Philippine Foundation for Science and Technology

Philippine Science Centrum

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science ADVENTURES

Philippine Science Centrum Traveling Exhibit

Manual of Exhibits

This Science Adventures Manual of Exhibits
is a publication of the Philippine Science Centrum.

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MESSAGE

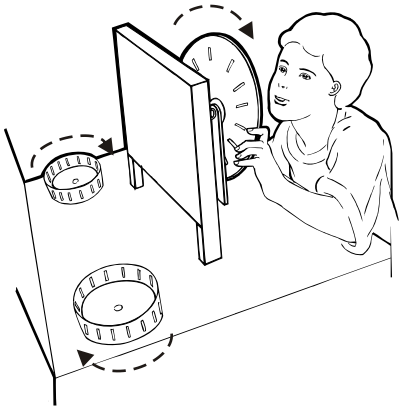
It is with pride and joy that we present the Science Adventures Traveling Science Centrum Exhibit Manual. This manual encapsulates the various science concepts and their applications presented through 40 interactive exhibits.

The Science Adventures is a traveling science exhibition component of the Philippine Science Centrum, the premiere science center-museum in the country. Through hands-on interactive exhibits and challenging activities, the Science Adventures and the four (4) sets of Traveling Science Centrum have successfully brought a unique medium for science and technology learning to 174 cities and provinces. It has registered more than 3 million visitors. Persistent requests from students, teachers and supporters have inspired us to produce the Science Adventures Exhibit Manual which will serve as a handy reference in getting to know and better appreciate science and technology and their relevance in daily life.

It is our ardent hope that this manual will be utilized to maximize science and technology among the general public and the Filipino youth in particular who will play an active role in shaping the future of the nation.

MAY M. PAGSINOHIN
Executive Director

ZOETROPE



Try this!

1. Look through a slit on the disk. Do you see a horse and its rider on the mirror?

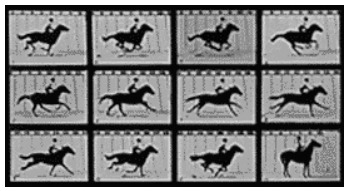
2. As you look through the slit, spin the disk slowly then spin it fast. How do the horse and the rider appear?

3. Repeat steps 1 and 2 for cylinders A and B. What images do you see?

What's going on?

Painted on the side of the disk facing the mirror is a sequence of pictures of horses and riders. When you spin the disk slowly, the horse and the rider seem to move continuously like in a horse race. In cylinders A and B, you see a man hurdling and a man tumbling.

The illusions of movement are based on the optical phenomenon, called persistence of vision, and the phi phenomenon. Persistence of vision causes the brain to retain images cast upon the retina for a fraction of a second after they have disappeared from the field of sight. The phi phenomenon creates apparent movement between images when they succeed one another rapidly. Together, these two phenomena permit the succession of still pictures which result in continuous movement, as observed in the exhibit.



The illusion of movement is applied in motion pictures and cartoon animation. A motion picture or animation is made up of thousands of still pictures, called frames. In each frame, the scene or subjects in the scene are slightly different in position from the previous frame. For every second, 24 frames of film flicker onto a screen to produce moving images. We cannot distinguish each still image, but instead see continuous movement.

AMAZING CAKE

Try this!

1. Look at the mirrors. How many slices of cake do you see?

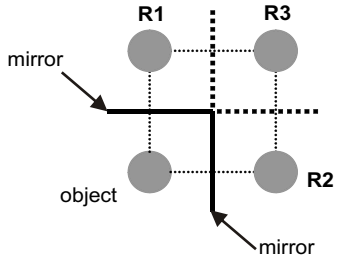
2. Move the right mirror to the left. What happens to the number of slices?

What's going on?

The number of slices of cake that you see depends on the angle between the mirrors. As you decrease the angle, you see more reflections of the slice of cake.

If you have one flat mirror, light from the object will reflect off the mirror once. When you have more than one mirror, you can create multiple reflections.

With two mirrors that are perpendicular to each other, one image will form from a single reflection from each mirror (R1 and R2). These two reflections create the third image, R3.



When the angle is decreased, more reflections will occur.

WHIRLPOOL

Try this!

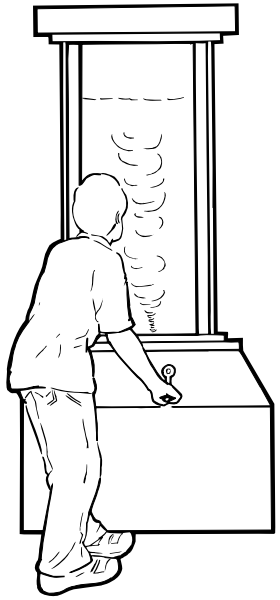
Press the button. What do you see?

What's going on?

When you press the button a propeller in the exhibit rotates. This causes the water to move in a circle around a central area and form a whirlpool.

A whirlpool is a large, swirling body of water. Its formation follows the **Law of Conservation of Angular Momentum**, which states that if an object is rotating about a center and is pulled in closer, it will rotate faster.

In a whirlpool, the slowly rotating water in the outer areas is drawn towards the center. The water begins to rotate faster, exerting a greater central force and making a hole. As a result, you see a vortex.



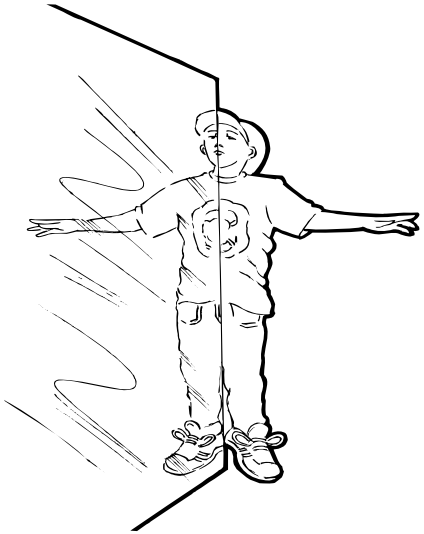
A whirlpool can form where:

1. two currents of water moving in opposite directions meet,
2. tides and rock formations in the ocean interfere with the path of an ocean current and the current is diverted in a circular path,
3. wind blows strongly against a tidal current, or
4. flow of water through a riverbed increases.

ANTI-GRAVITY MIRROR

Try this with a friend!

1. Ask your friend to stand on the right side of the mirror and align his/her nose to the mirror's edge.
2. Position yourself within the 45-degree angle with the mirror. Watch as your friend lifts his/her left leg and moves his/her left arm up and down. How does your friend look?
3. Change roles. You will do what your friend did and your friend will now observe you. You can try other movements.



What's going on?

A person standing at the right side of a large mirror such that the left half of the body is visible and the right half is hidden from view will look whole to an observer who is positioned within the 45-degree angle with the mirror. The fun begins when the person starts to do some movements. When the person lifts his/her left leg, the observer will see two legs off the ground. When the left arm is moved up and down, the person appears to be flying. Why?

The human body exhibits bilateral symmetry. This means that only one plane, called the sagittal plane, divides the body into roughly mirror image halves (external appearance only). The two halves can be referred to as the right and left halves. The right half is similar to the left half in size, shape and parts.

To an observer the reflection of the exposed half (left side) on the mirror appears to be the right half of the body, so the person looks whole. The lifted leg is also reflected by the mirror. This is why the person appears to be suspended in air and not pulled down by gravity.

THOMPSON RING

Try this!

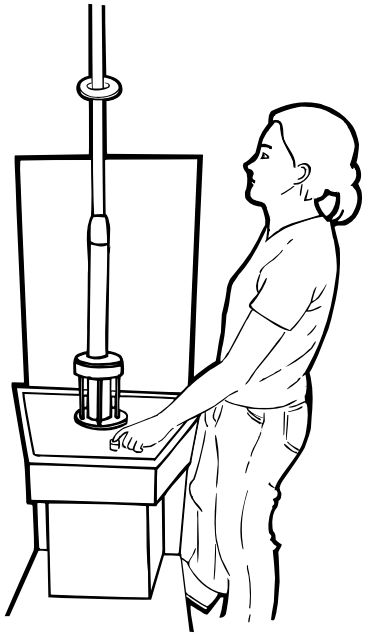
Press the button. What happens to the aluminum ring?

What's going on?

When the switch is turned on, the ring immediately "jumps" up the vertical rod. Why?

The exhibit consists of a transformer, an induction coil, and an aluminum ring over the core of the coil. An alternating current (AC) is used to power the transformer.

