CHM152 Quiz 2a 25 Pts Spring 2019 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. (6 Pts) The activation energy for the following first-order reaction is 122 kJ/mol.

$N_2O_5(g) \rightarrow 2NO_2(g) + {}^1/_2O_2(g)$

The value of the rate constant (k) is 1.35 10^{-4} s^{-1} at 45°C. What is the value of k at 10°C?

$$\ln\frac{k_2}{1.35\times10^{-4}} = \frac{122\times10^3\ J/mol}{8.314\ J/mol\cdot K}\left(\frac{1}{318} - \frac{1}{283}\right) = -5.70695\ldots$$

$$k_2 = 1.35\times10^{-4}\left(e^{-5.7069\ldots}\right)$$

$$k_2 = 4.49\times10^{-7}\ s^{-1}$$

2. (6 Pts) Calculate the activation energy, in kJ/mol, for the redox reaction

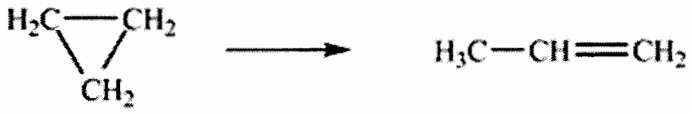
$Sn^{2+} + 2Co^{3+} \rightarrow Sn^{4+} + 2Co^{2+}$.

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

$$\ln\frac{3.12\times10^3}{27.0\times10^3} = \frac{E_a}{8.314\ J/mol\cdot K}\left(\frac{1}{300} - \frac{1}{275}\right)$$

$$E_a = 59,207\ \frac{J}{mol} = \frac{59.2\ kJ}{mol}$$

3. (4 Pts) The isomerization of cyclopropane to form propene is a first-order reaction.



At 760 K, 85% of a sample of cyclopropane changes to propene in 59.0 min. Determine the rate constant for this reaction at 760 K.

$$\ln\left(\frac{15}{100}\right) = -k(59.0)$$

$$k = 0.0322\ min^{-1}$$

$$3.2\times10^{-2}\ min^{-1}$$

******MORE QUESTIONS ON THE BACK*****

Key

4. (5 Pts) A reaction was experimentally determined to follow the rate law, Rate = $k[A]^2$ where k = 0.456 $s^{-1}M^{-1}$. Starting with $[A]_o$ = 0.500 M, how many seconds will it take for $[A]_t$ = 0.250 M?

2nd order $\frac{1}{[0.250} = 0.456(t) + \frac{1}{0.500}$

$t = 4.39$ s

5.(4 Pts) The reaction **2A + 2B → C + D** proceeds by this mechanism:

1	$2A \rightleftarrows A_2$	(equilibrium)
2	$A_2 + B \rightarrow X + C$	(rate determining)
3	$X + B \rightarrow D$	(rapid)

Write the rate equation for the reaction. You may want to first label any intermediates.

From step 2 rate = $k_2 [A_2^{\ddagger}][B]$

since A_2 is an intermediate use step 1

$$k_1 [A]^2 = k_{-1} [A_2^{\ddagger}]$$

$$\frac{k_1}{k_{-1}} [A]^2 = [A_2^{\ddagger}]$$

Substitution gives:

$$\text{rate} = \frac{k_2 k_1}{k_{-1}} [B][A]^2$$

CHM152 Quiz 2b 25 Pts Spring 2019 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. (6 Pts) The activation energy for the following first-order reaction is 132 kJ/mol.

$N_2O_5(g) \rightarrow 2NO_2(g) + {}^1/_2O_2(g)$

The value of the rate constant (k) is $1.35 \times 10^{-4}\ s^{-1}$ at 55°C. What is the value of k at 20°C?

$$\ln\frac{k_2}{1.35\times10^{-4}} = \frac{132\times10^3}{8.314}\left(\frac{1}{328} - \frac{1}{293}\right) = -5.782165\ldots$$

$$k_2 = 1.35\times10^{-4}\left(e^{-5.782165\ldots}\right)$$

$$k_2 = 4.16\times10^{-7}\ s^{-1}$$

2. (6 Pts) Calculate the activation energy, in kJ/mol, for the redox reaction

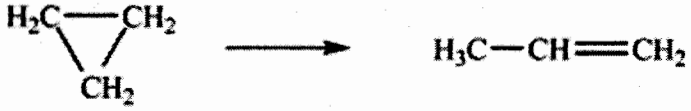
$Sn^{2+} + 2Co^{3+} \rightarrow Sn^{4+} + 2Co^{2+}$.

Temp (°C)	k (1/M·s)
2	$3.12\ 10^3$
27	$27.0\ 10^3$

See Key 2a

59.2 kJ/mol

3. (4 Pts) The isomerization of cyclopropane to form propene is a first-order reaction.



At 760 K, 75% of a sample of cyclopropane changes to propene in 69.0 min. Determine the rate constant for this reaction at 760 K.

$$\ln\left(\frac{25}{100}\right) = -k\,(69.0\ min)$$

$$k = 0.0201\ min^{-1}$$

$$2.01\times10^{-2}\ min^{-1}$$

******MORE QUESTIONS ON THE BACK******

4. (5 Pts) A reaction was experimentally determined to follow the rate law, Rate = $k[A]^2$ where k = 0.456 $s^{-1}M^{-1}$. Starting with $[A]_o$ = 0.500 M, how many seconds will it take for $[A]_t$ = 0.250 M?

See Key 1a

5.(4 Pts) The reaction **2A + 2B → C + D** proceeds by this mechanism:

$2A \rightleftarrows A_2$	(equilibrium)
$A_2 + B \rightarrow X + C$	(rate determining)
$X + B \rightarrow D$	(rapid)

Write the rate equation for the reaction. You may want to first label any intermediates.

See Key 1a