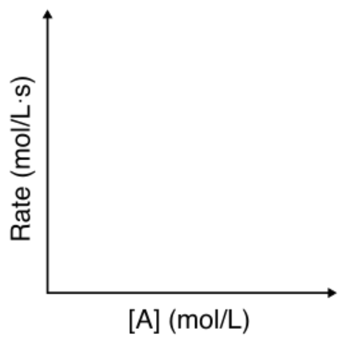
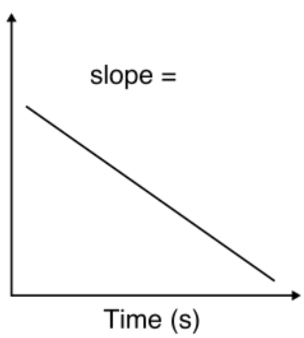
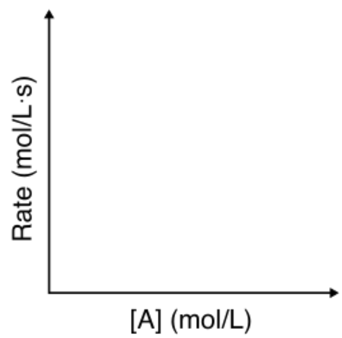
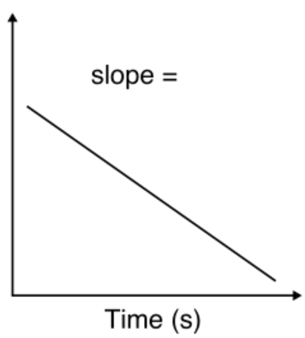
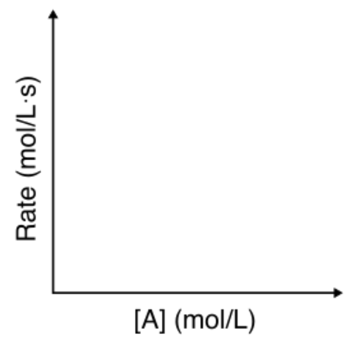
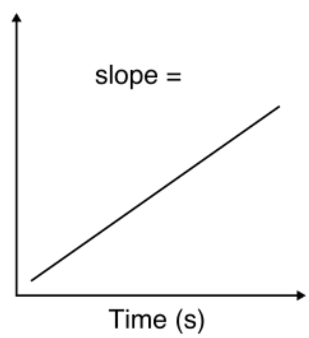
Here is your cheat sheet for kinetics. We will fill out most of this table today but will finish the rest next week.

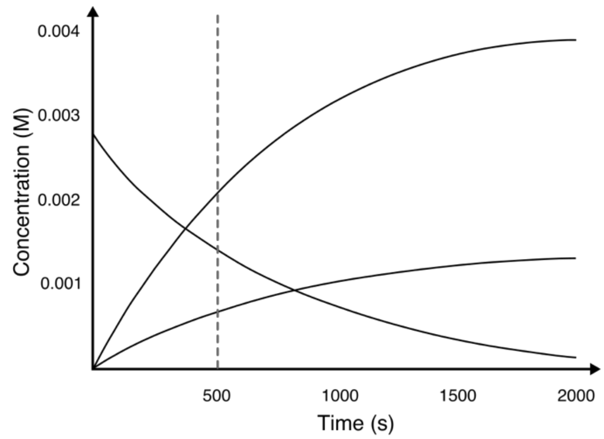
Consider the general chemical equation:

$$a\,\mathrm{A} \rightarrow b\,\mathrm{B} + c\,\mathrm{C} \qquad \text{Rate} = k[\mathrm{A}]^n$$

	Zero-Order (n = 0)	**First-Order (n = 1)**	**Second-Order (n = 2)**
Rate Law	Rate =	Rate =	Rate =
Units of k			
Integrated Rate Law			
Half-Life *“Half-life ________ with time.”*	$t_{1/2}$ = Decreases Stays the same Increases	$t_{1/2}$ = Decreases Stays the same Increases	$t_{1/2}$ = Decreases Stays the same Increases
Plots	 	 	 

1. Consider the degradation of ammonia gas into nitrogen gas and hydrogen gas.

$$2\ NH_3\ (g) \rightarrow N_2\ (g) + 3\ H_2\ (g)$$



A) For the concentration vs. time plot to the right, label each curve with the appropriate chemical species.

