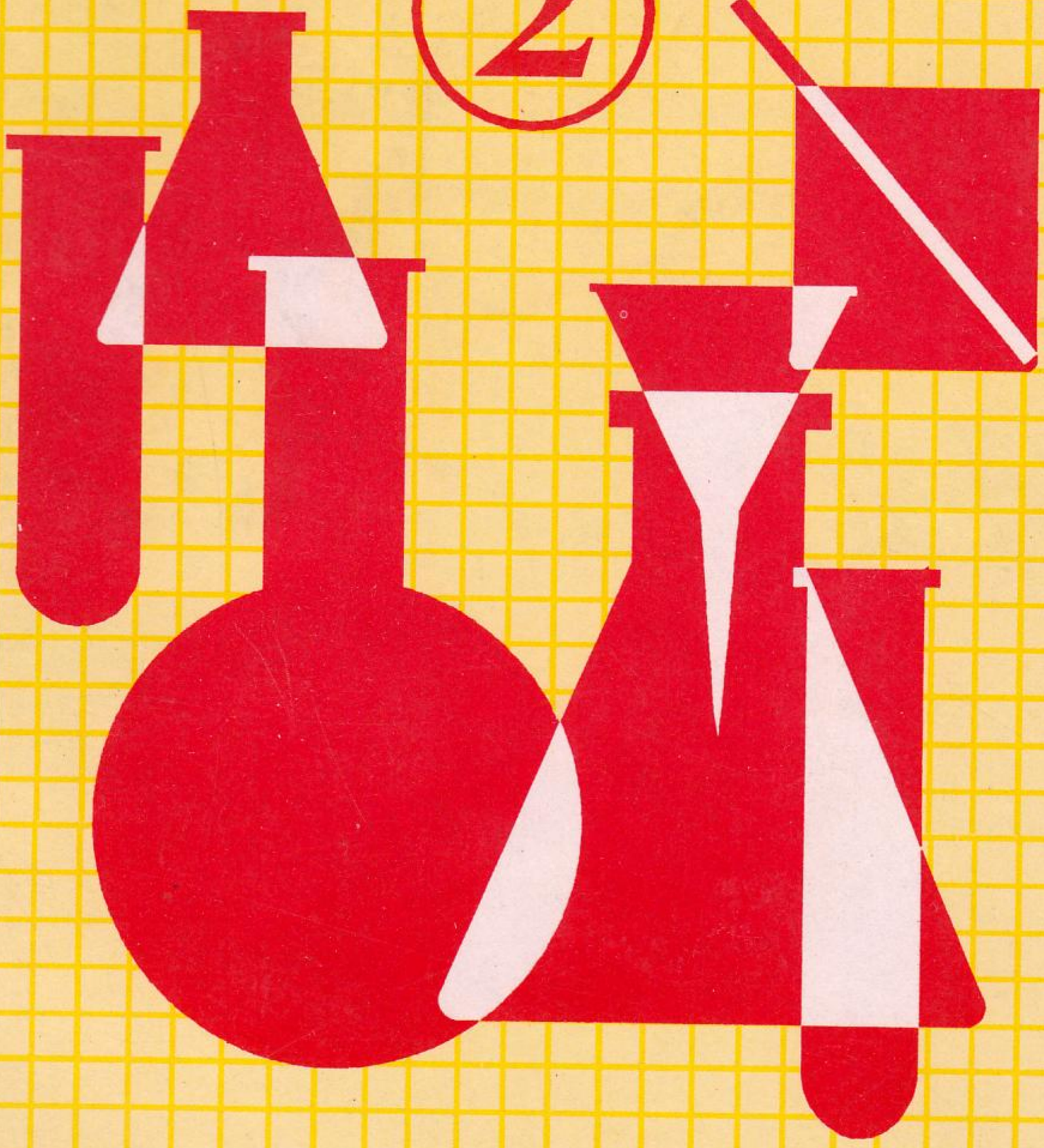
# Quest

## Learning Science By Doing

## 2



S. K. Bagchi

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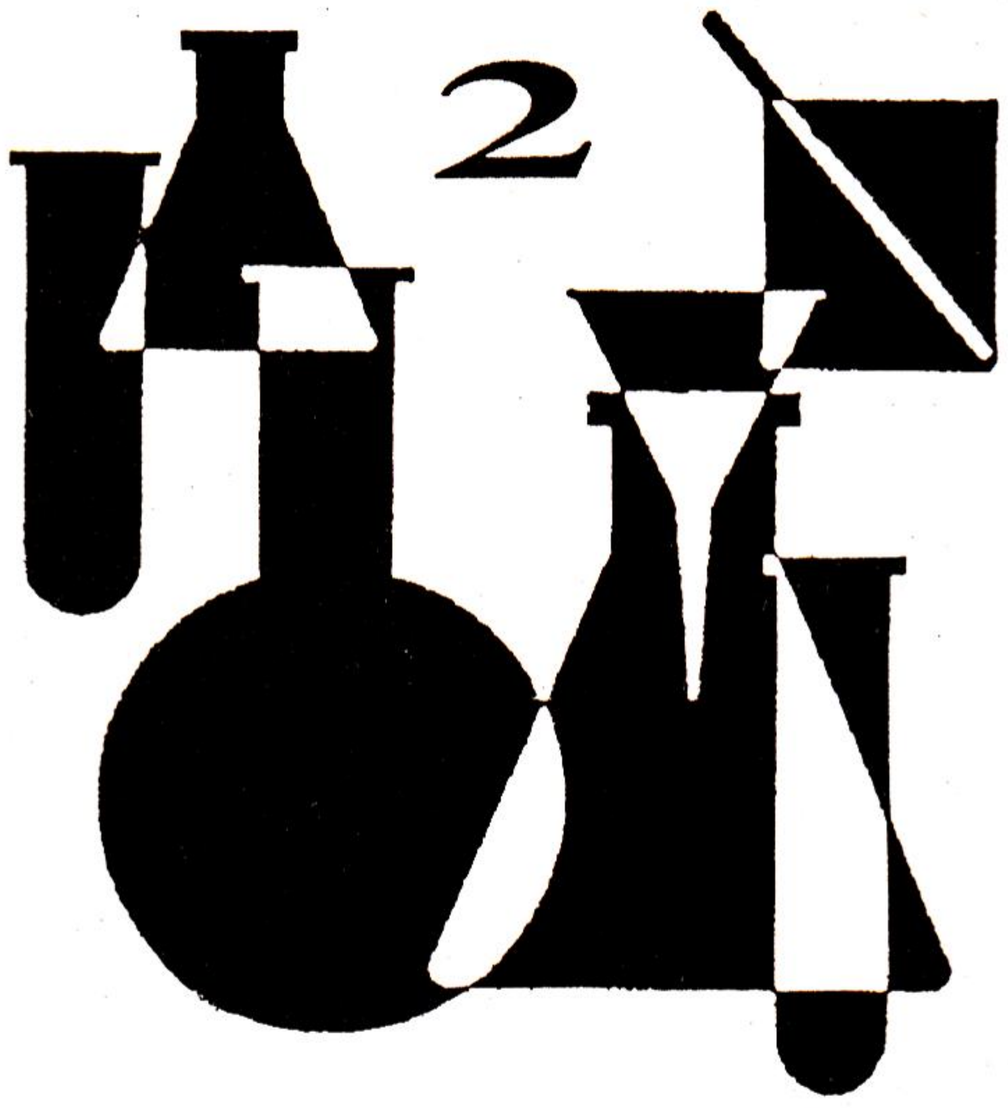

S. K. Bagchi

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**Calcutta**

Dedicated to those students — who enriched our understanding of science by their participation in the programme called 'Quest'.

–Author

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# Preface


Sri Samar Bagchi informs that out of the children that enroll themselves in the primary stage only twenty-three percent reach the high school stage. Again, only about five percent of them can become doctors, engineers and professionals in various humanistic disciplines. If anybody concludes from these facts that those who drop out lack intellect, it would be a gross mistake. Sri Bagchi would like to assert that it is the unsound educational system that is responsible for this tremendous wastage of human resources. The present system of memorizing facts and vomiting the same during the examination can never create interest among the students. According to Sri Bagchi, the educational system should be such that it is possible to develop fully the inner potential of each child. It is due to the lack of this approach that we are wasting so much of human resources.

The maximum neglect has been done in the field of science education from the primary to the higher secondary stage. In fact, the proper teaching method has never been adopted. Science education is destined to failure with rote learning. Many educationists have talked about this neglect, but nobody except Sri Samar Bagchi has thought about a well-planned infrastructure. His devotion is nonpareil. Taking premature retirement he has moved widely in different parts of West Bengal and India to gather information so that during the next few years of his active life he can materialize his vision of science teaching. He has mixed with the students and teachers intimately and has got to know their method of learning. He has tested his new ideas by the experiments devised by him and also demonstrated his experiments while lecturing on his method. This kind of interaction continued for quite a few years. This book is the result of his hard work and devotion. It is my firm conviction that this book will be a very valuable, information rich and thought-provoking one for those teachers who are striving to change the methodology of science teaching.

He has discussed time and again the need for training up efficient teachers. It is not an easy task. This book will be essential for this training. If one reads the book attentively and discusses with one's fellow teachers the experiments explained so elaborately here then one can get ahead towards a proper beginning.

Sri Samar Bagchi has accomplished a difficult task. It is my firm belief that the book will receive wide acclaim from the teachers of science and those who are engaged in the study of the methodology of science teaching.

This book is but an experiment. Nobody should hold the unscientific view that the directions given in the book are infallible and eternal. Rather, Sri Bagchi will be encouraged to modify and enlarge the book by criticisms, no matter how harsh these are. Every writer should keep his mind open. This is more applicable to the writers on science.

**Sushil Kumar Mukherjee**
Former Vice-Chancellor,
University of Calcutta.

# Introduction

At the threshold of the twenty-first century human civilisation faces a deep crisis. Earth's environment is threatened : vanishing forests, soil erosion, climatic changes, depletion of the ozone layer, spread of deserts, population explosion, extinction of bio-diversity etc. In different countries religious fundamentalism, regionalism, ethnic conflicts, terrorism and a terrible political and social turmoil are spreading their evil shadows. This ever-increasing crisis in the world reminds the writer of the prophetic lines of W.B.Yeats, "Things fall apart, the centre cannot hold, mere anarchy is loosed upon the world."

It has become amply clear that the type of education that goes on in the world today is creating three kinds of alienation. The first alienation is between man and nature. This creates the desire to conquer nature. That man is a part of nature is being forgotten by him. Tagore wrote the song, "The sky is full of the sun and stars, the universe pulsates with life. I have got my place amidst all that". Tagore established Santiniketan to overcome this alienation with nature and to provide a holistic education. Tagore wrote in one of his letters in "Bhanusingher Patrabali", "When the mind starts expanding, there is need for ample leisure around it. This leisure is present in the world of nature in abundance in a beautiful variegated way. The children can never flower healthily by attending the educational "deerhouse" at nine thirty or ten after somehow gulping their food. What joylessness has been created at the beginning of life by encircling education with walls, by gates, by generating with watchmen, by the thorns of punishment, and by chasing with the bells!.....If we cannot make education a joyous affair due to our own inability and barbarity, then why do we convert the innocent children's educational institutions to a prison wilfully and with great effort." The seeds of this alienation from nature was laid during the European renaisssance with the advent of the experimental philosophy of Francis Bacon. Bacon emphasised the idea of acquiring the "Fruits of Science". This resulted in the nature-conquering consumerist industrial economy of the western society. The philosophy that at one time freed man from the slavery of nature has now enslaved mankind through the worship of Mammon and consumerism in the post-Industrial-Revolution age and has destablised men's future by the destruction of nature. Man understands that he is digging his own grave; but he is not taking steps to establish a new socio-economic order by changing the society. The affluence of the 'Pillars of society' depends on the stability of the present socio-economic order. So the Latifundias of Brazil convert bio-diversity-rich tropical forests into grazing lands to profit from the export of meat. The same greed causes the disaffluence of the forests of Ayodhya hills of the Purulia district in West Bengal. Our educational and social system creates this alienation from nature.

The second kind of alienation that the present educational system breeds is that between the self and the others. This alienation creates a competitive and selfish mentality in a child. Alienation takes place between the child and its life and society. No sympathy and relationship grow with the people of the country and its soil. So, a doctor or an engineer trained by the country by spending lakhs of rupees can leave the country without bathing an eyelid to serve a foreign country. War and devastation that are going on in the world today is an expression of this alienation. Tagore has written about this alienation created by the educational system, "When we ponder over the fact that our education is not compatible with the way we are going to live our day to day life, that we do not acquire any higher ideal of society from the newly educated literature, that we do not directly meet with our parents — our dear friends and our brothers and sisters in it, then we understand that there is no real likelihood of a close unity between our life and education..... the shower of education falls far away from the place where lie the roots of our life." Rabindranath has further written, "It is not that we do not read books on ethnolgy. But when I observe that the study of those books does

not arouse in us any curiosity to know the full identity of those 'Rari','Dom', 'Kaibartya' and 'Bagi' who live near our homes, then only I can understand how much superstition has developed in us about books..... and realize how trivial are those whose reflections are the books ..... If our students enquire about these neighbours then there is no doubt that they will get the reward of their work in the work itself." The present educational system creates a discord between manual labour and intellectual work, between knowledge and work, and between the children and others. The education seperates him from the society. So, this education is self-contradictory. Tagore has expressed this alienation in superb language. He has written, "What we call education today had its origin in the cities. Commerce and service are its concomitants. This foreign educational system is like an island like a railway compartment. The compartment is bright with light, but the miles of road that the train covers remains in darkness. As if whole country pulsating with life is unreal." The so-called enlightened, the elite, the educated persons get alienated from the society and the masses.

The third alienation that the educational system breeds is the alienation with self. The dangerous menace of drugs is gradually gripping the youth. They suffer from mental breakdown. If the world has to get rid of this environment, the social and spiritual crisis, then a thorough change in the system of education is needed right from childhood. What will be the ideals of this new education ? The objectives of education should be :

a) Full realization of the inherent potentialities of a child. The American psychologist Howard Gardner in his well-researched book "Frames of Mind" has shown that a child is born with six dormant potentialities or mental abilities. They are : Linguistic, Logico-mathematical, Musical, Spatial, Bodily kalesthenic and Inter and intra-personal intelligence. The aim of education should be to develop these dormant potentials of a child. The present system of education mainly stresses the development of linguistic and logico-mathematical intelligence. This retards the possibility of the development of other abilities.

b) Creation of strong inquisitiveness in the child. If this is aroused, then the child will find its own way as it grows up.

c) Arousing curiosity and a desire to know.

d) Increasing the ability to observe.

e) Developing problem-solving and problem-facing skills.

f) Developing an analytical mind.

g) Developing concepts as opposed to rote learning.

h) Developing a harmonious relationship with nature.

i) Developing high moral and ethical values.

The complaint against the Indian educational system is that it is outdated. The present system of learning by rote and examination-oriented learning thwarts the blossoming of the individuality of the child. A small percentage of the large children population of the country that get the opportunity to enter into the portals of a school are overburdened with books. They are tired of memorization. They do not get the leisure to play, enquire, observe or enjoy. The pressure of memorization on the child increases with age. They are not encouraged to explore, to think independently and analyse the collected facts. Their rational attitude and imagination are not developed. These are essential qualities that have to be developed in a child to enable it to learn a subject. But it is imperative for learning science. Science means hands-on experiment to test the knowledge and understand a phenomenon. But in India experiment has vanished from the schools.

It seems astonishing that, even in the middle ages, learning through experimentation was given due importance in education. Ramchandra, a writer of thirteenth-fourteenth century in his chemical treatise 'Rasendrachintamani' has remarked,'Those are to be considered the real teachers who can verify by experiment

what they teach — those are to be regarded as landable disciples who can perform what they have learned — students and teachers other than these are mere actors on the stage". There is an

ancient Chinese proverb which says,"I read, I forget; I see, I remember; I do, I understand." This is perhaps the quintessence of all systems of learning.

The present educational system puts stress on teaching rather than on how a child learns. There have been numerous researches on how the faculty of imagination of a child can be sharpened by reasoning but very little of these have been implemented. The need of the day is to make education child-centred rather than teacher-centred. There are definite stage of development of the cognition of a child which is genetically determined. The famous Swiss educational psychologist Jean Piaget has shown that there are four distinct stages in the development of cognition in a child. They are :

0-2 years : Sensory motor stage : when the child cognises the outside world through the five senses only.

2-6 years : Pre-operational stage : When the child's focus is upon the immediate environment. The child is yet to form concepts.

7-11 years : Concrete operational stage : Thought is no longer dominated by perception alone. It is supplemented by mental action. However, thought is bound to the real world only. The reason for this is language. One thinks with the aid of language which forms the second signal system. As long as the vocabulary is not formed the normal flowering of thought process would not occur and the causal relationship will not be clear.

11-15 years : Formal operational stage : The child is able to think logically in abstract terms and can use reasoning for hypothetical situations.

Unless we are aware of the process of development of a child's cognition it is not possible for us to develop the infrastructure of education. It is a pity that the recent developments of educational psychology do not find a place in our teacher training courses. As direct experience is the cornerstone of science education, the teacher must have a proper grounding in child psychology.

The objectives of science education are :

a) To create inquisitiveness among the children about their environment and natural processes.

b) To generate the power of observation and to gather data about what he observes.

c) To record, organise and clarify the data and information in tables, histograms and graphs.

d) To make children keen observers so that they discover patterns and orders in such processes.

e) To analyse the available data so as to reach logically consistent and empirically valid conclusions or hypothesis.

f) To generate further information by experiment and activity.

g) To abstract such conclusions in order to arrive at 'Theories' or 'Models' so as to be able to predict phenomena.

The primary condition to realize the objectives is to provide the children with the opportunity to work with their own hands. The basis of this work is experimentation. There should be such opportunity in the school that every child can discover the process of nature and natural laws through experiments and activities in the classroom and outside. There is really no alternative to learning by doing. When a child himself discovers the solution to a problem there is no limit to his exhilaration and joy. If we are to provide the children with facilities in Indian schools, we have to arrange the following :

a) Use the environment around the school and house to learn science.

b) The equipment that will be used for the lessons has to be simple, cheap and available even in a village.

## The methodology

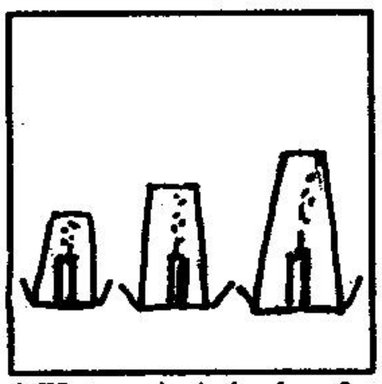
Attempt has to be made to cover the syllabus as much as possible through observation of nature and ex-

**Materials**
1. Three glass tumblers of different sizes
2. Three small birthday candles
3. Three saucers
4. A match box

**What to do ?**
1. Light the three candles and place them on three saucers.
2. Cover all of them simultaneously with the glasses.
3. Note the time upto which each candle burns before being extinguished.

**Students to Enquire**
1. Which candle is extinguished first and which one last ?
2. What was there in the glass before they covered the candles ?
3. Why does the candle stop burning under the glass ?

**The candle under glass-1**



4. What remains in the glass after the flame is extinguished ?
5. Why is the candle under the biggest glass extinguished last ?

**Explanation**
1. The candle under the small glass is extinguished first and the candle under the biggest glass last.
2. The glass contained air before they covered the candles.
3. Air or actually oxygen in the air is needed to sustain the burning of the candle. As the candle burns oxygen is consumed and carbon dioxide and water vapour are produced. Further, carbon dioxide inhibits burning. Hence, lack of oxygen and formation of carbon dioxide extinguish the flame.
4. After the flame is extinguished there remains nitrogen, carbon-dioxide, water vapour and some amount of oxygen.
5. The biggest glass has more oxygen. Hence, it is extinguished last.

perimentation. For every experiment an activity card has to be prepared. The card will contain the list of materials required for the activity, 'What is to be done' with those materials and what observations have to be made (see the figure).

The card also will contain a set of questions that may arise out of the observations made. The students will try to answer those questions in their exercise book based on their observation and world view. The model answers to the questions will be available in another card which may be kept with the teacher or in the library. The students will see the explanation card and correct their mistakes and clear their concepts. The teachers will be facilitators in this system. The experiments will be conducted in groups. After all the groups have completed all the activities in a set of ten or twelve experiments, the teacher will discuss with the students all the concepts arising out of the activities. This may take one or two periods. If necessary an activity may be repeated by the teacher.

**Arrangement of the classroom**

For science learning in a school no big science laboratory or gadgets are necessary. A small cupboard will contain materials and experiment cards needed for the experiment.

One of the students in the classroom has to be chosen as the science monitor. Before the class starts, the students have to be divided into 10-12 groups. Each group should not have more than 4-5 students. One or two students from the group will go to the cupboard to choose a card and collect the requisite materials for the experiment. Then the group will study the 'What to do' section of the card very carefully step by step. After they have understood what they have to do, they will perform the experiment step by step and observe what is going on. For the success of the experiment one should be very careful while conducting the experiment. A science experiment is like a work of art. After the experiment has been conducted all the students will answer the questions given in the section 'Students to enquire' according to their own understanding. After this, the students will take the explanation cards from the teacher or the library and correct themselves. A group can easily complete two experiments in a period. After all the groups have completed all the experiments the teacher will discuss the concepts, if necessary with experiments being repeated, which are inherent in the experiments.

**Grouping of experiments**

If there are 10 groups in a class, then at a time they will be conducting 10 different experiments. The whole syllabus has to be covered with 100 or 120 experiments and activity in the whole year. The total syllabus has to be broken up into 10 or 12 modules of experiments. Each module may contain 10-12 experiments from different chapters in the syllabus. This is necessary because the students have to proceed from the simpler to complex concepts in one chapter. Hence, one has to understand simpler concepts first and then perform experiments dealing with complex concepts in a chapter. Therefore, the first two or three sets of 10 experiments may contain experiments on topics like air, water and magnet whose contents are independent. Once all the topics of the chapters are completed then a new set of topics may be taken up from other chapters. In this way the whole syllabus may be covered with 100 or 120 experiments.

It is the firm conviction of the author that at least in the lower classes, i.e., upto Class VIII, science can be learnt in a more meaningful way, even in a village school, through experiment and activity . Everybody feels today that education in India needs a thorough clean up. But this is more important for learning science. And it is not difficult to do it.

**Samar Kumar Bagchi**
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Government of India

Calcutta
20.11.95

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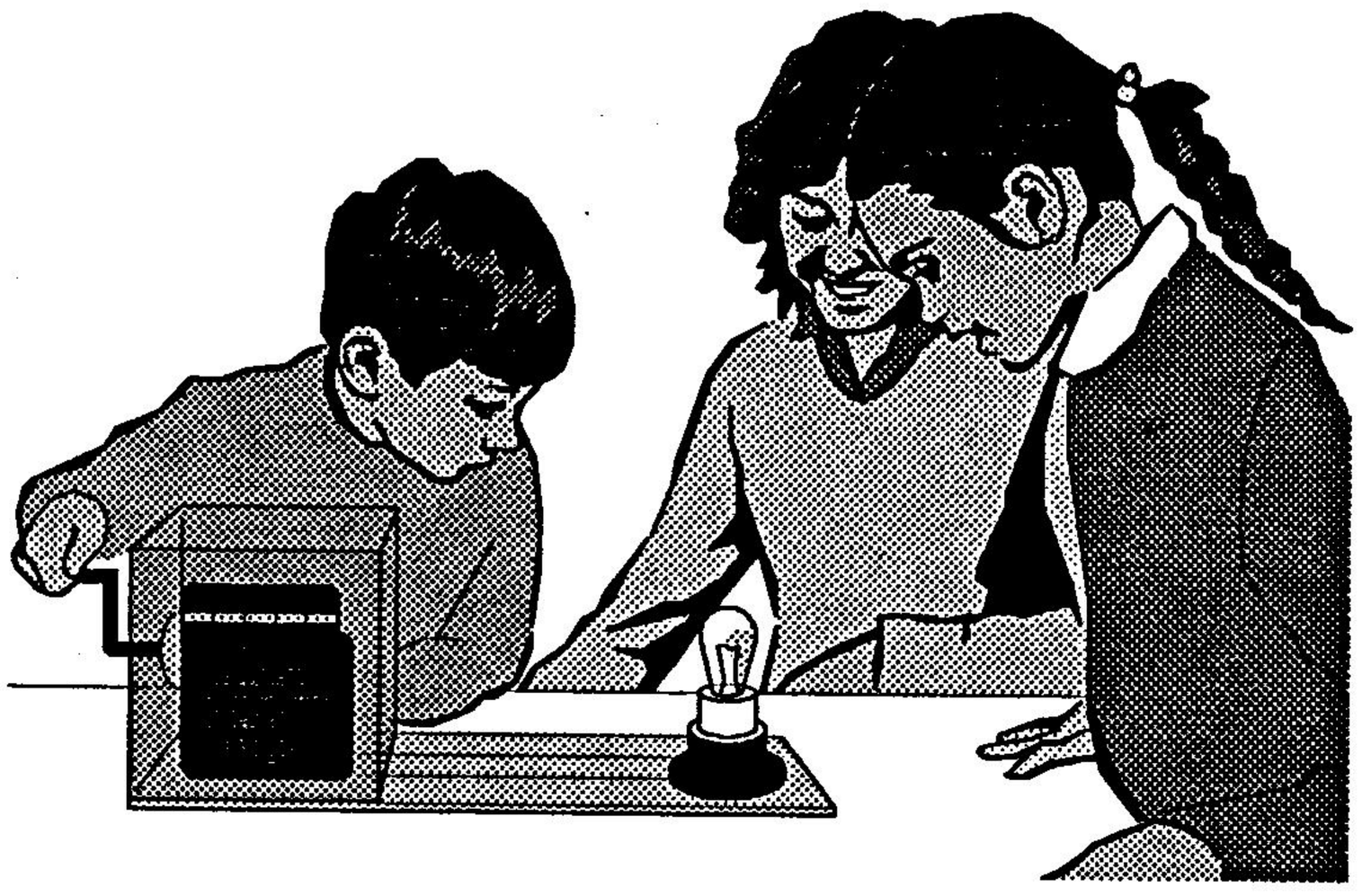


Air

Air occupies space

# Catch the air

1

## Materials

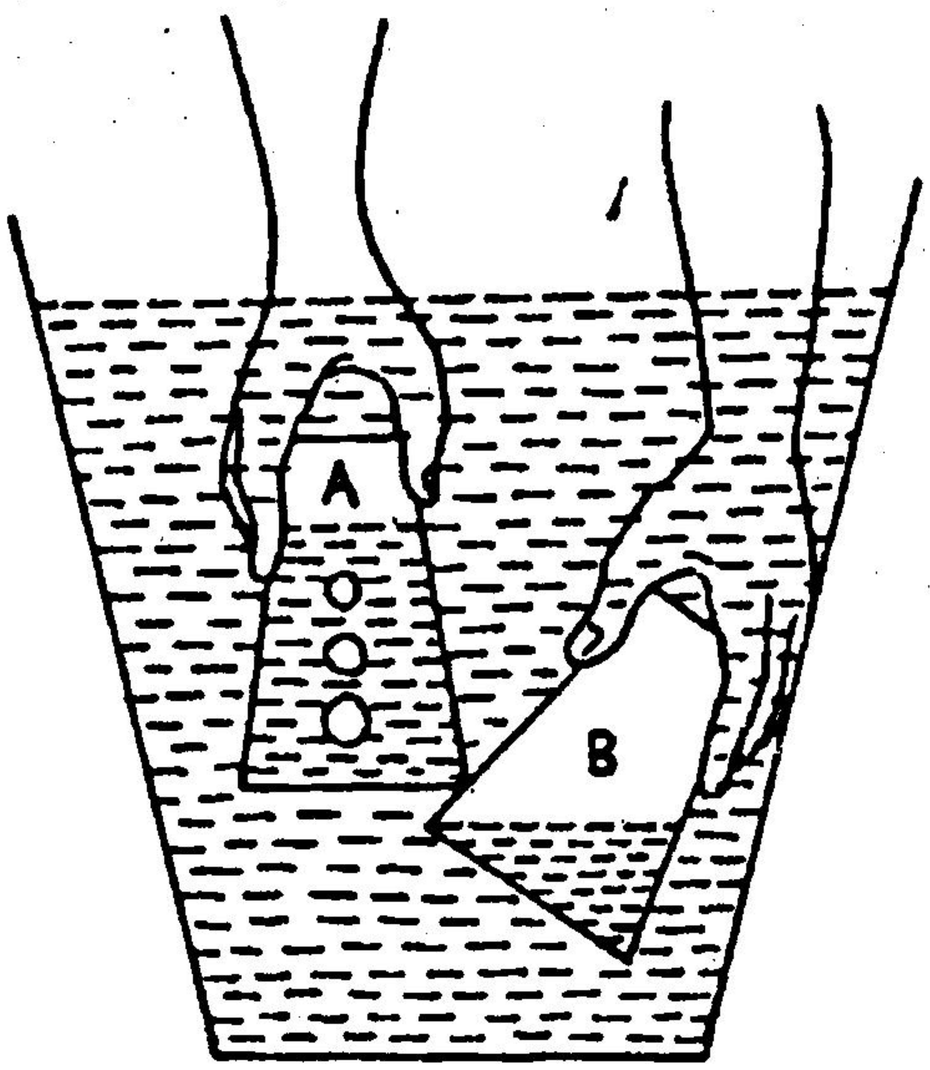
1. Two glass tumblers
2. A bucket of water

## What to do ?

1. Fill Glass A with water, dipping it into the water in the bucket. Observe that while you fill the glass with water, bubbles go up. Keep the glass vertically down as shown.
2. Take Glass B upside down vertically into the water below Glass A. Now tilt Glass B gently near the centre of Glass A. See that water enters into Glass B and bubbles enter into Glass A.
3. Observe that as the bubbles enter into Glass A the water level in it also goes down.
4. When Glass B is filled with water, all the water in Glass A also goes out. Take care that all the bubbles enter into Glass A.

## Students to enquire

1. What was there in Glass B before it was filled with water ?
2. What remains in Glass A when it is empty of water ?
3. Why do the bubbles go up and not down ?
4. Why did not water enter into Glass B when it was taken vertically down into the water?




## Explanation

1. There was air in Glass B before it was filled with water.
2. Air replaces the water in Glass A.
3. Bubbles are made of air. Their density is less than water. Hence they go up.
4. When Glass B is taken vertically down into the water, a little water enters into the glass and the air inside the glass is compressed. Hence its pressure increases. Because of this, water cannot enter into the glass.

