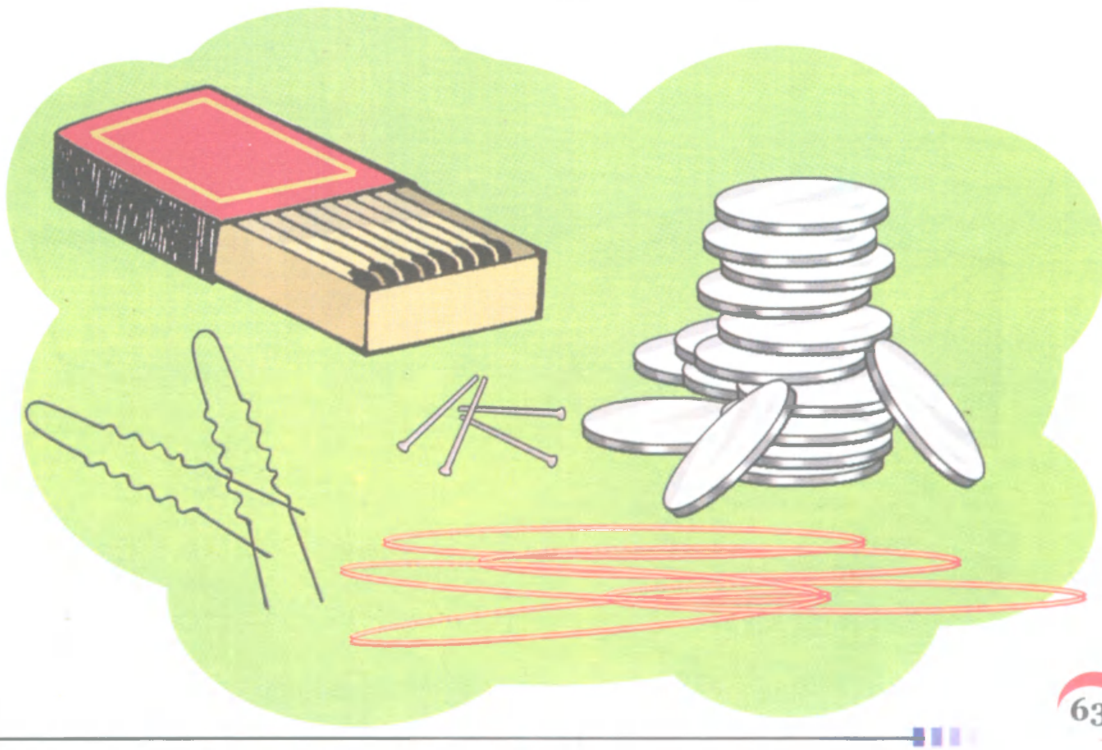
You know that a magnet possesses the power to attract. But can you tell which things get attracted by it?

Collect some twenty to twenty-five different types of things like matchboxes, pins, rubber bands, hair clips, nails, coins, bottle-caps, etc. from your house.

Now with the help of the magnet, try to lift these different things, one by one. Keep those things which are attracted by the magnet on one side and those unaffected by it on the other.

Thus, the entire heap of the collected objects will stand divided into two parts. Now observe them well and try to ascertain the special qualities of those objects that get attracted by the magnet.

Without any hesitation, you will reach to this conclusion that a magnet attracts only those objects which are made of iron or steel. In addition to these, there are certain other metals also which a magnet attracts but they are not in common use.

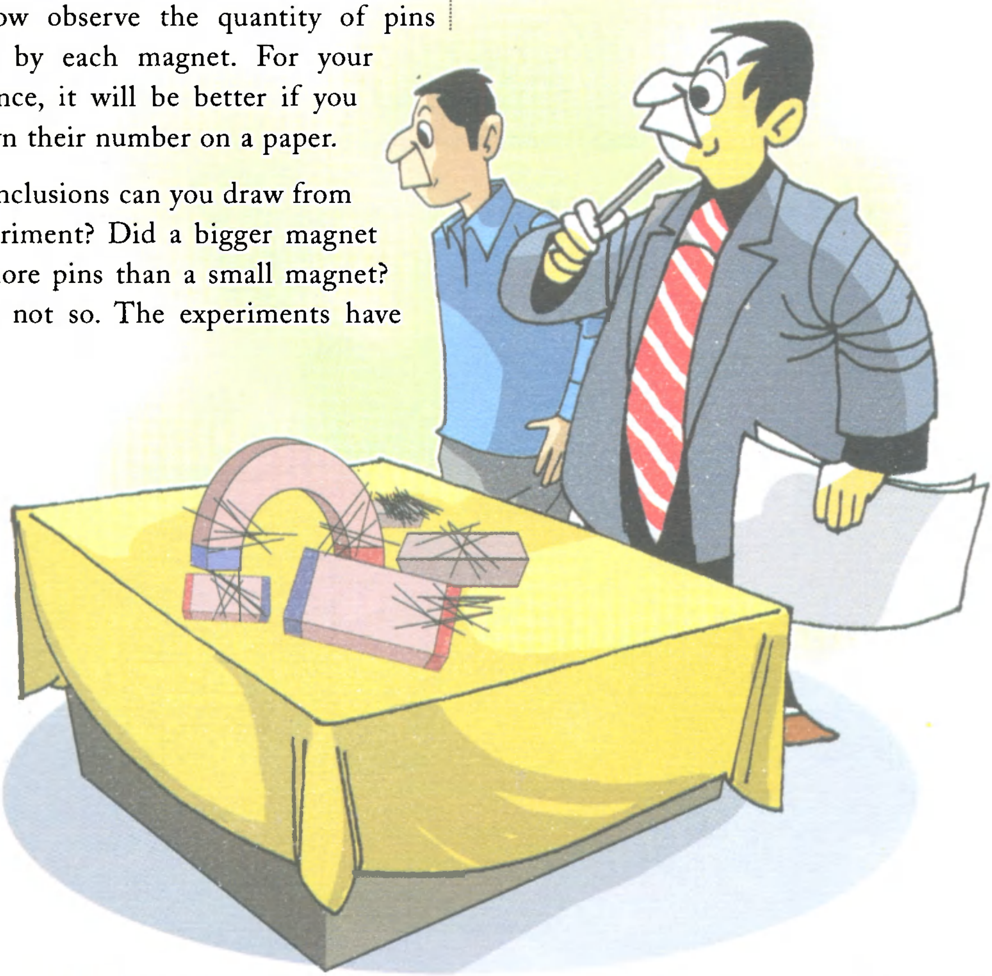


The strength of a magnet is not at all related to its size—is it a true statement?

Collect as many magnets of different sizes and shapes as you can. For this, you can seek help of your friend and your physics teacher as well.

Make a heap of pins on your table and bring all your magnets, one by one, above this heap. Now observe the quantity of pins attracted by each magnet. For your convenience, it will be better if you note down their number on a paper.

What conclusions can you draw from this experiment? Did a bigger magnet attract more pins than a small magnet? No, it is not so. The experiments have already proved that the strength of a magnet has no direct relation to its size. It does not depend on its physical dimensions. The age of a magnet and its proper maintenance are the most important factors in sustaining the power of a magnet.



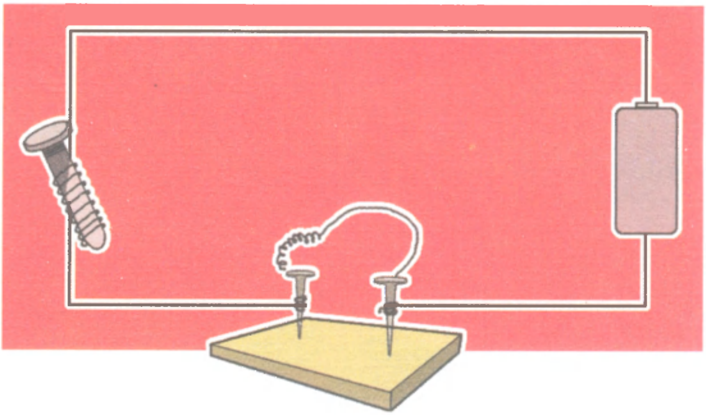
Controlling flowing electric current

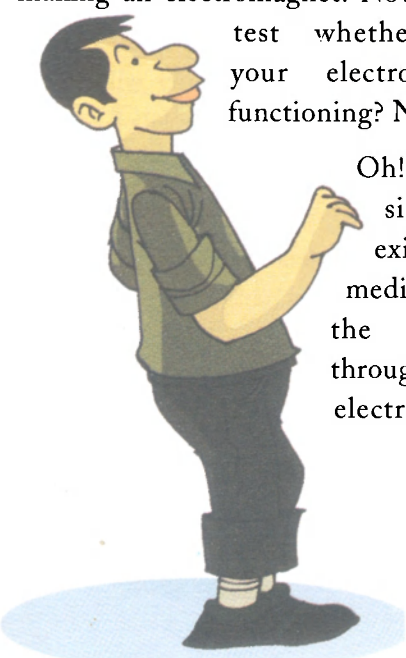
A very easy method for controlling the electric current passing through an electromagnet so that the current may flow or stop at your will.

To conduct this experiment, you need a 5 cm long, 2-3 cm wide and an equally thick piece of wood. Drive two nails into it, 3 cm apart.

Now connect one wire of your electromagnet with one of these nails and the other wire with the terminal of the cell. Connect the other nail in the wood with the other terminal of the cell by a similar piece of wire used in making an electromagnet. Now test whether your electromagnet is functioning? No? But why?

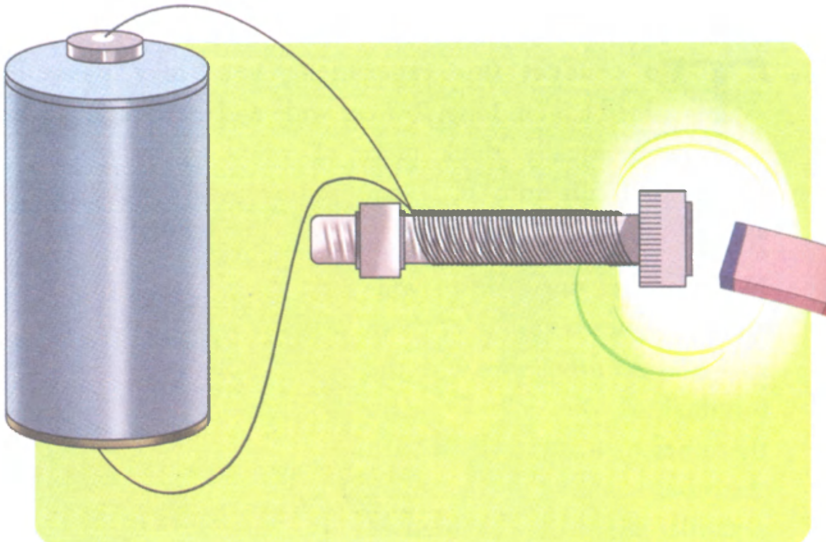
Oh! It's obvious, since there exists no medium between the two nails through which an electric current may pass. How will the current flow through it when the circuit is not complete?





Now take a piece of wire and make a noose at one end of it and put it on one of the fixed nails. Then coil the other end of the wire on the other nail. In case you wish, you can use a small plate of copper in place of this piece of wire. This is an elementary type of modern switch. The switches, in common use nowadays, are available in different shapes and sizes according to the need.

Like all other types of magnets, does an electromagnet too have two poles?



I have already told you in my last book (101 Science Games), about the method of making an electromagnet in your house without any difficulty. Here you have just to find whether such magnets too have two poles.

Before you start your experiment, place this magnet on the table and connect both of its wires with a battery and confirm its magnetism by bringing a pin near it.

Now take a bar magnet and bring its one pole slowly to one end of the electromagnet. See what happens. Then bring the other pole of the bar magnet also to the same end of the electromagnet in the same way as you did earlier. Mark the difference between the two positions.

Repeat this experiment by bringing the two poles of the magnet, one by one, to the other end of the electromagnet. But the result will again be the same this time. That is, the one end of the electromagnet will attract one pole and repel the other pole of the bar magnet proving that an electromagnet too has two poles.

Now the question arises—can the position of these poles be interchanged? For knowing this, interchange two wires of the electromagnet to the opposite terminals of the battery and repeat the above mentioned experiment. The results you achieve will automatically prove that this time the position of the poles have interchanged.

