CHM152 Quiz 1 25 Pts Fall 2019 Name: Key

Show all Work to Receive Credit

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)

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

3

1. (3 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?

$t_{1/2} = 0.693/k$

$k = \frac{0.693}{0.90\,hr} = 0.77\ hr^{-1}$

2

2. (2 Pts) Given the rate law for a reaction, rate = $k[A][B]^2$, where rate is measured in units of M s^{-1}, what are the units for the rate constant k?

$k = \frac{rate}{[A][B]^2} = \frac{M}{s} \cdot \frac{}{M} \cdot \frac{}{M^2} = M^{-2} \cdot s^{-1}$

2

3. (4 Pts) Given that E_a for a certain biological reaction is 48 kJ/mol and that the rate constant is $2.5 \times 10^{-2}\ s^{-1}$ at 15°C, what is the rate constant at 37°C?

$\ln\frac{k_1}{2.5\times10^{-2}} = \frac{48\times10^3\ J/mol}{8.314\ J/mol\cdot K}\left(\frac{1}{288\ K} - \frac{1}{310\ K}\right)$

$\ln\frac{k_1}{2.5\times10^{-2}} = 1.423...$

$k_1 = 0.104 = 1.0\times10^{-1}\ s^{-1}$

5

4. (4 Pts) Nitric oxide reacts with chlorine to form nitrosyl chloride, NOCl. Use the following data to determine the rate equation for the reaction and the value of the rate constant.

$NO + \frac{1}{2}Cl_2 \rightarrow NOCl$

Expt. #	[NO]	[Cl_2]	Initial Rate
1	0.22	0.065	0.96 M/min
2	0.66	0.065	8.6 M/min
3	0.44	0.032	1.9 M/min

rate = $k[NO]^x[Cl_2]^y$

For NO use $\frac{Expt\ \#2}{Expt\ \#1}$: $\frac{8.6}{0.96} = \frac{\cancel{k}}{\cancel{k}}\left(\frac{0.66}{0.22}\right)^x\left(\frac{\cancel{0.065}}{\cancel{0.065}}\right)^y$

$9 = 3^x$ $x = 2$

For Cl_2 use any in which Cl_2 changes $\frac{3}{1}$: $\frac{1.9}{0.96} = \frac{\cancel{k}}{\cancel{k}}\left(\frac{0.44}{0.22}\right)^2\left(\frac{0.032}{0.065}\right)^y$

$2 = 4(0.5)^y$

$0.5 = (0.5)^y$ $y = 1$

rate = $k[NO]^2[Cl_2]$

$k = \frac{rate}{[NO]^2[Cl_2]}$

$k = 300\ M^{-2} \cdot min^{-1}$

5. (4 Pts) Calculate the activation energy, in kJ/mol, for the redox reaction

$Sn^{2+} + 2Co^{3+} \rightarrow Sn^{4+} + 2Co^{2+}$.

Temp (°C)		k (1/M·s)
2	275	3.12×10^3
27	300	27.0×10^3

$$\ln \frac{k_1}{k_2} = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln \frac{3.12 \times 10^3}{27.0 \times 10^3} = \frac{E_a}{8.314}\left(\frac{1}{300} - \frac{1}{275}\right)$$

$E_a = 59\,207$ kJ/mol

59 kJ/mol

6. (4 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% Left

$$\ln \frac{90}{100} = -9.2 \times 10^{-3}(t)$$

$t = 11.4$ s

7. (4 Pts) The reaction 2A + B $\rightarrow$ *products* is second order with respect to A and zero-order with respect to B. Starting with 0.135 M of A, what is the concentration of A after 35 min if the rate constant is 0.11 $M^{-1}s^{-1}$?

$\text{rate} = k[A]^2$ so: $\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$

$$\frac{1}{[A]_t} = 0.11\frac{M}{s}(2100\ s) + \frac{1}{[0.135]}$$

$$[A]_t = 4.2 \times 10^{-3}\ M$$