2

# Who holds the water

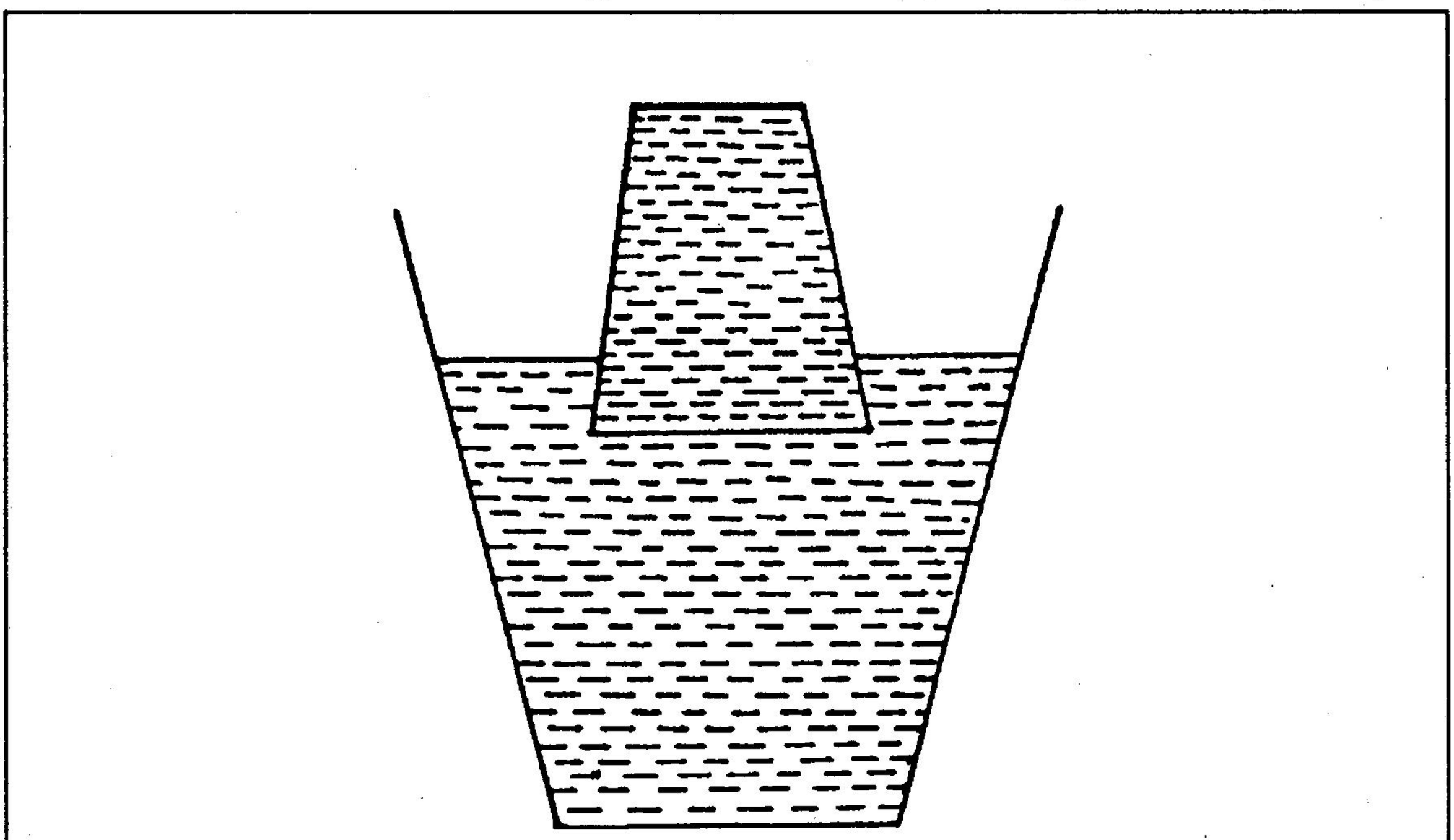
Air
Air pressure

## Materials

1. A glass tumbler
2. Water in a bucket

## What to do ?

1. Fill the glass with water to the brim.
2. Put the glass in the bucket of water in such a way that only the mouth of the glass is inside the water as shown in the figure.



3. You will observe that the water in the glass does not flow down to the bucket.
4. Now take the glass gently up so that the rim of the glass is just above water.
5. You will observe that bubbles come up through the water.

## Students to enquire

1. What keeps the water up in the glass ?
2. What are the bubbles made of ?
3. Why do the bubbles go up ?

## Explanation

1. Atmospheric pressure acts on the water in the bucket. This pressure holds the water up in the glass. Atmospheric pressure can hold a 34 feet high water column up.
2. The bubbles are made of air.
3. As bubbles are less dense than water, they move up.

Air

Air occupies space

# Filling the bottle with water

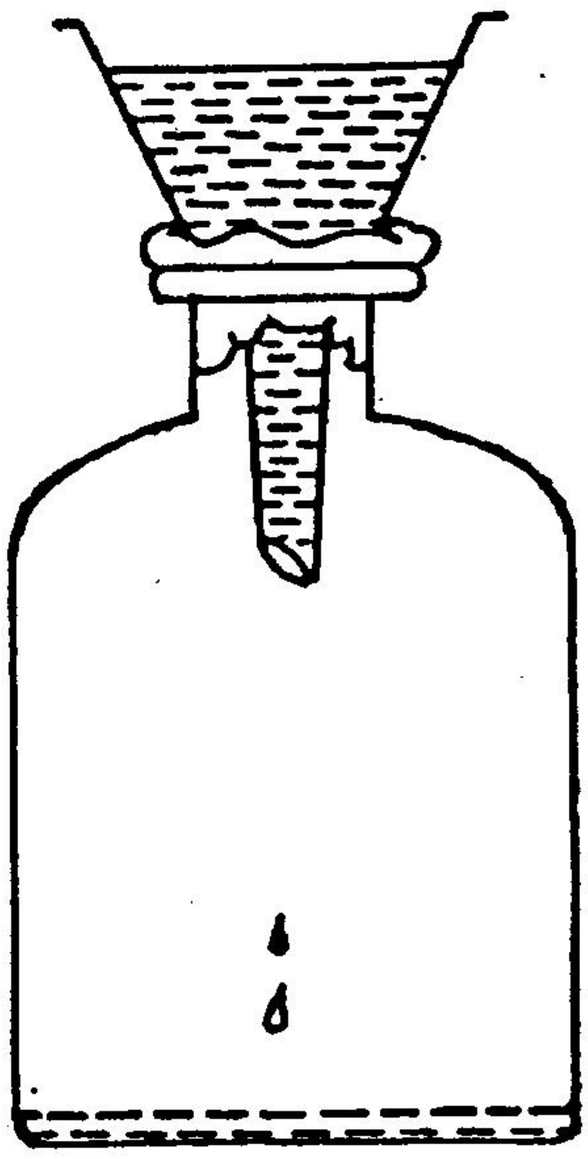
3

## Materials

1. A transparent bottle
2. A funnel
3. Flour dough

## What to do ?

1. Place the funnel on the bottle and fill the bottle with water. Observe that water enters the bottle.
2. Empty the bottle. Place the funnel again and put the dough in the space between the funnel stem and the bottle mouth in such a way that air can not go inside the bottle or come out.
3. Now, try to fill the bottle with water. You will observe that after a little water has gone in, no more water goes in.
4. Make a hole in the dough. Observe that water starts filling again into the bottle.



## Students to enquire

1. What was there in the bottle before it was filled with water ?
2. At first water entered, but when the dough was put in the mouth of the bottle, why did not water enter into the bottle ?
3. Why did water enter into the bottle when a hole was made in the dough ?

## Explanation

1. There was air in the bottle before it was filled with water.
2. When water was poured without the dough the inside of the bottle was connected with the outside. Hence, when water filled up the bottle, the air could come out of the bottle. But when dough was put, the air could not come out. After a little water had entered the bottle, the air inside the bottle got compressed and the pressure increased. This increased pressure did not allow anymore water to enter.
3. When a hole was made in the dough, a connection was made between the outside and the inside of the bottle. Hence, as water entered, air could escape.

4

# Keep paper dry under water

Air

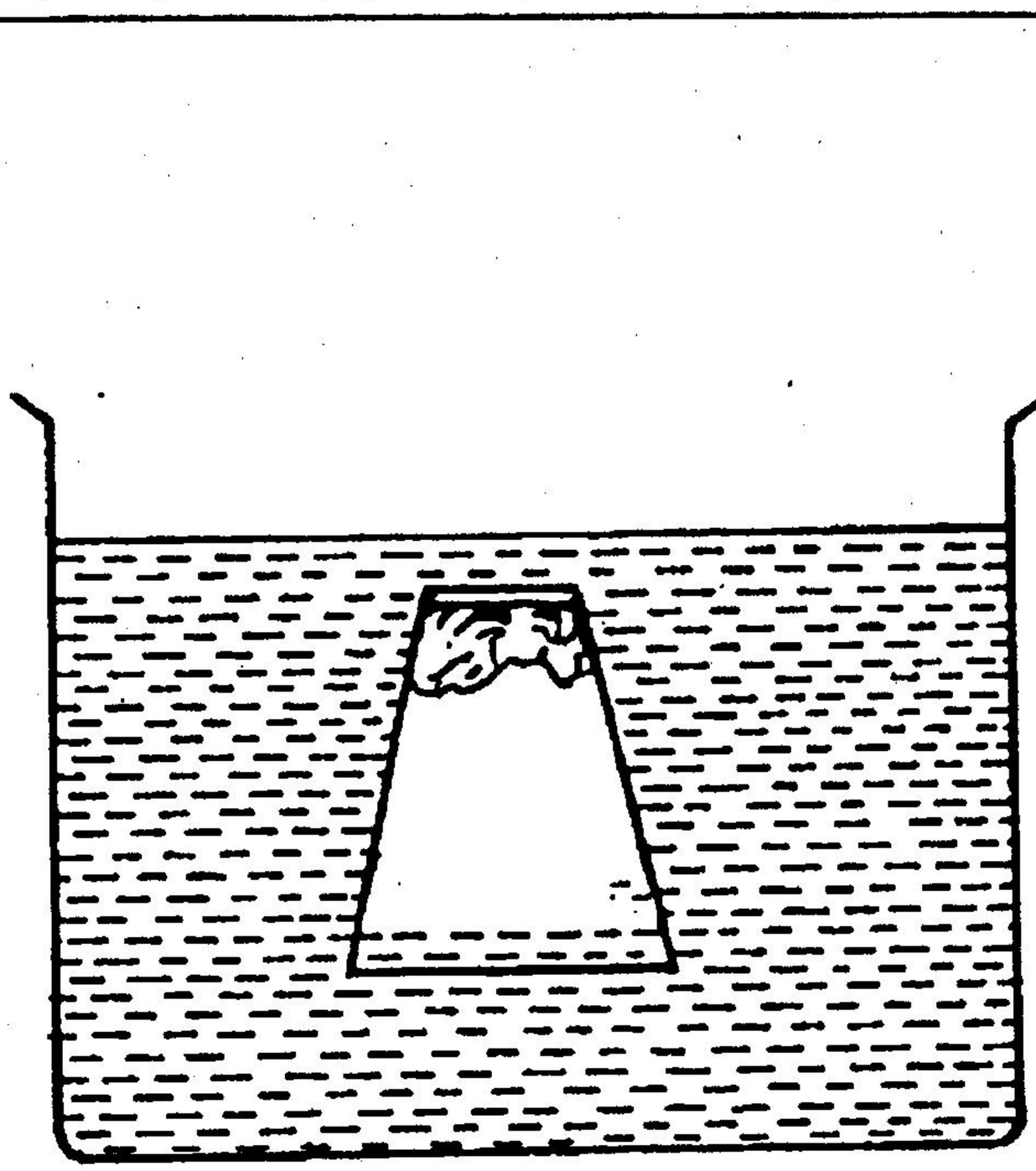
Air occupies space

## Materials

1. A dry glass tumbler
2. A plastic bucket with water
3. A newspaper (old)

## What to do ?

1. Crumple a piece of paper and place it at the bottom of the dry glass so that it sticks to the bottom.
2. Invert the glass making sure that the paper sticks to the glass and immerse the glass inside water holding it as vertically as possible. Take the glass to the bottom of the bucket.
3. Now take the glass out vertically up keeping it inverted. Take the paper out.
4. See that the paper remains dry.



## Students to enquire

1. What was there in the glass before introducing the paper ?
2. When you try to fill a glass with water why the air bubbles rise and do not sink ?
3. When you immerse the glass in water why does not the paper get wet ?

## Explanation

1. There was air in the glass before introducing the paper.
2. As an air bubble is less dense than water, it rises up and does not sink.
3. When the glass is immersed in water, a little water enters the glass & the air inside is compressed. The pressure increases. No water can then enter further into the glass. Hence the paper remains dry.

Air

Combustion requires air

# The candle under glass -1

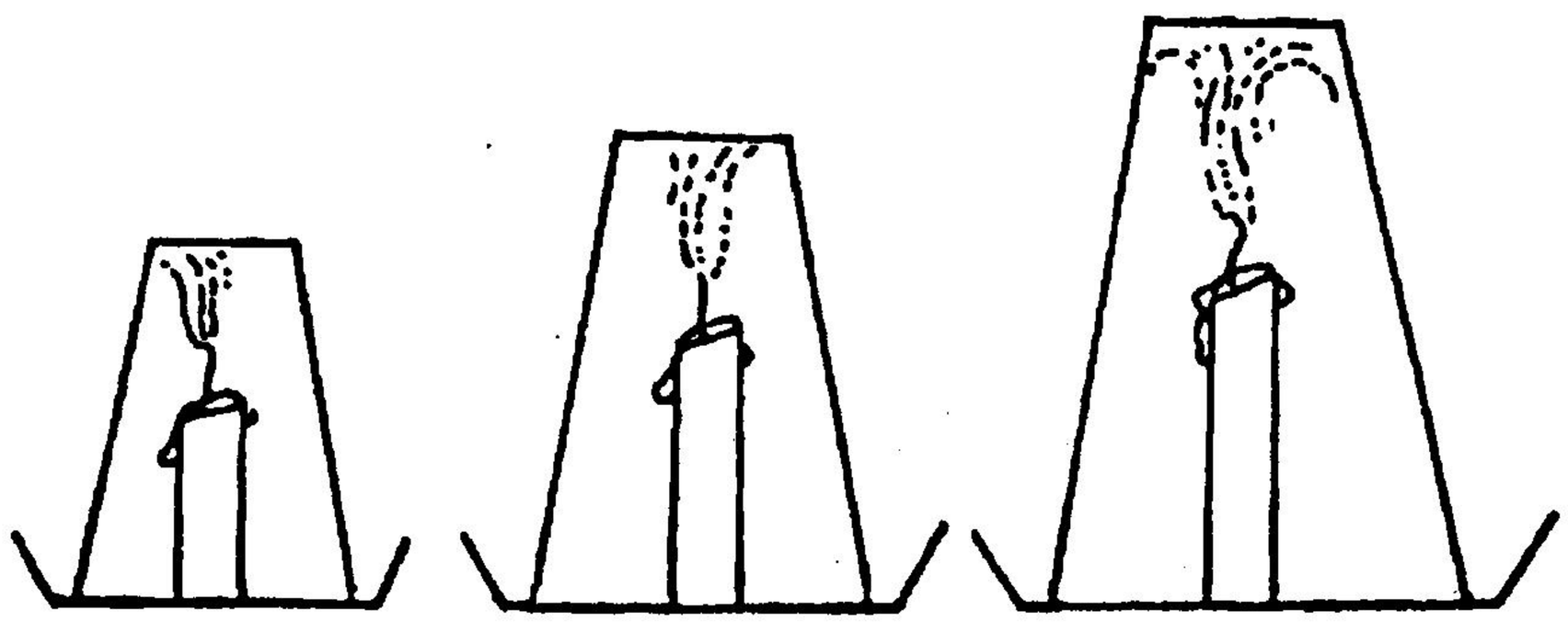
5

## Materials

1. Three glass tumblers of different sizes
2. Three small birthday candles
3. Three saucers
4. A match box

## What to do ?

1. Light the three candles and place them on three saucers.
2. Cover all of them simultaneously with the glasses.



3. Note the time upto which each candle burns before being extinguished.

## Students to Enquire

1. Which candle is extinguished first and which one last ?
2. What was there in the glass before they covered the candles ?
3. Why does the candle stop burning under the glass ?
4. What remains in the glass after the flame is extinguished ?
5. Why is the candle under the biggest glass extinguished last ?

## Explanation

1. The candle under the small glass is extinguished first and the candle under the biggest glass last.
2. The glass contained air before they covered the candles.
3. Air or actually oxygen in the air is needed to sustain the burning of the candle. As the candle burns oxygen is consumed and carbon dioxide and water vapour are produced. Further, carbon dioxide inhibits burning. Hence, lack of oxygen and formation of carbon dioxide extinguish the flame.
4. After the flame is extinguished there remains nitrogen,carbon dioxide, water vapour and some amount of oxygen.
5. The biggest glass has more oxygen. Hence, it is extinguished last.

# 6 The candle under glass -2

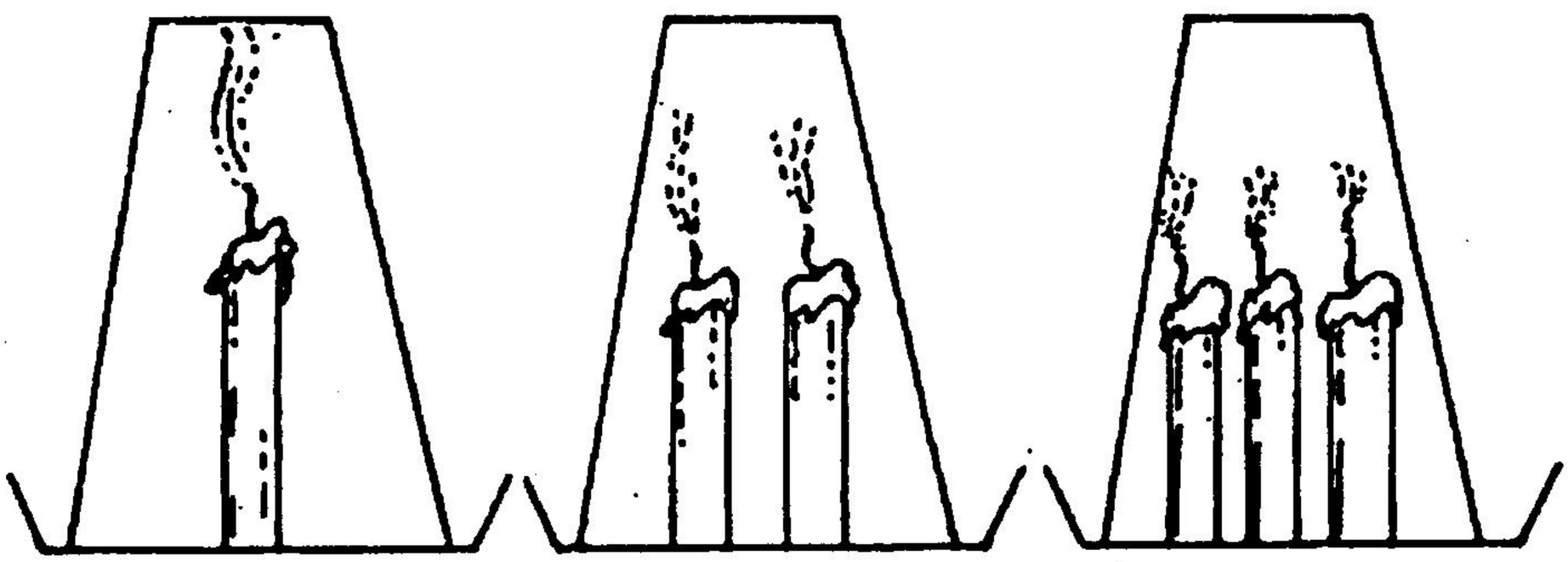
**Air**
**Combustion requires air**

## Materials

1. Three glass tumblers
2. Six birthday candles
3. Three saucers
4. Matches

## What to do ?

1. Light the candles. Place them on the saucers as shown in the diagram.



2. Cover all the burning candles simultaneously with the three glasses. Three children can do it on command from one.
3. Note which one goes out first.

## Students to enquire

1. Which of the candles stopped burning first and which one last ?
2. Why is it that the three candles inside the third glass got extinguished first ?

## Explanation

1. The glass covering three candles got extinguished first and that covering one candle, last.
2. Candles require oxygen to burn .The more the candles burn the more is the consumption of oxygen i.e. the rate of consumption of oxygen is highest in the glass with 3 candles and the least in that with one candle. Hence the three candles inside the third glass got extinguished first. Remember that there was no fresh supply of oxygen as air could not enter the glasses.

Air
Air Pressure

# Sucking of a balloon

7

## Materials

1. 150 c.c. — 200 c.c. conical flask
2. A balloon.
3. Heater.

## What to do ?

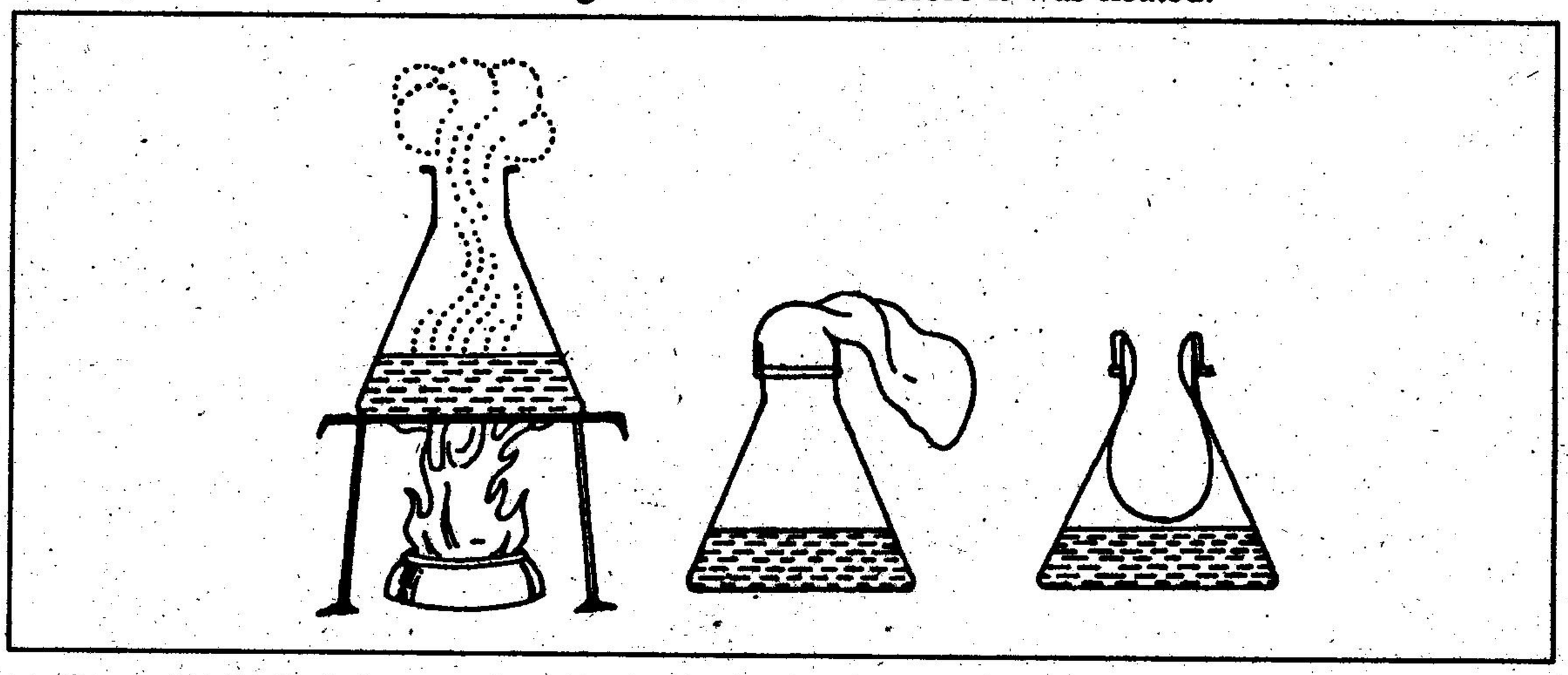
1. Take a little water in the flask and heat it.
2. When the water has been boiling for some time, take the flask down and attach a balloon to the mouth of the flask.
3. Allow the flask to cool. You may sprinkle some cold water on the flask. You will observe that after a little while, the balloon will be sucked inside the flask and the balloon will inflate by itself.

## Students to enquire

1. What was there in the flask besides water before it was heated ?
2. When water boils what is formed ?
3. When steam comes out what happens to the air inside the flask ?
4. Why did the balloon get sucked inside the flask ?
5. Why did the balloon get inflated by itself ?

## Explanation

1. There was air inside the flask besides water before it was heated.



2. Steam is formed when water starts boiling.
3. When steam is formed it drives out the air from inside the flask.
4. When the flask got cooled, the steam inside the flask was converted into water. Because of this, there was partial vacuum inside the flask. Hence, the balloon was sucked inside the flask.
5. There was partial vacuum inside the flask but normal air pressure inside the balloon. This pressure difference caused the balloon to inflate.

# 8 Who can win the drinking race

Air
Air pressure

## Material

1. Two glasses
2. Two straws

## What to do ?

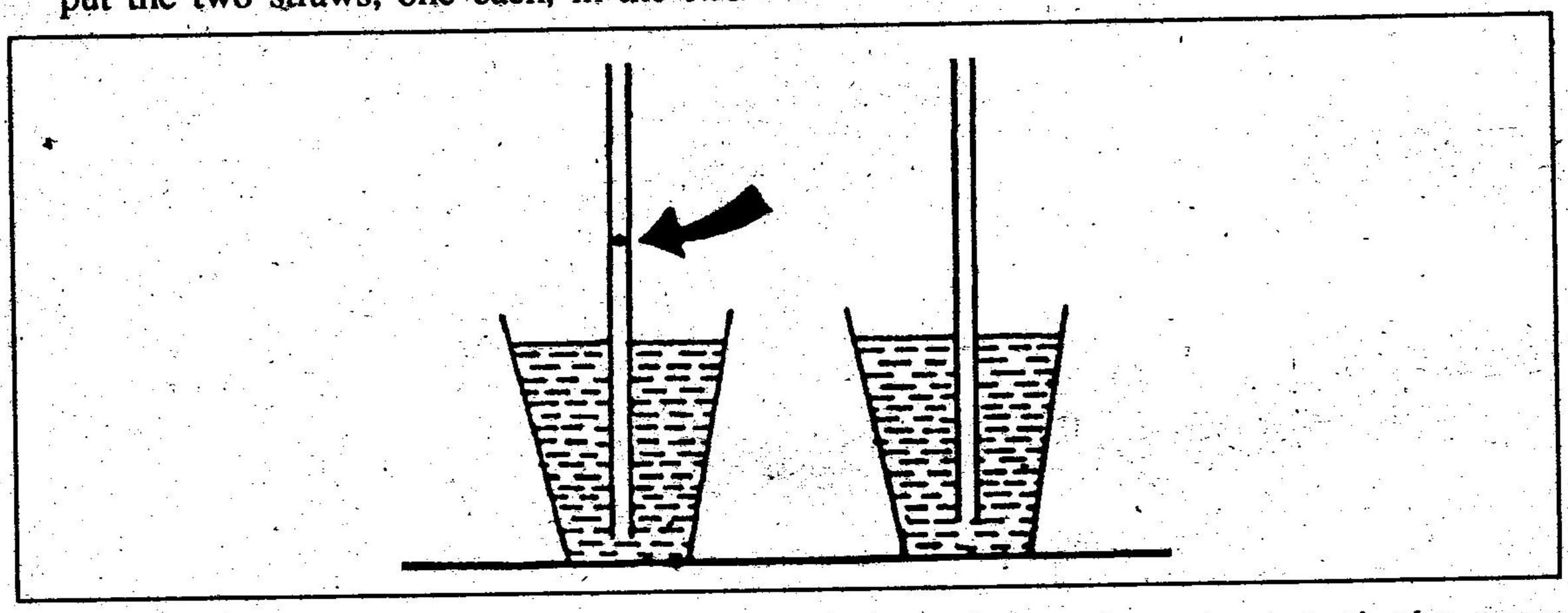
1. Make a hole or a cut below the end of one of the straws.
2. Take drinking water in the two glasses and put the two straws, one each, in the two glasses. The end of the straw which has the hole should be above water.
3. Let two students try to drink water from the glasses with the straws.
4. You will observe that the student who is using the straw with the hole cannot drink water, but the other one can drink water very easily.

## Students to enquire

1. What is there in the straw between the top of water and the top of straw ?
2. What happens when you suck through the straw ?
3. What is the driving pressure that forces the water up the straw ?
4. Why can you not drink water by the straw that has a hole ?

## Explanation

1. There is air in the straw between the top of water and the top of straw.
2. When sucked, a partial vacuum is created in the space above the water in the straw.
3. The difference between the atmospheric pressure on the surface of water in the glass and the reduced pressure inside the straw causes the water to rise in the straw.
4. In the straw with a hole the partial vacuum cannot be created by sucking as the inside of the straw is always connected with the outside atmosphere. Hence, there is no pressure difference to force the water up.



Air

Air pressure

# What pushes the water up-1

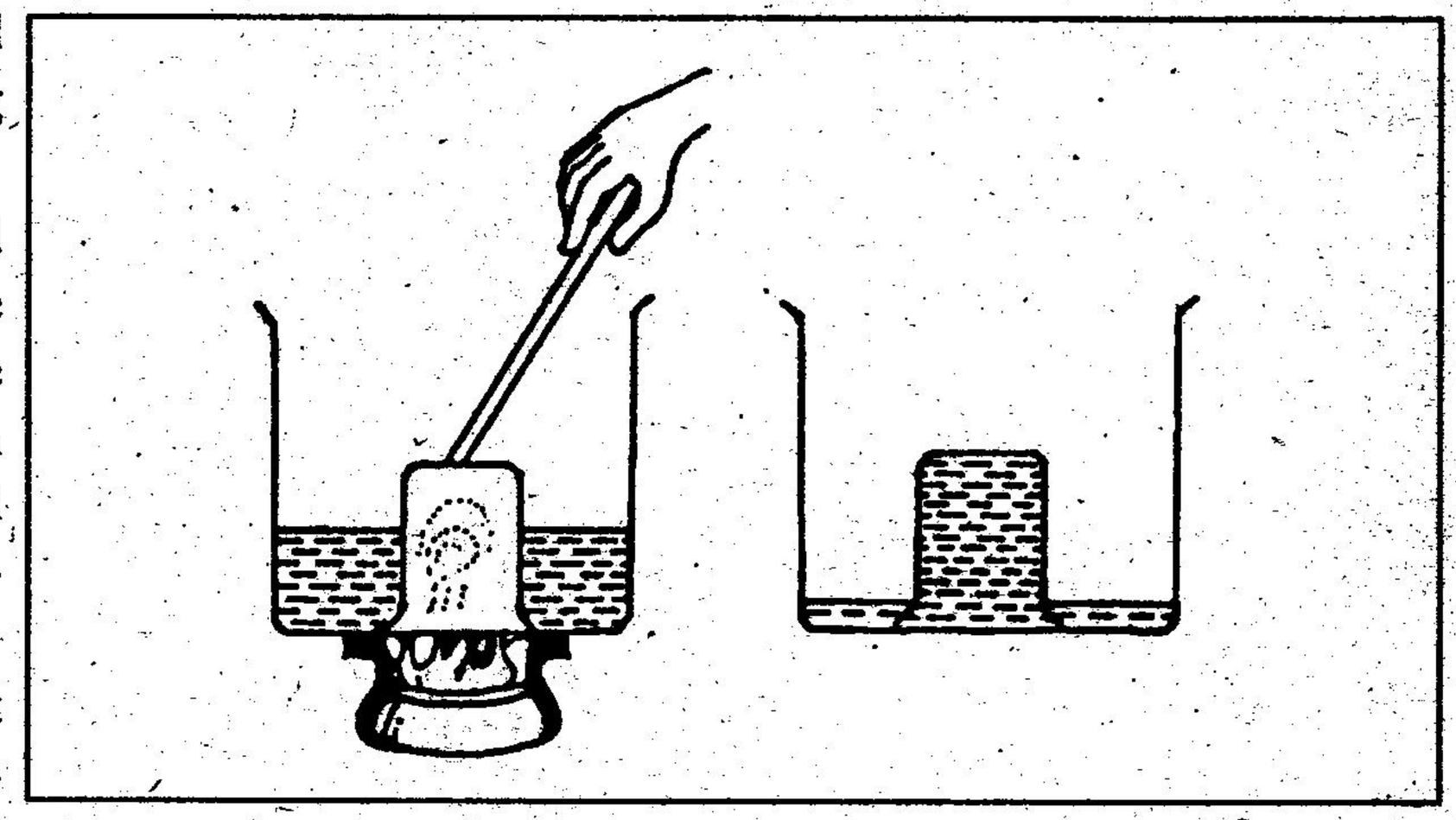
9

## Materials

1. A large beaker (500 c.c.)
2. A small beaker (100 c.c.)
3. Heater
4. A stick

## What to do ?

1. Take water in the big beaker and heat the beaker. Invert the small beaker, place it in the bigger beaker and hold it there by pressing it down with a stick.
2. After the water has boiled for some time, remove the heater and allow the small beaker to cool .You may sprinkle some cold water on the small beaker.
3. You will observe that water gushes upwards inside the beaker and fills it.