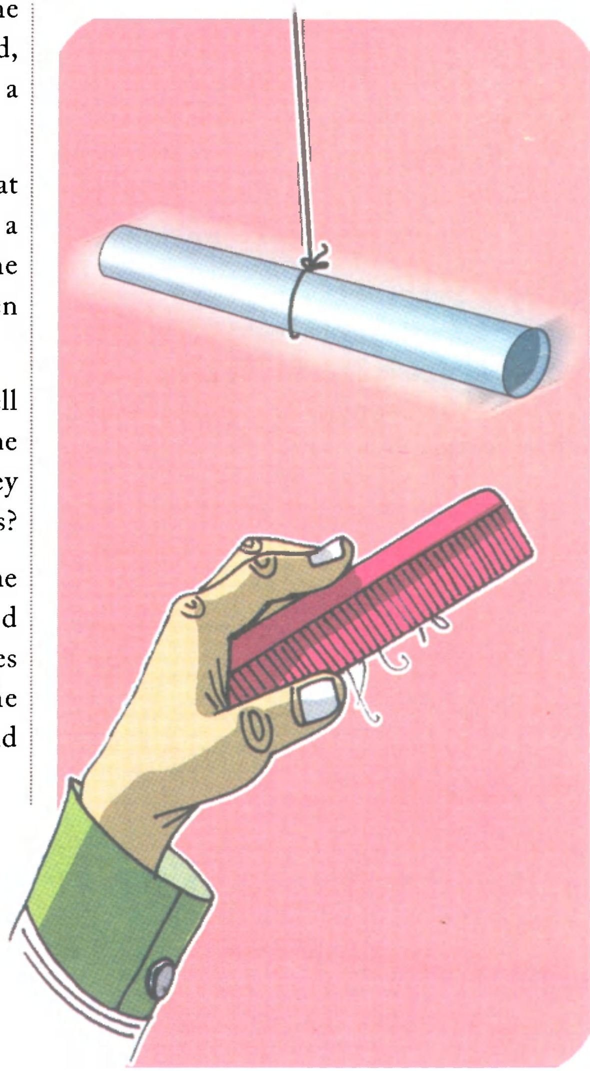
To prove by a simple experiment that unlike electric charges attract each other.

For doing this simple experiment, the things that you need are: a glass rod, a silk thread, a silken cloth and a rubber comb.

Take the glass rod and tie the silk thread at its middle point. Suspend it freely in a horizontal position (i.e., parallel to the earth). Now rub this rod well with a silken cloth.

Similarly, take a rubber comb and rub it well with a fur cloth. Take this comb near one end of the glass rod but take care that they do not touch each other. See what happens?

The negatively charged comb attracts the positively charged glass rod which proves the veracity of the basic principle behind it.



Is there any such method with the help of which electricity can be generated anywhere, at anytime, without much ado about it?

Whenever any mention of electricity is made, you must always be thinking in terms of electric current. Perhaps, you forget that there is another type of electricity which is known as *static* or *frictional electricity*.

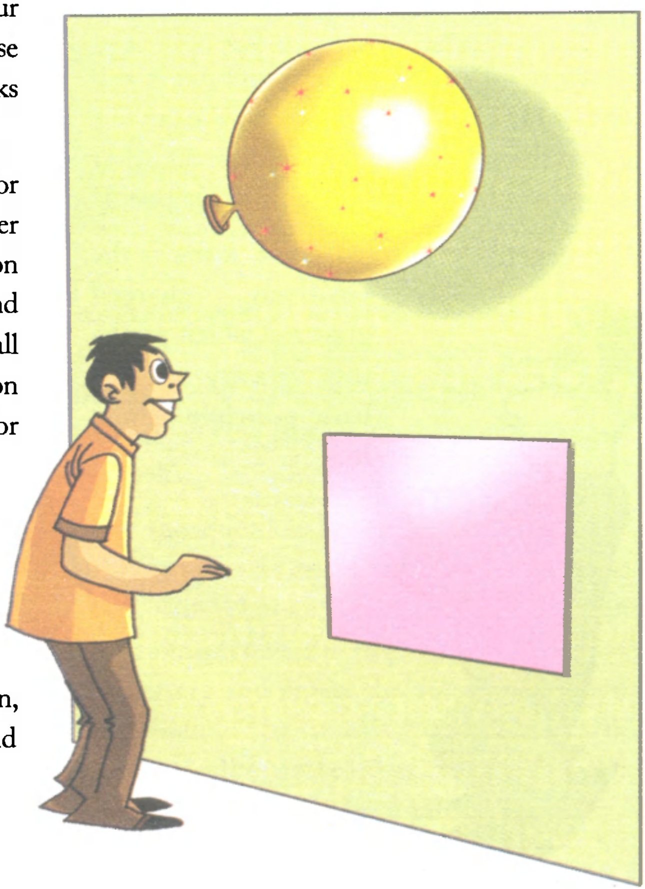
Rub an inflated balloon quickly on your clothes and then leave it free by going close to a wall. What happens? The balloon sticks to the wall, doesn't it?

Now take a sheet of thin paper used for making kites. Spread it on the wall and after rubbing it with your palm, stick it entirely on the wall. Now move aside from the wall and see what happens to the paper. Does it fall immediately? No? But what is the reason behind its remaining stuck on the wall for such a long time?

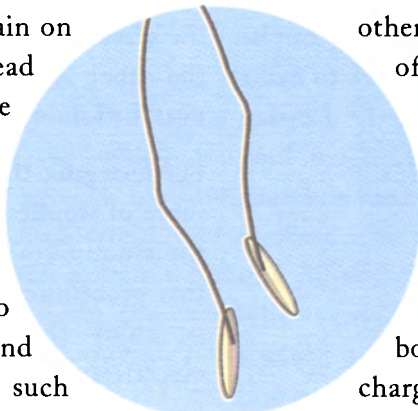
Actually, both the balloon and the paper get charged with static electricity produced by the rubbing which makes them stick to the wall.

Not only this, take off your cashmilon, pullover swiftly in a cold dark night and watch it carefully. Not only will you see the sparks coming out of it but you will also hear the crackling sound quite clearly.

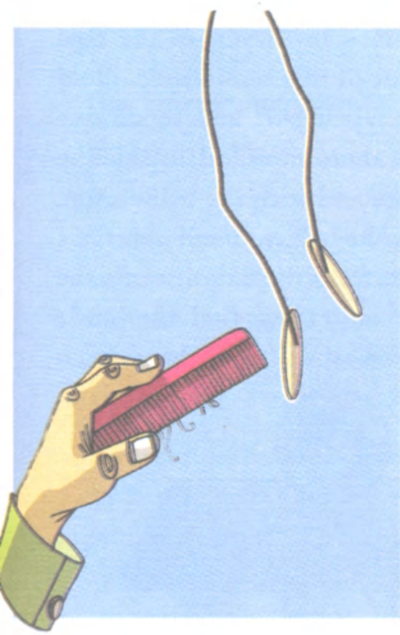
Now since you have seen and heard by your own eyes and ears about the static electricity, the question of disbelieving it cannot arise.



A game of puffed rice grains suspended by a silk thread



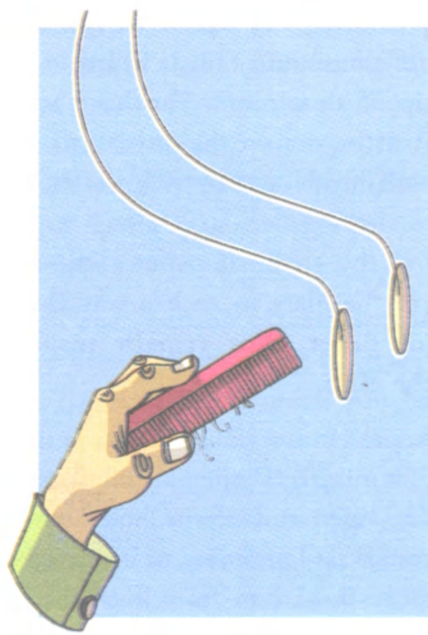
Stick a puffed rice grain on one end of a silk thread with the help of some adhesive. Suspend this silk thread in such a way that the puffed rice grain is at least 20 cm below its suspension point and is also in a position to move to and fro freely. Suspend another such puffed rice grain also in a similar way, just near the first one.



Now take a rubber comb and rub it well on a piece of flannel or fur and bring the comb near the suspended puffed rice grains.

First, the rice grains will run rapidly towards the comb, then they will suddenly run backwards and ultimately, they will run away from each other. It happens so because, first of all, the charged comb attracts the rice grains towards itself and when they reach there, they themselves get charged, exactly like the comb got charged. Hence, they make a retreat. Since both the grains have the same charge, they repel each other.

Well, the principle is also this that like *charges repel* and *unlike charges attract* each other.



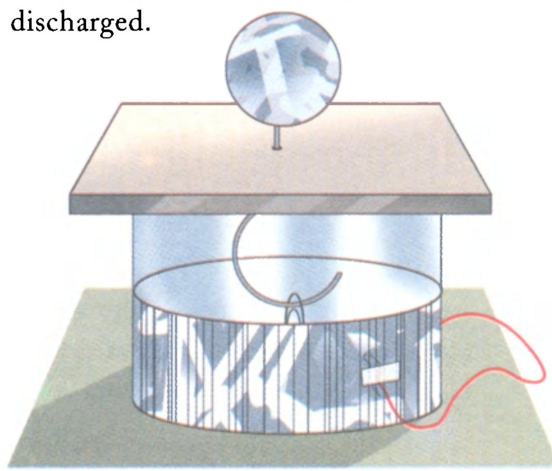
Is it possible to safely store static electricity for future use?

To show that static electricity can be stored safely, you will have to make a simple model called the Leyden Jar. For this purpose, take 12.5 cm long piece of a discarded coat-hanger and turn one end of it into the shape of a hook as shown in the diagram. Now take a 15 mm thick square wooden strip which may easily cover the mouth of a glass tumbler. Make a hole at the centre of the wooden strip and fix the hook into it. Further, make a chain of paper clips and suspend this chain on the hook.

One more thing you will need and that is known as aluminium foil. It is a thin paper like strip of aluminium. You have to stick this foil with gum on the lower half of the glass, both inside and outside. After doing it, place the wooden strip along with the hook and the chain of paper clips on the mouth of the glass in such a way that the chain of paper clips remain suspended inside the glass.

Take some more aluminium foil and crumple it into the shape of a small ball and thrust the open end of the hook into this ball. Now take a long piece of insulated wire and remove insulation from both the ends. Set one end of the wire on the foil outside the glass with the help of a tape and connect the other end with the pipe of your water tap. And now your Leyden jar is ready.

For charging this jar, rub a comb against a piece of woollen cloth and touch the ball of the aluminium foil with that comb. Repeat this procedure several times. Now in order to enjoy the spectacle of discharge of electricity by your own eyes, take a hangerwire about 20 cm long and shape it in a semi-circle. Stick a few layers of the tape on the middle part of this semi-circle. Hold that wire by the taped part and touch one end of it with the aluminium foil outside the glass and the other end with the ball on top. Before it touches the ball, you will observe a spark flashing out from the ball towards the end of the wire indicating that the static electricity stored by you has been discharged.



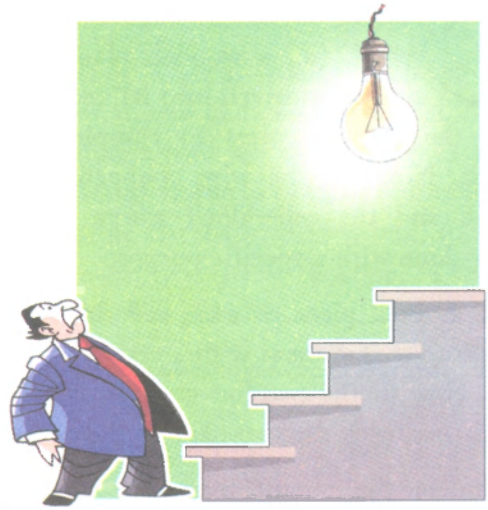
What is a two-way switch?

While climbing up or down the stairs, do you ever think how the bulb gets lighted by pressing either the switch fitted at the top or at the bottom of the stairs?

