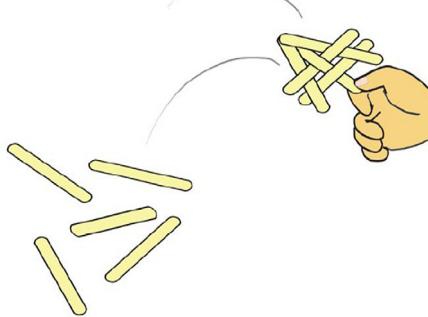
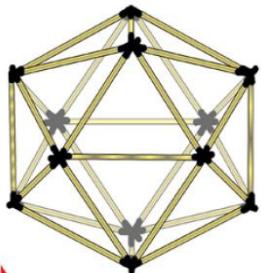


# A GLEAM IN THE EYES

Hand Made  
Maths and Science  
Toys



IIT Gandhinagar

Indian Institute of  
Technology Gandhinagar



# A GLEAM IN THE EYES

Hand Made  
Maths and Science  
Toys

**IIT Gandhinagar**  
Indian Institute of  
Technology Gandhinagar

Printed by:  
**Topsun Enterprises**  
Delhi

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Creative Learning Initiative  
**IIT Gandhinagar**

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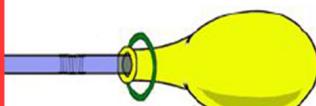
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# Balloon Spinner

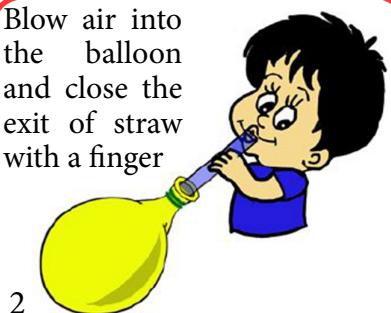


A perfect example of how Newton's third law of motion and torque help in rotating anything.

Tie the balloon with the straw using a rubber band.



Blow air into the balloon and close the exit of straw with a finger



3

Place the balloon on the floor

Remove finger from the straw.

Balloon races away in a straight line.



Now bend the straw

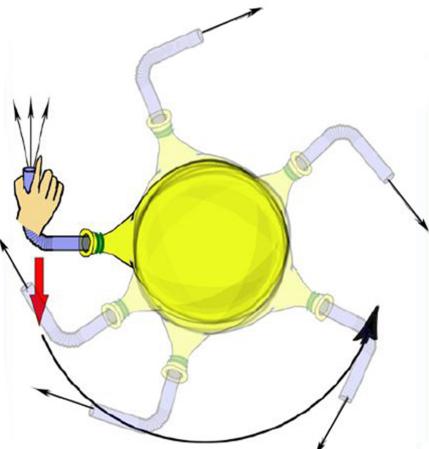
close it with finger after filling air in the balloon



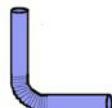
4

Methodology

Place the balloon on the floor and remove the finger from the straw. The balloon starts to rotate.



5



A bent straw



A big balloon



Rubber band

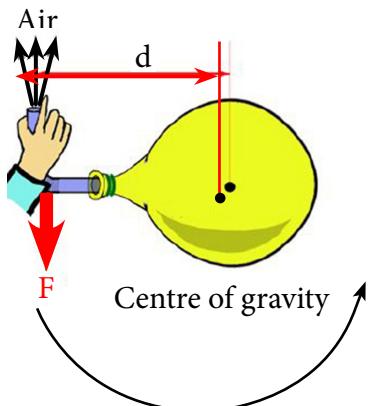
## Required Items



## How Did it Work!

Air coming out of the balloon is the “Action” and the force because of this is depicted with a red arrow.

As this **Force** is not being applied through the **Centre of Gravity (CG)**, it causes a **Torque** which forces the balloon to rotate.



The Formula for Torque is:-

$$\text{Torque} = \text{Force (F)} \times \text{Distance (D)}$$

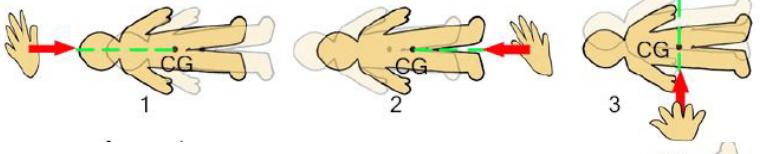


## Think About it??

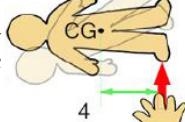
If we try to push a person who is lying down from his head or feet, he will move in a straight line.

But if we push him as shown in figure no 4, he starts to rotate and does not move in a straight line.

In the first three positions the force being applied passes through his CG so distance D = 0, and hence no Torque is experienced ( $T = F \times D (0) = 0$ ).



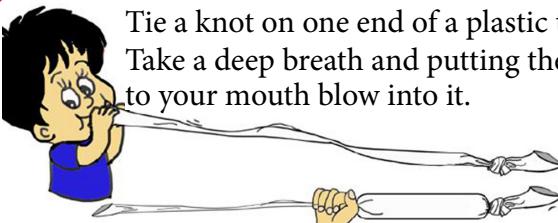
Whereas in Figure no 4, as the force is applied at a distance from the CG, he experiences a Torque and starts to rotate.



# Bernaulli's Bag

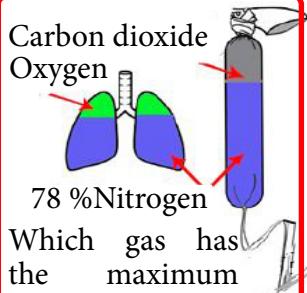


The challenge: How many breaths will be required to fill a plastic bag 2 meters long having a diameter of 25 cms? With a little practice and science - Just one breath.



Tie a knot on one end of a plastic tube.  
Take a deep breath and putting the tube to your mouth blow into it.

1

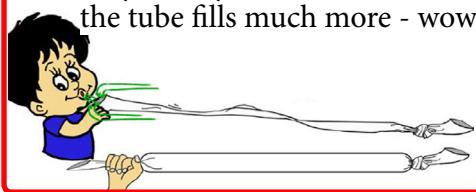


Carbon dioxide  
Oxygen  
78 %Nitrogen  
Which gas has the maximum proportion in this bag. We are under an impression that it is carbon dioxide. It is in fact nitrogen, and in the same ratio as it is present in the atmosphere i.e 78%.



What is our lung capacity?  
What is the volume of the air filled in this bag?  
We can compare this tube with a similar sized bottle. As per this, our lung capacity should be 3 to 3.5 Litres.

Blow into the tube, keeping it about 15 cms away from your mouth. This time the tube fills much more - wow.



2

Methodology





Required Items

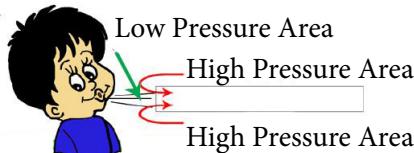


Plastic Tube



## How Did it Work!

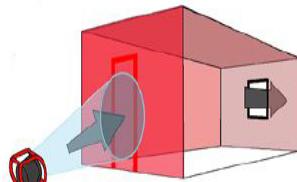
The bag gets filled up in one breath as the atmospheric air also gets sucked in because of the low pressure created. Faster the air, lower is the pressure in that area as was discovered by Daniel Bernoulli in 1738. When we blow into the tube we create a low pressure area around its mouth. The surrounding air which is at a relatively higher pressure also gets sucked in and fills it up.



## Think About it??

Firefighters use Bernoulli's principle to quickly and efficiently force smoke out of a building.

Instead of placing the fans up against the doorway or window, a space is left between the opening and the fan in order to force a greater amount of air into the building. Firefighters call this "Positive Air Flow."



- When measured the weight of an empty tube and a filled one is same. Its answer lies in the "Archimedes Principle". Can you guess?

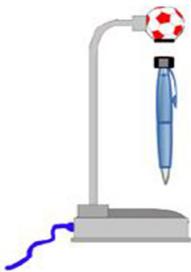
2.



It's warm when  
we blow slow      It's cool when  
                          we blow fast

Why?

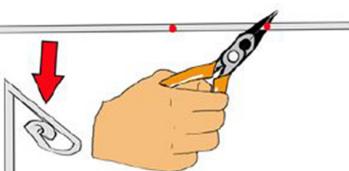




# Magic Pen Stand

A beautiful handmade toy which should be on the tables of each student and the teacher.

Using a plier bend the spoke as shown



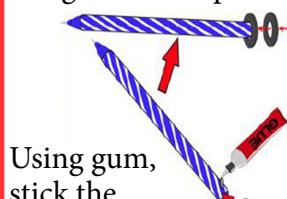
1

Using a cello tape, stick the bent end on a CD.



2

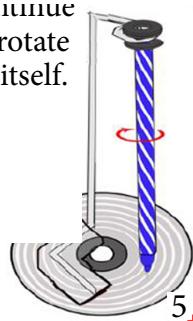
Both magnets should get attracted to the magnet on the pen.



Using gum, stick the magnet to back side of the pen

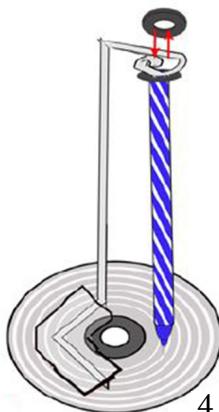
3

Rotate the pen slowly. It will continue to rotate by itself.



