

Review for Rates of Reactions Test

1. Excellent questions from the textbook: Chapter 6 Self-Quiz #'s 1-18 on page 407 and Unit 3 Self-Quiz # 20-30 on page 412 as well as Chapter 6 Review questions (especially #13) on page 408
2. The following data were collected for the reaction: $\text{SO}_2\text{Cl}_2 \rightarrow \text{SO}_2 + \text{Cl}_2$

$[\text{SO}_2\text{Cl}_2]$ (mol/L)	Time (s)
0.140	0
0.120	20
0.080	100
0.070	130
0.055	200
0.040	300
0.032	400
0.028	500
0.025	700

- a) Graph concentration vs time.
To view this graph, go back to Answers to Assignments and open "Graph for Question #1 on Review"
- b) Determine the rate of reaction when $[\text{SO}_2\text{Cl}_2] = 0.120 \text{ M}$, 0.080 M and 0.040 M .
Note: values will vary slightly based on variations on graphs
- c) Fill the information from (b) into the chart:

$[\text{SO}_2\text{Cl}_2]$ mol/L	Rate of reaction (mol/L.s)
0.040	1.3×10^{-4}
0.080	3.6×10^{-4}
0.120	8.0×10^{-4}

- d) Determine the rate law for the reaction.

As concentration doubles (0.040 to 0.080) the rate increases by 2.8x, which lies between 1st order and 2nd order. When the concentration triples (0.040 to 0.12) the rate increases 6.2x, which lies between 1st order and 2nd order. Using my values, a decision must be made - is it closer to 1st or 2nd order - either guess would be equally correct. My guess is 1st order Therefore:
Rate = $k[\text{SO}_2\text{Cl}_2]$

3. The following data was collected for the reaction: $2\text{NO}_{(g)} + \text{O}_{2(g)} \rightarrow 2\text{NO}_{2(g)}$

$[\text{O}_2]$ mol/L	$[\text{NO}_{(g)}]$ mol/L	Initial rate of formation of NO_2 (mol/L.s)
0.0010	0.0010	7.1
0.0040	0.0010	28.4
0.0040	0.0030	85.2

- a) What is the rate law? $\text{Rate} = k[\text{O}_2][\text{NO}]$
- b) What is the value of the rate constant?
 $7.1 = k(0.0010)(0.0010)$
 $k = 7.1 \times 10^6 \text{ L/mol}\cdot\text{s}$
- c) When the rate of formation of NO_2 is 7.1 mol/L.s, what is the rate of disappearance of O_2 ?
 3.5 mol/L.s NO ? 7.1 mol/L.s
- d) Is it reasonable to suggest that this reaction proceeds as a 1-step reaction? No because according to the rate law the rate-determining step involves 1 NO. Since there are 2 NO's in the reaction, another step is needed to introduce this second NO.
- e) If the reaction proceeds as a 2-step mechanism, propose a mechanism that is consistent with the rate law.
 $\text{O}_2 + \text{NO} \rightarrow \text{NO}_3$ (slow step)
 $\text{NO}_3 + \text{NO} \rightarrow 2\text{NO}_2$ (fast step)

