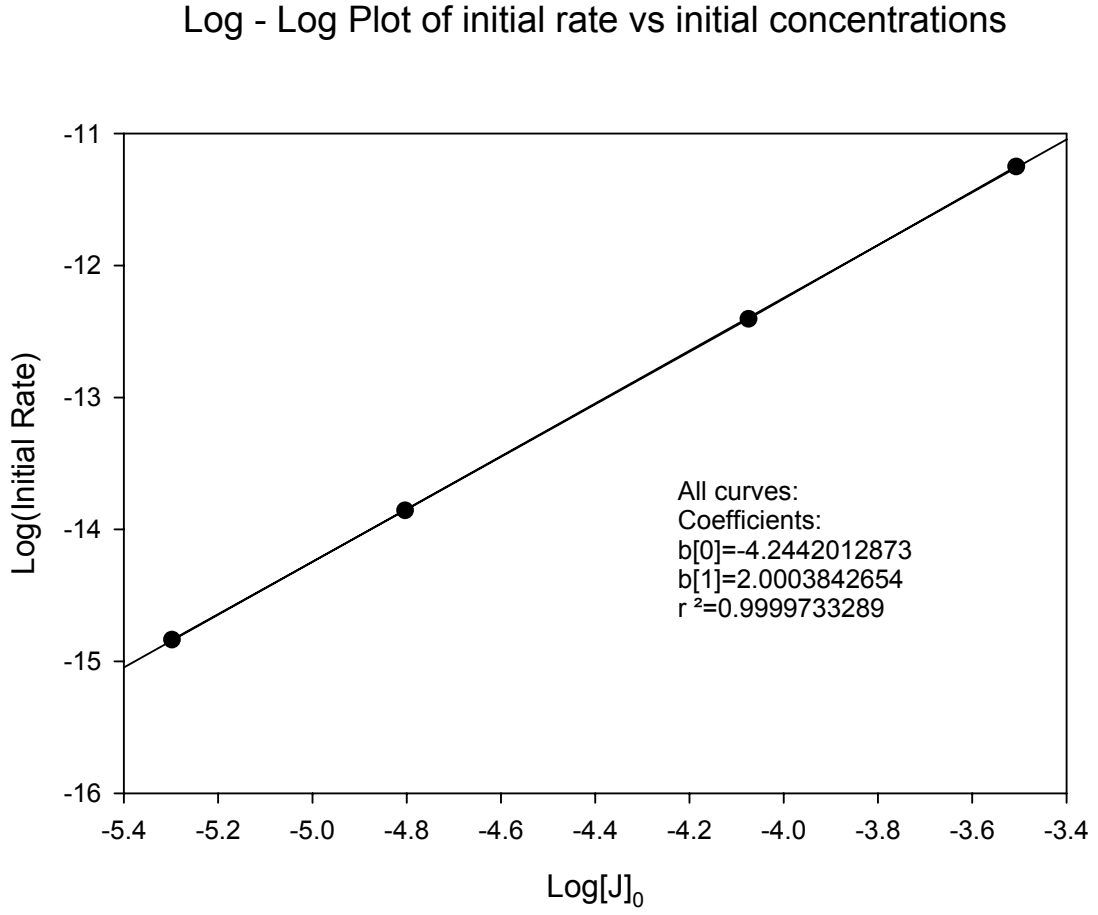
# Lecture # 11 Classroom Examples (Initial Rates).

For the reaction **J → Products**, the following initial rates were obtained for the respective initial concentrations of J:

| $[J]_0$ (M) | 0.005 | 0.0082 | 0.017 | 0.03 |
|---|---|---|---|---|
| $V_0$ (M $s^{-1}$) | 3.6E-7 | 9.6E-7 | 4.1E-6 | 1.3E-5 |

Determine the reaction's order with respect to concentrations of J.
Solution: Create a log-log plot and determine the slope.

| $\ln[J]_0$ | -5.298 | -4.8036 | -4.0745 | -3.5066 |
|---|---|---|---|---|
| $\ln v_0$ | -14.837 | -13.856 | -12.405 | -11.251 |