5

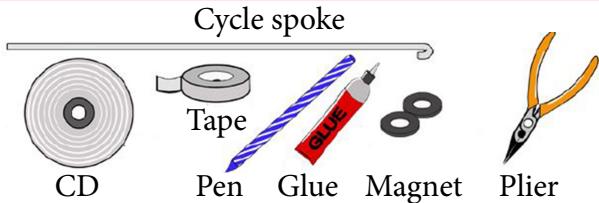
Put both magnets on the spoke. Now put the pen tip on the CD



4

## Methodology

## Required Items

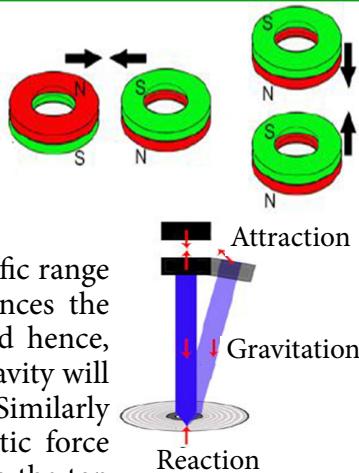


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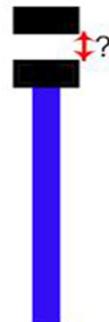
## How Did it Work!

Because of their opposite polarity as the top magnet attracts the one on the pen, it applies a force on the pen in the upward direction which keeps the pen in standing position. There is a specific range where the magnetic attraction balances the weight (gravity pull) of the pen and hence, the pen levitates. Away from that, gravity will dominate and make the pen fall. Similarly if we push the pen up, the magnetic force overpowers and the pen gets stuck to the top magnet



## Think About it??

1. How does it work?
2. Will the pen spin always?
3. Will the pen levitate even when magnets are repelling?
4. How much gap can you increase between the pen and top magnet?





# DC Motor

World's smallest motor in 15 minutes



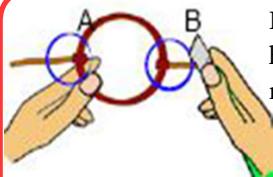
Using about 0.5 meters of a 18 to 25 guage insulated copper wire make a coil having 10 turns. Ensure there is no overlapping of these turns.

1

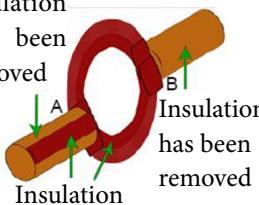


The coil will be like a spring. Press it to bring all turns together. Tie them and take out the two ends opposite each other as shown.

2



Insulation has been removed

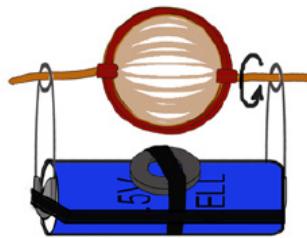


Insulation has been removed

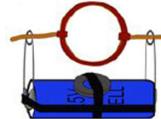
Using a blade remove insulation completely from one side but keep a long strip of insulation on the other side as shown

3

The coil vibrates over the magnet. A gentle push causes it to rotate. But if pushes in wrong direction, it stops after a few rotations and starts rotating in the right direction.



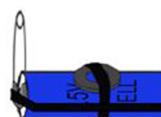
6



Put coil ends in the safety pin eyes.

5

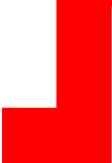
Attach the magnet to the battery using a rubber band



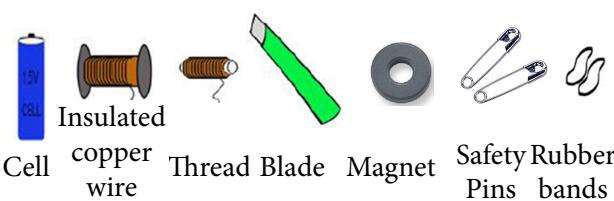
Attach the two safety pins to the sides using another rubber band

4

## Methodology



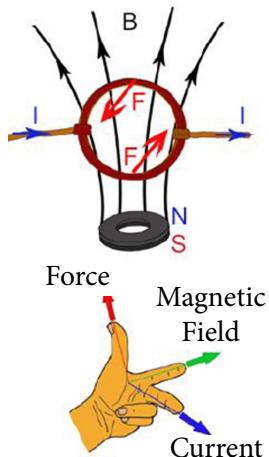
## Required Items



? ? ?

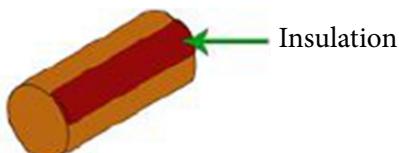
## How Did it Work!

When current flows through wire, it produces magnetic field around it making it an electromagnet. (Like poles repel; unlike poles attract). The North pole of the electromagnet is attracted to the South pole of the permanent magnet and is repulsed by its North pole. This mutual attraction - repulsion makes the motor coil turn.



## Think About it??

1. Which direction will the coil rotate?
2. What happens when we change the direction of current?
3. Why do we remove the insulation from the wire?
4. Why don't we remove insulation from one part of the wire?

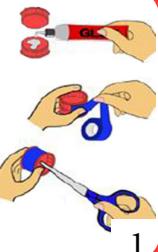




# Heron's Fountain

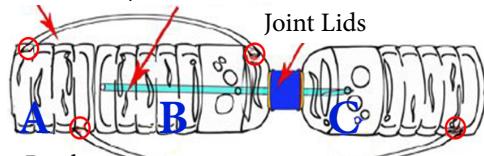
World's smallest motor in 15 minutes

Stick 2 bottle lids with glue making an air tight connection. Use a scissor to drill a hole in both lids.



Straw in bottle 'C' is near the mouth whereas in 'B' it goes till bottom.

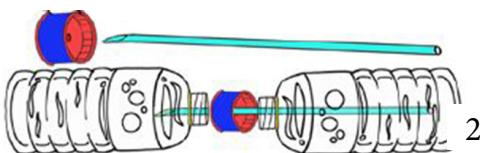
This Tube joins A & B  
This Straw joins B & C



Cut Bottle

This Tube joins B & C

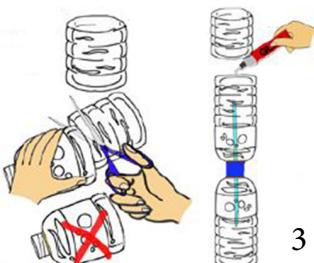
Pass a straw in between the two lids and use gum for an air tight connection. Next put these lids on both bottles



Fill colored water in the cut bottle till the lower bottle is full.

Fountain starts working

Cut the third bottle from middle and glue the bottom part to one end of the bottles.



All joints must be leak proof.

Now turn it upside down.

Water comes to the middle

Again turn it upside down. and put water in the cut bottle

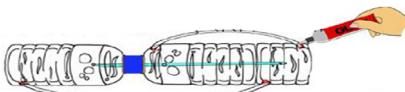


5

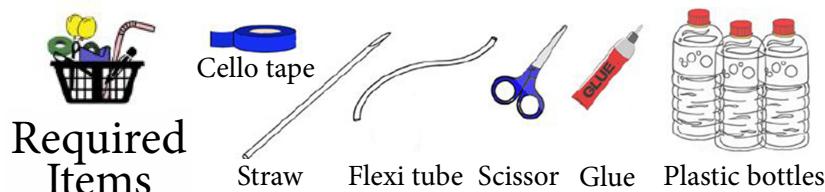
4



Cut holes in areas marked red and fix flexi tubes in them as shown. Put glue to seal them.



Methodology



? ? ?



## How Did it Work!



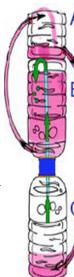
There are 3 containers: (A) Basin (top) (B) Water Supply (middle) (C) Air Supply (bottom).



Water from basin (A) flows by gravity into air supply container (C). This water forces air in (C) to move into water supply container (B), where the increased air pressure in (B) forces water in (B) to issue out of the top as a fountain into the basin (A).



Fountain water caught in basin (A) drains back to air supply container (C). Flow stops when water container (B) is empty. This appears to be a perpetual motion device; a machine that can keep running forever. However, it is not and to restart the machine, air supply container (C) should contain only air.



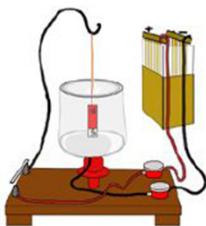
## Think About it??

Hero's fountain derives its name from its inventor, Hero (or Heron), who lived in Alexandria, Roman Egypt in 120 B.C. He was an ancient Greek mathematician and engineer. It is described in his book *Pneumatica* in which Hero describes a number of appliances invented by himself and by a predecessor named Ctesibius."



Find out more about perpetual motion machines?

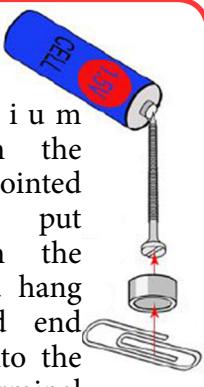
Have you wondered how did people have fountain before electricity?