## Students to enquire

1. What was there in the small beaker before it was heated ?
2. When water in the big beaker boils, what happens inside the small beaker ?
3. When the water starts boiling, why do the bubbles come out ?
4. What are the bubbles made of ?
5. Why does the water gush into the small beaker ?
6. What difference will it make if iced water is poured on the small beaker ?

## Explanation

1. There was air inside the small beaker before it was heated.
2. When the water is heated, steam accumulates inside the small beaker.
3. When water boils, the air inside the small beaker, gets heated and expands. This increases the pressure inside the small beaker, and, when this pressure becomes higher than the outside atmospheric pressure, the heated air from the small beaker bubbles out.
4. Bubbles are made of air.
5. When the heater is taken away, the small beaker cools, the steam inside the small beaker condenses and the air inside contracts. Thus, the pressure inside the small beaker drops. Outside atmospheric pressure forces the water from the big beaker to gush in.
6. If iced water is poured, then water will fill the small beaker more quickly.0

10

# What Pushes the water up -2

Air
Air pressure

## Materials

1. Test tube and test tube holder
2. A glass of water
3. Heater

## What to do ?

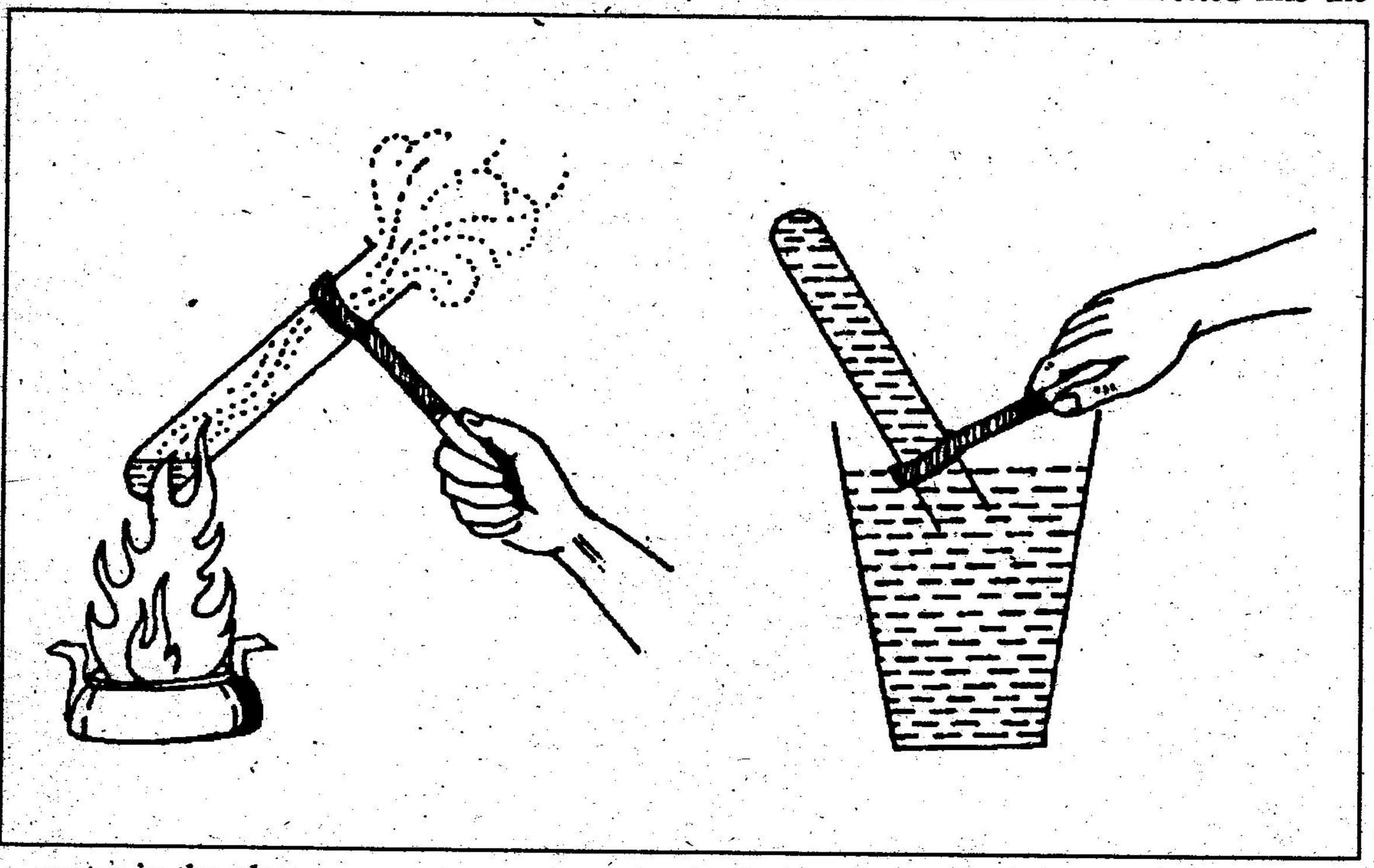
1. Boil a little water in the test tube. When the water has boiled for 10-15 seconds, quickly invert the test tube and introduce it into the water in the glass.
2. You will observe that after a while water will fill it slowly.

## Students to enquire

1. What was there in the test tube before the water was boiled ?
2. What was there in the test tube after the water started boiling ?
3. Why did the water fill the test tube ?

## Explanation

1. There was air in the test tube besides water.
2. After the water started boiling the steam displaced the air in the test tube.
3. When the test tube was inverted into the water, the trapped steam got cooled and was converted into water. This created a partial vacuum inside the test tube. Outside atmospheric pressure acting on the water in the glass forced the water up into the test tube.



Air
Air pressure

# Glass sticks to palm

11

## Materials

1. A glass tumbler (small mouthed)
2. A piece of paper and matches

## What to do ?

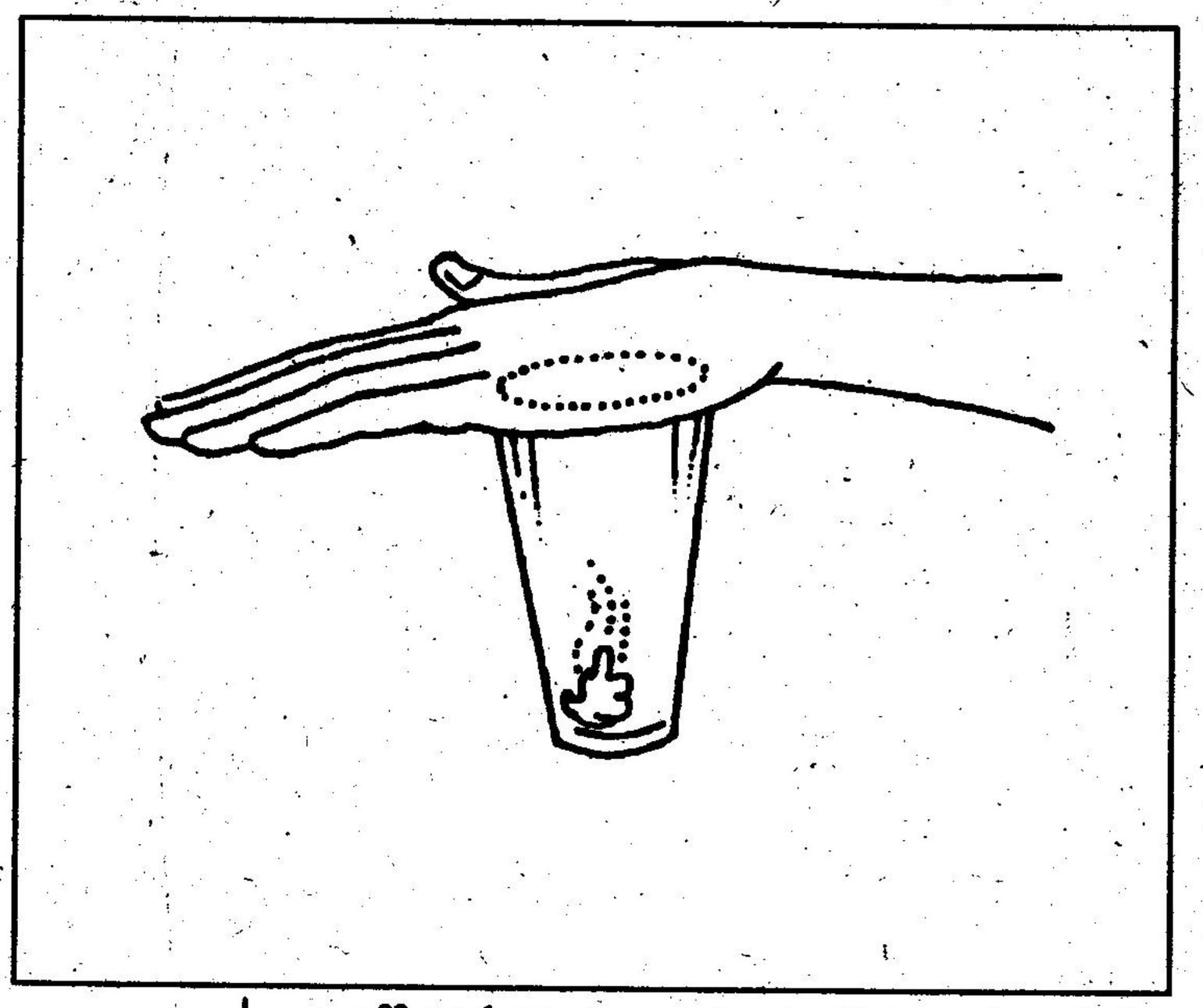
1. Take a small piece of paper.
2. Light the paper by striking a match and place it inside the glass. When the flame is about to be extinguished, place your palm tightly on the mouth of the glass so that air may not go inside the glass. Keep it pressed till you feel some suction on your palm.
3. Now raise your hand and you will find that the glass sticks to your palm.

## Students to enquire

1. What was there in the glass before the paper was burnt ?
2. Why did the flame inside the glass go out ?
3. What did the heat of the flame do to the air inside the glass ?
4. What was left inside the glass after the flame went out ?
5. What made the glass stick to the palm ?

## Explanation

1. There was air inside the glass before the burning paper was put inside the glass.
2. When the paper was burnt, carbon dioxide was produced and oxygen was consumed. So when you placed your palm over the glass, supply of oxygen was cut and the flame was extinguished.
3. By placing the burning piece of paper in the glass, the air inside the glass was heated and expanded. The expansion made the air rush out of the glass. The extinction of the flame caused the air inside the glass to cool



off and so to contract. This reduced the pressure inside the glass and the palm of the hand was sucked in. In other words, a partial vacuum was created inside the glass which made the glass stick to the palm.
4. When the flame went off there was nitrogen, carbon dioxide, water vapour and some amount of oxygen.
5. It was the partial vacuum inside the glass that made the glass stick to the palm.

# 12 Blowing up of a balloon

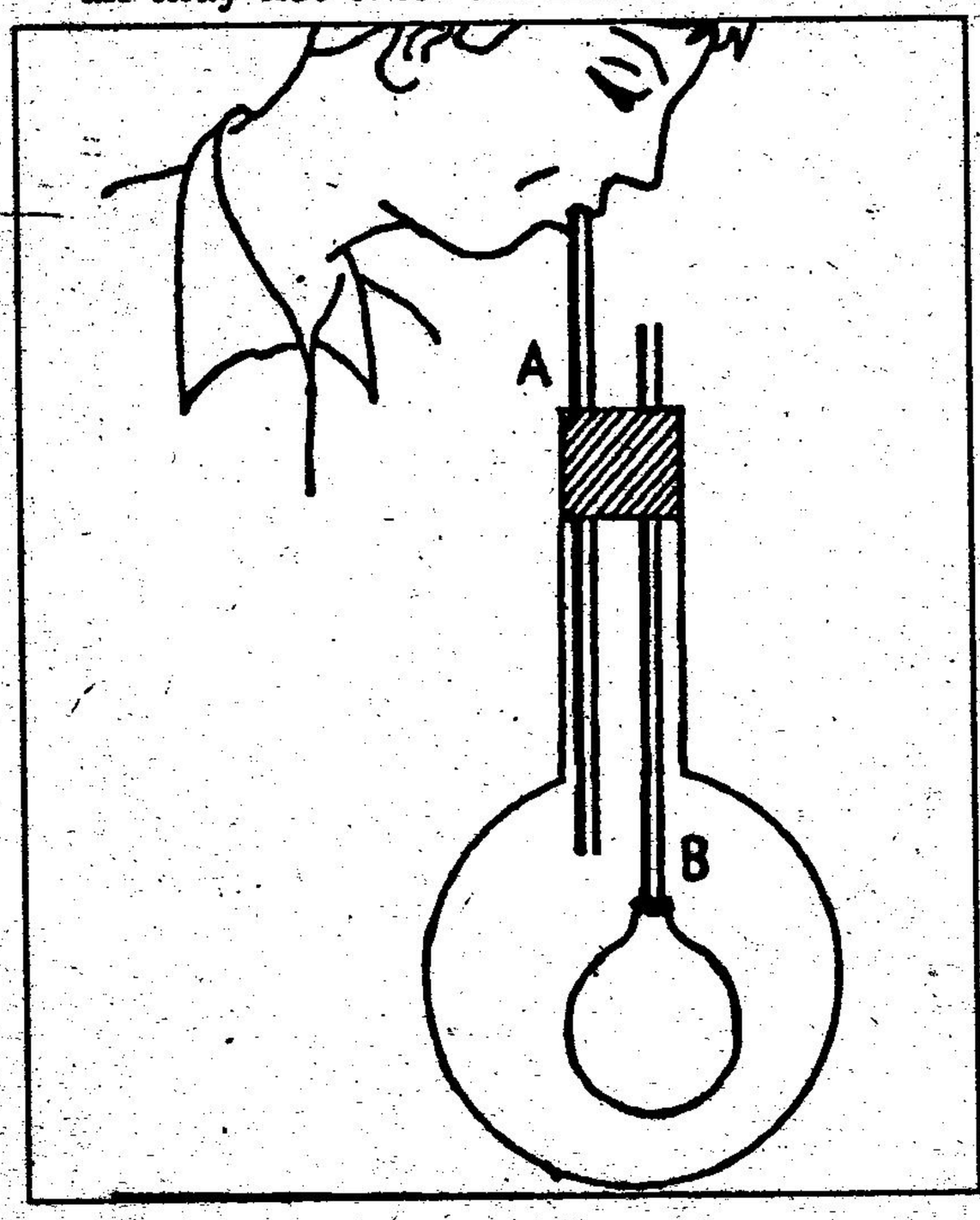
Air
Air pressure

## Materials

1. A flask with two holed rubber stopper through which two tubes pass
2. A balloon is tied at the end of one of the tubes

## What to do ?

1. Fix the stopper with the tubes tightly so that air may not enter the flask.




2. Try to suck the air out through Tube A. You will observe that the balloon attached to Tube B gets inflated. As long as you keep the mouth of Tube A closed, the balloon remains inflated.
3. Now close the mouth of Tube B with your finger and try to suck the air out through Tube A. Notice that the balloon does not inflate.
4. If you blow through Tube A or suck through Tube B, the balloon gets more deflated.

## Students to enquire

1. When you suck air out through Tube A, what happens to the air pressure inside the flask ?
2. Why does the balloon inflate ?
3. Why can not you inflate the balloon if you keep Tube B closed ?
4. If you blow through Tube A or suck through Tube B, why does the balloon deflate more?

## Explanation

1. When you suck air out through Tube A, the pressure inside the flask drops and there is a partial vacuum.
2. There is normal atmospheric pressure inside the balloon. But there is a partial vacuum outside the balloon inside the flask. Hence, the balloon inflates.
3. When you close the Tube B and try to inflate the balloon by sucking through Tube A air can not enter through Tube B. Owing to this the balloon does not inflate.
4. When you blow through Tube A the pressure inside the flask increases. For this, the balloon deflates further. Again, when you suck through Tube B, the pressure inside the balloon is reduced. There is normal atmospheric pressure inside the flask. Owing to this, the balloon deflates.

Air
Air pressure

# Water that does not fall - 1

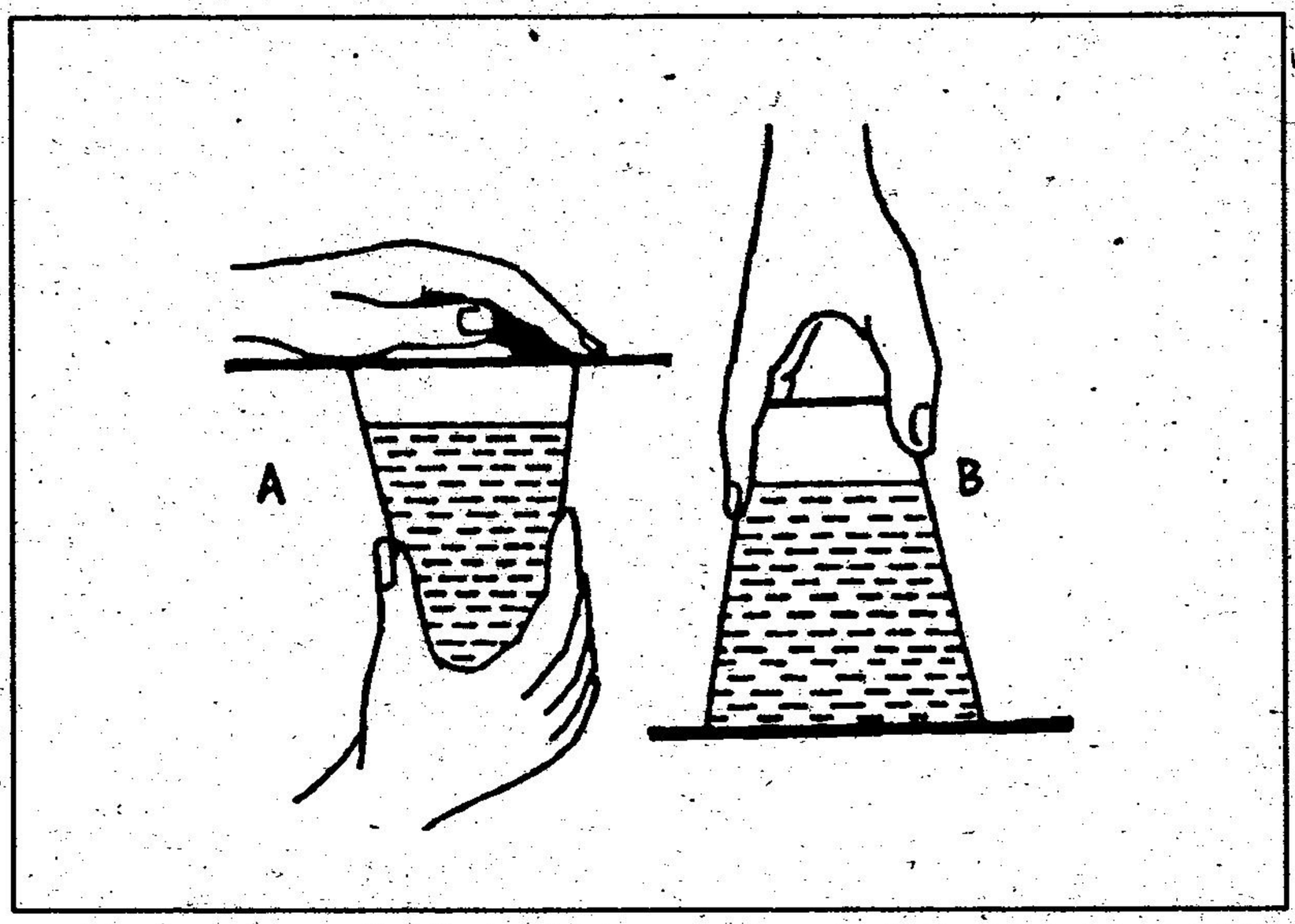
13

## Materials

1. A transparent glass
2. A card

## What to do ?

1. Take any amount of water in the glass.
2. Place a card on the glass as in fig.A.
3. Hold the card with one hand and invert the glass. Keep a container below the glass to catch any water that may fall. The card should be held tightly. The hand holding the card should be dry.
4. Take the hand that was holding the card slowly away .Water will not fall.
5. Vary the quantity of water in the glass and repeat the experiment. Water will not fall.




## Students to enquire

1. Why should the paper be rather stiff ?
2. Why do we have to make sure that the hand holding the card on the glass should be dry. What will a wet hand do ?
3. What is keeping the water in the inverted glass ?
4. Can we hold the glass slanted without letting water pour out ?

## Explanation

1. If the card is not strong, the paper may crumble and water may fall.
2. If the hand is wet, then it may stick to the card and the card may come out when the hand is removed from under the card. Hence the card and hand both should be dry.
3. When the hand is removed from below the card, it comes down a little due to the weight of water. Owing to this, the trapped air inside the glass expands and the pressure is reduced. There is upward atmospheric pressure on the card. This pressure balances the downward pressure of the trapped air and that of water. Owing to this the card does not fall.
4. The water does not fall when the glass is turned in different directions. This shows that air exerts pressure from all directions.

# 14 Water that does not fall - 2

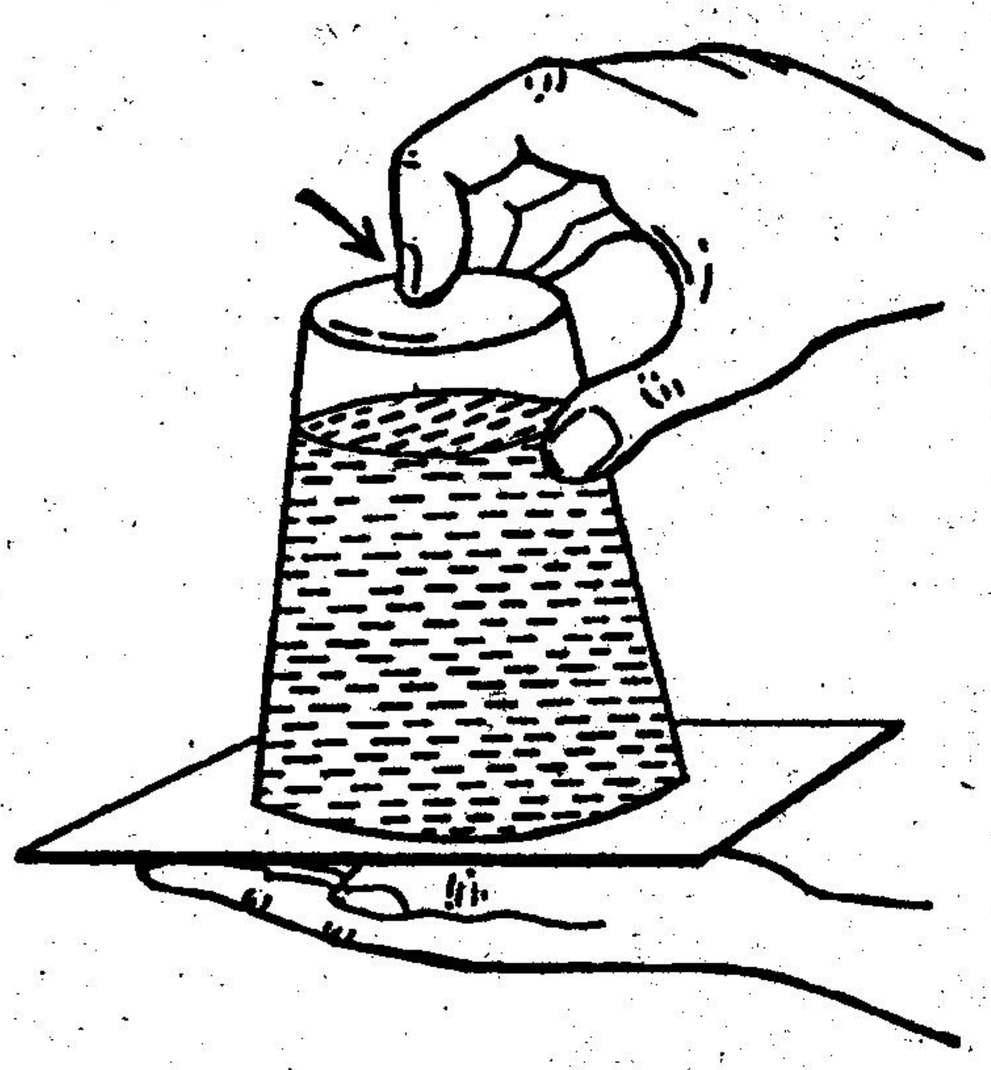
Air
Air pressure

## Materials

1. One plastic glass with a hole at the bottom
2. A card

## What to do ?

1. Take any amount of water in the glass and close the hole in the glass with your fore finger as shown in fig.



2. Place a hard card on the glass and then keeping your finger over the hole and holding the card with hand invert the glasses shown in fig. Slowly remove your hand. The water does not fall.
3. Now open the hole by taking your finger away. Immediately the card and the water will fall.

## Students to enquire

1. Why does not the card fall when you remove your hand and keep your finger over the hole?
2. Why does the water fall, when you take your finger away from the hole ?

## Explanation

1. It is the air pressure which holds the water. The upward air pressure acting on the card from the bottom is more than the weight of water and the pressure of air trapped inside the glass above the water. When you remove your hand from the card, the card goes down a little due to the weight of water. The trapped air expands and a partial vacuum is produced inside. Hence the air pressure acting upwards becomes more than that acting downwards.
2. When the finger is removed from the hole, the trapped air gets connected to the atmosphere. So, its pressure is atmospheric pressure. Hence, the pressure from top is more than the pressure on the card from below. On account of this, the water falls when you take the finger away from the hole.

Air
Air has weight

# Weight of air

15

## Materials

1. A football or volleyball
2. A pump
3. A common balance

## What to do ?

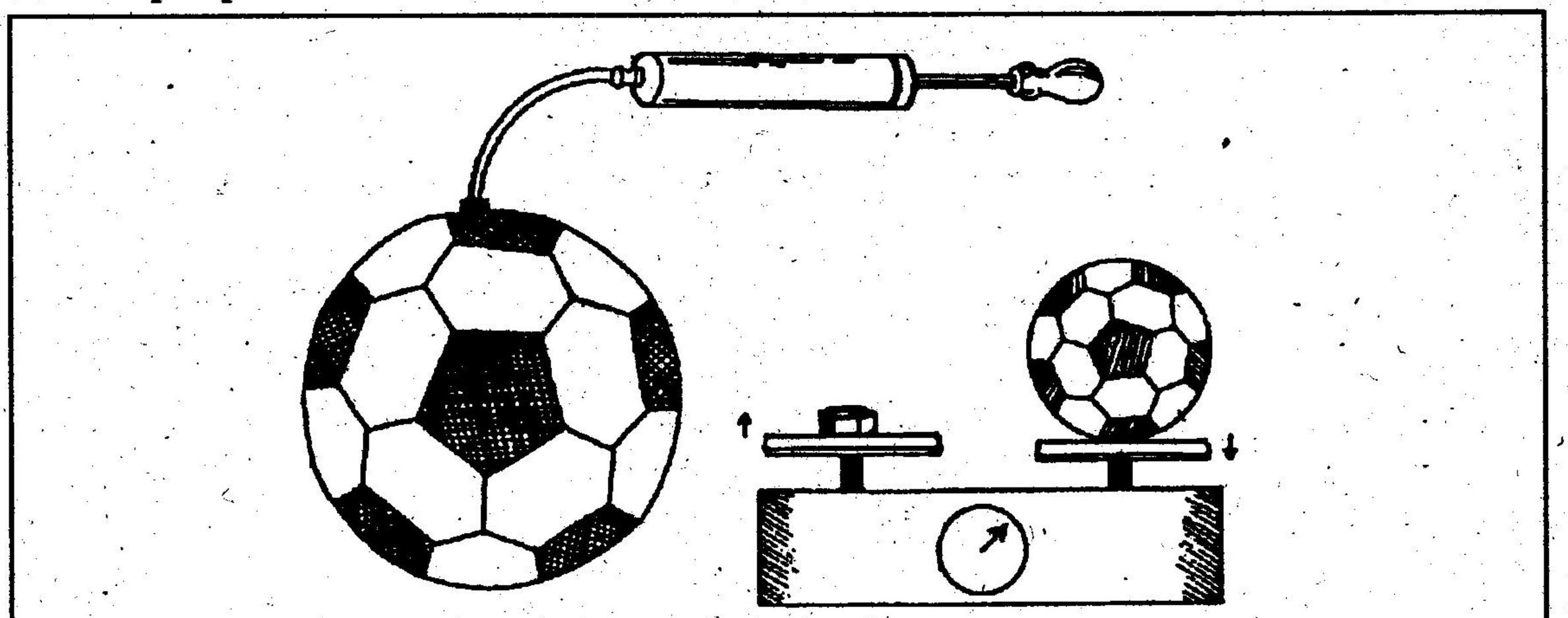
1. Weigh the uninflated ball.
2. Now pump sufficient air into the ball and weigh the ball. Observe if the ball has gained weight.
3. Repeat the experiment by pumping in more air. You will observe that the weight of the ball goes on increasing as more air is pumped in.

## Students to enquire

1. What made the ball gain weight ?
2. If you use an ordinary balloon instead of a ball would it give the same result ? If not, why not ?

