Chapters 13 through 15. Sample test questions:

1. How many grams of water must be added to 40.0 grams of NaOH to produce a 4.00 molal solution of the base? A) 200 g B) 250. g C) 160 g D) 4.00 kg E) 100. G

2. What is the mole fraction of water in a solution containing 46.0 grams of C_2H_5OH and 180 grams of water? A) 0. 900 B) 0.909 C) 0.100 D) 0.0909 E) 0.80

3. Which solution has the lowest freezing point? A) 0.100 m NaCl B) 0.090 m $BaCl_2$ C) 0.100 m C_2H_5OH D) 0.030 m Na_2SO_4 E) 0.100 m $NaNO_3$

4. Given that the boiling point elevation constant of water is 0.52°/m , what is the boiling point of a solution containing 90.0 grams of glucose (MM = 180 g) in 250 g of water? A) 1.04° B) 0.26° C) 101.04° D) 100.26° E) 98.96°

5. The freezing point depression constant of water is 1.86° . What is the boiling point of an aqueous solution of a non-volatile solute if the freezing point of the solution is -5.00° C? 101.40°C

6. An ionic solute is LESS likely to dissolve in water if
   A) it has a very high lattice energy B) it has a very large hydration energy
   C) it produces a large entropy increase when it dissolves
   D) it contains metal ions from group 1 on the periodic table
   E) the water is at or near its boiling temperature

7. A saturated solution of NaCl in water contains 6.83 moles of NaCl in 1000 grams of water at 95.° C, a temperature at which the vapor pressure of pure water is 600. torr. Assuming the complete dissociation of the NaCl, what is the vapor pressure of the water in the solution? A) 482 torr B) 534 torr C) 410 torr D) 580 torr E) 600. Torr

8. -10. Base your answers on the reaction $2\ N_2O_{5(g)} \rightarrow 4\ NO_{2(g)} + O_{2(g)}$

8. Assume that experiments have shown that at a certain temperature, the decomposition is shown as **second order**, and the rate constant based on the rate of disappearance of N_2O_5 is 3.00×10^{-3} atm^{-1}/s · What is the instantaneous rate of decomposition of N_2O_5 when the pressure of the N_2O_5 is 0.100 atm?
A) 3.00×10^{-5} atm/s B) 3.00×10^{-4} atm/s C) 3.00×10^{-1} atm/s
D) 3.30×10^{-2} atm/s E) 3.33×10^{-3} atm/s

9. If the rate of decomposition of N_2O_5 at a particular instant is 4.2×10^{-7}atm/s, what is the rate of appearance of oxygen at that instant? (in atm/s)
A) 4.2×10^{-7} B) 2.1×10^{-7} C) 8.4×10^{-7} D) 1.05×10^{-7} E) -4.2×10^{-7}

10. If the initial pressure of the N_2O_5 gas is 1.00 atm. how long would it take the gas to decompose to a pressure of 0.500 atm? (Recall that , the decomposition is shown as **second order**, and the rate constant based on the rate if disappearance of N_2O_5 is 3.00×10^{-3} atm^{-1}/s) A) 1.50×10^{-3} sec. B) 333 sec. C) 231 sec
D) 462 sec E) 1.20 sec.

11. At a certain temperature, the decomposition of $H_2O_2(aq)$ is studied. It is found that when $Ln[H_2O_2]$ is plotted against time, the resulting graph is a straight line with a slope of -0.0200/s. From this we can conclude that
A) the reaction is 0 order, with a rate constant of -0.0200/s
B) the reaction is first order , with a rate constant of 0.0200/s
C) the reaction is second order, with a rate constant of 0.0200 $M^{-1}s^{-1}$
D) the reaction is second order, with a rate constant of –0.0200 $M^{-1}s^{-1}$
E) the reaction rate is independent of the concentration of hydrogen peroxide

12. The following mechanisms are proposed for the decomposition of H_2O_2 .

A) One step: $2\ H_2O_2 \rightarrow 2\ H_2O + O_2$

B) Two steps: 1. $H_2O_2 \rightarrow H_2O + O$ (fast)
2. $H_2O_2 + O \rightarrow H_2O + O_2$ (slow)

C) Two steps: 1. $H_2O_2 \rightarrow H_2O + O$ (slow)
2. $H_2O_2 + O \rightarrow H_2O + O_2$ (fast)

