**Calorimetry Worksheet**

When energy is transferred to an object of mass $m$ in the form of heat transfer $Q$, the magnitude of the object’s temperature change $\Delta T$ depends on its specific heat $c$, a quantity that is characteristic of the material: $\Delta T = \frac{Q}{mc}$. If heat transfer is positive ($Q > 0$), the object’s temperature increases ($\Delta T > 0$).

3. Suppose we have two samples, $A$ and $B$, of the **same** material placed in a partitioned insulated container which neither absorbs energy nor allows it to pass in or out. Sample $A$ has the **same** mass as sample $B$. Energy but no material can pass through the conducting partition. (Assume specific heat is independent of temperature.)

   a. A long time after time zero, what ratio do you expect for the temperatures of the two samples?
      \[
      \frac{T_A}{T_B} = \text{_____}\?
      \]
      Explain your answer.

   b. Complete the bar charts below for temperature and energy transfer. If any quantity is zero, label that quantity as zero on the bar chart. Explain your reasoning below.

**Energy Transfer to Sample:**

<table>
<thead>
<tr>
<th></th>
<th>$A$</th>
<th>$B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$+4 \text{ kJ}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$+2 \text{ kJ}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$0 \text{ kJ}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$-2 \text{ kJ}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$-4 \text{ kJ}$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Absolute Temperature**

<table>
<thead>
<tr>
<th></th>
<th>$A$</th>
<th>$B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Zero</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long After</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Suppose we have two samples, \( A \) and \( B \), of the same material placed in a partitioned insulated container which neither absorbs energy nor allows it to pass in or out. Sample \( A \) has **three times** the mass of sample \( B \). Energy but no material can pass through the conducting partition. (Assume specific heat is independent of temperature.)

![Partitioned Insulated Container Diagram]

a. If the thermal energy of sample \( A \) changes by an amount \( \Delta E_{th0} \) (absolute value), what is the amount of thermal energy change (absolute value) of sample \( B \)?

b. If the temperature of sample \( A \) changes by \( \Delta T_A \), what would be the corresponding change in the temperature of sample \( B \)? \( \Delta T_B = \) _________? (Check that the sign of your answer is correct.)

c. Complete the bar charts below for temperature and energy transfer. If any quantity is zero, label that quantity as zero on the bar chart. Explain your reasoning below.

**Energy Transfer to Sample:**

- \( +4 \text{ kJ} \)
- \( +2 \text{ kJ} \)
- \( 0 \text{ kJ} \)
- \( -2 \text{ kJ} \)
- \( -4 \text{ kJ} \)

**Absolute Temperature**

- \( +4 \text{ kJ} \) For \( A \) and \( B \)
- \( +4 \text{ kJ} \) For \( A \) and \( B \)
5. Suppose we have two samples, A and B, of different materials, placed in a partitioned insulated container which neither absorbs energy nor allows it to pass in or out. Sample A has the same mass as sample B. Energy but no material can pass through the conducting partition. (Assume specific heat is independent of temperature.) The specific heat of material A is twice that of material B.

![Diagram of samples A and B in a partitioned insulated container]

a. If the temperature of sample A changes by $\Delta T_A$, what would be the corresponding change in the temperature of sample B? $\Delta T_B =$ ____________? Explain your answer.

b. Complete the bar charts below for temperature and energy transfer. If any quantity is zero, label that quantity as zero on the bar chart. Explain your reasoning below.

---

**Energy Transfer to Sample:**

- + 4 kJ
- + 2 kJ
- 0 kJ
- − 2 kJ
- − 4 kJ

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
</tr>
</thead>
</table>

**Absolute Temperature**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
</tr>
</thead>
</table>

Time Zero | Long After
6. Suppose we have two samples, \( A \) and \( B \), of different materials, placed in a partitioned insulated container which neither absorbs energy nor allows it to pass in or out. Sample \( A \) has 1.5 times the mass of sample \( B \). Energy but no material can pass through the conducting partition. (Assume specific heat is independent of temperature.) The specific heat of material \( B \) is twice that of material \( A \).

![Diagram of samples A and B in a partitioned container](image)

a. If the temperature of sample \( A \) changes by \( \Delta T_A \), what would be the corresponding change in sample \( B \)?

\[
\Delta T_B = \ldots
\]

Explain your answer.

b. Complete the bar charts below for temperature and energy transfer. If any quantity is zero, label that quantity as zero on the bar chart. Explain your reasoning below.

![Energy Transfer to Sample Chart](chart)

![Absolute Temperature Chart](chart)
Specific Heat and Latent Heat

100 grams of ice, with a temperature of –10°C, is added to a styrofoam cup of water. The water is initially at +10°C, and has an unknown mass $m$. If the final temperature of the mixture is 0°C, what is the unknown mass $m$? Assume that no heat is exchanged with the cup or with the surroundings. Use these approximate values to determine your answer:

Specific heat of liquid water is about 4000 J/(kg °C)
Specific heat of ice is about 2000 J/(kg °C)
Latent heat of fusion of water is about 3 x 10^5 J/kg

Hint: there is more than one possible answer for $m$ – find the range of possible answers for $m$. 