SCIENCE

On a shoe string

presented by
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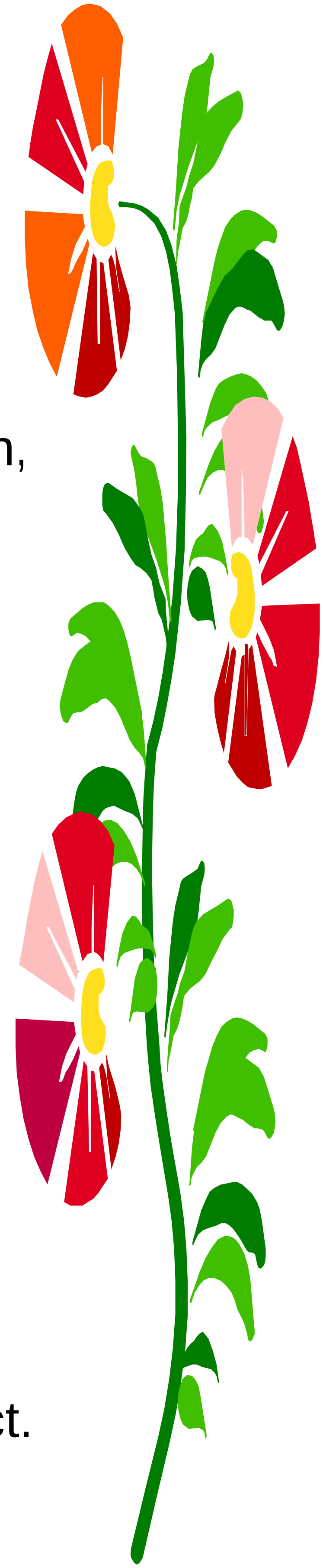
This booklet is dedicated
to the following people:

To Ernie Odell
- FAST facilitator -
Who reminded me that one person can,
does, and will make a difference,
especially in teaching.

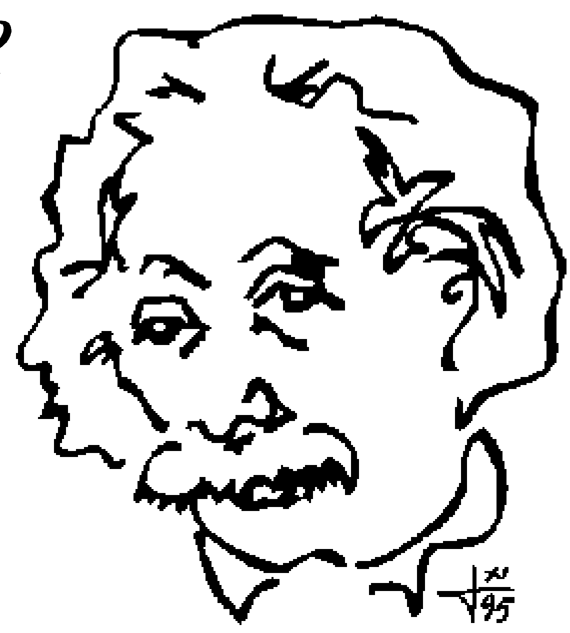
To Mark Smith
- my son -
Who reminds me every day
how bright the future is.

And most importantly

To Walt Smith
- best friend and husband -
Who has always seen the good in me,
and has put up with me
above and beyond the call of duty,
especially while completing this project.



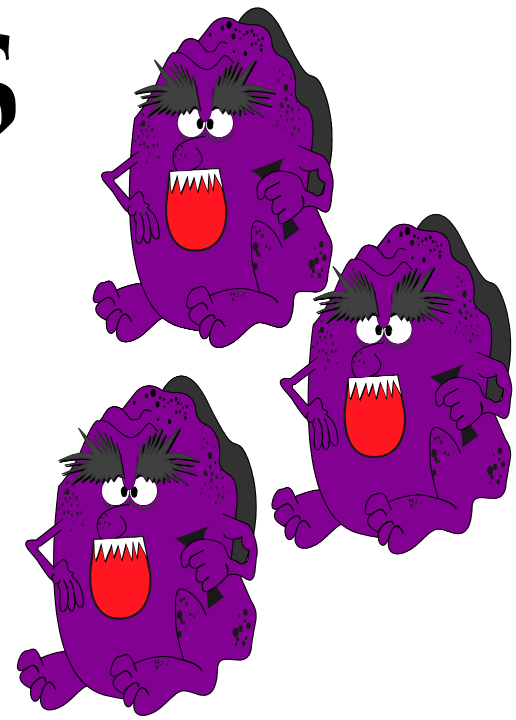
Imagination is More Important Than Knowledge



It is a preview of life's coming attractions.

