## Chem 1105-2015 Summer Problem Set \#2

1. Express the rate of reaction in terms of the change in concentration of each of the reactants and products: $2 \mathrm{~A}(\mathrm{~g}) \rightarrow \mathrm{B}(\mathrm{g})+\mathrm{C}(\mathrm{g})$

When $[\mathrm{C}(\mathrm{g})]$ is increasing at $2 \mathrm{~mol} / \mathrm{L} \cdot \mathrm{s}$, how fast is $[\mathrm{A}(\mathrm{g})]$ decreasing?
2. The accumulation of stratospheric ozone was one of the crucial processes that allowed life to develop on our planet: $3 \mathrm{O}_{2}(\mathrm{~g}) \rightarrow 2 \mathrm{O}_{3}(\mathrm{~g})$
At a given instant the reaction rate in terms of $\mathrm{O}_{2}$ is $2.17 \times 10^{-5} \mathrm{~mol} / \mathrm{L} \cdot \mathrm{s}$. What is the rate of formation of $\mathrm{O}_{3}$ ?
3. By what factor does the rate change in each of the following cases(assuming constant temperature)?
a) A reaction is first order in reactant A , and [A] is doubled.
b) A reaction is second order in reactant $B$, and $[B]$ is halved.
c) A reaction is second order in reactant C , and $[\mathrm{C}]$ is tripled.
d) Write the rate law expression for this reaction and state the overall reaction order.
4. For the reaction $4 \mathrm{~A}(\mathrm{~g})+3 \mathrm{~B}(\mathrm{~g}) \rightarrow 2 \mathrm{C}(\mathrm{g})$ the following data were obtained at constant temperature:

| Experiment | $[\mathrm{A}]$ (Molarity) | $[\mathrm{B}]($ Molarity $)$ | Initial Rate(M/min) |
| :---: | :---: | :---: | :---: |
| 1 | 0.100 | 0.100 | 5.00 |
| 2 | 0.300 | 0.100 | 45.0 |
| 3 | 0.100 | 0.200 | 10.0 |
| 4 | 0.300 | 0.200 | 90.0 |

a) What is the order with respect to each reactant? b) Write the rate law. c) Calculate $k$ using data from experiment 1 .
5. How are integrated rate laws used to determine reaction order? What is the order in the reactant if a plot of
a) The natural logarithm of [reactant] vs. time is linear?
b) The inverse of [reactant] vs. time is linear?
c) [reactant] vs. time is linear?
6. In a first-order decomposition reaction, $50.0 \%$ of a compound decomposes in 10.5 min . a)

What is the rate constant of the reaction? b) How long does it take for $75.0 \%$ of the compound to decompose?
7. The rate constant of a reaction is $4.7 \times 10^{-3} \mathrm{~s}^{-1}$ at $25^{\circ} \mathrm{C}$, and the activation energy is $33.6 \mathrm{~kJ} / \mathrm{mol}$. What is k at $75^{\circ} \mathrm{C}$ ?
8. For the reaction $\mathrm{ABC}+\mathrm{D} \leftrightharpoons \mathrm{AB}+\mathrm{CD}, \Delta \mathrm{H}^{\circ}=-55 \mathrm{~kJ} / \mathrm{mol}$ and $\mathrm{E}_{\mathrm{a}}(\mathrm{fwd})=215 \mathrm{~kJ} / \mathrm{mol}$. Assuming a one-step reaction
a) draw a reaction energy diagram; b) calculate $\mathrm{E}_{\mathrm{a}}(\mathrm{rev})$

## Answer Set for Chem 1105-2015 Summer Problem Set \#2

1. rate $=-\frac{1}{2} \times \frac{\Delta[A]}{\Delta t}=\frac{\Delta[B]}{\Delta t}=\frac{\Delta[C]}{\Delta t} ; 4 \mathrm{~mol} / \mathrm{L} \cdot \mathrm{s}$
2. $1.45 \times 10^{-5} \mathrm{~mol} / \mathrm{L} \cdot \mathrm{s}$
3.a) Rate doubles; b) Rate decreases by a factor of four; c) Rate increases by a factor of nine; d) rate $=\mathrm{k}[\mathrm{A}][\mathrm{B}]^{2}[\mathrm{C}]^{2} ; 5^{\text {th }}$ overall.
4.a) second order in $A$, first order in $B$; b) rate $=k[A]^{2}[B]$; c) $5.00 \times 10^{3} \mathrm{~L}^{2} / \mathrm{mol}^{2} \cdot \mathrm{~min}$
5.a) first order; b) second order; c) zero order
6.a) $\mathrm{k}=0.0660 \mathrm{~min}^{-1}$; b) 21.0 min
3. $0.033 \mathrm{~s}^{-1}$
8.a)


Reaction coordinate
b) $270 . \mathrm{kJ} / \mathrm{mol}$