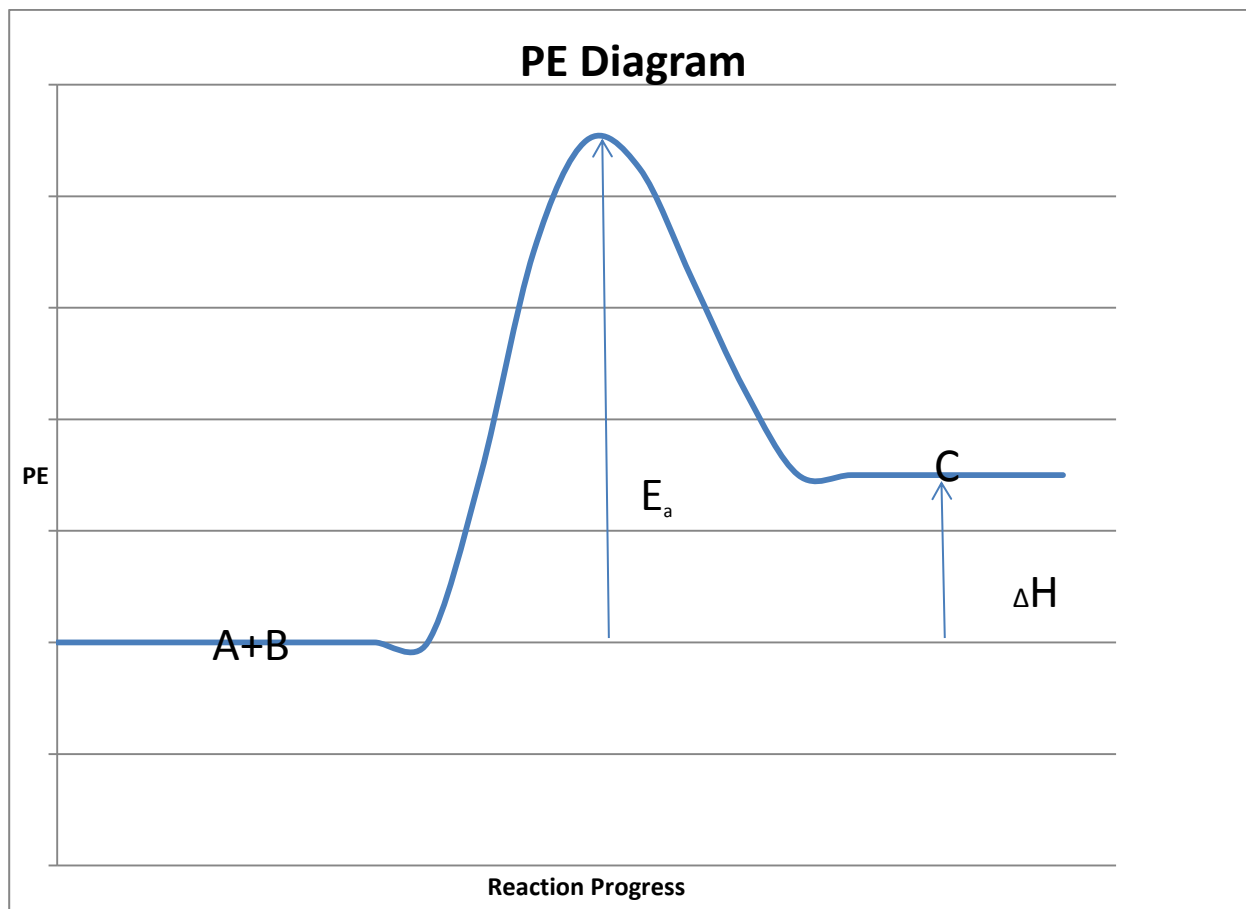
4. The following data was collected for the reaction: $2\text{P} + 3\text{Q} + \text{R} \rightarrow \text{T} + 2\text{U}$

Trial #	$[\text{P}]$ (mol/L)	$[\text{Q}]$ (mol/L)	$[\text{R}]$ (mol/L)	Rate of formation of T (mol/L.min)
1	1.0	1.0	1.0	3.0
2	1.0	2.0	2.0	6.0
3	1.0	2.0	3.0	6.0
4	1.0	3.0	4.0	9.0
5	2.0	3.0	5.0	36
6	3.0	3.0	6.0	81

- a) What is the rate law? $\text{Rate} = k[\text{P}]^2[\text{Q}][\text{R}]^0$ or $\text{Rate} = k[\text{P}]^2[\text{Q}]$
- b) What is the effect on the rate of i) doubling $[\text{P}]$ rate x4 ii) tripling $[\text{Q}]$ rate x3
 iii) quadrupling $[\text{R}]$ no effect iv) increasing temperature? Rate increased because 'k' will be bigger
- c) What is the overall order of the reaction? 3rd order
- d) Determine the rate constant. $k = 3 \text{ L}^2/\text{mol}^2\cdot\text{s}$
- e) What is the rate of formation of T when $[\text{P}] = 4.0 \text{ M}$, $[\text{Q}] = 3.0 \text{ M}$ and $[\text{R}] = 3.0 \text{ M}$? 144 mol/L.s

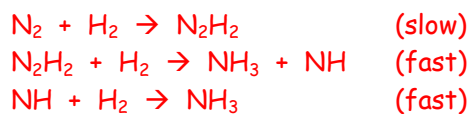
5. Draw a potential energy diagram for the reaction: $A + B \rightarrow C$ using the following information.

- The mechanism consists of one elementary step.
- The reaction is endothermic.
- The activation energy for the reaction has a value 3x the enthalpy value of the reaction.

