Season 1 Ep. 3 (#103)

Can Crusher

Description:
See the power of air pressure!

Materials:
Soda can
Tongs
Gloves
Container of cold water
Hot plate
Safety Glasses
Adult Supervision

Procedure:
1) Fill a soda can with enough water to cover the bottom of the can (about 1.5 tablespoons)
2) Place can on a hot plate turned on high until the sound of boiling water is heard and steam begins to exit the can
3) With a gloved hand, use the tongs to grip the base of the can and invert into a container of cold water (the can opening must be under water).
4) The can will instantly pop and be crushed

My Results:

Explanation:
The liquid water in the can turned into a gas and the resulting water vapor pushed the air that had been in the can out. When turned upside down the gas molecules (water vapor) were cold enough (slowing the molecular movement) to turn the vapor back into water (condensation). The vapor turned into only a couple drops of water and needed much less space, which also reduced the amount of air pressure inside the can. Because the air pressure outside the can was greater than the air pressure inside, the can was crushed or imploded. At sea level, the total pressure could reach more than 1800 kilograms!

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WKAR

The Curiosity Guide

Subject: Air Pressure

Investigation: 02

Season 1 Ep. 3 (#103)

Inverted Cup

Description:
Sometimes air pressure is greater than gravity.

Materials:
Plastic cup
Notecard or piece of acetate
Pitcher of water
Empty basin

Procedure:
1) Fill the plastic cup 1/3 to 1/2 full of water
2) Cover the top of the cup with the notecard or plastic
3) While keeping one hand flat on the cover and the other hand holding the cup near the bottom, quickly turn the cup over
4) Move your flat hand down and away from the cup
5) The card will be suspended to the cup and the water will not fall out
6) To empty the cup, hold it over the basin and pull away the card
7) Try experimenting with different amounts of water in the cup as well as different materials for the cover
8) Think about what could be holding the card in place

My Results:

Explanation:
Although gravity is pulling down on the water at about one pound of force, air pressure is pushing up on the cup at nearly 15 pounds of pressure for every inch. Because the force is greater pushing up, the water in the cup will not spill out.

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Season 1 Ep. 3 (#103)

Sipping Race

Description:
We know how a straw works, but do we know WHY it works?

Materials
3 normal straws
1 straw with numerous pinholes placed above the liquid line
Two small cups with water, juice, or a soft drink

Procedure Part 1:
1) Prepare the two cups with a beverage and place one good straw in one cup and the pin-holed straw into the second
2) Challenge two people to see who can finish the drink the fastest
3) The person with the good straw will finish first
4) Have people inspect the straws and hypothesize what could have happened

My Results:

Explanation:
When we sip through the straw, we reduce the air pressure inside the straw, but there is still air pressure pushing down on the surface of our drink. Because that pressure is greater it pushes the liquid up through the straw and into our mouths. By punching small holes in the straw air pressure is pulled into the straw so there is never an imbalance of air pressure or a way for air to exert greater force on the liquid. Try as they may, the straw will not work effectively. This is the same principle that makes a syphon work. So long as one end of a tube is submerged and the other end outside of the container of water is lower than the submerged opening, air pressure will continue to force the liquid out and drain the water.

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(Part 2)

Sipping Race with 2 Straws

Procedure Part 2:
1) Challenge the same two people to have a second race, each using two straws.
2) The person who lost the first round places both straws into their beverage.
3) The other person places two straws in his or her mouth placing one straw in the beverage and the second left in the air.
4) Challenge them both to drink
5) The person with both straws in the beverage should easily win
6) Encourage people to try these tricks on others

Explanation:
Once again the person will get a mouthful of air and not be able to reduce the air pressure of the straw going into the cup. If the person is able to seal the end of the straw going into the air using their tongue or lip, they then can reduce the air
pressure in the second straw and successfully drink.