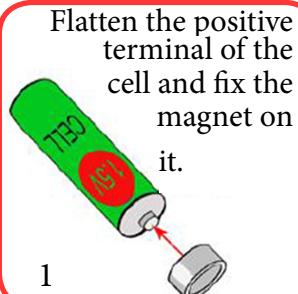
# Homopolar Motor

Its operation was demonstrated by Michael Faraday in 1821. These motors are inefficient, hence unsuitable for practical applications.

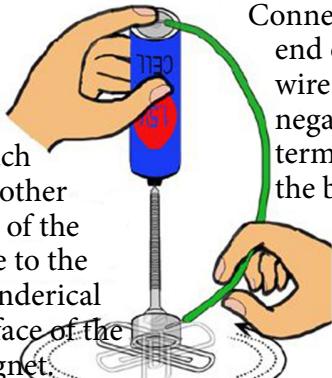
Stick a neodymium magnet on the head of a pointed screw. Next put a clip on the magnet and hang the pointed end of screw onto the positive terminal of the cell.



We can also use a copper wire loop which starts rotating just like the screw.



Touch the other end of the wire to the cylindrical surface of the magnet.  
The screw, paper clip and the magnet start rotating. Clip looks like a fan.



Connect one end of the wire to the negative terminal of the battery

2

Make a loop with copper wire without insulation on it.

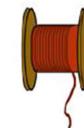


Placing the "V" of the loop in the small indentation on negative terminal, let the free end of the loop touch the magnet. It starts rotating.

3

## Methodology





## Required Items

Screw

cell

Flexi wire

Copper wire

Clip

Magnet

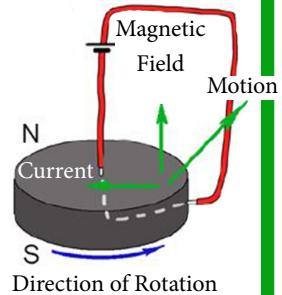
uninsulated

? ? ?



## How Did it Work!

The homopolar motor is driven by the Lorentz force (current carrying coil, when placed in a magnetic field experiences a force). The neodymium magnet itself acts as one of the terminals as well as a coil!. Out of the 3 components (magnetic field, current in the coil and torque), if we have any two we get a third as all of them in perpendicular direction (Fleming's Left hand rule).

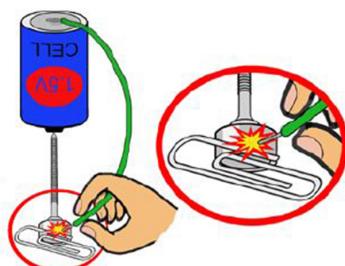
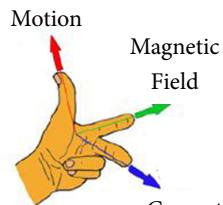


## Think About it??

The coil is experiencing the force in which direction? Use Fleming's Left Hand Rule to find that out.

What happens when we reverse the polarity of the magnet?

There is a small spark which appears where the wire touches the magnet. What is the reason for that?

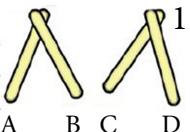


# Pentagram

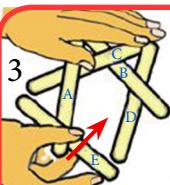
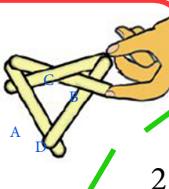


Here we will interlock ice-cream sticks to make various structures. These structures are interlocked and stable without any glue. On falling they do not come apart.

Hold 2 pairs of ice cream sticks spread them as shown

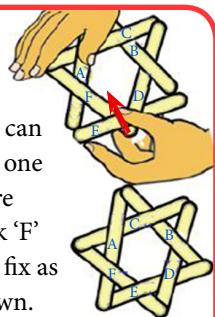


Join them as shown. 'C' over 'B' but below 'A'  
And 'D' below 'B' and over 'A'.

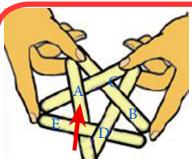


You can add one more stick 'E' to make a hexagon star

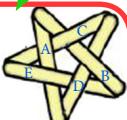
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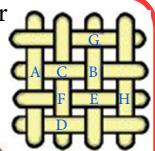
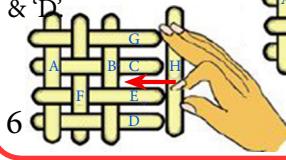
You can add one more stick 'F' and fix as shown.



You can add one more stick 'G' to make a pentagon star



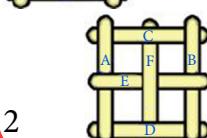
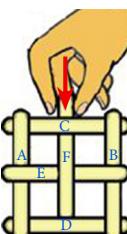
Now slide stick 'H' over 'G', & 'E' but below 'C' & 'D'



For making a square, start with stick 'C' & 'D' parallel to each other. Then place 'A' & 'B' over them. And 'E' over 'A' & 'B' as shown.

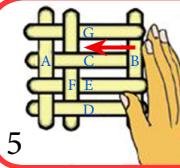
1

Now insert stick 'F' so that it crosses below 'C' & 'D' but above 'E'.

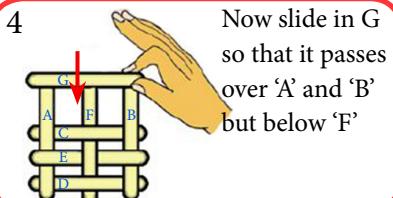


2

Now slide stick 'F' towards Stick 'A'



5



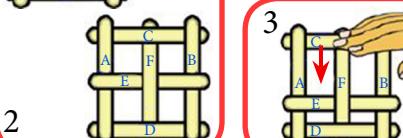
4

Now slide in G so that it passes over 'A' and 'B' but below 'F'



3

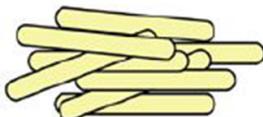
If you want to make a square then slide 'C' and 'E' near 'D'



## Methodology



Required Items



Ice-cream Straws



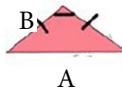
## Uh? How Did it Work!

For these sticks to stick together, each of them must be in touch with atleast three other sticks. We can make different weaving patterns. A 5 angled star is called a Pentagram. It has 10 isosceles triangles, 5 acute and 5 obtuse. The ratio of bigger arm A to smaller arm B is equal to

$$A/B = \varphi = \text{Golden Ratio} = 1.618$$



Acute  
Angled  
Isosceles  
Triangle



Obtuse  
Angled  
Isosceles  
Triangle

Definition of Golden Ratio is  $(A+B)/A = A/B = \text{Golden Ratio}$



## Think About it??



Do you know that the National Flag of Morocco has a Pentagram?



Can you find the angle between two sticks in a corner? Why does the structure not break on falling to the ground?

It is also seen as a symbol for good and for protection against evil.

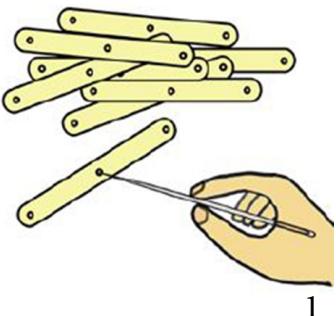


# Car Jack



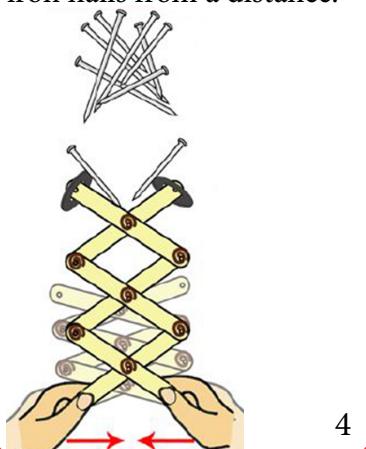
Using ice-cream sticks make a lazy tong which has magnets at one end. Use the other end to lift iron objects with magnets. This also gives illusion of a robotic arm!

Using a needle, make a hole in each of the ice-cream sticks.



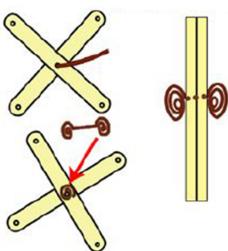
1

Attach magnets on two ends and now you can lift iron nails from a distance.



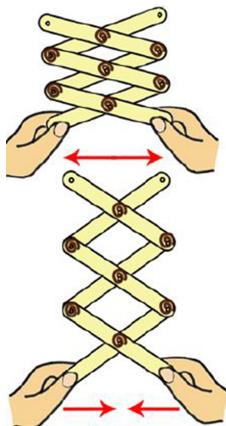
4

Join 2 sticks each from the middle using copper wire. Make a bunch at the end to prevent wire form coming out.



2

Make a tong as shown. It can be elongated or retracted.



3

Methodology



—



## Required Items

Magnet

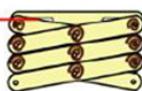
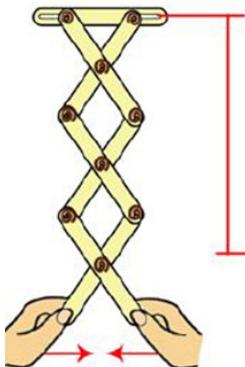
Needle

Copper wire

Ice-cream sticks



## How Did it Work!



The lazy tongs can stretch and shrink. On bringing the bottom two ends of the stick closer, the setup starts to stretch forward.

