Air (and Science) doesn't suck!

A Simple Inquiry Lesson to Illustrate Air Pressure

by Dr. Barry Farris

The concept of matter, especially gases, being composed of particles is a difficult one to fathom. Misconceptions can abound about temperature, gas laws, air pressure, the Bernoulli Effect, etc. without students being able to visualizing matter as composed of tiny particles in constant motion with tiny attractions for one another and which exchange (but not diminish) energy during collisions. The model and lesson activity described below helps to illustrate air pressure. This educator acquired a cache of practice golf balls by going to golf courses and requesting any "cut" balls they may have to use for science activities. The businesses were happy to help.

LESSON: (Aligns with SPI 0807.9.6, SPI 3231.2.1, and SPI 3221.2.6)

- Experiments are easily performed to demonstrate that air has mass. Scientists think of air (a gas) as made up of many tiny particles called molecules. In air, about 4 out of every 5 particles are nitrogen molecules. The remaining particle is usually just an oxygen molecule, (though there are traces of other gases in air too, such as carbon dioxide, water vapor, and argon). Since "air" has mass, then it follows that its molecules possess mass. Scientists think of these little particles as 1) moving wildly about inside a container with 2) mostly empty space between them, and 3) as they move, they occasional bump into each other and into the inside walls of the container pushing outward. Of course, air on the outside also is bumping into the walls of the container, pushing inward.

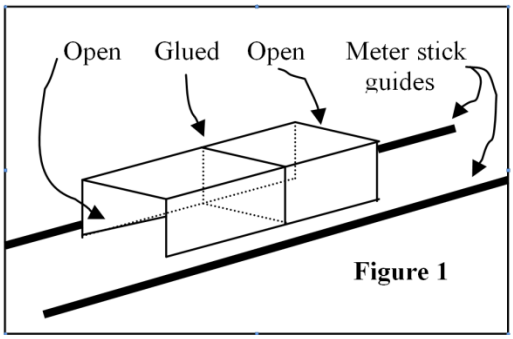

Figure 1

- Each group member (at least 4 to a group) needs to get 5 golf balls.
- Two boxes with one side and top cut off are glued together on the ends for this activity (see Figure 1). Take this box setup, and place it on the floor, using meter sticks on either side as guides. From about a meter away, roll 1 golf ball (representing a molecule of air that has mass) across the floor into the box so that the box moves about 10 cm. Now have 2 people each roll a ball into the same end of the box at the same time with the same speed. Measure how far they push the box. _____ cm Has the area of the end of the box changed (where the balls strike)? (yes, no) How far do you think 3 balls would push the box if 3 people were to roll them at the same time and at the same speed? (CHOOSE: more, less, same distance) Go ahead and do it, then record the distance the box moves _____ cm. Now roll 1 ball into the box with more speed. How far did it push the box? _____ cm How does that result compare to the distance a slow golf ball pushed the box? (CHOOSE: more, less, same) From this you can see that both the <u>number of balls and their speeds</u> affect how much push is on each box end.
- Scientists refer to the force something applies to a particular unit of area as PRESSURE. In formula form, it is and is often measured in units such as "pounds / in^2" or in the metric system, it would be "Newtons / m^2". In chemistry, air pressure is measured either in "atmospheres" (atm) - because it simply represents the pressure that the air of the atmosphere applies to objects at sea level- or in "kilopascals (kPa).
- What effect do you think there would be on the box if 1 golf ball were to come into it from BOTH sides <u>at the same time</u>? (CHOOSE: still move one way, stay pretty much the same). Go ahead and try it several times. Were you generally right? (Yes, No). If 2 balls came in from each side at the same time and speed, would it still have the same effect? (Yes, No) Try it. Were you generally right? (Yes, No)
- Even though air is pushing in on us, we are not crushed because we are pushing back on air. Our lungs have air in them pushing out and our heart pumps blood so that our skin is somewhat inflated with blood, thus pushing out on the air.
- Remember that air has pressure (a force on each unit of area) because its molecules bump into the surfaces. <u>Gases cannot pull or suck</u> in because the particles are not attached to each other; <u>they can only push</u>. Also remember that their motion is random and is characterized by a wide range of speeds, giving each particle various kinetic energies. Once again, the average kinetic energy of all the particles in an object is referred to as its TEMPERATURE.
- There is a major difference between the golf balls in the previous activity and real air molecules. The golf balls moved because YOU made them move; they couldn't have moved on their own. <u>Molecules</u>, on the other hand, <u>move simply because they have kinetic energy</u>, not because something has moved them. This energy is reflected in the temperature of the substance.

From Tennessee Science Teachers Association 2009
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