OUTREACH FALL QUARTER 2002

Training for outreach volunteers:  Monday Oct. 14, PSBN 1652: 3:00 to 5:00 PM

Tuesday, Oct. 15, PSBN 1652  Workshop I: 9:00 to 10:30
                              Workshop II: 10:30 to 12

Thursday, Oct. 24, PSBN 1652 Workshop I: 9:00 to 10:30
                                   Workshop II: 10:30 to 12

Thursday, Nov. 14, PSBN 1652 Workshop I: 9:00 to 10:30
                                   Workshop II: 10:30 to 12

Friday Nov. 15, PSBN 1652     Workshop I: 10:30 to 12
                              Workshop II: 12:00 to 1:30

Tuesday, Nov. 19, PSBN 1652  Workshop I: 9:00 to 10:30
                              Workshop II: 10:30 to 12

There will be eight 5th grade classes visiting the UCSB Chemistry Department. The students are from local elementary schools. There will be five stations. Students will spend 10-15 minutes per station and rotate to all five stations.

Please read the outlined procedures for the various activities. The suggested questions and information are to help guide you. The level of students will vary so your questions and discussion with them will depend on their level. Feel free to interact with the students in any way that you feel comfortable.

IF YOU ARE AVAILABLE TO HELP PLEASE EMAIL Maureen Frost.  
mfrost@umail.ucsb.edu

THANKS

The Chemistry and Biochemistry Club

The Chemistry Department Outreach Program is organized through the ACS chemistry club at UCSB. The goal of the Chemistry Club is to promote chemistry awareness, to furnish information on career and educational opportunities and to provide community service. With full support from the chemistry department, our outreach program was started with the help of approximately thirty undergraduates, graduate students, and faculty members. Feedback from those involved in the teaching aspects of the program has been equally as positive as that from the participants. Undergraduate participants report that they feel a new confidence in the subject matter, and an enhanced degree of understanding that is inherent with teaching a subject.

By introducing both students and parents from diverse backgrounds to UCSB, and enabling them to work with UCSB students who are also from diverse backgrounds, we hope to provide them with a new impression of the University. We want them to see that the university is in fact an attainable goal for them, an option that perhaps they had not previously considered. Our long-range goal of the program is to stimulate an interest to pursue a higher education in science at a UC campus.
Station 1  Dry Ice Experiments / Producing CO₂ in a reaction

NOTE: If there are two volunteers you can divide the students in two groups. One group starts with the burning of a dollar bill and the other starts with the following activity.

1. Put a chunk of dry ice on the counter. What do you see?
   - Does a puddle of liquid form?  Solid —> Gas  (Sublimation)
   - Put a quarter on the edge of the dry ice. What do you observe or hear?
   - Put a flat chunk of dry ice on the counter and see how easy it "floats" on top of the counter when you give it a small push. Also see how finely ground dry ice moves around on the counter.

2. What is dry ice? It is solid, frozen CO₂
   - We breathe in O₂ breathe out CO₂. Are we going to run out of O₂ on earth?
   - No! Trees and plants take in CO₂, produce O₂.

3. Why does it hurt to touch the dry ice? Have students touch it but only very briefly.
   - At room temperature and pressure CO₂ wants to be a gas. In solid CO₂, the molecules hold onto to each other. It requires heat to pull molecules apart. It takes the heat from your hand when you touch it or from the air molecules surrounding it.

4. Fill a plastic tub with very hot water from sink. Pour two cups of ground up dry ice into the hot water, all at once. What do you observe?

5. What is the fog? Why does it flow over the edge of the container and down to the ground?
   - FOG: The fog is not CO₂ (g). When you breathe out CO₂ (g), it is clear. The water vapor above the hot water condenses (when CO₂ (s) —> CO₂ (g) it absorbs heat, making it very cold so water condenses (like fog or clouds).
   - Why does the fog drop to the floor? It is heavier then the air. Talk about fire extinguishers: CO₂ (l) forms CO₂ (g), drops down onto the fire, keeps O₂ (g) away from fire, so it extinguishes the fire. Light a birthday candle and have the students put it in the fog. They will see that the CO₂ (g) blows out the flame immediately.

6. Fill a 250-mL beaker about half-way with water. Put a small chunk of dry ice in the water. Students can see bubbling as the CO₂ (s) —> CO₂ (g).

