Name _____

All About Air Pressure

Station 1: Collapsing Pop Can

Materials:

- Aluminum pop can
- Bunsen burner or small propane torch and striker
- Claw holder
- Bucket of cold water
- Oven mitt (or equivalent) and safety glasses
- Metric ruler
- Chart of Barometric Pressure vs. Altitude

Procedure:

1. Measure the height and diameter of the can. Make a note of this information on the activity sheet.
2. Put a small amount of water in the bottom of the can. Just enough to cover the bottom.
3. Wearing goggles and an oven mitt, hold the can in the claw over the heat source. Do so until there is a good chimney of steam coming out the opening in the can. This might take a couple of minutes.
4. Quickly invert the can into the bucket of cold water and watch the results.
5. Complete the questions on the activity sheet.

Dimensions of the Soda Can: _____ cm high and _____ cm in diameter.

Calculate the force from atmospheric pressure on the outer surface of the can:

1. Using the chart, find the average barometric pressure at your altitude. _____

2. Using the can dimensions you measured earlier, calculate an approximate surface area for the soda can. Remember, the equation for the surface area of a cylinder is:

   Surface Area = 2π (radius) (height) + π (radius)^2

Stop and Think Questions

1: If all that pressure is being exerted on the outside of the can, why doesn't it just collapse all the time?

Station 2: Balloon in a Bell Jar

Materials:

- Bell jar
- Vacuum pump
- 2 Small balloons, partially inflated to the same size.
- Masking tape

Procedure:

1. Tape one of the balloons to the top inside of the bell jar. Leave the other on the outside for comparison. (This step won't be necessary for subsequent groups.)
2. Connect the vacuum pump and evacuate some air out of the bell jar.
3. Complete questions on activity sheet.
4. Release the vacuum so that the apparatus is ready for the next group.

Stop and Think Questions

2: What happened to the balloon as you pumped air out of the jar?

3: Brainstorm an explanation for why this happened.

Station 3: Ruler and Newspaper

Materials:

- Sheet of newspaper
- Wooden ruler or flat piece of wood

Procedure:

Part A

1. Place the ruler on a bench top with about a quarter of its length hanging over the edge.
2. Make sure the area around you is clear of people, then give the overhanging piece a quick "karate chop" with your hand.
3. Retrieve the ruler and replace it in the same position on the bench.

Part B

4. Lay one full sheet of newspaper over the part of the ruler that is on the bench.
5. Repeat your chop to the overhanging part of the ruler.
6. Record your observations and answer the questions on the activity sheet.

Stop and Think Questions:

4: What did you expect to happen during each part of the activity?

5: Is it the weight of the newspaper that causes the difference? Back up your answer with your observations of the experiment and materials.

Station 4: Egg in a Bottle

Materials:

- Hard boiled egg (with shell removed)
- A bottle or flask with an opening that is just small to prevent the egg from entering the bottle.
- Matches

Procedure:

Part A

1. Drop a burning match into the bottom of the bottle.
2. After a few seconds, place the egg onto the mouth of the bottle.
3. Compete the relevant areas on the activity sheet.

Part B

4. Now that the egg is in the bottle, turn the bottle upside down so that the egg is resting in the neck of the bottle.
5. Tip back your head and blow vigorously into the inverted bottle.
6. Quickly remove your lips from the bottle hold it over the bench.
7. Complete this section of the activity sheet.

Stop and Think Questions:

6: What causes the egg to be pushed into the bottle? What does the match have to do with it?

7: Why does blowing into the bottle cause the egg to pop back out?

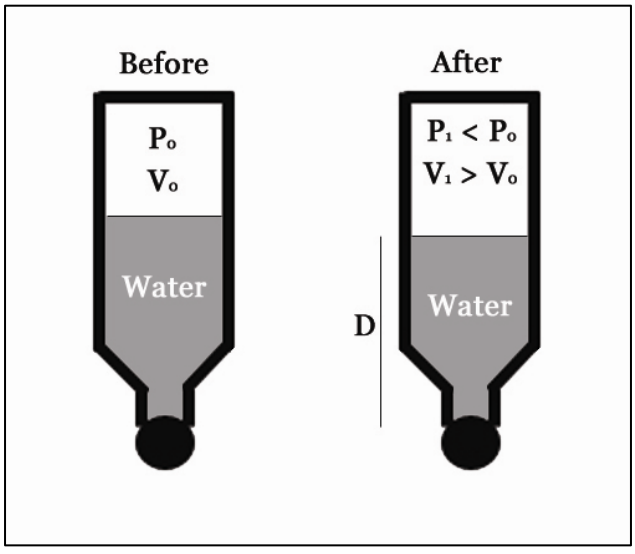
Station 5: Soda Bottle and Ping Pong Ball

Materials:

- Soda bottle
- 1 Ping pong ball
- Graduated cylinder
- Metric ruler
- Beaker to collect water
- A barometer

Procedure:

1. Obtain a reading of atmospheric pressure from the barometer at the station. Record this on the activity sheet.
2. Fill the bottle all the way to the top with water.
3. Push the ping pong ball onto the top to squeeze out a small amount of water.
4. Now, pour off about one third of the water in the bottle into the graduated cylinder and record this amount as $\mathbf{V_o}$ on the activity sheet.
5. Hold the ping pong ball on top of the bottle and invert it over the beaker. Hold the ball loosely against the opening so that some water is allowed to leak out into the beaker. Don't jiggle or rotate the ball during this process or you may allow too much water to escape and introduce an error into your data.
6. Eventually, enough water will leak out that the pressure on both sides of the ball will be the same and you can take your hand away and the ball will stay. Add the water that leaked out to the graduated cylinder and record this total amount as $\mathbf{V_1}$ on the activity sheet.
7. Measure the distance from the mouth of the bottle to the top of the water and record this distance as **D** on the activity sheet.
8. Complete the calculations called for on your activity sheet to determine the atmospheric pressure in your classroom. Compare your calculated value to the reading you took off the barometer and answer the questions on the activity sheet.



P (barometer) = _____ kPa

$\mathbf{V_o}$ = _____ mL

$\mathbf{V_1}$ = _____ mL

D = _____ cm = _____ m

ρ = 1.0 kg/m^3 (approximate)
g = 9.8 m/s^2

Calculation of Atmospheric Pressure:
Because the pressure is the same on both sides of the ball after the water has leaked out, that means that:

$$\mathbf{P_1} + \rho g \mathbf{D} = \text{Atmospheric Pressure}$$

Where $\mathbf{P_1}$ is the air pressure in the bottle, ρ is the density of water, g is the acceleration due to gravity, and **D** is the height of water in the bottle after some has leaked out (as shown above). We also know that, originally, the pressure inside the bottle was equal to atmospheric pressure. So, now we can say that:

$$\mathbf{P_1} + \rho g \mathbf{D} = \mathbf{P_o}$$

Since air is nearly an ideal gas, we can make the approximation that $P_1 V_1 = P_o V_o$ and that means that $P_1 = (P_o V_o)/V_1$. If we put this result in the equation above and solve for P_o, we get a relation that will allow us to calculate what the atmospheric pressure is.

$$\mathbf{P_o} = \rho g \mathbf{D}\, \mathbf{V_1} / (\mathbf{V_1} - \mathbf{V_o})$$

Stop and Think Questions:
8: Substitute your measurements into this equation and calculate $\mathbf{P_o}$. Show your work.

9: Compare your result to the atmospheric pressure you read off the barometer at the beginning. Are they the same? What are some factors that could affect how closely your result matches the measurement?

Station 6: News Article Review

Materials:

- Why the Earth's air is really an ocean
- Flatter oceans may have caused 1920s sea rise
- Caught in whirl of cyclone labels
- Forecasters Mark 15th Anniversary Of Hurricane Andrew
- Study Eyes Stratosphere, Weather

Procedure:

1. Everyone in the group should pick an article to read. Everyone should take a different one unless there are more group members than articles.
2. Spend the first few minutes reading your article and then write a paragraph summary (on your activity sheet) of what the main points of the article were and what you learned from it.
3. When everyone is finished, each person should spend 1 minute telling the rest of the group about the article and fielding any questions their group-mates might have about the material.
4. Keep an eye on the time so that everyone gets a chance to share what they learned!
5. In your own words, write a couple of sentences based on the summary that your group-mates give of their articles.

Your Article: _____

Summary:

Use this page to write your 2 sentence synopsis of your group-mates articles.