ASK WHY

A series of experiments for learning about the method of science

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First Edition : July 2018

Authors' Team - Contact @ geetamahashabde@gmail.com
Dr. Vivek Monteiro, Geeta Mahashabde, Deepak Gokhale
Neelima Sahasrabudhe, Khushboo Kumari

Photos
Dr. Chaitanya Guttikar

Cover Design

Thanks to -
All India Peoples' Science Network, Vipula Abhyankar
Navnirmiti Learning Foundation, Navnirmiti Eduquality Foundation
Kumar Gokhale, Tanaya Khanvelkar, Sanika Pawar, Rutvik Barbhai

Supported By -
Swati More
Varsha Khanvelkar

CONTACT - navnirmitilearning@gmail.com, 9850303396

For materials contact at
navnirmitilearning@gmail.com
navnirmitieduquality@gmail.com

National Scientific Temper Day - August 20

Statement On
Promoting Scientific Temper and Observing 'National Scientific Temper Day.'

As citizens of India as well as part of the world community of the 21st Century, it is one of our fundamental and civilizational duties "to develop and promote the scientific temper, humanism and the spirit of inquiry and reform;", as per article 51 A(h) of our Constitution.

We believe that this task has not received the attention and commitment it deserves and calls for, and on the contrary, there is a very worrying and disturbing atmosphere being whipped in the opposite direction. There is therefore an urgent need to take it up with much vigour and enthusiasm in a systematic and sustained manner at all levels. The role of schools, colleges and the educational institutions is particularly important and critical in taking it forward. Promoting scientific temper is not only the work of scientists, but of all citizens in Indian democracy.

Dr. Narendra Dabholkar was one of the foremost proponents of scientific temper in recent times. Through his lectures and writings, he spread the message of scientific temper among all sections of society. It is therefore particularly appropriate that 20th August, the day on which he was martyred should be observed as 'National Scientific Temper Day' all over the country.

We the undersigned, endorse and support this move, and appeal to all informed and concerned people as well as all educational institutions, organizations to join in this collective national endeavour for observing 'National Scientific Temper Day', towards building an India of reason and humanity with well informed and rationally empowered citizens.

ENDORSED BY :

Dr. Jayant Narlikar
Dr. Vidyanand Nanjundiah
Dr. Sabyasachi Chatterjee
Dr. Vinod Mubayi
Dr. Mihir Arjunwadkar
Dr. Titus K Mathew
Geeta Mahashabde
Dr. S. R. Bhandari
Dr. Naresh Dadhich
Dr. Vivek Monteiro
Dr. Satyajit Rath
Dr. Priyadarshini Karve
Nissim Kanekar
Shanta Laishram
Neelima Sahasrabuddhe
Mugdha Karnik
Arvind Gupta
Dr. Spenta Wadia
Dr. K. Subramaniyam
Dr. Prajval Shastri
Uday Nakade
Dr. Subhojit Sen
Patric Das Gupta
Prafull Pandav

and many other scientists, science activists and educationists

What Is Scientific Temper

Scientific Temper is based on applying the method of science for understanding the real world - both nature and society.

The method of science is based on doing experiments, collecting evidence and always asking questions.

Dr. Narendra Dabholkar

Dr. Narendra Dabholkar , in one of his popular lectures has given a brief definition- In four words of Marathi :

“जेवढा पुरावा, तेवढा विश्वास”
“As much belief, as there is evidence for”

Gautam Buddha

Gautum Buddha, 2500 years ago, also gives similar guidelines for believing :
“Do not believe in anything simply because you have heard it. Do not believe in anything simply because it is spoken and rumored by many. Do not believe in anything simply because it is found written in your religious books. Do not believe in anything merely on the authority of your teachers and elders. Do not believe in traditions because they have been handed down for many generations. But after observation and analysis, when you find that anything agrees with reason and is conducive to the good and benefit of one and all, then accept it and live up to it.”

·The 1981 statement on Scientific temper puts it thus :

Scientific Temper involves the acceptance, amongst others, of the following premises:

a) that the method of science provides a viable method of acquiring knowledge;
b) that human problems can be understood and solved in terms of knowledge gained through the application of the method of science;
c) that the fullest use of the method of science in everyday life and in every aspect of human endeavour from ethics to politics and economics- is essential for ensuring human survival and progress; and
d) that one should accept knowledge gained through the application of the method of science as the closest approximation to truth at that time, and question what is incompatible with such knowledge; and that one should from time to time re-examine the basic foundations of contemporary knowledge.

Why this booklet?

On August 20th this year, and every year from now, we will observe ‘National Scientific Temper Day’ in India.

We live in a world of science and technology. But, as Indian citizens, we are far from thinking and acting scientifically. Despite modern technology, most people still do not have basic needs and live in insecurity. There is tremendous unscientific wastage of precious natural resources. Religious and ethnic prejudice and hate are being propagated. We are asked to believe in many things without questioning. The television networks are full of fake news . Claims are being made that the stories from mythology are real history, that we had television, internet, and airplanes thousands of years ago. Darwin's theory of Evolution is one of the greatest achievements of modern science, but some of our national leaders say that it should not be taught in schools. Similar statements are made by national leaders in other countries like Turkey, USA and Saudi Arabia. All over the world, there is an attack on scientific thinking.