Produce carbon dioxide gas in a reaction

1. a) Put ~ 1 tsp or more of baking soda in a balloon. Pour about 30 ml of vinegar in a small Erlenmeyer flask. Place balloon on top of flask adding the baking soda to the vinegar. Students can see the balloon blows up.
   b) Add 1 Tbsp or more of baking soda to a large Erlenmeyer, add the vinegar and put a bouncy ball in the opening of the Erlenmeyer flask. The ball is forced up out of the Erlenmeyer flask.
2. You can talk about CO\(_2\) (g) in sodas. High T or high P (shaking soda) releases CO\(_2\) (g). Acid rain causes CO\(_2\) (g) to be released from lakes and oceans (like vinegar and baking soda). Burning fuel produces CO\(_2\) (g). Global warming.

3. Pour 200 mL of 7-up or Sprite into a tall 250-mL graduated cylinder. Add 5 – 10 raisons to the 7-up and watch the raisons rise to the top and drop back down to the bottom. Ask students what is causing the raisons to rise and drop? What are the bubbles that coat the raisons, where do the bubbles come from? Why do the raisons sink back to the bottom?

CO\(_2\)(g) is dissolved in soft drinks in the form of carbonic acid, CO\(_2\)(g) comes out of solution onto surfaces. You see the bubbles on the sides of the glass and on the raisons. Once a raison floats to the top, bubbles CO\(_2\)(g) are released to the atmosphere and the raison sinks.

**Burning a dollar bill ????**

**Solution:** 50 mL of isopropyl alcohol, 50 mL DI water, 1-2 g NaCl. This makes 50% isopropyl alcohol. The 70% isopropyl alcohol available in drugstores must be diluted.

1. Soak a $1 in 50% isopropyl alcohol. Remove $1 using tongs (grab $1 in center, hold it in horizontal position). Light the $1 using a Bunsen burner: put the $1 bill into the flame for only a minute than take it out of the flame to see it burn. **NOTE:** If $1 itself catches fire, wave the bill to blow it out.

2. Alcohol burns and the dollar bill is fine. Why?

3. What is the $1 made of?


4. Alcohol molecules don’t hold onto each other so strongly (note the high vapor pressures at room temperature and pressure, you can smell it). Alcohol burns at a much lower temperature than the paper so the paper does not catch fire.

   Burning the alcohol produces CO\(_2\) and H\(_2\)O just like when we burn up sugar or carbohydrates - to burn anything containing C, H and O you need O\(_2\) and the combustion reaction produces CO\(_2\) and H\(_2\)O. So we breathe in O\(_2\), burn up food and breathe out CO\(_2\).

5. Why is it better to use 50% then 70% isopropyl alcohol?

   The 50% alcohol contains more water, water does not burn and keeps the $1 from burning while the alcohol burns.

6. What is the purpose of adding the NaCl? Sodium atoms heated in a flame emit yellow light so the flame is more visible if you add some salt to the 50% isopropyl alcohol solution.
**Station 2 Methane Bubbles**

1. Blow some bubbles by blowing into a wand and watch the bubbles float down to the ground.

2. Methane gas is commonly used as fuel for heating homes and for cooking. The molecular formula for methane is \( \text{CH}_4 \) and has a relative mass of 16. Will methane gas bubbles rise or fall? Blow some methane bubbles to see what happens. Clean funnel with water if bubbles pop too easily.

3. What else can we do with methane bubbles?
   
   We can light them!!!
   
   Use a torch with a candle to light the methane bubbles. Use a big candle to light the small candle (using the big candle is easier than matches to re-light the candle).

4. What do you see? What happens as the gas burns? Do you see how the gas rises and spreads out as it rises? The flame is showing you where the gas is. What color is the flame?

5. Can you feel the heat given off as the methane burns. The methane burns in air. What gas in air does methane need to burn?

   Methane needs oxygen to burn.
   
   \[
   \text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O} + \text{heat}
   \]

   **NOTE:** If the bubbles break too easily, turn off the gas and rinse and dry the funnel.

**Heat Transfer**

An added activity will be for students to figure out how heat is transferred. There will be a piece of metal, a wood and plastic block.

If you touch a piece of metal, a piece of plastic or wood in a room, why is it that the piece of metal always feels colder than the plastic or wood? Aren’t they all at the same temperature?

To help students answer this question, first discuss the following. When a hot piece of metal is placed in contact with a cold piece metal, heat flows from hot to cold until both pieces of metal come to the same temperature. The question is: What is heat and how does it flow? What is the difference between heat and temperature?

