Virtual Lab

Separating Substances

When working with this Lab Report file, remember to save often.

PROBLEM
In this scenario, you are hired by your local government to help set up a plant that recycles waste cans. Specifically, you must identify a two-step process by which to separate aluminum cans from tin cans and to separate the tin coating from the steel of the tin cans. You will use the concepts of chemical and physical properties to produce a successful process.

Background
Every substance has chemical and physical properties and can undergo chemical and physical changes.

- A chemical property relates to a substance’s ability to undergo changes that transform it into different substances. A chemical change is where one or more substances are converted into different substances.

- A physical property is a characteristic that can be observed or measured without changing the identity of the substance. A physical change in a substance does not involve a change in the identity of the substance.

You will use the chemical and physical properties of aluminum, steel, and tin to separate aluminum and tin cans. Aluminum, steel, and tin are metals (steel is actually a metal alloy) and have similar properties; therefore, the challenge will be to choose conditions that will separate the three substances.

Steel and aluminum cans are the most recycled items because recycling these metals is very cost-effective. Aluminum cans and tin cans are easily recycled, and they can be recycled an unlimited number of times. Using recycled steel requires one-third as much energy, decreases air pollution by about 85%, and decreases water usage by about 40% when compared to using unrecycled steel. Making aluminum from recycled aluminum uses about 4% of the energy that it takes to make aluminum from ore.

PLANNING

Goal
Apply the chemical and physical properties of aluminum, steel, and tin to separate the metals by using a two-step process.

Objectives
Explore the chemical and physical properties of aluminum, steel, and tin.
Analyze these properties to produce a two-step process that separates aluminum, steel, and tin.
Evaluate the best two-step process to separate aluminum, steel, and tin.

Materials
This virtual lab requires:
- A computer or tablet capable of running the simulation.
- A sound card with speakers or headphones to play the audio.

Electrical Safety
Exercise caution when working with electrical equipment such as computers. Do not use electrical equipment with frayed or twisted wires. The area under and around electrical equipment should be dry; cords should not lie in puddles of spilled liquid.

Reality Check
The process of purifying metals by recycling plants has been simplified for the purposes of this lab. For example, during the real process, other materials may be grouped with the aluminum and tin cans, such as plastics. Furthermore, the lab does not take into account any paper, labels, or waste that come with the cans. These things can be removed by chemical reactions or through filtration.
The procedures shown in this lab are not suitable for a real-world experiment. The temperatures and solutions used in this lab require more complicated and expensive equipment than is available in high-school science laboratories.

Your Plan
1. Adjust or replace the following sample procedure to suit your plan for performing the virtual lab. You can also edit the data tables in Observations. For example, you might paste in more rows for more observations. For information about how to make a screen shot of the virtual lab to paste into this Lab Report, click Help in the virtual lab.

   a. Determine whether the properties are chemical or physical.

   b. Subject each metal to various conditions (heat the metals to determine if they will melt at various temperatures, try to attract the metals with a magnet, try to dissolve the metals in an acidic solution, try to dissolve the metals in a basic solution, and try to determine if any metal will float in water).

   c. Record observations in the data table.

   d. Analyze the observations to produce a two-step process to separate aluminum and tin cans into three metals.

   e. Evaluate the two-step process and produce other possible processes.
2a. **Evaluating Your Plan** What order will you test the conditions in?

2b. What observations will you need to make for each test? Will they all be the same?

**OBSERVATIONS (PERFORM)**
Select one of these data table options and adjust it suit your plan for performing this activity. Alternatively, you can delete all these tables and set up your own approach for recording data. Once a table fits your plan, you can copy and paste it into this Lab Report as many times as you will need it for your multiple trials.

**Data Table Option A**
<table>
<thead>
<tr>
<th>Metal</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>aluminum</td>
<td></td>
</tr>
<tr>
<td>steel</td>
<td></td>
</tr>
<tr>
<td>tin</td>
<td></td>
</tr>
</tbody>
</table>

**Data Table Option B**
<table>
<thead>
<tr>
<th>Test</th>
<th>Observations for aluminum</th>
<th>Observations for steel</th>
<th>Observations for tin</th>
</tr>
</thead>
<tbody>
<tr>
<td>acidic solution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>basic solution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>magnet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>temperature 300 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>temperature: 700 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>temperature: 1500 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>water</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ANALYSIS AND INTERPRETATIONS

3. **Determining a Two-Step Process** What two-step process separated the cans into aluminum, steel, and tin?

SUMMARY AND CONCLUSION

4. **Results** Explain which properties of the metals were used in your proposed separation process.

5. **Reflections** Explain whether or not the order of the steps mattered for your process.

6. **Conclusions** Explain how you used your observations to settle on a proposed two-step separation plan.

EXTEND

7. **Identifying Other Options** Identify other two-step processes to isolate the metals.

8. **Evaluating Different Processes** Of all the approaches you identified, which would you recommend, and why?