Bay Area Scientists in Schools Presentation Plan

Lesson Name Air pressure: invisible, powerful, mysterious
Presenter(s) Bruce Jackson
Grade Level 5th
Standards Connection(s) Earth Science: atmosphere, air pressure & winds; Physical Science: liquids, gases & water vapor

Abstract: Air is a gas, nitrogen, oxygen plus a little water vapor and CO_2. It has weight, (inflated ball demo) so it's pulled by gravity and fills any empty space. At sea level its pressure is about 15 psi. If we climb a mountain, the pressure is less (bags of chips inflate); below sea level, it's even more. That's a lot. If we take away a little, the surrounding air pushes in with great force. (toilet plunger, can crushing) If we add a little, we can lift great weights (bag lifts). Without air pressure, lots of things wouldn't work: wind, clouds & rain, breathing, sucking through straws, suction cups. When you know how air pressure works, you can do amazing things and understand mysterious phenomena.

Vocabulary/Definitions:
3 – 6 important (new) words (On board front center, pre-written on printer paper & posted):*

- ***Gas:*** a state of matter like air, where molecules float around freely
- ***Pressure:*** force pushing against something
- ***Compress:*** squish together to take up less space
- ***Suction:*** reduction of air pressure
- ***Vacuum:*** empty space with no air
- ***Oxygen:*** an element (O_2) in air that supports life and burning.
- ***Water vapor:*** water that's been turned into a gas.
- ***Carbon dioxide:*** a gas (CO_2) produced by burning, breathing, etc.
- ***Bernoulli effect:*** moving air has lower pressure at its sides. *(*Not pre-written: kids discover it!)*

Materials:
Brought to class: Plastic dish tub, glass, cards, angel chimes & box, Styrofoam cubes with holes, clean straws, cardboard with pins, 2 inflatable balls, air pump & needles; hair dryer & stand, ping-pong balls, funnel, plastic cups, tape, suction cups, toilet plunger, jar, plate, candle, food coloring, matches, balloon in bottle, water boiling device, ice, empty milk containers & soda cans, prepared plastic bags with straws inserted, barometer jar.

S*tudents should have ready:* Pencils, run off work sheets.

Classroom Set-up:
10 min. set-up, 10 min. clean-up: Grounded power outlet & demo table at front. Water available. Students in groups of 3-4, 8 groups maximum, *set up scale, tub, electric kettle, candle & dish, angel chimes, hair dryer in stand.*

Classroom Visit

1. **Personal Introduction & Topic Introduction:** **10 Minutes**
   I'm "Dr. J." I've had several careers—in Washington and embassies overseas, in the phone company with computers, and in schools with students of all ages. Science has always been a hobby—I've tinkered with science all my life, and I love puzzles & things that look like magic, especially when you can learn their secrets and show them to someone else. Here's one. How many of you have launched something with a straw? OK, how far will my disk go when I blow hard into the straw and suddenly let go? (demonstration).

   Distribution of work sheets for recording data

   (Point out key words on board & have them start copying definitions.) Who has ever felt their ears pop when they were on a drive up a mountain? Who has seen something fly out the window of a car? Who has played with a helium balloon? Used a bicycle pump? Played in an inflatable party house? So you all know something about air pressure, right? Well, today you'll be seeing and doing some things that may seem mysterious, but if you observe carefully, listen closely, and think about it, you should be able to explain what's happening in each activity.

2. **Learning Experiences: Demonstrations** **25 Minutes**

   A. Intro: the ocean of air: When you look up at the blue sky, you're looking thru an ocean of air. We're very lucky to be on earth—other planets don't have this ocean. Mars has very little air, the moon has none. Why doesn't ours fly away, too? The big reason: we have more gravity. *Pass out suction cups, discuss sketches & recording.*

   B. Weight of air: Does air really weigh anything? Yes, think about helium compared to our air. We can prove it, too. If air weighs anything, a ball should weigh more when we pump more air into it. Let's test it…(Demo with inflated balls, one losing air)
   ☛ Students complete worksheet section 1.
   Does air always weigh the same? Think about hot air balloons: air expands when you heat it and gets thinner, so it's light and rises, just like a balloon! (Light angel chimes)
   ☛ Students complete section 2

   C. Weather and air pressure: What happens when air gets hot in the summer? What happens to the cool air and fog over the ocean? What does that mean for summer weather in the Bay Area?
   ☛ Students complete section 3

   D. Pressure in all directions: So, is the pressure just pressing down? Does it press up, too? Let's see… (Demo with glass of water and card.)
   ☛ Students complete section 4

E. Air pressure power: How strong is air pressure? Story of Magdeburg hemispheres, 1620, (student demo.)
☛ Students complete section 5

F. Suction: What is suction? Suction is when we reduce air pressure in one place so other air can push in. (Examples: breathing, sucking on a straw, vacuuming, suction cups. Demo: toilet plunger. Discuss: space vacuum)
☛ Students complete section 6

G. Water vapor: How do we know there's always water vapor in the air? (Demo: "sweat" on icy drinks)
☛ Students complete section 7
When steamy air cools down, what happens to the pressure? (Demo: milk container collapsing)
☛ Students complete section 8

H. Oxygen and CO2: Burning anything uses up oxygen in the air and creates water vapor & CO_2; (candle in jar)
☛ Students complete section 9

3. Learning Experiences: Hands on activities **25** **Minutes**

A. Materials: *ID materials manager in each group. Distribute materials bags. Instructions on care with materials, classroom rules. Following directions. Checking materials list at beginning and end.*

B. How strong is your breath? Students work in groups with plastic bags and straws to see how many books they can lift with just the extra air pressure of their lungs
☛ Students complete section III-B

C. Fast-moving air streams, Bernoulli Effect 1: Students test what happens with streams of air below hanging strips of paper, then above.
☛ Students complete section III-C

D. Huffing and puffing, Bernoulli 2: Students use straws and Styrofoam cubes to experience the Bernoulli effect with cardboard squares. Students complete section III-D.

Floating balls demo: Students silent, watching. Turn on hair dryer, place balls in air stream.

E&F. Floating balls & jumping balls, more Bernoulli effects: Students take turns learning how to float a Styrofoam ball over a straw and how to blow a ping-pong ball out of a plastic cup.

G. Class discussion: students discuss what seems to be going on in the different Bernoulli examples and try to come up with a hypothesis around what's happening. Discussion of the Bernoulli effect and its applications to aircraft design, windmills, etc.
☛ Students complete section III-G

4. Wrap-up: Sharing Experiences and Building Connections **_____10____ Minutes**

Student questions: What surprised you about your activities today? What questions do you have that might be related to air pressure?

Prediction challenges: (Students write their predictions for each)

How much can I lift with a suction cup?

What will happen to a soda can if I have it full of water vapor and then seal it?

How far can I blow a ping-pong ball using a funnel?

For your class: a simple barometer (jar with balloon cover & pointer stick

4. Close: **_____5_____ Minutes**

Clean-up. All materials back in plastic bags; all worksheets to teacher. All demo materials packed up. *How can kids learn more?* Packet of follow-up Xerox masters for possible homework to teacher. *Thanks and good-bye!*

TOTAL __75___ Minutes

Huff, Puff & Whoosh!

Air Pressure Investigations

Name: _____ Date: _____

Partner: _____

Part I. Vocabulary

Gas: _____

_____

Pressure: _____

Compress: _____

Suction: _____

Vacuum: _____

Oxygen: element (O_2) in air that burns & supports life

Water vapor: _____.

Carbon dioxide: gas (CO_2) produced by burning, breathing, etc.

Bernoulli effect: _____

Part II. Demonstrations

Sketch:	Observe, think and answer:
Scale & balls	1. Does air have weight? _____ How do we know? What is our evidence? _____ _____ _____
Candles, chimes	2. Does air always weigh the same? _____ What is our evidence? _____ _____ _____
Smoke	3. Hot air usually…_____ What happens when air gets hot in one place but not another? _____ How does this explain some of our weather? _____
Water glass	4. Does air pressure push up as well as down? _____ What is our evidence? _____ _____
Suction cups	5. Is air pressure very strong? _____ What is our evidence? _____ _____ _____
Plunger, straw	6. What is suction? _____ What can suction help us do? _____ _____
Cold drink bottle	7. There is always water vapor in our air. What is our evidence? _____ _____
Milk container	8. When steamy air cools down, what happens? _____ _____
Candle in jar	9. Burning uses up something in the air. What is our evidence? _____ _____ What is it that gets burnt? _____

Part III. Explorations. Check off each box when completed.

❒ A. Materials manager: The person in your group responsible for distributing the materials and making sure they all get back into the bag: _____
To start, every student should have a clean straw. (These won't be used after today.)

❒ B. **Pneumatic lift, or How strong is your breath?:**
1. Each team member should have a zippered plastic bag with a short straw attached. Push your own straw carefully into the short one. After each student has practiced with their plastic bag, the team should work together to raise a stack of books off the surface of a desk. How many books were you able to lift as a team? _____
2. Draw a sketch of where each bag was placed: →

3. Why were you able to lift so much weight? _____

_____

❒ C. **Fast-moving air streams:**

1. Find the long strip of paper. Hold it just under your mouth so it curves gently down. Blow above the strip of paper. What does the paper do? _____

2. What might explain this?_____

❒ D. **Huffing and puffing**. 1. Each team member should have a Styrofoam cube. Insert your personal straw through the hole in the cube, so that it just reaches the far side. Place one of the cardboard squares flat against the cube with its pin inside your straw. Now BLOW! What happens? _____

2. What might explain this?_____

You and a partner will take turns completing the next activities:

❒ E. **Floating balls**. 1. With a plastic plate on your desk (to help catch things), adjust your personal straw so it blows vertically upward and you can balance the Styrofoam ball on its stream of air. How long can you make it float?	❒ F. **Jumping balls**. 1. Tape the plastic cup to your desk and place the ping-pong ball inside. Practice until you can repeatedly get it to jump out of its cup using nothing but air.

❒ G. **What's going on here?** After the class discussion, record what you've discovered about rapidly moving streams of air: _____

_____

_____

Part IV. Prediction challenges & wrap-up.

❒ H. **Write your prediction for each:**

Soda can with water vapor, on ice: _____

Lifting weight with plunger: _____

Ping-pong ball blown from funnel: _____

Follow-up Possibilities

- Students could look in their science books to see how the air pressure activities fit in.
- Student could write letters to "Dr J" about what they learned about air pressure and what happened with their classroom barometer.
- I will leave some handouts about things students could try at home and report back on.
- I will leave some sheets of suggestions the teacher could try in the classroom.
- Here's a list of websites for further exploration
    - http://kids.earth.nasa.gov/archive/air_pressure/index.html
    - http://www.kids-science-experiments.com/cat_pressure.html
    - http://simple.wikipedia.org/wiki/Wind
    - http://www.rcn27.dial.pipex.com/cloudsrus/pressure.html
- Here's a short list of things for Googling (in addition to all the new terms from the activities so far):
    - barometer
    - vacuum
    - wind
    - humidity
    - high pressure system
    - low pressure system
    - evaporation
    - condensation
    - combustion
    - pneumatic lift
    - Magdeburg hemispheres
    - hot air balloons,

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/