<table>
<thead>
<tr>
<th>Hot</th>
<th>Cold</th>
</tr>
</thead>
</table>

You can talk about temperature - the higher temperature the faster the atoms or molecules move. Transfer of KE from atoms in the hotter piece of metal to the atoms in the colder piece of metal, increase the temperature of the colder piece of metal. Eventually they will reach the same temperature. When we touch a piece of metal, wood or anything in the room - our body temperature is higher than any object so heat is transferred to the object. Metal feels colder because it conducts heat better then plastic or wood so it takes our heat away more quickly.

Ask students how the microwave heats our food? What molecules in our food absorb the microwaves? Water molecules absorb the microwaves. They start rotating more, run into other molecules in your food - all the molecules end up moving faster and the food is hot. When we feel hot - all the atoms and molecules in our body are moving faster.
Station 3  Liquid nitrogen experiment

1. What is in the air?  \( \text{N}_2, \text{O}_2, \text{Ar}, \text{CO}_2, \text{H}_2\text{O(g)} \) etc.

2. I don’t see anything. How can we prove air is composed of atoms and molecules?

   How about wind? Can you feel something hitting your hand when you blow on your hand?

   Show them a balloon filled with air: How does the balloon stay blown up? Atoms and molecules move, collide with the walls of the balloon, cause pressure inside the balloon.

3. Temperature at which water boils?  \( 100 \degree \text{C} \)

   Temperature at which water freezes?  \( 0 \degree \text{C} \)

   Temperature of liquid nitrogen?  \( -197 \degree \text{C} \Rightarrow \text{very cold!} \)

4. What is the fog above the liquid nitrogen? Condensed water vapor.

5. What happens to flowers or a banana when immersed in liquid nitrogen?

   How about a tennis ball? Rubber hose? What are the changes in properties?

   Have students do this.

6. What happens when we put a balloon filled with air in the hot sun? Why?

   Atoms and molecules speed up, increasing the number of collisions with the walls, increasing pressure.

7. What happens when we put a balloon filled with air in liquid nitrogen? Why? Put balloon in liquid nitrogen. Have students do this also.

   Shrinks \( \Rightarrow \) molecules slow down

8. How does a microwave heat food? Water molecules absorb radiation, excites rotational modes, water collides with other molecules in food, increases their motion (energy) \( \Rightarrow \) food is hot.

   Temperature is proportional to average kinetic energy.

9. Why does a balloon filled with helium rise?

10. At room temperature and pressure nitrogen is a gas. Put liquid nitrogen in a plastic water bottle using a funnel. Put a balloon over the top and secure balloon and bottle to ring-stand. What is happening?

    liquid nitrogen \( \Rightarrow \) nitrogen gas \( \Rightarrow \) blows up balloon

    How does it do this???

    Liquid nitrogen absorbs heat from the container and the surrounding air molecules outside the container to form the nitrogen gas. Energy is required to pull the \( \text{N}_2 \) molecules apart. It
blows up the balloon, so energy in the form of heat is converted to energy in the form of work.

\[
\text{heat} \rightarrow \text{work}
\]

11. Blow up a balloon with air (5-6 inches in diameter, not bigger!) and put it on a test tube. What is in the air that you blew into the balloon?

- N\textsubscript{2}, O\textsubscript{2}, CO\textsubscript{2}, H\textsubscript{2}O and whatever else is in the air you breathe out.

What is in between the gas molecules in air?

Nothing - it is just empty space.

How much space is between the molecules in a gas? Do an experiment to show this.

Immerse the test tube with the balloon on top in liquid nitrogen.

What will happen?

As the gas cools, the molecules slow down. The volume of the balloon decreases and eventually completely deflates.

Remove the test tube from the liquid nitrogen.

What is inside the test tube? liquid and solid

What liquids? N\textsubscript{2}(l), O\textsubscript{2} (l),

What solids? CO\textsubscript{2} (s), H\textsubscript{2}O (s)

How much space is between the liquid and solid molecules?

Not much - they are in direct contact with each other.

How does the volume of liquid and solid in the test tube compare with the volume of gas in the balloon?

The volume of liquid/solid inside the test tube is much smaller than the volume of gas in the balloon.

Thus, there is lots of space between the molecules in the gas.
**Station 4 Copper to Silver to Gold**

1. The alchemist’s dream. Talk about alchemy as you do the experiment.

2. Place polished pennies in hot 3M NaOH and powdered zinc solution (IN THE HOOD). A hot plate is used, keep solution near boiling temperature. Pennies remain in solution 2 to 3 minutes until pennies appear to be completely silver. Talk about the difference between pre-1982 and post-1982 pennies.

   Pre-1982 pennies work best because they contain a much greater percentage of copper. Post-1982 pennies are mostly zinc.

3. Remove “silver” pennies from solution using tongs and rinse them in water (use 600 mL beaker of water to cool pennies).

