Gassing Copper Exploratory

In this exploratory you will get practice making a new gas (hydrogen) and observe chemical reactions between copper and both air and hydrogen.

2.2a accurately describe macroscopic phenomena
3.1D correctly apply the terms “atom” and “molecule”
3.1F make submicroscopic models of observed phenomena that are consistent with observations.
P2.4: Develop and/or use models to provide mechanistic accounts.
P6.3: Apply scientific ideas and evidence to provide an explanation of phenomena.

PROCEDURE:

**Partner “A”**: Get a gas syringe kit and lubricate the black portion of both pistons with silicone oil. Make 2 syringes full of hydrogen gas. Follow the procedure as for carbon dioxide, but use a 5 cm strip of magnesium ribbon *(record the mass)* as the solid and 3-4 mL of 2M hydrochloric acid as the liquid. ACID GLOVES REQUIRED!!! Wash the remaining acid out of the syringes by drawing up 3-5 mL of water, capping the syringe, shaking the syringe, and then squirting out the water (but not the hydrogen gas) into a sink. Repeat.

**Partner “B”**: Get a pipet-and-tube assembly. Gently push a split cork onto the assembly and use the cork to clamp the pipet horizontally to a ring stand. Set up a Bunsen burner so that the top of the burner is 4-6” below the pipet. Then get a plain syringe, and pull out the piston to 60 cc. to fill it with air.

1. **Draw and label the set-up. Record the original color of the copper turnings.**
2. With the Bunsen Burner moved away from the pipet, turn it on. Adjust the flame so the top of the flame is about 1” higher than the pipet.
3. Attach the syringe filled with air to the tubing at the end of the pipet assembly. Hold on to it so it does not swing into the flame.
4. Move the burner under the pipet so it heats the copper but does not burn the cork. Heat for 5-10 seconds and then slowly push 60 cc of air through the syringe. Then pull the flame away from the pipet and turn off the burner.
5. **What color change do you see?**
6. Repeat steps 2-4 with the syringe filled with hydrogen, then again with the second syringe of hydrogen. **What color change did you see?**
7. Wash the hydrogen syringes as for carbon dioxide, and check to be sure your kit is complete before returning it.

REFLECTION:

a) What evidence do you have that chemical reactions happened to the copper?
b) What might be happening sub-microscopically to the copper to change its color and then change it back? Draw a sub-microscopic diagram to support your idea.
c) Based on “b”, what (if any) changes in mass would you expect to see as the copper changes color to black and back to coppery red? Explain your prediction.
d) **Record notes** from the class discussion. You may wish to revise your submicroscopic ideas.

modified from Microscale Gas Chemistry, Bruce Mattson
## Gassing Copper - Mass Data

(balance precision ± 0.003 g)

<table>
<thead>
<tr>
<th>Replicate</th>
<th>Mass of Cu (g)</th>
<th>Mass of Cu after adding O₂ (g)</th>
<th>Mass of Cu after adding O₂ and H₂ (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.521</td>
<td>0.650</td>
<td>0.522</td>
</tr>
<tr>
<td>2</td>
<td>0.534</td>
<td>0.670</td>
<td>0.535</td>
</tr>
<tr>
<td>3</td>
<td>0.561</td>
<td>0.705</td>
<td>0.564</td>
</tr>
<tr>
<td>4</td>
<td>0.502</td>
<td>0.628</td>
<td>0.500</td>
</tr>
<tr>
<td>5</td>
<td>0.511</td>
<td>0.636</td>
<td>0.509</td>
</tr>
<tr>
<td>6</td>
<td>0.519</td>
<td>0.645</td>
<td>0.511</td>
</tr>
<tr>
<td>7</td>
<td>0.523</td>
<td>0.655</td>
<td>0.522</td>
</tr>
<tr>
<td>8</td>
<td>0.551</td>
<td>0.680</td>
<td>0.550</td>
</tr>
<tr>
<td>9</td>
<td>0.549</td>
<td>0.669</td>
<td>0.551</td>
</tr>
<tr>
<td>10</td>
<td>0.540</td>
<td>0.674</td>
<td>0.542</td>
</tr>
</tbody>
</table>
Teacher’s Notes:
AFTER they complete the reflection we share ideas in a googledoc. We group explanations by mass change. Then I give them the (fake) mass data on page 2 and we eliminate any models that don’t fit the data. We do nothing with those that do fit: I explain that we need more data to differentiate among these models and that this will take us a few weeks.

Here are the hypotheses generated by 3 classes in October of 2016:

**HYPOTHESES for HC Period 1 on Gassing Copper**

- something in the air is burning, and adds ash to the copper to turn it black and somehow the hydrogen absorbs or removes the ash
- the heat causes the copper and oxygen to fuse together and this makes it black; when the hydrogen comes through it replaces the oxygen but does not form a color-changing fusion
- something in the air is burning, and adds ash to the copper to turn it black but then the hydrogen burns off the ash, leaving just copper
- the copper reacts to the heat to turn black – the hydrogen and the oxygen burn at different temperatures and the different temperatures causes the different colors
- the moisture in the air and the heat rust the copper: does hydrogen gas have moisture?
- in welding there are “shielding gases”: the hydrogen could shield the copper from the moisture in the air

**HYPOTHESES for HC Period 2 on Gassing Copper**

- something in the air combines with the copper to turn it black; and
- when the hydrogen comes through it replaces the “something” and the hydrogen-copper combo is not black
- the copper is burning differently in the presence of air vs. hydrogen,
- and that produces different colors
- the oxygen and the hydrogen change the heat of burning, and the different temperatures of copper have different colors
- the copper atoms are rearranging in the presence of air and hydrogen, and the different “allotropes” have different colors

**HYPOTHESES for HC Period 3 on Gassing Copper**

- The hot air and copper turned black; the hydrogen is cooler so the color changes back. Heat makes the copper change colors.
- The copper is burning, which turns it black. The air has carbon dioxide, and the carbon bonds to the copper, making it black. The hydrogen bonds better to the carbon, so it grabs the carbon and leaves, returning the copper to its original color.
- Exposure to oxygen turns the copper black – the oxygen coats the copper or may be mixed in between the copper atoms.
  - The hydrogen replaces the oxygen, and is not black.