During night, while ascending the stairs, you press the switch and the bulb lights up. On reaching upstairs, you press the switch fitted there and the light goes off. Then someone else comes after you. He too presses the same switch and the glow spreads all around. This means you can use any one of the two switches fitted in the stairs for putting on or off the same bulb. But do you know, how this arrangement works?

The wiring in the staircase is different from the one adopted elsewhere in the house. Today, you will learn as to how the connection is made between the switches and the bulb to complete the circuit. But for doing this, we will be using a battery cell for the sake of safety.

In addition to two 1.5 volt cells, one 3 volt bulb and a few copper wires or fuse wires, you will need 2 two-way switches. The difference between these switches and the ordinary switches is that these have four holes instead of the normal two for tightening the wire wherein one upper and one lower hole of the same side remain connected by the wire or a metal strip.



Connect the switch and the bulb with wires as shown in the diagram and fix them on a plywood or wooden plank. There may be some difficulty in connecting the bulb with the circuit. For this, cut two tin strips in the shape shown in the diagram and thus this problem can be solved.

With the position of the switches as they have been shown in the diagram, the bulb will light up the moment you connect the circuit with the cells but if you put on or off any of the switches, the bulb will go off or on. Now you must have understood the secret of functioning of these two-way switch systems fitted at the top and the bottom of the staircase.

What is a fuse?

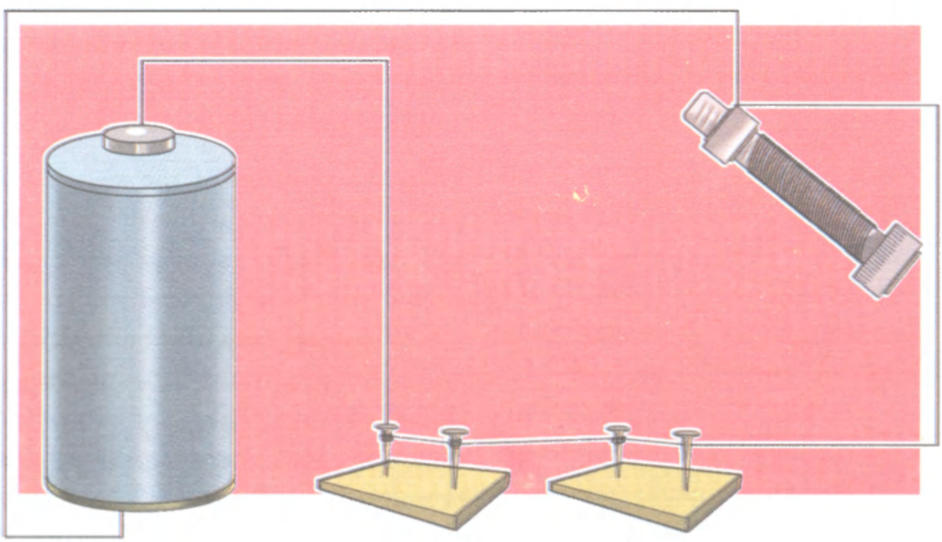
You must have heard of the fuse getting blown off when the electric power in your house goes out. What is a fuse and what is its advantage?

Connect an electromagnet with a switch (on a wooden plank with two nails driven into it) and a cell with the help of wires to complete the circuit. Now cut the wire connecting the switch and the cell—don't worry, this is being done with a specific purpose.

Take a small piece of cork and drive two nails into it. Tie them with a very thin iron wire. Now tie the two free ends of the wire, cut earlier, with the two nails of the cork.

Complete the circuit by connecting the switch and see that the electromagnet functions. Now connect one more cell with the earlier cell in the circuit and if necessary, another one also, that is, the third cell.

By this time, something must have happened to the thin iron wire tied to the nails of the cork. In other words, you can say that the fuse has blown off and together with it, the electro-magnet too has stopped functioning. Now you can comprehend the advantage of having the fuse. If due to some reason the electric current starts flowing in excess, then the thin wire in the fuse melts (due to the excess of heat generated) and breaks the circuit. Otherwise, in its absence, the wires in the entire circuit may get overheated and may even cause an outbreak of fire in the house!



How is a telegram sent?

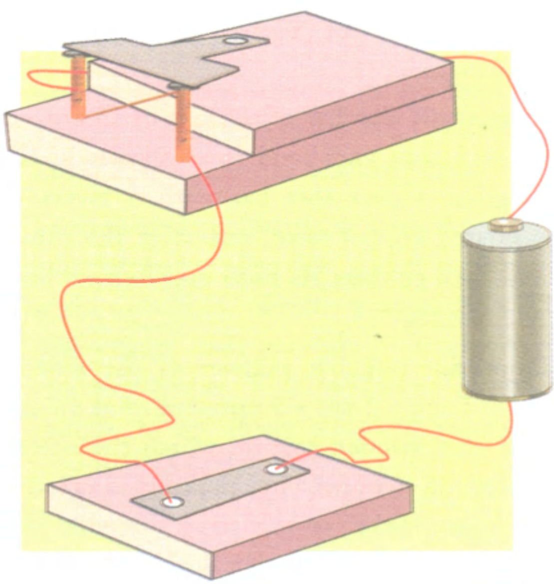
The moment any good or bad event occurs in your house, friends and relatives are informed about it immediately by means of a telegram. But how is this telegram or wire sent?

As shown in the diagram, take two wooden planks and fix the smaller one on the bigger plank with nails or with the help of 'Fevicol' (an adhesive solution). Then drive two long nails into the bigger plank and cover them with an insulated copper wire in such a way, that on one nail, it should be wrapped from bottom to top in an anti-clockwise manner. On each nail, there should be at least 20 turns of the wire. On connecting the two ends of the wire with the battery cells, these nails would function as an electro-magnet.

Now take a third wooden plank and drive a nail into it. Tie one end of the insulated wire on it but do not forget to remove the insulation from the end-part of the wire. Before driving another nail on this plank, you will have to do one thing more. Cut out two strips from an empty talcum powder tin in the shapes of 'T' and 'I'. Bend the 'I' shaped strip a little and fix it on the smaller plank and fix the 'T' strip on the larger plank with the nails. Complete the circuit by connecting the wires with the battery.

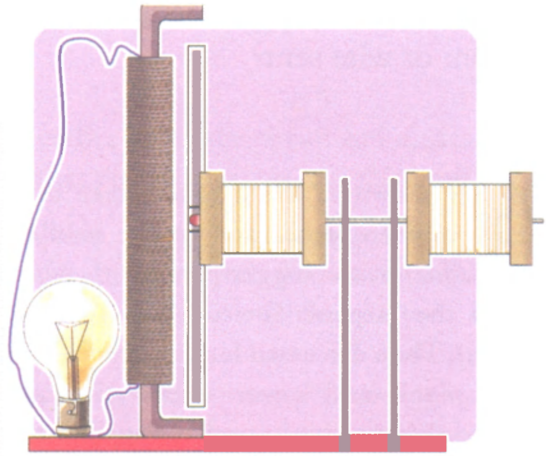
On pressing 'I' strip, when it touches the nail under it, the nails under 'T' strip will get converted into an electromagnet and start attracting the strip towards themselves. It will strike the nails with a 'tuk' sound. The moment you leave 'I' strip, 'T' will regain its earlier position.

Samuel F.B. Morse invented telegraphy, and with this sound, 'tuk' 'tuk', he created the symbolic language which till date is known as the **Morse Code.**



Making a generator at home

An experiment to show that a magnet rotating in a coil of wire causes flow of electric current in the coil.



If a bar magnet is rotated speedily in a coil of wire, the electric current starts flowing in the coil. As you know, the power of the electric current depends on three things—the number of turns in the coil, the power of the rotating magnet and its speed. Subsequently, on the basis of the invention done by Michael Faraday in 1831, the power station generators were developed by which electric power is generated and distributed on large scale for turning machines and for lighting and also for generating thermal power.

If you can prepare a model dynamo in your house, you can easily understand its working.

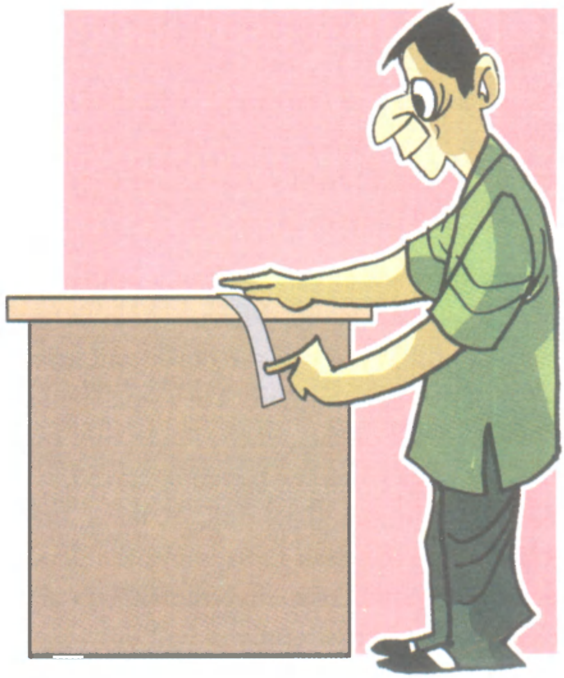
Take a soft iron bar of the size of 15 cm × 1 cm × 3 mm and bend it as shown in the diagram. Cover this bar with 5 layers of insulated copper wire, one after the other, and then connect its both ends with a bulb of 1.5 volts.

Now take one bar magnet of the size of about 8 cm × 1 cm × 5 mm and fix it on one side of a wooden reel on which the cotton thread is wound, by making a groove thereon. Take a knitting needle for connecting this reel with another reel. For support, pass this knitting needle through an iron-strip by making a hole in that strip. Fix both the reels on both sides of the needle in such a way that the reel with magnet comes to the side of the wire coil. Now connect the second reel by using thread with a cycle wheel or something like that which can be rotated speedily. Tighten this entire apparatus, i.e., the support, coil bar and the bulb with screws on a wooden plank as shown in the diagram.

When the wheel is set in motion, the first as well as the second reels start rotating because of the thread's pressure. The bar magnet too starts rotating in between the two ends of the soft iron strip and the electric current starts flowing in the coil, which makes the bulb glow. The glow of the bulb increases with the increase of the speed of the wheel.

What is sound and how is it produced?

Before understanding what sound is, why don't you do some minor experiments?



Place a scale on a table in such a way that more than half of it remains jutting out of the table-edge. Press the other end of the scale on the table and listen carefully whether any sound is coming from the scale.

Now press the free end of the scale with a finger and let go, keeping the other end pressed. Now listen carefully whether you hear any sound.

Your mother must be using a pair of tongs in the kitchen for preparing *chapatis*. Catch hold of it tightly from the joined side. You will hear no sound from it when it is in this position.

Now strike the tongs lightly against the ground and observe carefully its vibrating forks. Strike it once again, now watch it and also listen carefully.

Take an empty box without a lid and stretch a rubber band on it. There is no sound. Now pull the rubber band and release it. Do you hear any sound?

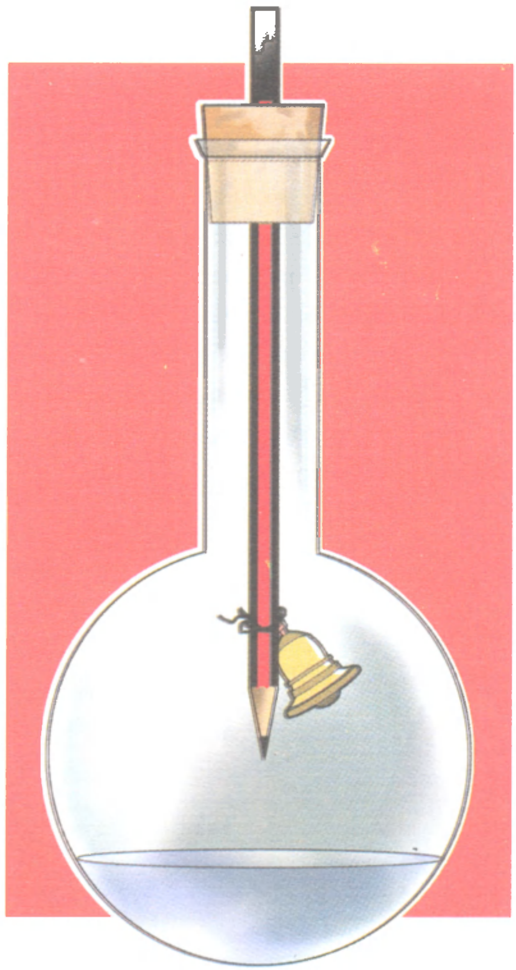
From these experiments, at least, this must be quite clear by now that sound is produced when an object vibrates continuously. This will mean that sound is produced by vibrating bodies. This continuous to and fro motion of an object is called vibration in scientific parlance.

