

# VERSION 1

CHM152 Quiz 2 25 Pts Spring 2014 Name: Key

rate = k    rate = k[A]    rate = k[A]<sup>2</sup>    [A]<sub>t</sub> = -kt + [A]<sub>0</sub>    ln[A]<sub>t</sub> = -kt + ln[A]<sub>0</sub>    t<sub>1/2</sub> = 1/k[A]<sub>0</sub>

R = 8.314 J/(mol•K)    1/[A]<sub>t</sub> = kt + 1/[A]<sub>0</sub>    t<sub>1/2</sub> = [A]<sub>0</sub>/2k    t<sub>1/2</sub> = 0.693/k    ln  $\frac{[A]_t}{[A]_0} = -kt$     ln  $\frac{k_2}{k_1} = \frac{E_a}{R} \left( \frac{1}{T_1} - \frac{1}{T_2} \right)$

\*\*\*\*\*SHOW ALL WORK TO RECEIVE CREDIT\*\*\*\*\*

1. (5 Pts) For the first-order reaction  $\frac{1}{2}\text{N}_2\text{O}_4(\text{g}) \rightarrow \text{NO}_2(\text{g}); \Delta H = 28.6 \text{ kJ}$  the rate constant is  $k = 7.58 \times 10^4 \text{ s}^{-1}$  at  $-22^\circ\text{C}$ , and the activation energy is  $53.7 \text{ kJ/mol}$ . What is the rate constant at  $27^\circ\text{C}$ ?

$$\ln \frac{k_2}{7.58 \times 10^4} = \frac{53.7 \times 10^3 \text{ J/mol}}{8.314 \text{ J/mol}\cdot\text{K}} \left( \frac{1}{251} - \frac{1}{300} \right)$$

$$\ln \frac{k_2}{7.58 \times 10^4} = 4.203 \dots$$

$$k_2 = 5.07 \times 10^6 \text{ s}^{-1}$$

2. (5 Pts) A certain reaction  $\text{A} \rightarrow \text{products}$  is second order with respect to A with a rate constant, k,  $0.122 \text{ M}^{-1}\text{min}^{-1}$ . Starting with  $[\text{A}]_0 = 1.01\text{M}$ , how many minutes will it take for A to reach a concentration of  $0.750\text{M}$ ?

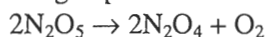
3. (5 Pts) The rate constant for the first-order decomposition of  $\text{C}_4\text{H}_8$  at  $500^\circ\text{C}$  is  $9.2 \times 10^{-3} \text{ s}^{-1}$ . How long will it take for 10.0% of a  $0.100 \text{ M}$  sample of  $\text{C}_4\text{H}_8$  to decompose at  $500^\circ\text{C}$ ?

4. (5 Pts) The rate constant for a first-order reaction is  $1.5 \times 10^{-2} \text{ s}^{-1}$  at  $748 \text{ K}$  and  $3.8 \times 10^{-2} \text{ s}^{-1}$  at  $820 \text{ K}$ . What is the activation energy?

$$\ln \frac{1.5 \times 10^{-2}}{3.8 \times 10^{-2}} = \frac{E_a}{8.314} \left( \frac{1}{820} - \frac{1}{748} \right)$$

$$E_a = 65800 \text{ kJ/mol} = 66 \text{ kJ/mol}$$

5. (5 Pts) Nitrogen pentoxide decomposes by a first-order process yielding  $\text{N}_2\text{O}_4$  and oxygen.



At a given temperature, the half-life of  $\text{N}_2\text{O}_5$  is  $0.90 \text{ hr}$ . What is the first-order rate constant for  $\text{N}_2\text{O}_5$  decomposition?

$$t_{1/2} = \frac{0.693}{k} \quad k = \frac{0.693}{0.90 \text{ hr}} = 0.77 \text{ hr}^{-1}$$

# VERSION 2

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rate = k    rate = k[A]    rate = k[A]<sup>2</sup>    [A]<sub>t</sub> = -kt + [A]<sub>0</sub>    ln[A]<sub>t</sub> = -kt + ln[A]<sub>0</sub>    t<sub>1/2</sub> = 1/k[A]<sub>0</sub>

R = 8.314 J/(mol•K)    1/[A]<sub>t</sub> = kt + 1/[A]<sub>0</sub>    t<sub>1/2</sub> = [A]<sub>0</sub>/2k    t<sub>1/2</sub> = 0.693/k    ln  $\frac{[A]_t}{[A]_0} = -kt$     ln  $\frac{k_2}{k_1} = \frac{E_a}{R} \left( \frac{1}{T_1} - \frac{1}{T_2} \right)$

\*\*\*\*\*SHOW ALL WORK TO RECEIVE CREDIT\*\*\*\*\*

1. (5 Pts) The rate constant for the first-order decomposition of C<sub>4</sub>H<sub>8</sub> at 500°C is 9.2 × 10<sup>-3</sup> s<sup>-1</sup>. How long will it take for 10.0% of a 0.100 M sample of C<sub>4</sub>H<sub>8</sub> to decompose at 500°C?

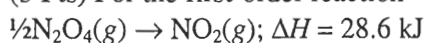
90% will be left

$$\ln \frac{[A]_t}{[A]_0} = -kt$$

$$\ln 0.90 = -9.2 \times 10^{-3} t$$

$$t = 11.4 \text{ sec}$$

2. (5 Pts) For the first-order reaction



the rate constant is  $k = 1.68 \times 10^5 \text{ s}^{-1}$  at -14°C, and the activation energy is 53.7 kJ/mol. What is the rate constant at 9°C?

$$\ln \frac{k_2}{1.68 \times 10^5} = \frac{53.7 \times 10^3 \text{ J/mol}}{8.314 \text{ J/mol}\cdot\text{K}} \left( \frac{1}{259} - \frac{1}{282} \right)$$

$$\ln \frac{k_2}{1.68 \times 10^5} = 2.033 \dots$$

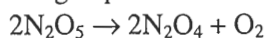
$$k_2 = 1.28 \times 10^6 \text{ s}^{-1}$$

3. (5 Pts) The rate constant for a first-order reaction is 1.7 × 10<sup>-2</sup> s<sup>-1</sup> at 718 K and 4.0 × 10<sup>-3</sup> s<sup>-1</sup> at 904 K. What is the activation energy?

$$\ln \frac{1.7 \times 10^{-2}}{4.0 \times 10^{-3}} = \frac{E_a}{8.314} \left( \frac{1}{904} - \frac{1}{718} \right)$$

$$E_a = 24800 \text{ J/mol} = 25 \text{ kJ/mol}$$

4. (5 Pts) Nitrogen pentoxide decomposes by a first-order process yielding N<sub>2</sub>O<sub>4</sub> and oxygen.



At a given temperature, the half-life of N<sub>2</sub>O<sub>5</sub> is 0.90 hr. What is the first-order rate constant for N<sub>2</sub>O<sub>5</sub> decomposition?

5. (5 Pts) A certain reaction A → products is second order with respect to A with a rate constant, k, 0.122 M<sup>-1</sup>min<sup>-1</sup>. Starting with [A]<sub>0</sub> = 1.01M, how many minutes will it take for A to reach a concentration of 0.750M?

$$\left[ \frac{1}{0.750} \right] = \frac{0.122}{\text{M}\cdot\text{min}} (t) + \left( \frac{1}{1.01} \right)$$

$$t = 2.81 \text{ min} \approx 169 \text{ sec}$$