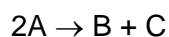


Part II Kinetics. Answer three (3) of problems 5-8. Clearly mark the problems you do not want graded. 15 points each. (13 points each)

Use the tabulated data below for problems 5 and 6. The data corresponds to the reaction below and shows dependence of concentration of A on time in experiments run at three temperatures.



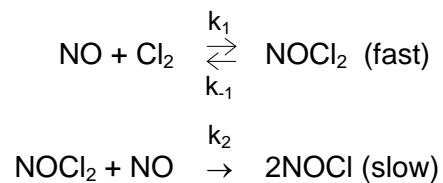
	T = 298 K	T = 348 K	T = 398 K
Time (sec)	[A] (M)	[A] (M)	[A] (M)
0	0.1000	0.1000	0.1000
1	0.0999	0.0991	0.0940
2	0.0999	0.0983	0.0883
8	0.0995	0.0932	0.0609
32	0.0980	0.0755	0.0137

5. Consider the data above. Clearly describe how the data could be used to determine the order for the reaction in A. No calculations are necessary. Feel free to include appropriate diagrams.
6. Consider the data above. Assuming you know the reaction to be first order in A, describe how you could determine the activation energy for the reaction. No calculations are necessary. Feel free to include appropriate diagrams.

7. The reaction $\text{I}^-(\text{aq}) + \text{OCl}^-(\text{aq}) \rightarrow \text{IO}^-(\text{aq}) + \text{Cl}^-(\text{aq})$ was studied and the data below were obtained. Determine the rate law and the value of the rate constant for this reaction.

$[\text{I}^-]_0(\text{mol/L})$	$[\text{OCl}^-]_0(\text{mol/L})$	Initial Rate (mol/Ls)
0.12	0.18	0.0791
0.060	0.18	0.0395
0.030	0.090	0.00988
0.24	0.090	0.0791

8. Experiment has shown that the rate law for the reaction $2\text{NO}(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{NOCl}(\text{g})$ is $\text{Rate} = k[\text{NO}][\text{Cl}_2]$. One proposed mechanism for this process is shown below, with the second step being rate-determining. Is this a reasonable mechanism for the reaction? Justify your decision.



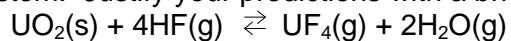
Part III Equilibrium. Answer three (3) of problems 9-12. Clearly mark the problems you do not want graded. (13 points each)

9. What do we mean when we say a system has *come to equilibrium*? Describe the equilibrium condition and why we don't use a single headed arrow when we write equilibria. What does a small equilibrium constant mean in terms of thermodynamics?

10. Consider the reaction below. If the initial concentrations of H_2 , F_2 , and HF are 0.0100M, 1.25 M, and 2.21 M, respectively, is the system at equilibrium? If not, which way will the reaction go to achieve the equilibrium condition? Set up, but do not complete the calculation you would use to determine the equilibrium concentrations of each of the species in the reaction. You DO NOT need to arrive at a numerical answer, just get to the point where you have one algebraic expression you could solve, given additional time. Be sure to tell me what you would do with the result of your calculation.



11. Suppose the reaction system below has already reached equilibrium. Predict the effect of the following changes on the system. Justify your predictions with a brief statement.



- More UO_2 is added to the system.
 - The reaction is performed in a glass reaction vessel and the HF reacts with the glass.
 - Water vapor is removed.
 - The volume is increased.
12. You have been tasked with determining the equilibrium constant for the reaction of H_2 and S_2 gases to produce hydrogen sulfide. A mixture of 1.00 g H_2 and 1.00 g H_2S in a 0.500 L flask comes to equilibrium at 1670 K. At equilibrium, there is 8.00×10^{-6} mol of S_2 present. What are the values for K_c and K_p at this temperature?