AC is a constantly varying current, meaning the electrons change directions 50 times per second. When the switch is turned on, AC produces a constantly changing magnetic field through the coil. This in turn induces a constantly changing current in the ring, producing a constantly changing magnetic field in the ring. This is called the **Law of Induction**.



According to the **Law of Conservation of Energy**, the induced fields must be in the opposite direction to the original fields. For example, if the original field (in the coil) has a north pole pointing up, then the induced field in the ring will have a north pole pointing down. As like poles repel, the north poles will repel each other. Thus, the ring jumps up.

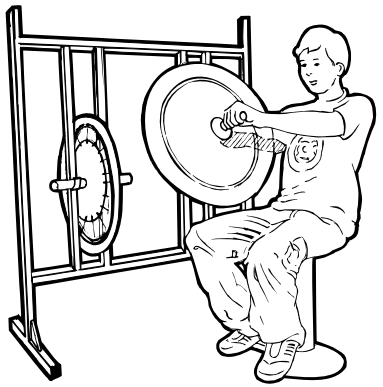
BICYCLE WHEEL GYRO

Try this with a friend!

1. Sit on the chair. Stretch your arms forward.

2. Ask your friend to spin the bicycle wheel fast and hand it to you as it spins. Make sure that the rapidly spinning wheel does NOT touch your body. (Take note of the direction of the spin.)

3. Tilt the spinning wheel to the left. Does the chair rotate to the right or to the left? Tilt the wheel to the right. In what direction does the chair rotate?



What's going on?

When you tilt the wheel that is spinning inward to the right, you (on the chair) rotate to the left. When you tilt this spinning wheel to the left, you rotate to the right.

When you tilt the wheel that is spinning outward to the right, you rotate to the right. When you tilt this spinning wheel to the left, you rotate to the left. Why?

The exhibit demonstrates **Conservation of Energy**. Energy from the spinning wheel transfers to your arms, body and legs. When you tilt the spinning wheel you are applying a twisting force or torque on your body. Since you are seated, the energy transfers to the chair, and the chair rotates.

The exhibit also demonstrates **Conservation of Angular Momentum**. This is a principle of motion involved in rotating objects. You, the chair and the spinning wheel make up a system. Any change in the angular momentum within the system must be accompanied by an equal and opposite change so that the total effect is zero. In order to counterbalance this torque, the wheel applies an equal and opposite twisting force on you. Since you are sitting on a low-friction pivot chair, you (on the chair) rotate.

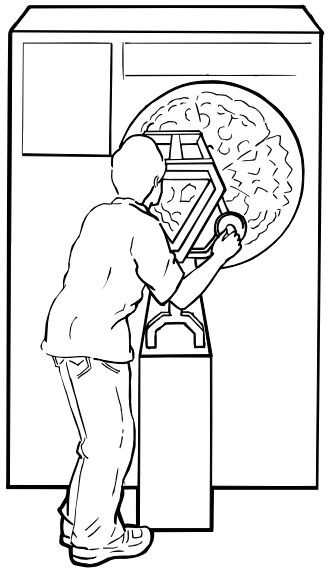
SYMMETROSCOPE

Try this!

1. See the drawings of parts of objects on the disk at the back end.

2. Look through the opening of the three-sided tube.

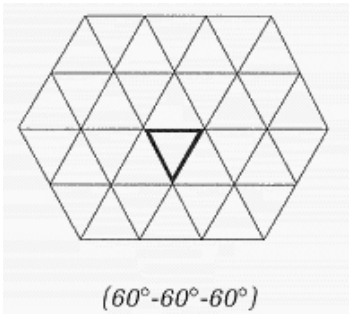
3. Slowly rotate the disk until a part of an object fits a corner formed by two sides of the tube. What happens to this part? Does this part become whole?



What's going on?

The drawings on the disk are parts of circular objects. As a part fits a corner formed by two sides of the tube, that part is reflected by the three mirrors. The reflections bounce back and forth. This is why you see many reflections of whole circular objects–a slice of pizza becomes a whole pizza! Each whole pizza consists of six identical parts.

The arrangement of the three mirrors inside the symmetroscope produces the reflections you see. The longer



sides of the rectangular mirrors are joined to form a 60-degree triangle. The sum of the three angles total 180 degrees. Each angle produces six-fold patterns, resulting in a design of continuous triangles.

CALYPSO REEF

Try this!

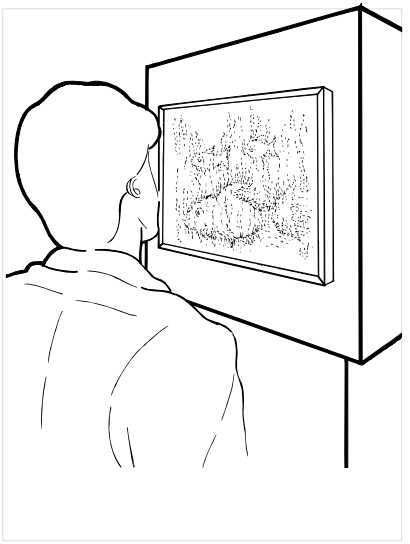
1. Face the exhibit from a distance of two feet. Look at your reflection on the glass.

2. Relax your eyes, free your mind but keep looking at your reflection for at least 30 seconds. Do you see a three-dimensional (3D) image? What is it?

You may also try these:

- As you look at the 3D image, move closer, then farther. Does the image also move?

- Close one eye. What happens to the image?



What's going on?

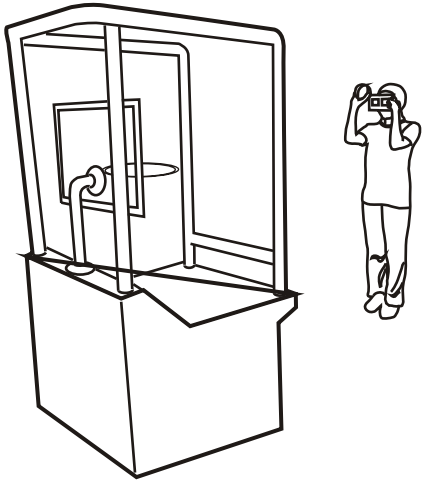
As you focus on your reflection on the glass, a 3D image of dolphin and fish appear.

Depth perception enables you to see a 3D image that is hidden within a two-dimensional pattern, called a stereogram. The slight differences in vertical repetitions of figures or random dots create this illusion of depth.

Once you perceive the hidden image and depth, you can look at the whole 3D image. When you move closer, the image becomes clearer. When you move farther, you see more depth.

A person with impaired depth perception or a person with only one eye will have difficulty seeing the 3D image.

SHOOT THE BALL



Try this!

1. With one hand, hold the goggles close to your eyes. With the other hand, shoot the ball into the ring. Did the ball go into the ring? Keep trying.

2. Shoot the ball without looking through the goggles. Did the ball go into the ring this time?

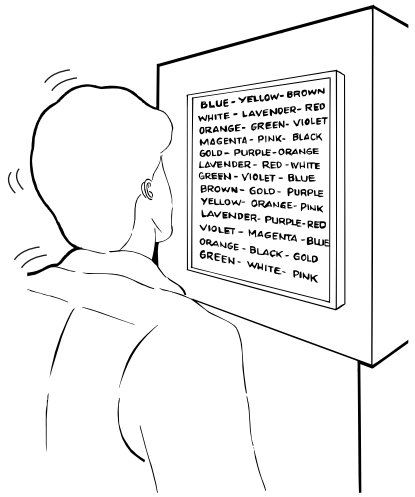
What's going on?

When you shoot the ball while looking through the goggles, you cannot make the ball go into the ring. Your shot is always way off even after several tries. Then, when you shoot without the goggles, you still cannot make the shot in the first few tries. Why?

Normally, your sense of touch and sense of sight work together (synchronize). You depend on your eyes to tell you where the ring is, so that you can shoot the ball in that direction. However, the goggles produce a slight visual distortion–light bends as it passes from air to the goggles' lenses. This results in the shifting of your visual field. The ring appears to be slightly to one side when you look through the goggles, but actually the ring is just in front of you. So when you aim the ball to that direction the ball misses the ring. When you decide to change the direction of your shot, you may succeed.

Similarly, when you remove the goggles and repeat the task, at first you have difficulty making the shot. After trying several times, your eyes adjust back to normal view–you see the ring in its actual position and you shoot the ball in that direction.

COLOR OR WORDS



Try this!

1. See the printed words on the poster. They are names of colors.

2. Say aloud the name of the color used in printing each word. (Do not read the word.) Do this as fast as you can. Is this an easy task?

