Quiz 17.1 – Buffer Solutions

Name: Key

Question 1

Each acid/base conjugate pair can act as a buffer. $pH = pK_A \pm 1$ $pK_a = -\log K_a$
Give the pH range over which each pair below works (Consult Appendix A.3 for K_a values):

NH_4^+/NH_3	$HClO_2/ClO_2^-$	HPO_4^{2-}/PO_4^{3-}	$HC_5H_5N^+/C_5H_5N$
8.26 - 10.26	0.96 - 2.96	11.32 - 13.32	4.23 - 6.23

Question 2

1.5 g of MgF_2(s) are dissolved in a 100.0 ml solution of 0.5 M HF. Find the pH of the solution

$pK_A = 3.20$ $100.0\,ml\left(\frac{0.5\,mmol}{ml}\right) = 0.050$ moles HF

$$1.5\,g\,MgF_2 \left|\frac{1\,mol}{62.30\,g}\right|\frac{2\,F^-}{1\,MgF_2} = 0.048 \text{ moles } F^-$$

$$pH = pK_a + \log\frac{F^-}{HF}$$

$$pH = 3.20 + \log\left(\frac{0.048\,moles}{0.050\,moles}\right) = 3.18$$

Question 3

Find the pH if 25.0 ml of 0.75 M HCl are added to the buffer solution prepared in Question 2

$0.025\,L \cdot \frac{0.75\,moles}{L} = 0.0188$ moles HCl

	HCl	$+ F^-$	$\rightarrow HF$	$+ Cl^-$
B	0.0188	0.048	0.050	
C	-0.0188	-0.0188	+0.0188	
A	0	0.029	0.069	

$$pH = 3.20 + \log\left(\frac{0.029\,moles}{0.069\,moles}\right)$$

$pH = 2.82$

Question 4

You want to make a buffer solution with $pH = 9.750$ using a HCN/CN^- buffer. You have one solution with $[HCN] = 0.100\ M$ and another with $[CN^-] = 0.200\ M$ which you can mix together to make the buffer. If you start with 125 ml of the HCN solution, How many ml of CN^- solution should you use?

$pK_A = 9.208$

$pH = pK_A + \log\frac{B}{A}$

$9.750 = 9.208 + \log\frac{B}{A}$ $\log\frac{B}{A} = 0.542$

$$\frac{B}{A} = 3.48 = \frac{M_B V_B}{M_A V_A} = \frac{0.200\,M\,V_B}{0.100\,M\,125\,ml} \rightarrow V_B = 217.7\,ml$$

218 ml

Question 5

Find the buffer capacity of the solution prepared in Question 4 (The easy way: how many moles of strong acid and strong base could be added before all buffer reactants are consumed?)

Against acid, capacity $\approx n_{base}$ $0.200\,M \cdot 0.218\,L = 0.0436$ moles

Against base, capacity $\approx n_{Acid}$ $0.100\,M \cdot 0.125\,L = 0.0125$ moles