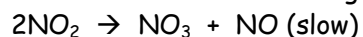


6. Consider the following reaction: $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$. Suppose the reaction is first order in N_2 and first order in H_2 ,

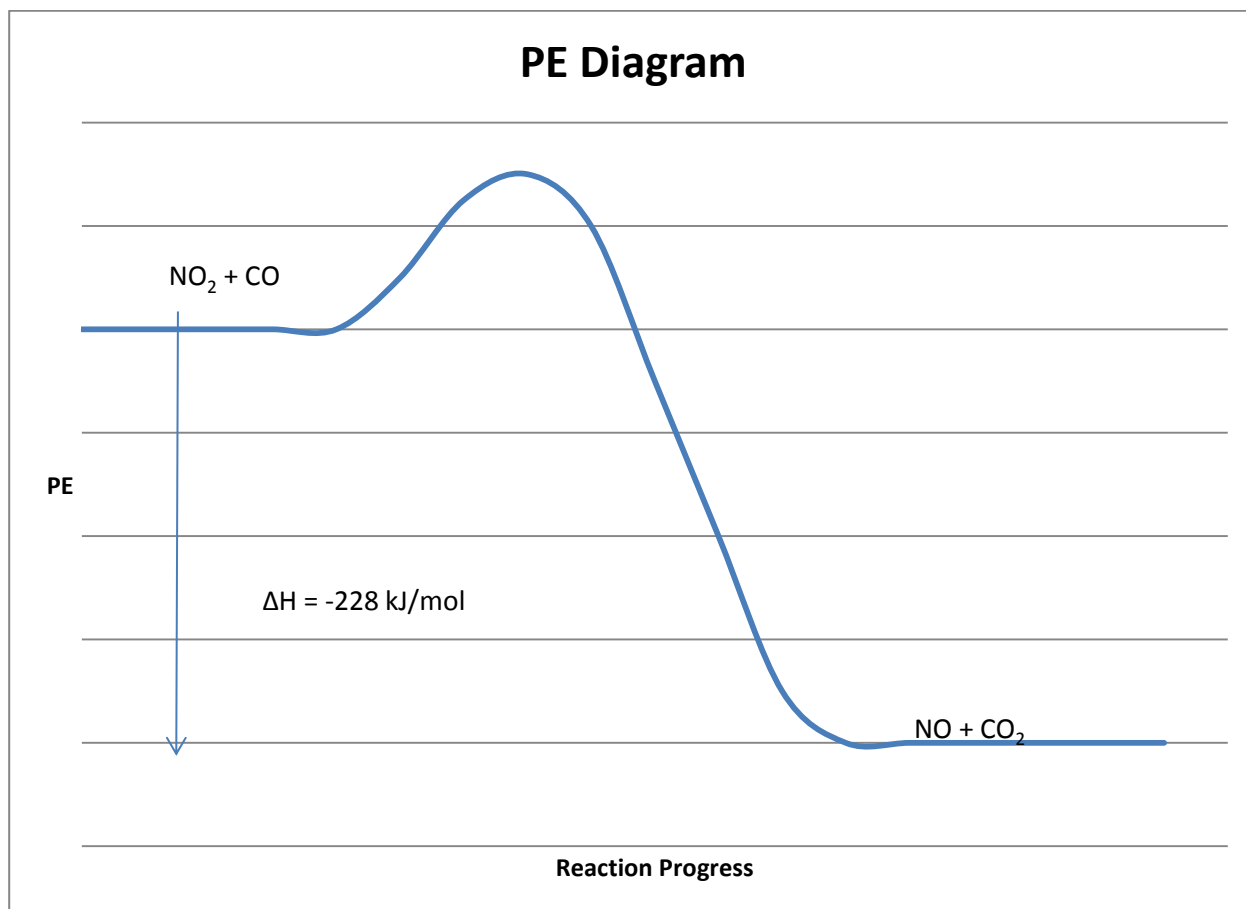
- Write the rate law. **Rate = $k[N_2][H_2]$**
- Propose a probable mechanism?



7. A reaction has the following mechanism:



- What is the rate law? **Rate = $k[NO_2]^2$**
- What is the overall reaction? **$NO_2 + CO \rightarrow NO + CO_2$**
- The overall reaction has an enthalpy change of -228 kJ/mol. Draw the potential energy diagram for the overall step.



- d) Draw a potential energy diagram for the 2-step reaction if $\Delta H = -100 \text{ kJ}$ for step one and ΔH for step two is -128 kJ .

See me in class for answer.