## Explanation

1. As the air has weight, so when air was pumped in, the ball gained weight.
2. When a balloon or a ball is inflated, the buoyant force of air acts upwards on them. In the case of an ordinary balloon, the buoyant force is nearly equal to the weight of air that is pumped inside the balloon. Hence, the difference in weight cannot be found out by a common balance or a spring balance. In the case of a ball, a large volume of air can be pumped in without a comparable change in the volume of the ball. Hence, after a ball gets inflated, there is not much increase of buoyant force. Buoyant force depends upon the volume of the ball. In the case of a balloon you cannot pump in large volumes of air, for if you do so the balloon will burst. But, if the balloon is made of thick rubber then the experiment will work.



# 16 Paper does not lift

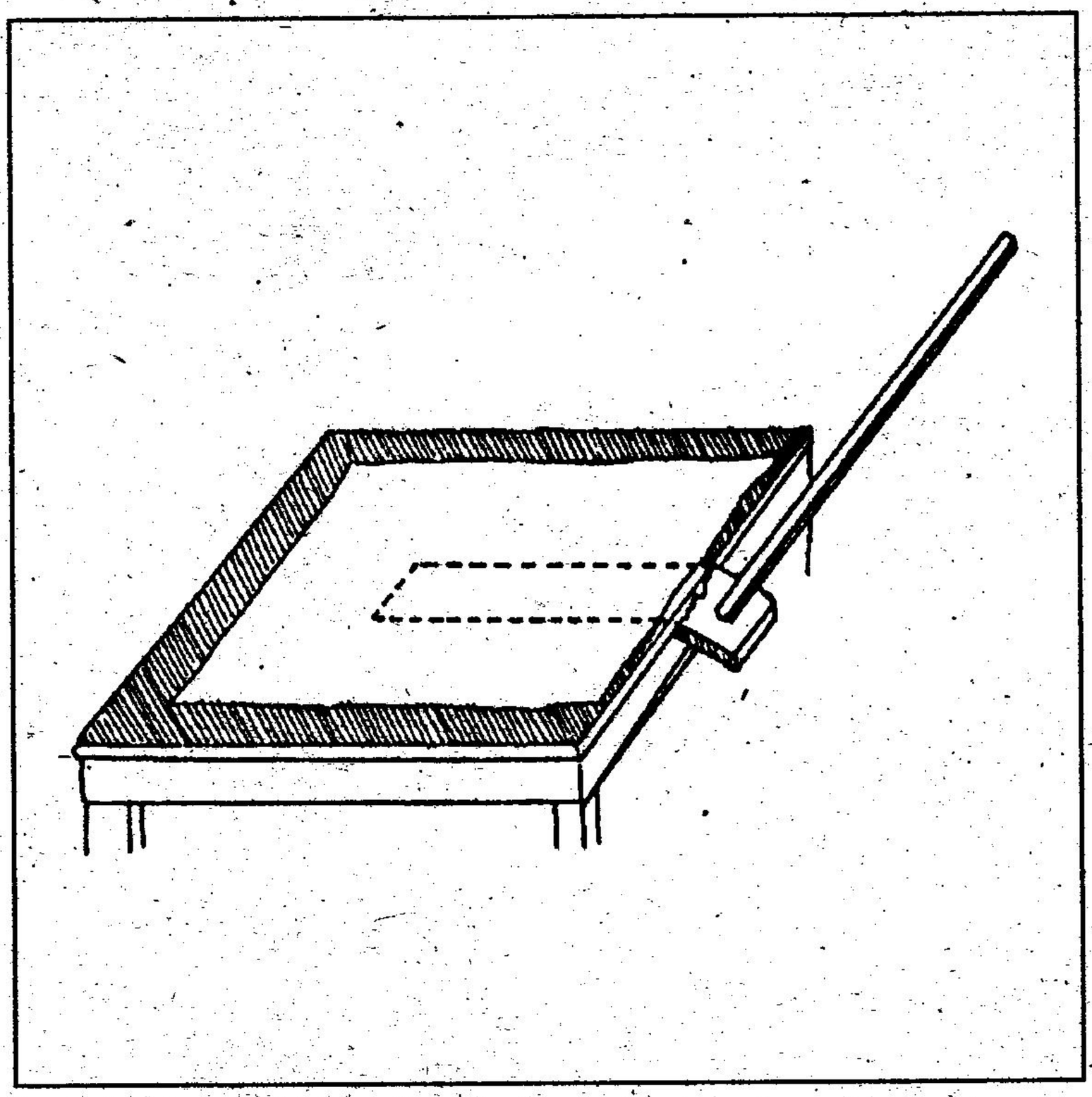
Air
Air pressure

## Materials

1. A newspaper sheet
2. A wooden strip-$1^1/_2$"x2"x$^1/_8$"(an old scale will do)
3. A heavy wooden or iron rod

## What to do ?

1. Place the strip at the edge of the table with one-fourth part outside the table and three-fourths on the table.
2. Place the newspaper over the strip. Press the paper on the table.
3. Now, hit the protruding end of the strip a quick hard blow with the heavy rod. You will expect that the paper will go up. But instead, the strip breaks from the edge and the paper does not go up.
4. But if you strike the strip slowly, you will observe that the paper goes up.



## Students to enquire

1. What is the pressure acting on the paper ?
2. Why does the strip break when you give it quick, hard blow ?
3. Why does the paper lift up if you strike slowly ?

## Explanation

1. Normal atmospheric pressure acts on the paper.
2. When you strike a sudden, hard blow, force is applied very quickly. Before this force can be transmitted to the paper the strip breaks . Hence the paper does not go up. The normal atmospheric pressure acting on the paper holds the paper on the table.
3. If you strike the strip slowly, the force gets time to be passed on to the paper. This force is more than the force exerted by the atmospheric pressure acting on the paper. Hence, the paper goes up from the table.

Air
Air pressure

# Water rises in the glass-1

17

## Materials

1. One glass
2. One candle
3. One saucer
4. One match box

## What to do ?

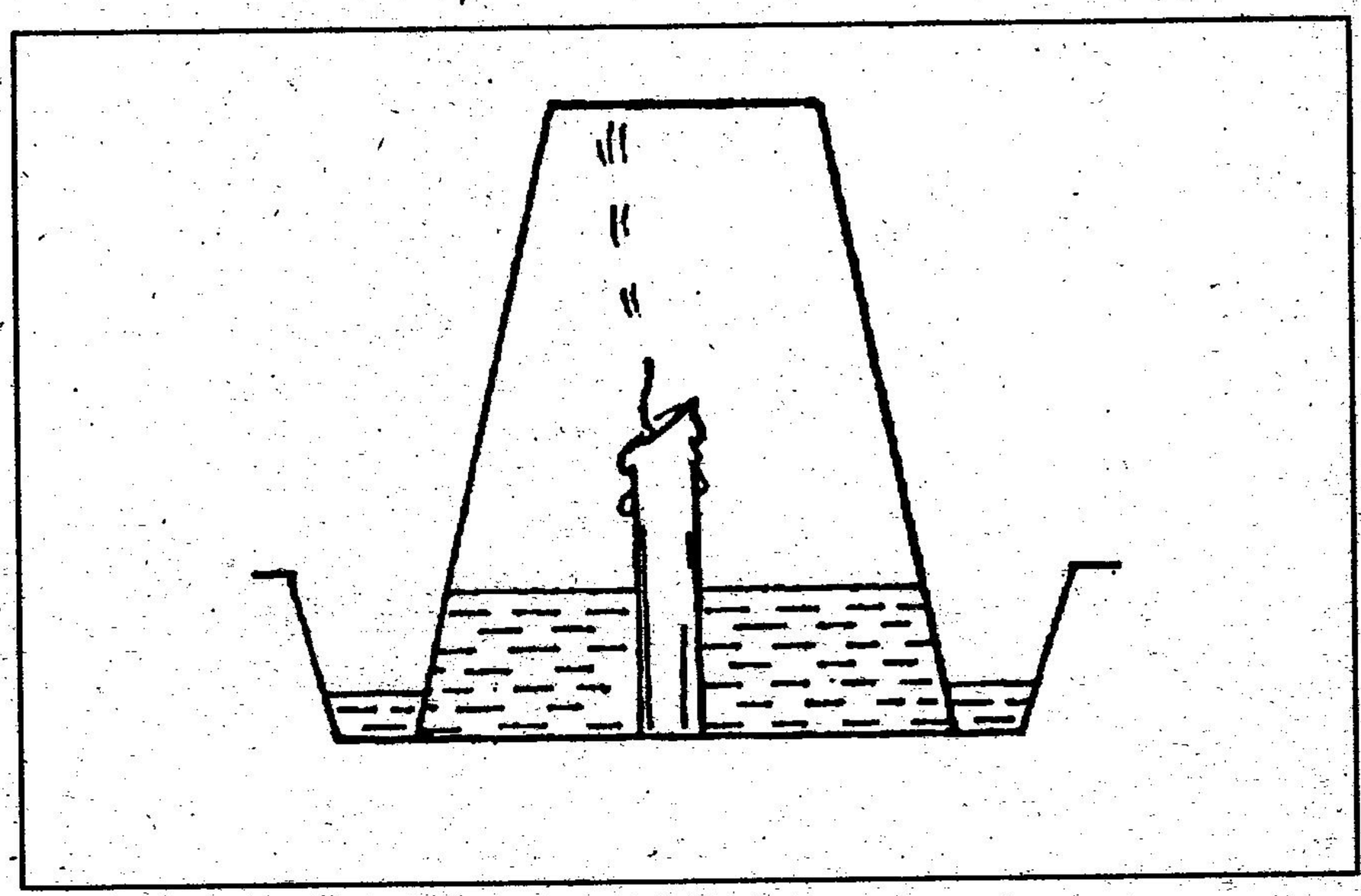
1. Light a candle and stick it on the saucer.
2. Pour water on the saucer till it is about $^3/_4$th. full.
3. Now gently place the glass over the candle on the saucer and observe what happens.

## Students to enquire

1. What was there in the glass before you placed it over the candle ?
2. What happened to the candle when you placed the glass over it ?
3. Why did the candle stop burning when you placed the glass over it ?
4. What happened to water level inside the glass ?
5. Why did the water go inside the glass and raise its level ?

## Explanation

1. There was air in the glass before it was placed over the candle.
2. When the glass was placed over the candle, the candle stopped burning.
3. The candle was extinguished because oxygen was consumed by the candle while burning and carbon dioxide was built up inside the glass which did not support combustion.
4. The water level inside the glass rose.
5. When the glass was lowered over the candle the air inside the glass got heated up and it expanded. The pressure of gas inside the glass increased and it was forced out of the glass, bubbling through the water. When the flame got extinguished the air inside the glass cooled. It contracted and its pressure lowered. Hence, the atmospheric pressure forced the water on the plate to get into the glass.



# 18 Water rises in the glass-2

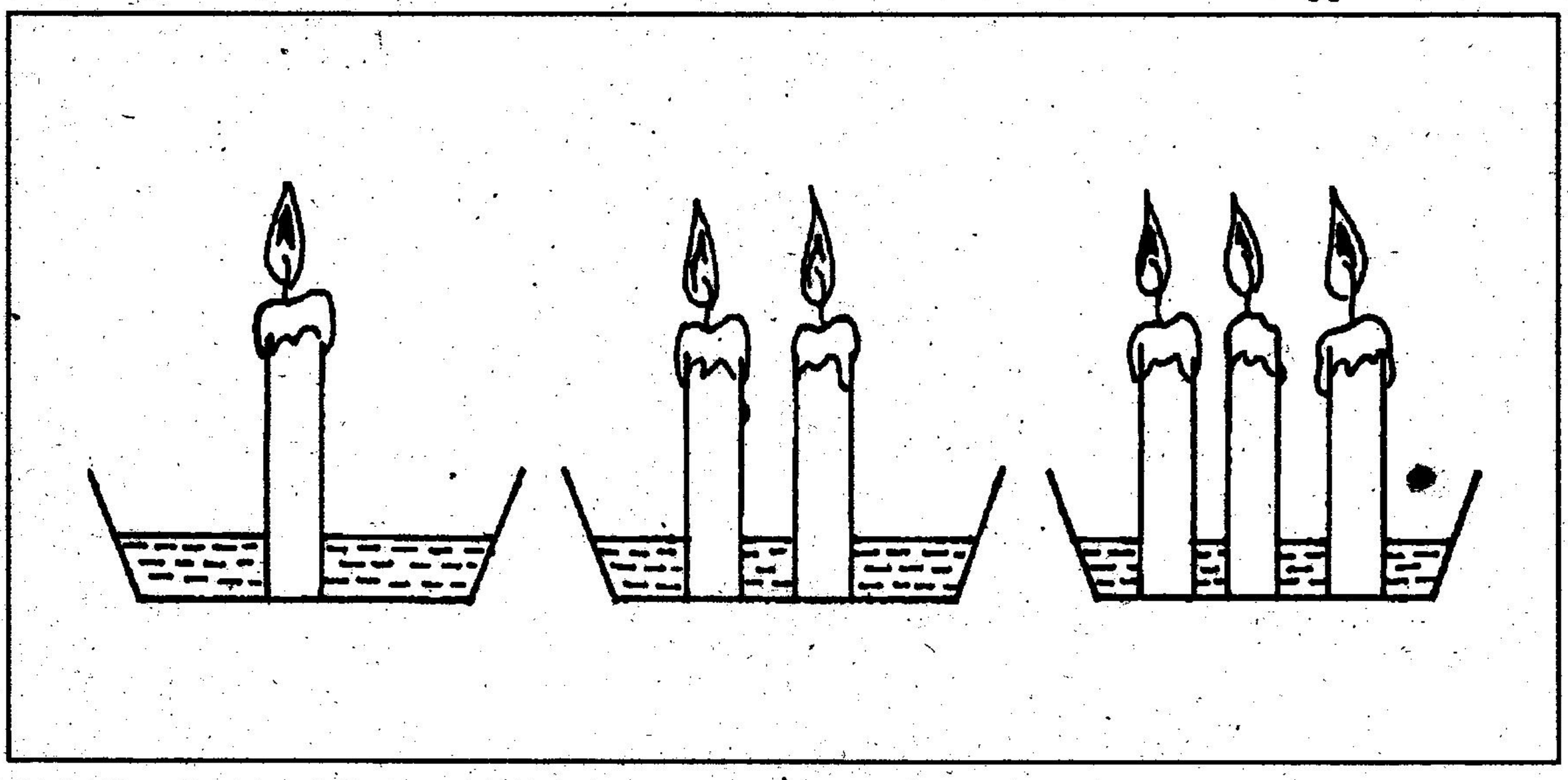
Air
Air pressure

## Materials

1. Three identical saucers
2. Three identical glass tumblers
3. Six small birthday candles

## What to do ?

1. Place one, two and three candles respectively at the centre of the first, second and third saucer as shown in figure.
2. Fill each saucer with water.



3. Light all six candles and wait till all burn evenly.
4. Place the three glasses over the candles on the saucer as shown. Ask your friend to help you to place the glasses. Observe that water rises in the glasses.

## Students to enquire

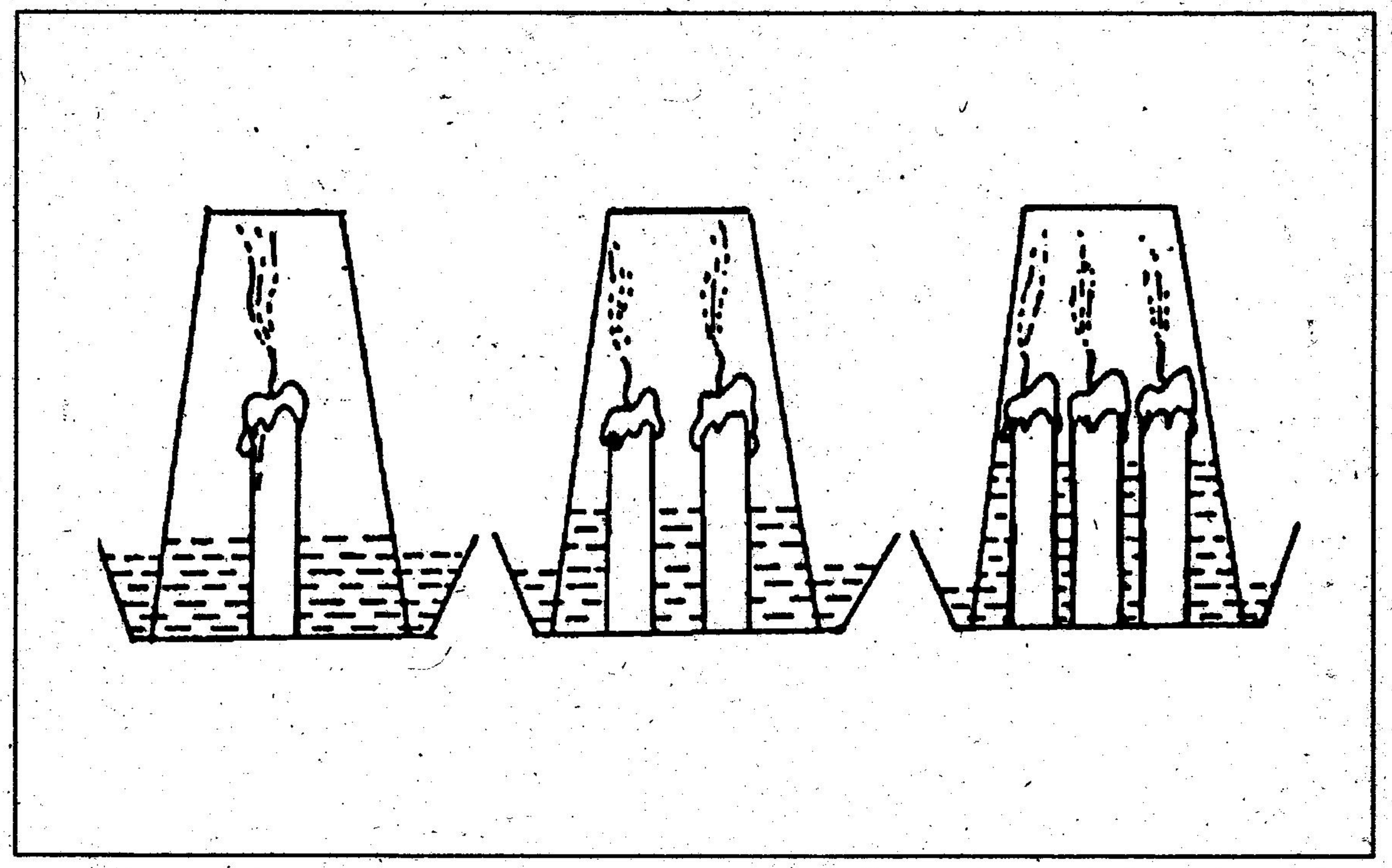
1. Under which of the glasses does the water rise the highest ?
2. Why did we take identical glasses, saucers and candles ?
3. Do we need to put the same quantity of water in all the saucers ?
4. Which variable is altered in comparing A, B and C ?
5. Above which saucer the heat developed the most ?
6. Was the amount of air trapped under the glasses before heating, the same for all the three ?
7. Why did the water level rise highest in C ?

## Explanations

1. The water rises the highest under the glass C.
2. Identical saucers, candles and glasses were taken so that the variables might be the same in all the cases. This means that these

variables did not influence the rising of the water level.

3. It was not necessary to put the same quantity of water. But there should be sufficient water in the saucer.
4. The only variable that was changed was the amount of heat transmitted to the air inside the glass. This was achieved by having different number of candles under different glasses.
5. As the number of candles was the largest in C, the air was heated the most in it.
6. Yes, the air trapped inside the glasses before heating was the same.
7. When the air was heated, it expanded, as the glass was placed over the candle. It expanded the most in C. When the air expanded, the pressure increased. As the expansion was the maximum in C, the pressure increase in it was also the highest. When the pressure increased, the air bubbled out through the water. More air bubbled out in C. When the glasses were cooled after the flames got extinguished, the gases contracted, thereby decreasing the pressure. The pressure decreased the most in C. The difference in pressure between the atmospheric pressure acting on the water surface and the partial vacuum inside, raised the water level. As the partial vacuum was the highest in C the water level rose the highest in C.

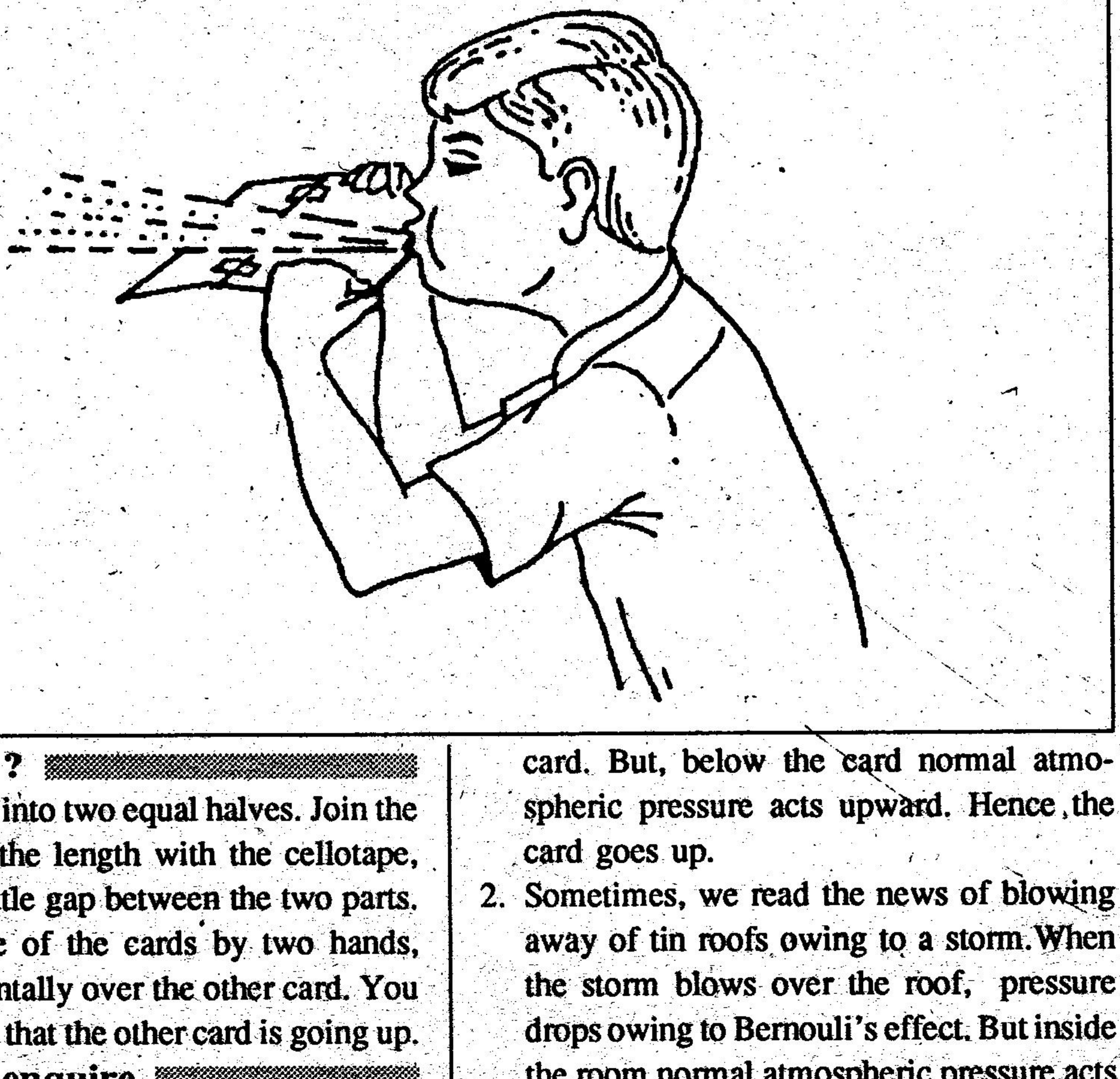


# 19 Storm blows away the roof

**Air**
**Bernouli's principle**

## Materials

1. A 7" x 5" card
2. Cellotape
3. Scissors



## What to do ?

1. Cut the card into two equal halves. Join the parts along the length with the cellotape, keeping a little gap between the two parts.
2. Holding one of the cards by two hands, blow horizontally over the other card. You will observe that the other card is going up.

## Students to enquire

1. Why does the card go up ?
2. Where do we find its application in daily life ?

## Explanation

1. Flowing air has less pressure. This is known as Bernouli's principle. When you blow air over the card, the pressure drops above the card. But, below the card normal atmospheric pressure acts upward. Hence, the card goes up.
2. Sometimes, we read the news of blowing away of tin roofs owing to a storm. When the storm blows over the roof, pressure drops owing to Bernouli's effect. But inside the room normal atmospheric pressure acts on the roof upwards. This excess pressure from below blows the roof away, if the roof is not very strongly anchored to the walls.

Characteristics of matter
Density

# Floating a drop of oil

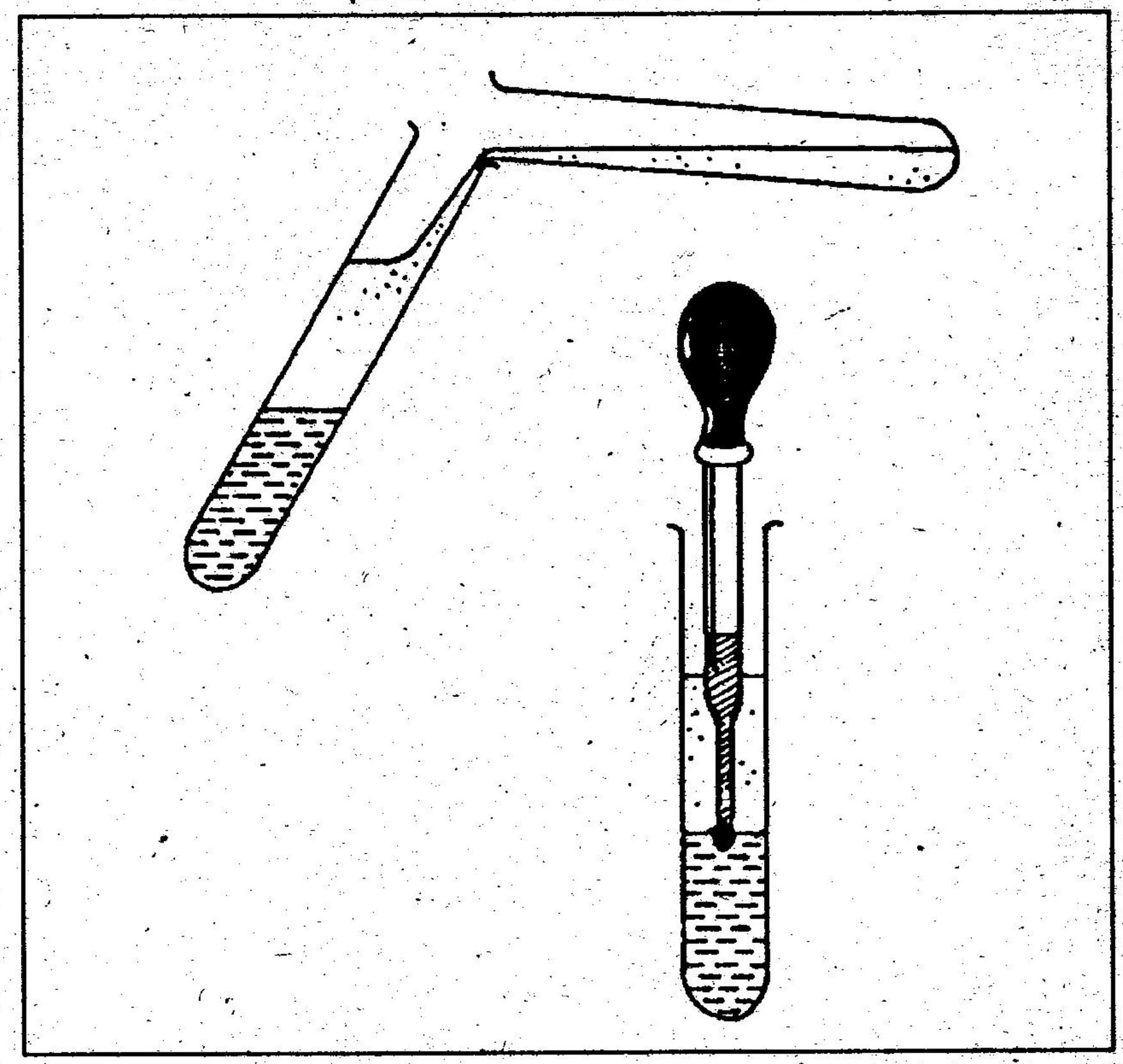
20

## Materials

1. A large test tube
2. An ink dropper
3. Methyl or ethyl alcohol
4. Mustard oil

## What to do ?

1. Fill a little less than half the test tube with water.
2. Tilt the test tube a little and pour very gently an equal amount of alcohol into the test tube. See that they do not mix. Alcohol will float on water.
3. Now take a little mustard oil in the dropper and release a drop at the junction of alcohol and water very gently. You will observe that the oil drop will float there and would not rise.



## Students to enquire

1. Why does alcohol float on water ?
2. Is alcohol completely immiscible with water ?
3. Why does the oil drop float at the junction of alcohol and water ?
4. If the oil drop was released in water, what would have happened ?

