CHEM 441-02 Name ______________________________
College of Charleston
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Exam 4 Score ____________ / 125

1(75). For the reaction

$$2\ HI(g) \rightleftharpoons H_2(g) + I_2(g) \qquad (1)$$

the temperature dependence of the equilibrium constant is given by

$$\ln K_p = (-2.33966) - \frac{(1020.3)}{[T/(K)]} + (0.6833)\ \ln\ [T/(K)]$$

A(10). Calculate K_p at 400 K.

B(15). Calculate $\Delta_r H^o$ at 400 K.

C(20). If a reaction mixture contains $P(HI) = 1.0 \times 10^{-3}$ bar, $P(H_2) = 1.1 \times 10^{-6}$ bar, and $P(I_2) = 0.52$ bar, is the reaction mixture at equilibrium? __________
If not, in which direction will the reaction proceed to attain equilibrium?
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D(10). Calculate K_p for the reaction

$$\tfrac{1}{2}\ H_2(g) + \tfrac{1}{2}\ I_2(g) \rightleftharpoons HI(g) \qquad (2)$$

at 400 K using your answer from part A.

E(20). For chemical equation (1)

$$K_p = \left(\frac{m_{H_2} m_{I_2}}{m_{HI}^2}\right)^{(3/2)} \left(\frac{\sigma_{HI}^2}{\sigma_{H_2}\sigma_{I_2}}\right) \left(\frac{\theta_{rot,HI}^2}{\theta_{rot,H_2}\theta_{rot,I_2}}\right) \left(\frac{(1-e^{-\theta_{vib,HI}})^2}{(1-e^{-\theta_{vib,H_2}})(1-e^{-\theta_{vib,I_2}})}\right) e^{(D_{0,H_2}+D_{0,I_2}-2D_{0,HI})/RT}$$

Use the following data to evaluate K_p at 400 K.

	HI(g)	H_2(g)	I_2(g)
θ_{vib}/(K)	3266	6215	308
θ_{rot}/(K)	9.25	85.3	0.0537
D_0/(kJ mol^{-1})	294.7	432.1	148.8

2(15). Compare the values of the average kinetic energies of the H_2 and I_2 molecules in the reaction mixture described by chemical equation (1).

Compare the values of the root-mean-square speeds of the H_2 and I_2 molecules in the reaction mixture described by chemical equation (1).

3(10). If the temperature of a gas is doubled, by how much is the average speed of the molecules increased?

4(25). The distribution function for speed is

$$G(u) = 4\pi\left(\frac{m}{2\pi k_B T}\right)^{(3/2)} e^{-mu^2/2k_B T} u^2$$

Determine the ratio of $G(u)_{T2} / G(u)_{T1}$ where $T_2 = 2T_1$ and $u = 2u_{rms}$ measured at T_1.