What's going on?

In doing the task, most likely you experienced either one of these:

- Instead of naming the color, you read the printed word.
- It took you some time before you could name the color. Why?

What you experienced is the *Stroop Effect*, named after J. Ridley Stroop, a psychologist. It demonstrates that the words themselves have a strong influence over your ability to name the color. The two kinds of information (what the word says and the color of the printed word) cause confusion in the brain.

Young children who cannot read yet but can recognize colors would be able to do the task easily. Older children or adults who can read fast would not be able to do the task as fast.

There are two theories that may explain the Stroop effect:

1. Speed of Processing Theory - Words are read faster than colors are named.

2. Selective Attention Theory - Naming colors requires more attention than reading words.

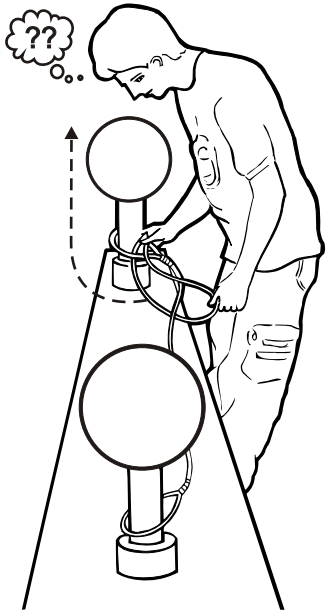
ROPE PUZZLE 1

Try this!

1. See the way the black rope and the red rope are arranged:
   - The black rope has its ends looped around the posts. The spheres prevent the rope from being pulled out of the posts.
   - The red rope forms a loop around the black rope. This loop is large enough to pass through a sphere.

2. Solve this puzzle: Free the red rope from its loop around the black rope, the post and the sphere.

3. Return the red rope to its original position, that is, the red rope is looped around the black rope.



What's going on?

Did you do the following to solve the puzzle?

A. To take the red rope out of the black rope, the post and the sphere:
1. Hold up the red rope. Pass it through the sphere down to the post.
2. Pass it through the loop of the black rope.
3. Pull it up the post and out of the sphere.

B. To return the red rope to its original position:
1. Pass the loosened (freed) red rope through the sphere, then down to the post.
2. Insert it through the loop of the black rope.
3. Hold it up and pass it through the sphere down to the post.

The rope puzzle is an example of topology, a branch of mathematics. Topology is sometimes called "rubber-sheet" geometry, because it studies those properties of figures (like the circular rope) which remain unchanged if the figures are stretched, twisted, bent or otherwise "elastically" deformed. Such elastic deformations are continuous functions since points, which start out close together end up close together after the deformation–the rope remains circular after freeing it from its loop around the black rope, the post and the sphere.

CYCLONE

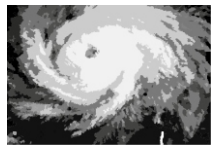
Try this!

Press the red button until you see a lot of mist rising. Then, press the yellow button.
What happens to the mist?

What's going on?

The exhibit simulates the formation of a cyclone. The mist represents warm air. The air being blown from holes in the pipes causes the mist to rotate.

A cyclone is formed when a large mass of warm air rises, causing a drop in air pressure in the place where it occurs. The cool air from the surroundings moves toward this low-pressure area. This makes the cyclone take a spiral upward motion. The cyclone's center, which is the area of lowest atmospheric pressure, is called the eye.



As air pressure below the rising air decreases further, it causes more cool humid air in the surroundings to move into the eye faster. Air around a cyclone moves counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere of the Earth.

Tropical cyclone is one of the six main types of cyclones. It usually occurs over warm oceans that supply water vapor to the warm rising air. The water vapor condenses and forms clouds and rain. The energy given off during the process of condensation causes air to rise faster. A continuous supply of energy carried by water vapor increases wind speed. Based on wind speed, there are three types of tropical cyclones: depression (60km/h), storm (60-118 km/h), and typhoon (119 km/h or faster).

Tropical cyclones are also called hurricane, typhoon, tropical storm, cyclonic storm or tropical depression depending on their location and strength. In the Philippines, tropical cyclones occur most frequently in August.

RAINBOW CURTAIN

Try this!

Slowly pull the cord to raise the bar until you form a soap film.

Do you see colors of the rainbow on the soap film?

What's going on?

You see a beautiful display of all the colors of the rainbow on the soap film. The colors change as the film moves, changes shape, or thins out–a thin part reflects blue light strongly, a thick part reflects red light strongly. Varying thickness of other parts reflect other colors.

The soap film consists of two surfaces of soap molecules separated by a layer of water. When light strikes the front surface, some of it is reflected and some of it is transmitted to the back surface. From the back surface, some light is also reflected. Light waves reflected from the two surfaces meet.

Like water waves, light waves affect each other when they meet. This can result in the energy of two waves adding and forming a big wave with more energy. The waves can also cancel each other out. This wave interaction is called *interference*. It is what produces the bands of beautiful colors, like what you see in a rainbow.

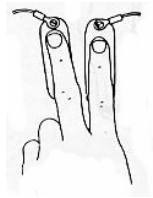
FINGER TINGLER

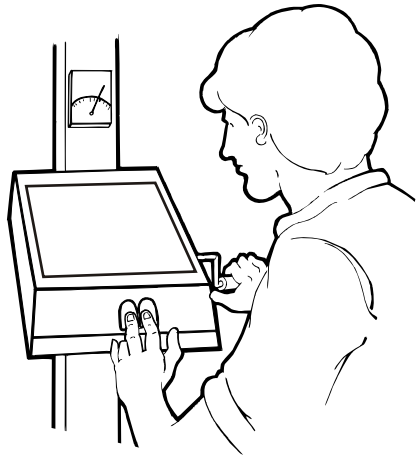
Try this!

1. Rotate the crank several times. Look at the voltmeter. Does the needle move?

2. Place a finger on a brass plate and slowly rotate the crank. Does your finger feel anything?

3. Place another finger (from the same hand) on the other brass plate and slowly rotate the crank. What do you feel?





What's going on?

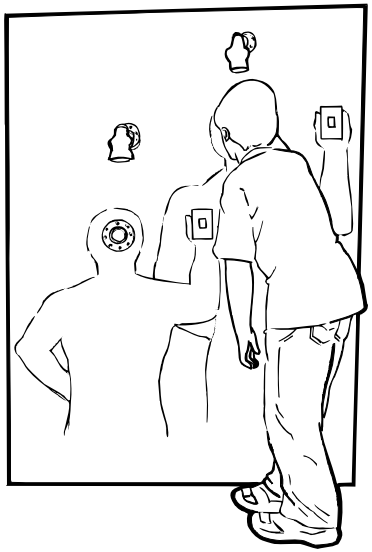
Generally, we have no way of knowing the presence of electricity except when it makes appliances work or when an instrument, like the voltmeter, is used.

When you rotate the crank, electricity is produced as indicated by the movement of the voltmeter needle. (Voltage can be present without current by cranking the generator and not touching the brass plates.)

When you place a finger on a brass plate then rotate the crank, you feel nothing in your finger. When you place two fingers from the same hand on the two brass plates and rotate the crank, you experience a tingling feeling or mild electric shock in your fingers. This indicates that electricity flows through your fingers as in a closed circuit.

The degree of electric shock that is felt depends on the following: 1) speed of rotation, 2) presence of moisture, and 3) surface area. More current can pass through when you rotate the crank faster, when your fingers are moist since moist skin has a lower resistance than dry skin, and when a bigger part of your fingers is in contact with the brass plates.

PUPIL OF THE EYE



Try this!

CAUTION: Turn the knob SLOWLY to prevent the sudden flash of light from damaging your eye.

1. Position your eye on the circular shield.

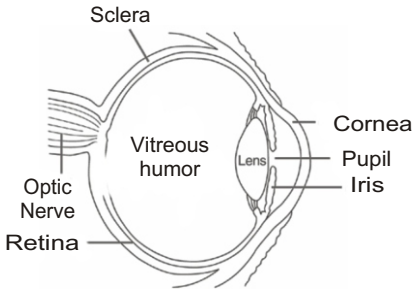
2. Look at the reflection of your pupil on the mirror.

3. Turn the knob SLOWLY clockwise to brighten the light. What happens to your pupil?

What's going on?

The pupil becomes narrower in bright light. (It becomes wider in dim light.)

The pupil is the opening in front of the eye. Its diameter is controlled automatically by the surrounding iris. The iris is the part of the eye that gives the eye its color–black, brown, blue, or green.



