

*Sample Chemistry 1066 Exam III*

1. (3 points) Which of the following oxides are commonly associated with acid rain?

- a.  $\text{NO}_2$       b.  $\text{CaO}$       c.  $\text{SO}_2$       d.  $\text{FO}$       **e. both a & c**

2. (3 points) An acid compound with a  $K_a$  of  $4.7\text{E}-6$  would be considered a \_\_\_\_\_.

- a. strong acid      **b. weak acid**      c. strong base  
d. neutral compound

3. (3 points) An acid called HA is 2.0% dissociated in a 0.100 M solution. What is the  $K_a$  of the acid based on this information?

- a.  $2.0\text{E}-3$       b.  $2.0\text{E}-2$       **c.  $4.1\text{E}-5$**       d.  $2.4\text{E}+4$       e.  
 $2.0\text{E}+3$

4. (4 points) What is the hydronium ion concentration in a 0.150 M solution of carbonic acid ( $\text{H}_2\text{CO}_3$ ) which has  $K_{a1}=4.3\text{E}-7$  and  $K_{a2}=4.7\text{E}-11$ ?

- a.  $2.5\text{E}-4$**       b.  $4.3\text{E}-7$       c.  $4.7\text{E}-4$       d.  $5.0\text{E}-4$       e.  
 $4.5\text{E}-6$

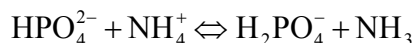
5. (3 points) A Bronsted-Lowry base in aqueous solution is a(n) \_\_\_\_\_.

- a. hydrogen ion donor                      b. hydroxide ion acceptor  
**c. hydrogen ion acceptor**                      d. electron pair acceptor

6. (3 points) A Lewis acid is a(n) \_\_\_\_\_.

- a. hydrogen ion acceptor                      b. electron pair donor  
c. a hydroxide ion donor                      **d. electron pair acceptor**

7. (3 points) In the following reaction the dihydrogen phosphate is the \_\_\_\_\_ of the monohydrogen phosphate.



- a. conjugate base                      **b. conjugate acid**  
c. conjugate ammonia                      d. Lewis base

8. (3 points) The pH of a 0.0207 M solution of nitric acid is \_\_\_\_\_.

- a. 2.07                      b. 0.685                      c. 3.772                      **d. 1.684**

9. (3 points) What is the pOH of a 0.17 M solution of hydrochloric acid?

- a. 0.770                      b. 1.17                      c. 11.70                      **d. 13.2**

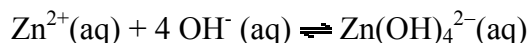
10. (4 points) Calculate the  $K_a$  of a weak acid if a 0.217 M solution has a pH of 5.85.

- a. 9.2E-12**                      b. 4.4E-4                      c. 1.5E+5                      d. 2.0E-12

11. (5 points) Calculate the pH of a 1.00 L of a 0.15 M buffer solution of aqueous ammonia to which 4.82 g of ammonium chloride



16. (3 pts) Which of the choices below is the appropriate mass action expression for the following reaction?

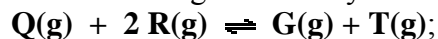


- a.  $K_c = \frac{[\text{Zn}^{2+}]^2[\text{OH}^{-}]}{[\text{Zn}(\text{OH})_4^{2-}]^2}$       b.  $K_c = \frac{[\text{Zn}^{2+}][\text{OH}^{-}]^4}{[\text{Zn}(\text{OH})_4^{2-}]}$
- c.  $K_c = \frac{[\text{Zn}(\text{OH})_4^{2-}]}{[\text{Zn}^{2+}][\text{OH}^{-}]^4}$       d.  $K_c = \frac{[\text{Zn}^{2+}][\text{OH}^{-}]}{[\text{Zn}(\text{OH})_4^{2-}]}$

17. (3 pts) The ratio given by the mass action expression for a particular reaction is \_\_\_\_\_.