How can we distinguish between true and false statements, between illusion and reality? How can we learn to spot deception, fake news and fake, pseudoscience ?

We need scientific temper to become more and more widespread. On the previous page we said that ‘scientific temper is based on understanding the real world around us with the method of science.’

What is the method of science? This booklet of simple experiments is a small and partial introduction towards understanding the method of science. You can do each and every experiment yourself. Is the pin upright, or upside down ? What we see must be examined carefully and critically. Logical sounding arguments may not be correct. But by questioning and critical thinking, we can step by step arrive at reliable understanding.

Scientific method is asking 'Why?', always, and all ways.

CONTENTS

What is the method of science ?
The method of science is :
Understanding why;
by doing, observing, reasoning
and always asking 'why?'

ACTIVITY 1

Hole in the hand

Take an A4 size sheet of paper (or a sheet of newspaper). Roll it lengthwise so as to make a roll of about 2 cm diameter and 30 cm length. You may use sticky tape to firm up the roll, so that it doesn't unroll.

Hold the roll in your right hand. Close your left eye, and look through the roll only with right eye. You should see distant objects through the paper roll.

Keeping left eye closed, hold your left palm, facing towards you, and touching the roll, at about half the length of the roll.

Now open your left eye. With both the eyes open, what do you see?
You will see, as if your left palm has a hole in it and you are looking through the hole.

Isn't it funny and exciting? Why does this happen?

Look at one object through the paper roll with your right eye, keeping the left eye closed. Now if you close the right eye and open your left eye, where does the roll point? Does it point to the same object?

Try to figure out what left and right eye sees.

It is not only our eyes that see! Even though the left eye and the right eye see different scenes, since they are looking from different places, it is our brain that puts together what the left eye sees and what the right eye sees, and what we see is a single composite picture as integrated (put together) by our brain. We may say that we see with our eyes together with our brain.

What we see in this experiment is the composite picture as integrated (put together) by our brain, when each eye is seeing a very different picture because of the restriction of the paper roll.

Think now, about how you 'see' the hole. Do the next experiment to get a better understanding to your questions.

ACTIVITY 2

Shifting the classroom

Stand near a wall of the classroom, facing towards the room. Hold your index (pointing) finger upright and stretch your arm fully, so that the finger is at arm's length away from you. Align the finger to any vertical edge in the room, a corner, any window or door. Close your right eye and look at the finger with your left eye. Then close your left eye, and at the same time, open your right eye and look at the finger.

Do this again and again opening and closing right and left eye alternately, keeping your focus on finger. You will feel as if the room behind the finger is shifting towards left and right alternately.

Why?

As discussed earlier in experiment 1, our left eye and right eye see separate images, which are overlapped and we get a sense of 'seeing' our surroundings. Because of the distance between our eyes, these separate images are slightly different. With the eyes making different angles with the finger, objects exactly falling behind the finger are different. Since our focus is on finger, the background appears to be relatively shifted and we feel as if the room is shifting.

Think – What Is there in common between this experiment and the previous 'hole in the hand' experiment ?

ACTIVITY 3

An extra finger

Sit upright on a chair. Keep a coin on the floor in front of the chair. Now, touch the tips of the index fingers or thumbs of each hand to each other. Hold the tips of your touching fingers in the same line of sight as the coin on the floor. Open both your eyes and look towards the coin.
Can you see a third finger formed between your two fingers?

Why?

Based on the earlier two experiments you should be able to explain what is happening here.

ACTIVITY 4

The Surya Sandesh Card

Cut out the Surya Sandesh card which is on the last page. Using a cutter, carefully remove the various symbols. Hold the Surya Sandesh card close to the ground in the sunlight. Examine the shadow cast by the card. You will see the various signs on the card projected on the ground. Now slowly raise the card towards the sun as high as possible. The different signs all become the same. They all become circles of light, circles of our broadening understanding. As you go higher and higher, the circles touch each other, an expression of unity, of coming together, of our essential oneness as human beings, as citizens of secular India and as citizens of planet earth.

This is not a miracle, but a scientific phenomenon. The circles of light that you see are all images of the sun. They are round because the sun is round. Therefore the poem on the card has 'Many Signs, One Sun'. This effect is known as pinhole projection or pinhole camera.

SURYA SANDESH

तमसो मा ज्योतिर्गमय

From Darkness to Light

Many Schools, One Experiment.

Many Signs, One Sun.

Many Faiths, One God.

Many Races, One Human.

Many Cultures, One Nation.

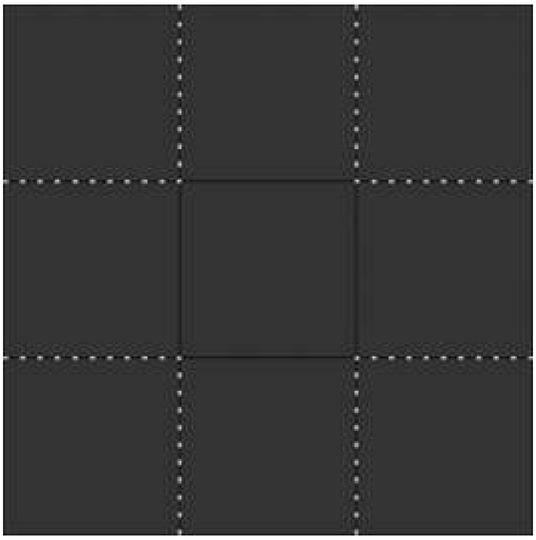
Many Nations, One World.