Does sound necessarily need a medium to reach you?

Sound is produced by the vibrations of an object. Sound waves travel through a medium, whether that medium be a solid, a liquid or a gas. Sound cannot travel through vacuum and it can be proved by this experiment.

Take a little water in a flask or a bottle and heat it on the flame. Make a hole at the centre of the stopper of the bottle and insert a pencil through this hole. Tie a small bell at the lower end of the pencil. Make sure that the bell rings when the pencil is moved. Let the water in the flask boil. After a little while, when the flask cools, move the pencil a little. You will see that the bell is also moving but surprisingly, you will only see it moving, but hear no sound of its tinkle. Now, remove the stopper and then refix it. This time if you shake the flask, you can clearly hear the sound of the bell. But how?

The water in the flask changes into steam which pushes out the air from the flask. The entire steam changes back into water when the cork is fixed air-tight on the bottle and the bottle is allowed to cool. Thus, a partial vacuum is created in the flask because the outside air cannot enter the flask to fill the vacuum. As soon as the stopper is removed, the outside air enters the flask speedily and fills the vacuum. So, now you are able to hear the sound which you could not hear earlier. The reason is that the waves of sound need a medium for travelling from one place to another. They cannot pass through vacuum.



Hearing the heart-beat

Your heart beats round the clock and you can yourself hear the sound of its beating. Isn't it interesting? But you better know how it becomes possible.

The heart of a normal human being beats **72 times a minute.** But during exertion, the heartbeat increases. You can hear the sound of your own heartbeats by doing a simple experiment.

For this experiment, the apparatus you are going to make will have the same shape and function like that of the stethoscope, used by doctors. To separate the flow of water into two parts, 'T' and 'Y' shaped water joints are commonly used. Buy such pieces from a sanitaryware shop. Then take three rubber or plastic tubes, each about 50 cm long, which can be fitted into the 'Y' shaped piece. To enjoy this game, you will also need three metal funnels for fitting in the free ends of these three rubber tubes. After assembly, the shape of your apparatus will be like the one shown in the diagram.

Now ask one of your friends to place the two funnels on your ears. And you place the third funnel on your chest exactly upon your heart. Then count how many times your heart beats in one minute.

Now run for a while and count the beats in the same way as done before. After a brief rest, count your heartbeats again. The beats this time will be equal to those that you had counted the first time. But do you know as to why your heartbeats increased when you exerted yourself a little?

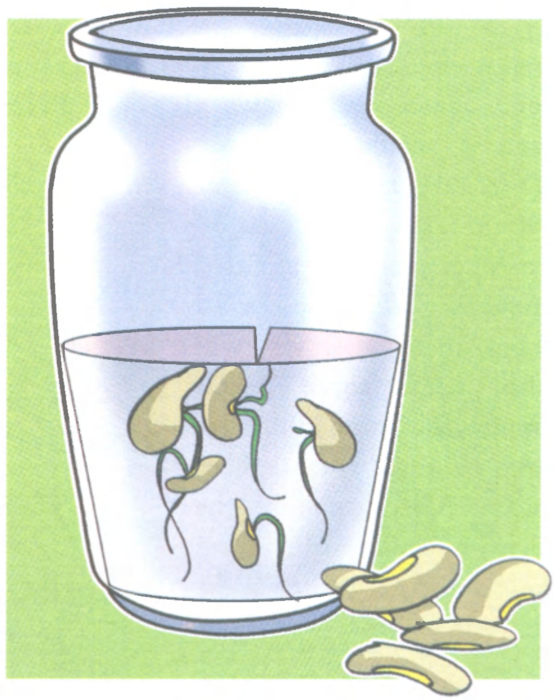
Actually, your body requires extra oxygen to produce energy when you exert yourself physically a little. This oxygen is supplied by your blood through the lungs to the whole body. While running, you need more oxygen and this deficiency makes you pant. And since the heart is like a pump to supply blood quickly to the whole body, it has to work faster, which you measure by its beats.

Can it be proved by an experiment that the trunk of a tree always grows upwards and the root downwards?

Roll up a piece of blotting paper round and put it in a wide-mouthed glass bottle. Now place some seeds of bean between the blotting paper and the wall of the bottle. These seeds should have been soaked in water well for about two to three hours. Wet the blotting paper and pour some water in the bottle too, so that the paper does not get dry. Place this bottle at a place where it gets both light and heat.

In a few days, the seeds will germinate, which means that their roots will start coming out. Within the next few days, they will start growing downwards. It is nature's wonder that the roots paving their way into the soil will always grow downwards owing to the pull of a special force called *positive geotropism*. It is due to the influence of this force that the root moves, in search of water, further inside the earth, going away from light.

Take out the seeds from the bottle and place them upside down in the bottle again so that the free end of the root may remain upwards. Let them remain as they are in between the layers of the soaked blotting paper for a few days more. Now what changes do you notice in the roots? Instead of going upwards, the roots have started growing downwards. When the stem starts coming out of the seed, it will always grow upwards because of the force called negative geotropism. The stem will always grow towards light. Now for a few days, keep the bottle with its mouth downwards. Again you will notice that the roots and the stems have reversed their respective growth to grow in their natural directions.



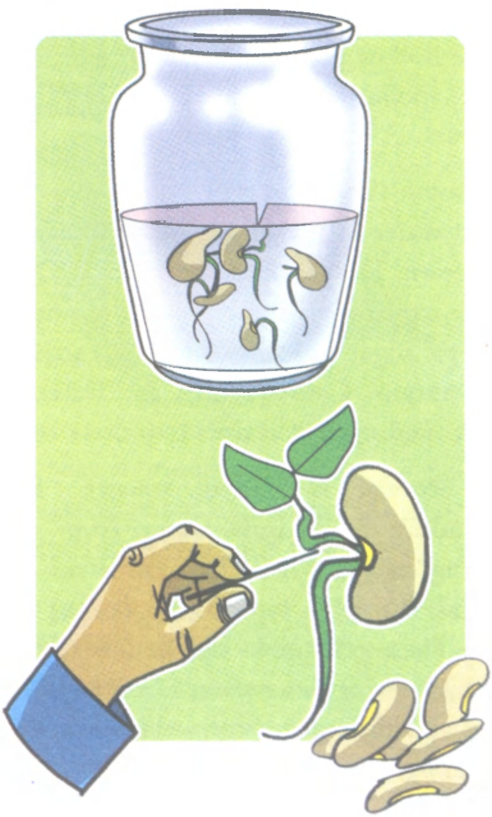
How would you find out whether the growth of all the parts of the root is uniform or the growth of a particular part is more than the other parts?

A plant consists mainly of three parts—root, shoot and leaves. The part of the plant which stays buried under the soil is called the 'root'. Besides fixing the plant to the ground, the root draws water and food from the soil. Is the growth of the whole root uniform or some parts of the root grow more quickly than the others? We can find this by means of a simple experiment.

Germinate some bean seeds. Take an open-mouthed jar and keep a rolled sheet of blotting paper inside it. After doing this, put some bean seeds between the wall of the jar and the blotting paper and wet the blotting paper thoroughly. Now keep the jar in such a place where it gets sufficient light and heat. Let it remain there for a few days but keep it in mind that the blotting paper should never get dry.

After a few days, the root will start growing from the seed. When they grow up to a length of about 2-5 cm, take out one or more seeds. Now, using a ruler, put marks on the roots at about every 3 mm distance. You can do it with the help of a needle and waterproof ink but do it carefully so that you do not injure the roots.

Now put the seed in the bottle and keep the bottle at some place to observe them daily for recording the difference between the marks. You will find that the maximum difference will be at the bottom-most tip of the root. The growth is maximum over there owing to it being the growing region of the root.



How does the water absorbed by the roots from the surrounding soil reach the other parts of the plant?

Take a big potato and cut it into two parts. Take one of them and hollow it out partially with the help of a knife. But be sure not to cut it through its bottom resulting in a hole.

Place the hollowed half of the potato in a bowl, keeping its open side upwards. Now slowly pour water in the bowl so that two-thirds of the potato remains submerged in it. Mark the level of water on the potato. Fill the hollow of the half potato with two to three spoonfuls of sugar and leave it for a few hours.

After some time, you will notice that the level of water in the bowl has significantly come down. Do you know the reason? No? Let me explain it. The cells of the potato closer to sugar absorb sugar and acquire concentration. Consequently, the water in the surrounding cells is drawn to these cells.

This process is called *osmosis*. The surrounding cells draw water from the adjoining cells and this chain continues till it reaches the cells closer to the skin of the potato. These cells make up the loss of this water by drawing more water from the bowl. This is why the level of the water inside the bowl comes down.

It is this process of osmosis which causes absorption of mineral salts by the roots in the form of a solution from the soil. The roots have fine bristles whose skin functions like semi-permeable film which draws the dilute solution of mineral salts towards the root but does not allow the concentrated solution in it to go out. By the way, the activity that takes place in making it reach up to the stems and other parts of the plant is called *capillarity*.

The water drawn by the roots from the earth gives life to the plants and trees, but then, what happens to the water?

The water absorbed by the roots of a plant ends up in evaporation through the fine pores of its leaves. This phenomenon in plants is called *transpiration* and you can understand it through this simple experiment.

Take a planted pot and cover around it one polythene sheet. Place this pot in the sun and leave it there for some time.

After five or six hours, when you go to inspect it, you will be surprised to observe something. What do you see on the inner side of the polythene? Where have these tiny dew-like drops come from? Think hard and try to find the answer. No success? Then let me tell you.

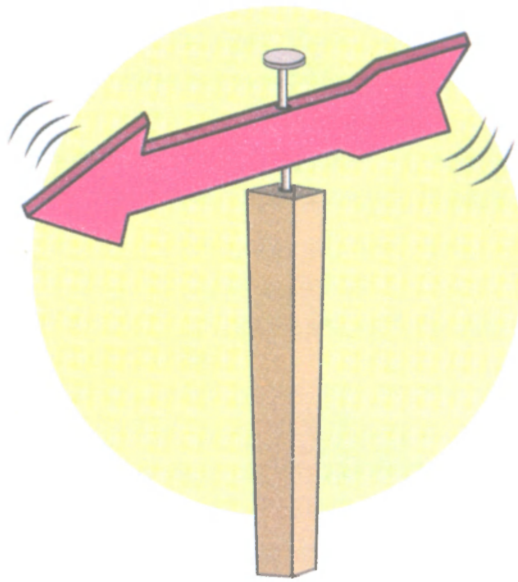
Fast-growing leafy plants cannot survive without water. You may water the plant daily and yet you will find it quite dry. In summer, you will have to water it as many as two times a day. The water drawn by the roots from the soil passes through the stem to the leaves which have fine pores called the **stomata**. Through these pores, this water evaporates. This evaporation by the leaves is called transpiration. The entire process—starting from the drawing of the water by the roots to the transpiration by the leaves—seems to assure every cell of the plant that it would never have to face the shortage of water, and of the minerals and chemicals dissolved in it.

The water drops seen on the inner side of the polythene sheet in the above mentioned experiment give an incontrovertible evidence of transpiration which is the culmination of the use of the water sucked up by the roots.

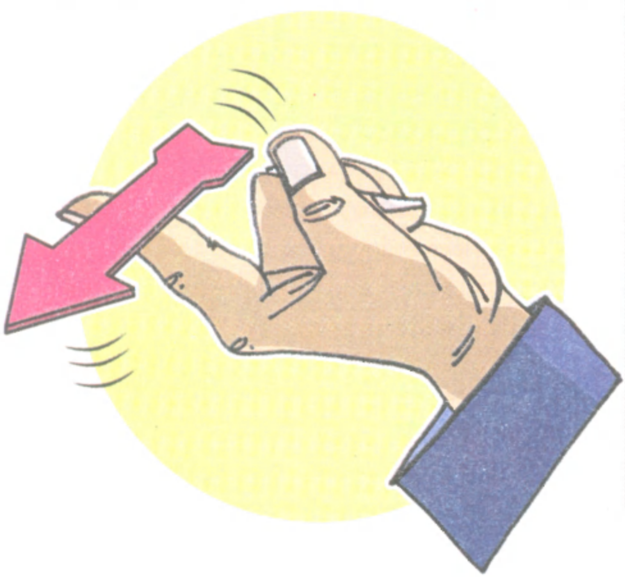
What is a wind vane?