Which of these mechanisms, if any is (are) consistent with the data given in question 11? A) None of them B) A and C only C) C only
D) B and C only E) B only

13. Which of the mechanisms shown above would result in a rate law that contained water in the denominator of the rate law? A) None of them B) A and C only
C) C only D) B and C only ***E) B only***

14. The reaction $2\ NO(g) + 2H_{2(g)} \rightarrow N_2(g) + H_2O(g)$ has the rate law Rate = $k[NO]^2[H_2]$. What would be the impact on the instantaneous rate, if the volume of the reaction vessel was suddenly halved? The rate would
A) halve B) double C) become 8 x faster D) become 4 x faster
E) remain the same

15. Based on the mechanism: 1. $MnO_2 + H_2O_2 \rightarrow MnO_3 + H_2O$
2. $MnO_3 + H_2O_2 \rightarrow MnO_2 + O_2$

A) H_2O_2 is a catalyst, and H_2O is an intermediate
B) MnO_2 is a catalyst, and MnO_3 is an intermediate
C) MnO_3 is a catalyst, and MnO_2 is an intermediate
D) H_2O is a catalyst, and H_2O_2 is an intermediate
E) MnO_3 and MnO_2 are both intermediates

16-18 Assume that the rate law for the reaction $2\,NO_2(g) \rightarrow 2\,NO(g) + O_2(g)$ is Rate = $k[NO_2]$. When NO_2 has an initial concentration of 0.200 molar, it decomposes at an intial rate of 0.00200 M/s.

16. What is the rate constant, based on the rate of decomposition of the NO_2? (in s^{-1}) A) 0.00100 B) 0.0100 C) 0.000400 D) 100. E) 0.0400

17. How long would it take for the 0.200 molar solution to decompose to a molarity of 0.100 molar? A) 69.3 sec. B) 0.00100 sec C) 0.00400 sec D) 25 sec E) 34.6 sec

18. The rate constant for the reaction could also be calculated based on the rate of formation of oxygen. How would a rate constant that predicts the rate of formation of oxygen compare with the rate constant you calculated in question 16? A) it would be the same B) it would be twice as large C) it would be half as large D) it would be three times greater E) it would be one third as large

19. If at a certain temperature, the Kp for the reaction $N_2O_{4(g)} \rightleftarrows 2\,NO_2\,(g)$ is 4.00×10^5, then what is the Kp for the reaction $2\,NO_{2(g)} \rightleftarrows N_2O_4$ at that temperature?
A) 4.00×10^5 B) 4.00×10^{-5} C) 2.5×10^{-5} D) 2.5×10^{-6} E) -4.00×10^5

20. Given the following reactions and their Keq:

$H_3PO_{4(aq)} \rightleftarrows H_2PO_4^{2-}(aq) + H^+(aq)$ $K = 7.5 \times 10^{-3}$

$H_2PO_4^{2-}(aq) \rightleftarrows HPO_4^{2-}(aq) + H^+(aq)$ $K = 6.2 \times 10^{-8}$

What is the equilibrium constant for the reaction

$H_3PO_{4(aq)} \rightleftarrows HPO_4^{2-} + 2\,H^+$?

A) 1.2×10^5 B) 8.3×10^{-6} C) 4.65×10^{-9} D) 4.65×10^{-10} E) 7.5×10^{-3}

21. At 450 K, the Kp for the reaction $H_{2(g)} + I_{2(g)} \rightleftarrows 2\,HI(g)$ is 75.0. Find the Kc for the reaction at that temperature.
A) 37.5 B) 75.0 C) 2770 D) 2.03 E) 44.7

22. For the gas phase reaction $N_2 + 3\,H_2 \rightleftarrows 2\,NH_3$ it is found that at 472° C, an equilibrium mixture contains 7.38 atm H_2, 2.46 atm N_2 and 0.166 atm NH_3. What is the Kp for the reaction at that temperature?
A) 2.79×10^{-5} B) 9.14×10^{-3} C) 1.68×10^{-4} D) 5.96×10^3 E) 109.4

For 23 to 26 the choices are:

A. Reaction shifts to the left, with no change in Kp
B. Reaction shifts to the right, with no change in Kp
C. Reactions shifts to the left, and Kp decreases
D. Reaction shifts to the right, and Kp increases
E. There is no change in the equilibrium system. (reaction does NOT shift)