Possibly Useful Information

$\text{slope} = m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$	$R = 0.08206 \text{ L atm mol}^{-1} \text{ K}^{-1}$ $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$
$pV = nRT$	$\Delta G = -RT \ln K$	$K_p = K_c(RT)^{\Delta n}$
$k = Ae^{-E_a/RT}$	$\ln k = -\left(\frac{E_a}{R}\right)\left(\frac{1}{T}\right) + \ln A$	$\ln \frac{k_2}{k_1} = \frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$
$\text{rate} = k[A]^1$	$[A]_t = -kt + [A]_0$	$t_{1/2} = [A]_0/2k$
$\text{rate} = k[A]^2$	$\ln[A]_t = -kt + \ln[A]_0$	$t_{1/2} = 1/(k[A]_0)$
$\text{rate} = k[A]^0$	$\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$	$t_{1/2} = 0.693/k$

1 1A																	18 8A
<div><div>1 H 1.00794</div><div>2 2A</div></div>												13 3A	14 4A	15 5A	16 6A	17 7A	<div><div>2 He 4.00260</div></div>
<div><div>3 Li 6.941</div><div>4 Be 9.01218</div></div>												<div><div>5 B 10.811</div><div>13 Al 26.9815</div></div>	<div><div>6 C 12.011</div><div>14 Si 28.0855</div></div>	<div><div>7 N 14.0067</div><div>15 P 30.9738</div></div>	<div><div>8 O 15.9994</div><div>16 S 32.066</div></div>	<div><div>9 F 18.9984</div><div>17 Cl 35.4527</div></div>	<div><div>10 Ne 20.1797</div><div>18 Ar 39.948</div></div>
<div><div>11 Na 22.9898</div><div>12 Mg 24.3050</div></div>	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B		10 10B	11 1B	12 2B	<div><div>31 Ga 69.723</div><div>32 Ge 72.61</div></div>	<div><div>33 As 74.9216</div><div>51 Sb 121.757</div></div>	<div><div>34 Se 78.96</div><div>52 Te 127.60</div></div>	<div><div>35 Br 79.904</div><div>53 I 126.904</div></div>	<div><div>36 Kr 83.80</div><div>54 Xe 131.29</div></div>		
<div><div>19 K 39.0983</div><div>20 Ca 40.078</div></div>	<div><div>21 Sc 44.9559</div><div>39 Y 88.9059</div></div>	<div><div>22 Ti 47.88</div><div>40 Zr 91.224</div></div>	<div><div>23 V 50.9415</div><div>41 Nb 92.9064</div></div>	<div><div>24 Cr 51.9961</div><div>42 Mo 95.94</div></div>	<div><div>25 Mn 54.9381</div><div>43 Tc (98)</div></div>	<div><div>26 Fe 55.847</div><div>44 Ru 101.07</div></div>	<div><div>27 Co 58.9332</div><div>45 Rh 102.906</div></div>	<div><div>28 Ni 58.693</div><div>46 Pd 106.42</div></div>	<div><div>29 Cu 63.546</div><div>47 Ag 107.868</div></div>	<div><div>30 Zn 65.39</div><div>48 Cd 112.411</div></div>	<div><div>49 In 114.818</div><div>80 Hg 200.59</div></div>	<div><div>50 Sn 118.710</div><div>81 Tl 204.383</div></div>	<div><div>51 Sb 121.757</div><div>82 Pb 207.2</div></div>	<div><div>52 Te 127.60</div><div>83 Bi 208.980</div></div>	<div><div>53 I 126.904</div><div>84 Po (209)</div></div>	<div><div>54 Xe 131.29</div><div>85 At (210)</div></div>	<div><div>55 Cs 132.905</div><div>86 Rn (222)</div></div>
<div><div>87 Fr (223)</div><div>88 Ra 226.025</div></div>	<div><div>89 Ac 227.028</div><div>104 Rf (261)</div></div>	<div><div>105 Db (262)</div><div>106 Sg (266)</div></div>	<div><div>107 Bh (264)</div><div>108 Hs (277)</div></div>	<div><div>109 Mt (268)</div><div>110 Ds (271)</div></div>	<div><div>111 Rg (272)</div></div>												

*Lanthanide series	58 Ce 140.115	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.965	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.967
†Actinide series	90 Th 232.038	91 Pa 231.036	92 U 238.029	93 Np 237.048	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

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