The wind blows from one direction to another. A device called Wind vane is used to find out the correct direction in which it is blowing. You can also make one if you so wish.

Cut out the shape of an arrow, as shown in the diagram, from a piece of cardboard. Place this arrow on your finger to find out its centre of gravity. The point at which the arrow is balanced in a horizontal position will be its centre. Pierce a long pin at this point through its thickness.



Now take a wooden rod and make a hole on one of its sides so that the pin piercing the arrow could go into it but the hole should not be so deep as to swallow the entire pin jutting out on the other side of the arrow. As a matter of fact, the depth of the hole should be less than the length of that portion of the pin coming out of the arrow.



Fix the other end of the stick in the earth or keep it straight with the help of some strong support. Then put the pin of the arrow in the hole of the stick and observe the activity. Your *Wind vane* will indicate the direction of the wind by turning itself towards that direction.

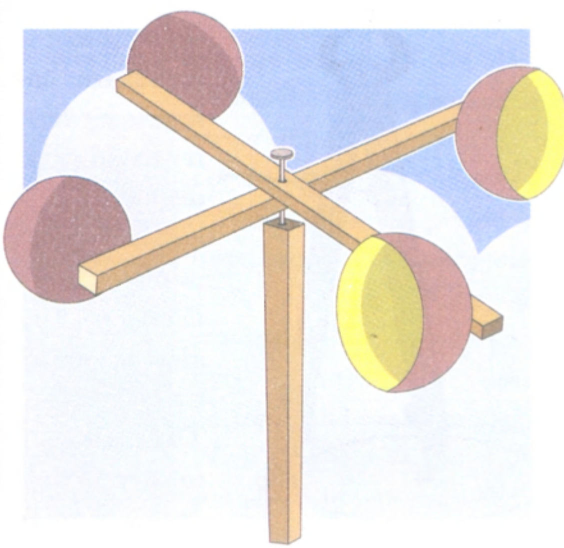
Making an anemometer

The wind does not always blow at the same speed; now it is slow, now fast and now very fast. Anemometer is the device with which you can measure the velocity of the wind. Make one all by yourself.

Take two rubber balls and cut each ball into two halves. Paint the inner sides of the two halves in different colours so that you can identify them easily from one another. Take two wooden strips, each 45 cm long and 2 cm thick. Fix the two halves of a ball on the two ends of the strip with nails as shown in the figure. Repeat the same process on the other strip also.

Then place one strip on the other so that the strips cross each other at 90 degrees angle with their centres lying overlapped. Now drive one long nail through them without disturbing their position so that the pointed end of the nail may jut out of the strip. Now take another 60 cm long beam and clamp it on with some other support. Then make a hole of such dimension on the upper end of the strip that the pointed end of the perpendicularly driven nail on the wooden strip may easily fit into it, leaving just a small part of the nail projecting outside, as shown in the figure. This is your anemometer.

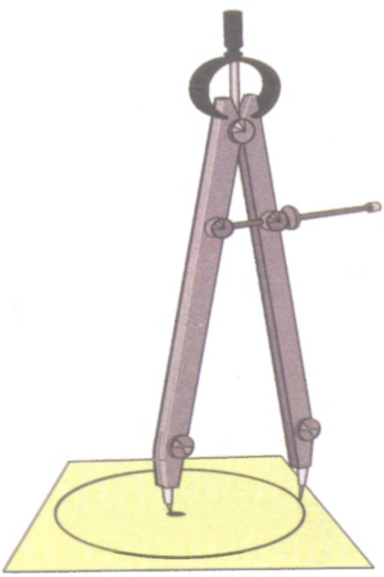
Now place your anemometer somewhere outside your house in the open, as on the roof of your house, so that it can revolve on its axis when the wind blows. How will you know the speed of the wind? Count the number of turns taken by any part of the ball in half a minute and divide that number by 3. The answer will give the approximate speed of the wind in the unit of km per hour. (In case you want to know the speed in miles per hour, then you will have to divide the number of turns by 5 instead of 3).



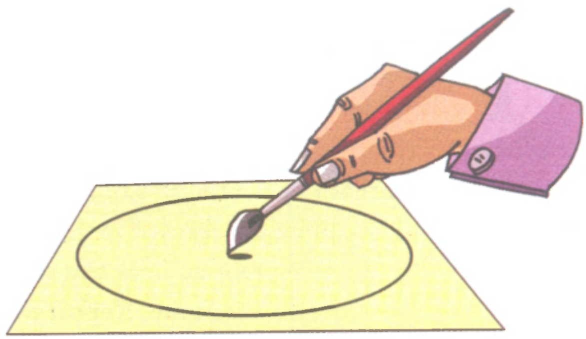
How to measure direction of wind?

A wind vane is a device used for determining the direction of the wind near the surface of the earth. Now, tell with the help of which device is the direction of the wind at a very high altitude determined?

Since it is not necessary that the direction of the wind flowing at a very high altitude may tally with that flowing near the earth's surface, it becomes imperative for the meteorologists to study the direction of the wind not only on the earth's surface but at high altitudes also. The clouds are used to study this direction of wind at high altitudes along with a device called **nephoscope.** The sole requirement to use this device is a slightly overcast sky.



Take a 20 cm square piece of cardboard and draw a circle on it having the diameter of 15 cm. Now take a mirror of equal diameter and glue it on the cardboard. Then allow it to dry. Put a drop of nail-polish or any



coloured liquid at the centre of the mirror and mark points to indicate the directions—north, south, east and west—by the abbreviations—N, S, E, W respectively on the periphery of this circle. Not only this, you must also mark the angles formed between these directions like NW, NE, SW and SE as shown in the diagram.

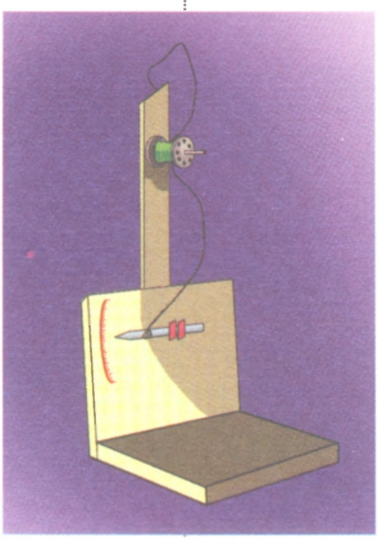
While using the nephoscope, place it in the open on some even surface and set the indication 'N' towards the North. Now watch the images of the clouds floating in the sky, in the mirror—shown with a coloured point. Note the direction of the moving clouds. This is the direction in which the wind is blowing at a very high altitude and moving in from the opposite direction.

How to measure humidity in air?

The instrument used for measuring the humidity in the atmosphere is known as Hygrometer. By its name, it might appear to be a difficult device but it is not difficult to understand how it functions. Let us see!

First of all, make a stand as shown in the diagram by joining wooden pieces and fix an empty thread spool to wind the cotton thread, with some support so that it may revolve freely round its axis. Now fix a piece of white cardboard below the reel on which you are to draw a scale, later.

Take a straw used for drinking cold drinks and make its one end pointed with a sharp blade. As displayed in the diagram, stick it in the middle of the cardboard just below the reel with the help of a drawing pin but take care that the portion between the drawing pin and the pointed straw remains larger than the remaining portion of the straw to ensure that the weight of the straw remains more towards the pointed end. Also, take precaution that the straw does not get fixed up with the cardboard. Rather, it should be in a position to move up and down freely with just a suggestion.



Now take a long human hair and fix one end of it on the upper portion of the reel with the help of a pin or cellotape, and then taking the hair above the reel, tie its second end with the pointed end of the straw, keeping the straw horizontal.

To perform this experiment, cover your *hygrometer* with a towel soaked in hot water. Remove the towel after sometime and note the position of the pointed end of the straw. Due to humidity, the hair will expand and grow longer, causing the straw to come down. Now remove the moisture on the hair by keeping it at some warm and dry place. When the pointed end of the straw remains steady at a certain point for a sufficiently long period of time, mark this point also. This will be above the previous point: Divide these two points into small portions and graduate them. With the help of this scale, you can find out yourself the atmospheric humidity on different days.

How to measure gravity in liquids?

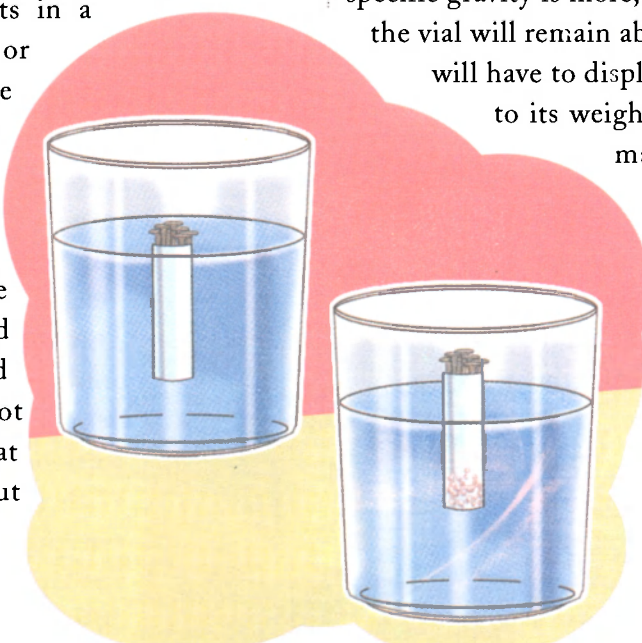
The device used for measuring the specific gravity of a liquid is known as Hydrometer. What kind of device is this? Why don't you make it yourself and see?

First try to catch hold of a plastic cover of your mummy's lipstick, if you can. In case you fail to get one, take a vial of homeopathic drug of one or two drachma capacity or any discarded thing of such shape and size.

For conducting this experiment, after you have procured a vial, take a glass filled with water and also some small-sized nails.

Now put some small nails in this vial and see if it floats in a glass of water or sinks due to the weight of the nails. If it sinks, take out some of the nails and see once again the effect. You should keep it in mind that it should not only vertically float in the water but some part of it must remain above the water level. Mark this portion above the water level. Then take out the vial from the glass and mix 3 to 4 spoonfuls of sugar in the glass of water and float the vial again in the water. You will see that this time a larger part of the vial remains above the water level. This proves that the specific gravity of water increases by mixing sugar in it.

If the liquid is heavy, or in other words, its specific gravity is more, then a larger part of the vial will remain above water because it will have to displace less liquid, equal to its weight. Similarly, you can make a comparative study of the specific gravity of milk and solution of salt and other liquids with the help of hydrometer.

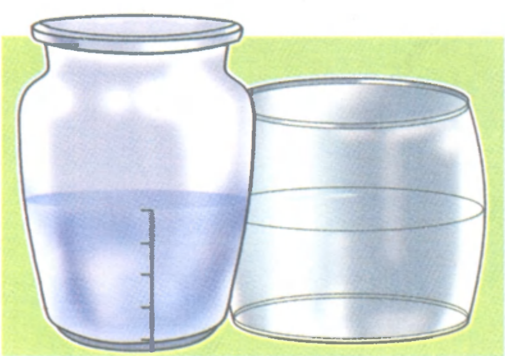


How to measure rainfall?

You can see the rain falling but you cannot measure the amount of rainfall merely by observation. The instrument devised to measure rainfall is known as rain gauge. It is very easy to make one.

It starts to rain when the moisture in the air condenses. It is important to know the extent of rainfall for meteorological and agricultural purposes. By this simple experiment, you can understand how rainfall is measured.

For this, you will be needing two bottles: one wide-mouthed with wide bottom and the other wide-mouthed with narrow bottom. First of all, pour water into the wide-bottomed bottle so that the level of water is 2.5 cm from the bottom. Transfer this water carefully to the narrow bottle and divide this water column into 5 equal parts. Every part will represent 5 mm each. Now mark each of these points with some colour and let the coloured mark get dried. This will be your **rain-gauging jar**.



Bury the empty bottle with wide bottom into the earth upto its neck, and, if possible, place a funnel on it, which must have the same diameter as that of the bottle. If not, it will serve the purpose without the funnel as well.

When it starts raining, the rain-drops will fall in the bottle buried in the earth. Transfer this collected water to the slender bottle, and when the rain stops, read the level of rain water in terms of millimetres. In this way, by measuring the rain water daily, you can know the average rainfall of the entire season. In case the rainfall of your area is more than 2.5 cm, you will be required to put more markings on the bottle meant for measuring the rainfall.

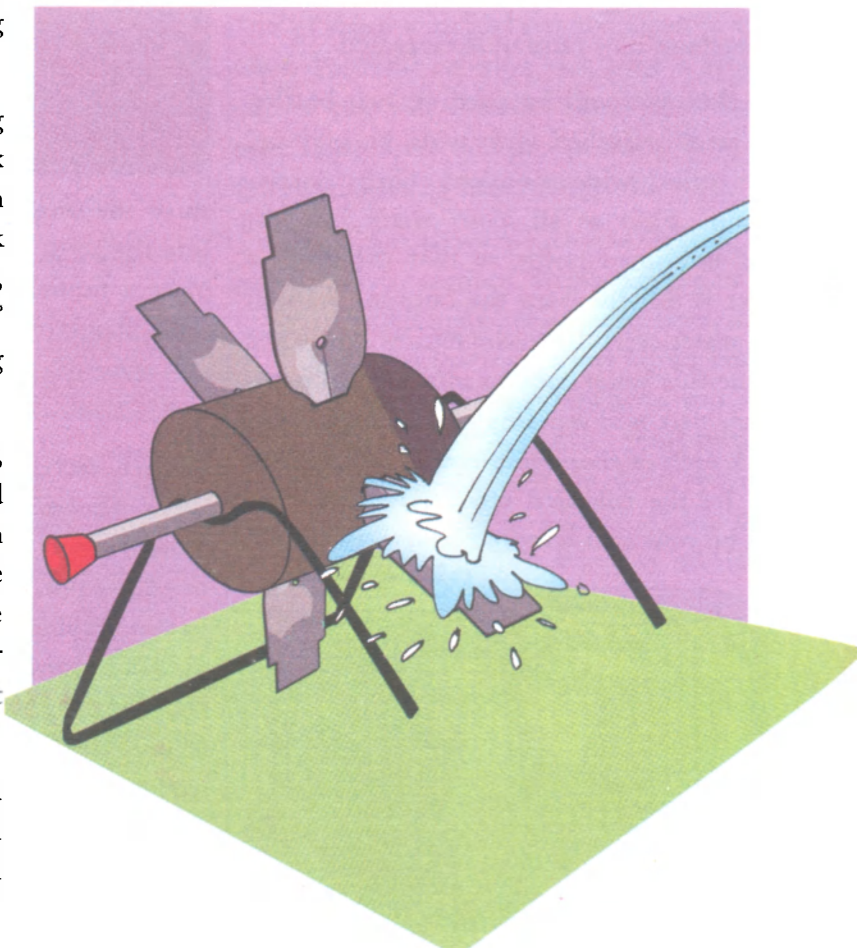
What are turbines and how do they rotate with the help of water?

The flowing water has immense power. So much so that its power can help in operating some very big and heavy machines. Huge water wheels, called **turbines**, are used nowadays to generate electricity under hydro-electric schemes. How do they function? You can see for yourself by conducting the following experiment.

Pierce through a knitting needle across a large cork. Fix six holder-nibs, as shown in the diagram, around the cork at equal distance in between, so that these nibs make a 90° angle with the knitting needle.

Take a discarded coat-hanger, open up its bends fully and shape it in the form shown in the diagram. Then place the needle on this stand to see whether it can rotate freely or not. If it rotates, then take it that your turbine is ready.

Now take a tin container and make a hole near its bottom and place it in such a position that, when filled with water, the stream coming out of this hole falls directly on the blades (i.e., the nibs) of your turbine. Do you know what will happen? Your turbine will start rotating with the rapidly flowing stream of water in the same way as the real turbines rotate.



What is photometer?

What is a Photometer? You can understand its process of working by means of a simple experiment.

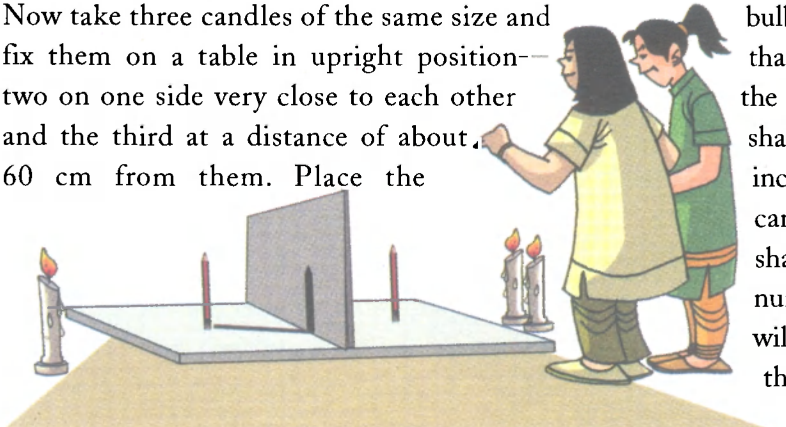
The device used for measuring the intensity of light is known as **photometer**. With its help, two such sources of light can be compared, out of which the power of one is known and that of the other, unknown. Let us see how it is done.

Cut a narrow groove in a wooden plank and fix an erect white sheet of cardboard into it. In case you face any difficulty in cutting the groove, you can apply some other easier method also. The purpose is that the cardboard sheet should remain straight and erect. That's all. On the plank, stick one pencil each with their sharpened ends upwards, on both the sides of the cardboard at a distance of 4 cm from the cardboard sheet.

Now take three candles of the same size and fix them on a table in upright position— two on one side very close to each other and the third at a distance of about 60 cm from them. Place the wooden plank with cardboard and pencils exactly at the middle point of the distance between the candles.

Then light the candles. Of the two shadows falling on the cardboard, one will be darker. Now move the plank slowly forward and backward till it comes to the position from where both the shadows look alike. The plank will be twice far away from the two candles in comparison to its distance from the single candle. It is because the light of one candle will be half compared with that of the two candles.

When this plank is at equal distance from the sources of light and the shadows falling on the cardboard are also similar, then deem it that the candles are giving light of equal intensity. Now if you want to know the 'candle-power' of a bulb, keep it at a distance equal to that of the two candles kept on the other side. Then to make the shadows look equally dark, go on increasing the number of the candles. The moment the shadows look similar, count the number of the candles and this will tell you the 'candle-power' of the bulb.



Making a microscope at home?

You all have heard about the microscope. It is an optical device to magnify objects too small to be seen by the naked eye. Let us make one with smaller dimensions ourselves.

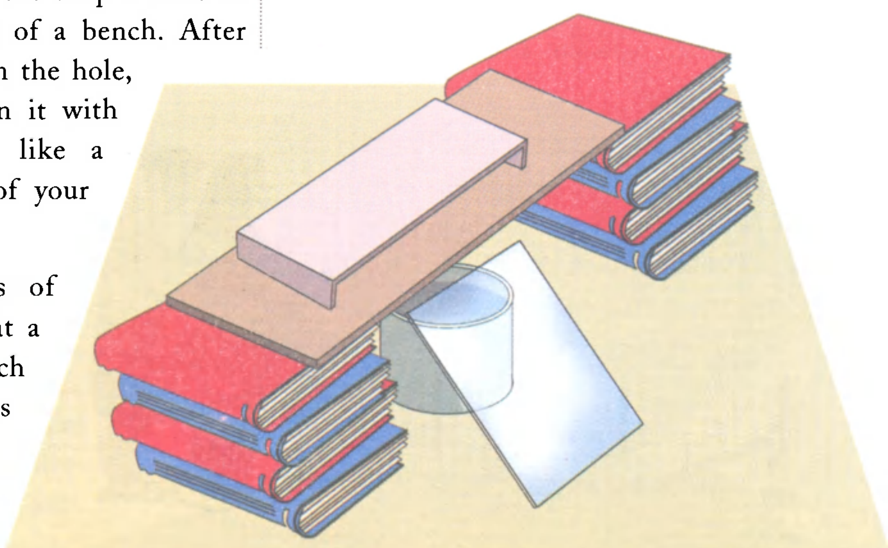
The most important components of a **microscope** are its lenses through which you see the object in its magnified form. Here you will make the lenses also by yourself—know this too!

Take a tin box and get a strip of 4 cm × 12 cm cut out of it. Stick some cellotape on its edges so that its sharp edges may not cut your fingers. Make a small hole of 2 mm exactly in the middle of the strip with the help of a nail. How will you do it? Just put the strip on a wooden plank and drive a nail at the appointed place.

Now turn the edges of the strip a little so that it takes the shape of a bench. After applying some grease on the hole, put a drop of water on it with some pointed object, like a pencil. Now the lens of your microscope is ready.

Then make two piles of books of equal height at a short distance from each other and place a glass sheet on them. On this sheet, place the tin strip exactly in the middle and place a mirror with some support in a tilted position under the sheet in such a way that the light falling on it after the reflection, first falls on the glass above and then passes through the drop of water. Your microscope is now ready for use.

Keep a grain of some cereal, small insect or any other tiny object on the glass sheet and set the focus of your 'water-drop' lens by pressing and adjusting the strip with your fingers very carefully. You will immediately see the object clearly, many times bigger than its actual size.



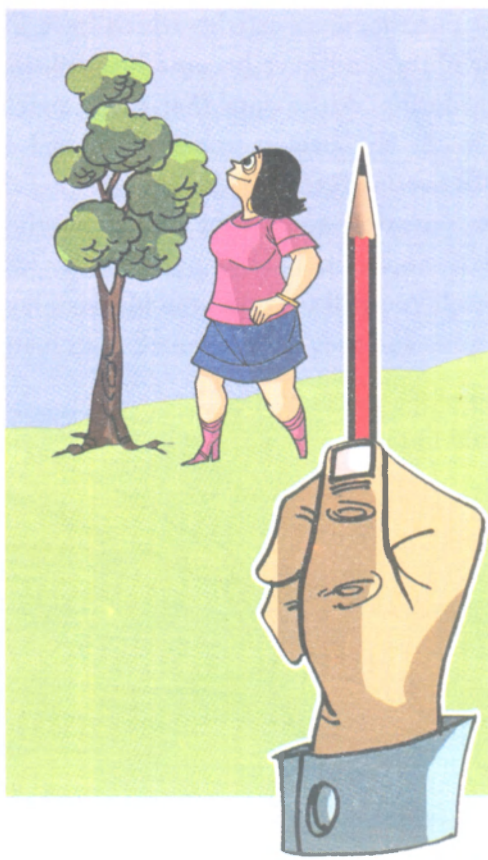
Can you measure the height of a building or a tree, etc. without climbing on it?

This measuring of height is a very easy job. Only you should know how to do it. And that you will know, now.

Ask one of your friends to stand by a wall and then put a mark on the wall touching the crown of the head. Measure the distance between this mark and the ground. That will be your friend's height.

Now ask your friend to stand very close to the building or the tree whose height is to be measured. Stand about 15 metres away from your friend. Make sure that the building or the tree, whose height is to be measured, and your friend are equidistant from you. Stretch your right hand towards your friend and hold a pencil in it in such a way that the sharpened end of the pencil comes exactly in line of your vision with the crown of the head of your friend. Then start sliding your thumb on the pencil until it is in line with your friend's feet. Do you know what it means? That the part of the pencil which is above your thumb represents the height of your friend which you have already measured.

Now measure the height of the building or the tree with the pencil in the same manner and see how many times this length of the pencil is more than the length of the pencil you measured your friend's height with. Suppose it is 12 times more and the height of your friend is 1.4 metres. Multiply the two figures and you will get the correct height of your object which is 16.8 metres. So this gives the actual height of the tree or the building whichever you have measured.

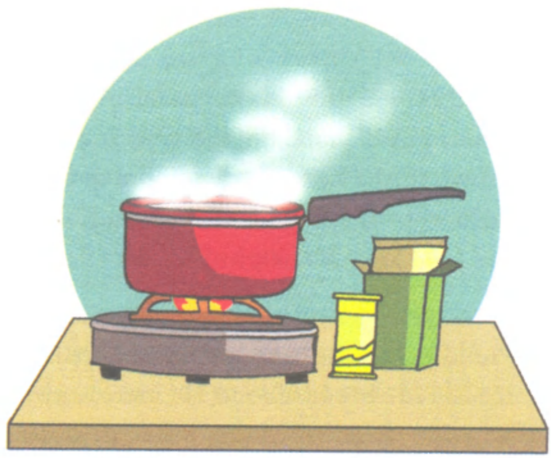


Cleaning the silver articles

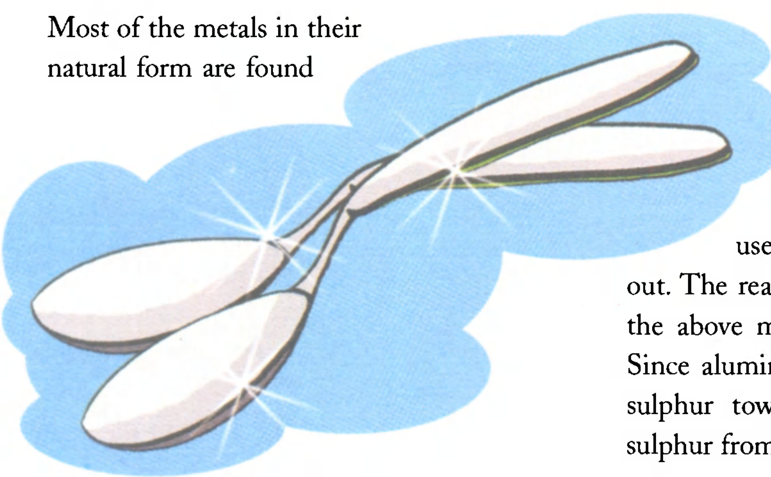
The effect of the atmosphere on silver articles is such that they lose their glitter after some time and a blackish layer covers them. Do you know any easy method to remove it?

Take an aluminium frying pan and fill half of it with water. Put in it two or three spoonfuls of baking soda and equal quantity of salt. Heat this solution and remove the pan once the solution starts boiling.

Now put the silver articles which have lost their glitter and have become blackish into the solution. Make sure that these articles do touch the pan at some place and lie totally submerged in the solution. Take them out after some time and wash them with clean water. Then wipe them dry with a towel. You will find that the blackish layer has gone and they have regained their lustre.



Most of the metals in their natural form are found in compounds from which their pure form is separated. For example, silver is also found in its natural form as a compound known as silver sulphide. It is this silver sulphide, a compound of silver and sulphur—which is formed and accumulated as a blackish layer on silver. The best way to separate sulphur from silver is to use some element capable of pulling it out. The reason of using an aluminium pan in the above mentioned experiment is also this. Since aluminium has the property of drawing sulphur towards it, it attracts and removes sulphur from the silver.



What are stalactites and stalagmites and how are they formed?

To understand them, it will be better to conduct an experiment first. Remove the lid of a cardboard box and place one glass tumbler each on both sides of the box. But be sure that the box is below the level of the glasses. Take four pieces of a thick string of cotton and putting them together, tie one nail each with the two ends of the threads. The length should be such that passing over the box the strings can reach the bottoms of the two glasses.

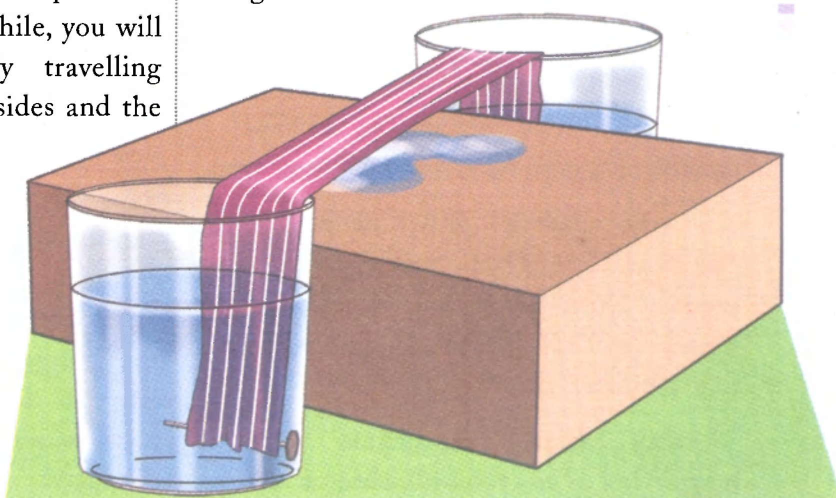
Now prepare a saturated solution of the epsom salts i.e., mix as much of these salts in the water as can get dissolved in it.

Fill both the glasses with this saturated solution. Immerse each nail tied, to the strings, in the two glasses and pass the strings over the box. After a while, you will see that the solution is slowly travelling along the strings on both the sides and the droplets getting collected in the middle. This is how the formation of **stalactites** starts.

Again, when enough solution gets collected there, it starts dripping on the floor of the box and the drops thus collected there start mounting upwards. This exactly is the process of the formation of the **stalagmites**.

The process of rising up and dripping down of the drops of the solution continues unchecked. With the passage of time, the water part of the solution evaporates leaving behind the solid salt. Similarly **stalactites** and **stalagmites** are formed in nature.

In the caves of the limestone region, these wonderful creations of nature—the stalactites and stalagmites—look like pointed large icicles but in reality, they are the result of the continuous deposition of the calcium-mixed water from the caves' ceiling which eventually leaves only calcium salt behind in the form of stalactites and stalagmites.



How do fingerprints help in detecting criminals?

There are lots of ridges on the uppermost layer of the skin of your fingers. Their function is to help the hands have a good grip on any object to prevent it from slipping from them. If you want to know in detail about them, just try the following method:

Blacken a piece of paper with a 2 B or 3 B soft lead pencil and then rub one of your fingers on the paper vigorously to blacken it too. If necessary, rub the pencil once again on the paper because you need a thick layer of the black lead powder on your finger.

Now, cut about 5 to 6 cm long strip of transparent sticky tape and place the blackened fingertip on the sticky side, pressing it carefully there. Now when you remove your finger, you will find a mark on the tape which is your own **fingerprint**! Stick this side of the tape on a blank paper. Now it is fully preserved.

Similarly, take the prints of your other fingers and also of your family members and friends. Don't forget to write down the names of the persons against their fingerprints.

Viewing these fingerprints with a magnifying glass, you will observe that no two fingerprints are identical. That is why the fingerprints found at the place of crime play an important role in apprehending the criminals by the police. The. fingerprints taken from the site of crime are tallied with the fingerprints of the professional criminals and of the other suspects available in the police records to identify the criminals.

How to trace footprints?

Footprints, like fingerprints too play an important role in detecting criminals. How are footprints preserved as an evidence?

A thief while escaping often leaves his footprints on the damp earth in such a way that the police get a vital clue against him. You can yourself see how these marks are preserved.

Press your foot a little on a flower-bed or somewhere else where the earth is soft and wet and then remove it. You will see a full footprint on it. Now cut a long strip of cardboard sheet and encircling the footmark by its edges, thrust it inside the earth. Then prepare a paste of Plaster of Paris with water and pour it in the cardboard's circular enclosure and then allow it to dry. After 8 to 10 hours, the plaster will become so hard that you can easily lift it from the earth after removing the cardboard strip. Remove the soil stuck on to the cast and then apply grease or mustard oil on it.

Now place this cast on a table, keeping the side with the footmark upward and encircle it with another strip of cardboard. Pour again a paste of the Plaster of Paris in this enclosure too as you did earlier.

After a few hours, when it becomes quite hard, separate the two parts carefully. The second part which you prepared subsequently is the replica of your foot which can be produced as an evidence anywhere and can be preserved for a long time.

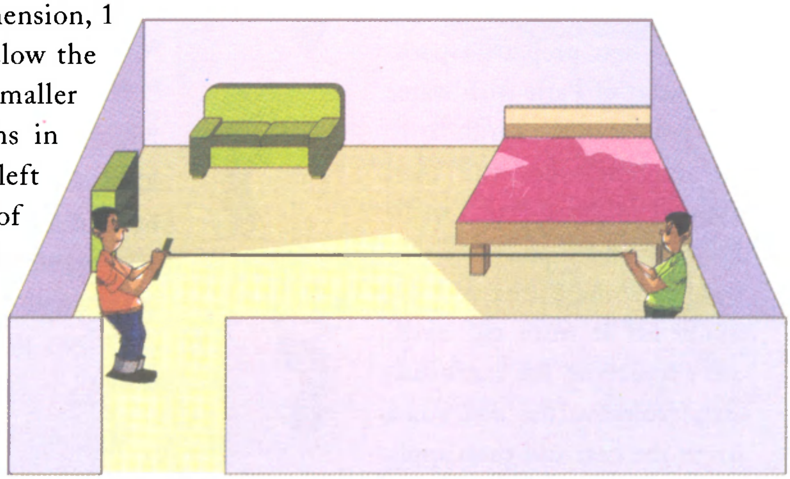
How is it possible to measure the distance between the earth and various heavenly bodies so accurately while sitting on earth? Do you know?

First conduct an experiment yourself in a big room. Suppose you have to measure the length of the floor of your room without actually crossing it. What will you do? Can you tell? Okay, I will tell you. Now listen attentively!

First take a 3-metre long string and ask two of your friends to hold it at its ends in a stretched position and to stand about half a metre away from the wall of the width-side of the room. Now keep one end of the drinking straw on the left side of the string and pointing this straw towards the opposite wall, look at some point or mark there through the straw.

Now ask one of your friends to take a strip of thick white paper of the dimension, 1 m × .25 m and place it just below the straw in such a way that the smaller side of the paper strip remains in touch with the string and its left corner meets the joining point of the straw and the paper strip. Now draw a line on the paper along the straw. Again keep the straw on the right side of the string in the same way and look at the same mark through the straw in this position. Repeat the process. This time you will get a line drawn on the paper which is meeting at its right corner. Now with the help of a scale draw these lines further so that they meet, and measure its length. Then multiply it by 12. So you have measured the length of your room without crossing it. Now measure it by a footscale and check it by actual measurement. If there is a difference between the two measurements, you have committed a mistake somewhere.

But don't worry, you can correct these mistakes by regular practice.



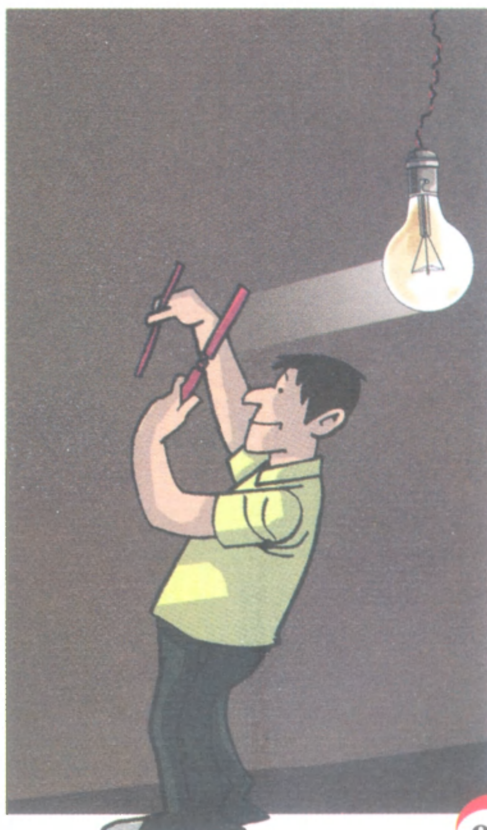
How can we measure the temperature of the moon and other heavenly bodies?

We use a thermometer to find out the temperature of an object. But this method is possible only for those objects which are within our reach. However, scientists do measure the temperature of distant celestial bodies while sitting right on earth. How does it become possible—have you ever thought of it?

You can get the idea by conducting a simple experiment. All you have to do is to procure a thermometer having coloured water instead of mercury. You can also buy or borrow such a thermometer from your school laboratory. The rest is easy. Light a bulb in your room and keeping the thermometer a little away from the bulb, note down the temperature immediately. Then note the temperature again after two minutes. From the difference found in the temperature recorded both the times, it will be clear that the heat present in the light affects the thermometer.

Now converge the light of the bulb at a point with the help of a magnifying glass and hold the thermometer in such a position that the converging light falls straight on the bulb of the thermometer. You will see that the temperature is rising. What actually happens is that the rays of the light coming from the bulb are deviated by the magnifying glass to focus them on the bulb of the thermometer to record the temperature.

Scientists measure the temperature of the celestial bodies by this method only. The difference being that they must also know the size of the body and that of the lens, the distance between the lens and the body and the variation between the two recorded temperatures. The rest is quite easy for them to know by calculations.

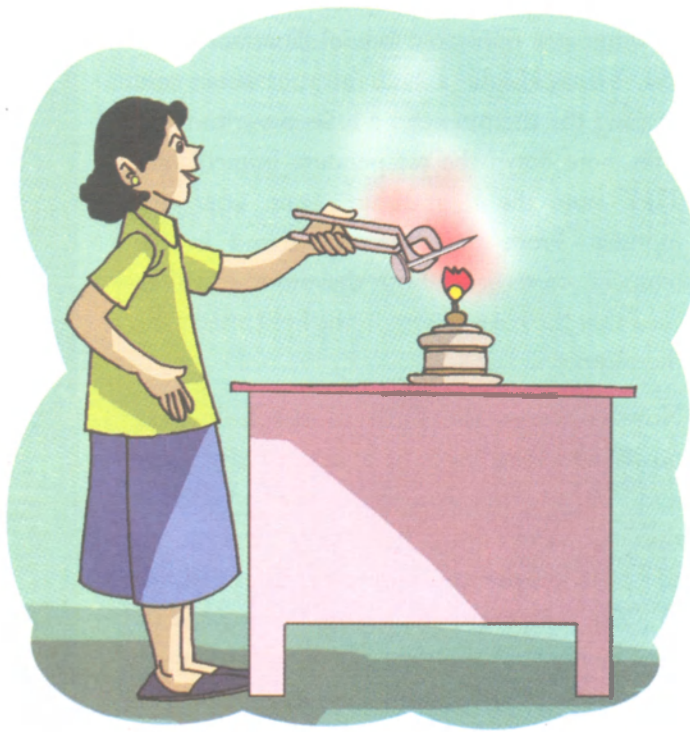


The astronomers have their own method of recording the temperature of the celestial bodies? What is it actually?

Do you know the difference between a star and a planet? The stars are the bodies which are illuminated by their own light but the planets do not have their own light and they only reflect the light they receive from a star. The method adopted by the astronomers to find the temperature is applicable only to those celestial bodies which are stars and are extremely hot.

Hold a nail with the pliers on a high flame and notice closely the change that appears in its colour on getting hot. Then you will observe that with the increase in temperature, its colour is also changing in a gradual manner. The dull red colour will turn to bright red and then to yellow and orange. If the flame is quite bright, this yellowish hue of the nail will turn to white and then bluish-white. The astronomers try to guess the temperature of the distant bodies by closely watching their emitted colours with the help of a very powerful telescope. For example, the stars with yellowish hue are considered to have higher temperature than those which appear red, while the ones with bluish hue are hotter than even the yellow ones.

You reckon our sun to be very hot, don't you? But in fact, it is just a yellow star. Another similar yellow star is *Capella*. *Antares* and *Arcturus* look red and *Sirius*, *Rigel* and *Vega*, etc. appear blue.

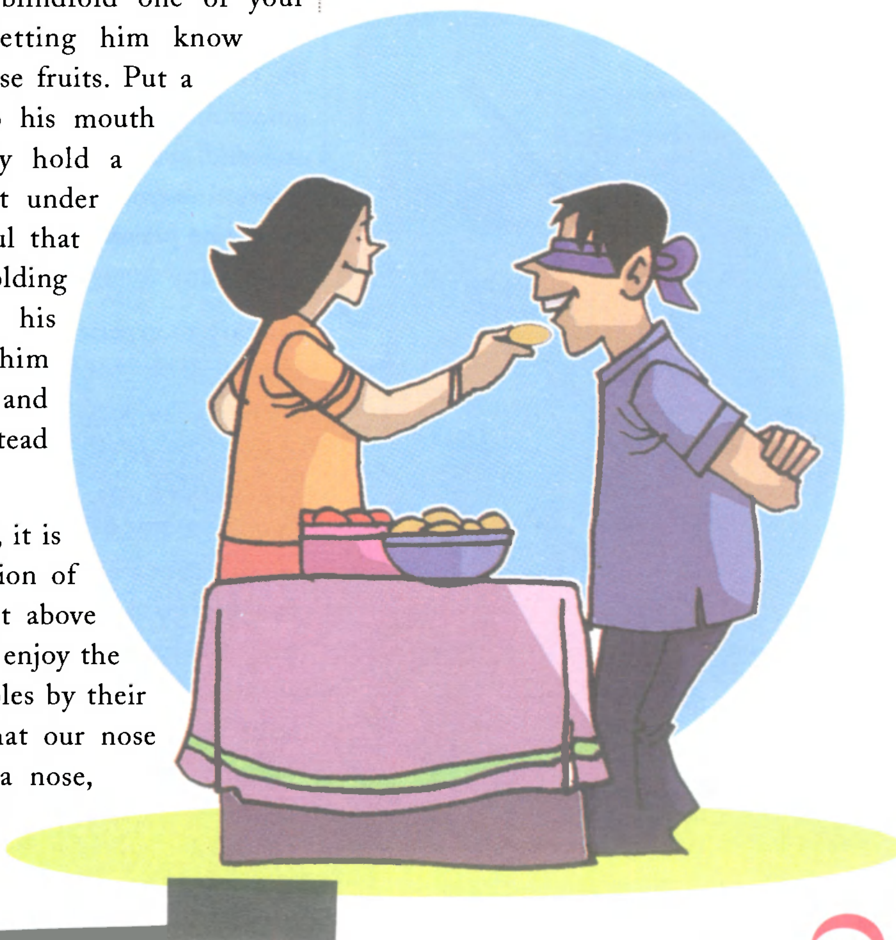


Is it possible that your tongue may at times deceive you in recognising a particular taste?

It may seem incredible to you. How is it possible to get a taste of something different than the one you eat? But it is true and you will have to agree with it also when your tongue fails to tell you the correct taste.

Take an apple and a pear and cut these into thin slices. Now blindfold one of your friends without letting him know anything about these fruits. Put a slice of apple into his mouth and simultaneously hold a piece of pear right under his nose. Be careful that the piece you are holding must not touch his nose. Now ask him what he is eating and he will say pear instead of apple.

As a matter of fact, it is owing to the position of our nose being just above our mouth that we enjoy the taste of some eatables by their smell or flavour that our nose receives. Without a nose, we will not be able to enjoy our food fully. Have you ever noticed that just when your nose gets blocked due to cold, you do not enjoy the taste of your food? Anyway, now onwards, notice it carefully, and then you will know that your tongue enjoys the taste of most of the eatables because your nose fully cooperates in recognising them.



Is it ever possible that the sensitivity of your skin may deceive you too?

Whenever something touches us on any part of our body, we instantly become aware of it, don't we? But how is it possible without our having a look at it? Let me tell you. There exists a network of nerves just beneath our skin, all over our body wherein different nerves remain active for different experiences. But this network is not uniformly spread in our entire body. In order to test this fact, you can conduct the following experiment.

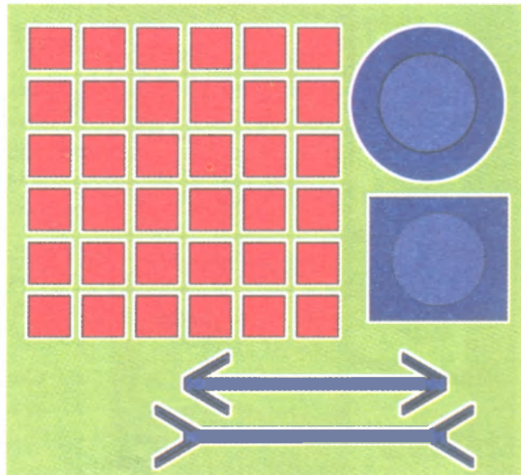
Blindfold yourself and ask one of your friends to prick gently on your palm with the pointed end of a pencil. Ask him to take another pencil and prick with the pointed end of both the pencils on your palm keeping a distance of about 5 mm between the two points. Let him repeat it at different points on your palm—sometimes with only one and sometimes with both the pencils. Every time you must tell him whether he is using one pencil or two in his each attempt. How many times can you answer correctly?

Now try to experience this prick on the back of your neck. Ask your friend to repeat the action on this part also and see how often you answer correctly. Do not be disappointed if your answers are mostly incorrect. This is bound to happen. The number of nerves beneath the skin of your palm is much more than that of the nerves at the back of your neck. It is these nerves which transmit the experience of the prick to the brain. It is owing to this reason that sometimes you get confused. Try to conduct this test on the other parts of your body also.

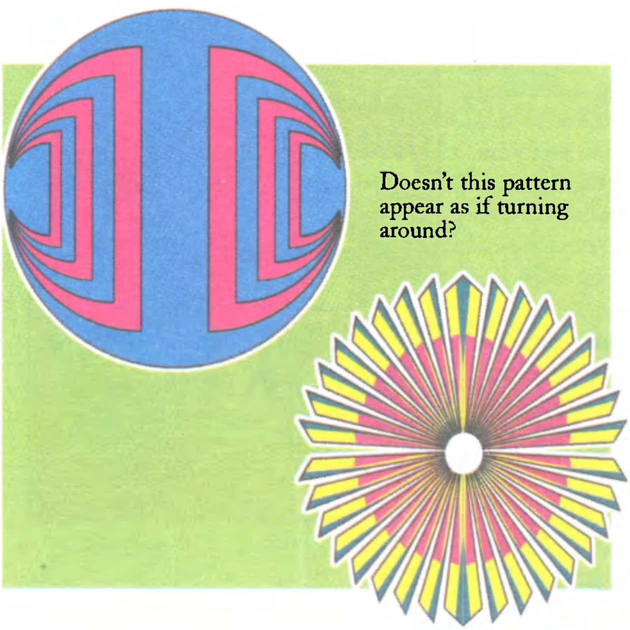
When your own eyes deceive you!

Many a time, it so happens that things look different to you from what they actually are. Such a situation is known as ***optical illusion***. There can be a number of reasons for this. At times, it so happens that our eyes are not able to see any object or a scene properly and send wrong description to the brain which creates confusion. At other times, without paying much attention to the description sent by the eyes, the brain conceives a picture which is incorrect.

Here are some examples of optical illusion which perhaps will compel you to get confused. See them for yourself.



Which line is longer of the two?



Doesn't this pattern appear as if turning around?

What do you see : two heads or a candle-stand?

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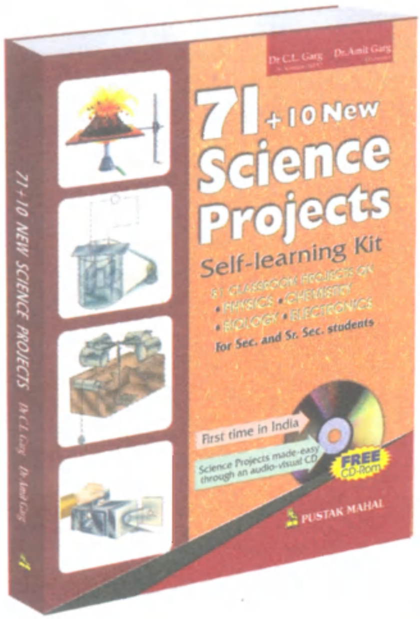

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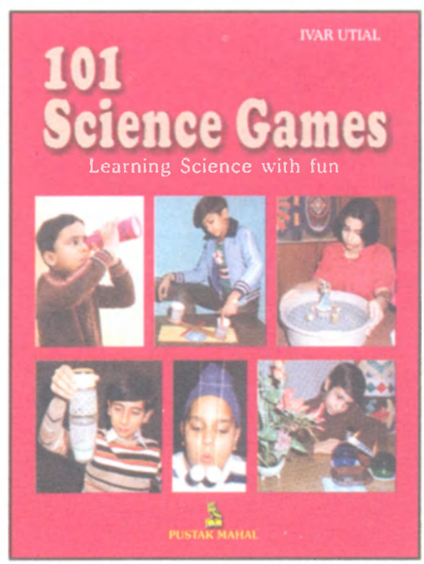

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