## Explanation

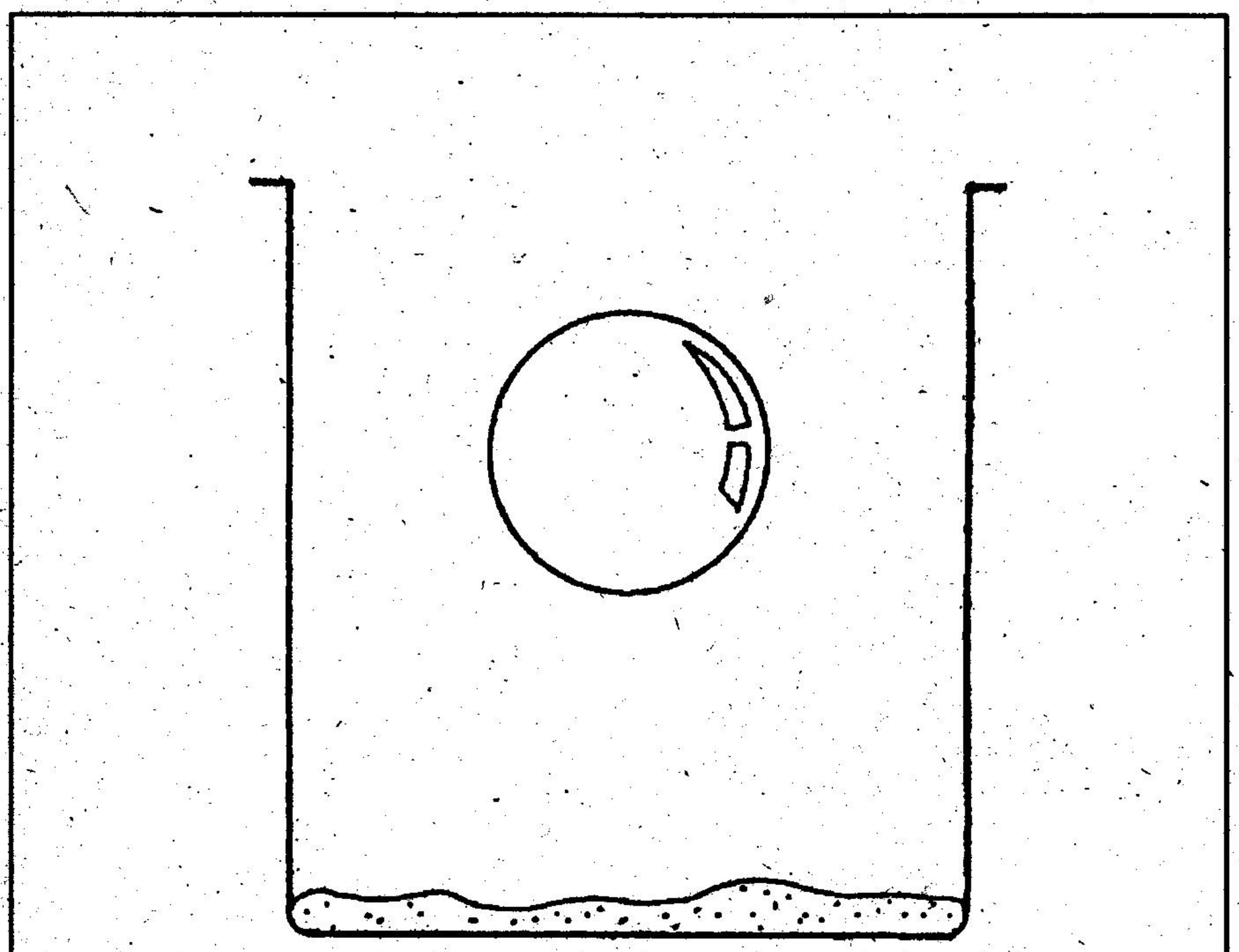
1. Density of alcohol is less than water. When two immiscible liquids are mixed, the liquid which is less dense separates from and floats on the denser liquid.
2. Alcohol is not totally miscible with water.
3. Density of mustard oil is less than water but more than alcohol. Hence, the drop of oil floats at the junction of two liquids.
4. If the oil drop was released in water, it would float up.

# 21 Floating bubble

Characteristics of matter
Density

## Materials

1. Liquid soap, glycerine and water
2. A big glass and a cup
3. A straw
4. Calcium carbonate or baking soda
5. Hydrochloric acid



## What to do ?

1. Mix up soap, glycerine and water in the ratio 1 : 2.5 : 3 in the cup.
2. Take two spoonful of calcium carbonate in the glass and mix it with about 50 c.c. of dilute hydrochloric acid.
3. Now, take soap solution in the straw and release a medium-sized soap bubble in the glass.
4. You will observe that the soap bubble will float in the glass.

## Students to enquire

1. When you add dilute hydrochloric acid to calcium carbonate, what is formed ?
2. Why does the bubble float ?

## Explanation

1. When calcium carbonate reacts with hydrochloric acid, carbon-di-oxide is formed.
2. Carbon-dioxide is denser than air. Hence it settles down in the glass. Soap bubble is less dense than carbon-dioxide but a little more dense than air. Hence, the bubble at first comes down in the glass. But when it comes at the junction of air and carbon-dioxide, it cannot go down further. It floats at the junction.

Characteristics of matter
Density

# Floating different solids

22

## Materials

1. Mercury, carbon-tetrachloride, kerosene and oil
2. Pieces of iron, ebonite, candle and cork
3. A long glass cylinder

## What to do ?

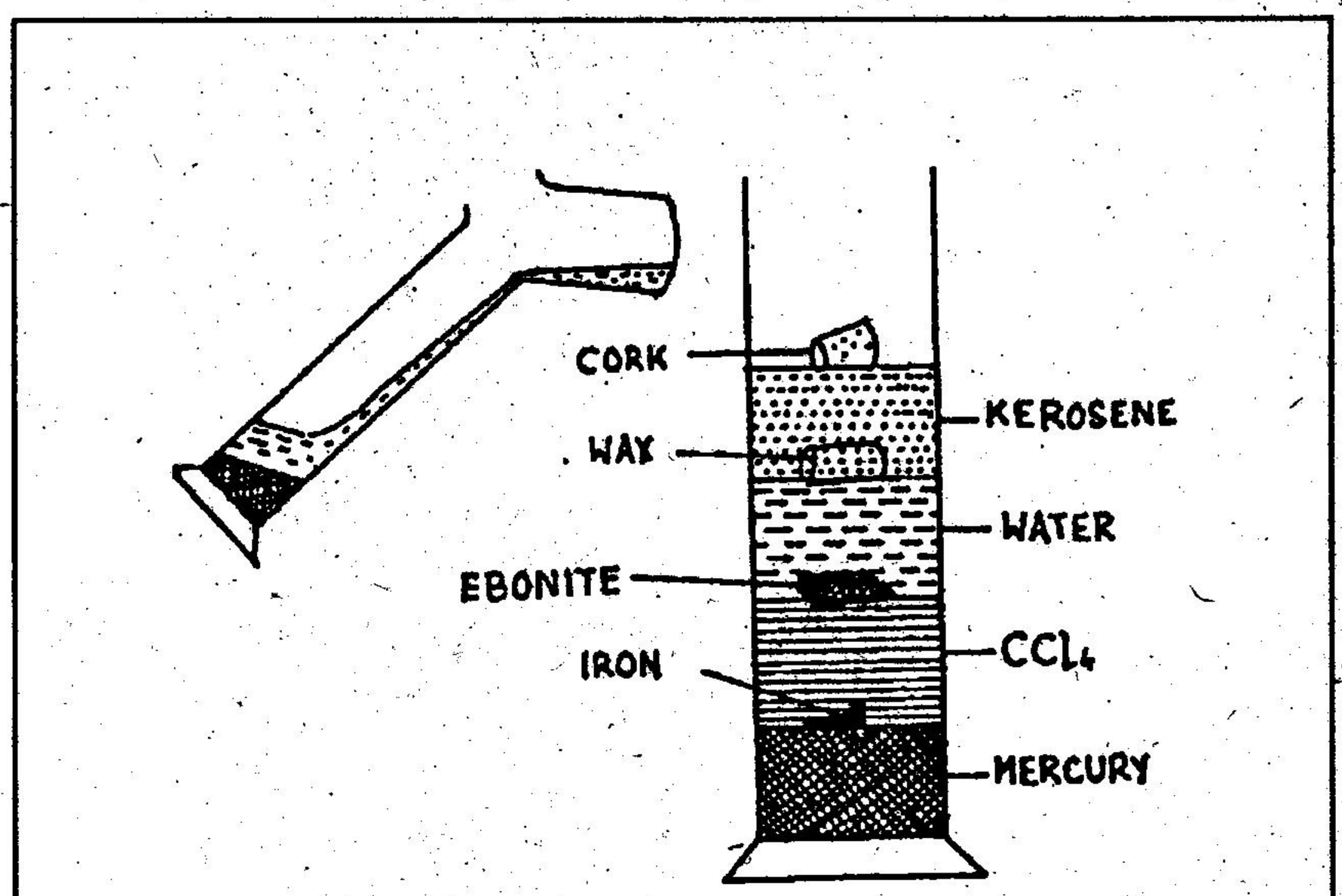
1. Gently pour one by one mercury, carbon-tetrachloride, water and kerosene into the cylinder.
2. Then, release gently iron, ebonite, candle and cork pieces into the liquid. You will observe that the different materials will float on the top of different liquids; iron over mercury, ebonite over carbon-tetrachloride, candle over water and cork over kerosene.

## Students to enquire

1. Compare the densities of different liquids.
2. Compare the densities of different solids– iron, ebonite, candle and cork.
3. On which property of matter will depend the floating of an object in a liquid ?

## Explanation

1. The ascending order of densities of liquids are : kerosene, water, carbon-tetrachloride, mercury.
2. The ascending order of densities of solids are : cork, candle, ebonite, iron.
3. If the density of an object is less than the liquid, then the body will always float whatever may be the weight of the body. If the density of an object is more than the liquid, then normally the object will sink. But if the shape of the body is changed, it may float. Iron is denser than water. But when it is given the shape of a ship, the ship floats.The floating of an object depends upon the amount of liquid displaced by the body. If the weight of the liquid displaced by the body is more than the weight of the body, then the body will float.

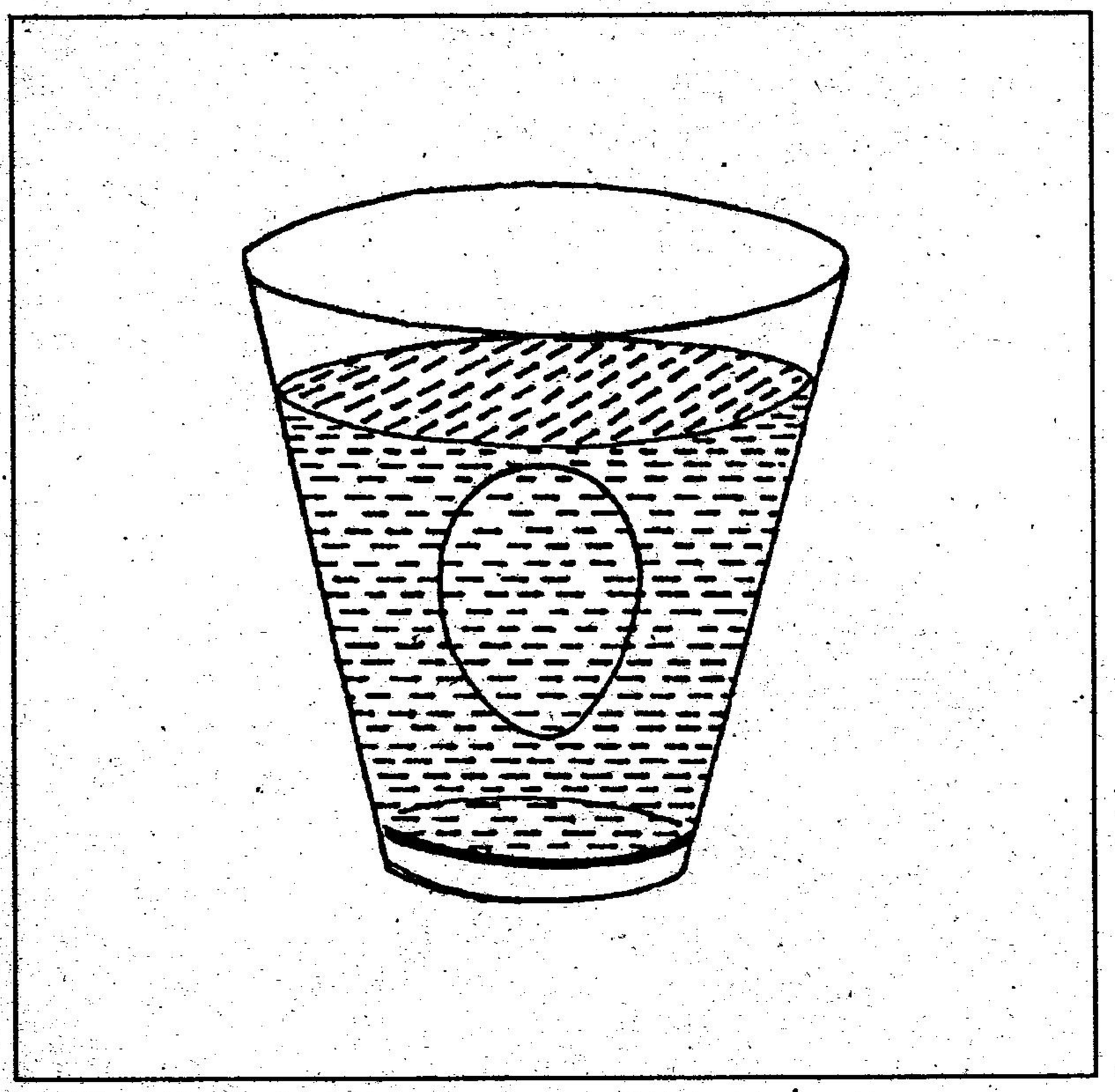


# 23 Floating of an egg

Characteristics of matter
Density

## Materials

1. A boiled or an unboiled egg
2. A glass of water
3. Table salt



## What to do ?

1. Release the egg in water. The egg sinks.
2. Go on adding salt to the water till the egg floats up.

## Students to enquire

1. How much liquid will the egg displace ?
2. What is the density of an egg compared to that of water ?
3. Which property of water is changed by adding salt to it ?
4. Why did the egg sink in fresh water ?
5. Why did the egg float up when you mixed salt to water ?

## Explanation

1. The egg displaces its own volume of water.
2. The density of an egg is more than that of fresh water.
3. The density of water is increased by adding salt to water.
4. When the egg was released in fresh water, the weight of water that the egg displaced was less than the weight of the egg. The weight of the egg was more than the buoyancy or the upthurst on the egg by water. Hence, the egg sank.
5. When salt was mixed the density of water increased. Owing to this, though the volume of liquid displaced was the same, the weight of displaced liquid increased. The density of water went on increasing as more and more salt was mixed. When buoyancy became more than the weight of the egg, it floated up.

Characteristics of matter
Adhesion

# Capillary action

24

## Materials

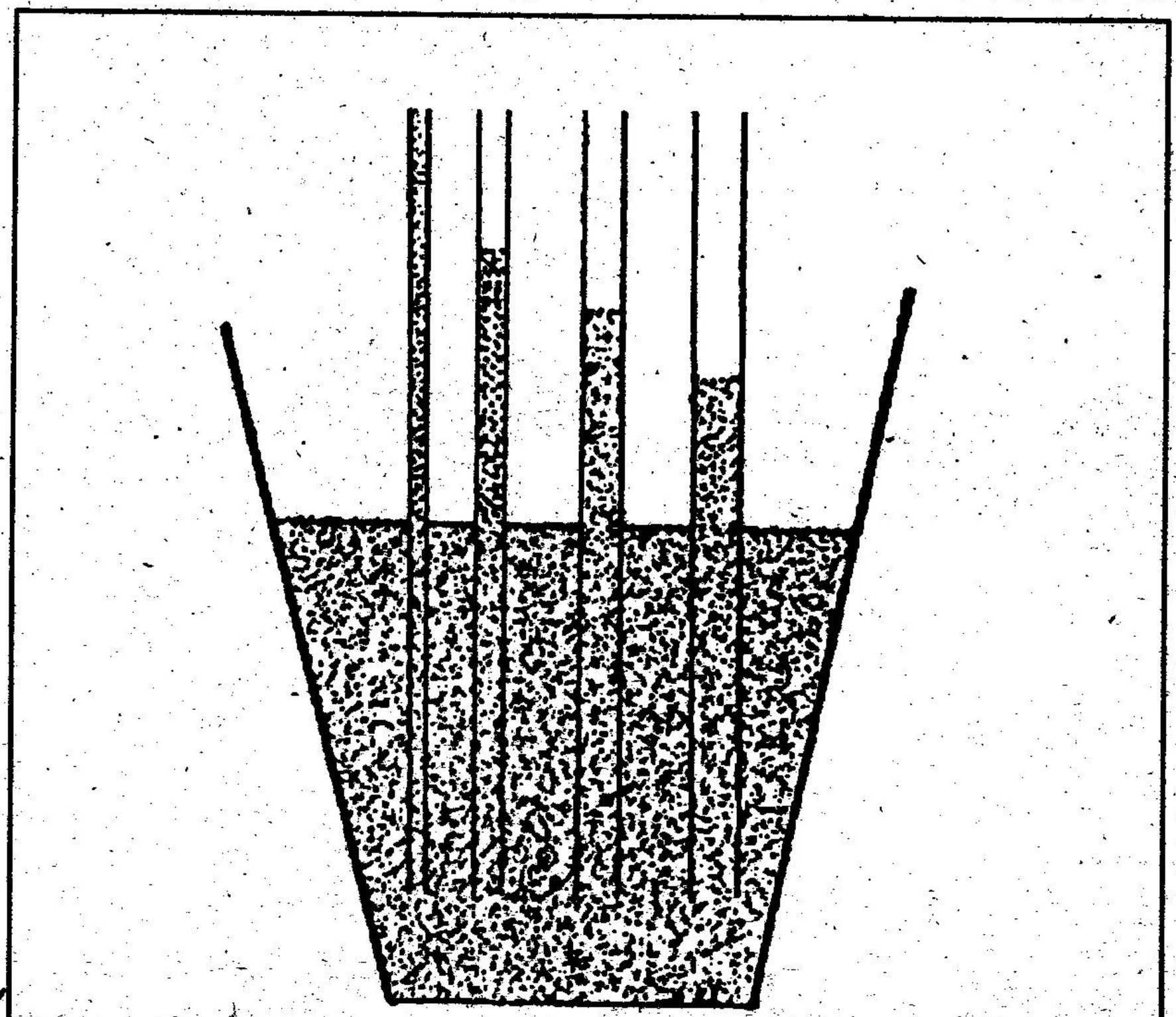
1. Capillary tubes of different diameters
2. Coloured water in a glass

## What to do ?

1. Keep the capillary tubes in the water. You will observe that the water will rise by itself the maximum in the narrowest tube and the least in the tube with the largest diameter.

## Students to enquire

1. Why does the water rise in the tubes by itself ?
2. Why does the water rise the maximum in the narrowest tube ?
3. If the tubes are raised or lowered in the water, will there be any change in the height of water ?
4. Where do you find in your daily life the application of capillary action ?



## Explanation

1. The attraction between the molecules of different substances is called adhesion. When the glass tubes are introduced in the water, the molecules of glass attract the water molecules. Because of this the water rises in the tubes.

If the tube is narrow, then for each molecule of water there are more glass molecules per unit of area. Due to this the attraction between the water molecules and the glass tubes is more in the case of narrower tubes. Hence, the water rises higher in narrower tubes.

3. If the tubes are raised or lowered in water, there is no change in the height of water.
4. In nature the tree draws water from the soil to the leaves through osmotic and adhesive force. If a part of towel is dipped in water, then by capillary action water rises in the towel and wets it. It is owing to adhesive force that paint sticks to objects after painting.

25

# Attraction between water streams

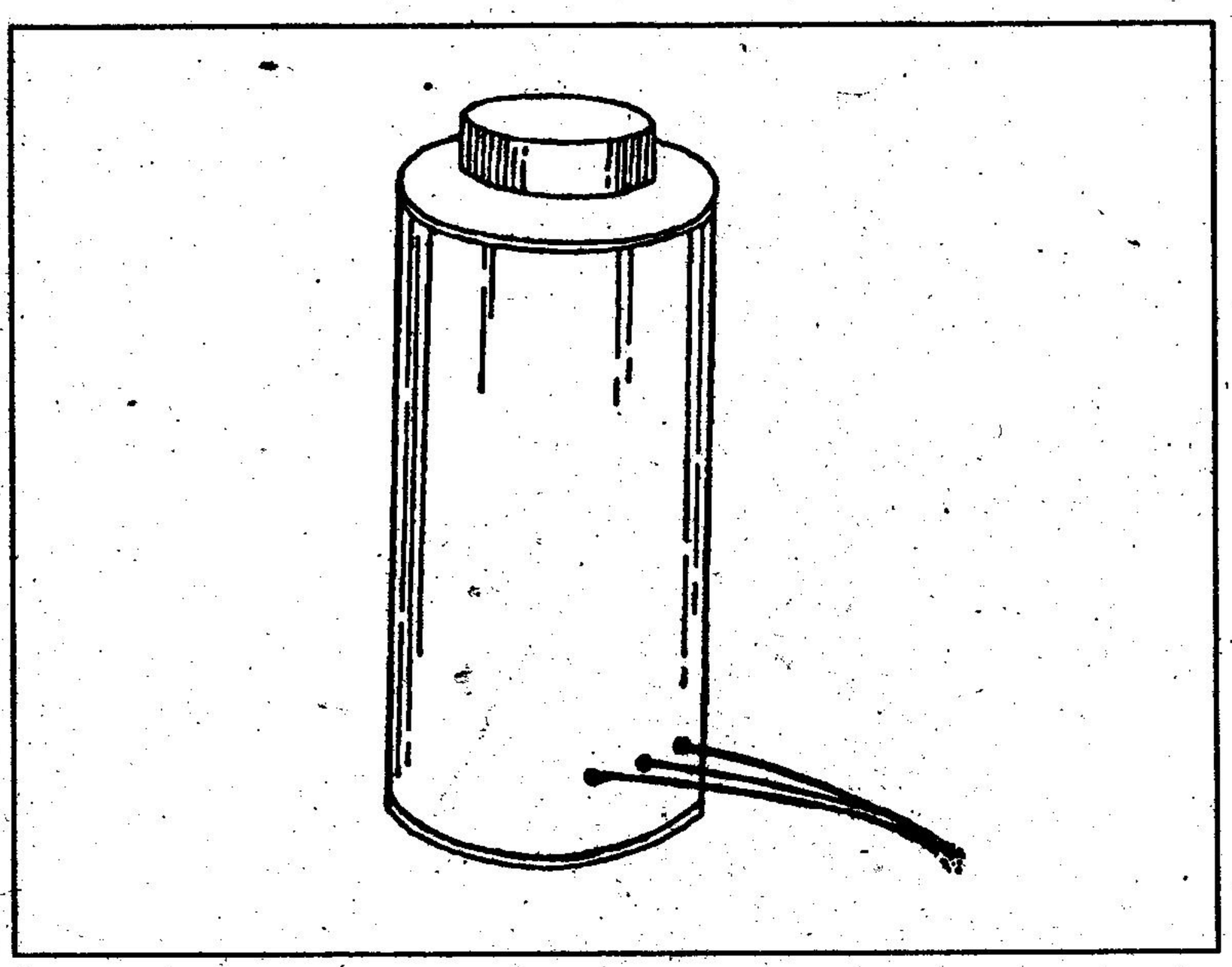
Characteristics of matter
Cohesion

## Materials

1. A long empty powder case

## What to do ?

1. At the lower end of the powder case make three holes, each 3 mm. apart from the other.
2. Keep the three holes closed with a finger and fill the can with water.
3. Hold the can with the left hand & open the holes.The water streams will come out .Now,



cut the water streams with your forefinger. You will observe that either two of the streams or all the three streams will join together. If the holes are too far apart, this will not happen.

## Students to enquire

1. Why do the streams join together when you cut through them ?
2. Why is it difficult to separate them ?
3. Will it be easier to separate the streams if the can is half filled ?
4. How much apart the holes should be so that you can bring them together ?

## Explanation

1. There is attraction between the molecules of liquid called cohesion. When you cut through the streams with your finger and bring the streams together, the cohesive force between the water molecules keep the streams joined together.
2. It is difficult to separate the streams because of the force of cohesion.
3. It is easier to bring the streams together if the tin is half filled. If the tin is full, the velocity of water stream is greater. Then it is more difficult to bring them together because the cohesive force is very weak. But if the tin is fairly empty, then the adhesive force becomes more active and makes the streams stick to the side of the can.
4. It is difficult to bring the streams together when the holes are quite apart. The cohesive force, being very weak, cannot join the streams together.

Characteristics of matter
Molecular structure

# Contraction on heating and cooling on pulling

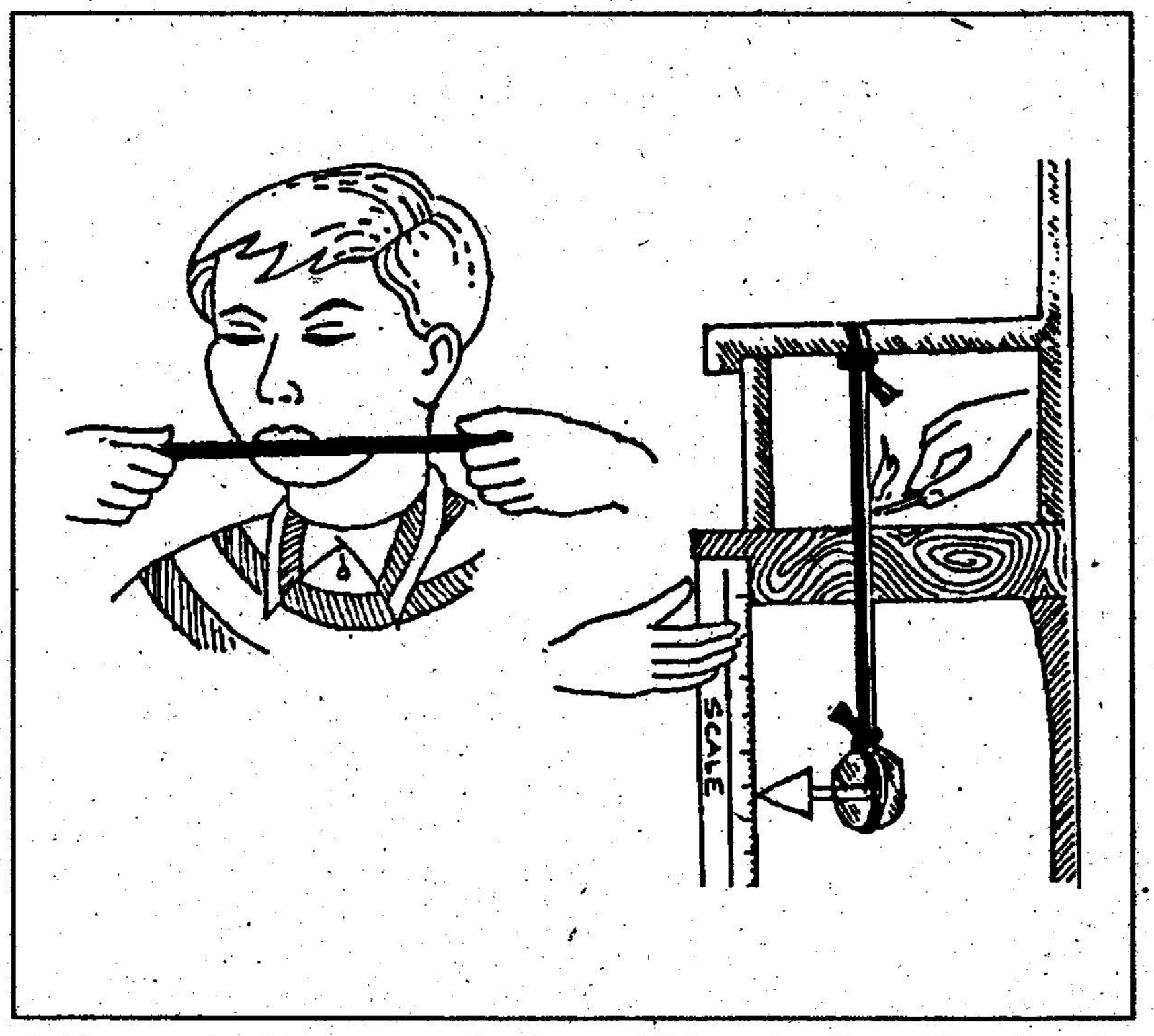
26

## Materials

1. A wide rubber band
2. A scale
3. A matches
4. A piece of stone
5. A paper arrow
6. Cellotape

## What to do ?

1. Pull the rubber band partly and touch the upper lip with it.
2. Keeping the band on the lip, pull the band harder and then release it gradually, your lip will feel cold.
3. Attach the paper arrow to the stone with the help of cellotape. Tie the stone with the rubber band and hang it so that the arrow may show the height on the scale.
4. Notice the recording on the scale.
5. Light a match stick and hold it near the rubber band. Do not touch it with the flame. Notice the reading on the scale again. You will observe that the arrow is moving up.




## Students to enquire

1. When you pull the band, what happens to its molecules ?
2. When you heat a metal, what happens to it ?
3. Which other materials will behave like rubber ?

## Explanation

1. Rubber is a high polymer. Its molecules are large with many side chains. When the band is pulled , the molecules of rubber rubs against each other and this creates heat. So, when the band is pulled ,the lip feel hot. When the tension is released, the molecules come back to their original position. The band cools. Because of this, the lip feels cold.
2. When a metal is heated, it expands.
3. Different types of plastics, polythene, polystyrene behave like rubber.

27

# The glass that does not move

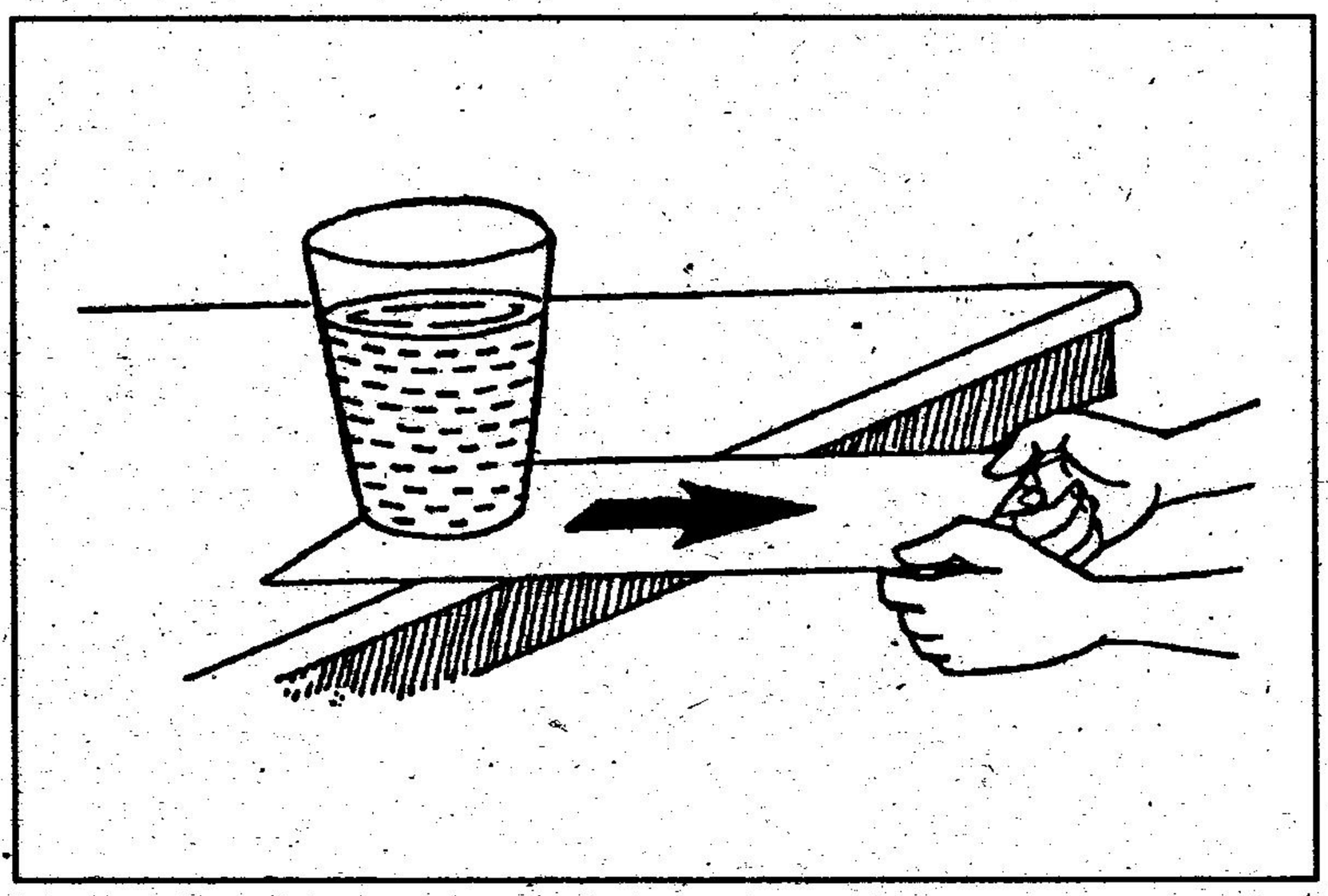
Characteristics of matter
Inertia

## Materals

1. A glass of water
2. A strip of paper 6"x18"

## What to do ?

1. Take a dry glass and fill it with water.
2. Keep the paper strip over a smooth table near its edge and place the glass on it at the other end.
3. Pull the paper slowly and bring the glass within about 2 cm.of the edge of the table.



