Ex: we want to make 1.0 L of a "phosphate" buffer w/ pH of 7.05

H_3PO_4 triprotic weak acid.

$pK_{a1} = 2.125$ $K_{a1} = 7.5\times10^{-3}$

$$H_3PO_4(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + H_2PO_4^-(aq)$$

* $pK_{a2} = 7.208$ $K_{a2} = 6.2\times10^{-8}$

→ $$H_2PO_4^-(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + HPO_4^{2-}(aq)$$

$pK_{a3} = 12.319$ $K_{a3} = 4.8\times10^{-13}$

$$HPO_4^{2-}(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + PO_4^{3-}(aq)$$

$$pH = pK_a + \log\frac{[base]}{[acid]}$$

pK_a ← $-\log K_a$; [base], [acid]: conj. pairs (weak)

Buffer: $[base] \approx [acid]$

$\Rightarrow pH \approx pK_a$

$H_2PO_4^-$: $pK_a = 7.21$ (weak acid)

+ also need conj. base : HPO_4^{2-} (base)

$$pH = pK_a + \log\frac{[base]}{[acid]}$$

[base] ← HPO_4^{2-}; [acid] ← $H_2PO_4^-$

pH ↑ 7.05 ↑ requested pH; pK_a ↑ 7.21

want 1 L

$$\Rightarrow \log\frac{[base]}{[acid]} = pH - pK_a$$

$= 7.05 - 7.21$

$\log b/a = -0.16$

$$\Rightarrow \frac{[base]}{[acid]} = 10^{-0.16}$$

$$\Rightarrow \frac{[HPO_4^{2-}]}{[H_2PO_4^-]} = 0.692$$

easy... $[H_2PO_4^-] = 1.0\ M$ (assume)

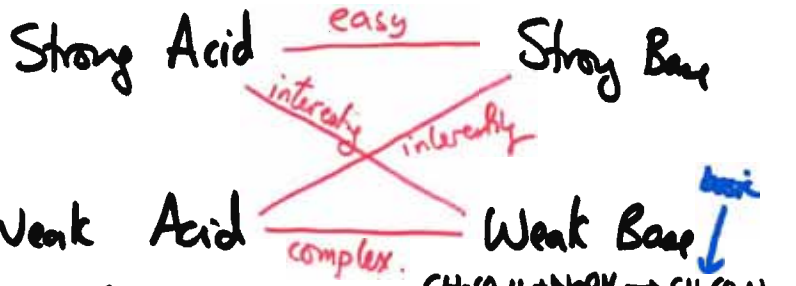
then $[HPO_4^{2-}] = 0.69\ M$

– take 1.0 mol $Na^+H_2PO_4^-$ (NaH_2PO_4) and 0.69 mol $2Na^+HPO_4^{2-}$ (Na_2HPO_4) } add to 1 L vol flask + add H_2O

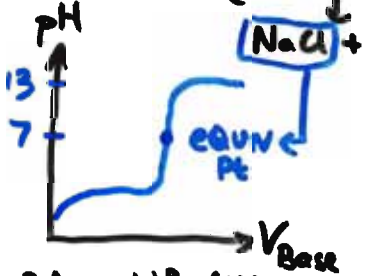
Acid-Base Titration

used to det [ ]

4 kinds of titrations...

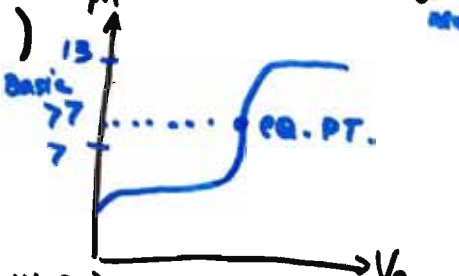


SA vs SB (HCl + NaOH → NaCl + H_2O)



$CH_3CO_2H + NaOH \rightarrow CH_3CO_2Na + H_2O$

WA vs SB

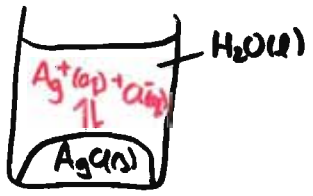


SA vs WB ($HCl + NH_3 \rightarrow NH_4Cl$)

$NH_4^+Cl^-$ → neutral / acidic

Solubility Equilibria

$AgCl(s)$ ← 1st semester ← INSOLUBLE



slightly soluble!

- dynamic eqm.

$$AgCl(s) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$$

all ionic cpds are like this!

ex: Calcium fluoride – insol?

$$CaF_2(s) \rightleftharpoons Ca^{2+}(aq) + 2F^-(aq)$$

calcium phosphate – insol?

$$Ca_3(PO_4)_2(s) \rightleftharpoons 3Ca^{2+}(aq) + 2PO_4^{3-}(aq)$$

K_{sp} ← solubility product ← tells us about sol → / ← ppt

$K_{sp}(AgCl) = [Ag^+][Cl^-]_{eq} = 1.6 \times 10^{-10}$ @ 25°C

$K_{sp}(CaF_2) = [Ca^{2+}][F^-]^2_{eq} = 4.0 \times 10^{-11}$

$K_{sp}(Ca_3(PO_4)_2) = [Ca^{2+}]^3[PO_4^{3-}]^2_{eq} = 1.2 \times 10^{-26}$