-Albert Einstein

Sewer Bugs



Purpose*:*
To emphasize the importance of looking at things thoroughly through "Science Eyes".

Materials:
3 10 oz. cans of 7-up
1 10 oz can cola
1 small box raisins
3 500 ml beakers

Procedure:
1. Before students arrive set up as follows:
a. Fill one beaker to 3/4 full with cola
b. Put 1/4 of the cola in the second beaker.
Fill the rest of the beaker to the 3/4 full mark with 7-up.
c. Fill the third beaker to 3/4 full with 7-up.
d. Add 5 raisins to each beaker.

sewage 2. Tell students that through your research you have found an organism that actually eats raw
Hold up beaker a. The raisins will be bobbing up and down. Tell your students that the dark liquid is raw sewage. Note how "active" the "Sewer Bugs" are inside the "sewage".

3. Hold up beaker b. Tell your students that the "Bugs" in this beaker have been in there for two weeks. Note how much lighter the "sewage" is and how active the "bugs" are.

4. Hold up beaker c. Tell your students that these bugs have been in there for over 4 months and have "eaten" all the sewage. Tell them that the most incredible thing about the bugs is that they are edible. At this point reach into beaker c, pull out one of the raisins, and eat it..
(Expect some gagging from your students .)

be;5. Now that you have their attention, point out that sometimes things are not really what they seem to but if you look hard enough and closely enough with your "science eyes"
you will be able to find a reason for everything that happens.

6. Explain what is really happening.

What's Really Happening

The liquids are carbonated soda. The bugs are raisins. Raisins are heavier, or more dense than the soda, so they sink to the bottom of the beaker. The Carbon Dioxide bubbles in the soda get caught in the folds of the raisins, which makes them lighter, or less dense, than the soda they are in. Because they are less dense now, they float to the top of the beaker. When the raisins hit the top of the liquid, the $CO2$ bubbles that were caught in them are released into the air, which makes the raisin heavier, or more dense again, causing them to sink to the bottom of the beaker where the process starts all over again. They'll repeat this process until all the carbon dioxide bubbles are released into the air. Depending on the amount of carbonation in the soda, the raisins will "bob" for up to an hour.

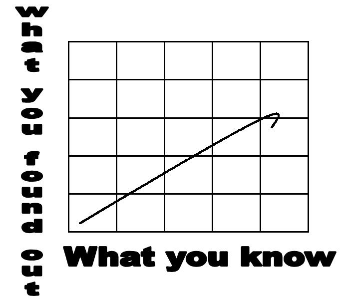
March 1999, Linda L. Smith, Paulsboro Elementary Schools, Paulsboro NJ 0@-

Purpose:
To create a working model of MASS

Sinking Straws

Materials: (per Group)

1. Deep clear container half-filled with water (500 ml beaker)
2. Metric ruler
3. Clear plastic straw with one end glued shut with hot glue
4. 1 small rubber band (like the ones used in braces)
5. Handful of bird seed
6. 1 piece graph paper for each student
7. 1 scale and set of weights



Procedure:

1. Before student arrive put rubber band around straw
2. Have students position the rubber band so that it is 4 cm from the bottom of the straw
3. Have student predict how many pieces of birdseed it will take to sink the rubber band so that it is even with the surface of the water in the beaker
4. Repeat step #3 sinking the straw to 5cm, 6cm, 7cm, and 8cm
5. Have students graph and share their results
6. Question: If everyone did the same experiment, why did we all come up with different answers to graph? (Note the different shapes and sizes of the birdseed)
7. Introduce the concept of MASS measurement
8. Have students do the same experiment, this time massing the bird seed and using gram measurements
9. Have students share data. The answers should be much closer and more consistent.
10. If time permits, this is a good place to have your students extrapolate answers for how much mass it would take to sink their straws to 2cm, 3cm, 9cm, 19cm, etc.

