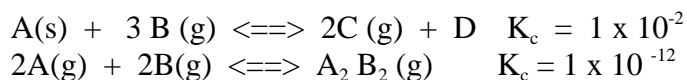


For the following acids and bases:



1.      What is meant by the term dynamic equilibrium?

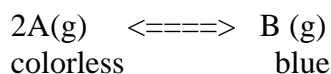
2.      For two separate chemical reactions:



(a) Write the equilibrium expressions for each

(b) Which is product favored? Explain your answer.

3.      Consider the gaseous equilibrium process for compound A which is colorless, and compound B which is blue, according to the equation:

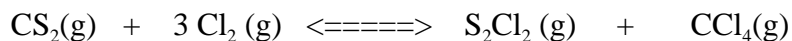


The size of the container is suddenly halved and a new equilibrium is established. Use LeChatelier's principal to explain

(a) the change in color (if any) that would be observed initially when the size of the container is decreased.

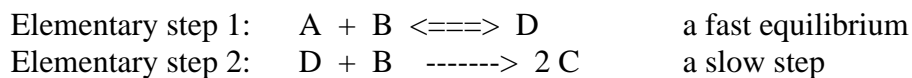
(b) the change in color (if any) that would be observed in the smaller container after time has passed.

4. Consider the reaction of carbon disulfide and chlorine according to the following equation:



When 1.2 moles of  $\text{CS}_2$  and 3.6 moles of  $\text{Cl}_2$  are placed in a 1.00 L container and allowed to reach equilibrium, the mixture contains 0.90 mol of  $\text{CCl}_4$ . Calculate the equilibrium concentrations of all species and  $K_c$ .

5. The reaction  $\text{A} + 2\text{B} \rightarrow$  proceeds via the following mechanism



Derive the rate law for this reaction.

6. For the reaction:  $\text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{CO}_2(\text{g})$   
At 325 °C, the concentrations are: 0.10 M  $\text{CO}$ , 0.10 M  $\text{H}_2\text{O}$ , 0.10 M  $\text{H}_2$  and 0.40 M  $\text{CO}_2$ .  
Calculate the equilibrium constant for this reaction.

7. For the reaction in question number 6 above, when the concentrations are: 0.0010 M CO, 0.0010 M H<sub>2</sub>O 0.0010 M H<sub>2</sub> and 0.0040 M CO<sub>2</sub> at 325 °C, using the reaction quotient, determine weather the reaction is at equilibrium or will favor the forward or reverse direction.
8. Three models describing acid-base chemistry were presented in class. Give these and describe how they differ from one another.
9. For the acid-base reaction:  $\text{SO}_4^{2-}(\text{aq}) + \text{CH}_3\text{CO}_2\text{H}(\text{aq}) \rightleftharpoons \text{HSO}_4^{-}(\text{aq}) + \text{CH}_3\text{CO}_2^{-}(\text{aq})$   
(a) In which direction would this reaction be favored to proceed.  
  
b) Give your reasoning.
10. Write equations for the reaction of phosphoric acid (H<sub>3</sub>PO<sub>4</sub>) and water and discuss to what degree each occurs in terms of the dissociation constants and which would have the most pronounced effect on the pH.

11. Calcium hydroxide is a slightly soluble compound. Does the pH of a saturated calcium hydroxide solution increase, decrease or remain the same when calcium chloride is also present? Explain your answer.

12. For a solution of 0.0013 M  $\text{HNO}_3$

(a) Calculate the pH

(b) What is the hydroxide ion concentration?

(c) Is the solution acidic or basic?

13. For a 0.025 M solution of HCN,

(a) what are the equilibrium concentrations of  $\text{H}_3\text{O}^+$ ,  $\text{CN}^-$  and HCN?

(b) What is the pH for the solution?

14. Describe what a buffer solution is and qualitatively how a buffer works

16. What is the  $pK_a$  for acetic acid?

Employing the Henderson-Hasselbach relation, determine the pH of a solution that has an acetic acid concentration 0.050 M and a sodium acetate concentration of 0.075 M.

17. Describe what the equivalence point of an acid base reaction is.

18. Decide if the pH is equal to 7, less than 7 or greater than 7 when the following reactions occur using equal molar amounts of acid and base.

- (a) A weak base with a strong acid
- (b) A strong base with a strong acid
- (c) A strong base with a weak acid
- (d) A strong acid with a strong base
- (e) A weak acid with a weak base

19. Sketch titration curves for the following titrations

(a) A weak base with a strong acid

(b) A strong base with a strong acid

(c) A strong base with a weak acid

20. What is the pH of a solution when you titrate 100 mL of 0.100 M acetic acid with 90 mL of 0.100 M NaOH?