Chem 10123, Quiz 6 **Answer Key**
March 18, 2020

1. (6 points) **SHOW ALL WORK.** A gas is compressed from an initial volume of 4.50 L to a final volume of 1.20 L by an external pressure of 2.5 atm. During the compression, the gas releases 225 J of heat. Determine the change in the internal energy of the system in joules. (1 L·atm = 101.3 J).

   $\Delta E = q + w$ $q = -225$ J (heat is lost by the system)

   $w = -P\Delta V = -(2.5 \text{ atm})(1.2 \text{ L} - 4.5 \text{ L}) = 8.25$ L·atm (work is done on the system)

   $\Delta E = -225 \text{ J} + (8.25 \text{ L·atm})(101.3 \text{ J / L·atm}) = 611$ J

2. (4 points) In the following statement, fill in the blanks with the relevant thermodynamic terms, e.g., ΔG, ΔH, ΔS, R, and/or combinations of them.

   If the equilibrium constant (K) for a reaction is measured at various temperatures (T), a plot of ln K on the y-axis vs 1/T on the x-axis should be a straight line in which the slope = $-\Delta H/R$ and the y-intercept = $\Delta S/R$.

3. (10 points) **SHOW ALL WORK.** Consider the following gas-phase reaction and the related thermodynamic data. Determine the equilibrium constant (K_p) for this reaction at a temperature of 450 K.

Compound	$\Delta H°_f$ (kJ/mole)	S° (J/mole·K)
$CO_{2(g)}$	- 393.5	213.8
$CCl_{4(g)}$	- 95.7	309.7
$COCl_{2(g)}$	- 219.1	283.5

$\Delta H° = 2(-219.1) - [(-393.5) + (-95.7)] = 51.0$ kJ

$\Delta S° = 2(283.5) - [213.8 + 309.7] = 43.5$ J/K $= 0.0435$ kJ/K

Since ΔH° and ΔS° are relatively independent of temp, they can be used to estimate ΔG and K at another temp.

$\Delta G = \Delta H° - T\Delta S° = 51.0 \text{ kJ} - (450 \text{ K})(0.0435 \text{ kJ/K}) = 31.42$ kJ

$\Delta G = -RT\ln K$

$\ln K = -\Delta G/RT = -(31.42 \text{ kJ}) / (8.314 \times 10^{-3} \text{ kJ/mole·K})(450 \text{ K}) = -8.40$

$K = 2.25 \times 10^{-4}$