The iris has two muscles–the dilator and constrictor muscles. The dilator muscle makes the iris smaller and therefore the pupil wider, allowing more light into the eye. The constrictor muscle makes the iris larger and the pupil narrower, allowing less light into the eye.

Pupil size can change from 2 millimeters to 8 millimeters. However, in very bright light we have to close our eyes because the iris cannot completely close the pupil.

GRAVITY WELL

Try this!

1. Insert a coin into the groove.

2. Observe the coin's movement. Does the coin go straight down to the hole?

What's going on?

When the coin lands on the well, the force of gravity should make it go straight down to the hole. Instead, the coin moves round and round the cone gradually moving towards and into the hole.

The coin moves in a spiral because the force toward the center of the well is the only horizontal force. (The vertical component of the force is opposed and canceled by gravity.) This horizontal force is called the central force, which is created by the slope of the gravity well. The slope is steeper towards the hole, hence the force is greater. This causes the coin to accelerate towards the hole.

The gravity well demonstrates **Kepler's laws of planetary motion**. It simulates the effects that the gravitational pull of the Sun has on objects in our Solar System.

- First Law: The orbit of every planet is an ellipse with the sun at one of the foci. An ellipse is characterized by its two focal points.

- Second Law: A line joining a planet and the sun sweeps out equal areas during equal intervals of time as the planet travels along its orbit. This means that the planet travels faster while close to the sun and slows down when it is farther from the sun.

- Third Law: The squares of the orbital periods of planets are directly proportional to the cubes of the semi-major axes (the "half-length" of the ellipse) of their orbits. This means not only that larger orbits have longer periods, but also that the speed of a planet in a larger orbit is slower than in a smaller orbit.

In space which is essentially a vacuum offering no resistance, planets and other objects would continue in their elliptical orbits almost indefinitely. But in the gravity well, the gravitational pull causes the coin to spiral down to the hole.

PEDAL GENERATOR

Try this!

1. Pedal the bike slowly. How many bulbs light up?

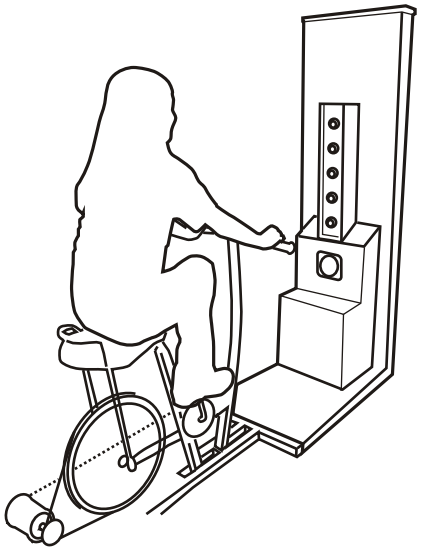
2. Pedal faster. Does the top bulb light up? Do you also hear a musical sound?

What's going on?

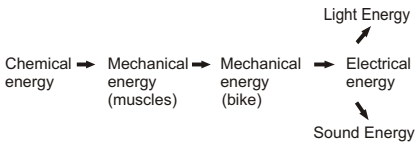
When you pedal slowly, the lower bulbs light up. When you pedal faster, all the bulbs light up and you also hear a musical sound. Energy transformation makes these things happen.

Energy exists in one form or another–it cannot be created and it cannot be destroyed. In the exhibit, energy is transformed this way:

- Food is stored chemical energy.
- When you pedal the bike, you transform the energy in the food you eat into the mechanical energy that moves the muscles.
- The bike in motion also has mechanical energy.
- The electric generator transforms the mechanical energy of the bike into electrical energy. The rotation of the front wheel turns the coil of wire between the poles of the magnets inside the generator. The resulting current is channeled to the attached power strip to which several bulbs and a sound device are connected.
- The bulbs use the electrical energy, which is transformed into light energy.
- The sound device also uses the electrical energy, which is transformed into sound energy.



The diagram below shows the energy transformation in the exhibit:



LASER DISPLAY

Try this!

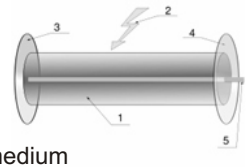
Look at the laser display.
What do you see on the white panel?

What's going on?

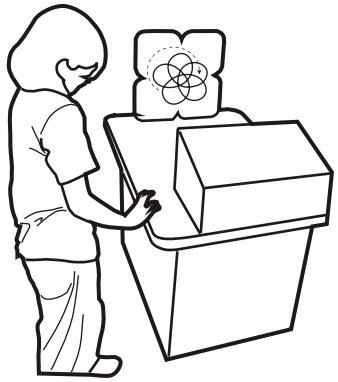
The various designs you see on the white panel are actually the path taken by the moving laser spot, called patterns.

LASER is an acronym, which stands for Light Amplification by Stimulated Emission of Radiation. It is a device that emits light in a narrow, low-divergence beam and with a well-defined wavelength (corresponding to a particular color if the laser is operating in the visible spectrum). This is in contrast to a light source such as the incandescent bulb, which emits light in a large solid angle and over a wide spectrum of wavelength.

Principal components of a laser:



1. Gain medium
2. Laser pumping energy
3. Mirror
4. Half-silvered mirror
5. Laser light



A laser consists of a gain medium inside an optical cavity with a means to supply energy to the gain medium. The gain medium is a material (gas, liquid, solid or free electrons) with appropriate optical properties. The optical cavity consists of two mirrors arranged in such a way that light bounces back and forth, each time passing through the gain medium. The mirror at one end of the laser is “half-silvered”, meaning it reflects some light and also allows some light to pass through. The light that passes through is the laser light.

The most widespread use of lasers is in compact disc and DVD players, in which the laser scans the surface of the disc to play. As bar code readers the laser decodes the price of a product. In industry, lasers are used for cutting metals and for inscribing patterns. In medicine, lasers are used in some surgical procedures.

MUSICAL PIPES

Try this!

Hit each pipe with the rubber pad. From which pipe do you hear a low pitch? From which pipe do you hear a high pitch?

Hit the pipes to produce a rhythm.

What's going on?

When you hit the pipes with the rubber pad, you hear “boink” sounds. The sound from each pipe has a different pitch.

Pitch is a term used to describe the frequency of sound waves or how fast or slow sound waves travel. When the air inside the pipe vibrates at a fast rate, we say the sound has a high frequency. A high frequency means a high pitch.

Sound waves travel faster through a shorter distance. In the shortest pipe, sound waves travel the fastest. The sound has the highest frequency and the highest pitch. In the longest pipe, sound waves travel the slowest. The sound has the lowest frequency and the lowest pitch.

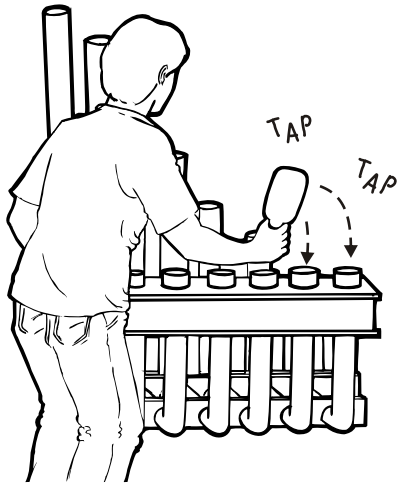
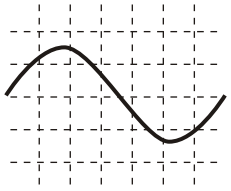
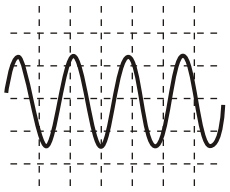


Diagram of sound waves



Low Frequency (Low Pitch)



High Frequency (High Pitch)

MAGNETIC FIELD

Try this!

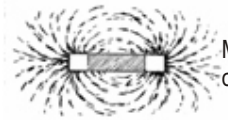
1. Hold the magnet against the backside of the casing. Slowly move the magnet in any direction. What happens to the iron filings?

2. Hold the magnet in place where the iron filings are thinly spread. Do the iron filings align in a certain way?

What's going on?

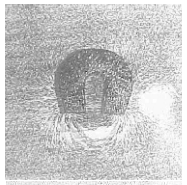
A magnet has a magnetic field. The shape of the magnetic field is determined by the shape of the magnet and the location of its poles.

Iron filings are magnetic materials, meaning they are attracted to magnets. When you move the magnet, the iron filings align in the direction of the magnetic field lines of the magnet, making the field visible.

