This print-out should have 8 questions. Multiple-choice questions may continue on the next column or page — find all choices before answering. The due time is Central time.

1. **Msci 15 0108**
   19:03, general, multiple choice, > 1 min, .
   001
   If a system absorbs heat and also does work on its surroundings, its energy

   1. must increase.
   2. must decrease.
   3. must not change.
   4. may either increase or decrease, depending on the relative amounts of heat absorbed and work done. **correct**

   **Explanation:**
   \[
   \Delta E = q + w
   \]
   
   \( q > 0 \) because heat is absorbed and \( w < 0 \) because the system does work on its surroundings. Therefore \( \Delta E = (+) + (-) \). \( \Delta E \) can be positive only if \( q > w \), and negative only if \( w > q \).

2. **ChemPrin3e T06 14**
   19:03, general, multiple choice, < 1 min, .
   002
   A system had 150 kJ of work done on it and its internal energy increased by 60 kJ. How much energy did the system gain or lose as heat?

   1. The system lost 90 kJ of energy as heat. **correct**
   2. The system lost 210 kJ of energy as heat.
   3. The system gained 60 kJ of energy as heat.
   4. The system gained 90 kJ of energy as heat.
   5. The system gained 210 kJ of energy as heat.

   **Explanation:**
   
   **DAL Thermo Instability**
   20:06, general, multiple choice, > 1 min, .
   003
   Consider the following compounds and their thermodynamic data:

<table>
<thead>
<tr>
<th>Compound</th>
<th>( \Delta H_f^\circ ) (kJ/mol)</th>
<th>( S^\circ ) (J/mol·K)</th>
<th>( \Delta G_f^\circ ) (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH₄</td>
<td>-75</td>
<td>186</td>
<td>-50</td>
</tr>
<tr>
<td>CH₂O</td>
<td>-108</td>
<td>218</td>
<td>-102</td>
</tr>
<tr>
<td>C₆H₅NH₂</td>
<td>87</td>
<td>166</td>
<td>319</td>
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<tr>
<td>C₂H₄</td>
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<td>219</td>
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   Using this data, which of the following answers includes the compounds that are thermodynamically unstable?

   1. CH₄, CH₂O, C₂H₄
   2. CH₂O, C₆H₅NH₂
   3. CH₄, C₂H₄
   4. C₆H₅NH₂, C₂H₄ **correct**
   5. Cannot be determined from the data provided.
   6. All of the compounds are thermodynamically stable.

   **Explanation:**

3. **ChemPrin3e T07 15**
   20:04, general, multiple choice, < 1 min, .
   004
   The enthalpy of fusion of H₂O(s) at its normal melting point is 6.01 kJ · mol⁻¹. What is the entropy change for freezing 1 mole of water at this temperature?

   1. +20.2 J · K⁻¹ · mol⁻¹
   2. 0 J · K⁻¹ · mol⁻¹
   3. −20.2 J · K⁻¹ · mol⁻¹

   **Explanation:**

4. **ChemPrin3e T09 15**
   20:06, general, multiple choice, > 1 min, .
   005
   Consider the following compounds and their thermodynamic data:

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   Using this data, which of the following answers includes the compounds that are thermodynamically unstable?

   1. CH₄, CH₂O, C₂H₄
   2. CH₂O, C₆H₅NH₂
   3. CH₄, C₂H₄
   4. C₆H₅NH₂, C₂H₄ **correct**
   5. Cannot be determined from the data provided.
   6. All of the compounds are thermodynamically stable.

   **Explanation:**

5. **ChemPrin3e T09 16**
   20:07, general, multiple choice, > 1 min, .
   006
   The enthalpy of fusion of H₂O(s) at its normal melting point is 6.01 kJ · mol⁻¹. What is the entropy change for freezing 1 mole of water at this temperature?

   1. +20.2 J · K⁻¹ · mol⁻¹
   2. 0 J · K⁻¹ · mol⁻¹
   3. −20.2 J · K⁻¹ · mol⁻¹

   **Explanation:**
4. $+22.0 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$

5. $-22.0 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$ correct

Explanation:

The temperature of 2.00 mol Ne(g) is increased from 25°C to 200°C at constant pressure. Assume the heat capacity of Ne is 20.8 J/K-mol. Calculate the change in the entropy of neon. Assume ideal behavior.

1. $+7.68 \text{ J} \cdot \text{K}^{-1}$

2. $+19.2 \text{ J} \cdot \text{K}^{-1}$ correct

3. $-7.68 \text{ J} \cdot \text{K}^{-1}$

4. $-19.2 \text{ J} \cdot \text{K}^{-1}$

5. $+9.60 \text{ J} \cdot \text{K}^{-1}$

Explanation:

If you have an endothermic process in which the change in entropy is positive, how can you make it spontaneous?

1. Increasing the pressure

2. Decreasing the volume

3. Increasing the temperature correct

4. Decreasing the temperature

5. Reducing the entropy change

Explanation:

$\Delta G = \Delta H - T \Delta S$

$\Delta H > 0$ for endothermic processes.

$\Delta G < 0$ for spontaneous processes.

$T$ is always positive, so

$$\Delta G = \Delta H - T \Delta S = (+) - T \Delta S$$

$\Delta G$ is negative if $T$ is very large, so increasing the temperature makes the process endothermic.

If you have an endothermic process in which the change in entropy is positive, how can you make it spontaneous?

1. Increasing the pressure

2. Decreasing the volume

3. Increasing the temperature correct

4. Decreasing the temperature

5. Reducing the entropy change

Explanation:

$$\Delta H_{\text{rxn}} = \sum n \Delta H_{f, \text{prod}} - \sum n \Delta H_{f, \text{rect}}$$

$$= 0 \text{ kJ/mol} - 2(-30.57 \text{ kJ/mol})$$

$$= 61.14 \text{ kJ/mol}$$

$$\Delta S_{\text{rxn}} = \sum n \Delta S_{f, \text{prod}} - \sum n \Delta S_{f, \text{rect}}$$

$$= [4(42.55 \text{ J/mol} \cdot \text{K})$$

$$+ (205.0 \text{ J/mol} \cdot \text{K})]$$
\[
- 2(121.7 \text{ J/mole} \cdot \text{K}) \\
= 131.8 \text{ J/mole} \cdot \frac{\text{kJ}}{1000 \text{ J}} \\
= 0.1318 \text{ kJ/mole} \cdot \text{K}
\]

\[
\Delta G = \Delta H - T \Delta S \\
= (+61.14 \text{ kJ/mole}) \\
- (298 \text{ K})(0.1318 \text{ kJ/mole} \cdot \text{K}) \\
= 21.8636 \text{ kJ/mole rxn}
\]

**ChemPrin3e T07 42**
20:04, general, multiple choice, < 1 min, .

**008**
The entropy of fusion of water is +22.0 J·K\(^{-1}\)·mol\(^{-1}\) and the enthalpy of fusion of water is +6.01 kJ·mol\(^{-1}\) at 0°C. What is \(\Delta S_{\text{total}}\) for the melting of ice at 0°C?

1. \(-6010 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}\)
2. 0 correct
3. \(-22.0 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}\)
4. +6010 J·K\(^{-1}\)·mol\(^{-1}\)
5. +22.0 J·K\(^{-1}\)·mol\(^{-1}\)

Explanation: