## Kinetics Hand-Out

### First Order Rate Expression

\[
\frac{\Delta[A]}{\Delta t} = k[A] \\
[A]_t = [A]_0 e^{-kt} \\
\ln[A]_t = -kt + \ln[A]_0 \\
t_{1/2} = \frac{\ln 2}{k}
\]

### Second Order Rate Expression

\[
\frac{\Delta[A]}{\Delta t} = k[A]^2 \\
\frac{1}{[A]_t} = k[t + \frac{1}{[A]_0}] \\
t_{1/2} = \frac{1}{k[A]_0}
\]

### Zero Order Rate Expression

\[
\frac{\Delta[A]}{\Delta t} = k \\
[A]_t = [A]_0 - kt
\]

### Determining Activation Energy

\[
\ln k = -\frac{E_a}{R} \left(\frac{1}{T}\right) + \ln A
\]

if you can determine the rate constant at a couple of different temperatures, you can plot \(\ln k\) v. \(1/T\) and the slope of the line will be the activation energy divided by \(R\)

\(R\) is the gas constant (8.314 J mol\(^{-1}\) K\(^{-1}\))

### Understanding Rate Constants

\[
k = Ae^{\frac{E_a}{RT}}
\]

A is often called the “prefactor” and it represents something about the steric requirements for the reaction and the number of molecular collisions per second.

- **Diagram:**
  - Graph: \(\ln[A]\) vs. \(t\)
  - A straight line with a slope of \(k\).