4. Now pull the paper below the glass with a sudden jerk. Do not hesitate. You will observe that the paper slips out from under the glass, but the glass does not move.
5. Observe that when the paper is pulled slowly, the glass also move along with the paper.

## Students to enquire

1. When you pulled the paper with a sudden jerk, why did not the glass also come along with the paper ?
2. When you pull the paper gently, why did the glass move along with it ?
3. Why do you need a smooth table to conduct this experiment ?
4. Why should you have a dry glass ?
5. Where do you find the same phenomena in your daily life ?

## Explanation

1. When you pulled with a sudden jerk, the glass did not move because of the property of inertia of a body.This is called inertia of rest .The more the mass of a body the more is its inertia.
2. There is friction between the bottom of the glass and the paper. This friction resists the motion of the glass on the paper. Because of this friction, the glass moves along with the paper when you pull gently.
3. You need a smooth table so that friction between the paper and the table may be the minimum and the paper may come out easily.
4. If the glass is wet, then the paper will stick to the wet glass and would not come out.
5. When someone gets up in a running bus, he leans back. When he gets in the bus, the leg suddenly gets motion, but the upper part of the body tries to remain at rest owing to inertia. So he leans back.

Characteristics of matter
Inertia

# Dropping a coin in a glass

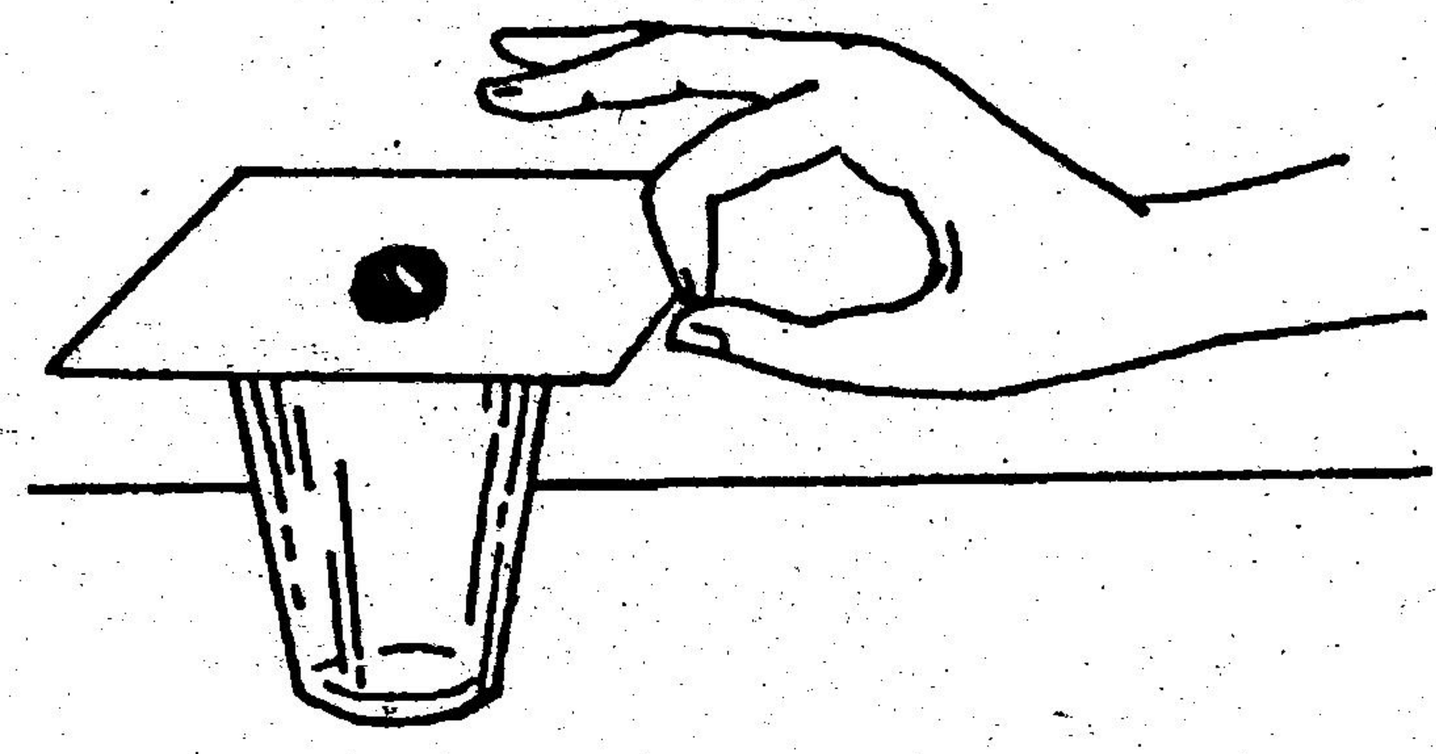
28

## Materials

1. A glass
2. A card
3. A coin

## What to do ?

1. Keep the card on the glass and keep the coin over the card at the centre.



2. Push the card slowly. You will observe that the coin also moves away along with the card.
3. Now, strike the card with a sudden jerk with your forefinger. You will observe that the card will fly off, but the coin will fall into the glass.

## Students to enquire

1. When you push the card slowly, why does the coin go out along with the card ?
2. When you strike the card with a jerk, why does the coin fall into the glass ?
3. Where do we find its application in our daily life ?

## Explanation

1. There is friction between the coin and the card. When the card is pushed slowly, friction holds the coin with the card and it moves along with the card.
2. But when the card is struck with a jerk, the coin does not get time to get the motion of the card. Inertia is a property of matter. According to this property, all bodies try to remain at rest or in a state of uniform motion in a straight line unless it is acted on by an outside impressed force to change that state. When the card is struck hard, owing to inertia the coin tries to remain at rest . So it falls into the glass.
3. We observe the application of this principle when we move in a bus or a tram. When a bus suddenly starts with a jerk , we fall back. When the bus suddenly starts, the lower part of the body gets motion but the upper part tries to remain at rest. Hence we fall back.

# 29 Which thread will snap

Characteristics of matter
Inertia

## Materials

1. A heavy book
2. Thread
3. Chair with handles

## What to do ?

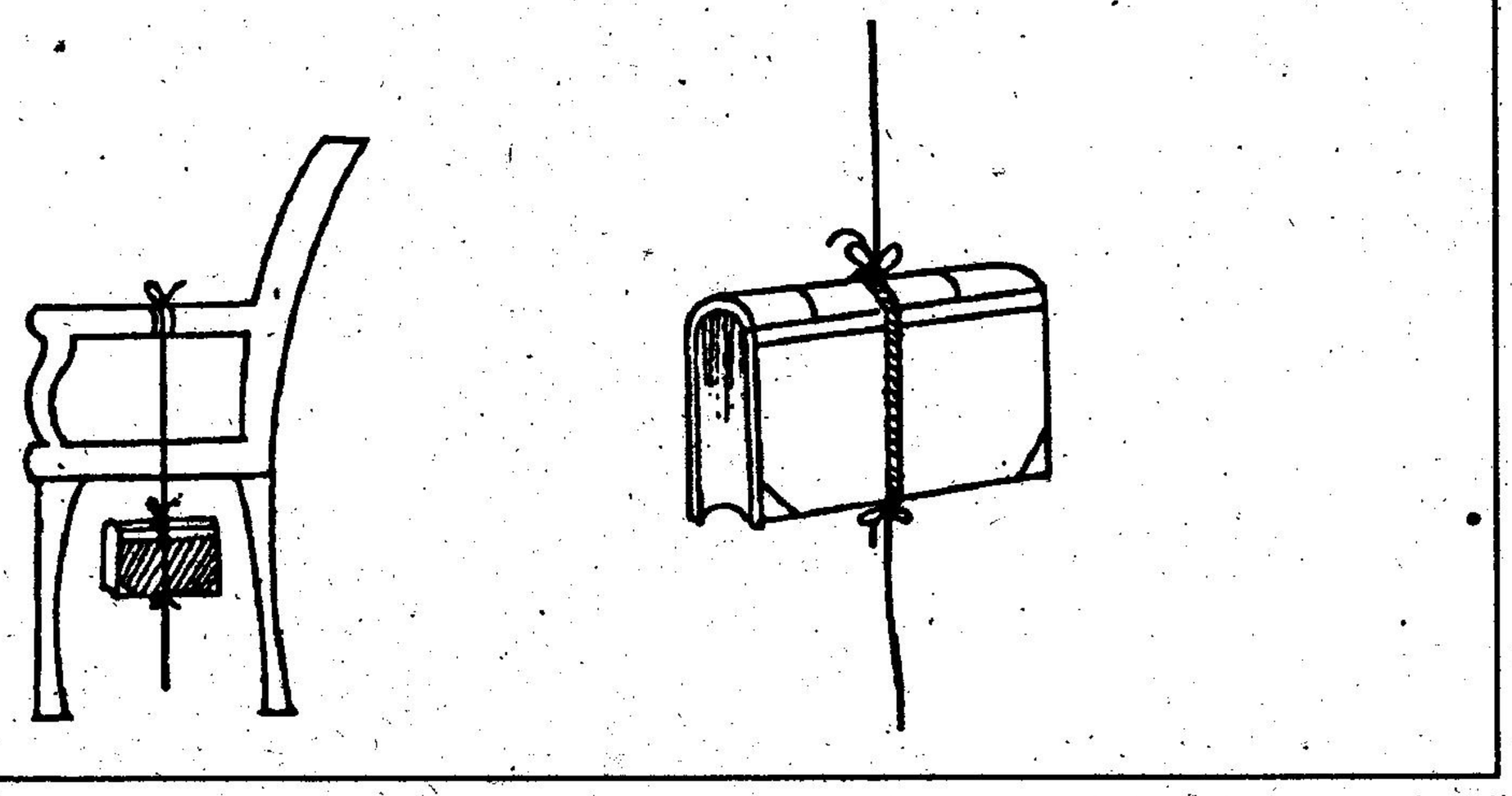
1. Tie the thread around the book. Give three or four rounds.
2. Tie two threads about 2" each, with the threads round the book at the top and bottom as shown in the figure.
3. Tie the upper thread with the handle of the chair and hang the book freely.
4. Now , hold the bottom thread by hand and gradually increase the pull on the thread. You will observe that the upper thread with snap and the book will fall.
5 Tie the top thread again and pull the bottom thread with a sudden jerk, you will observe that the bottom thread will snap and the book would not fall.

## Students to enquire

1. Why does the upper thread snap when you gradually increase the pull on the lower thread ?
2. Why does the lower thread snap when you pull the lower thread with a sudden jerk ?

## Explanation

1. When the lower thread is pulled gradually, the applied force gets time to be transmitted to the book. Under such conditions the weight of the book and the force of the pull acts on the upper thread. Hence the upper thread snaps.
2. When the lower thread is pulled with a sudden jerk, the force does not get time to be transmitted to the book and the upper thread. The heavy book, owing to inertia of rest, tries to remain at rest. Hence, the upper thread does not snap.



Characteristics of matter
Surface tension

# Drifting pepper

30

## Materials

1. A beaker or a plate
2. Ground pepper
3. Detergent powder
4. Pepper globules

## What to do ?

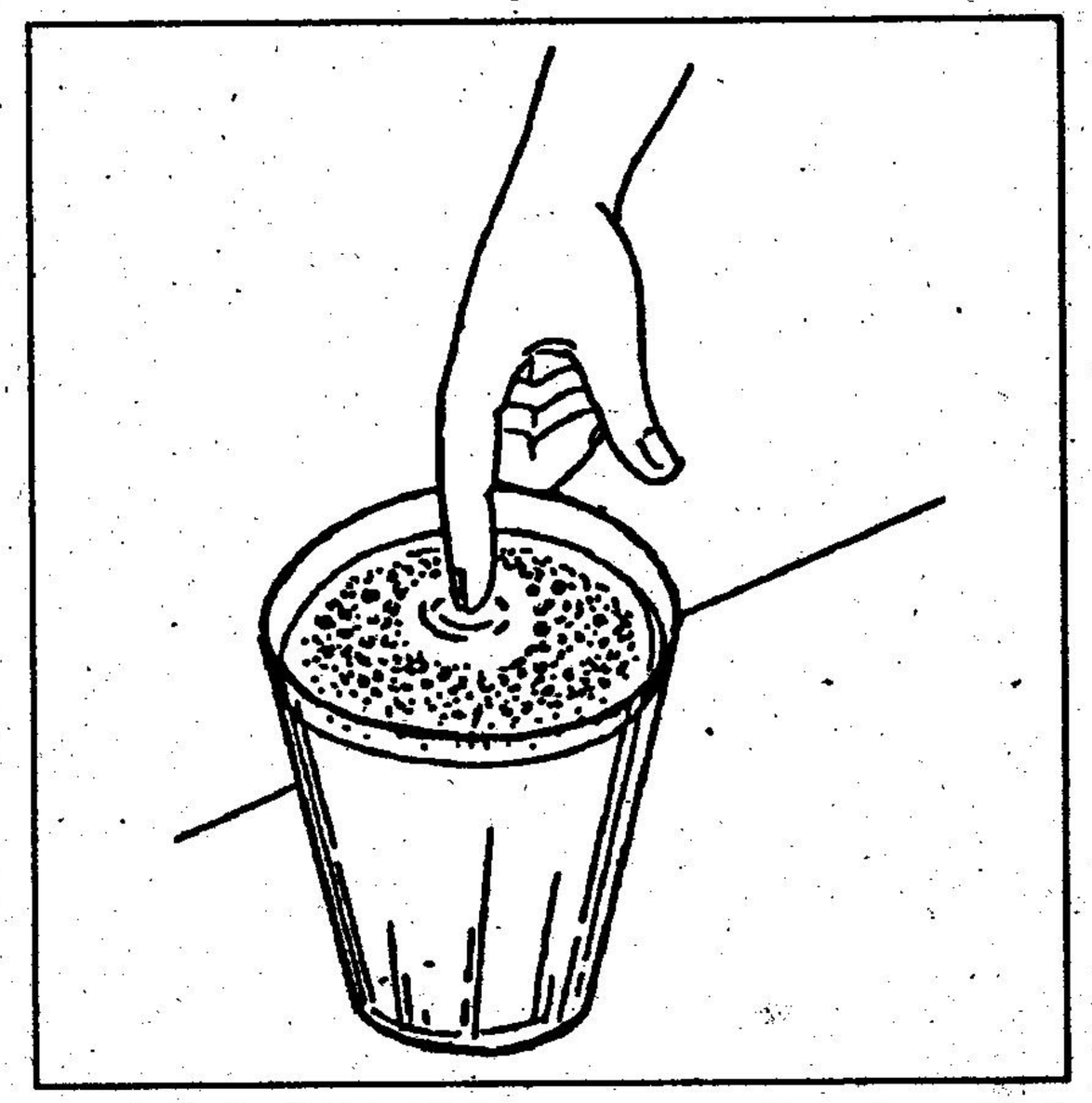
1. Sprinkle pepper powder on the water in the beaker or the plate.
2. Put one of your fingers on the detergent powder and then touch the surface of water at the middle of the beaker.
3. You will observe that the pepper powder round your finger fly apart as if repelled by your finger. See that without detergent, pepper does not fly apart.
4. Release the pepper globule in water. It sinks.

## Students to enquire

1. Why does the pepper powder float on water ?
2. Do we change the density of the pepper by grinding ?
3. Why does the pepper powder fly apart when you touch the water surface with the detergent ?
4. Why does a full pepper globule sink ?

## Explanation

1. Owing to surface tension, the water surface in the beaker behaves like a stretched membrane. When you sprinkle pepper powder, which is very light, it is held by the water surface because of surface tension.
2. No, the density of pepper remains the same whether it is full or grounded. The only difference is that each small particle becomes light in weight .
3. Detergent has the property of reducing the cohesive forces of attraction between the water molecules and thus weakening the surface tension of water. Hence, the surface tension of the place where you touch the water with detergent gets reduced and like a stretched rubber membrane the stretched water surface is pulled out on all sides



radially. When the water surface is pulled apart the pepper powder also goes away with it.

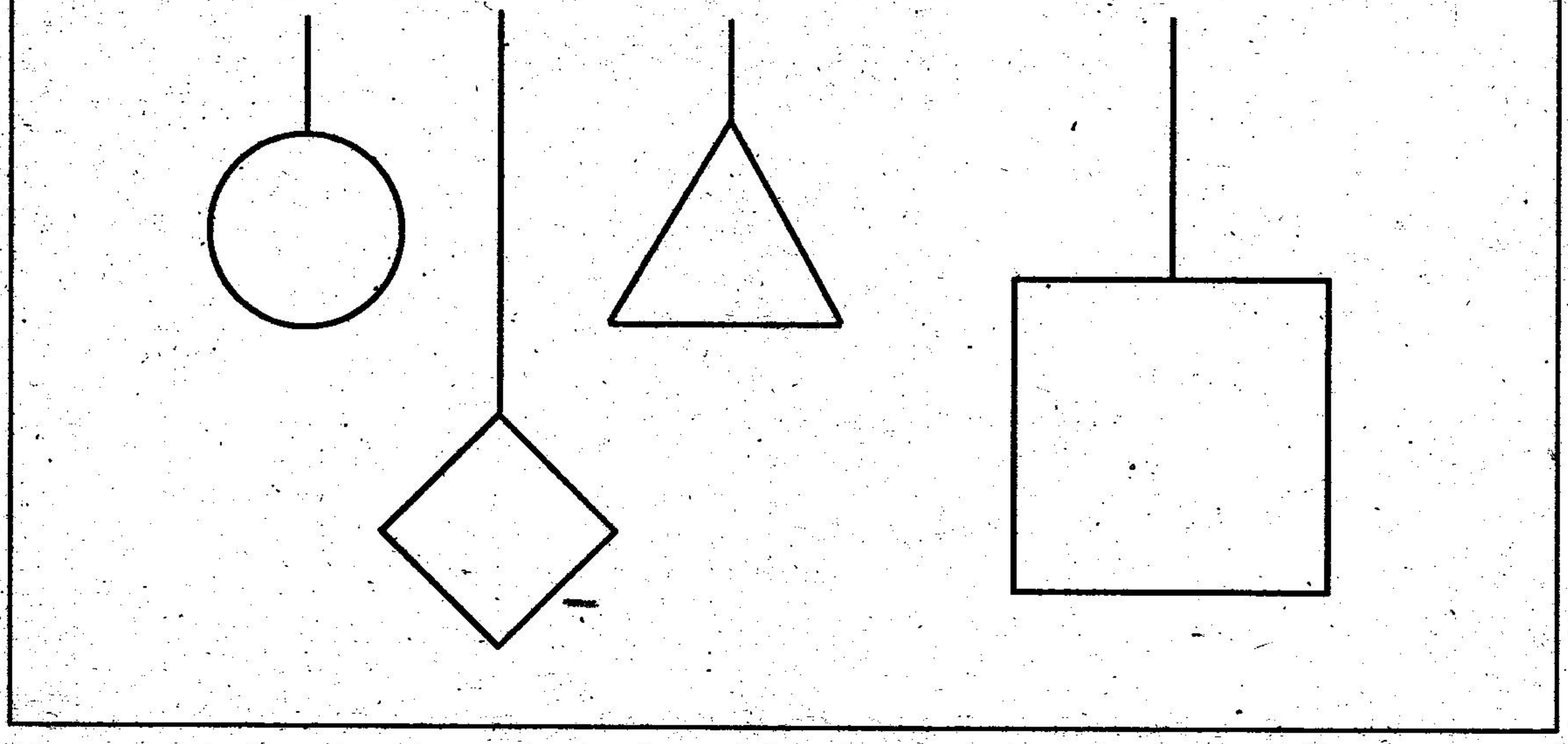
4. A full globule sinks is in water because its density is more than water and it displaces water whose weight is less than the weight of the pepper globule, i.e.the upthrust is less than the weight of the pepper.

# 31 Soap bubble

Characteristics of matter
Surface tension

## Materials

1. Rings of different shapes
2. A cup of water
3. A cup of liquid soap
4. A cup of glycerine
5. A large vessel



## What to do ?

1. You may make rings of different shapes from old aluminium hangers. Make the rings as shown in the fig.
2. Now, mix the water, soap and glycerine in the large vessel.
3. Now, take the rings one by one and dip them in the soap solution, raise it at an angle and move the rings in the air to and fro. You will observe that big bubbles will be formed. If you pull the ring with a jerk in the air, the bubbles will be released in the air.

## Students to enquire

1. What happens to the water when you mix soap to it ?
2. What is the purpose of adding glycerine to the mixture ?

## Explanation

1. If soap is not mixed, the bubbles will not be stable. If soap is mixed, then a layer of soap solution is formed outside and inside the bubbles. The soap solution reduces the surface tension of water. Qwing to this big and stable bubbles can be formed.
2. Glycerine forms a layer on the bubbles. Hence, water cannot evaporate and the bubbles become stabler.

Characteristics of matter
Surface tension

# Floating a needle or a blade

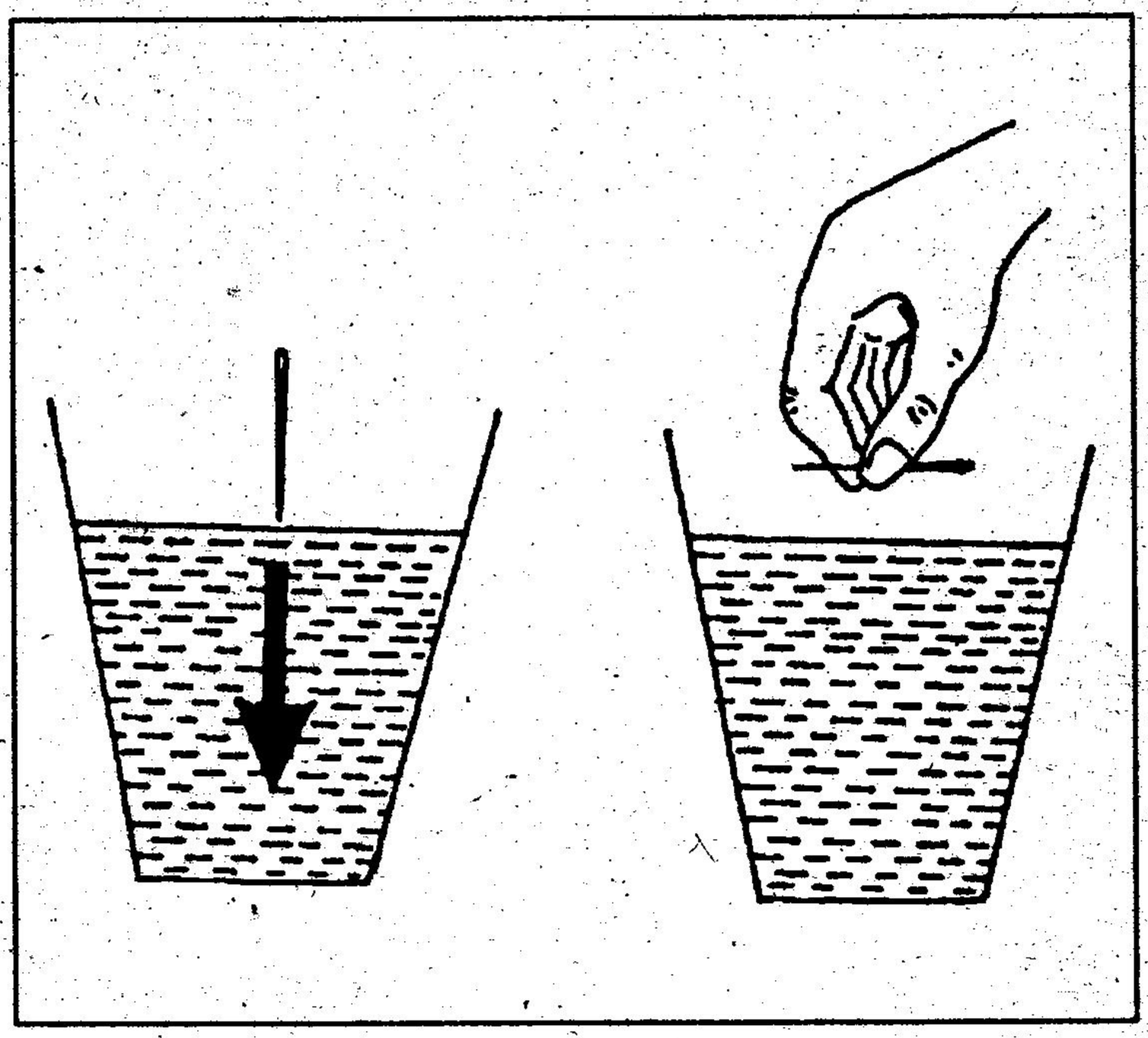
32

## Materials

1. A needle or a blade
2. A glass of water

## What to do ?

1. Release the needle or the blade vertically in the water of the glass. You will observe that it will sink in the water.
2. Now release the needle or the blade horizontally very carefully on the water. You will observe that it will float. If you are not successful, dry the needle or the blade and realese it in the water again. You may also rub it against a wax candle.



## Students to enquire

1. Why can not you float the needle or the blade if you release it vertically ?
2. Why should the needle or the blade be dry ?
3. What happens if you rub the needle or the blade on candle ?
4. Why does the needle or the blade float when released horizontally ?
5. How can you make a floating needle sink without touching it ?

## Explanation

1. When you release the needle or the blade vertically, it can overcome surface tension and it sinks. As the area of the pointed ends is very small, surface tension of that area of water is also very little. Hence, because of its weight the needle or the blade can easily penetrate the water and sink.
2. If the needle or the blade is wet then the cohesion between water molecules will cause the needle or the blade to sink.
3. If wax is rubbed on the needle or the blade, then water does not wet the blade. Hence there is greater chance for the needle or the blade to float.
4. When the needle or the blade is released horizontally, a bigger area of the blade or the needle is in contact with water. Hence there is greater surface tensions and it is easier for the blade or the needle to float.
5. When soap is mixed with water, the surface tension is reduced and the needle or the blade can sink easily.

33

# Floating a cork at the centre

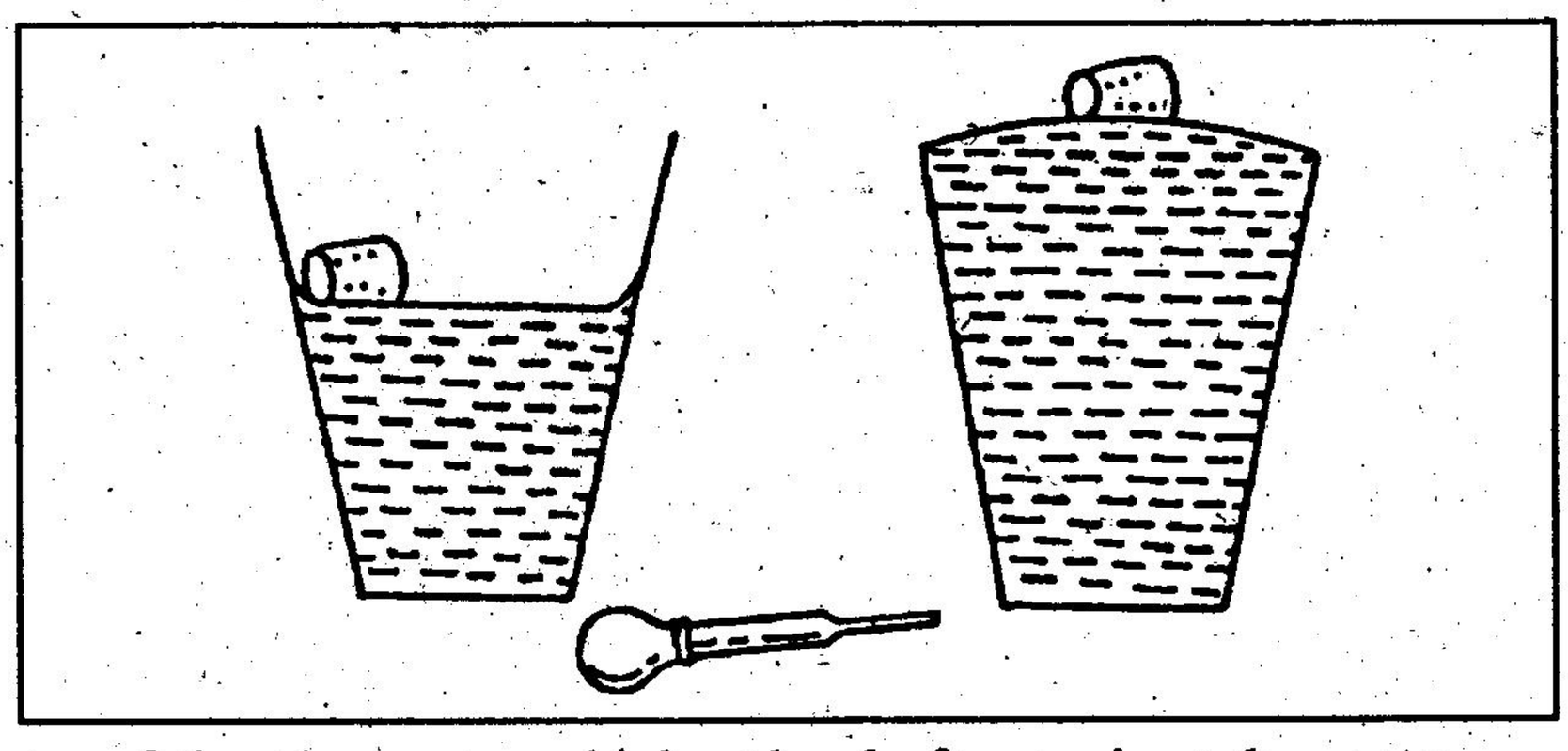
Characteristics of matter
Surface tension

## Materials

1. A glass tumbler and water
2. A piece of cork
3. An ink dropper

## What to do ?

1. Fill about three-fourths of the glass with water and release the cork in the water at the centre of the glass.
2. You will observe that the cork will move and attach itself to the side of the glass as if the glass were attracting it.
3. Now fill the glass with water till it is full to the brim. Go on adding water with the help of the ink dropper till the water surface becomes convex. You will observe that the cork slowly comes to the centre of the glass.



