CHEM442-001/002 Name _________________________________

College of Charleston

Spring 2001

Exam I Score ___________ /100

1(15). Suppose $\Delta_r G = J + KT - \Delta a\, T \ln T - (\Delta b/2)T^2 - (\Delta c/6)T^3 - (\Delta c'/2)T^{-1}$ is known for the reaction A → B. ***Explain*** how you can find the temperature at which the reaction

A) reaches equilibrium.

B) is most spontaneous.

Suppose $\Delta_r G = \mathscr{J} + \mathscr{K}T - \Delta \mathscr{a}\, T \ln T - (\Delta \mathscr{b}/2)T^2 - (\Delta \mathscr{c}/6)T^3 - (\Delta \mathscr{c}'/2)T^{-1}$ is known for the reaction A → C. ***Explain*** how you can find the temperature at which the reaction A → B is more spontaneous than the reaction A → C.

2(10). In our study of the hydrogen atom we encountered three quantum numbers. Name these and give the respective symbols and permitted values.

3(20). Calculate $\Delta_r G^o$ for the reaction

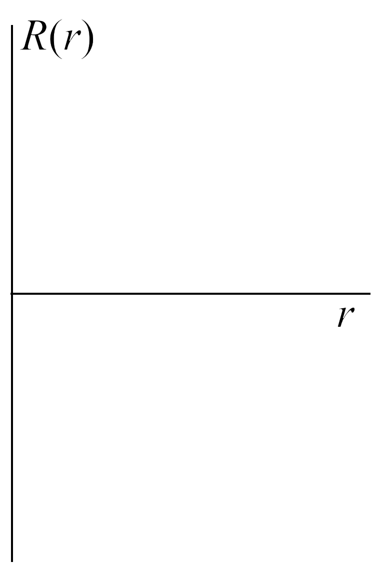
$$4\ KClO_3(s) \rightarrow 3\ KClO_4(s) + KCl(s) \qquad \Delta_r H^o = -144.08 \text{ kJ}$$

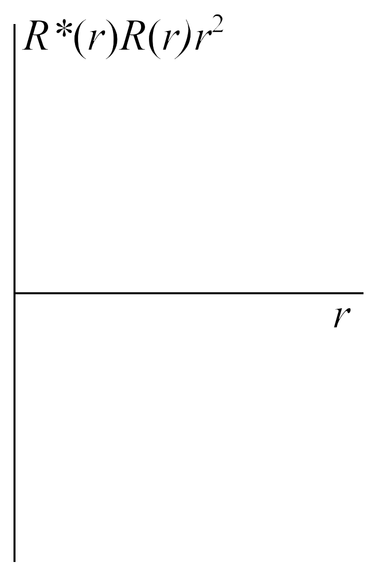
given $\Delta_f G^o/(\text{kJ mol}^{-1}) = -409.14$ for KCl(s), -296.25 for $KClO_3$(s), and -303.09 for $KClO_4$(s).

Is the entropy change for this reaction a favorable change? __________

4(10). In Barrow Problem 10-11 we saw that there was no orbit of a helium atom that has approximately the same radius as the $n = 1$ orbit for a hydrogen atom. Is this true for the energy as well? __________ (Prove your answer.)

5(10). For a hydrogen atom with $n = 3$ and $l = 0$, sketch on the respective axes





6(10). ***List*** the contributions that would be included in the internal hamiltonian operator for a multielectron atomic system.

What is the physical significance of the eigenvalues determined by using the hamiltonian operator on the eigenfunctions describing the system.

7(25). Use the following to determine $\Theta_{2,\pm 1}(\theta)$:

$$\Theta_{l,m}(\theta) = \left[\frac{(2l+1)(l-|m|)!}{2(l+|m|)!}\right]^{(1/2)} P_l^{|m|}(\cos\ \theta)$$

$$P_l^{|m|}(x) = \frac{1}{2^l\ l!}(1 - x^2)^{|m|/2}\frac{d^{l+|m|}}{dx^{l+|m|}}(x^2 - 1)^l$$