Identification and Characterization of Unknowns

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Intensive Properties for Identifying Unknowns

- *Intensive properties* are independent of the amount of substance. The value does not change with added mass or volume.

- Texture
- Polarity
- Color
- Solubility
- Melting Point/Boiling Point
- Density
- Refractive Index
- Electrical Conductivity
- Spectral data
Extensive Properties

- *Extensive properties* depend on the amount of a substance. The more of a substance you have, the larger the value. Extensive properties must NOT be used to ID unknowns.

- mass
- Volume
- shape
- Amount
- Thickness
- Energy
Identification of Unknowns

- **Goal:** Identification of unknown substances based on the intensive properties: solubility, density, melting/boiling points.
- **Hypotheses:** The intensive properties of a substance do not change with mass or volume.
- **There are 3 unknowns in this experiment.**
  1. Find the unknown # required on the quiz and identify that unknown
  2. Solid Unknown, select from bottles according to Last Name
     - A-D Solid 1
     - E-H Solid 2
     - I-M Solid 3
     - N-R Solid 4
     - S-U Solid 5
     - V-Z Solid 6
  3. Liquid Unknown, select from bottles according to Last Name
     - A-D Liquid 7
     - E-H Liquid 8
     - I-M Liquid 9
     - N-R Liquid 10
     - S-Z Liquid 11
Solubility

• The solubility of a substance in a pure solvent is the weight of that substance that will dissolve in a given volume (usually 100 mL) of that solvent at 25 °C.

• Many Ionic Compounds dissolve in Water as both are polar ex. AgNO$_3$. Not all ionic compounds are soluble ex. CaCO$_3$ or marble.
  
  – AgNO$_3$ is ionic and very soluble. 225g/100 mL
  – CaCO$_3$ is ionic but insoluble 0.00 g/ 100 mL water
Solubility Experiment

• Add 10.0 mL of water to test tube
• Take the Unknown and add 1.0 g of the unknown to the test tube containing water.
• Observe – Take Lab Notes
• Keep adding 1 g at a time until you get to 5.0 g.
• Use the legend to classify the solubility:
  • If Solid persists after
    1 g – insoluble
    2-4.9 g – slightly soluble
    5.0 g – very soluble
Measure Density as in Density Expt.

Density = Mass/Volume
Melting Point Experiment

- Melting Point is the Temperature at which a solid melts to a liquid at Atmospheric Pressure (i.e. 1 atm)
- Add 5.0 g solid Unknown to test tube and heat.
- The melting point occurs when the solid melts into a liquid. The temperature remains constant for a few moments at this point.
- Record Temperature
- Zoom to see melting and take notes
Compare with Known Literature Values to Identify Unknown

- The Data of Intensive Properties for solids is provided in the Background.
- Identify the compound that has the closest physical properties to your Unknown.
- Make sure you mention the unknown #

### Table of Solid Compounds

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
<th>Density (g/mL)</th>
<th>Solubility (g/100 mL)</th>
<th>Melting Point (°C)</th>
<th>Boiling Point (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver Nitrate</td>
<td>AgNO₃</td>
<td>3.50</td>
<td>235</td>
<td>212</td>
<td>227</td>
</tr>
<tr>
<td>BHT</td>
<td>C₁₅H₂₄O₉</td>
<td>1.05</td>
<td>0</td>
<td>71</td>
<td>265</td>
</tr>
<tr>
<td>Ascorbic Acid</td>
<td>C₆H₈O₆</td>
<td>1.7</td>
<td>40</td>
<td>168</td>
<td>347</td>
</tr>
<tr>
<td>Calcium Carbonate</td>
<td>CaCO₃</td>
<td>2.71</td>
<td>0</td>
<td>1330</td>
<td>4727</td>
</tr>
<tr>
<td>Calcium Sulfate</td>
<td>CaSO₄</td>
<td>2.96</td>
<td>0.21</td>
<td>1193</td>
<td>1460</td>
</tr>
<tr>
<td>Cobalt Chloride</td>
<td>CoCl₂</td>
<td>3.36</td>
<td>56.2</td>
<td>740</td>
<td>1049</td>
</tr>
<tr>
<td>Zinc Nitrate</td>
<td>Zn(NO₃)₂</td>
<td>2.00</td>
<td>120</td>
<td>110</td>
<td>131</td>
</tr>
</tbody>
</table>
Identifying Liquids - Boiling Point

• Boiling Point is the Temperature at which a Liquid boils to vapor at Atmospheric Pressure (1 atm).
• The boiling point occurs when the temperature remains constant momentarily and the liquid turns to a vapor.
• You should be able to see some vapors rising from the test tube.
• Record Temperature
• Zoom and take Lab Notes
Finding the Density of a Liquid

- Follow Procedure in the Density Experiment
- Weigh the Graduated cylinder empty
- Weigh it with 10.0 mL of your unknown
- Density = mass/Volume
- Identify the compound that has the closest physical properties to your Unknown.
- Make sure you mention the unknown #
Compare with Literature Values to Identify the Liquid Unknown

Table of Liquid Compounds

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
<th>Density (g/mL)</th>
<th>Boiling Point (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic Acid</td>
<td>C₂H₄O₂</td>
<td>1.05</td>
<td>117.9</td>
</tr>
<tr>
<td>Acetonitrile</td>
<td>C₂H₃N</td>
<td>0.79</td>
<td>81.6</td>
</tr>
<tr>
<td>Cyclohexane</td>
<td>C₆H₁₂</td>
<td>0.078</td>
<td>80.7</td>
</tr>
<tr>
<td>Cyclopentylamine</td>
<td>C₅H₁₁N</td>
<td>0.86</td>
<td>107.0</td>
</tr>
<tr>
<td>Ethanol</td>
<td>C₂H₆O</td>
<td>0.79</td>
<td>78.3</td>
</tr>
</tbody>
</table>
Assignment: Short Answer Questions

1. Record the three intensive properties of the solid substance - solubility in water, density and melting point.

Soluble or insoluble in water?

density = ?

melting point = ?

2. Identify the unknown solid from the chart of solid substances in the Background section of the lab manual.
Assignment: Short Answer Questions contd.

• 1. Record the 2 intensive properties of the liquid substance - density and boiling point.
  • density = ?
  • boiling point = ? °C

2. Identify the unknown liquid from the chart of liquid substances in the Background section of the lab manual.
Take the Quiz

• Best Wishes!