1. Answer the questions below for each of the following reaction coordinate diagrams:

   ![Reaction Coordinate Diagrams]

   a) Is the reaction exothermic or endothermic?

   b) What is the sign of $\Delta H$?

   c) Is heat absorbed or released?

   d) What happens to the temperature of the surroundings?

   e) What does the asterisk (*) at the top of the hill represent?

2. Based on the following equation:

   $$2 \text{C}_2\text{H}_5\text{OH} \ (l) + 9 \text{O}_2 \ (g) \rightarrow 6 \text{CO}_2 \ (g) + 8 \text{H}_2\text{O} \ (g) + \text{heat}$$

   a) Is this reaction exothermic or endothermic? (circle one)

   b) Is the entropy (randomness) of the system increasing or decreasing? (circle one)

   c) Label the sign (+ or −) of each variable in the equation below. If $\Delta G$ depends on the temperature, enter a question mark (?)

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

   $$= (\ ) - (\ ) (\ )$$

   d) At what temperatures is the reaction above spontaneous? (circle one)

   at all temperatures (always spontaneous) only spontaneous at high temperatures only spontaneous at low temperatures at no temperatures (never spontaneous)
3. Based on the following equation:

\[ \text{NH}_4\text{Cl}^{(s)} + \text{heat} \rightarrow \text{NH}_4^{+}^{(aq)} + \text{Cl}^{-}^{(aq)} \]

a) Is this reaction exothermic or endothermic? (circle one)

b) Is the entropy (randomness) of the system increasing or decreasing? (circle one)

c) Label the sign (+ or –) of each variable in the equation below. If \( \Delta G \) depends on the temperature, enter a question mark (?).

\[ \Delta G = \Delta H - T \Delta S \]

\[ (\ ) = (\ ) - (\ ) (\ ) \]

d) At what temperatures is the reaction above spontaneous? (circle one)

<table>
<thead>
<tr>
<th>at all temperatures</th>
<th>only spontaneous at high temperatures</th>
<th>only spontaneous at low temperatures</th>
<th>at no temperatures</th>
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4. What is the fuel value (in kcal/g food) of a food item if 15.00 g of the food is burned in a bomb calorimeter and the temperature of the enclosed 5000.0 g water increases by 22.31°C? (the specific heat of water \( C_w \) is \( 10^{-3} \) kcal/g°C exactly)

Answer: ________________

5. Fill in the “stress, shift, equilibrium” diagram for the following reaction, which has been knocked out of equilibrium by increasing the volume of the container. Use appropriate size arrows.

\[ \text{N}_2^{(g)} + 3 \text{H}_2^{(g)} \rightleftharpoons 2 \text{NH}_3^{(g)} \]

Stress:

\[ \text{N}_2^{(g)} + 3 \text{H}_2^{(g)} \]

Shift:

Equilibrium: