Bay Area Scientists in Schools Presentation Plan

Lesson Name Air pressure and you
Presenter(s) Peter Combs
Grade Level 5th
Standards Connection(s):

- Earth Science: atmosphere, air pressure;
- Physical Science: Properties of gasses

Teaser: The air around us isn't just empty space. It's filled with a mixture of gasses that are pushing on us all the time. Air takes up space, and the amount it pushes on us depends on the speed its moving. In this fun-filled hour we'll show that this is all true, and think about what air pressure is and does!

Vocabulary/Definitions: *3 – 6 important (new) words*

1. Gas: A state of matter where molecules bounce around freely
2. Molecule: The smallest, single particle of a substance that still has the same chemical properties
3. Pressure: Force pushing evenly on a surface
4. Bernoulli Effect: Moving air has lower pressure on its sides compared to air that's standing still

Materials:

What will you bring with you?
Balloons, dish tub, glasses, index cards, thumbtacks, thread spools, string, tape

What should students have ready (pencils, paper, scissors)?
None

Classroom Set-up: *Student grouping, Power/Water, A/V, Light/Dark, set-up/clean-up time needed*
Chalkboard/whiteboard, water;
Need ~5-10 minutes setup time to fill the dish tub with water.

Classroom Visit

1. Personal Introduction: 5 **Minutes**

Who are you? What do you want to share with students and why? How will you connect this with students' interests and experiences?

I'm Peter, a graduate student in Biophysics at UC Berkeley. When I was your age, I watched TV shows like Bill Nye the Science Guy and Mr. Wizards World. They were all about showing you

different ways that you, yourself, could test out scientific ideas, and they did a good job of getting you to understand what's really going on, and that's what got me hooked on science, especially physics.

Once I got into college, I took a biology class that really looked at things as tiny molecules, and that really got me excited about biology. To really understand biology, we need to understand things at the really, really microscopic scale. My research is all about trying to understand how just one molecule at a time works.

Topic Introduction: **5 Minutes**

What questions will you ask to learn from students? Big Idea(s), vocabulary, assessing prior knowledge…

One of the first places that we, as scientists, really got to understand the microscopic scale of things was looking at gasses, like Air. Does anyone know what's in air? (78% nitrogen, 21% oxygen, .038% CO_2, ~1% water vapor, ~1% other stuff—draw a pie chart, water and other are about as thin as the chalk/marker lines) Is there the same amount of air everywhere? Why do mountain climbers and airplanes need air masks?

2. Learning Experience(s): **30-40 Minutes**

What will you do, what will kids do? Demonstrations, hands-on activities, images, games, discussion, writing, measuring… Describe in order, including instructions to kids.

Demonstration 1: Does air weigh anything? Tape two empty balloons to either end of a yard stick, then tape a string to the center of the yard stick so the yard stick balances from the string. Then, while blowing up the balloon, ask the students to predict whether the inflated balloon will be heavier or lighter than the empty one, and say why. Show that the balloon is, now, heavier. Then, use a pin and tape to deflate the balloon, show that it's back to balanced.

Demonstration 2: Does air push on us at all? Fill a glass with water, wetting the rim. Then, put an index card onto the rim, and then quickly turn it upside down. In this demonstration, air pressure is pushing on the card, but only on the side exposed to air. The other side has the weight of the water, which is less than the air pressure (14 psi! Would not work for a column 32 feet long).

In stations:

Activity 1: Can we move air around? In the tub of water, have students fill up one of the glasses underneath the water, then take the other glass, push it down into the water so it stays full of air, then "pour" the air between glasses. Here, water in the first glass is pushed out by the air in the second glass.

Activity 2: Can we change the air pressure in certain places? Give each student a strip of paper, and have them blow. The strip of paper should rise up. Also have two ping-pong balls suspended by string a few inches apart. Blowing between the balls causes them to come together towards each other. Hovering card trick: put a pin through the center of a card, then have the point of the pin go through the center of a spool of thread. Students blowing as hard as they can through the central hole of the spool cannot blow the card off. These three activities demonstrate the Bernoulli effect.

3. Wrap-up: Sharing Experiences **5-10 Minutes**

Putting the pieces together – how will students share learning, interpret experience, build vocabulary?

Briefly (1-2 minutes) explain about the molecular view of gasses: lots of tiny particles bouncing around at high speed. This is not obvious, and took a long time, historically, to convince ourselves this is true.

(Atomic hypothesis: If, in some cataclysm, all scientific knowledge were to be destroyed, and only one sentence passed on to the next generation of creatures, what statement would contain the most information in the fewest words? I believe it is the *atomic hypothesis* (or atomic *fact*, or whatever you wish to call it) that ***all things are made of atoms — little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling upon being squeezed into one another.*** In that one sentence you will see an *enormous* amount of information about the world, if just a little imagination and thinking are applied.)

Ask what people learned today.

Why don't people feel the air pressure around them? (normally, they're used to it. What about changing altitudes... ever notice your ears pop when flying on an airplane or driving through the mountains? What happens to bags of chips in the mountains?)

Do you think the Bernoulli effect can be used for anything? (Airplanes!)

4. Connections & Close: **5 Minutes**

What else might kids relate this to from their real-life experience? How can they learn more? Thanks and good-bye! Clean-up.

Wind and weather depend a lot on air pressure. Drinking straws use air pressure too!

Lots of great simulations online: PHET.colorado.edu

TOTAL 50 – 60 Minutes

Follow-up – After Presentation

Write a letter to me explaining "What I learned about air and pressure."

http://kids.earth.nasa.gov/archive/air_pressure/index.html
http://www.kids-science-experiments.com/cat_pressure.html
http://www.rcn27.dial.pipex.com/cloudsrus/pressure.html
http://phet.colorado.edu/simulations/sims.php?sim=Gas_Properties

I Can't Take the Pressure (*Integrated Teaching and Learning Program, College of Engineering, University of Colorado at Boulder*) Learners develop an understanding of air pressure in two different activities. They model the magnitude of air pressure as gravitational force per unit area, and they use cookie wafers to model how air pressure changes with altitude. Instructions are also included for a demonstration to crush an aluminum can using air pressure. This activity has connections to other activities to create a larger lesson or curriculum unit. Resource contains vocabulary definitions and suggestions for assessment, extensions, and scaling for different levels of learners.
http://www.teachengineering.org/view_activity.php?url=http://www.teachengineering.org/collection/cub_/activities/cub_air/cub_air_lesson04_activity1.xml

A Pressing Engagement (*National Weather Service*) In this quick and easy activity and/or demonstration, learners illustrate the effect of the weight of air over our heads. Since we do not typically feel atmospheric pressure, this activity allows learners to explore the effect of air pressure on two different types of paper. In a simple test, learners will compare the ease of lifting printer paper versus newspaper. This resource includes information about atmospheric pressure, water pressure, and how pressure relates to wind and thunderstorm safety.
http://www.srh.noaa.gov/jetstream/atmos/ll_engagement.htm

Why Does Water Rise? (*Steve Spangler Science*) You'll have to watch closely and use everything that you know about air in order to explain the mystery of the rising water. You heard right! Air is the key to why the water rises in this experiment... but you'll have to do the experiment yourself to find out just how air affects the water. http://www.stevespanglerscience.com/experiment/why-does-the-water-rise

Reading Connections:

- Facinating Science Projects: Air by Sally Hewitt http://www.amazon.com/Air-Sally-Hewitt/dp/0761323376/
- Experiment with Air by Bryan Murphy http://www.amazon.com/Air-Bryan-Murphy/dp/1587282445/
- Air is Everywhere (Investigate Science) by Melissa Stewart http://www.amazon.com/Everywhere-Investigate-Science-Melissa-Stewart/dp/0756506387/

Can Crushers

(Children's Museum of Houston)
http://www.cmhoustonblog.org/2010/07/20/can-crushers/

In this one, we are discussing air pressure. We have many miles of air sitting on top of us. The actual amount varies depending on temperature, etc. – air is a fluid like water, after all, so it does sort of "slosh" around. But, on average, 99% of our air extends about 31 miles above sea level (in comparison, Mt. Everest is only 5.5 miles). With all this air pressing down, we experience about 14.7 pounds of pressure per square inch. Based on the surface area of your average 8 year old, that's equivalent to the weight of a school bus! So why aren't we squished? Simple – our bodies push back – we evolved with a certain fluid pressure internally that presses back against the 14.7 lbs/sq. in. In fact, we get altitude sickness when we're up too high because of that pressure!

What to Do:

1. Place about a tablespoon of water inside an empty aluminum can. No need to wrap with foil like we did. We were just covering the brand.
2. Place it on the stove and turn the heat to high.
3. While the can is heating, fill a bowl with cold water – the colder, the better.
4. When you see steam, use tongs to quickly flip the can over upside down into the water. Do NOT touch the can until it has a chance to cool!
5. If it doesn't crush, you may have either taken too long to flip it, didn't fully submerge the hole into the water, or pressed the can too far against the bottom. Reheat it and try it again.

What's Happening?

What we did here was to heat up the air. Heated air expands because warmer air can exert more pressure. Think of it this way – the molecules moving inside the can move faster and faster when heated. All this motion causes them to press harder against each other and the sides of the can. BUT, due to the opening on top, some of the molecules leave the can so the pressure never really rises inside the can. If it were sealed, the pressure would rise until it burst.

When the can is flipped over, we seal the hole. At the same time, the air inside cools, so the molecules aren't pressing as hard against the sides of the can and the pressure inside drops. But, with the hole sealed, the outside air can't get inside to equalize the pressure, so the air simply crushes the can (and shoves water up into it). Had the can just been left out to cool, it wouldn't have crushed.

Alternative Experiements & Videos: http://www.stevespanglerscience.com/experiment/incredible-can-crusher