## Students to enquire

1. When the glass is partly filled with water where is the level of water the highest ?
2. Why does cork stick to the side of the glass when the glass is partly filled ?
3. When the glass is full to the brim, where is the level of water the highest ?
4. When the glass is filled to the brim with water, why does the cork come to the centre ?
5. How can you put more water in the glass even after the glass is full ?

## Explanation

1. When the glass is partly filled, the level of water is the highest at the edges where the water touches the glass.
2. There is adhesive force between the molecule of glass and water. This force raises the water at the edges. The floating cork occupies the highest position. Hence, the cork strikes to the side of the glass.
3. When the glass is filled to the brim, the highest level of water is at the centre.
4. When the glass is filled with water to the brim, the cork floats at the centre of the glass where the level of water is the highest. In this situation when the water makes a convex surface, only surface tension and cohesive force work.
5. Owing to surface tension the surface of water in the glass behaves like a stretched rubber membrane. Because of surface tension and cohesive force between water molecules, the glass can be filled to the brim with water.

Characteristics of matter
Surface Tension

# How many coins can go in 34

## Materials

1. A glass of water
2. Liquid soap
3. 50 ten paise coins

## What to do ?

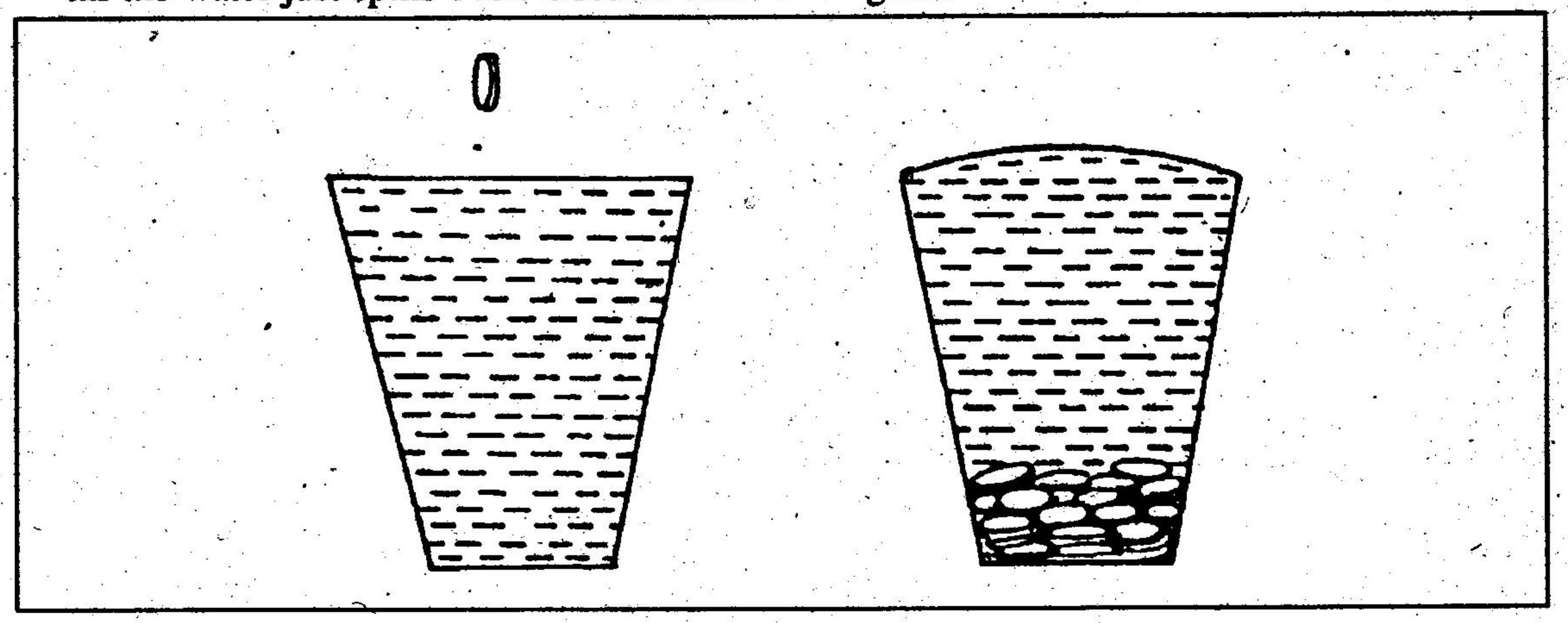
1. Take a glass full of water.
2. Now, drop one by one coins into the water till the water just spills over. Observe that the water surface has become convex.
3. Take out the coins. Add a little liquid soap to the water and repeat the experiment. You will observe that water starts spilling over with fewer coins dropped into the water.

## Students to enquire

1. Before water started spilling over how many coins could go into the water in the first and the second experiments ?
2. What was the shape of the water surface in the first experiment when the glass was full to the brim before spilling ?
3. Why in the first experiment more coins could be dropped without spilling ?
4. Why in the second experiment water spilled out so easily with fewer coins dropped into the water ?

## Explanation

1. The number of coins that can go in will depend upon the amount of water in the glass.




2. In the first experiment the surface of water was convex when the glass became full to the brim.
3. It is the surface tension of water which allows more coins to go into the water without spilling.
4. When soap is added the surface tension of water is reduced, because the cohesive force between the molecules is reduced. Owing to this, the surface of water cannot become convex. Hence the water spills out with fewer coins dropped into it.

35

# Driving a paper boat by soap

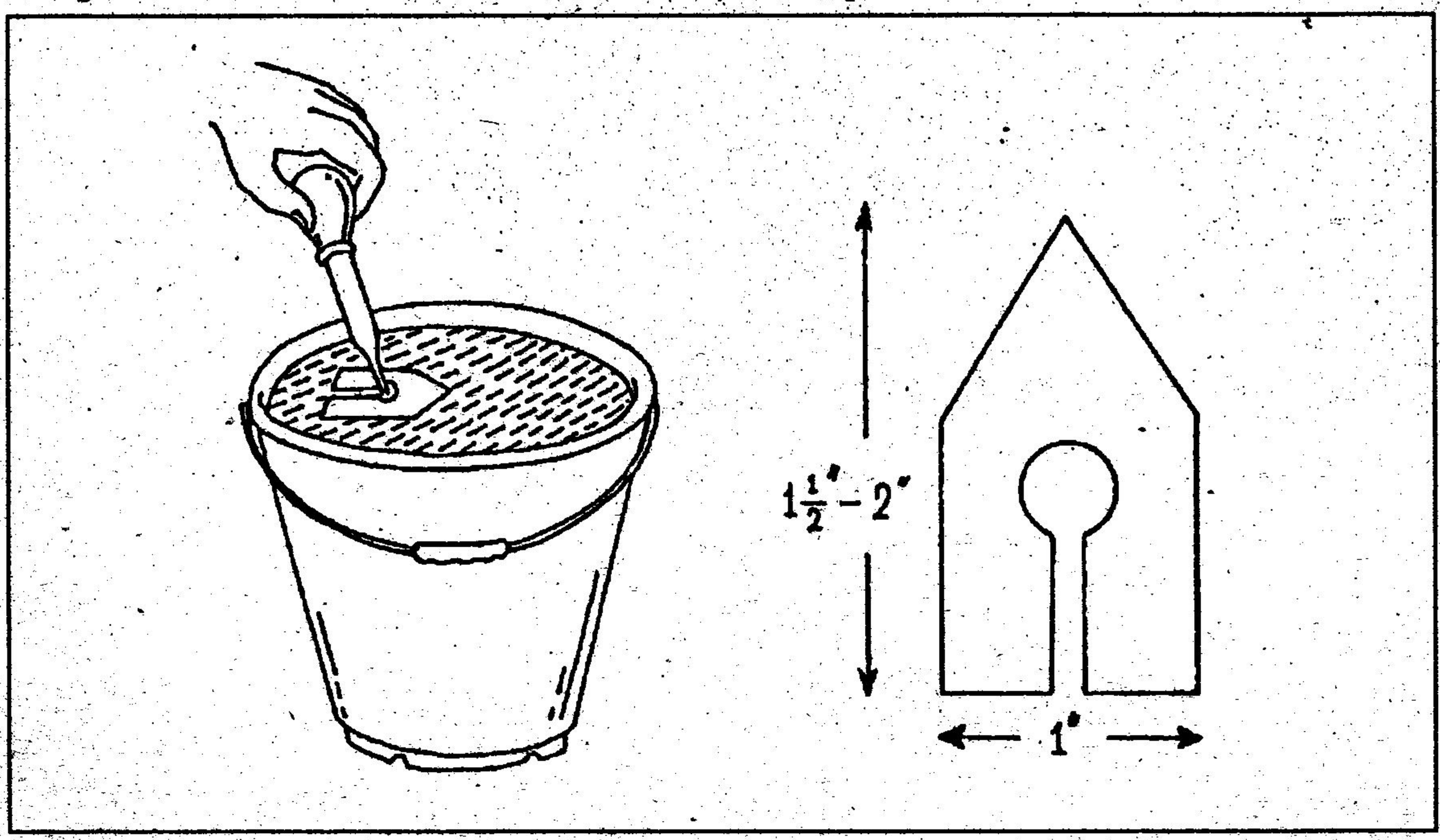
Characteristics of matter
Surface tension

## Materials

1. A hard card
2. A bucket of water
3. Soap solution
4. An ink dropper.

## What to do ?

1. Cut the card into the shape of boat as in the figure.




2. Release the paper boat in the bucket of water. Bring the boat to an edge with its pointed end pointing towards the centre of the bucket.
3. Now pour two drops of soap solution with the help of the ink dropper on the circular portion of the boat. You will observe that the boat will move towards the centre of the bucket.

## Students to enquire

1. Why does the paper boat move forward towards the centre of the bucket ?

## Explanation

1. When soap solution is dropped on the circular portion of the boat, surface tension of the place gets suddenly reduced. But surface tension works in front. Owing to this, the boat is pulled forward. One may experiment with different shapes of boats. Also soap solution may be dropped on different portions around the boat. Everytime the experiment has to be conducted, fresh water has to be taken.

Characteristics of matter
Molecular structure

# Where does the water vanish

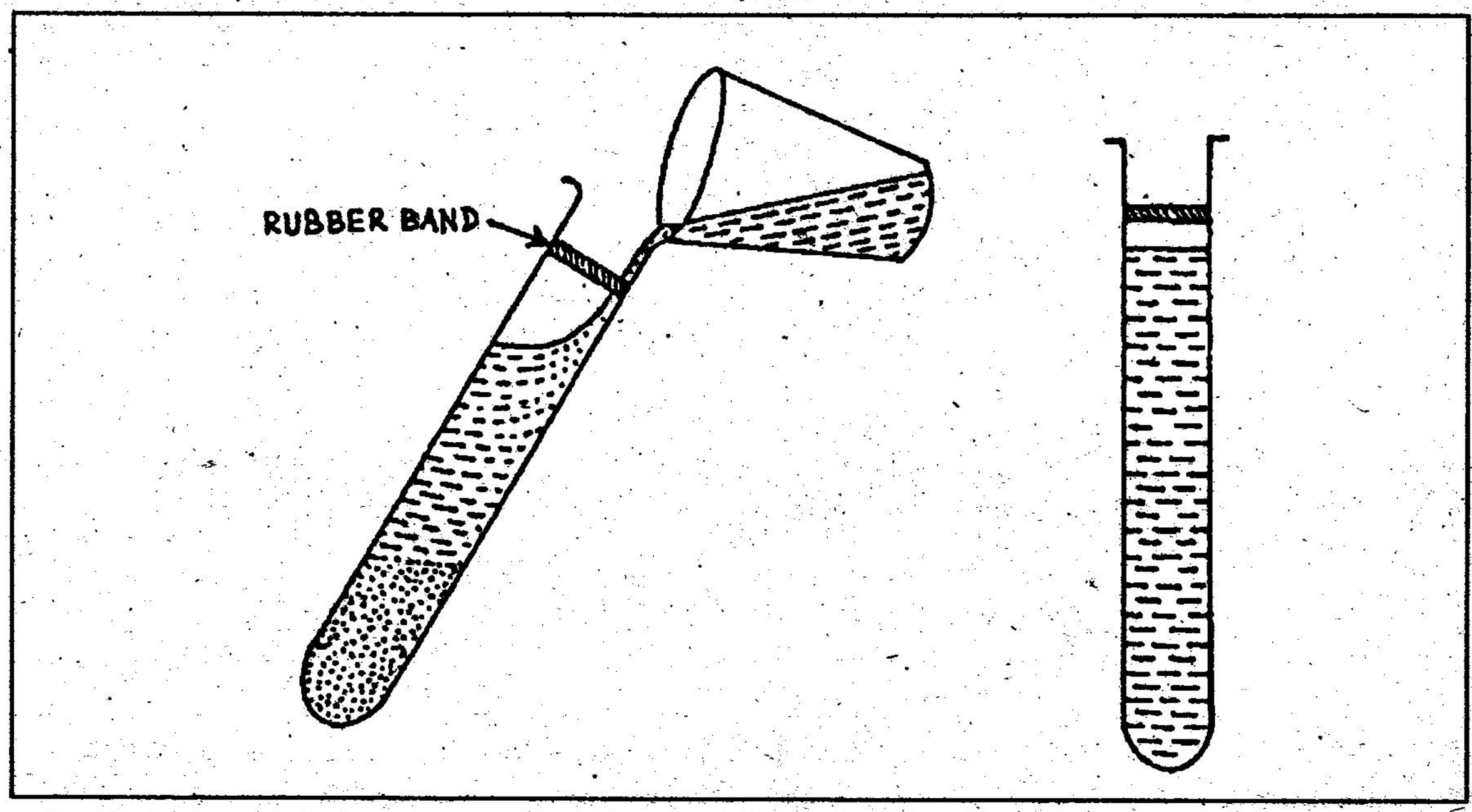
36

## Materials

1. Two test tubes
2. Table salt-one packet
3. A glass tumbler, a rubber band and water

## What to do ?

1. Take one-third test tube of salt.




2 Take water in the other test tube and pour water gently into the test tube with salt in such a way that salt and water stay separately and do not get mixed up.
3. Mark the height of water in the test tube with the rubberband.
4. Now, close the mouth of the test tube by your thumb and shake it so that the salt may dissolve in the solution.
5. Keep the test tube in the glass for some time.

You will observe that the water level has gone down below the rubber band.

## Students to enquire

1. Why did the water level go down ?
2. Conduct the same experiment with other materials.

## Explanation

1. When salt goes into the solution the molecules of salt break up into sodium and chlorine ions. These ions are much smaller in size compared to the size of salt or sodium chloride molecules. These ions occupy the intermolecular space of water molecules. Owing to this the overall volume becomes less and the water level goes down.

37

# How much water it can hold

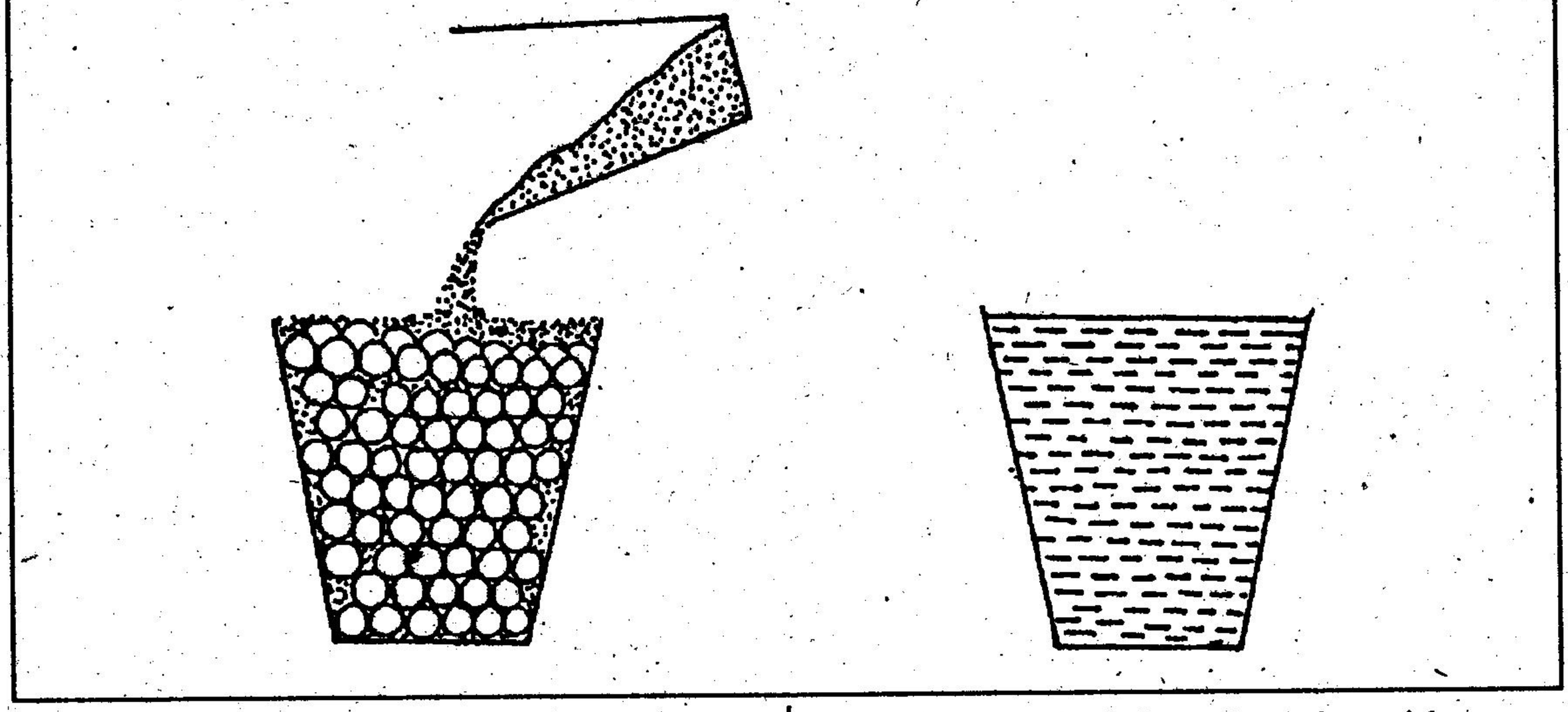
Characteristics of matter
Molecular structure

## Materials

1. Three tea cups
2. 30-40 marbles
3. Dry sand

## What to do ?

1. Fill a cup to the brim with the marbles.



2. Go on adding sand till the container is full to the brim with marbles and sand. Shake well and fill.
3. Now go on adding water to the mixture till the water starts overflowing.

## Students to enquire

1. How can sand and water go into the cup that is full to the brim with marbles ?
2. If you fill a cup to the brim with water, can you put the marbles and sand ?
3. What inference can you draw about the molecules of different materials ?

## Explanation

1. There is space in between the marbles. Sand particles being smaller can go into this space. Water molecules, being still smaller than the sand particles, can go into the space between the sand particles.
2. If the cup is full to the brim with water, marbles or sand cannot go in. Inter-molecular space in water is very small. Marbles and sand particles are too big to go into the intermolecular space of water.
3. Marbles, sand grains and water are examples to show that molecules of different substances have different sizes. It has to be understood that molecules are very very small and cannot be seen even by ordinary microscopes.

Characteristics of matter
Molecular structure

# Liquid mixtures lose volume

38

## Materials

1. Two test tubes
2. Methyl or ethyl alcohol
3. A rubber band

## What to do ?

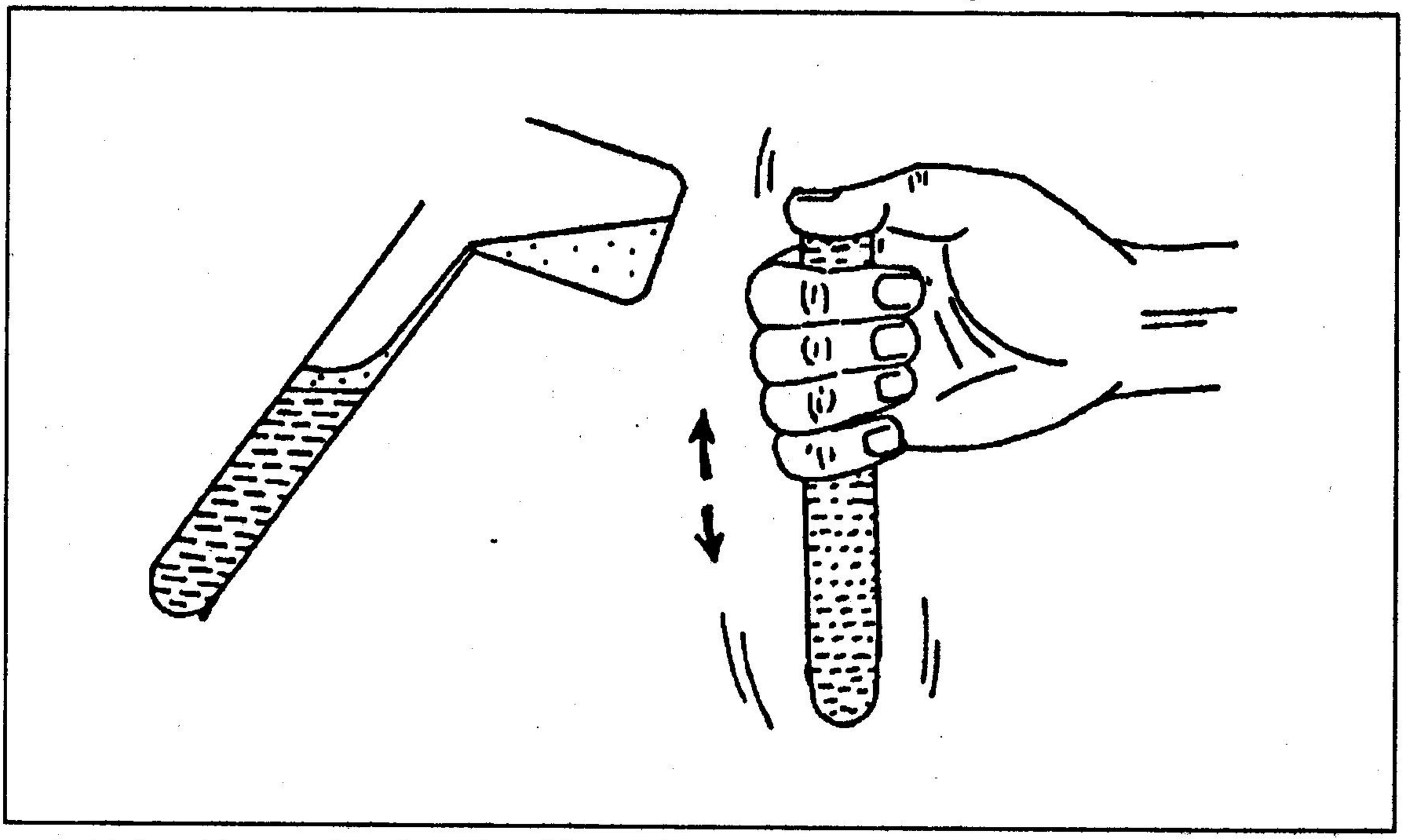
1. Fill half of a test tube with water.
2. Take alcohol in the other test tube. Hold the test tube with water in a slanted position and pour the alcohol very carefully into it till the test tube is nearly full.
3. Mark the height of the alcohol above water with the rubber band.
4. Close the test tube with your thumb and shake the test tube so as to mix the alcohol with water well. Observe that the level of the liquid mixture has gone down.

## Students to enquire

1. Why does the level of liquid mixture go down ?

## Explanation

1. When the test tube is shaken the alcohol and water mix together. The water and alcohol molecules have intermolecular space. The molecule of alcohol is smaller than water molecules. Hence, the alcohol molecules enter into the intermolecular space of water molecules. Hence, the total volume of the mixture becomes less. This experiment proves that there is intermolecular space.



39

# Which balloon shrinks more

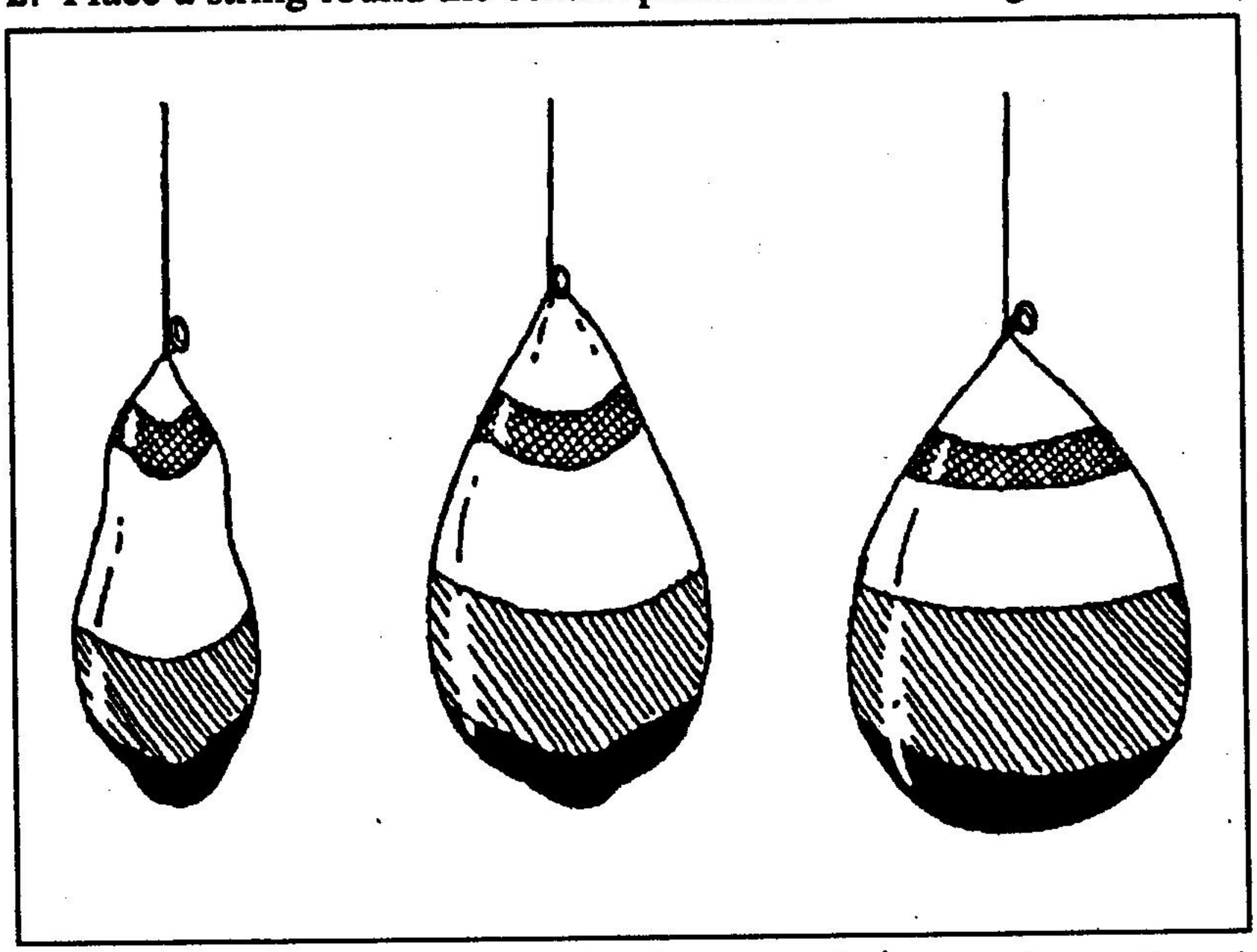
Characteristics of matter
Molecular structure

## Materials

1. Three balloons
2. String
3. Meter scale

## What to do ?

1. Blow the balloons to full, half and quarter, sizes and tie them with strings.
2. Place a string round the central position of each balloon and measure the diameter of the balloons with the help of the scale.
3. Keep the balloons for observation next day.
4. Measure the diameters of the balloons again. You will observe that though the balloons are tied tightly at the mouth, the fully blown balloon has decreased in size much more than smaller ones. The bigger the size of the balloon, the more is the rate of losing air.



## Students to enquire

1. What made the balloons shrink in size ?
2. If you keep the balloons for a day more, what will happen to the balloons ?
3. Why is the rate of shrinking more in the biggest balloon ?
4. Where do you find the same thing happening in our daily life ?

## Explanation

1. The size of the molecules of which the air is made is much smaller than the intermolecular space of the material of which the balloon is made. Though the balloon membrane is made up of different layers of molecules the smaller air molecules can easily pass through the intermolecular space. The increased pressure inside the balloons drives air out of the balloons though intermolecular space of rubber.
2. The balloons will shrink further if you keep the balloons for one day more.
3. As the difference in pressure is more in the biggest balloon, the rate of shrinking is the highest in that balloon.
4. If cars remain standing at a place for a long time, then the tyres will deflate slowly.

Characteristics of matter
Gravitation

# Which falls earlier

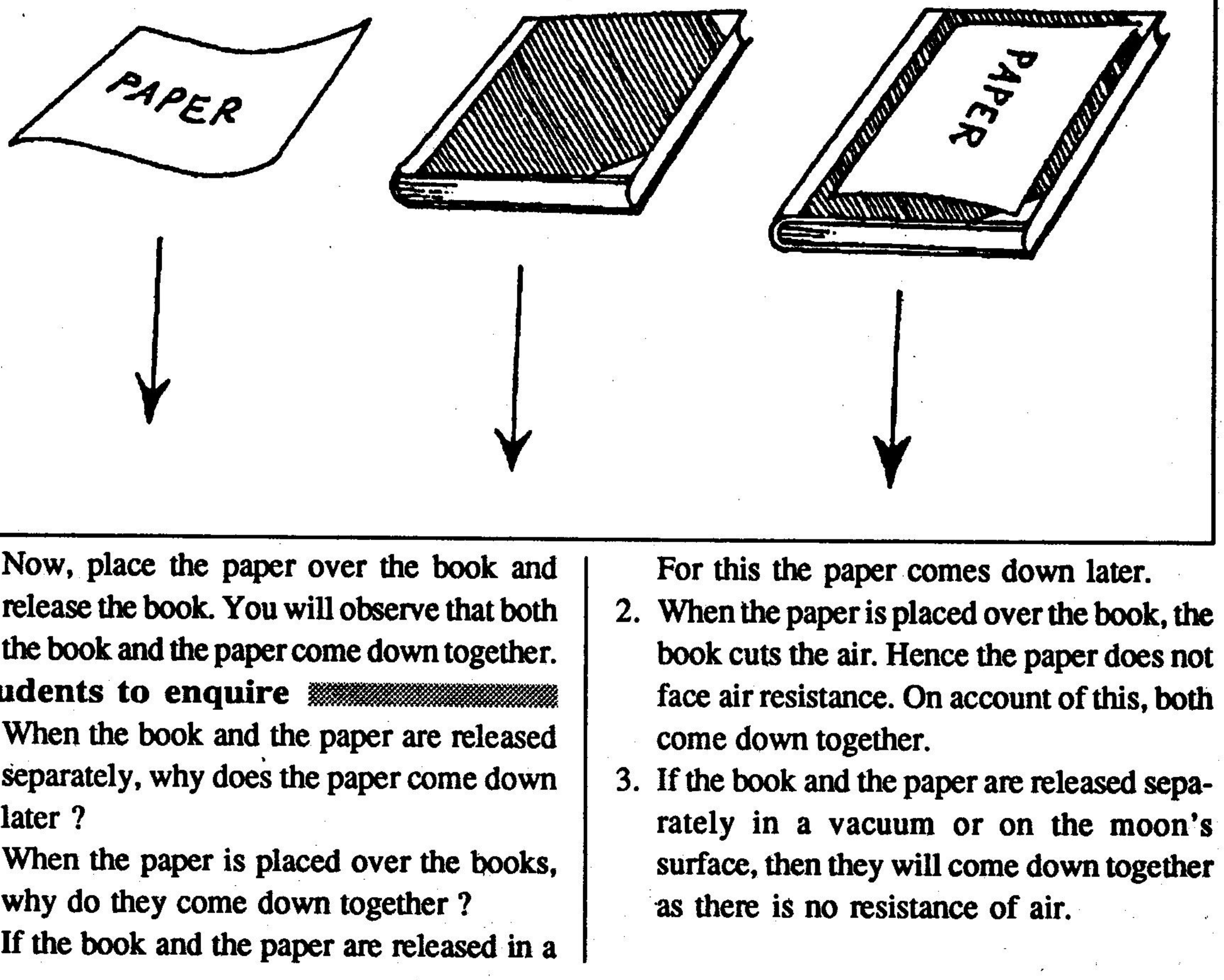
40

## Materials

1. A book
2. A piece of newspaper smaller in size than the book

## What to do ?

1. Release the book and the paper separately. You will observe that the paper floats and come down to the floor later than the book.