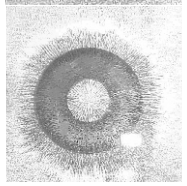


Magnetic field lines of a cow or bar magnet

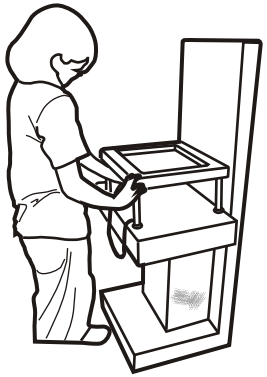
There are different shapes of magnets.

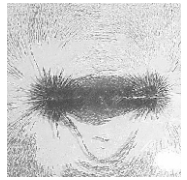


Horseshoe magnet - Field is strongest at the south pole standing up, and weakest at the arched end.



Round magnet - Field is strongest standing on edge, and weakest lying on flat side.





Wand magnet - Field is strongest standing up on long side, and weakest standing up on tip.

The closer the magnetic field lines are to each other, the stronger is the magnetic field.

The cow magnet, like the one in the exhibit, has an important use in the cattle industry in preventing Hardware Disease. While grazing, cow may ingest iron objects (nails, staple wires and pieces of bailing wire). These objects tend to remain in the stomach walls, threatening the surrounding organs, causing irritation and inflammation known as Hardware Disease. The cow loses appetite, produces less milk, and loses weight. To prevent this, ranchers feed cow magnets to their cows. The magnet settles in the cow's first stomach and attracts the iron objects.

MOMENTUM MACHINE

Try this!

1. Stand on the platform and lean your body on the handle. Hold the handles tightly.

2. Push on the floor with your left foot. Once you are rotating, raise your left leg backward. Do you slow down or speed up?

3. Put your left leg swiftly back on the platform. What happens to your speed?

What's going on?

When you extend your left leg backward, your rotation becomes slower. When you put your left leg swiftly back on the platform, your rotation becomes faster.

Your body has a center of gravity and so does your leg. It is as if there are two bodies accelerating–your body accelerates differently from your extended leg. The leg's acceleration affects (decreases) the body's acceleration, and so rotation of the system slows down. When your legs are close together on the platform, the system has acceleration. This makes the rotation faster.

If you are getting dizzy and want to stop, what should you do–will you pull in your leg before stepping down from the platform? Remember, pulling in your leg drastically increases your speed! The proper way is to extend your leg backward as much as you can. As the rotation slows down, bring your leg slowly back to the platform then put it down on the floor to stop while still holding on to the handles.

MONEY DETECTOR

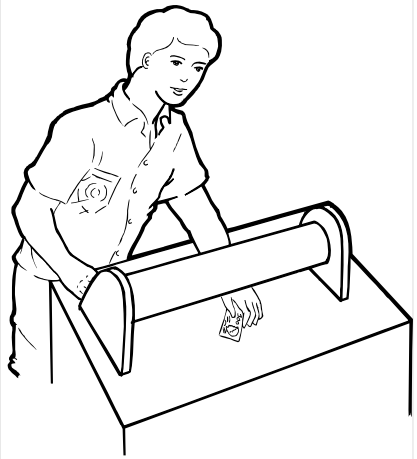
Try this!

1. Place any bill (P20, P50…) under the lamp of the device. Do you see any glowing marks on the bill?

2. Take the bill out of the device and look at it. Do you still see the glowing marks?

What's going on?

When a bill is slid under the lamp, the device will let you know if it is genuine or fake. Some parts of the bill glow and reveal interesting marks. The marks are called fluorescent prints and they fluoresce or glow when exposed to the lamp.



The money detector device has a special bulb called the UV lamp or black light. This emits ultraviolet light which causes the fluorescent dye on the bill to light up. Fluorescent marks usually portray the denomination of the bill. The dye is also incorporated in the serial numbers and security fibers. This causes them to glow as well.

Money detectors can also determine the authenticity of credit cards, traveler's checks, and other special documents. Fluorescent dyes on these documents produce the same effect as bills under the UV lamp.

LOOK INTO INFINITY

Try this!

1. Look through a pair of holes on the panel. What do you see?

2. Push the panel gently. Do you still see the same thing?

What's going on?

When you look through two holes on the panel, you see a tunnel with lights at the sides. The tunnel is long and seems to have no end.

What you see is the optical effect of two mirrors facing each other. The row of lights along the sides of a mirror is reflected on the other mirror. This reflection is reflected back and forth many times between the two mirrors. Each reflection looks smaller than the previous one. These reflections that become progressively smaller create a sense of apparent depth and distance.

When you push the panel the mirrors are no longer parallel to each other and so the tunnel curves down and becomes shorter.

The tunnel effect can be seen in hair salons where there are mirrors on two opposite walls.

OPTIC LAND

Try this!

1. Push the button to switch on the light source.

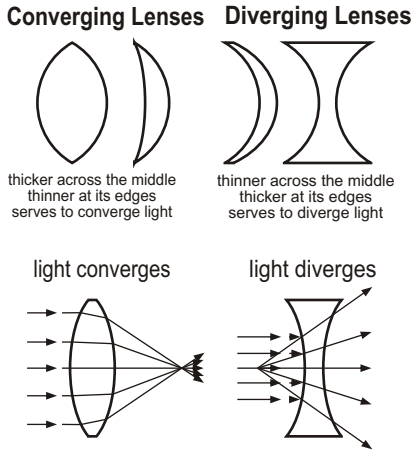
2. Rotate the bolt head on a lens holder and observe the light.

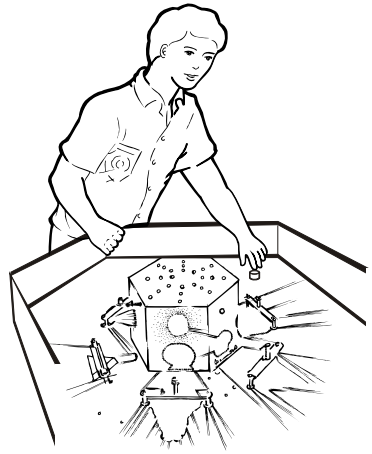
3. Rotate the bolt head on the other lens holders. What happens to the light that hits the different lenses?

What's going on?

The light source projects rays of white light and colored light on the table. The lenses and prism bend these rays in different ways.

The convex lens bends the light and brings the beams together (converge). The concave lens makes the beams spread out (diverge).





When a beam of white light strikes the prism, white light separates into rainbow colors. The white light entering the prism is a mixture of different frequencies, each of which gets bent slightly differently. Blue light is slowed down more than red light and will therefore be bent more than red light. This type of prism is dispersive.

Prisms are sometimes used for the internal reflection at the surfaces rather than for dispersion. This makes a prism a useful substitute for a mirror as in binoculars.

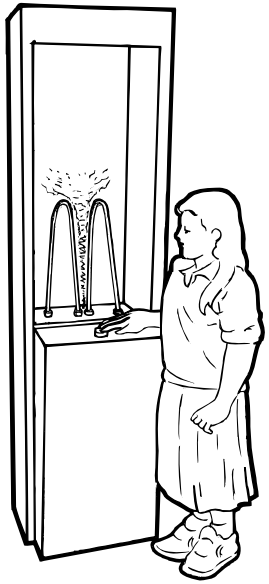
Lenses are used for correcting visual defects such as myopia, hyperopia, presbyopia, and astigmatism. They are also used in imaging systems of binoculars, telescope, spotting scope, microscope, and camera (photographic lens). The magnifying glass uses a single convex lens.

JACOB'S LADDER

Try this!

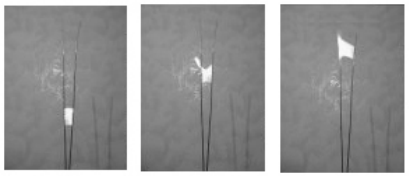
1. Push the button. Do you see a spark? Does the spark form an arc between the two copper rods? What happens to the spark as it reaches the top?

2. Blow air through the small holes. What happens to the arc?



What's going on?

A high voltage occurs at the lower end of the pair of electrodes (two copper rods in a V shape). The electric forces due to the high voltage difference between the two electrodes are strongest at the bottom where the electrodes are close together. These forces are strong enough to ionize the air between the electrodes. Atoms that make up the ionized air collide with each other and release light energy, which is the spark you see.



Spark, which is produced at the lower end of the electrodes, travels up. As the space between the electrodes widens, a path is created for the arc. The arc is much hotter and less dense than the surrounding air. Thus, the arc rises up the electrodes until the available voltage and current can no longer maintain the air in an ionized state. The arc extinguishes, then a new spark forms at the lower end of the electrodes and the whole process begins all over again.

