

Chemistry 14B: Week 7 Workshop Midterm Review

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Q1. ATP hydrolysis, $\text{ATP} + \text{H}_2\text{O} \rightarrow \text{ADP} + \text{HPO}_4^{2-}$, is a highly exergonic reaction that provides the energy necessary for most endergonic biological processes to occur. $\Delta G^\circ = -30.2 \text{ kJ/mol}$.

a) Calculate the equilibrium constant for ATP hydrolysis at 25°C .

b) If the concentration of ATP is adjusted to four times its equilibrium concentration, what is the value of ΔG ?

Q2A. Calculate the work, in kJ, associated with the isothermal, reversible expansion of 1.00 mol of an ideal gas from 7.00 L to 15.50 L at 25.0°C.

Q2B. Calculate the work, in kJ, associated with the irreversible adiabatic expansion of the sample of gas described in part A against a constant atmospheric pressure of 760. Torr.

Q2C. Calculate the final temperature of the gas in part B.

Q3.

- a) The photosynthesis of glucose inside the chloroplast of an old growth Coastal Redwood tree.

$$\Delta G < 0$$

$$\Delta G = 0$$

$$\Delta G > 0$$

- b) The cooling of a hot bowl of soup after being removed from the microwave.

$$\Delta G < 0$$

$$\Delta G = 0$$

$$\Delta G > 0$$

- c) The rusting of an iron fence as it is left outside over time.

$$\Delta G < 0$$

$$\Delta G = 0$$

$$\Delta G > 0$$

Q4. Calculate the change in molar Gibbs free energy for the process $\text{NH}_3(\text{l}) \rightarrow \text{NH}_3(\text{g})$ at 1 atm and (a) -15.0°C and (b) -45.0°C . In each case, indicate whether vaporization would be spontaneous. $\Delta H_{\text{vap}} = 23.4 \text{ kJ/mol}$, $\Delta S_{\text{vap}} = 97.6 \text{ J/K}\cdot\text{mol}$

Q5. The compound P_4O_{10} is often used to adsorb water vapor in dry boxes by the following reaction: $6\text{H}_2\text{O} (\text{g}) + \text{P}_4\text{O}_{10} (\text{s}) \rightarrow 4\text{H}_3\text{PO}_4 (\text{s})$

	$\Delta S^\circ (298\text{K}) \text{ J/K}\cdot\text{mol}$	$\Delta H_f^\circ (298\text{K}) \text{ kJ/mol}$
$\text{H}_3\text{PO}_4 (\text{s})$	110.5	-1279
$\text{P}_4\text{O}_{10} (\text{s})$	228.9	-2984
$\text{H}_2\text{O} (\text{g})$	188.7	-241.8

- a) Calculate ΔG° and K at 25.0°C and decide whether the reaction is spontaneous in the forward direction.

- b) The $\text{P}_4\text{O}_{10} (\text{s})$ is regenerated by heating the $\text{H}_3\text{PO}_4 (\text{s})$ and removing the water. To what temperature should the $\text{H}_3\text{PO}_4 (\text{s})$ be heated (i.e. at what temperature does the reaction become spontaneous in the reverse direction)? What assumption are you making to solve this problem?

Q6A. Determine which of the following two molecules has a higher residual entropy. Calculate the residual entropy for 1 mole at 0K.



Q6B. 1.00 mole of He is held inside a 1.00L closed glass jar at 25.0°C (room temperature). The jar is left on top of the stove until the He is heated to 100.0°C. Calculate the change in entropy associated with this process and the heat required to heat the gas.

Q7. A student leaves a bowl of 56 grams of ice cream sitting out in the hot sun. The heat completely melts the ice cream and raises its temperature to 30.0°C. Assuming that the ice cream was initially completely solid and at its freezing point (0.0°C), how much energy was supplied to the ice cream?

Enthalpy of fusion of ice cream = 210. J/g; Specific heat capacity of liquid ice cream = 3.1 J/g*°C