This is called 'Mechanical Advantage'.

The copper wire loops acts like hinge and allow easy rotation of stick.



## Think About it??

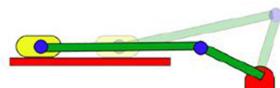
Tongs are a tool used to grip and lift objects.



What is the mechanical advantage with this tong?

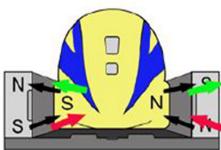


Can you make a car jack using the same concept ?

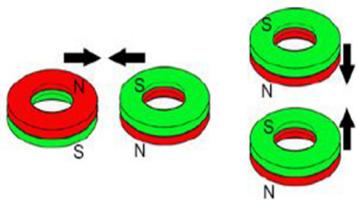


How can we add a slider mechanism in this arrangement?

# Maglev



Hamsa Padmanabhan has been awarded in the Intelliscience fair for presenting her research paper on pencil levitation. NASA has named a dwarf planet after her.

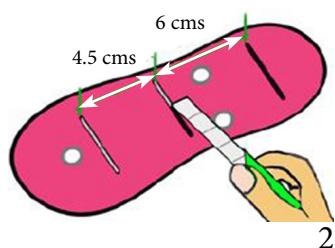


Mount 2 magnets on the pencil. Use paper if required to prevent slipping



1

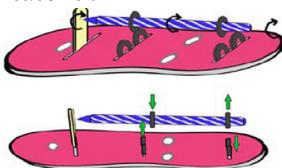
On an old sleeper mark lines at a distance of 4.5cms and 6 cms respectively. Make a cut of about 5 cms long on these lines.



2

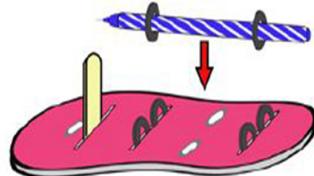
## Methodology

Now the pencil should levitate. Rotate the pencil a bit, it will continue to rotate for some time. You may need to adjust the position of magnets on the pencil to levitate it .

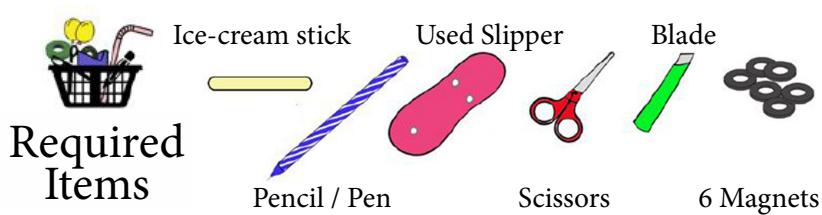


Ensure that the magnet fitted on the rear of the pencil is in-line with two magnets in the third cut and the front magnet is slightly ahead of the magnets in the second cut.

4



Put a ice-cream stick in the first cut. Put 2 magnets in the second cut in a way that they attract the magnet fitted towards the pencil lead. Place 2 magnets in the third cut so that they repel the magnet at the end of the pencil.



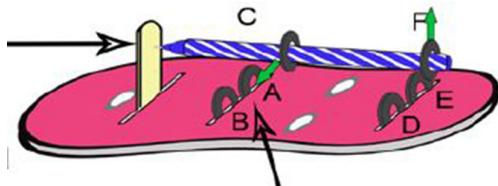
? ?? ?



## How Did it Work!

There is repulsion between two magnets D & E and the magnet F on the pencil.

The stick does not allow the pencil to move ahead and so it levitates.

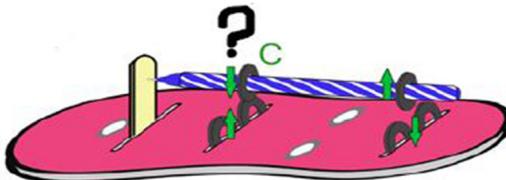


There is attraction between two magnets B & A and magnet C on the pencil.



## Think About it??

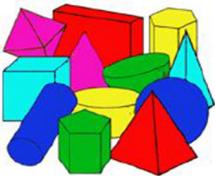
What happens if we change the polarity of magnets A & B?  
What should be the position of magnet C in that case?



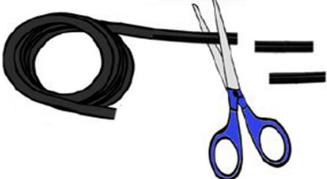
Why is the use of a pointed pencil or a ball point suitable here?

Is this a “perpetual Motion Machine”.

# Platonic Solids



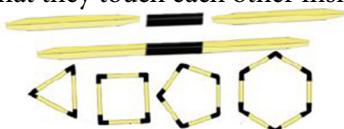
Have you observed structure of football closely? Its made up of hexagons and pentagons. Its structure is based on one of the types of platonic solid icosahedrons whose all 12 corners are chopped off.



Cut 2 cm long pieces from a cycle valve tube

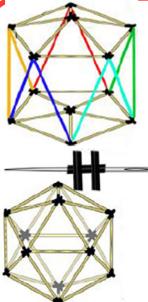
1

Put match sticks on both ends so that they touch each other inside.



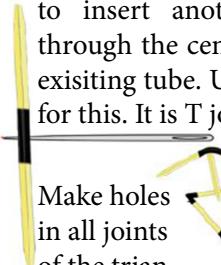
Make a triangle, square, pentagon or a hexagon.

2

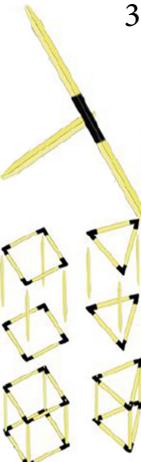


To make an icosahedron shape, we require 12, 6 cornered joints and 30 sticks. Put an additional rubber valve piece in a 4 cornered joint to make it. 5 sticks meet at each joint. One point remains empty. Make the icosahedron with this. Keep 2 pentagonal pyramids opposite each other and make 10 triangles between them. 5

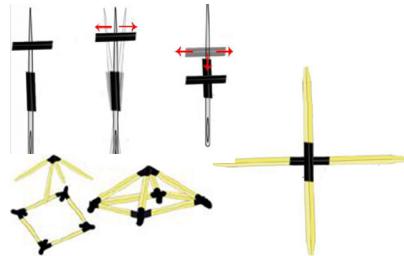
These are 2D structures. For making 3D, you need to insert another tube through the centre of the existing tube. Use needle for this. It is T joint.



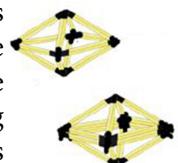
Make holes in all joints of the triangle. Insert 3 sticks in them. You have a pyramid. Make a Cube and a Prism.



For Octahedron we need 6, 4 cornered joints. Pass needle through one needle and pierce the needle through another tube. Increase the size of the hole and pass the first tube through this as shown.



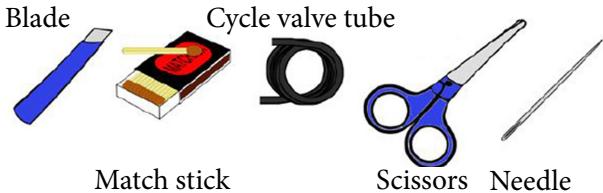
Now using these 4 cornered joints make a square pyramid. Create another one using the remaining holes on the other side.



## Methodology

4

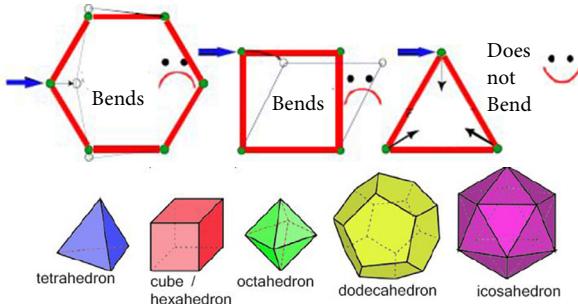
## Required Items



? ::?

## Uh? How Did it Work!

Triangles are the only 2D shapes which do not change. Hence, they are in 3D shapes like Tetrahedron, Octahedron, Icosahedron



Platonic solids are 3D structures having similar vertices which are regular polygons and every corner has similar no of polygons. e.g. a cube has 3 squares on each of its vertices. These platonic solid are only 5 types. They are based on Plato's name.



## Think About it??

Why only 5 platonics solid exists? You are sure to get a Nobel prize if you find the sixth one.

There can be triangular pyramid, square pyramid, and pentagonal pyramid. Can there be hexagonal pyramid?

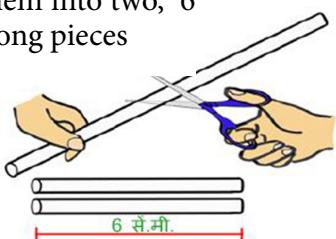
Can you find any relationship between cube and octahedron and icosahedron and dodecahedron!

# Mist Spray



This is a simple toy which the children can use for making their own 'Pichkaari' during holi.