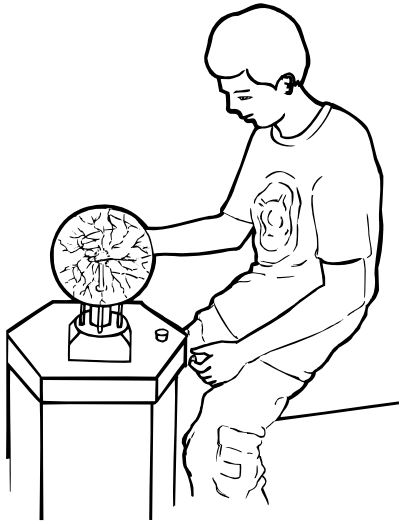
The arc can be made to stop when air is blown into the tiny holes because the ionized air is blown away. When this happens, a new spark forms at the lower end.

PLASMA SPHERE

Try this!

1. Push the button. What do you see?

2. Touch the glass sphere. Move your fingers over the surface. What happens to the streaks of light?



What's going on?

The plasma sphere is made of a glass flask that contains a mixture of inert gases under a reduced pressure. At the center of the flask is an electrode that releases electrical energy. When electrical energy passes through the gas mixture, atoms that make up the gases become highly ionized. (Ionized atoms are those that have had one of their electrons knocked off.) You see these ionized gases, called plasma, streaming from the central electrode towards the glass like short lightning bolts.

Different gases produce different colors of the plasma streaks. The gases used in the plasma sphere are argon, neon and nitrogen, which produce blue, red and white colors.

When you touch the surface of the sphere or even just hold your fingers very close to the surface, the streaks move towards your fingers. When you move your fingers over the surface, the streaks move and follow your fingers.

FROZEN SHADOW

Try this!

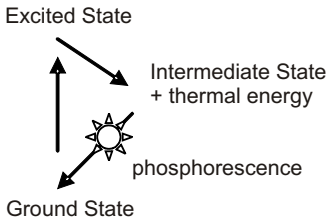
1. Press the button and go near the wall.

2. Make a funny pose, wait for the flash, and step away from the wall. Why is your shadow still on the wall?

What's going on?

The wall is painted using glow-in-the-dark pigments and white paint binder. (This paint is also used in printing t-shirts and signages.) The pigments or phosphors absorb light and continue to glow for 2 to 3 minutes even after the light switches off.

The pigments have electrons that are easily excited to higher energy levels when they absorb light energy. The excited electrons drop to a lower but still excited intermediate level. They stay there for a period of time before returning to their ground state (original energy level) and emitting the excess energy as visible light. This explains why your shadow remains on the wall after the short burst of bright light goes off. No light hits the part of the wall where you stand and so no light is emitted, while the rest of the wall glows in the dark.



Additional Information: Phosphors have three characteristics: the type of energy required to energize them, the color of visible light they produce, and their persistence–the length of time they glow after being energized. A glow-in-the-dark product must have a phosphor that is energized by normal light and has a long persistence.

We usually see phosphors in a television screen and in fluorescent light bulbs. In a TV screen, an electron beam strikes the phosphor to energize it. A color television screen actually contains thousands of tiny elements with phosphors that emit three different colors–red, green, and blue. In a fluorescent light, ultraviolet light energizes a mixture of phosphors that together create light that appears white to us.

RADIOMETER

Try this!

Press the three buttons and observe the rotation of the vanes.

Do the vanes in the three radiometers rotate at the same speed?

What's going on?

The vanes in the three radiometers rotate at different speeds.

The radiometers are made from glass bulbs. There are four vanes in each radiometer. Each vane has a silver surface and a black surface. Much of the air inside the bulbs has been removed to form a partial vacuum. This permits motion of the vanes because there are enough air molecules to cause air molecules to move.

When radiant energy from the spotlight strikes the vanes, the silver surface of one vane reflects this energy causing it to move. The energy reflected by the silver surface strikes the black surface of the vane next to it. The black surface absorbs the energy that strikes it–energy reflected by the silver surface and energy from the spotlight. The air molecules hitting the warm black surface of the vanes pick up some of the heat, bouncing off the vanes with increased speed. The increased temperature inside the bulb also makes the air molecules move faster, causing the vanes to rotate continuously.

One-bulb radiometer

The angle at which light strikes the vanes has an effect on the amount of light absorbed or reflected, and hence the speed of the vanes' rotation. When the light strikes the vanes' surface at a 90-degree angle, absorption is favored and reflection less favored. If the light strikes the surface at a low angle, reflection is favored over absorption.

In the exhibit, the distance and orientation of the spotlights with respect to the radiometers differ. The radiometer on the left has its spotlight closest to it and strikes the surfaces of the vanes directly. These vanes rotate the fastest. In the middle radiometer, the spotlight is farther away but still strikes the surfaces of the vanes directly. The radiometer on the right has its spotlight striking the top part of the vanes rather than its surfaces. These vanes rotate the least.

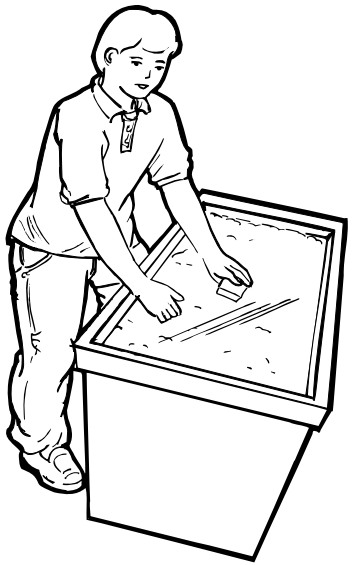
Additional information: The amount of radiant energy absorbed by objects depends on the color of their surface–dark colors absorb better than light; flat black absorbs best of all. Light or silver colors reflect better than dark colors. The amount of radiant energy reflected by objects also depends on the smoothness of their surface–smooth reflects better than rough.

ELECTRIC FLEAS

Try this!

1. Rub the plastic surface vigorously with the styro block. What happens to the styropore bits?

2. Continue rubbing the surface and observe what happens.



What's going on?

The styropore bits represent fleas. At the start, the fleas are electrically neutral. When you rub the plastic surface, negative charges transfer from the styro block to the plastic. Since the plastic is a poor electrical conductor, these charges do not flow all over the surface but only on the part where it is rubbed. The negative charge on the plastic attracts the fleas' positive charges and concentrate them on the upper part of the flea while repelling the fleas' negative charges and concentrating them on the bottom part. Thus, the fleas become polarized–positive on the upper part and negative on the bottom part. The attraction between the charges on the upper part of the flea and the plastic is strong enough to lift this particular flea to the plastic.

When the flea touches the plastic, negative charges flow from the plastic to the flea, neutralizing the top of the flea and so the flea falls. However, since the flea is electrically neutral at the start, it now has an excess of negative charge. When the flea touches the wood it loses its charge slowly, and the process can begin again. Eventually, the plastic is discharged completely and the process stops.

RING BUBBLES

Try this!

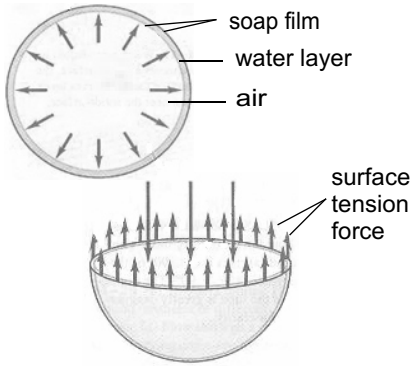
1. Dip the ring in the soap solution.

2. Wave the ring through the air to make a bubble. Observe the bubble as it floats in the air. What is the shape of the bubble?

What's going on?

A single soap bubble in the air is a nearly perfect sphere. This shape of the bubble results from the force acting on it. The force is called surface tension.

A soap bubble consists of two spherical surface films of soap with a layer of water between them. Due to surface tension, the films contract. As the bubble contracts, it compresses the air inside. This increases the internal pressure to a point that prevents further contraction. Eventually, the pressure on the soap film exerted by the air inside and outside the bubble becomes equal.



The spherical shape provides the minimal surface area needed to enclose a given volume of air, making it the most efficient shape for a bubble. If a bubble were any other shape (it is often oval while being blown), it will keep moving until it takes on a spherical shape. Once it has become spherical, the bubble stops adjusting its shape.