- a. the same constant for any set of reaction conditions  
 b. **constant only at a given temperature**  
 c. variable if the temperature doesn't change  
 d. dependent only on concentration and not on reaction conditions

18. (3 pts) A mixture of the following reaction system:



has these concentrations:  $P(\text{Q}) = 0.15 \text{ atm}$ ;  $P(\text{R}) = 0.087 \text{ atm}$ ;  $P(\text{G}) = 0.22 \text{ atm}$ ;  $P(\text{T}) = 0.088 \text{ atm}$ . If the pressure dependent equilibrium constant for this reaction is 2.7, will this reaction mixture proceed in the forward or reverse direction?

- a. forward      **b. reverse**  
 c. neither, the system is at equilibrium      d. can't tell, not enough data

19. (4 pts) The value of the equilibrium constant  $K_p$  for the reaction given below is 0.684 at  $800^\circ\text{C}$ . ( $\Delta H^\circ(\text{rxn}, 298 \text{ K}) = 41.2 \text{ kJ/mol}$ )



Calculate the value of  $\Delta G^\circ$  for this reaction.

- a.  $2.04\text{E-}3 \text{ kJ/mol}$       b.  $4.9\text{E-}2 \text{ kJ/mol}$   
 c. **39.2 kJ/mol**      d.  $-6.10 \text{ kJ/mol}$

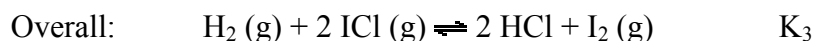
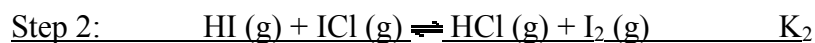
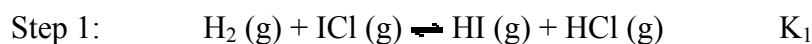
20. (4 pts) Use the Standard Free Energy of formation for the components of the following reaction to find the equilibrium constant at 298 K.



Component	$\Delta G_f^\circ$ (kJ/mol)
SO <sub>3</sub>	-371.1
CO	-137.2
SO <sub>2</sub>	-300.1
CO <sub>2</sub>	-394.4

- a. 2.3E-33      b. 5.8E-17      c. 2.1E16      **d. 4.4E32**

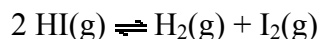
21. (3 pts) The following two-step process has equilibrium constants  $K_1$  and  $K_2$ .



What is the expression for the equilibrium constant for the overall reaction,  $K_3$ ?

- a.  $K_3 = K_1^{1/2}$       b.  $K_3 = 1/(K_1K_2)$       c.  $K_3 = K_1 + K_2$   
**d.  $K_3 = K_1K_2$**       e.  $K_3 = (K_1K_2)^2$

22. (4 pts) 2.0 moles of hydrogen iodide are placed in a 2.0 L container at a constant temperature. The hydrogen iodide partially dissociates according to the equation,

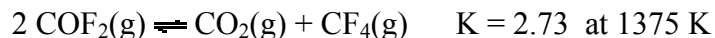


If 20.% of the HI has dissociated at equilibrium, what is the value of  $K_c$ ?

- a. 0.063      **b. 1.6E-2**      c. 0.25      d. 0.50

23. (3 pts) At equilibrium, what is equal?
- concentrations of products and reactants
  - rate constants for the forward and reverse reactions
  - the rate of forward and reverse reactions**
  - the partial pressures of the reactants and products
  - the reaction quotient and the rate of both reactions

25. (4 pts) Carbonyl fluoride,  $\text{COF}_2$ , is an important intermediate used in the production of fluorine-containing compounds. For instance, it is used to make the refrigerant carbon tetrafluoride,  $\text{CF}_4$ .



If the initial concentration of carbonyl fluoride is 1.90 M for this reaction, what is the concentration of carbon tetrafluoride at equilibrium?