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Season 1 Ep. 3 (#103)

Candle Vacuum Demonstration

Description:
See how air pressure can move water

Materials:
Shallow pan filled with 5 cm of colored water
Large mouth jar
3 candles stuck in lumps of modeling clay
Matches or lighter
Adult supervision

Procedure:
1) Fill the pan with 5 centimeters of water and add food coloring to increase visibility.
2) Place three candles in lumps of clay in the center of the pans of water.
3) Light the candles and quickly invert the jar over the candles
4) Observe that the candles will burn out and the liquid will draw up inside the jar
5) It is best to do the experiment multiple times using one, then two, then thee straws and note the difference in the amount of liquid entering the jar

My Results:

Explanation:
Most will assume that the oxygen that was burned out is replaced by the liquid water, however this can be proven incorrect by conducting the experiment several times with different numbers of candles. The more candles lit the higher the water will go in the jar, so the oxygen loss is not the primary contributor. In actuality it has to do with the heated air, which expands and takes up more space. When observed closely, people might hear heated air bubbling out right after the bottle is inverted. After the fire goes out, the air begins to cool, which contracts taking up less space in the jar and leaving a partial vacuum. Air outside exerts pressure on the liquid in the pan and causes it to rise into the jar. Therefore, the greater the heat in the jar, the more the air is expanded and forced out, which increases the amount of water in the jar. Increasing the number of candles used, increases the height of the water.

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Season 1 Ep. 3 (#103)

Eggciting Bottle Demonstration

Description:
Put an egg in a bottle. Without smashing it.

Materials:
Hard-boiled egg (peeled)
Glass jar (the neck must be just smaller than the peeled egg)
Scrap of paper
Match
Rubbing alcohol
Tissue
Safety glasses

Procedure:
1) Explain the following procedure and predict what will happen
2) Put on safety glasses
3) Take the small scrap of paper and light it with a match
4) Quickly toss the burning paper inside the jar
5) Immediately place the hard boiled egg on the top of the jar with the small end facing down
6) Observe that the fire goes out and the egg is drawn into the bottle
7) Hypothesize how to get the egg out

My Results:

Explanation:
Like the Can Crusher Investigation and the Vacuum Candle Investigation, the flame heated the air in the jar, which heats up the air causing it to expand. Close observers may notice the egg bounce slightly as the hot air begins to push its way out. Once the fire goes out and the air begins to cool, it contracts and creates a partial vacuum with lower air pressure than what is outside the bottle. As a result the egg is forced in to balance the pressure. In order to get the egg out, first clean the bottle opening with a tissue dipped in rubbing alcohol (and repeat if different people attempt this), then invert the bottle so the egg falls into the larger opening with its small end first. Next, blow through the bottle opening to force more air into the bottle and increase the air pressure. The egg once again will be forced out of the bottle as the higher pressure moves toward the lower pressure.

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Season 1 Ep. 3 (#103)

Pesky Paper Ball

Description:
Think you can blow a ball of paper into a bottle?

Materials:
Empty plastic bottle
Small ball of paper towel or paper (rolled tightly) and so that it is half as big as the bottle opening size

Procedure:
1) Remove the cap from the bottle and place the bottle on its side
2) Place the paper ball just inside the opening of the bottle
3) Challenge someone to blow the ball into the bottle
4) With each attempt the ball will fly out

My Results:

Explanation:
Because the air is moving quickly in front of the ball, it creates a lower pressure there than the air inside the bottle - so the ball is pushed toward the moving air (Bernoulli's Principle).

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Season 1 Ep. 3 (#103)

Ping Pong Ball In a Funnel

Description:
Bernoulli is stronger than you!

Materials:
Funnel
Ping pong ball

Procedure:
1) Place the ping pong ball inside the funnel and hold it up above you
2) Lower the funnel to your upturned mouth and attempt to blow the ball out
3) The ball will not come out

My Results:

Explanation:
Because the air is moving quickly below the ball it creates a lower pressure there than the air above the ball so the ball is pushed toward the moving air (Bernoulli's Principle).

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Season 1 Ep. 3 (#103)

Floating Ball

Description:
The power of air!