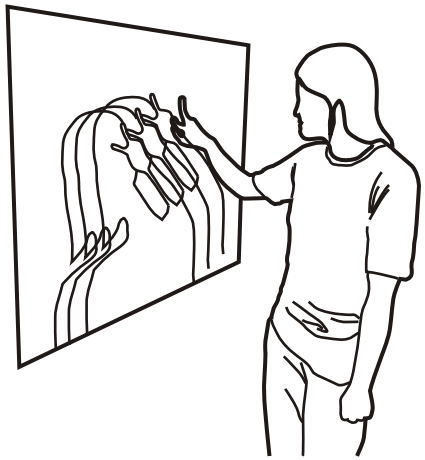
COLORED SHADOWS

Try this!

1. Stand in front of the white wall. What colors are your shadows?

2. Move closer to the wall. Do you see more colors?

3. Go to the right side, then to the left side of the wall. What is the color of your shadow at each side?



What's going on?

When you stand in front of the wall, you produce three colored shadows: cyan, magenta, and yellow. The color of each shadow is the complement of the color of the light source–red, green, and blue. These three primary colors make up white.

The complement refers to the color needed to produce white by addition. So, when a shadow removes one color from white, it must leave the complementary color. The area of one shadow is lighted by the two remaining primary colored lights. Hence, it can be seen that the two primary colors add to produce the complement of the third. For example, red and green lights form a yellow shadow in the path of the blue light.

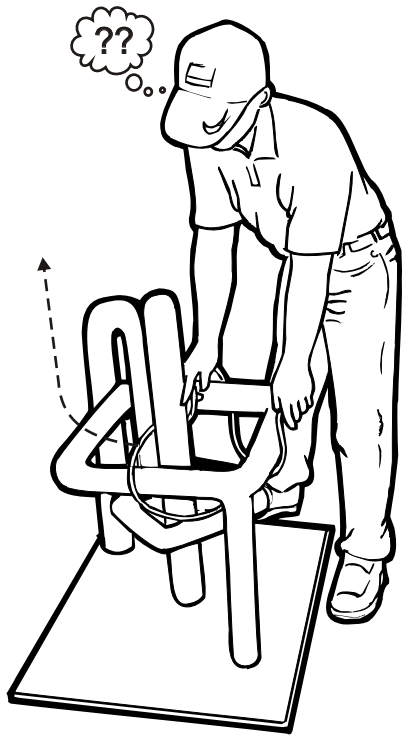
When you move closer to the wall, parts of your colored shadows overlap. These overlapping areas are primary colors. The part where all the primary and complementary colors overlap is black.

When you block	The color of your shadow is
Red	Cyan (mixture of green and blue)
Green	Magenta (mixture of red and blue)
Blue	Yellow (mixture of red and green)
Red and Green	Blue
Red and Blue	Green
Green and Blue	Red

ROPE PUZZLE 2

Try this!

Get the rope out of the pipes.



What's going on?

Did you do the following to solve the puzzle?

1. Loop the rope around the blue pipe, then transfer it to the red pipe.
2. Move the rope to the yellow pipe.
3. Get the rope out of the blue pipe.

The rope puzzle is an example of topology, a branch of mathematics. Topology is sometimes called "rubber-sheet" geometry, because it studies those properties of figures (like the circular rope) which remain unchanged if the figures are stretched, twisted, bent or otherwise "elastically" deformed.

Such elastic deformations are continuous functions since points which start out close together end up close together after the deformation–the rope remains circular after getting it out of the three pipes.

CHANGING COLORS

Try this!

1. Place a colored object in the right compartment. What is the object's color?

2. Place the same object in the left compartment. Do you see the same color of the object?

What's going on?

In the right compartment (with white light), you see the actual color of the object. In the left compartment (with yellow light), you see the same object with a different color. Why?

The exhibit demonstrates the principle of *Color Subtraction*. White light consists of the three primary colors–red, green and blue. When white light shines on an object, red, green and blue light also shine on that object. If the object absorbs blue light, then only red and green light will be reflected from the object. Red and green light give the appearance of yellow, and so the object will appear yellow.

White - Blue = (Red + Green + Blue) - (Blue) = Red + Green = Yellow

Yellow light consists of red and green light. When yellow light shines on a blue object, the object will absorb yellow light, meaning, it will absorb both the red and green light. Since no light will be reflected from the object, you see the object as black.

Yellow - Yellow = (Red + Green) - (Red + Green) = No reflected light = Black

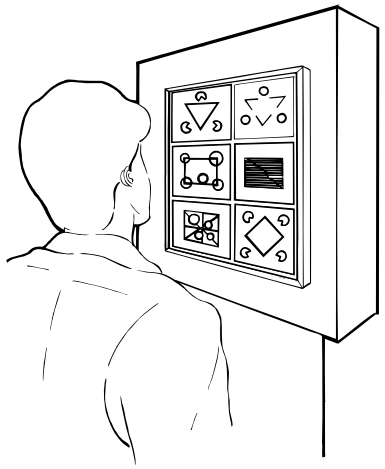
When yellow light shines on a red object, the object will absorb cyan light (a mixture of blue and green light). When green is subtracted, red light is reflected which is the color of the object you see. (What you see is not purely red, but with a tinge of blue.)

Yellow - Cyan = (Red + Green) - (Blue + Green) = Red - Blue

SUBJECTIVE SHAPES

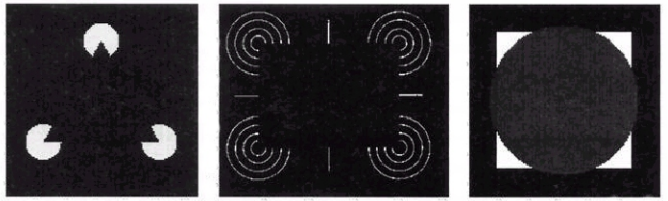
Try this!

Look at the diagrams.
Do you see familiar shapes?



What's going on?

The shapes you see in the diagrams have no real outlines. Yet you see outlines so distinct that you could draw a line along them. Your brain creates these outlines to fill in missing parts of the diagrams and make sense of what you see. Thus, you see a circle, triangle, square and curved line where there are none. In many situations, the person's visual system fills in missing gaps in edges and boundaries, building and completing information that is not present. The person is drawn to a reference point within the image. From that reference point, the completion process is constructed.



A B C

Diagrams A, B and C are three images with subjective contours. In diagram A, a solid triangle in the center appears to have well defined contour even in completely homogeneous areas. In diagram B, a large rectangle is perceived. In diagram C, a white square seems to be partially blocked by a gray circle.

BIRD IN THE CAGE

Try this!

1. Look at the red bird steadily for at least one minute, then look at the empty cage. Do you see a bird in the cage? What is this bird's color?

2. Repeat step 1 for the green and blue birds. What is the color of the bird that appears in the cage?

What's going on?

After looking at the birds in the picture one at a time, you see the following afterimages in the cage:

Color of bird in picture	Color of afterimage
red	light bluish-green (cyan)
green	light reddish-blue (magenta)
blue	light reddish-green (yellow)

The color of an afterimage is the complement of the bird's color in the picture.

The back of the eyes (retina) is lined with light-sensitive cells called rods and cones. Rods are sensitive to colored light, while each type being sensitive to a particular range of color.

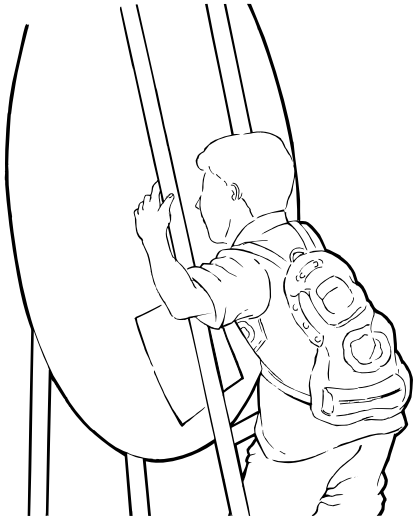
When you stare at the red bird, the image falls on one region of your retina. The red-sensitive cells in that region start to get tired, then stop responding strongly to red light. The white board reflects red, blue and green light to your eyes (since light is made up of all these colors). When you suddenly shift your gaze to the blank white board, the tired red-sensitive cells do not respond to the reflected light, but those sensitive to blue and green respond strongly to the reflected blue and green light. As a result, you see a bluish-green (cyan) afterimage of the bird.

TALK AND LISTEN

Try this with a friend!