Results:
Measures recorded when we used birdseed for our measure, were inconsistent because the birdseeds were of different shapes, sizes and weights. When we used a standard measure our answers become much more consistent with other answers in the class.

Conclusion:
The birdseeds are of varying sizes, which makes the counts of the first experiment appear to be inaccurate. When we measure the amount of “stuff” (mass) in each birdseed and add up the total weight, we begin to see that there is a pattern which suggests that we can predict how much “stuff” will be needed to sink the rubber band to desired depths, even if we can’t determine the number of seeds. Using mass as opposed to counting things proves to be more accurate for our purposes because it allows other scientists to replicate and verify or dispute our work.

Floating Boxes

Purpose:
To create a working model
of the concept of VOLUME

To create a working model
of the concept of DENSITY

Materials: (per group)
1 1/2 pint milk carton
1 1/2 gallon orange juice carton
2 rubber bands (number 8 size works nicely)
BB's & Straws from
Sinking Straw Experiment
Pan of water (cut off bleach cartons work well)

Procedure:

1. Before students arrive cut the tops off the cartons.

2. Review data from the Sinking Straw Experiment.

3. Have students compare the 1/2 pint cartons to the straws.

4. Ask them if they think that it will take the same amount of BB's to sink the carton as it did to sink the straw..Have them give reasons for their answers. Accept all answers.

5. Have students guess how much mass would be needed to sink the carton to 2 cm.

6. Have them move the rubber band so that it measures 2 cm from the bottom of the container.

7. Sink the cartons and record their results. It will take more mass to sink the cartons than it did the straw..

8. Suggest that maybe more than mass is involved with the sinking of objects. Point out the different size of the containers.

9. Introduce the concept of volume (the amount of space stuff takes up)

10. Repeat steps 5 to 7 using the bigger container. Record results.

11. Share results with the class. Have them come up with their own (guided) concept of volume that every one can agree on.

What's really happening

There seems to be another force beside mass that is in play here. Since the straw is thinner than the carton, it doesn't have to push away as much water before it can sink. The Carton,being wider, needs more force to overcome the upward push of a larger amount of the water. It is almost as if there is a force that is evenly distributing the mass of the BB's throughout the entire space of the carton. The amount of space an object takes up effects how it sinks, just as the amount of mass you put into it does.The smaller the carton, the less mass is needed to sink it. The larger the carton the more mass is needed to sink it. Scientist call the amount of space something takes up its VOLUME. There seems to be a constant and direct relationship between the mass of an object, its volume, and its ability to sink or float. Scientist call this relationship DENSITY.

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PURPOSE:

To create a working model of
ATTENUATION, COMPRESSION, and DENSITY

MATERIALS:

1 clear plastic bottle
1 eye dropper or syringe
1 bucket - to collect spills
water

Diver Dan

Procedure:

1. Fill bottle to the top with water.
2. Fill eyedropper or syringe about 2/3 full of water.
3. Drop eyedropper or syringe into bottle.
4. Close bottle tightly.
5. If the dropper or syringe sinks to the bottom, take it out, remove some water and repeat steps 3 and 4.
6. Manipulate the bottle by squeezing it. The more you squeeze the bottle, the farther "Dan" will sink.. Practice squeezing in a way that makes it appears as if you're just holding the bottle.
7. Command "Dan" to sink, surface, and subsurface. Ask the students if they can figure out how to get "Dan" to obey them.
8. Explain what's really happening.
9. Have students create their own Diver Dan as homework.

What's Really Happening

It has to do with the bubble inside Diver Dan. Dan's mass consists of the water and air in the eyedropper or syringe. When the bubble inside Dan is bigger, the air in it is attenuated, or stretched out; therefore there is less mass inside Dan than there is outside him. He is less dense, so he floats. When we get Dan's density to be exactly that of the water that surrounds him, he will subsurface, or hang around the middle of the bottle. When we squeeze the bottle, the water in it has nowhere to go except inside Dan, where the bubble is. As it pushes into Dan it compresses the air that was inside into a smaller space and replaces it. Because the water is denser than the air which previously took up the space, Dan's density increases, making him heavier, so he sinks. When we stop squeezing the bottle, the water flows out of Dan back into the bottle, the bubble gets bigger, the air in the bubble attenuates again which decreases Dan's density, and he floats again.

