VERSION 1

CHM152 Quiz 2 25 Pts Spring 2014 Name: Key

rate = k rate = k[A] rate = k[A]^2 $[A]_t = -kt + [A]_0$ $\ln[A]_t = -kt + \ln[A]_0$ $t_{1/2} = 1/k[A]_0$

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

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

1. (5 Pts) For the first-order reaction $\frac{1}{2}N_2O_4(g) \rightarrow NO_2(g)$; $\Delta H = 28.6$ kJ
the rate constant is $k = 7.58 \times 10^4$ s^{-1} at –22°C, and the activation energy is 53.7 kJ/mol. What is the rate constant at 27°C?

$$\ln\frac{k_2}{7.58\times10^4} = \frac{53.7\times10^3\ \text{J/mol}}{8.314\ \text{J/mol·K}}\left(\frac{1}{251} - \frac{1}{300}\right)$$

$$\ln\frac{k_2}{7.58\times10^4} = 4.203\ldots$$

$$k_2 = 5.07\times10^6\ s^{-1}$$

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

3. (5 Pts) The rate constant for the first-order decomposition of C_4H_8 at 500°C is 9.2×10^{-3} s^{-1}. How long will it take for 10.0% of a 0.100 M sample of C_4H_8 to decompose at 500°C?

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

$$\ln\frac{1.5\times10^{-2}}{3.8\times10^{-2}} = \frac{E_a}{8.314}\left(\frac{1}{820} - \frac{1}{748}\right)$$

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

5. (5 Pts) Nitrogen pentoxide decomposes by a first-order process yielding N_2O_4 and oxygen.
$2N_2O_5 \rightarrow 2N_2O_4 + O_2$
At a given temperature, the half-life of N_2O_5 is 0.90 hr. What is the first-order rate constant for N_2O_5 decomposition?

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

VERSION 2

CHM152 Quiz 2 25 Pts Spring 2014 Name: Key

rate = k rate = k[A] rate = k[A]^2 $[A]_t = -kt + [A]_0$ $\ln[A]_t = -kt + \ln[A]_0$ $t_{1/2} = 1/k[A]_0$

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

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

1. (5 Pts) The rate constant for the first-order decomposition of C_4H_8 at 500°C is 9.2×10^{-3} s^{-1}. How long will it take for 10.0% of a 0.100 M sample of C_4H_8 to decompose at 500°C?

90% will be left

$\ln\frac{[A]_t}{[A]_0} = -kt$ $\ln 0.90 = -9.2 \times 10^{-3}\, t$

$t = 11.4$ sec

2. (5 Pts) For the first-order reaction
$\frac{1}{2}N_2O_4(g) \rightarrow NO_2(g)$; $\Delta H = 28.6$ kJ
the rate constant is $k = 1.68 \times 10^5$ s^{-1} at –14°C, and the activation energy is 53.7 kJ/mol. What is the rate constant at 9°C?

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

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

$k_2 = 1.29 \times 10^6\ s^{-1}$

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

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

$E_a = 24\,800$ J/mol $= 25$ kJ/mol

4. (5 Pts) Nitrogen pentoxide decomposes by a first-order process yielding N_2O_4 and oxygen.
$2N_2O_5 \rightarrow 2N_2O_4 + O_2$
At a given temperature, the half-life of N_2O_5 is 0.90 hr. What is the first-order rate constant for N_2O_5 decomposition?

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

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

$t = 2.81$ min or 169 sec