Discuss how you chose each curve.

B) At t = 500 s, you determine the slope of a line tangent to the NH_3-curve to be -1.94×10^{-6} M/s. What is the rate of the reaction at this instant?

C) If you were to compare the slopes of the tangent lines for the N_2- and H_2-curves at t = 500 s, how do you think they compare quantitatively to the slope in part B for NH_3? Why?

2. The overall stoichiometry in parts A and B below are the same, but the rate laws differ.

A) Determine the rate law for the following reaction using the initial rates data.

$$2\ NO\ (g) + O_2\ (g) \rightarrow 2\ NO_2\ (g)$$

Experiment	$[NO]_0$ (M)	$[O_2]_0$ (M)	Initial Rate (M/s)
1	0.100	0.100	1.24
2	0.100	0.050	0.62
3	0.050	0.100	0.31

B) Determine the rate law for the following reaction using the initial rates data.

$$2\ NO\ (g) + Cl_2\ (g) \rightarrow 2\ NOCl\ (g)$$

Experiment	$[NO]_o$ (M)	$[Cl_2]_o$ (M)	Initial Rate (M/s)
1	0.200	0.100	0.63
2	0.200	0.300	5.70
3	0.800	0.100	2.58

3. The following initial rate data was collected for the following chemical reaction:

$$2\ MnO_4^-\ (aq) + 5\ H_2C_2O_4\ (aq) + 6\ H^+\ (aq) \rightarrow 2\ Mn^{2+}\ (aq) + 10\ CO_2\ (g) + 8\ H_2O\ (l)$$

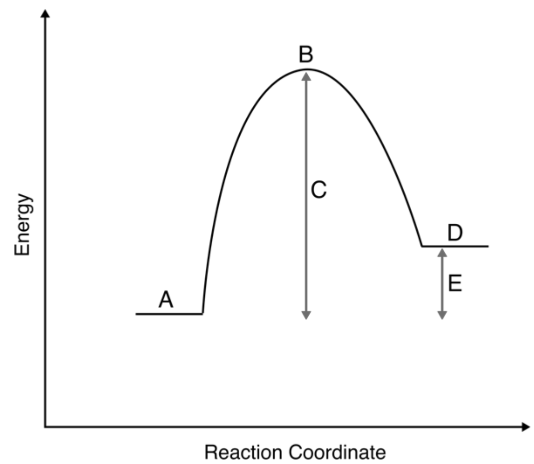
Experiment	$[MnO_4^-]_o$ (M)	$[H_2C_2O_4]_o$ (M)	$[H^+]_o$ (M)	Initial Rate (M/s)
1	1.0×10^{-3}	1.0×10^{-3}	1.0	2.0×10^{-4}
2	2.0×10^{-3}	1.0×10^{-3}	1.0	8.0×10^{-4}
3	2.0×10^{-3}	2.0×10^{-3}	1.0	1.6×10^{-3}
4	2.0×10^{-3}	2.0×10^{-3}	2.0	3.2×10^{-3}

A) Determine the rate law for this reaction.

B) Determine the rate constant, including its units.

C) Predict the initial reaction rate if $[MnO_4^-]_o = [H_2C_2O_4]_o = [H^+]_o = 1.5 \times 10^{-3}$ M?

4. Consider the following energy diagram.



A) Which letter corresponds to the activation energy for the reaction?

B) Which letter corresponds to the position of an "activated complex" or "transition state?"

C) Is this reaction exothermic or endothermic? Which letter helps you decide this?

D) In the energy diagram above, draw a new label (letter F) which corresponds to the activation energy for the reverse reaction.

E) Is the activation energy in the reverse direction greater than or less than the activation energy for the forward reaction?