There are only two ways to make something sink - decrease the volume or increase the mass.

There are only two ways to make something float - increase the volume or decrease the mass.

The Power of Air

Purpose:
To demonstrate the power of Air Pressure

Materials:
Empty soda can
Water
Burner
Tongs or potholders
Bowl of ice water

Procedure:
1. Pour about 5 ml of water into the soda can
2. Put on burner. Heat until steam comes out of the can.
3. Grab can with potholders or tongs, flip it upside down and immediately submerse in ice water

Results:
The can implodes.

What's Really Happening:
Two forces are in play here. First of all, air is pushing down on all things at about 14 pounds per square inch, including inside and outside the can.

Heat inside the can is causing the water molecules to move faster and take up more space, forcing the air inside the can out.

When you plunge the can into the ice water, you slow down the water molecules very fast. They take up less space without letting air come back into the can to take up that space again. (you eliminated access to outside air because the only opening is under water.) The air outside the can pushes with enough force to push into the empty space that was taken up by the water molecules, crushing the can as it does.

The faster you can get the water molecules to move, the more air is pushed out of the can, and the more the can will crush.

What a State We're In!

Purpose:

To understand the effects of heat on states of matter.

Materials:

2 thermometers
1 clear balloon
1 roll duct tape
1 pyrex container (beaker)
1 hot plate
1 clock with a second hand
1 per student graph paper
1 ring stand
Computer with data base program (optional)

Procedure:

1. Before students arrive set up as follows:

a. Fill balloon with water. Stick bulb end of a thermometer into balloon & seal wit

b. Freeze thermometer and balloon. (Over night is best, but it will freeze in an hour if necessary)

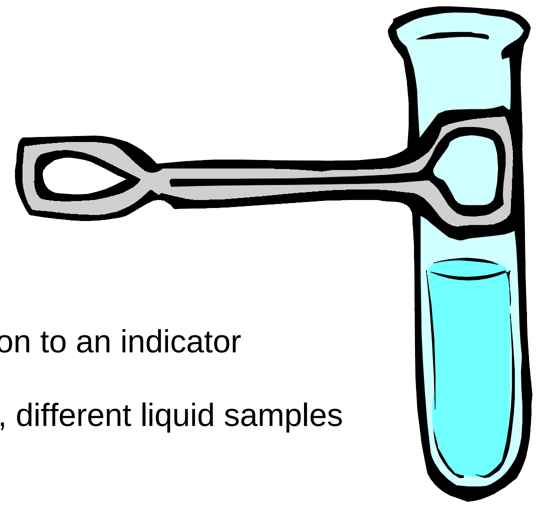
2. Fill beaker 3/4 full of water.
3. Put beaker on hot plate.
4. Assign 1 student to be time keeper, 1 to be ice thermometer reader, 1 to be wa thermometer reader, and 1 to record data on computer. Have all other students re on a chart at their desk.
5. Use ring stand to suspend both thermometers (one with ice and one without i beaker.
6. Heat beaker.
7. Record temperature changes every 30 seconds until water boils inside the balloon. (about 8 minutes)
8. Graph Data.
9. Explain what's really happening

What's Really Happening

Heat, like all kinds of energies, makes molecules move. As you add heat the mole begin to move faster, running into each other. The faster the molecules move the they run into each other. The harder they run into each other, the farther apart th That's why the balloon starts to get bigger. The farther apart they get the harder i on to each other. That's why the water turns into steam.

When you graph your data you will notice that as ice is changing to water there is increase in temperature, even though you are still putting heat in at the same rate The same thing happens as water turns to steam. There's no increase while ice is water or when water is turning to steam because the heat you're putting into the s being used to change the state of the water. This proves that it takes energy to cl state.

What Makes Different Stuff Different?