Many Problems, One Resolve.

Let's come together to build a better world.

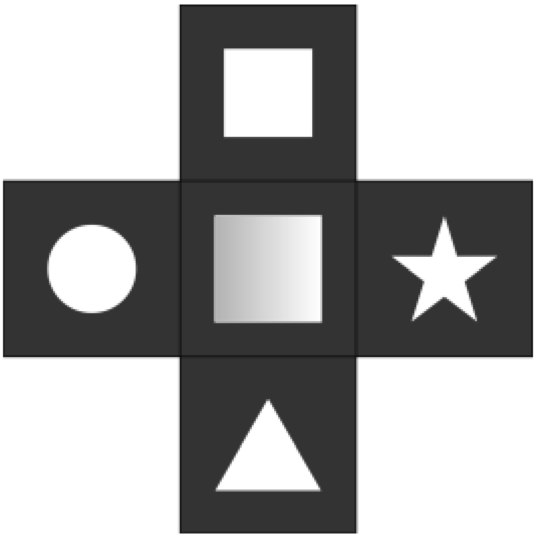
ACTIVITY 5

The Magic Mirror



Make a Magic Mirror

Take a 15 × 15 cm black coloured square drawing sheet. From each corner cut away a square piece of 5 × 5 cm. Now the sheet looks like a large plus sign. Then cut holes of shapes of a square, a star, a circle and a triangle on the extended parts as shown. These will be used as masks on the mirror. Fix a small 3 cm × 3 cm plane mirror at the centre. (If the size of your mirror is different then take drawing sheet of appropriate size accordingly). Cover the mirror with the mask of the square shaped hole and hold the mirror outside in the sun.



Reflect the sun light on (your friend's shirt or) over a short distance (one metre or less) .

Observe the image.

What is the shape of the image?

Repeat the experiment with the masks with holes of other shapes.

We get a square shaped image with the square hole mask on the mirror, a triangular shaped image with a triangular hole mask on the mirror, a circular image with aa a circular hole and a star with a star. This is not surprising, is it?

But now cast the projected images with each of these different shaped hole masks on a distant wall (about 20 metres away). What do you see? Isn't it surprising?

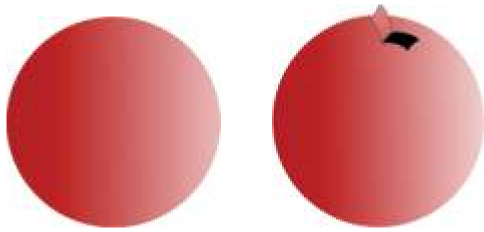
What are the shapes of the projected images when you take projections over a long distance?

The image at a far distance is round even if the mirror is square or triangular.

ACTIVITY 6

Ball Mirror Solar Projector

Make a Ball Mount



Take a plastic ball. Using a cutter, cut open a small window as shown. Fill the ball with sand (so as to make a heavy and steady ball mount) and seal it with sticky tape.

Place this ball mount upon a suitable ring on a stool or on any rigid platform. Now your ball mount is ready for use.

Make a ball and mirror solar projector and use it to project the sun

Take a ball mount. Now take a small plane mirror. Cover it with a brown paper with circular hole on it and then stick this mirror to the ball mount as shown.

Place this ball mirror upon a suitable ring on a stool or on any rigid platform in the sunshine. Now your ball mirror solar projector is ready for use.

Project the image of the Sun with this ball mirror. Adjust the angle of the mirror so that it projects the Sun into a dark room / dark place, on a white screen. Increase the distance of the mirror from the screen to around 30-40 metres. At this distance you can get a nice big image of the sun around 30 cm in diameter.

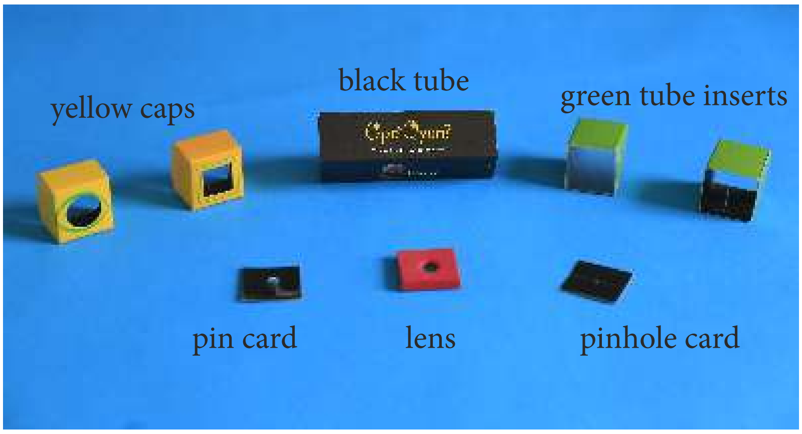
Observe the position of the image carefully. Is it still, or is it moving?

ACTIVITY 7

The OptiQyon?

The " OptiQyon?" is an enquiry. It is a journey of experiment, discovery and thinking. Can you crack the mystery?