Take two straws and cut them into two, 6 cms long pieces



1

If you interchange the straws, you will have a whistle

5

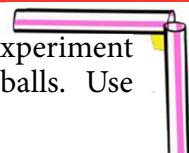


With glue and rubber cubes join both the pieces making a 90 degree joint in such a way that one straw covers half of the other straw's hole



2

Perform the same experiment using styrofoam balls. Use bigger straws



4

3 Use the straw with blocked passage to blow through it while keeping the other one in water. Your straw is ready.



## Methodology



## Required Items

Big and small straw Glue



Styrofoam balls



Rubber Cube

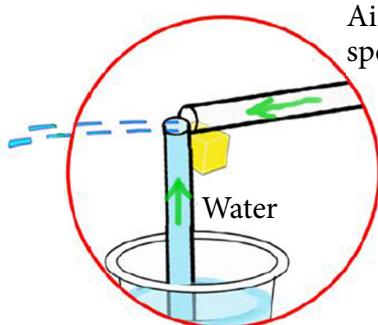


Water



## How Did it Work!

Blow into the straw causes air to rush at speed but its speed increases further on encountering second straw. This causes pressure on top of second straw drop. This sucks water from the glass which when mixed with fast moving air forms a mist. Low pressure caused is in accordance to the Bernoulli's principle. It is precisely because of this reason one should not stand near a speeding train as the low pressure created can suck you causing injury.



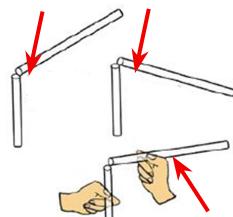
## Think About it??

What will happen if we change the angle of the straw? Will we get the mist?

Will there be mist if we hold the straw in our hand?

Why doesn't it work when we increase the length of the straw?

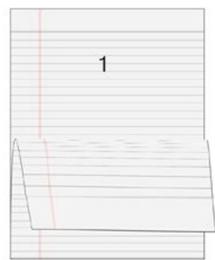
More than 90 deg      Less than 90 deg





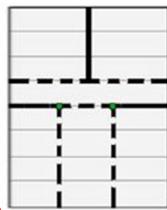
# Paper Helicopter

A seed falling from the tree falls and scatters into pieces. Why does it happen? We will make a paper fan and try to understand this.

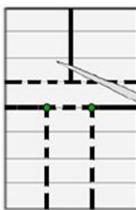


Take one page from a copy. Fold it four times so that it gets divided into 16 parts.

1



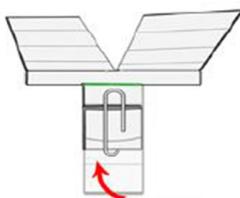
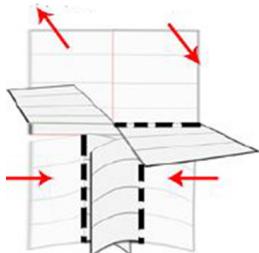
Put marks as shown.



Now cut all the undotted portions

2

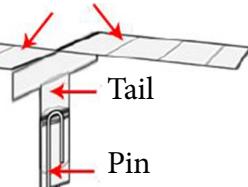
Fold all dotted lines.



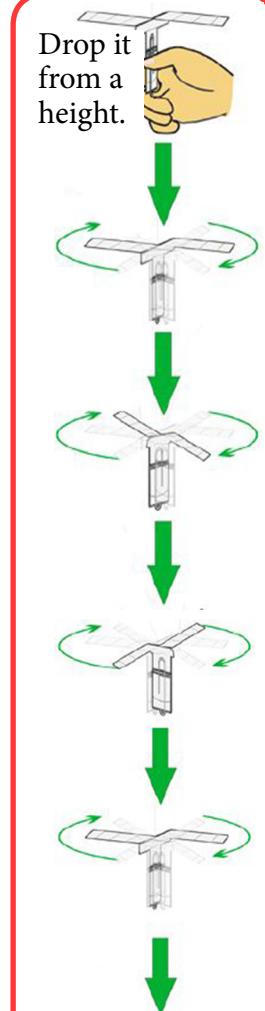
Use an office pin on the lower portion.

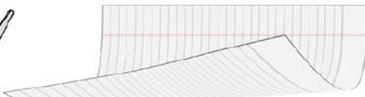
3

Rotor



Methodology





## Required Items

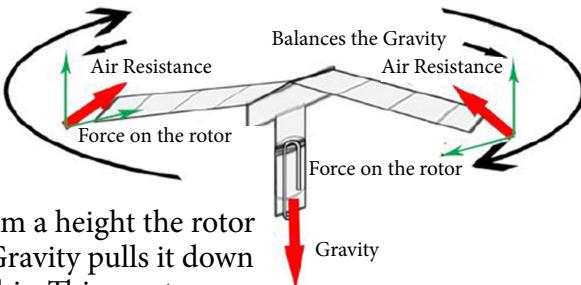
Office Pin Scissors

A Page from a copy

? ? ?



## How Did it Work!

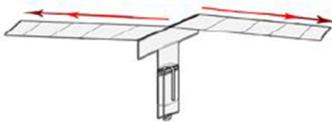


When dropped from a height the rotor design rotates it. Gravity pulls it down but the air resists this. This exerts a force on both the wings which then rotate.

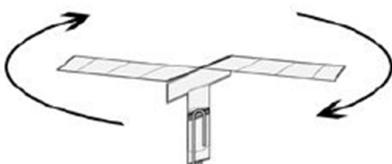
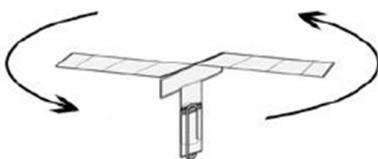


## Think About it??

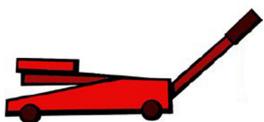
What happens if we increase the size of the wings? Will it take more time to reach the ground?



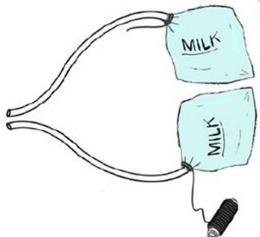
What did you notice about the direction of spin? Was it clockwise or anticlockwise? How can it be changed?



# Pascal's Bag

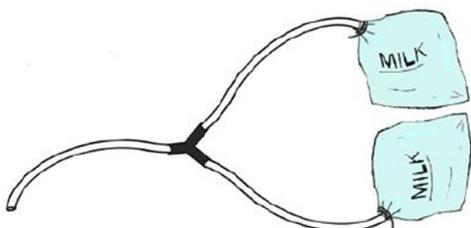


Lift heavy books with just one breath.



Put two flexi tubes in both the bags and tighten the joints using thread. 1

Make a 'Y' Joint as shown.



2

Put some weight on the bags and blow into the flexi tube.



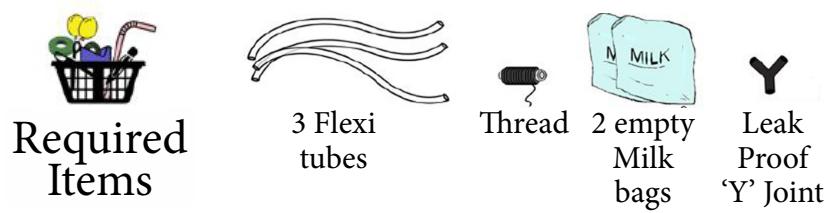
3

If you blow into the tube with force, you can lift upto 10 Kg of books.



4

Methodology



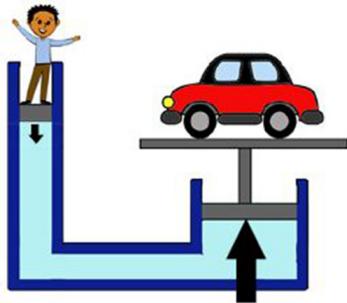
? ? ?



## How Did it Work!

Blowing into the bags causes the pressure to increase but bags having a greater area as compared to the tube, so the upwards force in the bags is enough to lift heavy weights.

Less area of the tubes enables us to lift the weight of the books by using our finger to block the tube. This is a classic example of 'Pascal Law'.



## Think About it??

What will happen if we take a thicker pipe to blow? Will it ease the process or makes it more difficult for us to lift?

Hydraulic press is also based on Pascal's Law ! Can you think of other application of pascal's law?

Suppose the piston is moved 'x' units in downward direction, what will be displacement of car in upward direction?

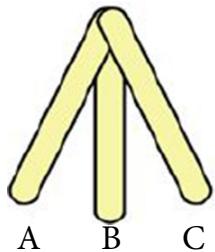




# Peace Bomb

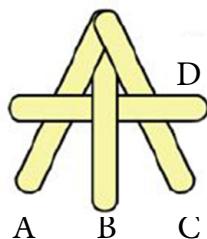
This bomb signifies peace instead of war.

Spread three ice cream sticks 'A', 'B' & 'C' as shown. Keep 'B' below.



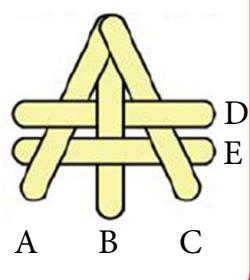
1

Put another stick 'D' so that it is above 'A', 'C' but below 'B'.