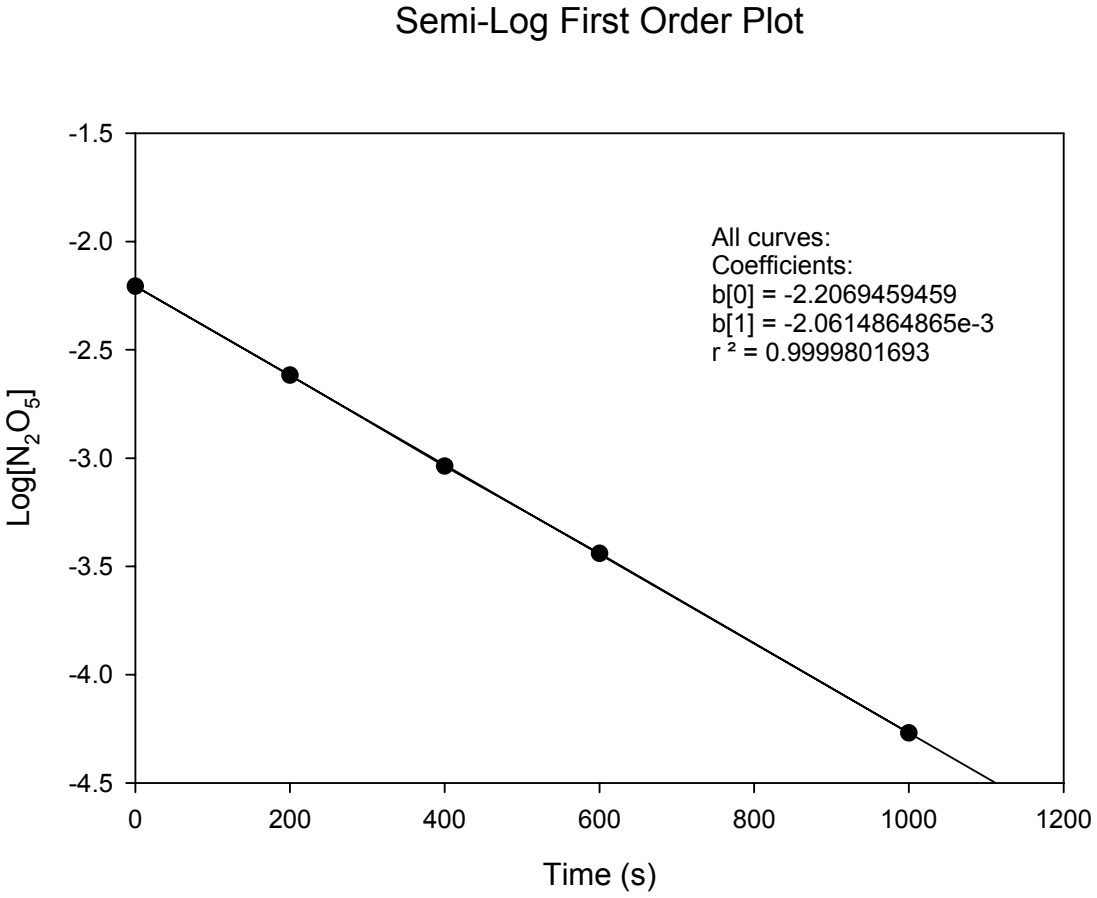



The slope of this log-log plot is exactly 2.00; and so the order of the reaction with respect to J concentrations is 2: Rate = v = $-d[J]/dt = k[J]^2$
Experimental data are rarely this clean; and in general experimentally determined reaction orders rarely deliver whole integers. One generally rounds off to the nearest integer.

# First Order Kinetics (semi-log plots).

For the reaction: **$N_2O_5$(aq) + $Br_2$(l) → Products**; the following data are obtained when dinitrogen pentoxide concentrations are followed with respect to time:

| Time (s) | 0 | 200 | 400 | 600 | 1000 |
|---|---|---|---|---|---|
| $[N_2O_5]$ (M) | 0.110 | 0.073 | 0.048 | 0.032 | 0.014 |
| | | | | | |
| $\ln[N_2O_5]$ | -2.207 | -2.617 | -3.037 | -3.440 | -4.269 |




The slope of the plot is -0.00206 which equals –k.
The rate constant for this reaction is 0.00206 $s^{-1}$

The half-life for the reaction is 0.693/k = 336 s.

**Apparently, this reaction does not depend on $Br_2$(l) conc$^{ns}$.**

# Homework example on initial rates.

The initial rate for the reaction $2Fe^{2+} + Br_2(l) \rightarrow 2Fe^{3+} + 2Br^-(l)$ was monitored at constant $[Br_2(l)]_0$ while varying $[Fe^{2+}]_0$. The following initial rate data was obtained:

| $[Fe^{2+}]_0$ | 0.030 | 0.040 | 0.050 | 0.060 | 0.080 |
|---|---|---|---|---|---|
| Initial Rate, M $s^{-1}$ | 0.0122 | 0.0161 | 0.0211 | 0.0240 | 0.0315 |

Evaluate reaction order with respect to ferrous ion concentrations.

To start on this problem, assume Initial Rate, $r_0 = k_0[Fe^{2+}]_0^x[Br_2]_0^y$

Then $\log r_0 = \log k_0 + x\log [Fe^{2+}]_0 + y\log [Br_2]_0$

Next, if one is told that y = 1; evaluate $k_0$. What are the units of $k_0$?

## Another Method is to GUESS the order with respect to $[Fe^{2+}]_0$. Yes, it works!!!!

## If, say the order (in this case, x) is 1.00; then there is a linear relationship between initial rate and initial ferrous ion concentrations, and a plot of Initial rate vs $[Fe^{2+}]_0^1$ will give a straight line.
## If, on the other hand, x = 2 (second order in $[Fe^{2+}]_0$'s; then a plot of Initial rate vs $[Fe^{2+}]_0^2$ will give a straight line.