The optiqyon ki



The optiqyon kit consists of a black tube with two yellow removable caps, one at each end of the tube. Each cap has a large aperture. Inside each cap we can insert and fit small square cards. We call these 'aperture cards'. Each square aperture card carries small apertures (pinholes), or a small lens, or a small object. There are also two short green tube inserts. They are about 3 cm in length. These short green tubes can slide back and forth inside the black outer tube. One green tube has a butter paper screen at one end. It is open at the other end. Another green tube has an upright pin fitted at one end, using cello tape. It is also open at the other end.

We use different combinations of the square cards and inserts for various experiments.
The optiqyon kit also contains :

- One pin for punching holes in the aperture cards.
- One square made of foam. In its centre is fitted a small lens. The lens has a short focal length.
- One aperture card has a round hole punched in its centre using a common paper punch. Bend a pin into an L shape, and fix it onto this card with tape such that the pin head is visible in the centre of the round hole. We will call this card as "the pin card".
- Extra black square aperture cards for doing more experiments.

EXPERIMENT 7.1

Looking through a single pinhole.

Punch a single pin hole at the centre of a black square aperture card with a pin. Fit this single pinhole aperture card in the yellow cap and place the cap at one end of the black tube. We call this 'side A.' The other side of the black tube is called 'side B'.

If you wear spectacles, remove your spectacles before doing the following :
Hold the side A close to your eye and look through the pinhole, at a bright scene, through an open window. We see bright round circle, and the inside of the tube. Inside the circle, we see the scene outside the window. Even without your spectacles, no matter what is your 'number', the details of the scene are quite clear.

Repeat the experiment, by looking from side B, through the pinhole. We see the same scene but the circle is much smaller, so we only see a small portion of the scene outside the window.

EXPERIMENT 7.2

Single pinhole and pin

Place the single pinhole aperture inside the yellow cap and fit the cap at end A of the black tube. Place the pin card inside the other cap. Fit this cap at the other end (side B) of the black tube.

Now look through the pin hole from side A towards a bright outdoor scene as background. Do you see the upright pin against the bright circle and background scene?

Now turn the black tube horizontally and look at the same bright background from side B. Again we see a smaller bright round circle. Can you see the pin head against this bright background?
But now the pin is seen upside down!

WOW!

Question: Why is the pin seen upside down? WHY? HOW?
That's what we will try to discover with 'the method of science.'
We will do some more experiments and do some reasoning based on these experiments.
This is known as the method of science - experiments, observation and reasoning.

EXPERIMENT 7.3

Lens and screen.

Remove the caps and the contents of each cap. Now, keep the foam square with the convex lens inside one cap. Push the green tube insert with the butter paper screen end inside the black outer tube. Push it till the green insert is just fully inside the outer black tube. Fit the cap with lens at end A. The distance between the lens and the screen will be about 3 centimeter (focal length of the lens you have).

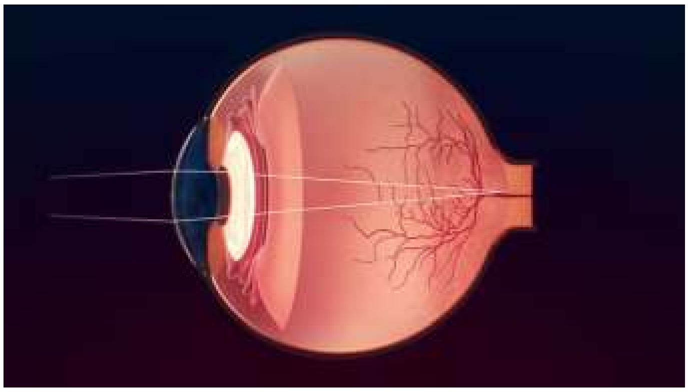
Look through the other side B from a distance of about 30 cm and examine the screen. You will see that an upside-down image of the outside world is formed on the screen.

WOW!
We get a beautiful sharp HD upside down image of the scene that we are looking at outside the window.

Discussion :

Experiment No 7.3 is a model of your eye.

Your eye also has a short focus transparent convex lens. The eye muscles focus the image of the outside world onto a screen. The retina of your eye is the screen. Just like in this experiment , an upside-down image of the outside world is formed on the retina screen of your eye.



So why does the scene appear upright to you, even though the image on your retina is upside down? This is because your brain then processes this upside-down image and makes the world seem upright!

EXPERIMENT 7.4

Model of experiment 7.1

Keep the screen and the lens at the same position as in experiment 7.3, i.e. at side A. When you look at the screen from side A through the lens, we see the texture of the butter paper screen clearly.
This is because when the lens is properly focused in experiment 7.3 for forming a sharp image on the screen, it is also properly focused in this experiment for examining the screen closely, when we look through side A at the screen. Note that, in this experiment, the lens at side A is not representing the lens of the eye and is merely being used to examine what is happening on the screen.

We now create a model of experiment 7.1

Place a black card with a pinhole in the yellow cap. Fit the yellow cap at end B of the black tube.
Hold the optiqyon so that light from a bright background, like an open window, falls through the pinhole, on the butter paper screen.

Now examine the image on the screen from end A, looking through the lens. With the help of the focused lens, the image looks brighter, and sharper, as compared with your naked eye view of the image on the butter paper.

