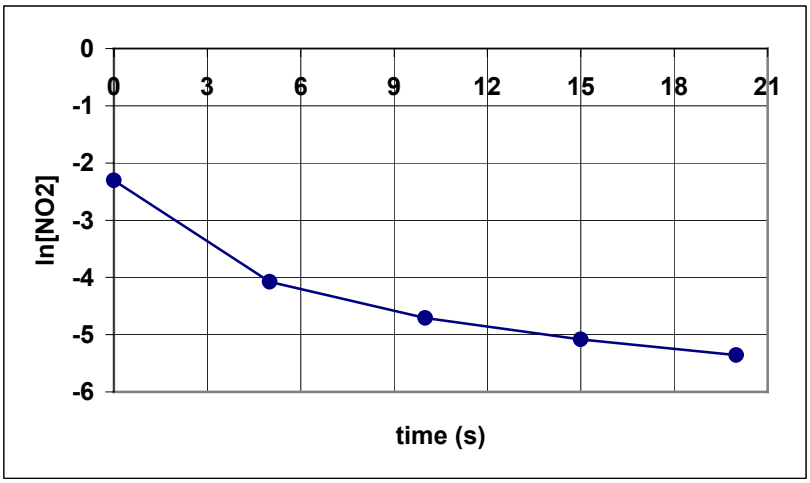
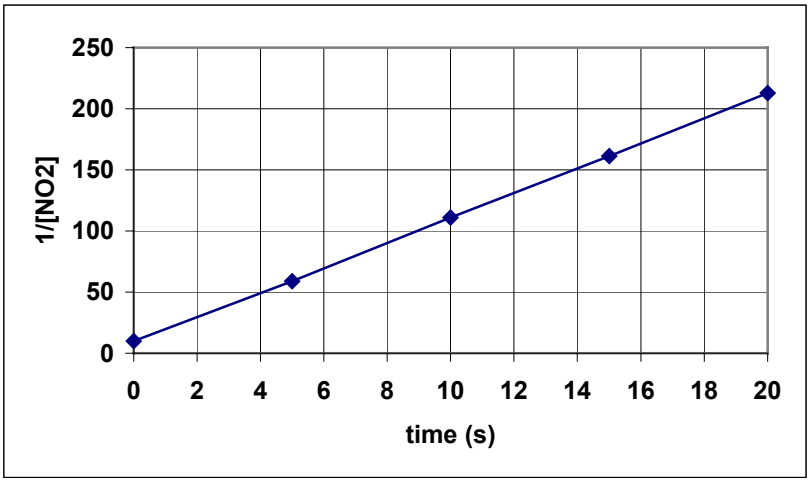
November 5, 2003

Review and Problem set for Exam 2

I. Kinetics. The gas-phase decomposition of NO_2, $NO_2(g) \rightarrow NO(g) + \frac{1}{2} O_2(g)$, is studied at 383°C, giving the following data:





a) Is the reaction first or second order with respect to the concentration of NO_2?

b) What is the value and the units of the rate constant?

c) Determine the half-life of NO_2 assuming that its initial concentration is 3×10^{-6} M

II Chemical Equilibria. A mixture of H_2, S, and H_2S is held in a 1.0 L vessel at 90 ^oC until the following equilibrium is achieved:

$$H_2\,(g) + S\,(s) \rightleftharpoons H_2S\,(g)$$

At equilibrium the mixture contains 0.46 g of H_2S and 0.40 g of H_2. The reaction is exothermic.

a) Write the equilibrium constant expression for this reaction

b) What is the value of K_c for the reaction at this temperature?

c) Which direction will the equilibrium shift (i.e., tend to shift toward the formation of reactants, toward the formation of products, or have no effect) if the system is subjected to each of the following changes:

Stress 1 H_2 is added

Stress 2 The amount of S is increased

Stress 3 The temperature is increased

Stress 4 The amount of H_2S is decreased

Stress 5 The partial pressure of H_2S is decreased

III. Acids and Bases. Predict the products of the following acid-base reactions, identify the conjugate acid-base pairs, and also predict whether the equilibrium lies to the left or to the right of the equation:

a) $H_3O^+ + OH^- \rightleftharpoons$

a) $HCO_3^-(aq) + F^-(aq) \rightleftharpoons$

b) $HC_2H_3O_2(aq) + HS^-(aq) \rightleftharpoons$

c) $HClO_4(aq) + Cl^-(aq) \rightleftharpoons$

	Acid	Base	
Strongest Acids	$HClO_4$	ClO_4^-	Weakest Bases
	H_2SO4	HSO_4^-	
	HI	I^-	
	HBr	Br^-	
	HCl	Cl^-	
	HNO_3	NO_3^-	
	H_3O^+	H_2O	
	HSO_4^-	SO_4^{2-}	
	H_2SO_3	HSO_3^-	
	H_3PO_4	$H_2PO_4^-$	
	HNO_2	NO_2^-	
	HF	F^-	
	$HC_2H_3O_2$	$C_2H_3O_2^-$	
	H_2CO_3	HCO_3^-	
	H_2S	HS^-	
	HClO	ClO^-	
	HBrO	BrO^-	
	NH_4^+	NH_3	
	HCN	CN^-	
	HCO_3^-	CO_3^{2-}	
	H_2O_2	HO_2^-	
	HS^-	S^{2-}	
	H_2O	OH^-	
Weakest Acids			Strongest Bases

IV. Definitions. Define each of the following:

1. Chemical kinetics
2. Reaction rate
3. Rate law
4. Rate constant
5. First order reaction
6. Expression for the first order reaction rate
7. Second order reaction
8. Expression for the second order reaction rate
9. Zero-order reaction
10. Expression for the zero-order reaction rate
11. Half-life of a reaction
12. Expression for half-life of the first-order reaction
13. Expression for half-life of the second-order reaction
14. Collision theory
15. Activation energy
16. Activated complex
17. Arrhenius equation
18. Reaction mechanism
19. Elementary step
20. Reactants
21. Products
22. Intermediates
23. Catalysts
24. Molecularity of a reaction
25. Unimolecular reaction
26. Bimolecular reaction
27. Termolecular reaction
28. Rate-determining (rate-limiting) step
29. Homogeneous catalysis
30. Heterogeneous catalysis
31. Chemical equilibrium
32. Equilibrium constant: definition, expression for a given chemical reaction
33. Homogeneous equilibrium
34. Heterogeneous equilibrium
35. Reaction quotient
36. Equilibrium position
37. Le Châtelier's principle
38. Bronsted acid, Bronsted base
39. Conjugate acid-base pairs
40. Strong acid, strong base
41. Weak acid, weak base
42. Acid ionization constant, base ionization constant
43. Ion product of water
44. pH, pOH
45. Neutral, acidic, basic solutions