Worksheet 3 on Kinetics. Answer Key

1. Write the rate of the reaction $2O_3 \rightarrow 3O_2$ in terms of $\Delta[O_3]/\Delta t$.

$$-\frac{1}{2}\frac{\Delta[O_3]}{\Delta t}$$

2.Consider the following stoichiometric reaction: $2A + B \rightarrow C + D$
The reaction rates are measured with the following results:

Initial rate	$[A]_0$	$[B]_0$
1	2	1
2	4	1
1	2	2

What is the order of the reaction with respect to $[B]_0$?
Since we're looking at the order of $[B]_0$, all we have to look at where $[B]_0$ changes and where $[A]_0$ stays the same. You can see that $[B]_0$ doubles from the first row to the third row. However, the rate doesn't change, therefore the rate order is 0.

3. The first-order rate constant is $k = 3.4 \times 10^{-3}$ sec-1 for the decomposition of cyclobutane and the half-life is 204 seconds.

Cyclobutane → 2 (ethylene)

What fraction of a sample of cyclobutane remains after 612 seconds under the specified conditions?

Time	Amount left (cyclobutane = C)
0	C
204	C/2
408	C/4
612	C/8

After 612 seconds, 1/8 of the original amount of cyclobutane is left.

4. The reaction $A + 3B \rightarrow C + 2D$ has a rate constant $k = 1.0 \times 10^{-5}\ \text{sec}^{-1}$ at 27° C. If the activation energy for the reaction is 20,000 cal/mol, what is the value of the rate constant at 0°C?

Explanation: Use the combined Arrenhius equation, $\ln\frac{k_2}{k_1} = (E_a/R)\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$.

$$\ln\frac{k_2}{1e-5} = \left(\frac{20{,}000\text{cal/mol}}{1.987\text{cal/molK}}\right)\left(\frac{1}{300K} - \frac{1}{273K}\right)$$

$$k_2 = e\wedge\left[\left(\frac{20{,}000}{1.987}\right)\left(\frac{1}{300K} - \frac{1}{273K}\right)1e\text{-}5\right]$$

$$= 3.6 \times 10\wedge 7$$

5.

The following data were collected for the following reaction at a particular temperature.

$$A + B \rightarrow C$$

Three experiments give

Trial	Initial [A] M	Initial [B] M	Initial rate $\Delta[C]/\Delta t$ M/min
1	0.1	0.1	4.0×10^{-4}
2	0.2	0.2	$3.2 \times 10\ ^{3}$
3	0.1	0.2	1.6×10^{-3}

What is the rate law expression for this reaction?

0.4 M ^{2}min ^{1}[A][B]^{2}

See also: http://neon.cm.utexas.edu/academic/courses/Spring2002/CH302/Laude/answers/e2key.pdf

6.

A first order elementary reaction,

$$A \rightarrow \text{products},$$

has a rate constant of 3.16×10^{8} sec^{-1}. At an instant in time, a concentration of 3.16×10^{-6}M of species A is created.

How long does it take for the concentration to fall by a factor of 4?

Solution:

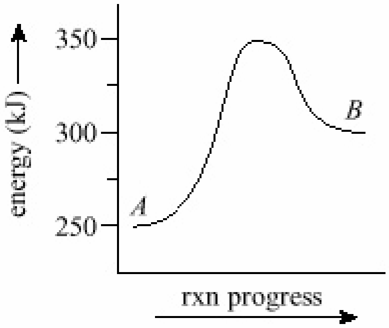
$\ln([A_o]/[A]) = akt$
in this case, a = 1 and k = 3.16E8

Since the concentration of A is decreasing by a factor of 4, $[A_o]/[A]$ is equal to 4.

So, ln(4) = (1)*(3.16E8)*t
t = ln(4)/3.16E8 = 4.38E-9 sec

7.

Consider the potential energy diagram shown below.



What is the activation energy E_a for the reaction $A \rightarrow B$?

Solution:

We need to have enough energy to 'get to the top of the hill' in order to fall down to the products. So the energy must raise from 250 kJ (where A is) up to the top of the hill at 350 kJ. 350-250 = 100 kJ