3. Answer the following questions about glucose, $C_6H_{12}O_6$, an important biochemical energy source.

(a) Write the empirical formula of glucose.

In many organisms, glucose is oxidized to carbon dioxide and water, as represented by the following equation.

$$C_6H_{12}O_6(s) + 6\ O_2(g) \rightarrow 6\ CO_2(g) + 6\ H_2O(l)$$

A 2.50 g sample of glucose and an excess of $O_2(g)$ were placed in a calorimeter. After the reaction was initiated and proceeded to completion, the total heat released by the reaction was calculated to be 39.0 kJ.

(b) Calculate the value of $\Delta H°$, in kJ mol^{-1}, for the combustion of glucose.

(c) When oxygen is not available, glucose can be oxidized by fermentation. In that process, ethanol and carbon dioxide are produced, as represented by the following equation.

$$C_6H_{12}O_6(s) \rightarrow 2\ C_2H_5OH(l) + 2\ CO_2(g) \qquad \Delta H° = -68.0 \text{ kJ mol}^{-1} \text{ at } 298 \text{ K}$$

The value of the equilibrium constant, K_p, for the reaction at 298 K is 8.9×10^{39}.

(i) Calculate the value of the standard free-energy change, $\Delta G°$, for the reaction at 298 K. Include units with your answer.

(ii) Calculate the value of the standard entropy change, $\Delta S°$, in J K^{-1} mol^{-1}, for the reaction at 298 K.

(iii) Indicate whether the equilibrium constant for the fermentation reaction increases, decreases, or remains the same if the temperature is increased. Justify your answer.

(d) Using your answer for part (b) and the information provided in part (c), calculate the value of $\Delta H°$ for the following reaction.

$$C_2H_5OH(l) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 3\ H_2O(l)$$

S T O P

If you finish before time is called, you may check your work on this part only.
Do not turn to the other part of the test until you are told to do so.