1. A chemist heats a sample of liquid bromine in a sealed closed container. Liquid bromine is the standard state form of bromine. Here are her observations: (25)

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Br₂ (l) → Br₂ (g) → Br (g)
dark orange liquid orange gas colorless gas
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For this two-step process above address the following questions:

What is happening as heat is added to the test tube?

How does the enthalpy change? Explain what is going on at the molecular level.

How does the entropy change? Explain what is going on at the molecular level.

Does the mass of the test tube change? Explain.

Could this process ever be spontaneous? Explain.
2. Predict the mode of radioactive decay for the following nuclides. Write a balance decay reaction for each. (15)

<table>
<thead>
<tr>
<th>Nuclide</th>
<th>Stable isotope</th>
<th>Decay reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{122}$I</td>
<td>$^{127}$I</td>
<td></td>
</tr>
<tr>
<td>$^{290}$Th</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>$^{186}$Ta</td>
<td>$^{181}$Ta</td>
<td></td>
</tr>
</tbody>
</table>

3. How long would it take to deposit 14 grams of aluminum from a solution of Al$^{3+}$ if the current in the cell is 300 amps? (15)

4. Construct a battery, a common galvanic cell, from the following two half-cells. Write a balanced reaction, identity the anode and cathode, and calculate the voltage of the battery. (15)

$$\text{Li}^+ + e^- \rightarrow \text{Li} \quad E^0 = -3.05 \text{ v}$$

$$\text{F}_2 + 2e^- \rightarrow 2\text{F}^- \quad E^0 = 2.87 \text{ v}$$