With little effort you will be able to notice that the image is upside down.

This is a model of what was happening inside your eye, in experiment 7.1. In experiment 7.1 when you look through the pinhole at the outside world, the lens of your eye is relaxed and does not play any role in the formation of the image on your retina. This is why, even if you use spectacles, no matter what is your 'number', through a pin hole you can still see a clear image of a distant scene, after removing your glasses.

In experiment 7.1, the image of the outside world is being formed on the screen - your retina - by the pinhole camera effect. The image on your retina in experiment 7.1 was also formed upside down as in this experiment.

Then why did we see the image right side up in experiment 7.1?

You should reason this for yourself. (Hint : Read experiment 7.3 again.)

EXPERIMENT 7.5

Pin between pinhole and screen

We create a model of experiment 7.2.

Keep the lens and the screen in the same position as in the previous experiment. From the other side insert the green tube having pin so that the pin is about 3 cm inside. Now place the cap with a pinhole card at end A. Hold the optiqyon with the pin in an upright position (pin-head on top) and observe against the bright background. Looking through the lens examine the image on the screen.

What do we see?

As in experiment 7.4, we see an upside-down image of the bright background formed on the screen. But in addition, we also see a dark pin, standing upright against the bright background. Why is the dark 'image' of the pin seen upright on the screen?

Try to reason for yourself why the pin is seen in an upright position in this experiment. The explanation is really simple. The answer is given at the bottom of the page.

This is a model of what is happening in your eye, in experiment 7.2.

Now can you reason for yourself, why the pin appears upside down to us in experiment 7.2?

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(Why is the pin seen upright in this experiment?
Because, it is not an image formed by the pinhole camera effect.
It is the shadow of the pin thrown on the screen by the light rays coming from the pin hole.)

ACTIVITY 8

Light that is trapped in water and travels with it.

Take a clear plastic bottle with tight fitting cap. Take a laser pointer and pass the rays through the bottle. The rays will pass through the bottle and fall on the tile/ paper on the other side.

Make a hole of about 6 mm diameter, approximately at 3 cm above the bottom of the bottle. Plug the hole and fill the bottle with water up to top and fix the cap tightly.

Keep the bottle at the edge of a table and arrange a bucket below to collect water falling from the hole, when opened.
Keep the laser pointer, at the same height as the hole in the bottle, such that the rays will pass through the bottle horizontally and hit the hole at the centre, from straight behind.
When the setup is ready, unscrew the cap of the bottle and let the water jet fall from the hole. Put the laser pointer on.

You will observe that the laser rays do not pass through the hole in straight direction, but they travel through the water jet, to fall in the bucket. The rays are bent along the path of jet.

Isn't it fascinating?

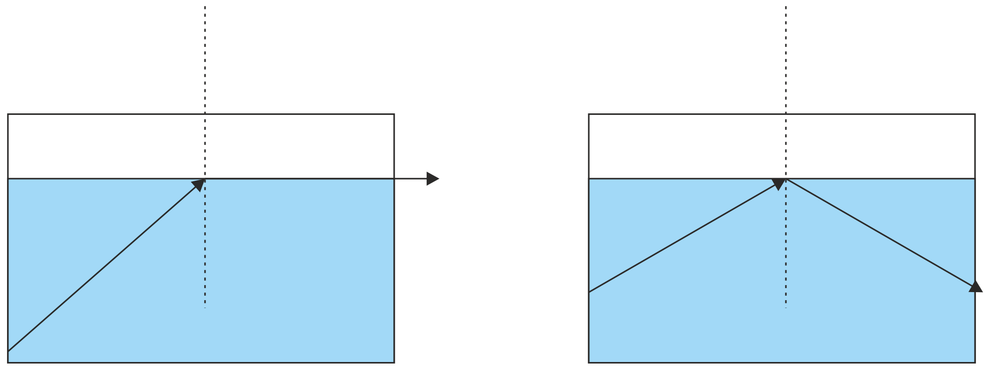
Ensure that the diameter of the hole is bigger than the cross section of the laser beam and the rays hit completely within the hole. If you don't see the laser light point at the bottom of the water jet you may repeat the experiment by keeping the bottle on a smaller stool, thereby reducing the height of the falling water.

To understand 'why' of this experiment, you will have to do a series of other experiments.

See how laser beam travels when passed from air to water in a transparent container (preferable rectangular like a fish tank). Examine what happens at the point where the rays passes from water to air. (If you have a glass slab , experiment with the beam passing from air to glass slab, glass slab to air etc.)

Every time change the angle of incidence of the laser beam and observe what happens.

Pass the laser beam from denser to rarer medium (e.g. water to air as shown in the figure). Change the angle of incidence and observe.



What happens as you increase the angle of incidence? Does the beam come out into air? Or does it reflect back into water as shown in this figure?

The rays bend and follow the path of jet due to a phenomenon called 'total internal reflection'.
When light rays pass through two different media, instead of travelling straight further, they bend and make an angle at the location of change in media. This is called as 'refraction'. Along with this, some fraction of rays travels back in the first medium. This is called as 'internal reflection'.
When the angle of incidence of the rays is such that it causes no refraction and all the rays are 'reflected' back in the original medium, instead of crossing in to the second medium, 'total internal reflection' occurs and the rays remain within the first medium.