Materials:
Square window fan (or canister vacuum with the hose in the "Exhaust" slot)
4 small 2 x 4 wood blocks
Beach ball (or racquetball ball)

Procedure:
1) Lay the fan on its back and support each corner with a wood block
2) Plug the fan in and turn it on
3) Carefully place the ball over the fan so that it becomes suspended in the stream of upward flowing air
4) Gently tilt the air source to move the ball from side to side
* A fan could be substituted with a canister vacuum cleaner with the nozzle on output, using an electric leaf blower, or hair dryer but the ball must be exchanged as well so the diameter of the ball is smaller than the diameter of the air source.

My Results:

Explanation:
The column of air above the fan begins to move faster than the air on either side of the column. That static air is higher pressure than the air column whose pressure is reduced with the moving air. As a result the ball will not move out of the shaft and when it moves to the side, the high pressure there will push the ball back. By moving the air source, the ball can move as well.

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Season 1 Ep. 3 (#103)

Plunger Pull and Rubber Suction

Description:
Air pressure is powerful!

Materials:
Clean sink plunger
Damp sponge
Smooth rubber flexible mat (at least 7" by 12")
Threaded screw eye
1 rubber washer
2 metal flat washers (with a larger diameter than the rubber washers)
2 nuts

Procedure:
1) Drill a hole in the center of the rubber mat (just bigger than the diameter of the threaded eye screw)
2) Screw on a washer and spin it up toward the eye
3) Slide on a large metal flat washer followed by the rubber washer
4) Insert the screw eye through the mat
5) Place the second flat washer on the underside of the mat
6) Spin the second nut on next so that it is flush with the end of the screw eye
7) Tighten the top nut to squeeze it all together on the matt
8) Tie a loop of rope through the screw eye to serve as a handle
9) Smooth out mat on a table surface so press some of the air out and attempt to pull up on the rope handle (moistening the underside edge will help improve the seal)
10) Lightly moisten the lip of the clean plunger with a sponge and force it down onto the table or against the wall
11) It is difficult to pull the mat or plunger off

My Results:

Explanation:
In both cases the air under the mat and plunger were forced out so there was less air pressure than there was on top. The higher air pressure above pressed down at 14.7 pounds per square inch making it difficult to remove.

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Season 1 Ep. 3 (#103)

Air Pressure Car

Description:
Make a car and see how far it will go.

Materials:
(Per Car)
Cardboard (for wheels)
Top of a Styrofoam egg carton (for chassis)
3 flexible straws (2 to house axles and 1 for tail pipe)
2 wooden barbecue skewers (6" or longer to serve as axles inside the straw)
Duct tape or strong masking tape
Balloon
Scissors
Large flat washer (to serve as wheel template)
Drawing compass (to make varying size wheel patterns)

Procedure:
1) Cut two straws just wider than the width of the top of the egg carton (cutting off the bendy end)
2) Tape them across the short sides of the egg carton on either end
3) Using the flat washer or compass trace and cut out 4 cardboard wheels (try to avoid flat spots)
4) Using the sharp edge of the skewer carefully pierce the center of one wheel and slide it near the blunt end
5) Insert the point of the skewer through one of the taped straws and pierce the second cardboard wheel
6) Repeat for the second axle
7) Cut the very end of the balloon (that you blow into) off with scissors
8) Slide the non-flexible end of the final straw one inch into the balloon
9) Tightly tape around where the balloon and straw meet to eliminate air leaks
10) Securely tape that same joint down to the egg carton
11) Blow up the balloon and cover the open end of the tail pipe with your finger (pinching or kinking the straw works well too)
12) Remove your finger and let it go

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Season 1 Ep. 3 (#103)

Part 2

Air Pressure Car

Try different placements of the balloon, different balloons, the amount of air in the balloon; different wheel options and sizes (such as CD wheels held with long thin bolts, flat washers and nuts) Lego chassis, matchbox cars; or different tail pipe materials such as surgical tubing, pen or mechanical pencil bodies. People can draft blueprints, collect and compare data to determine what combinations improve speed and distance traveled, and reflect upon their blueprints to explain future modifications.

My Results:

Explanation:
When the balloon is inflated the latex keeps the air under higher pressure and builds up more potential energy so that when the tailpipe is opened the air rushes out toward lower air pressure. The action of the escaping air causes an opposite reaction for the car to move (Newton's Third Law of Motion).

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