2

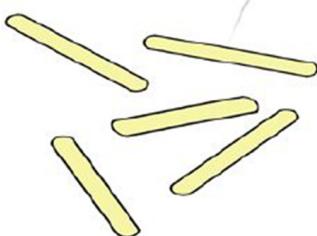
Now put stick 'E' so that it is below 'A', above 'B', and below 'C'



3

4

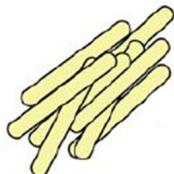
Now throw this arrangement towards any wall.



When it hits the wall, all the sticks will scatter like a bomb.

## Methodology

## Required Items



Ice cream Sticks

? ? ?



## How Did it Work!

This is an example of how five ice-cream sticks can be arranged so that they hold together without any glue or staples.

The beauty of this arrangement is that, on throwing it up against a wall, the sticks come loose and fall apart!

This is symbolic representation of bomb which which is designed not to hurt people!



## Think About it??

The United States dropped nuclear weapons on the Japanese cities of Hiroshima and Nagasaki on August 6 and 9, 1945, respectively. And this lead to the end of the second world war. The two bombings, killed around 129,000 people.

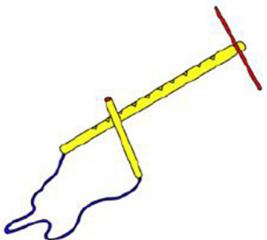
Wars are expensive, they displace a lot of people and they lead to the injury or death of many others.

Why do you think wars happen? Are they good or bad?

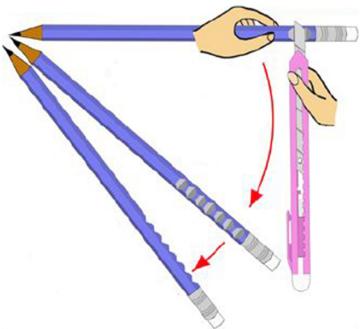
What are the changes we need to bring in our own live to live in harmony with oneself and others?



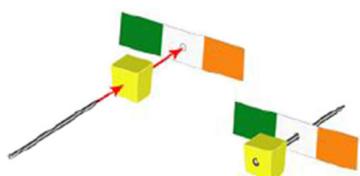
# Pencil Spinner



This is at least a hundred years old toy. It is so interesting that about 6 people have written papers on it (towards a Ph.D.). Yet the exact physics is not very clear.

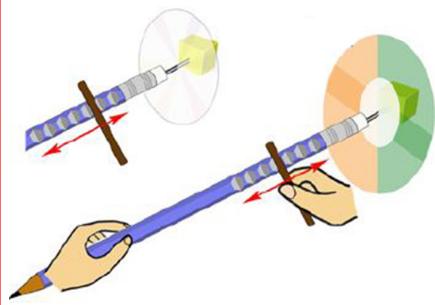


Make 7 serrations on the pencil 1



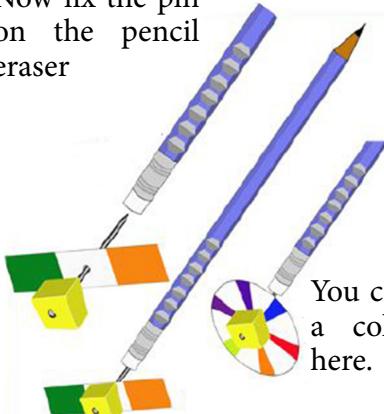
Pierce the rubber piece with oil pin and pass it through the fan 2

Holding it from one side, rub the broom stick or a refill too & fro on the serrations. The fan starts rotating.



4

Now fix the pin on the pencil eraser



You can also fix a colored fan here.

3

Methodology



Pencil



Broom Stick



Cutter



## Required Items

Rubber piece



Card fan



Card roundFan



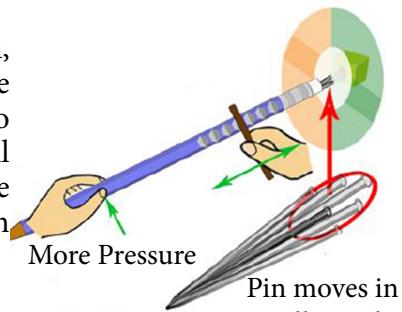
Pin

? ?? ?



## How Did it Work!

As we rub the stick on the pencil, we generate vibrations along the z axis (bending vibrations due to up & down movement) as well as x axis (spatial vibrations). The resultant force pushes the strip in a circular direction.



We can control the direction of rotation by controlling the direction of sideways vibrations.

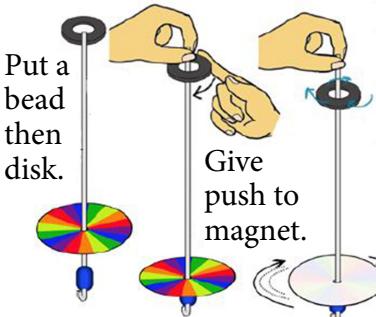


## Think About it??

How can one change the direction of rotation?  
What will happen if we hold the pencil firmly below the notches?



Which kind of fan goes the fastest?

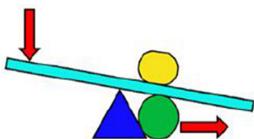


A toy made with a cycle spoke and a round magnet. When the magnet comes down, it creates vibrations which rotate the Newton disk below. 7 seven colors of a rotating Newton disk make white color.

Check the direction of rotation of the magnet and the disk.

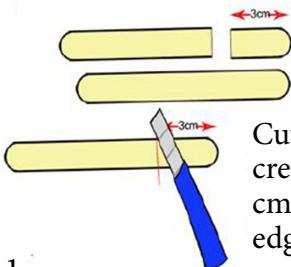
Find out about about Newton's disk.

# Rampuri



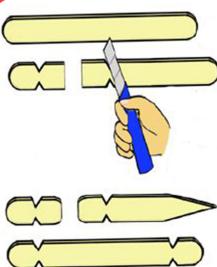
This automatic mechanical knife - a Rampuri Chaku, is fun to make and a sheer delight to play with.

1



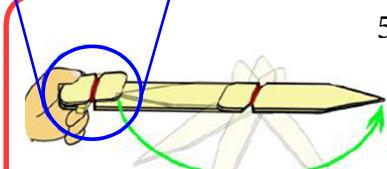
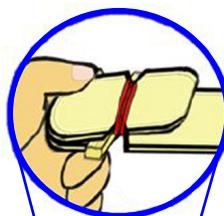
Cut an ice cream stick 3 cm away from edge

2



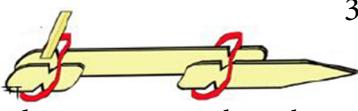
Make serrations in both pieces as shown. Also sharpen the bigger piece like a knife. Do it on an uncut piece also.

5



The knife opens in a second when you press the button.

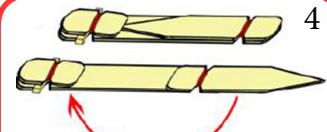
Now join both cut pieces on the uncut stick



3

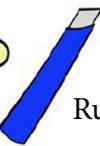
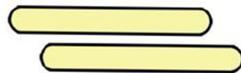
with rubber bands. Insert a match stick between the smaller cut piece and the uncut piece. This will act as a fulcrum of the lever.

4



Pull the blade portion back below the smaller cut piece towards the handle of the knife.

## Methodology



## Required Items

2 Ice cream sticks

Blade

Rubber band

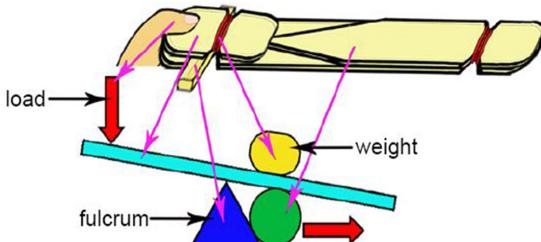
Match stick

? ?? ?



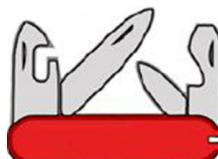
## How Did it Work!

There is a trigger in this knife that actuates a spring mechanism and makes a naive piece of wood flick out in a jiffy! When the lower part is pressed it raises the lower stick, which releases the trapped upper part and the stick comes out.



## Think About it??

1. Which lever class do you see here?
2. What would happen if we had used cotton thread instead of rubber band for putting the sticks together?
3. Can you make a swiss knife with has 4 blades?
4. Make a variation of the knife with blades at both the ends.

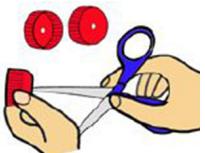


# Bottle Pump

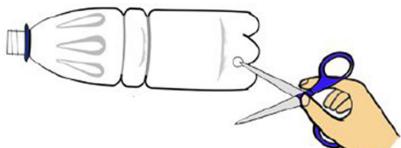


Anonymous

Use a scissor to drill a hole in bottle lid



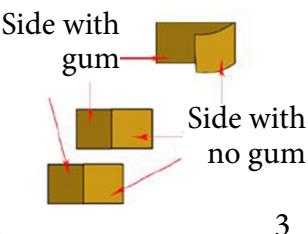
1



Drill another one in bottom of the bottle

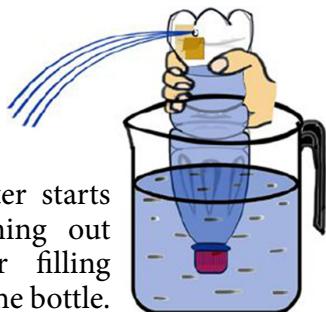
2

Take a piece of tape and fold it at 1/3 of its length. Your valve is ready. Make 2 of these.