This happens only when the first medium is optically denser than the second medium. In this case the first medium viz. water is optically denser than the second medium, viz. air.
This phenomenon is used in optical fibres to transmit light rays. In this experiment, you have constructed an optical fibre with a jet of water.

ACTIVITY 9

The reversing arrows

Seeing is believing ? Not in the this experiment.

Take a card of about post card size and with a marker or sketch pen, draw two thick arrows (of about 6 to 8 cm long, about 3 to 4 cm apart) parallel to each other on it. One of these two arrows should point towards left, and the other towards right.

Keep the sheet paper upright on the table with the support of the wall or with the help of a clamp.

Take an empty cylindrical shaped drinking glass (made of clear glass or plastic) and keep it on the table, in front of the paper at about 10 cm from the card. Adjust its distance from the paper, such that both the arrows can be fully seen through the empty glass, when you observe from the horizontal direction.

Now, fill some water slowly in the glass, so that the level of water is above the lower arrow, but below the upper arrow. Observe direction of the arrows through the glass. You will see both the arrows pointing to the same direction. Now fill the water further, to a level above both the arrows. What do you see? You will see both the arrows have reversed their pointing directions.

Explanation: Do the following experiment
Keep an arrow pointing towards a plane mirror and observe its image in the mirror. It appears to be reversed . An image seen after one reflection in a plane mirror appears to reverse front and back.
When you look towards arrows through the empty glass, the rays from the arrow images pass through air, glass, air, glass and again through the air. Refraction takes place whenever the medium changes and you can see image through the glass. What you see is the rays of light which are emerging after all these refractions. The rays reaching your eyes are not reflected anywhere. But when the rays pass through the cylindrical column of water, in the glass, they reach the eye with one internal reflection inside the water which appears to change the direction of the arrow .

Experiments that changed our view of the universe

ACTIVITY 10

The static Dhruvtara and moving stars

At night all stars appear to move in the sky, except one star.

Make a tube by rolling a A4 size piece of paper and sealing it with gum or tape, or a rubber band.

The diameter of the tube should be less than 2 cm. Fix the tube on a ball mount as in the figure.

At night aim at any star by looking at it through the tube, adjusting the ball mount.

After 10 minutes look again through the tube without touching it or the ball mount. Do you still see the star? No, it has moved (due to the rotation of the earth).

Now, identify Dhruva tara and take aim on dhruva tara by looking through the tube on the ball mount. Look through the tube after 10 minutes. Do you still see dhruva tara? Look after one hour.

Don't disturb the ball mount. Look through it after a day. Do you still see Dhruva tara?

Discussion : Why does Dhruva tara appear fixed?

Stand exactly below a static ceiling fan and look up towards the fan.

Now start rotating yourself while standing, as much as possible, at the same spot. The blades of the ceiling fan appear to rotate in the opposite direction to your rotation. But the centre point of the ceiling fan, directly above your head does not appear to move.

Every rotation has an axis. A point object which is exactly on the axis of rotation does not appear to move, during the rotation. Everything else appears to rotate in the opposite direction.

The static position of Dhruv tara is evidence that we are standing on a rotating earth, and Dhruva tara is situated exactly on the axis of rotation of the earth, very, very far away.

All the other stars in the night sky, the sun, the planets and the moon, appear to rotate in the opposite direction of the rotation of the earth, just like the blades of the fan appeared to rotate in the opposite direction to your rotation.

This is what Aryabhata wrote 1600 years ago :

Just as a passenger in a boat moving downstream sees the stationary (trees on the river banks) as traversing upstream, just so does an observer at Lankii (the axis of rotation of the earth) see the fixed stars as moving towards the west at exactly the same speed (at which the Earth moves from west to east).

Decades later, Aryabhat was severely criticized by the famous astronomer Varamihira, in his 'Panchsiddhantika', in which he wrote : 'Other people say that the earth is rotating as if on a potter's wheel. They say that the stars in the sky are stationary. If this is so, then how do birds return to their nests at night? And additionally, if the earth rotates about its axis once in one day, then all the kites, birds, etc., would be swept towards the west.'

Another hundred years later, the great astronomer Brahmagupta also criticized Aryabhata. writing similarly to Varahmihira, in his treatise 'Brahmasphutasiddhhanta' , that if the earth rotates, then anything standing upright on the earth would fall down, as the earth rotated away under it.

Logical sounding arguments may not be correct. Great astronomers like Varahmihira and Brahmagupta did not realise or accept that Aryabhata had given a revolutionary and correct explanation of the rotary motion of the night stars.

Scientific temper is always modest. Science only says 'Based on the evidence which I have at this point in time, this is true to that extent. If tomorrow, there is some other evidence, then some other truth may be established.' Science never claims ultimate truth. Science stands on the persistence of truth.

- A part of Dr. Narendra Dabholkar's speech

ACTIVITY 11

Galileoscope and Venus

This is what Galileo observed for the first time 5 centuries back. This was a conclusive proof that Copernicus was right.

Galileo was not the first person to build a telescope.
Before him, others like Lippershey from Holland had built telescopes. But Galileo was the first person to turn the telescope to the skies and use it for astronomy. This is a photograph of Galileo's telescopes. The most important part of the telescope is the optics - the lenses. Galileo's telescopes had two lenses. The front lens, called the objective, and the rear lens, called the eyepiece. The front lens has a long focal length. The eyepiece has a small focal length.

