(1) Review Problems: context for today vs. Wednesday
(2) Specific Heats and Latent Heats
(3) Problems to work on (Calorimetry)

2. Solids & Liquids: $W \approx 0$
   
   $Q = \Delta E_{th} \propto \Delta T$

   $Q = mc \Delta T$

   $Q = m \cdot L_f$

   $1, 2, 5$

   1, 4 are phase changes

   $Q = mL$
A gas undergoes a process in which 30 J of heat is added to the gas yet its temperature goes down. Which of the below best describes what’s going on with the volume of the gas?

A) The gas definitely expands.
B) The gas definitely contracts.
C) The gas could have expanded or contracted; there isn’t enough info.

Take the following first-law bar chart, and sketch a possible process on a pV diagram.
Suppose you have 1 Joule of energy to give to a substance via heat. A temperature vs. heat-added graph for the substance is given. Which phase should you give the energy to the object to get the largest \( \Delta T \)?

A) Solid  
B) Liquid  
C) Gas  
D) I dunno

\[ Q = mc \Delta T \]

The specific heat of water is 4.19 kJ / (kg K) and the heat of fusion of water is 333 kJ / kg. Suppose you have 1kg of ice at its melting point, and 1kg of water at temperature \( T_i \). What should \( T_i \) be so that, when mixed, you have a pool of water (in equilibrium) at its freezing point?

A) 7°C  
B) 13°C  
C) 20°C  
D) 93°C  
E) None of the above is close

\[ 333 \text{kJ} = (1\text{kg})(4.19 \frac{\text{kJ}}{\text{kg K}}) \Delta T \]

\[ \Delta T = \frac{333 \text{kJ}}{4.19 \frac{\text{kJ}}{\text{kg K}}} = 79°C \]
21. 30 g of copper pellets are removed from a 300°C oven and immediately dropped into 100 mL of water at 20°C in an insulated cup. What will the new water temperature be?

**TABLE 19.2** Specific heats and molar specific heats of solids and liquids

<table>
<thead>
<tr>
<th>Substance</th>
<th>(c) (J/kg K)</th>
<th>(C) (J/mol K)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Solids</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td>900</td>
<td>24.3</td>
</tr>
<tr>
<td>Copper</td>
<td>385</td>
<td>24.4</td>
</tr>
<tr>
<td>Iron</td>
<td>449</td>
<td>25.1</td>
</tr>
<tr>
<td>Gold</td>
<td>129</td>
<td>25.4</td>
</tr>
<tr>
<td>Lead</td>
<td>128</td>
<td>26.5</td>
</tr>
<tr>
<td>Ice</td>
<td>2090</td>
<td>37.6</td>
</tr>
<tr>
<td><strong>Liquids</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethyl alcohol</td>
<td>2400</td>
<td>110.4</td>
</tr>
<tr>
<td>Mercury</td>
<td>140</td>
<td>28.1</td>
</tr>
<tr>
<td>Water</td>
<td>4190</td>
<td>75.4</td>
</tr>
</tbody>
</table>

\[30g \text{ Cu} @ 300^\circ C\]

\[100g = 100\text{ mL water} @ 20^\circ C\]

\[t_f = ?\]

Assume \(20^\circ C < t_f < 100^\circ C\) (no phase changes)

\[Q_{\text{Cu cool}} + Q_{\text{H}_2\text{O warm}} = 0\]

\[m_{\text{Cu}} C_{\text{Cu}} (t_f - 300^\circ C) + m_{\text{H}_2\text{O}} C_{\text{H}_2\text{O}} (t_f - 20^\circ C) = 0\]

\[t_f = 27.5^\circ C\]
20. An experiment measures the temperature of a 500 g substance while steadily supplying heat to it. **FIGURE EX19.20** shows the results of the experiment. What are the (a) specific heat of the solid phase, (b) specific heat of the liquid phase, (c) melting and boiling temperatures, and (d) heats of fusion and vaporization?

(Solution to Exercise 19.20 from our textbook is given in HW Solutions on class website.)