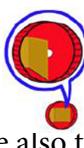
3

Putting the lid on the bottle, immerse it upside down in water. Squeeze & release.



5

Put these tapes on both holes ensuring that the side without glue is towards the holes.

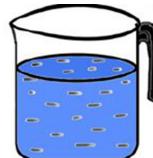


Ensure also that tape is inside the lid and outside the bottle

!

## Methodology





## Required Items

Bottle Cello tape Scissor

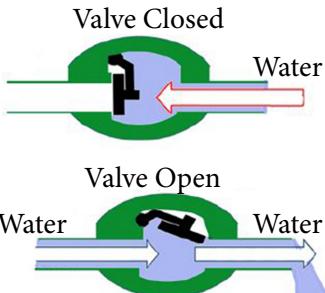
Water mug



## How Did it Work!

A valve is a device, which enables water, or air to flow in one direction only. There are two valves here.

When we press the bottle, water gushes from the valve at the top. The bottom valve does not allow water to go outside. On releasing the bottle, the top valve closes, so water gushes from the bottom valve inside to fill the remaining space and the cycle continues.

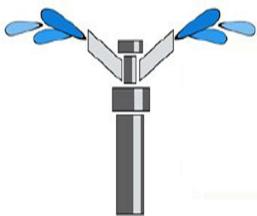


## Think About it??

Try using different size water bottle ie 2L and 500mL and see when you find it more easy to lift the water. Is the size and shape of vase influencing the range to which the water goes after coming out from bottle? Do you know that India Mark II which is a human powered pump is the world's most widely used hand pump? It can lift water from depth upto 50 m and was designed in 1970 through the joint efforts of the government of India, UNICEF and WHO. Its purpose was to address the deadly problem of scarcity of water in rural areas of developing nations

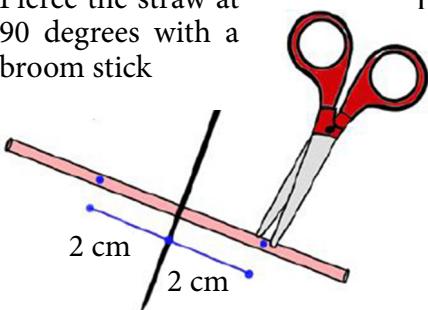


# Sprinkler

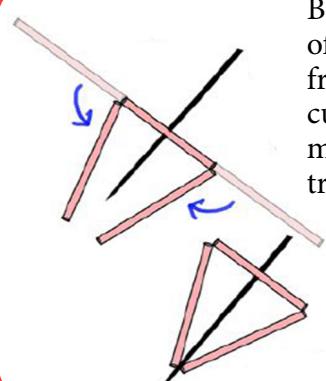


This simple device working on the principle of ‘Centrifugal Force’ will leave you surprised.

Pierce the straw at 90 degrees with a broom stick

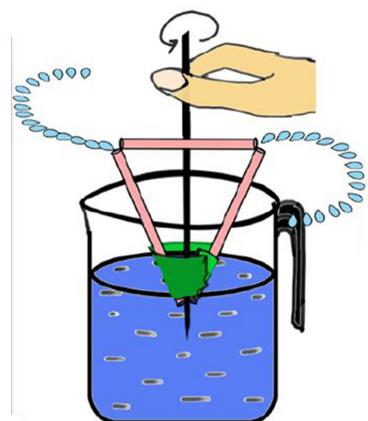


Make 2 small half cuts 2 cm from centre of the straw on both sides



Bend sides of straw up from the cut marks making a triangle.

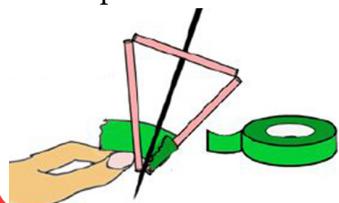
Put this triangle in water and rotate it by turning the broom stick. Water starts flowing out of the cut portions of the straw just like centrifuge.



4

Methodology

Stick both sides of straw with a cello tape.



3



## Required Items

Straw



Cello tape

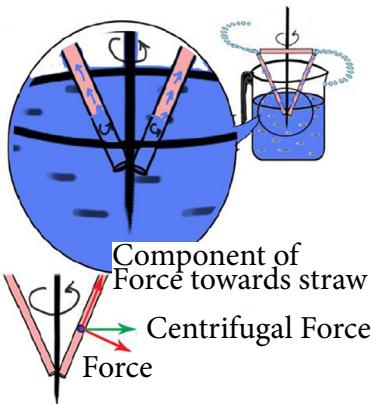


Water mug

? ?? ?



## How Did it Work!



As we rotate the stick, the water inside the straw also moves in a rotational direction and hence, gets thrown outwards.

However, the straw walls stop it from moving outwards, which makes the water particles climb up instead and finally, come out from the top of the straw.

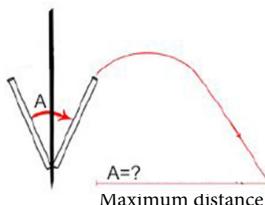
This is also a simple model of a centrifugal pump.



## Think About it??

What if we increase the radius of bottle?

What if we decrease the angular velocity?

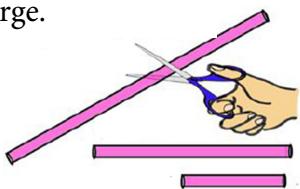


# Flute (Bansuri)



What do we do with plastic straws we get with in market ? we generally throw it in dustbin isn't it? Do you know we can literally make a working flute using those?

Cut the straw into 2, one small, other large.



1

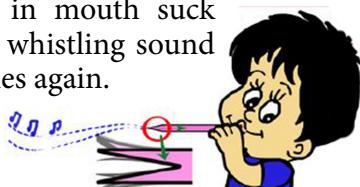
Flatten 2 cm of one end of both straws by pressing. Put a mark.  
Cut both from the mark as shown

2

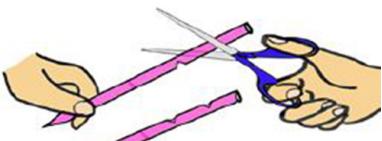
Keeping the cut end in mouth blow out air. A whistling sound comes



Now Keep the uncut end in mouth suck air. whistling sound comes again.

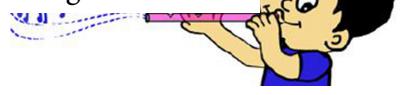


3



Take the other straw and cut it in V shape at 2 - 3 places.

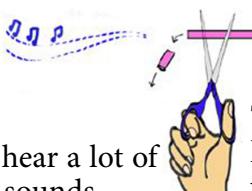
This is your flute. Take out different sounds by opening/closing the holes.



4

## Methodology

Make a whistle out of a long straw. Keep cutting it as you blow into it.



You will hear a lot of different sounds

The pitch of sound keeps increasing as you cut the straw.

5



Straw



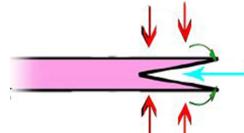
Scissor

## Required Items

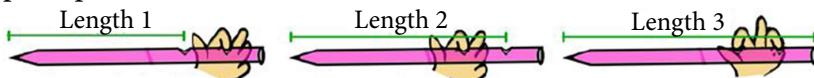
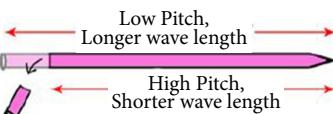


### How Did it Work!

When we blow on the end of the straw, the two pieces of the tip vibrate together. The vibration travels down the straw, and reflects up from the end.



This sets up a wave in the air inside the straw. The vibration moves through air molecules and hits our eardrum. It is this vibration that we are hearing! Changing the length of the straw (by clipping it off) changes the wave length of the wave produced which leads to change in the pitch. Shorter the straw, shorter the wavelength, higher the pitch produced!



We have cut three holes here but we can have three different sounds because these two holes divide the straw into three parts.

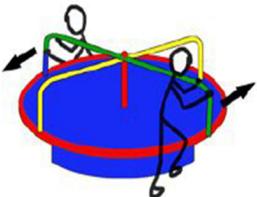


### Think About it??

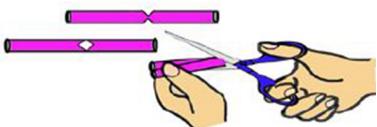


Did you know that different animals can make and hear different sounds than humans? Dogs and many other animals can hear pitches that are too high for our ears. Whales, when they sing their whale songs, sometimes create pitches that are way too low for human ears, but whales can hear them just fine for hundreds of miles across the ocean!

# Straw Propeller

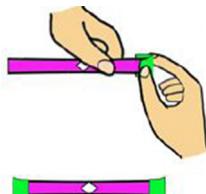


This is amazing propeller which we can make with just few straw pieces and a cello tape!