You can make your own telescope by using cardboard tubes and lenses. You can also make a ball mount for the telescope by attaching 4 strings to the ball. The strings should be placed before filling the ball with sand. Use your ball mount to keep the telescrope steady while viewing. With this telescope, you will be able to see the moons craters.

Observing Venus with a simple telescope :

Sometimes we see Venus in the evening sky and sometimes in the early morning sky. Some months are more suitable for observing the crescent phases of Venus. You may refer to internet information to find about these dates every year. Observing Venus through a simple telescope can be an exciting item!

Your simple telescope may show 'chromatic aberration' – the image of Venus is blurred and distorted by the lens splitting light into different colours. You can greatly reduce the chromatic aberration by a simple procedure. Make a circular card aperture which covers the lens. Cut a small circular hole at its centre about 15 mm in diameter. Hold this aperture in front of the lens when you view Venus. You will see that this procedure greatly reduces chromatic aberration and gives a sharper image of Venus clearly showing its crescent phase.

For obtaining lenses and more details, you can contact:
'Samatesathi Gunavatta' at Navnirmiti Learning Foundation Pune.
'Discover It' Centre at Navnirmiti Mumbai.

The Science Behind So-called Miracles

ACTIVITY 12

Blood from a Lemon

Have you ever seen blood coming out of a lemon, when you cut it?

Fraud godmen try to 'trick' unsuspecting bhaktas with their supposed 'magical' powers.
Blood oozes out of lemon after a godman cuts it.

What is the trick?

Use this trick to perform a 'miracle' and confuse your friends.

Take a steel knife with blackish blade. (preferably made of hack saw blade).

Take some red Hibiscus flowers, crush them and smear the paste on the blade. Let it dry.

Do this 2-3 times, so that a sufficiently thick layer of Hibiscus crush paste is accumulated on the steel blade. Because of the original blackish colour of the blade, this layer will not be noticeable.

Now take a lemon and cut it with this knife. The cut surfaces and drops of lemon juice will have red colour, appearing as if blood is coming out of lemon.

This happens because crushed paste of Hibiscus acts as chemical indicator and becomes red when comes in contact with acidic juice of lemon.

Try different flowers to know which flowers have similar property.

ACTIVITY 13

Changing the colours of turmeric and Kunku (Sindur)

Many times tricks are done by Babas. They convert Turmeric into kunku or kunku into Bukka (Black Holy powder)

You need Turmeric , Kumkum, spoon , water, Detergent (Nirma) powder, lime (wet chuna that you get in a paan shop).

Take two dishes. Put turmeric powder in one & turmeric powder + detergent (nirma) powder mixture to another. Give a sample of each one by a spoon in one each hand of your friend. Ask your friend to close his/her fist. Put some water by spoon on both hands. Ask your friend to rub her fingers so that the water mixes in it. Now ask her to open her fist. One of the powders is turned red like kumkum or blood.

Repeat the procedure with Kumkum and lime. Do not use water. Kumkum will turn into bukka powder. The Kumkum may not be pure if doesn't turn black after putting lime.

What is the magic? The colour change is because of the alkali.

So whenever you see such 'miracles' being performed in the name of religion, think!!

What could be the reason?

So called 'Godmen' use such tricks. People believe in them as 'miracles.' Dr. Narendra Dabholkar used to expose such fake miracle men.

No godman has yet accepted the challenge of Dr. Kovoor and of the Andhashraddha Nirmoolan Samiti to show these miracles under controlled conditions.

ACTIVITY 14

Fire by chanting Mantra

Have you ever seen anybody who can create fire by chanting some mantras?

You can try this, of course with due care and under supervision of your teacher or parents.

You need some potassium permanganate and a little glycerin. You may hide potassium permanganate under the sawdust.

Crush the potassium permanganate into powder.

Take some sawdust and mix small quantity of potassium permanganate.

Now take a spoonful of glycerin, chant any mantra (you can say your favorite poem or song also!).

Now put the glycerin on the mixture.

Find out the reaction which takes place after few moments. The mixture generates fire.

ACTIVITY 15

Lord Ganesha Drinking Milk

You must have heard about the story that everywhere in India, Ganapati idols started drinking milk.

We can see what happens practically.

Collect some idol statues made of metal, stone, plaster of Paris, terracotta or any other material. You can use water, tea or milk also.

Find out a protruding portion of that idol, where you can hold a spoon full of water. First tilt the spoon slightly to start the flow and then bring it back to horizontal position. Now do not tilt the spoon and do not let the water fall due to gravity.

You will find that at some particular positions on the idols, water starts flowing down along the curves.

Be it Ganapati, snake, human figure or any other similar shape with curves.

The water flows down and drops to the floor.

Keep the 'drinking object' on sand. The water, or milk falling down is absorbed in the sand.

'Ganpati is drinking milk'!

Find out which particular shapes are able to draw water / milk.

Find out if there is any difference depending on the liquid.

Find out the effect of the material of idol if any.

So, we see Ganpati drinking milk was no miracle, but a simple scientific phenomenon which can be repeated everyday with everyday objects. There are many articles available on internet which explain in more detail the science behind this amusing experiment.