Purpose:
To create a working model of an indicator
To classify different substances according to their reaction to an indicator
Materials:
Hot plate; water; red cabbage; lemon juice, baking soda, different liquid samples
Procedure:

1. Boil red cabbage in water until liquid turns purple
2. Pour cabbage juice in plastic cups
3. Add lemon juice to one cup. Observe. Define as an acid
4. Repeat step 3. Point out the reaction is the same every time because lemon juice is an acid; which means it's made of hydrogen atoms.
5. Add baking soda to another cup. Observe. Define as a base.
6. Repeat step 5. Point out the reaction is the same every time because it has hydrogen and oxygen atoms that have combined in it. Anything that has that kind of molecule in it will always turn blue in this indicator.
7. Ask what will happen if you add both an acid and a base to the indicator. Do it.
8. Explain that there are varying strengths of acids and bases. The stronger the base is the bluer the indicator will get. The stronger the acid is the pinker the indicator will get.
9. Give students remaining cups of cabbage juice and liquids. Have them smell each liquid and guess whether it is an acid or a base.
10. Allow them to add small amounts of the liquids to the cabbage juice and record findings.
11. Have students bring in mystery liquids from home to test.

What's Really Happening

Everything is made up of a combination of atoms. Scientists found that if you take something that has the element Hydrogen in it and put it in an indicator the indicator will turn red. There are lots of substances that contain hydrogen atoms. Scientists call them ACIDS. Acids are sour in taste. Fruit juices are usually acids.
Sometimes hydrogen and oxygen atoms get too close to each other and their electrons get stuck together causing a chemical bond. Scientists found out that if you put substances that have hydrogen and oxygen atoms stuck together in an indicator the indicator will turn blue. Scientist call these compounds BASES. Bases are smooth and slippery. Most cleaning products are bases.
Red cabbage juice is a natural indicator. It will change from red (acidic) to purple (neutral) to blue (base) and back again according to the mixtures you put into it. Adding different acids and bases randomly creates a visual sliding scale.

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Problem

Does the speed of air effect its pressure?

Materials

1. Strip of notebook paper
2. Coffee stirrer
3. Soda straw
4. Cup of water
5. Leaf blower
6. Broom stick
7. Roll of toilet paper

Procedure

1. Put paper strip under lip.
2. Blow across paper. Record what happens.
3. Place thin straw in cup of water.
4. Use regular plastic straw to blow air across coffee stirrer. Record what happens
5. Use leaf blower to blow air over toilet paper roll. Record what happens

Results

The paper strip rises.

Water "Squirts" out of coffee stirrer.

Toilet paper shoots across the room

Conclusion

This works because of a concept called Bernoulli's Principal. It states that as the speed of a fluid, like air or water, increases the pressure in the fluid decreases.

When you blow across the paper the high-speed air above the paper pushes with less force than the still air below it. That makes the air below able to push the paper upward.

As you blow across the top of the stirrer, you decrease the air pressure pushing down into the stirrer. The still air pushing on the water in the glass is now able to push the water up the stirrer and into the air stream. The air stream carries the water with it.

As you blow air across the toilet paper roll, the high-speed air above the paper pushes with less force than the still air below it. That makes the air below able to push the paper upward. Since the paper is connected on the roll it continues to shoot as far as the low-pressured air will take it.

Splitting a Flame

Purpose
1. To demonstrate how a candle works
2. To observe matter as it changes state

Materials
1. Candle and holder
2. 2 Small piece of wire screen
3. Matches
4. Tongs or oven mitts to hold screen

Procedure
1. Light candle in holder.
2. Using tongs or oven mitts, hold screen above candle flame.
3. Slowly lower the screen down onto the candle flame. The flame will not go through the screen even if you lower it all the way down to the wick.
4. Lower the screen until it is stopping about half of the flame.
5. Bring the flame of a match near the flame above the screen. The flame will appear above the screen.
6. Repeat steps 4 & 5, Holding 2 pieces of screen together. Slowly move the screens about a half inch apart. The space between the two screens will be empty and there will be a flame above and below the screens.

Results

When the screen is in the flame, the flame disappears. When a match is held over the screen the flame reappears over the screen and under it. When 2 screens are use a flame appears over the screen, under the screen, but not in-between the two screens.

Conclusion

The candle flame melts the wax of the candle, which flows up the wick, just as water flows up a paper towel. As the wax gets too close to the flame, it gets hot enough to start to break apart into other substances. One of those substances is a gas, which burns. This gas makes up the candle flame. When the flame hits the screen the metal of the screen cools the gas enough so that it doesn't burn. The unburned gas flows through the screen so you can relight it on the other side.

