Weak Acid Titrated by Strong BASE

Add 50.0 ml of 0.100 M NaOH to 50.0 ml of A 0.10 M $HC_2H_3O_2$ (HAc)

Using stoichiometry to get rid of all NaOH

$$1\ NaOH_{(aq)} + 1\ HAc_{(aq)} \rightarrow 1\ H_2O_{(l)} + 1\ Na_1Ac_{1\,(aq)}$$

$$mole\ OH^{1-}_{add} = (50.0\,ml)\left(\frac{1\,l}{1000\,ml}\right)(0.100\,M\ NaOH)\left(\frac{1\,mole\ OH^{1-}}{1\,mole\ NaOH}\right)$$

$$= 5.00 \times 10^{-3}\ mole\ OH^{1-}_{add}$$

$$mole\ HAc_{left} = mole\ HAc_I - mole\ HAc_r$$

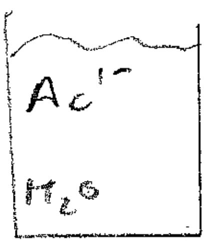
$$= \left[(50.0\,ml)\left(\frac{1\,l}{1000\,ml}\right)(0.100\,M\ HAc)\right] - \left[(5.00 \times 10^{-3}\ mole\ OH^{1-}_{add})\left(\frac{1\,mole\ HAc_r}{1\,mole\ OH^{1-}_{add}}\right)\right]$$

$$= 5.00 \times 10^{-3}\ mole\ HAc_I - 5.00 \times 10^{-3}\ mole\ HAc_r$$

$mole\ HAc_{left} = 0$ moles $\qquad V = (50.0\,ml + 50.0\,ml)\left(\frac{1\,l}{1000\,ml}\right) = 0.100\,l$

All HAc reacted with all NaOH; *called Equivalence Point*

∴ only species left in bucket is conjugate base Ac^{1-}



$$Ac^{1-} + H_2O \rightleftharpoons HAc + OH^{1-} \quad K_{b_{Ac^{1-}}} =$$

$$H_2O + H_2O \rightleftharpoons H_3O^{+} + OH^{1-}$$

$$K_w = 1.0 \times 10^{-14}$$

$$K_{a_{HAc}} \cdot K_{b_{Ac^{1-}}} = K_w$$

$$K_{b_{Ac^{1-}}} = \frac{1.0 \times 10^{-14}\,M^2}{1.8 \times 10^{-5}\,M}$$

$$K_{b_{Ac^{1-}}} = 5.56 \times 10^{-10}$$

$K_{b_{Ac^{1-}}} = \frac{[HA][OH^{1-}]}{[Ac^{1-}]}$ $\quad K_{b_{Ac^{1-}}} >> K_w$ so it "run" bucket

$$mole\ Ac^{1-}_{left} = mole\ Ac^{1-}_I + mole\ Ac^{1-}_r$$

$$= 0 + \left\{(5.00 \times 10^{-3}\ mole\ HAc_r)\left(\frac{1\,mole\ Ac^{1-}_r}{1\,mole\ HAc_r}\right)\right\} = \frac{5.00 \times 10^{-3}\ mole\ Ac^{1-}}{0.100\,l}$$

$[Ac^{1-}] = 0.050\,M$ $\qquad$ Assume 5% rule ✓ → $\frac{5.272 \times 10^{-6}\,M}{0.05\,M} \cdot 100\% < 5\%$

	Ac^{1-}	HAc	OH^{1-}
I	0.05M	0	0
C	$-x$	x	x
E	$0.05M - x$	x	x

$$5.56 \times 10^{-10}\,M = \frac{x^2}{0.050\,M}$$

$$[OH^{1-}] = x = \sqrt{(5.56 \times 10^{-10}\,M)(0.050\,M)} = 5.272 \times 10^{-6}\,M$$

$$pOH = -\log(5.272 \times 10^{-6}\,M) = 5.278$$

$$pH = 14.000 - pOH = 14.000 - 5.278 = 8.722$$

pH = 8.72