Science and Magic

ACTIVITY 16

Magic in your fingertip – Pepper powder runs away.

Take two shallow plate.

Pour water approximately 1 cm deep or more.

Sprinkle a dusting of black pepper (*miri*) powder all over the surface of water.

You will find the pepper sits on the surface of the water.

Ask your friend to dip her/his finger into the water. Nothing special happens.

Now you dip your finger into the center of water.

WOW! Something different happens.

The pepper powder immediately scatters and darts away from your finger, towards the edge of the water.

Trick – Secretly wipe a bit of dish soap on the tip of your finger before doing this experiment.

ACTIVITY 17

Needle through a balloon

Blow up a balloon, but not to its full capacity.

Tie a knot.

Fix two pieces of adhesive tape in cross shape on the surface of the balloon.

Try to use good quality, 'invisible' adhesive tape which is available in some stationery stores.

Take a precaution that bubbles are not formed while sticking the tape on balloon.

Hide that side from your friends.

You may tell your friends that you have a magic balloon.

You can insert needles into it.

Insert a sharp needle in the balloon, but at the junction of the cross of adhesive tape.

You can also insert a sharp needle at the dark potions on the balloon. This doesn’t require adhesive tape.

The 'scientific' explanation in the textbook may not be so scientific after all!

ACTIVITY 18

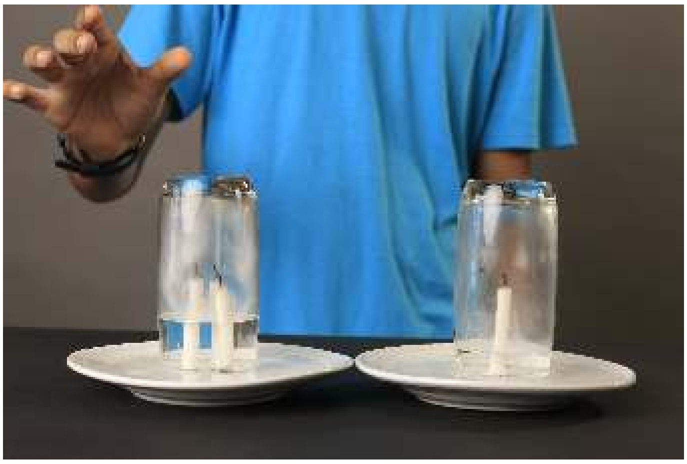
Candle and water Experiments

Are the textbooks always right? Check yourself. Every 'Scientific' explanation may not be scientific. It must be questioned. Question everything!

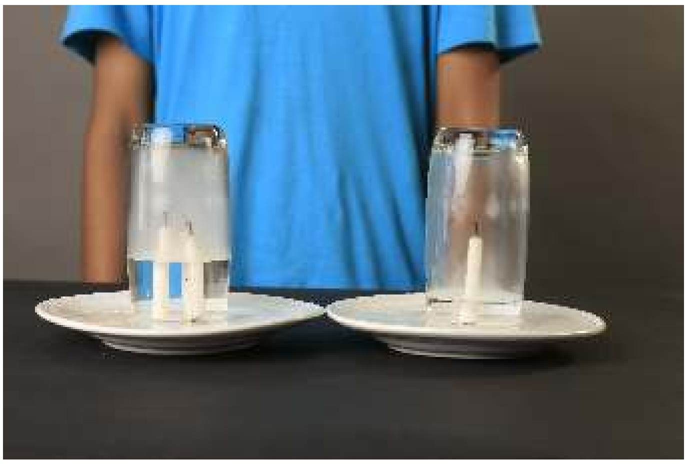
You must have done the simple experiment using a candle lighted in a dish, adding water to it and then inverting a glass quickly on it. After a while the candle goes off. And after a minute or so, the water from the dish suddenly rises in the glass.

You must have heard some reasons. One such explanation is there in many textbooks. – Oxygen is needed for burning. There is 20% oxygen in the air. The oxygen in the glass gets utilized for burning of the candle. Therefore the water rises to 1/5th level. Quite convincing? Isn't it?

But, have you lighted two candles in the dish and done the same experiment? And used three candles instead of one? You get interesting results!
Please use different sizes and heights of the glass used, different sizes and heights of the candles. And then think of the reasons.



The following questions remained unanswered in the textbook explanations -
Oxygen is used up slowly, but the water rises suddenly and after a while. Why?
Oxygen gas was converted into CO2 gas. Carbon dioxide also has volume. Then why should the volume change?
Was all the Oxygen used up?
Was all O2 converted into CO2? Was some CO produced?
The wax is a hydrocarbon. It contains hydrogen as well as carbon. What happens to the hydrogen during burning? Was some H2O vapor created due to burning of wax?



So considering all the above questions, it is not so easy to answer the question "Why did the water rise".

In fact, this experiment is more than 2000 years old. Read about the history and different explanations in the following:
http://www.math.harvard.edu/~knill/pedagogy/waterexperiment/vera_rivera_nunez.pdf

SURYA SANDESH

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From Darkness to Light

Many Schools, One Experiment.

Many Signs, One Sun.

Many Faiths, One God.

Many Races, One Human.

Many Cultures, One Nation.

Many Nations, One World.

Many Problems, One Resolve.

Let's come together to build a better world.

cover 2