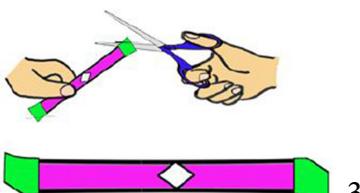
1

Bend a 6 cm straw from the middle and make a brick shaped cut on the bent portion.



2

Block both sides using a tape.



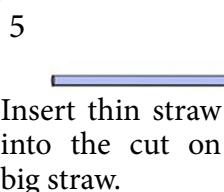
3

Cut opposite sides at an angle as shown.

Close one end of the thin straw with cello tape and blow through the other end.



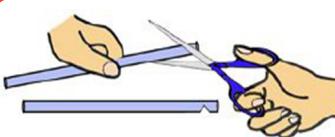
6



5

Insert thin straw into the cut on big straw.

## Methodology



4

Make a V shaped cut on the thinner straw

## Required Items



Thick Straw  
Thin Straw

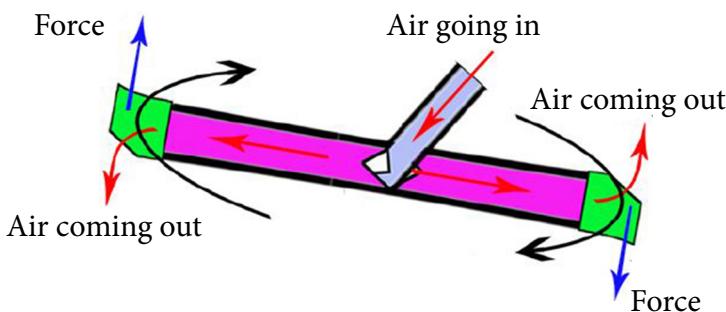


Cello tape



## How Did it Work!

This is a classical Newton's third law in action (Every action has an equal and opposite reaction). As we blow air through the thin straw, the air finds an outlet through the two triangular openings at the diametrically opposite ends of the spinner straw. As the air rushes out, it pushes the straw in the opposite direction. Force on both the ends are in opposite direction, but the torque is in same direction. So the spinner spins. As long as you keep blowing, the straw gets a steady torque from the two streams of rushing out air and it keeps spinning.



## Think About it??

Will the straw spin if we just make a single cut on the spinner for the air to come out?



What happens when we cut the holes on the spinner straw anywhere else along the length instead of the ends ?

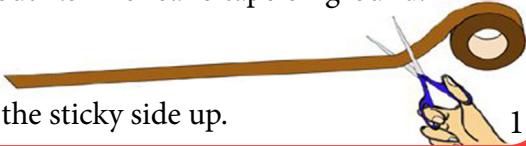


# Straw Waves



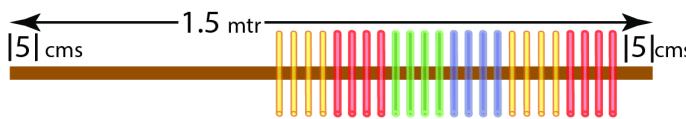
This is a simple wave model which helps us understand propagation of waves. You twist it and it becomes a DNA model

Roll out 1.5 m of callo tape on ground.



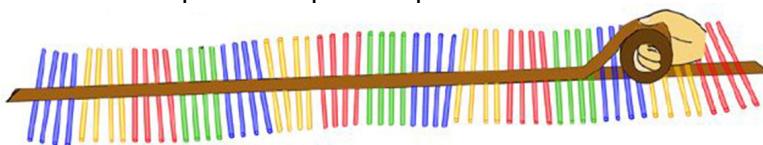
keep the sticky side up.

Leave 5 cm on both sides to handle the tape.

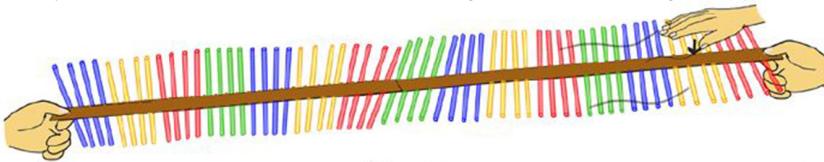


On this tape<sup>2</sup> stick about 60 straws with 2 cm gap in between

Stick another piece of tape on top to enclose straws from both sides 3

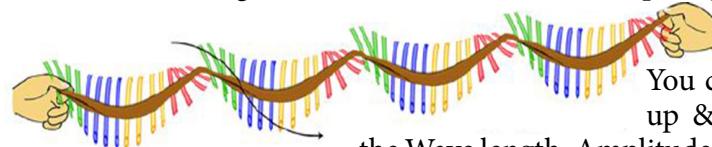


Let your friend hold end and holding the other one give a jerk.



A wave forms and goes to your friends side. Gets reflected back.

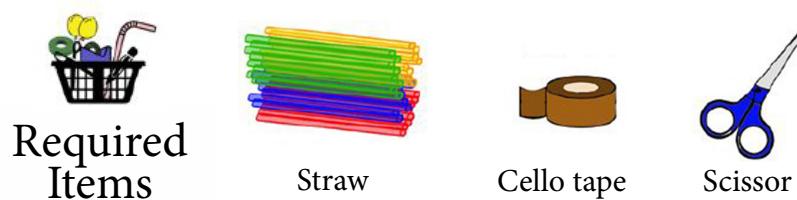
To make a standing wave, twist both ends of the tape slightly.



You can now see the up & down motion, the Wave length, Amplitude and Frequency

## Methodology

This also looks like a Double Helix DNA Model



## How Did it Work!

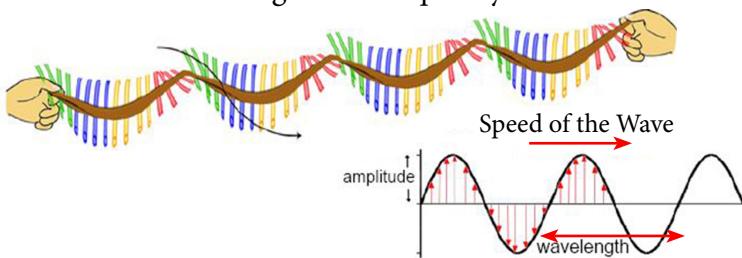
When we tap the straw, pulse is produced in it. The pulse gets transmitted to the adjacent straw and returns to its initial state of rest. The process gets repeated and pulse keeps on moving thus producing a wave like motion. This is similar to the waves which are produced when we drop a pebble in still water. The water remains at its place but the water wave moves outwards from the center. In wave model, the energy is transmitted via the tape. So, when the tension is more in the tape, the speed of transmission of wave increases. If we would have taken, neem branch or a cycle spoke instead of straw, the speed of the wave generated will be different!



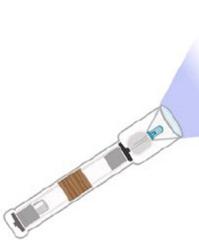
## Think About it??

What is the role of energy in wave travel?

When we give it a twist, sine wave is created. How do we calculate the wavelength and frequency in that case?



# Syringe Generator



Today we will make one of the simplest generators in the world using just a syringe and a magnet!



1

Take out the rubber piston from the plunger of the syringe



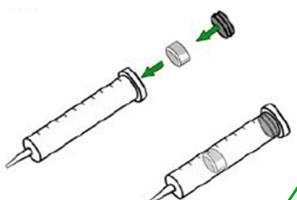
Shake the syringe. 6  
The magnet moves too and fro inside.

LED lights up



Put the magnet inside and close with rubber piston

2



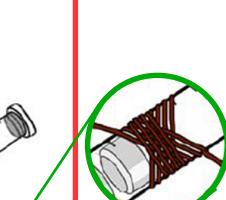
2

Connect these ends to a LED



5

Wind around 700 to 1000 turns of copper rewinding wire around the syringe



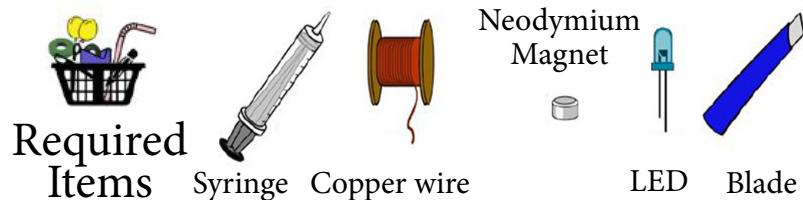
3

Remove insulation at both ends of wire.



4

Methodology

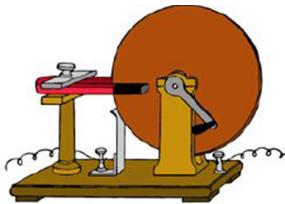


? ? ?



## How Did it Work!

In 1831, Michael Faraday gave Faraday's law of electromagnetic induction which says that whenever there is relative motion between a coil and a magnet, a current in the coil will get induced.



The reciprocating magnet inside the barrel produce current, which lights up the LED.



## Think About it??

What is the source of energy of the electricity that is produced?

Why does the LED stop glowing if you don't shake the magnet?

Why does the LED not glow when we shake the magnet slowly?

When really does the LED glow? When magnet come out of coil or when the magnet goes in?

# Notes