- a. 0.730                      **b. 1.18**                      c. 0.314                      d. 0.696
26. (3 pts) Ammonia can be produced via the chemical reaction:



During the production process, the production engineer determines the reaction quotient. She finds that  $Q = 3.56 \times 10^{-4}$ . If  $K = 6.02 \times 10^{-6}$ , what can be said about the reaction?

- the reaction has reached equilibrium
- The reaction is not at equilibrium and will approach equilibrium from the left
- The reaction is not at equilibrium and will approach equilibrium from the right**
- The reaction is not at equilibrium but it is not possible to determine whether the reaction needs to proceed right or left to reach equilibrium

27. (3 pts) The addition of a catalyst to a system at equilibrium will \_\_\_\_\_.  
(no other changes are made)
- increase the concentration of products and decrease the concentration of reactants.
  - decrease the concentration of products and increase the concentration of reactants.
  - have no effect on the concentration of reactants and products**
  - increase the activation energy of the forward reaction
28. (3 points) Which of the following is NOT an acid-base conjugate pair?
- HCN and  $\text{CN}^-$
  - $\text{H}_2\text{O}$  and  $\text{OH}^-$
  - $\text{H}_2\text{S}$  and  $\text{OH}^-$**
  - $\text{NH}_4^+$  and  $\text{NH}_3$
29. (3 points) We have a solution of  $\text{NH}_4\text{Cl}$ . What effect will addition of  $\text{NaCl}$  have on the pH of the solution?
- increase pH
  - decrease pH
  - no effect**
  - cannot tell from information given
30. (3 points) Which one of the following is the strongest acid?
- $\text{HClO}$
  - $\text{HClO}_3$
  - $\text{HClO}_2$
  - $\text{HClO}_4$**
31. (3 points) Concentrated  $\text{HCl}$  is 12 M. What is the pH of concentrated  $\text{HCl}$  at  $25^\circ\text{C}$ ?
- 1.08
  - 1.08**
  - 12.00
  - 1.55
32. (3 points) At  $10^\circ\text{C}$  the water ionization constant,  $K_w$ , is  $2.9 \times 10^{-15}$ . What is  $[\text{H}_3\text{O}^+]$  in neutral water at  $10^\circ\text{C}$ ?
- $4.44 \times 10^{-6} \text{ M}$
  - $1.00 \times 10^{-7} \text{ M}$
  - $1.70 \times 10^{-7} \text{ M}$
  - $5.39 \times 10^{-8} \text{ M}$**

33. (4 points) What is  $[\text{H}_3\text{O}^+]$  in a 0.034 M solution of HF at 25 °C? ( $K_a$  for HF =  $7.2 \times 10^{-4}$ )

- a)  **$4.60 \times 10^{-3} \text{ M}$**       b)  $4.95 \times 10^{-2} \text{ M}$       c) 0.034 M  
d) 0.027 M

34. (4 points) What is the pH of a 0.52 M solution of  $\text{NaCH}_3\text{COO}$  at 25 °C? ( $K_b$  for  $\text{HC}_3\text{COO} = 5.6 \times 10^{-10}$ )

- a) **9.23**      b) 4.77      c) 9.37      d) 10.21

35. (4 points) We mix 100. mL of 0.20 M HBr and 50.0 mL of 0.40 M NaClO. What is the pH of the resulting solution?  $K_a(\text{HClO}) = 3.5 \times 10^{-8}$ .

- a) 9.83      b) 4.07      c) **4.17**      d) 3.92

36. (5 pts) Extra Credit

The activation energy for the following reaction is 250. kJ. If the rate constant for this reaction is  $0.380 \text{ L/mol}\cdot\text{s}$  at 1001K, what will the value of  $k$  be at 25.0°C?



- a.  $6.38 \text{ E-32}$**       b.  $1.57 \text{ E31}$       c. 0.113      d. 8.83