2. Now, place the paper over the book and release the book. You will observe that both the book and the paper come down together.

## Students to enquire

1. When the book and the paper are released separately, why does the paper come down later ?
2. When the paper is placed over the books, why do they come down together ?
3. If the book and the paper are released in a vacuum or on the moon's surface, what will happen ?

## Explanation

1. The book and the paper have to fall through the air. As paper is very light in weight it comes down floating owing to the resistance of air. The book is heavier. Hence, it can cut through the air better. For this the paper comes down later.
2. When the paper is placed over the book, the book cuts the air. Hence the paper does not face air resistance. On account of this, both come down together.
3. If the book and the paper are released separately in a vacuum or on the moon's surface, then they will come down together as there is no resistance of air.

# 41 Weightlessness

Characteristics of matter
Weightlessness

**Materials**

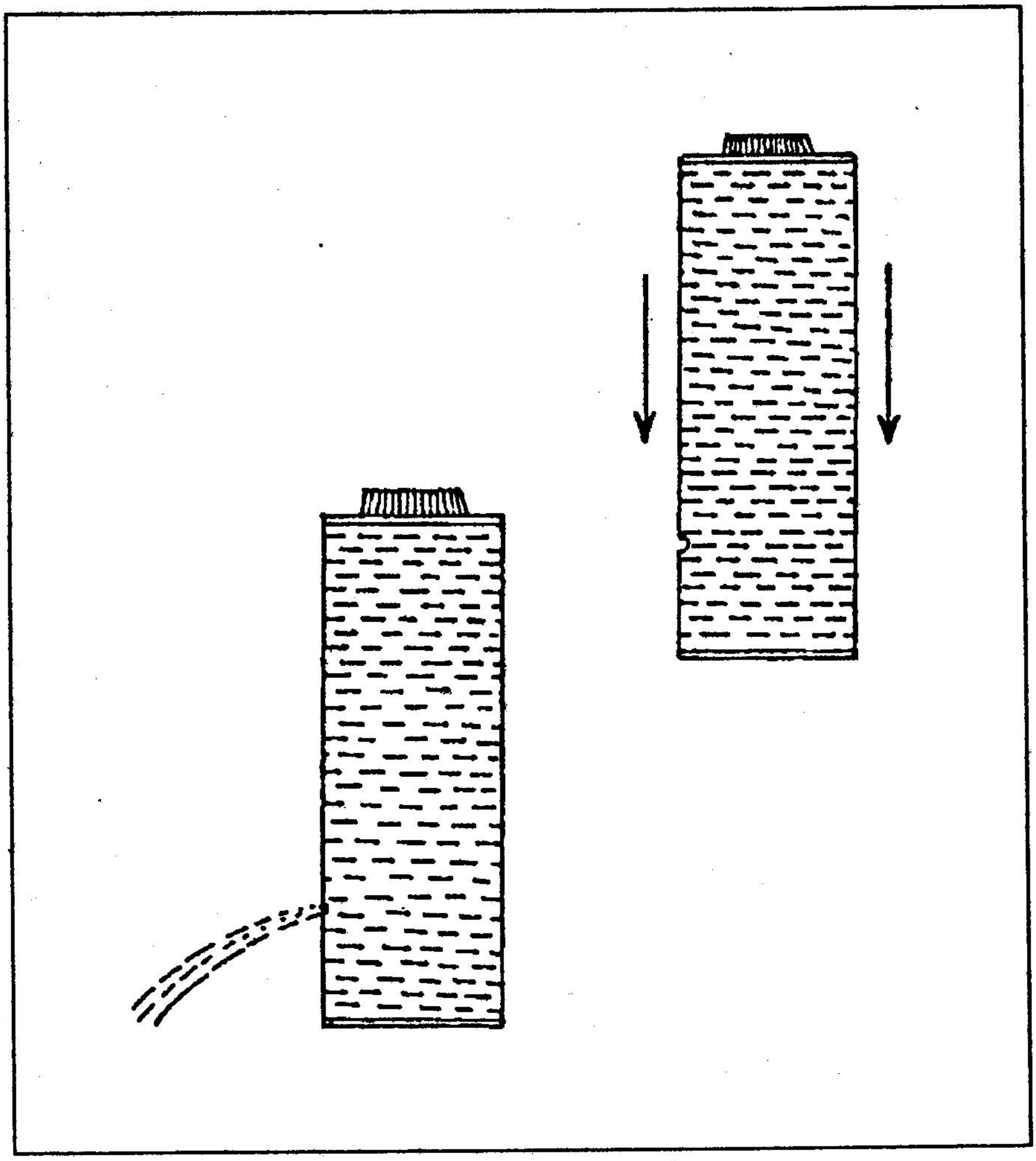
1. An empty powder can with a hole at bottom.

**What to do ?**

1. When you fill the can with water it gushes out through the hole.
2. But, when you let the can full of water fall freely to the ground, water stops falling immediately you release the can.

**Students to enquire**

1. Why is the water falling in the first case ?
2. When you release the can, why does water stop falling?



**Explanation**

1. Liquids exert pressure. As a liquid substance has weight, pressure is experienced. Hence, when there is a hole, water gushes out.
2. When the tin is released, it falls freely. A freely falling body has no weight. Weight comes in a body when the force of gravity is resisted. When the tin falls there is no weight of water. Hence, there is no pressure of water. This is why water stops falling when the can is released.

Characteristics of matters
Laws of floating

# Sinking and floating

42

## Materials

1. Three small containers one empty, one partially filled with sand and the third full of sand.
2. Water in a bucket.

## What to do ?

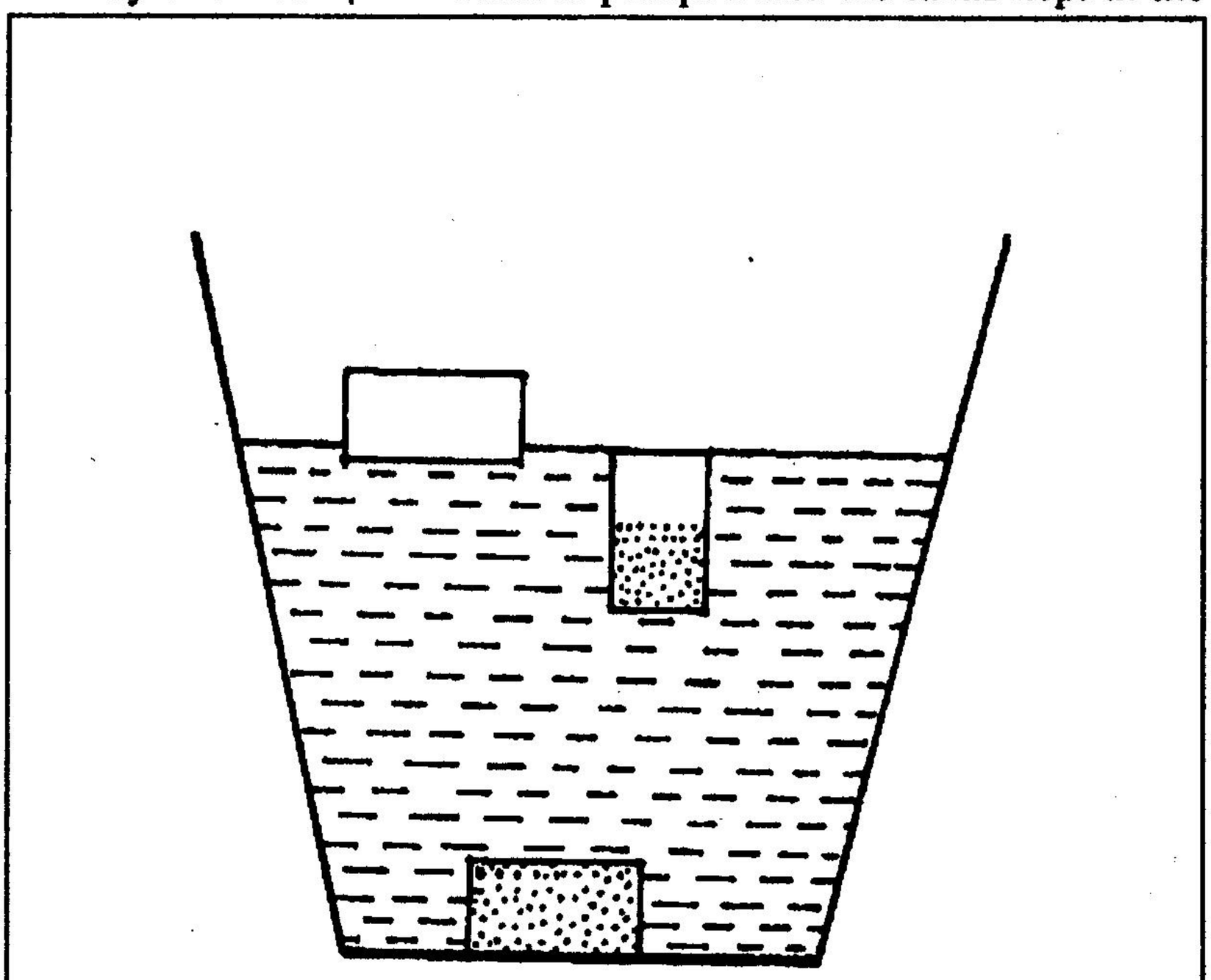
1. Drop the three containers one by one into the water in the bucket. Observe what happens.

## Students to enquire

1. What happens to the three containers when you drop them into water ?
2. What makes a container float ?
3. What makes the container full of sand sink ?
4. In which machine is the principle of floating and sinking utilised ?

## Explanation

1. The container full of sand sinks. The container partially filled with sand floats fully immersed in water. The empty container floats partially immersed.
2. A force or a thrust exerted by water makes a container float if the thrust or force is more or equal to the weight of the container. This upward thrust by water is called buoyancy.
3. The container full of sand sinks because the weight of the container is more than the thrust or force exerted by water on the container.
4. This principle is utilised in submarines. When a submarine is required to sink, sea water is pumped into the tanks kept in the submarine. The submarine becomes heavy and it sinks. When it wants to float up, water is pumped out into the sea to make it light.



# 43 Energy due to motion and position

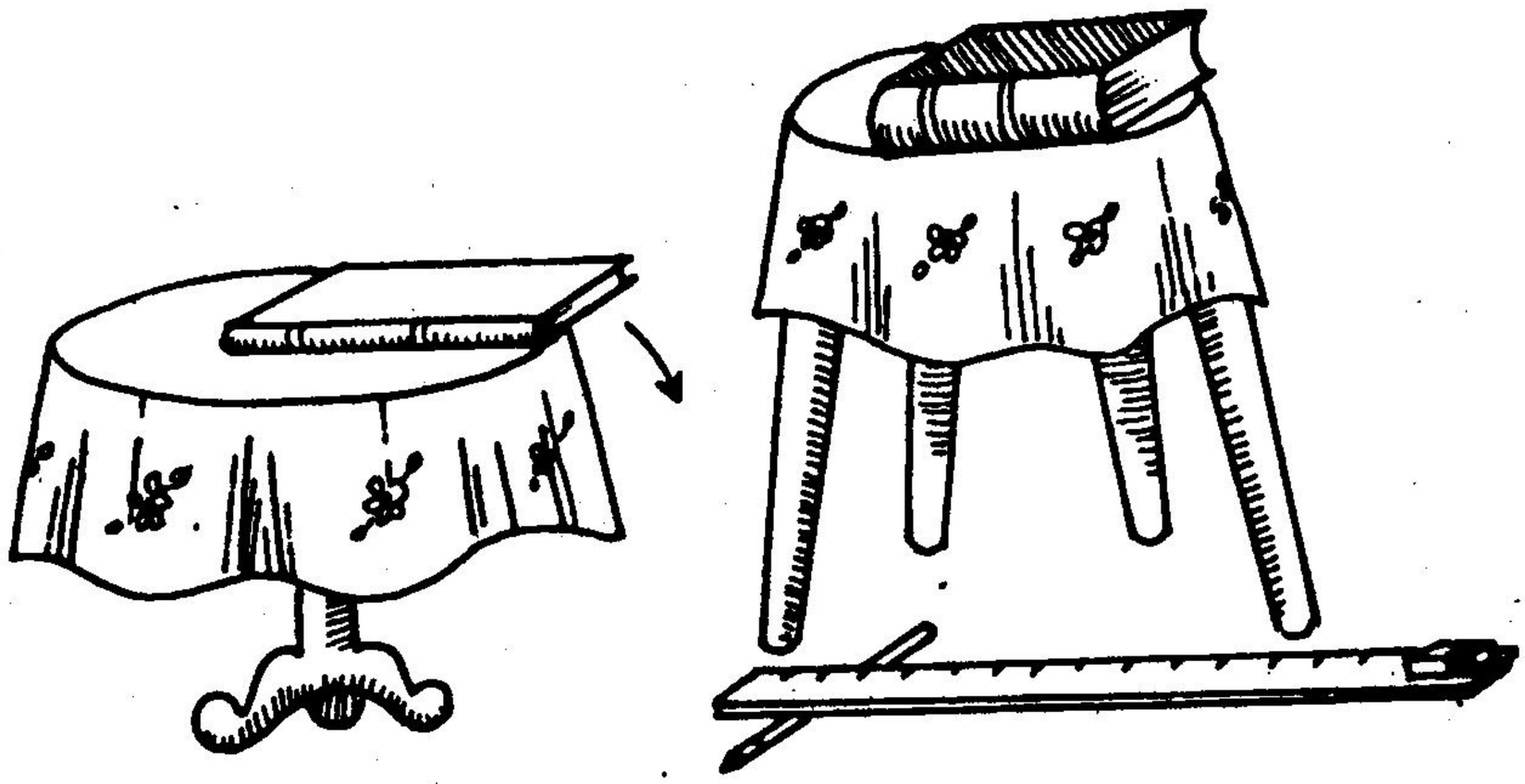
Energy
Kinetic & Potential energy

**Materials**

1. A pencil
2. A rubber
3. Two books one thin and the other thick
4. Two stools of different heights
5. A meter scale

**What to do ?**

1. Keep the thin book on the low stool.
2. Keep the scale in such a position near the stool that if the book falls then it falls on one end of the scale.
3. Keep the pencil below the scale 4" away from the end where the book is likely to strike the scale.The scale becomes a lever with the pencil as its fulcrum.
4. Keep the rubber at the other end of the scale.
5. Now slide the book to fall on the scale.You will observe that the rubber will jump.
6. Now take the taller stool and repeat the experiment. You will observe that the rubber will rise to a great height.
7. Now repeat the experiment with a heavy book. You wil observe that the rubber rises to greater heights.



**Students to enquire**

1. When the book is on the stool, what kind of energy is there in the book ?
2. When the book strikes the scale, what kind of energy is there in the book ?
3. What kind of energy does the rubber get

when the book strikes the scale ?

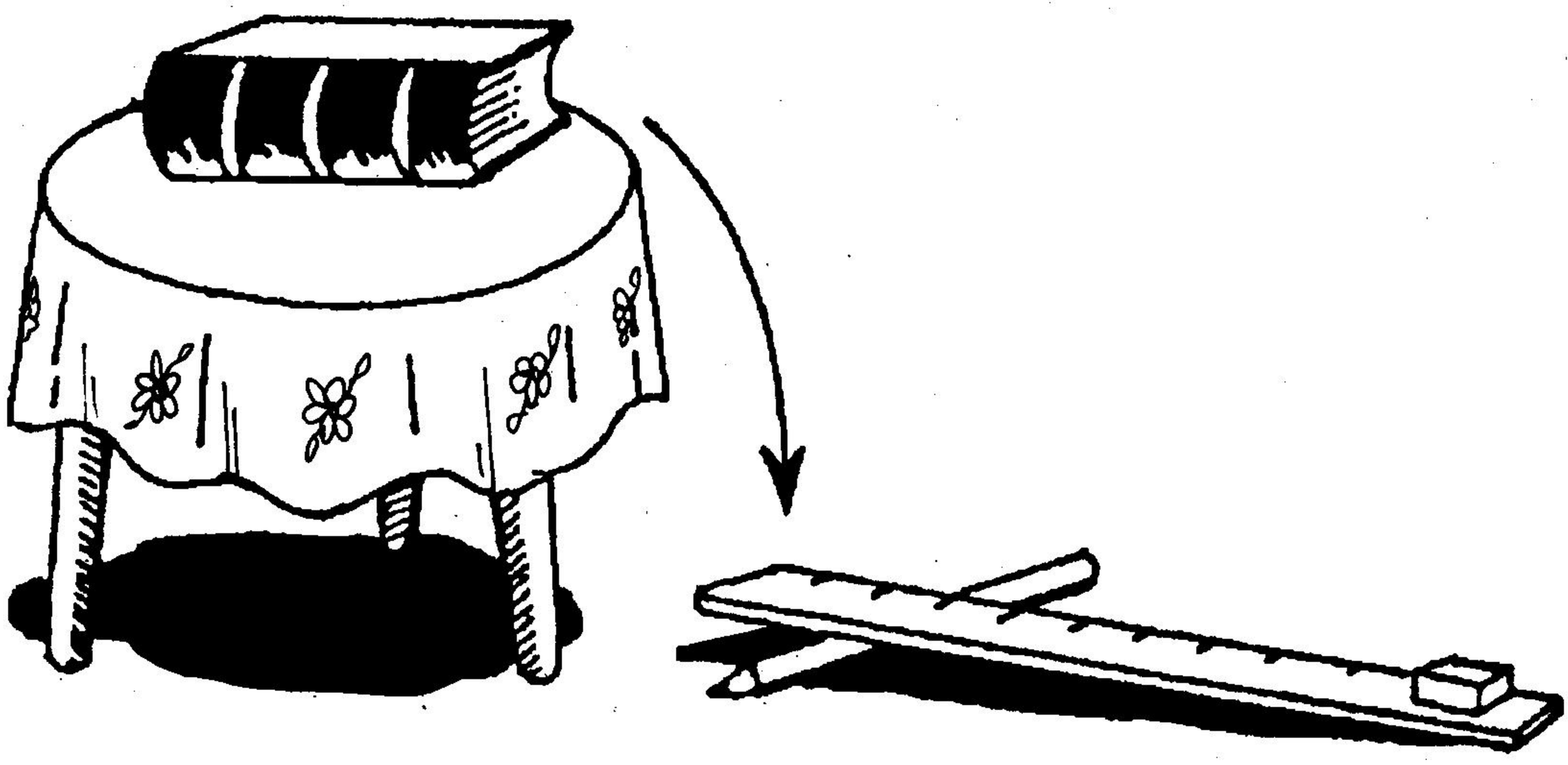
4. What is the primary source of energy that makes the rubber jump up ?

**Explanation**

1. When the book is on the stool there is potential energy in the book.
2. When the book strikes the scale, mechanical

the kinetic energy is the maximum and the potential energy is zero.

3. The rubber jumps up because of the application of the mechanical energy. When the rubber is moving up it has kinetic energy. As the rubber moves up, its kinetic energy decreases but its potential energy increases.



energy works on it. But when the book is falling, it has both potential and kinetic energy. As the book nears the scale it speeds up and thereby its kinetic energy goes on increasing and its potential energy goes on decreasing. Just as the book strikes the scale

4. One has to use muscle energy to raise the book to the top of the stool. Muscle energy comes from food. Plants make food through photosynthesis. Photosynthesis takes place in the presence of sunlight. Hence the primary source of energy is solar energy.

44

# Energy by shaking

Energy
Transformation of energy

## Materials

1. A conical flask with a rubber stopper.
2. Dry sand
3. Thermometer

## What to do ?

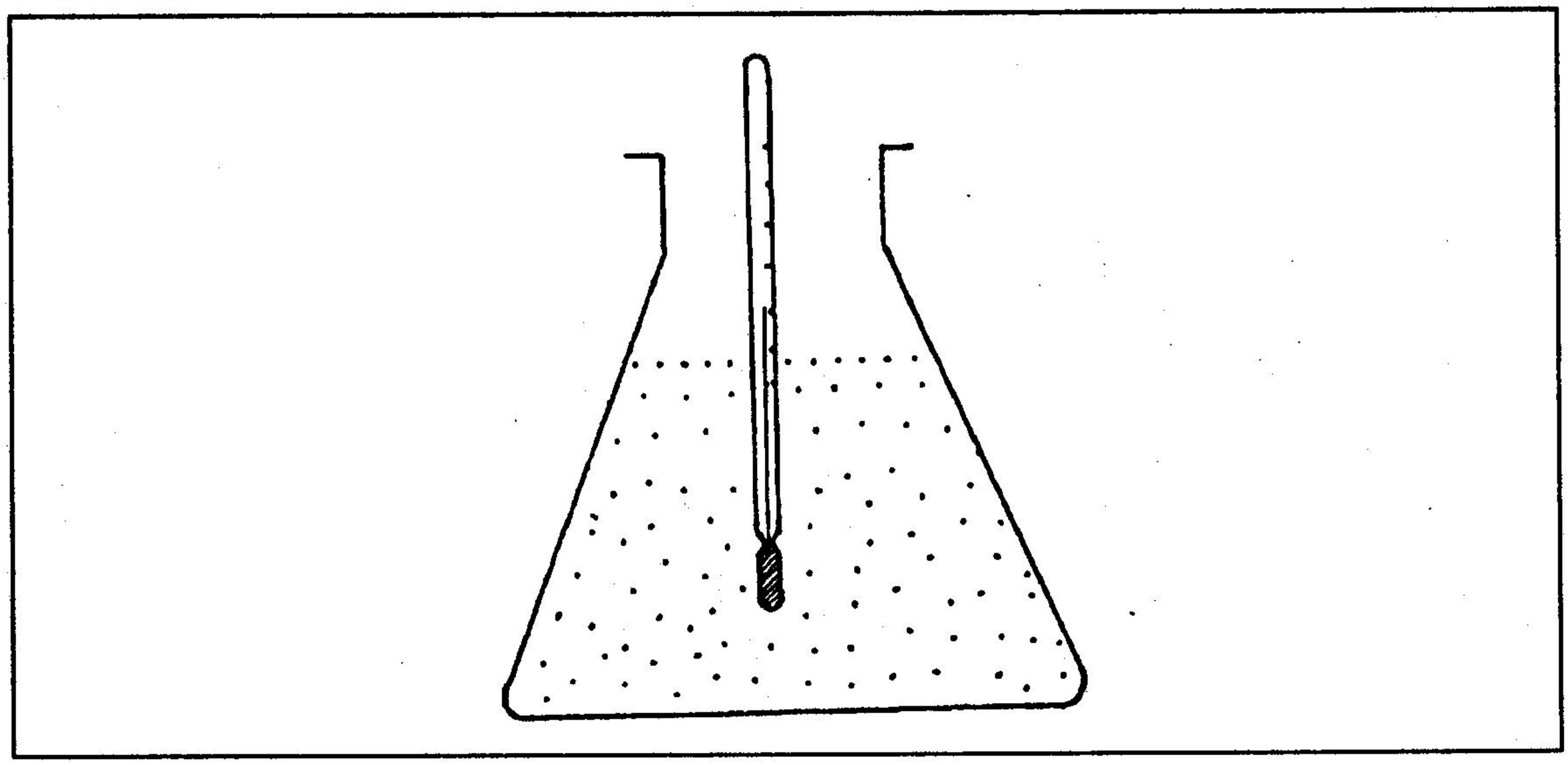
1. Take sand in the flask. Introduce the thermometer into the sand and note down the temperature.
2. Take out the thermometer and close the mouth of the flask with the stopper. Shake the flask for a few minutes.
3. Open the stopper and introduce the thermometer into the sand again and measure the temperature, you will observe that the temperature has increased.

## Students to enquire

1. Why does the temperature increase when the sand is shaken ?
2. Which kind of energy is transformed into heat ?
3. What is the primary source of energy that is transfered ?

## Explanation

1. When the flask is shaken, the sand gets kinetic energy.The sand particles rub against one another when the flask is shaken. The temperature of sand increases because of friction.
2. When the flask is shaken, mechanical energy is put forth on the sand. The mechanical energy is converted into heat energy.
3. Mechanical energy is obtained through muscle energy which in turn is obtained through the intake of food. Plants prepare food through photosynthesis. Hence solar energy is the primary source of energy.



Energy
Solar energy

# Burning paper

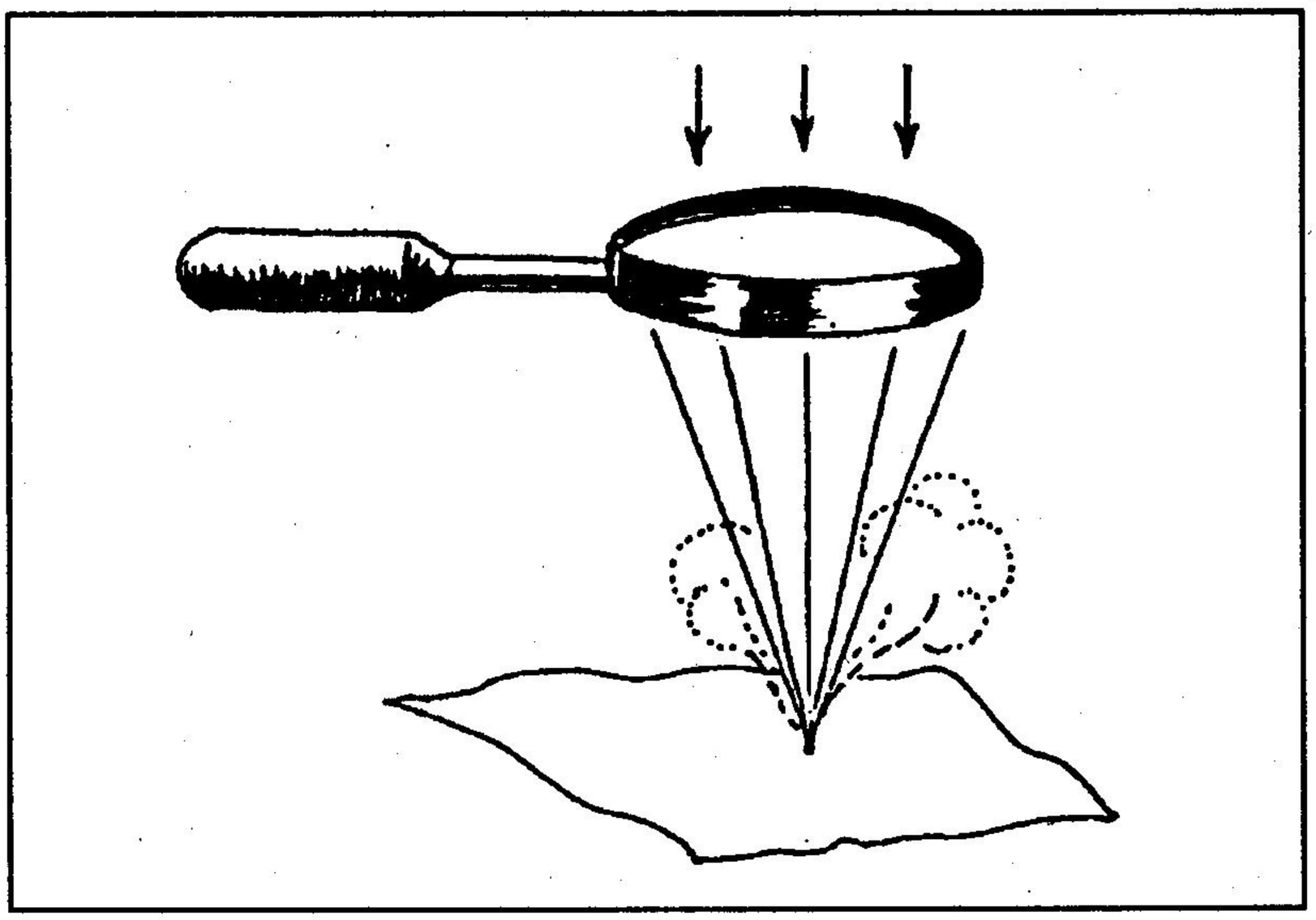
45

## Materials

1. A powerful magnifying glass
2. A piece of newspaper or very thin paper

## What to do ?

1. Go out in the sun. Try to concentrate sunlight on the paper by holding the magnifying glass 20-25 cm. above the paper. When the light is concentrated to a bright point on the paper you will find that the focussing is perfect.
2. If you hold the magnifying glass in this position for about 15-20 seconds, you will observe that at first smoke will rise from the paper and then the paper will catch fire.



## Students to enquire

1. Why does the paper catch fire ?
2. Why does not the paper catch fire in sunlight without the magnifying glass ?
3. On what will depend how far above the paper you should hold the magnifying glass ?
4. What does the magnifying glass do to sunlight ?
5. What else can you burn with the help of sunlight ?

## Explanation

1. The magnifying glass focuses the sun's rays to a point. For this the solar energy is increased by about 100 to 200 times and the temperature of the paper is raised above its ignition point when the paper catches fire.
2. If there is no magnifying glass, solar energy is distributed over a wide area and energy per unit area is not sufficient to raise the temperature of the paper above its ignition point. Hence, the paper does not catch fire.
3. The focal length of the magnifying glass will determine how much above the paper the magnifying glass has to be held.The greater the convexity of the glass, the more powerful will it be with its focal length reduced. If the focal length is less, the lens has to be held nearer to the paper.
4. The magnifying glass concentrates sunlight at its focus.
5. Dry leaves can be burnt by sunlight. If the magnifying glass is very powerful, then even thick paper can be burnt.