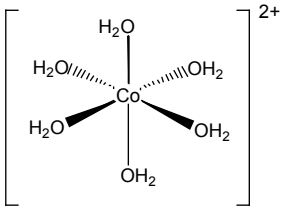
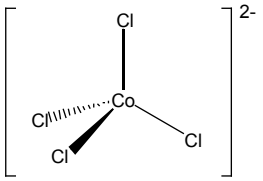
Lecture Notes N: Acid-Base Chemistry I

1) Discussion of Laboratory 2





$Co(H_2O)_6^{+2}{}_{(aq)}$ + $4\ Cl^-_{(aq)}$ ⇌ $CoCl_4^{-2}{}_{(aq)}$ + $6\ H_2O$

Lab chemicals:

Cobalt Chloride Hexahydrate	$[Co(H_2O)_6]Cl_{2\ (s)}$
Cobalt nitrate or sulfate	$Co(NO_3)_{2\ (s)}$ or $Co(SO_4)_{\ (s)}$
Sodium chloride	NaCl

2) Water self-ionization and pH Scale

$$H_2O_{(l)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + OH^-_{(aq)} \qquad K_w$$

Dependence of K_w on Temperature:

T(^{o}C)	K_w
0	0.114×10^{-14}
25	1.008×10^{-14}
40	2.92×10^{-14}
60	9.61×10^{-14}

PH	2	3	4	5	6	7	8	9	10	11	12
[H+]	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}	10^{-12}
[OH-]	10^{-12}	10^{-11}	10^{-10}	10^{-9}	10^{-8}	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}
POH	12	11	10	9	8	7	6	5	4	3	2

3) Strong acids and bases

Strong acid: $HA + H_2O \rightleftharpoons H_3O^+ + A^- \qquad K_a > 1$

Strong base: $BOH \rightleftharpoons OH^- + B^+ \qquad K_b > 1$

Strong Acids

Hydrioidic	HI	$K_a \sim 10^{11}$	pKa = -11
Hydrobromic	HBr	$K_a \sim 10^{9}$	pKa = -9
Perchloric	$HClO_4$	$K_a \sim 10^{7}$	pKa = -7
Hyrdrochloric	HCl	$K_a \sim 10^{7}$	pKa = -7
Chloric	$HClO_3$	$K_a \sim 10^{3}$	pKa = -3
Sulfuric	H_2SO_4	$K_a \sim 10^{2}$	pKa = -2
Nitric	HNO_3	$K_a \sim 20$	pKa = -1.3

Strong Bases

Lithium hydroxide	LiOH	
Sodium hydroxide	NaOH	
Potasium hydroxide	KOH	$K_b \sim 10^2$-10^3
Rubidium hydroxide	RbOH	
Cesium hydroxide	CsOH	
Magnesium hydroxide	$Mg(OH)_2$	
Calcium hydroxide	$Ca(OH)_2$	$K_b \sim 0.01$ to0.1
Strotium hydroxide	$Sr(OH)_2$	
Barium hydroxide	$Ba(OH)_2$	

4) Reactions of strong acids and bases (limiting reagents, with a twist)

What is the pH of a 1.00M solution of HCl

Consider mixing 10.0ml of a 1.00M NaOH solution with 25.0ml of a 1.00M HCl solution

Consider mixing 24.0ml of a 1.00M NaOH solution with 25.0ml of a 1.00M HCl solution

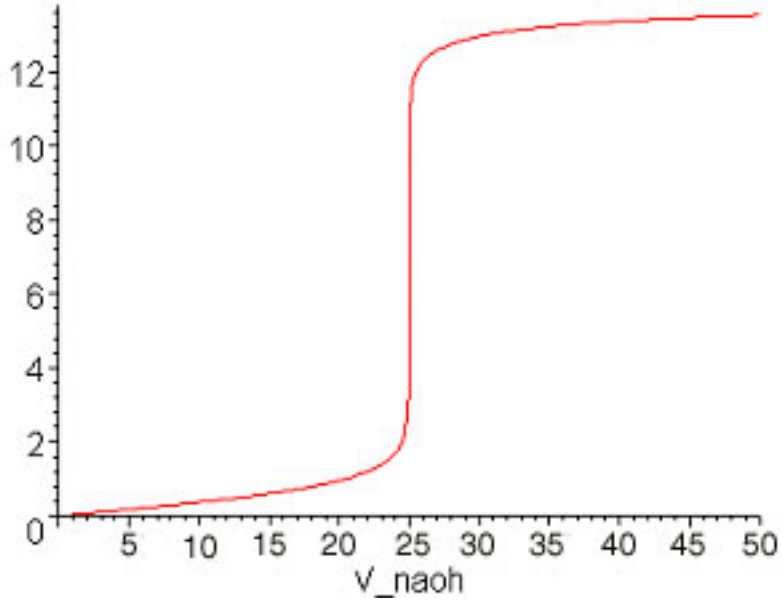
Consider mixing 25.0ml of a 1.00M NaOH solution with 25.0ml of a 1.00M HCl solution

Consider mixing 26.0ml of a 1.00M NaOH solution with 25.0ml of a 1.00M HCl solution

Consider mixing 50.0 ml of a 1.00M NaOH solution with 25.0ml of a 1.00M HCl solution

5) Titration of a strong acid with a strong base

Slowly add 1.0M NaOH to 25.0ml of 1.0M HCl



Concept test

How many moles of solid NaOH do you need to add to 100ml of 1M HCl to get a pH of 7?

a) 0.010 moles b) 0.10 moles c) 0.50 moles d) 1.0 moles

How many ml of 5M NaOH do you need to add to 100ml of 1M HCl to get a pH of 7?

a) 10ml b) 20ml c) 25ml d) 50ml

10ml of 1M NaOH is mixed with 7ml of 2M HCl. The resulting solution is:

a) acidic (pH < 7) b) basic (pH > 7) c) neutral (pH = 7)

How many ml of 1M NaOH do you need to add to 100ml of 1M HCl to get a pH of 8?

a) 100ml b) 125ml c) 150ml d) none of the above

A comic book villain is holding you at gun point and is making you drink a sample of acid. She gives you a beaker with 100ml of a strong acid with pH=2. She also gives you a beaker of a strong base with a pH=13. You can add as much of the strong base to the strong acid as you want, and you must then drink the solution. You'd be best off trying to make the solution neutral before drinking it. How much of the base should you add?

a) 1 ml b)10 ml c) 100 ml d) 1000 ml