Sir Humphrey Davy used this idea to develop a lamp for miners. Coal miners had to be very careful as the coal dust and gases which were often found in coal mines would burn. The flame of a lamp could cause an explosion, but the did not have electric lights, so a flame was their only choice for light to see with. Davy built a lamp what was surrounded by a metal screen. This kept the lamp flame from setting off the flammable gas and dust, and saved many lives.

Flip the cup

Purpose:
To demonstrate the effects of air pressure

Materials:

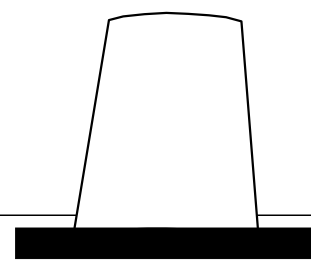
1. Plastic cup (9 oz. Works well)
2. Paper plate (the little hamburger plates work well)
3. water

Problem:
What will happen to the water?

Hypothesis:
Have students answer problem question before doing experiment

Procedure:

1. Fill cup with water
2. Place plate over cup, pushing the palm of your hand over the rim of the cup
3. Flip the cup over
4. Hold on to the cup.
5. Let go of the plate

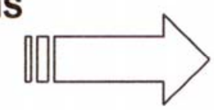


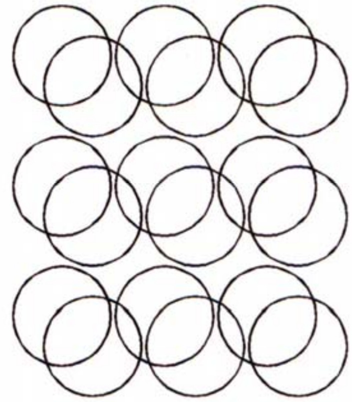
Results:
The water stays in the cup.

Conclusion:
We are swimming in a sea of air all the time. There is so much air around us and piled on top of us that it pushes with a force of over 14 pounds for every square inch of stuff. In a natural state, air takes up all the spaces around the cup, in the cup, and around the water.
When you flip the cup the air around the cup is actually pushing harder than gravity can pull the water in the cup, so the water says in the cup … held there by the pressure of the air around it.

Mass

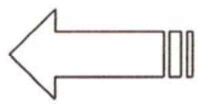
**Is a measure of how much "stuff"
is in something.
Scientist use units called GRAMS
to measure it.**





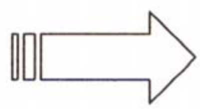
Volume

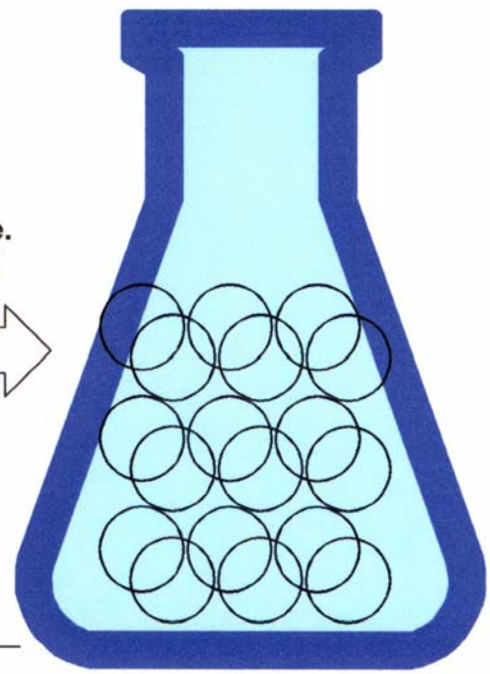
**Is a measure of how much space something takes up.
Scientist use units called cubic centimeters (cm3)
to measure it.**



Density

**Is a measure of how much mass
would be in each cubic centimeter of an object
if it were distributed exactly evenly through its volume.
Scientists use units call grams per cubic centimeters
(g/cm3) to measure it.**





**Since Density is a relationship between
an object's mass and its volume, it can
be represented as a mathematical ratio.**

Density =	**MASS**	**How much stuff you have**
	VOLUME	**How much space you have broken into even and equal pieces called cubic centimeters**

Or

Mass) Volume

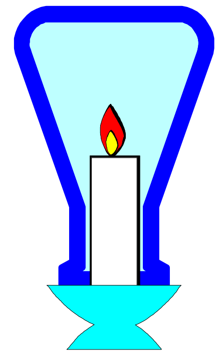
The answer you get is what Scientist call the object's DENSITY

Candle Magic

Purpose:
To demonstrate the effects of air pressure

Materials

1. Glass jar or bottle
   (Erlenmeyer flasks
   and Mason Jars works well)
2. Small bowl
3. Candle
   (birthday candles
   hot glued to pennies work well)
4. Matches
5. Water



Hypothesis:
Ask Students what they think will happen
to the water in the bowl.

