Acid-Base Equilibria: Buffer Problems

1. Which of the following is a buffer solution?
a) 0.40 M HCN + 0.10 KCN b) 0.20 M CH_3COOH c) 1.0 M HNO_3 + 1.0 M $NaNO_3$

2. Which one of the following combinations cannot be a buffer solution?
a) HCN + KCN   b) HCl + NaClc) NH_3 + $(NH_4)_2SO_4$ d) HNO_2 + $NaNO_2$

3. Which is the net-ionic equation for the reaction that occurs when small amounts of HCl $_{(aq)}$ are added to a HOCl/ NaOCl buffer solution?
a) $H^{+1} + H_2O \rightarrow H_3O^{+1}$b) $H^{+1} + OCl^{-1} \rightarrow HOCl$ c) $HOCl + H^{+1} \rightarrow H_2OCl^{+1}$

4. Consider a buffer solution prepared from HOCl and NaOCl. Which is the net ionic equation for the reaction that occurs when NaOH is added to this buffer?
a) $OH^{-1} + HOCl \rightarrow H_2O + OCl^{-1}$ b) $OH^{-1} + OCl^{-1} \rightarrow HOCl + O^{-2}$

5. Assuming equal concentrations of conjugate base to acid, which one of the following mixtures is suitable for making a buffer solution with an optimum pH of 4.6 – 4.8?
a) CH_3COONa/ CH_3COOH Given K_a = 1.8 x 10^{-5}
b) $NaNO_2$/HNO_2 Given K_a = 4.5 x 10^{-4} c) NH_3/ NH_4ClGiven K_a = 5.6 x 10^{-10}

6. A buffer solution that contains ethanoic acid and sodium ethanoate has a pH = 4.0. Explain how could the pH of this solution be changed to 5.0.

7. Calculate the pH of buffer solution that contains 0.25 mol dm^{-3} benzoic acid, C_6H_5C00H, and 0.15 mol dm^{-3} sodium benzoate, C_6H_5COONa. Given K_a = 3.2 x 10^{-5}

8. A solution is prepared by mixing 500 cm^3 of 0.10 mol dm^{-3} NaOCl and 500 mL of 0.20 mol dm^{-3} HOCl. What is the pH of this solution? Given K_a = 3.2 x 10^{-8}

9. Calculate the pH of a buffer solution prepared by dissolving 0.20 mole of cyanic acid, HCNO and 0.80 mole of sodium cyanate, NaCNO, to make 1.0 dm^{-3} of solution. Given K_a = 2.0 x 10^{-4}

10. Calculate the pH of a solution that is 0.410 mol dm^{-3} in HOCl and 0.050 mol dm^{-3} in NaOCl. Given K_a HOCl = 3.2 x 10^{-8}

11. You are asked to go into the lab and prepare an acetic acid – sodium acetate buffer solution with a pH of 4.00 ± 0.02. What molar ratio of CH_3COOH to CH_3COONa should be used?
(Ka CH3COOH = 1.8 x 10^{-5})

12. 2.00 g benzoic acid, C_6H_5COOH, and 2.00 g of sodium benzoate, C_6H_5COONa are dissolved to make 1.00 dm^{-3} of solution. Given K_a C_6H_5COOH = 6.3 x 10^{-5}
a) What is the pK_a of the acid?   b) What is the pH of the solution?

13. Suppose that you mix 15.0 g $NaHCO_3$, and 18.0 g Na_2CO_3 to make 1.0 dm^{-3} of solution given $K_a HCO_3^{-1} = 5.61 \times 10^{-11}$. Calculate the pH of the solution.

14. A nutrition scientist needed to make up an aqueous buffer with a pH of 3.90. Would methanoic acid and its salt sodium methanoate, make a good pair for this purpose? If so, what mole ratio of the anion of the salt to the acid is needed.
Given $K_a HCOOH = 1.8 \times 10^{-4}$.

15. What must be the concentration of F^{-1} in a NaF/ HF buffer to give a pH = 4.00, when solid NaF is added to 0.10 mol dm^{-3} solution of HF? Given $K_{a,} HF = 6.5 \times 10^{-4}$

16. Describe fully, with calculations how you would prepare a "phosphate buffer" with a pH of 7.40.
Given $K_a H_3PO_4 = 7.5 \times 10_{-3}$, $K_a H_2PO_4^{-1} = 6.2 \times 10^{-8}$, $K_a HPO_4^{-2} = 4.8 \times 10^{-13}$

17. A buffer is prepared by adding 5.0 g NH_4NO_3 to 1.0 dm^3 and 1.0 mol dm^{-3} NH_3. What is the pH of the buffer?

18. What is the pH of a buffer solution made by adding 0.2 mol of sodium ethanoate to 500 cm^3 of 1.0 mol dm^{-3} ethanoic acid, given that K_a for the acid 1.8×10^{-5}?

19. How can you make a buffer of pH 4.5 from propanoic acid, $pK_a = 4.87$?

20. How would you prepare a litre of "carbonate buffer" at a pH of 10.10? You are provided with $H_2CO_{3(aq)}$, $NaHCO_3$ and Na_2CO_3.

21. Calculate the pH of a buffer solution by adding 5.00 g CH$_3$COONa to 1.00 dm^{-3} of a 0.10 mol dm^{-3} CH_3COOH. K_a for ethanoic acid is 1.8×10^{-5}

22. Calculate the pH of a 0.30 mol dm^{-3} NH_3, and 0.36 mol dm^{-3} NH_4Cl buffer system. $pK_a NH_3 = 9.25$