CHM 152/54 Quiz #2 25 Pts Fall 07 Name: Key

rate = k rate = k[A] rate = k[A]^2 $[A]_t = -kt + [A]_0$ $\ln[A]_t = -kt + \ln[A]_0$ R= 8.314 J/(mol•K)

$1/[A]_t = kt + 1/[A]_0$ $t_{1/2} = [A]_0/2k$ $t_{1/2} = 0.693/k$ $t_{1/2} = 1/k[A]_0$ $\ln\frac{k_1}{k_2} = \frac{E_a}{R}(\frac{1}{T_2} - \frac{1}{T_1})$ $e=mc^2$

1. The rate constant for the formation of hydrogen for the reaction: $H_2(g) + I_2(g) \rightarrow 2HI(g)$ is 2.7×10^{-4} L/(mol·s) at 600 K and 3.5×10^{-3} L/(mol·s) at 650 K.

a. (5 Pts) Determine the activation energy.

$\ln\frac{k_1}{k_2} = \frac{E_a}{R}(\frac{1}{T_2} - \frac{1}{T_1})$ so $\ln\left(\frac{2.7\times10^{-4}}{3.5\times10^{-3}}\right) = \frac{E_a}{8.314\,\frac{J}{mol\cdot K}}\left(\frac{1}{650K} - \frac{1}{600K}\right)$

$E_a = 166000\,\frac{J}{mol} = 166\,\frac{kJ}{mol}$

b. (6 Pts) Determine the rate constant at 750 K

Same formula use either k.

$\ln\left(\frac{k_1}{2.7\times10^{-4}}\right) = \frac{166150\,J/mol}{8.314\,\frac{J}{mol\,K}}\left(\frac{1}{600K} - \frac{1}{750K}\right) = 6.6615\ldots$

$\frac{k_1}{2.7\times10^{-4}} = e^{6.6615\ldots}$

$k_1 = 2.1 \times 10^{-1}\,\frac{L}{mol\cdot s}$

c. (6 Pts) Determine the temperature in K at which the value of the rate constant is 3.2×10^{-2} L/(mol·s)

$\ln\frac{2.7\times10^{-4}}{3.2\times10^{-2}} = \frac{166150}{8.314}\left(\frac{1}{T_2} - \frac{1}{600}\right)$

$0.0014277 = \frac{1}{T_2}$

$T = 700\,K$

2. The following ***STEPS*** are proposed for a reaction mechanism.

(1) fast $NO(g) + Br_2(g) \leftrightarrows NOBr_2(g)$

(2) Slow $NOBr_2(g) + NO(g) \rightarrow 2NOBr(g)$

a. (4 Pts) Identify any intermediates and show the overall reaction.

intermediate: $NOBr_2(g)$

overall RxN: $2NO(g) + Br_2(g) \rightarrow 2NOBr(g)$

b. (4 Pts) Determine the rate law. Show all work

from slow step: rate $= k_2[NOBr_2^{\ddagger}][NO]$

since $NOBr_2$ is an intermediate, we must use (1) to solve and substitute for it.

from (1) $\frac{k_1}{k_{-1}}[NO][Br_2] = \frac{k_{-1}[NOBr_2^{\ddagger}]}{k_{-1}}$

therefore: rate $= \frac{k_2 k_1}{k_{-1}}[NO]^2[Br_2] = k[NO]^2[Br_2]$