   The pennies are zinc plated and appear silver in color. Small chunks of zinc are usually stuck on the penny. Students take a penny to the sink and in the tub of water they use their hands to remove all the zinc chunks, until the penny is totally clean.

4. Students take their penny to a Bunsen burner. They use tongs to pick up one penny at a time (the tongs are positioned on the edges of the penny). Adult supervision is required anytime a Bunsen burner is on.

   Heat zinc plated copper pennies in the flame of a Bunsen burner. The zinc and copper atoms form brass. The copper and zinc atoms merged to produce “gold” pennies.

   Remove from heat immediately when yellow color appears and submerge the penny and tongs in the beaker of water located next to the Bunsen burner. This will cool the tongs and the penny so no one gets hurt.

**Densities of Metals**

An added activity will be to compare the mass of equal volumes of mercury and lead. Have students feel the weight of each jar to figure out which one weighs the most. Have them lift the jars only an inch up. **DO NOT let them lift the jars out of the container.** Mercury is hazardous and must be kept in the container. Have students find Mercury (Hg) and Lead (Pb) on the periodic table. Which is heavier according to the periodic table?

Let students figure out why the mercury liquid feels heavier than the lead solid when the periodic table says lead is heavier. Hopefully they will see mercury is a liquid and there is no unoccupied space between the Hg atoms. Lead is heavier. Why does the mercury feel heavier? Have them discuss this and figure it out.

**NOTE:** The amount of mercury in the vile is approximately 1 mole.
Station 5  Transport of Carbon Dioxide through a Soap Film

1) Students will see how the dry ice goes from a solid to a gas by putting a chunk of dry ice into a balloon. Stretch a balloon wide-open using both hands – put your fingers deep into the balloon to stretch it open as wide as you can. Using a pair of tongs, have a student place a small piece or a couple small pieces of dry ice in the balloon. Tie the balloon shut and watch it inflate as the dry ice sublimes (solid → gas). Students can keep the balloon.

2) You can also show how easy a chunk of dry ice "floats" on top of the counter when you give it a small push. Have students do this with dry ice, CO\textsubscript{2} (s), and regular ice, H\textsubscript{2}O (s), to see if they see a difference. The regular ice moves easily only if a pool of liquid forms.

3) In addition, to make sure students understand that dry ice is different than normal ice, H\textsubscript{2}O(s), we'll have them put universal indicator in some water in two beakers. To one beaker add an ice cube, to the other beaker add dry ice. The CO\textsubscript{2} dissolves in water to produce carbonic acid: CO\textsubscript{2} + H\textsubscript{2}O → H\textsubscript{2}CO\textsubscript{3} → H\textsuperscript{+} + HCO\textsubscript{3}-- making the solution acidic.

Students will see a color change for the dry ice / water reaction and not for the regular ice dissolving in water.

4) Then students see how air bubbles drop to the ground outside of the aquarium and float on CO\textsubscript{2} vapor in the aquarium. They will also see bubbles grow as they float.

The bottom of a 10-gallon aquarium is covered with chunks of dry ice.

If we blow bubbles with the air we breathe out, do the bubbles go up to the ceiling or down to the floor? Blow some bubbles. What do you see?

The bubbles drift down to the floor.

Blow some bubbles and catch one with the wand. Have students note the color and pattern in the soap film. Lower the captured bubble into the box of carbon dioxide gas. What happens to the size and color of the bubble? The bubble will expand, and its color pattern will change as it grows. Remove the bubble from the box and it will shrink and change color again. You can immerse and remove the bubble repeatedly.

Gently blow soap bubbles over the box so that some of them settle into the box. The bubbles will float on the carbon dioxide gas in the box. WHY do the bubbles float on the carbon dioxide gas? Ask students to watch the bubbles and make observations. Is there a change in the size or color of the bubbles?

Within several seconds the bubbles will begin to grow and change color. As they grow, they will gradually sink down into the box. Occasionally they land on the dry ice and freeze.

<table>
<thead>
<tr>
<th>What is in the air?</th>
<th>N\textsubscript{2}</th>
<th>O\textsubscript{2}</th>
<th>Ar</th>
<th>CO\textsubscript{2}</th>
<th>H\textsubscript{2}O (g)</th>
<th>etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Mass?</td>
<td>28</td>
<td>32</td>
<td>40</td>
<td>44</td>
<td>18</td>
<td>etc.</td>
</tr>
</tbody>
</table>

Why does a balloon filled with helium rise?

Helium is lighter than air. The relative mass of helium is only 4.