In the reaction $PCl_{5(g)} \rightleftarrows PCl_{3(g)} + Cl_{2(g)}$, which has a $\Delta H°$ of + 87.9 kJ

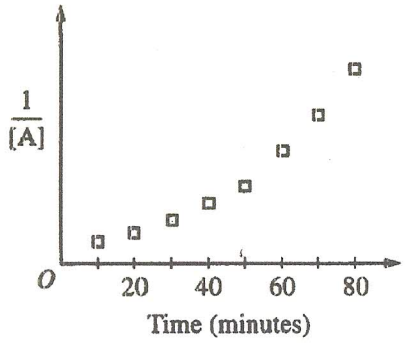
23. Some chlorine gas is removed (T constant) B

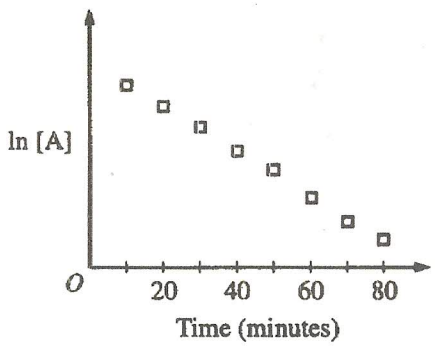
24. The temperature is increased D

25. The volume of the system is decreased (T constant) A

26. The formation of ammonia from its elements is exothermic. The temperature of an equilibrium mixture of nitrogen, hydrogen and ammonia is increased. C

Data for the chemical reaction $2A \rightarrow B + C$ were collected by measuring the concentration of A at 10-minute intervals for 80 minutes. The following graphs were generated from analysis of the data.





Use the information in the graphs above to answer the following. (3 pts each)

27. Write the rate-law expression for the reaction. Justify your answer. Rate = k[A] Only a first order reaction produces a straight line for log[A] against time.

28. Describe how to determine the value of the rate constant for the reaction.
Take the slope of the line in the Ln[A] vs time plot, and change the sign.

29. In the reaction $PCl_5(g) \leftrightarrows PCl_3(g) + Cl_2(g)$
0.200 mol of PCl_5 is introduced into a 2.00 liter vessel.
At equilibrium, the concentration of Cl_2 is found to be 0.0500 molar.
Find Kc for the reaction. (4 pts)

0.0500.

30. In the reaction $2\ SO_{2(g)} + O_{2(g)} \leftrightarrows 2\ SO_{3(g)}$, at a temperature where the Kc is 4.00×10^2, what is the equilibrium concentration of $SO_{2(g)}$ when the $[O_2]$ is 0.800 M, and the $[SO_3]$ is 3.60 molar? 0.201 M

31. $A_{(aq)} + 2\ B_{(aq)} \rightarrow 3\ C_{(aq)} + D_{(aq)}$

For the reaction above, carried out in solution of 30°C, the following kinetic data were obtained:

Experiment	Initial Conc. of Reactants (mole·liter^{-1})		Initial Rate of Reaction (mole·liter^{-1}·hr^{-1})
	A_o	B_o	
1	0.240	0.480	4.00
2	0.240	0.120	1.00
3	0.360	0.240	4.50
4	0.120	0.120	0.25
5	0.240	0.0600	0.50
6	0.0140	1.35	?

(a) Write the rate-law expression for this reaction. (3 pts) Rate = $k[A]^2[B]$

(b) Calculate the value of the specific rate constant k at 30°C and specify its units. (3 pts)

(c) Calculate the value of the initial rate of this reaction at 30°C for the initial concentrations shown in experiment 6. (2 pts) $k = 145\ M^{-2}hr^{-1}$ Rate = 0.0383 M/hr

32. Jack Daniels Tennessee whiskey is 40.00% ethanol by volume. However, % alcohol by mass is quite different from % by volume. The molality of ethanol in an aqueous solution that is 40.00 % ethanol by volume is 10.88 molal.

A) Find the % ethanol by MASS, based on the molality. The MM of ethanol, C_2H_5OH is 46 g. 33.35%

B. Find the mole fraction of alcohol in the 10.88 molal ethanol solution. 0.164

C. The solution has a density of 0.948 g/mL. Find the molarity of the solution. 6,88 M