1. Talk directly into the ring while your friend listens at the ring of the other dish.

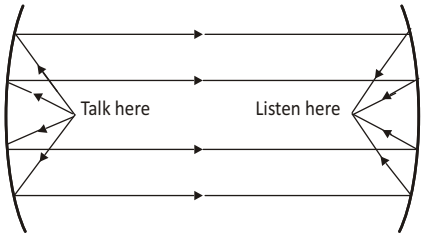
2. Switch roles. Your friend will talk while you listen. Can you hear your friend clearly?



What's going on?

Despite the great distance between the two dishes, you and your friend hear each other clearly. Why?

As you talk into the ring, the sound waves travel from your mouth to the dish in front of you. From this dish, the sound waves are reflected toward the opposite dish where your friend is. Your friend hears you clearly because the dish focuses the sound of your voice onto the ring. The same thing happens when your friend talks and you listen. It is the parabolic shape of the dish that focuses the sound onto the ring, which is the focal point.



Sound waves traveling across the room

The parabola is used in many ways to collect or distribute energy such as sound, light, and radio waves. As a sound reflector, it is used in radio and cassette speakers, surveillance microphones, and other acoustic devices. As a light reflector, it is used in searchlights, spotlights, car headlights, and solar cookers. It is also used in communication satellites as radio wave and microwave reflectors.

BERNOULLI BLOWER

Try this!

1. Turn on the switch and place the ball on top of the air stream.

2. Hold the ball with both hands and pull it partly out of the air stream, then release the ball. What happens to the ball?

What's going on?

Notice that when only a part of the ball is out of the air stream you can feel the ball being sucked back. If you release the ball, it will move back to the center of the air stream and stay afloat.

When the ball is pulled partly out of the air stream, the air that is moving fast along the side of the ball exerts less sideways pressure on the ball than the still air in the room. The greater pressure of the surrounding air pushes the ball back to the center.

The ball stays afloat because the air from the blower exerts an

upward force on the ball. The maximum capacity of the blower makes the ball stay at a certain height. In other words, when a stronger source of moving air is used, the higher the ball will float.

Additional Information: An airplane wing is designed in such a way that the air moves faster over the top of the wing than it does below. The higher air pressure on the bottom of the wing pushes the airplane up, giving it a lift.

TINY BUBBLES

Try this!

1. Dip the wire frames in the soap solution.

2. Wave the frames through the air to form bubbles. Do the bubbles have the shape of the wire frames?

What's going on?

A soap bubble is a sandwich of air on the inside, a layer of soap molecules, a layer of water and finally another layer of soap molecules. The inner and outer layers of soap can stretch a lot while the water helps hold the bubble together.

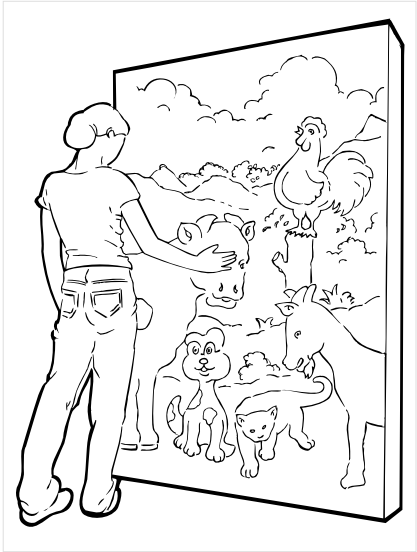
Scientists refer to bubbles as "minimal surface structures". This means that bubbles always hold the air inside of them with the least possible surface area. The geometric form with the least surface area for any given volume is always a sphere, not a pyramid, a cube or any other shape. This is why soap bubbles formed by frames of different shapes end up as spheres.

ANIMAL SOUNDS

Try this!

1. Choose an animal you like. Cover the eye of this animal. What do you hear?

2. Cover the eyes of the other animals. Do you hear different sounds?



What's going on?

A sensor has been placed in the eye of each animal. When you cover an animal's eye, it blocks the light reaching the sensor. The sensor responds to the blocking of light by closing the electric circuit and this turns on the switch for the sound. The sounds you hear are recordings of sounds that real animals make.

Additional Information: Since sensors are programmed to detect and respond, they are used in buildings for safety and security. Sensors using photo cells are used for exterior and perimeter lighting where they maintain lights throughout the night and shut off during the daylight hours. This can help save energy because people often forget to turn off outdoor lights during the day. Sensors are also used in hallways and lobbies where nighttime entry and exit is made more secure. Motion detectors turn on lights automatically when motion is detected in the room.

Other sensors are combined with an alarm mechanism. An example is the photoelectric smoke detector. This utilizes light as a detection mechanism based on light obscuration (blocking). It requires that smoke particles obscure or block a portion of a light beam transmitted to a sensor. Smoke between the light source and light sensor will reduce the amount of incident light on the sensor. If the light is reduced to a low level, an alarm is sounded.

YOU AND ME ARE ONE

Try this with a friend!

1. Sit on one side of the exhibit and have your friend sit on the other side. Be sure that both of you are at the same distance from the mirror.

2. Slightly turn the knob. Ask your friend to do the same. Do you see each other?

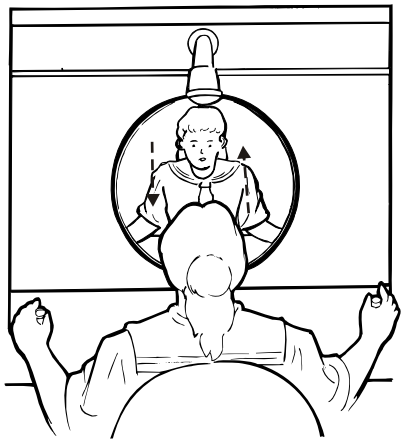
3. Ask your friend to turn the knob on his/her side halfway. This makes your friend's side brighter.

4. Align your face with that of your friend.

5. Ask your friend to dim her side. Then, brighten your side.

6. Ask your friend to align his/her face with yours.

7. Both of you should dim and brighten the light alternately. Do this fast. What do you see?



What's going on?

The glass is both a mirror and a window. It reflects some light but allows an equal amount of light to pass through. By adjusting the amount of light in the two sides of the exhibit, an interesting thing happens. When you and your friend turn the switch slightly halfway, you see each other through the glass.

By alternately brightening the lights, you and your friend will see a face that has features from both of you, like you have your friend's hair or your friend's eyeglasses and likewise your friend has your nose and lips.

CONTENTS

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The Philippine Foundation for Science and Technology

VISION

A nation of science-culture and productive citizenry.

MISSION

To promote science and technology consciousness and literacy among the youth, general public and various sectors of the society through the Philippine Science Centrum.

OBJECTIVES

To promote S&T appreciation and consciousness;

To develop and fabricate interactive exhibits;

To implement educational and outreach programs/trainings;

To conduct studies in the field of S&T promotion;

To address key issues in S&T affecting our country; and

To become a conduit in the exchange of S&T information

In 1984, the Philippine Foundation for Science and Technology was established by a group of private individuals as a response to the government's call for private sector support in the task of creating an environment of Science conscious and literate populace, especially among the youth sector. The Department of Science and Technology has accorded two recognitions to PFST: as an Outstanding S&T Foundation in 1997 and as the 1st GAWAD LIDER Awardee for Exemplary Leadership- Institution Category in 2007. In 2012, the Association of Science and Technology Centers based in Washington DC accorded the Roy Shafer Award to the Philippine Science Centrum as an Outstanding Science Center outside of the United States.The Department of Education recognizes the effectiveness of PFST's Philippine Science Centrum by issuing annual National Advisory encouraging all schools to visit the PSC for educational field trips.

It has been vigorously conducting innovative programs aimed at improving public awareness, understanding and interest in science and technology.

MAJOR PROGRAMS, ACTIVITIES AND SERVICES

PHILIPPINE SCIENCE CENTRUM (PSC) - established in 1990 as the foundation's flagship program.It is a combination of a science center and museum featuring overr 100 interactive exhibits. To date, over 3 million students, teachers and the public in general have already been accommodated.

TRAVELING EXHIBITIONS – since its maiden travel to Lapu-Lapu City in 1995, the PSC's mobile exhibitions have already accommodated more than 3 million Filipinos from all over the country. There are now 5 sets of PSC's mobile exhibitions – Science Adventures, Sci-Fun Caravan, Science On the Move, Science Works!, and Science Sparks!

TEACHERS TRAINING - recognizing the importance of teacher factor in the youth's education, this module is being offered to teachers and school administrators on the interactive approaches in science teaching.

EXHIBIT DEVELOPMENT AND FABRICATION SERVICES- – In 2007, the Science Centrum Fabrication Inc. (SCFI) was created to solely undertake the exhibit development and fabrication requirements of the PSC and other science centers locally and abroad.