Procedure:

1. Fill bowl half full of water
2. Put candle in middle of bowl and light it
3. Put jar over candle.
4. Observe and explain what's happening

Results:
After the candle goes out, the water in the bowl rises into the jar.

Conclusion:
There is a pile of air on top of everything on earth. There's so much air piled up on us that it pushes with a force of a little more that 14 pounds for every square inch of stuff. In a natural stat that air takes up all the space around the water in the bowl and inside the jar.
The lit candle "uses up" or exchanges the oxygen in the air. As the oxygen is changed, and empty space is created in the jar.
The force of the air pushing down on the water in the bowl forces the water into the jar to take up the empty space that used to be occupied by the oxygen molecules.

The following materials can be substituted for scientific apparatuses:

Beakers - Use wide mouth jars such as jelly or mayonnaise jars. Have students pour known amounts of water into the jar and mark the levels. Use a fine line permanent magic marker. Do not heat any jars that are not Pyrex. You can also use clear plastic cups the same way.

Balances - Use balances made from a meter stick with pie pans or shallow plastic cups attached to the ends with string. Make sure the strings are equal lengths and the same distance from the middle of the stick. Various objects can be used as masses by calibrating on a commercial balance.
Pinch Clamps - Use clothespins, alligator clamps, or aquarium air valves

Cylinders - Use test tubes calibrated by adding known amounts of water and marking the levels. (20 drops of water from a medicine dropper equals about 1 ml.)Try using syringes plugged with clay at the tips. Syringes come with caps that can be used as plugs and are already calibrated. You can also use olive jars calibrated by adding known amounts of water and marking the levels.

Petri Dishes - Use plastic or metal lids from various containers. You can also use milk cartons cut to about 1 cm in height.

Medicine Droppers - Use pipettes, 1 cc syringes, or pipettes made from glass tubing. You can also ask parents to save the droppers from baby medicine drops. Make sure they are sterilized before using in class.

Funnel - Use the cut off top from various plastic bottles.

Overflow Container - Bore a hole in the side of a 2 quart plastic bucket, or the bottom of a bleach container. Push a barrel of a syringe through the hole. Be sure the fit is snug. Seal with glue or silicone sealant. You can also bore a hole through a plastic beaker or cup. Push a straw through the hole and seal with glue or silicone as above. You can also cut off the top of a milk carton. Cut down both side of one corner and then bend the corner to make a spout.

Heat Source - Use a hot plate, tabletop cooker, or a propane tank with a Bunsen burner attached. Cooking fuel (Sterno) is available in most grocery & camping stores.

Stirring Rods - Use chopsticks or solid glass rods or glass tubing cut in desired lengths.

Metric Rulers - Cut strips of graph paper (1 cm x 1 cm grid) and staple or glue them to cardboard strips. You can also mark a strip of cardboard by using a metric ruler to calibrate the length. Metric tape measures are available in dry goods stores and notions sections of department stores.

Sandpaper - Use nail files or emery boards.

Y joints - Use air values from aquarium filter pumps (2 or 3 way gang valves).

Hydrogen Gas - Put 20 ml of Sodium Hydroxide and a small piece of tinfoil in an Erlyn Meyer Flask. Cover the flask lip with a balloon. The gas captured in the balloon is Hydrogen

Carbon Dioxide Gas - Mix Alka-Seltzer & water in a flask as above. The gas captured in the balloon is CO2. You can also add a piece of chalk to 10 ml of Hydrochloric Acid. The gas given off is also CO2.

Cobalt Chloride Paper - Mix 10 g of Cobalt Chloride crystals with 100 ml of water. Soak paper towels overnight in the solution. Remove the towels from the solution and dry them in a warm oven or over a light bulb. The paper will turn blue. Cobalt chloride paper is blue when dry and pink when wet. This makes the paper a test for the presence of moisture.