CHM 152/54 Quiz #2 25 Pts Fall 04 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 equation and the rate law for the reaction between NO(g) and H_2(g) are respectively:

$$2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g) \qquad \text{Rate} = k[NO]^2[H_2]$$

a. (3 Pts) Which integrated rate law equation would apply to [NO] and what would one plot on each axis of a graph to obtain the rate constant and order?

Equation: $\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$ (2nd order)   Plot (x) time vs (y) $\frac{1}{[A]_t}$

b. (3 Pts) Which integrated rate law equation would apply to $[H_2]$ and what would one plot on each axis of a graph to obtain the rate constant and order?

Equation: $\ln[A]_t = -kt + \ln[A]_0$ (1st order)   Plot (x) time vs (y) $\ln[A]_t$

c. (2 Pts) In the rate expression below, one term is incorrect, CIRCLE THE INCORRECT TERM.

$$\text{rate} = -\frac{\Delta[NO]}{2\Delta t} = -\frac{\Delta[H_2]}{2\Delta t} = \frac{\Delta[N_2]}{\Delta t} = \frac{\Delta[H_2O]}{\Delta t} = k[NO]^2[H_2] \quad \text{(applies to above RXN)}$$

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2. (5 pts) A chemical reaction that is first order in X is observed to have a rate constant of 1.2 x 10^{-2} s^{-1}. If the initial concentration of X is 2.0 M, what is the concentration of X after 200 s?

$$\ln[A]_t = -kt - \ln[A]_0$$
$$= -1.2\times10^{-2}(200) + \ln[2.0]$$
$$= -1.7068\ldots$$
$$[A]_t = e^{-1.7068\ldots} = \underline{0.181 \text{ M}}$$

3. (4 Pts) In a first-order reaction the half-life is 20.0 minutes. Determine the rate constant, k, in min^{-1}.

$$t_{1/2} = \frac{0.693}{k} \qquad k = \frac{0.693}{t_{1/2}} = \frac{0.693}{20} = \underline{0.03466 \text{ min}^{-1}}$$

4. (8 Pts) A first order reaction was found to have a rate constant of 2.52 x 10^{-5} s^{-1} at 189.7°C. If the activation energy is 1.6 x 10^2kJ/mol, determine the value of the rate constant at 251.2°C.

$$\ln\frac{k_1}{k_2} = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$
$$\ln\frac{k_1}{2.52\times10^{-5}} = \frac{1.6\times10^2\times10^3 \text{ J/mol}}{8.314 \text{ J/mol K}}\left(\frac{1}{273+189.7} - \frac{1}{273+251.2}\right) = 4.8796.$$
$$\frac{k_1}{2.52\times10^{-5}} = e^{4.8796\ldots} = 131.58$$
$$k_1 = 0.003315 = \underline{3.32\times10^{-3} \text{ s}^{-1}}$$