Chemistry 192
Quiz Number 5
Spring 2018
Solution

R =8.3144 J mol^{-1} K^{-1}

R=0.0821 L atm mol^{-1} K^{-1}

R=0.08314 L bar mol^{-1} K^{-1}

$N_A = 6.022 \times 10^{23}$ molecules mol^{-1}

$T = t + 273.15$

$[H_3O^+][OH^-] = 1.0 \times 10^{-14}$

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Acrylic acid [$(CH_2)_2COOH$] has pK_a= 4.25. When a 0.200 L sample of acrylic acid is titrated with 0.100 M NaOH, the equivalence point is reached after the addition of 0.106 L of the strong base. Calculate the initial concentration of acrylic acid and the pH of the solution at the equivalence point. Approximations work for this problem.

Solution

$$n_{(CH_2)_2COOH} = n_{OH^-} = (0.100 \text{ mol L}^{-1})(0.106 \text{ L}) = 0.0106 \text{ mol}$$

$$[(CH_2)_2COOH] = \frac{0.0106 \text{ mol}}{0.200 \text{ L}} = 0.053 \text{ M}$$

$$(CH_2)_2COO^-_{(aq)} + H_2O_{(\ell)} \rightleftharpoons (CH_2)_2COOH_{(aq)} + OH^-_{(aq)}$$

$$\text{p}K_b = 14.00 - \text{p}K_a = 9.75 \qquad K_b = 10^{-9.75} = 1.8 \times 10^{-10}$$

$$[(CH)_2COO^-] = \frac{0.0106 \text{ mol}}{0.200 \text{ L} + 0.106 \text{ L}} = 3.46 \times 10^{-2} \text{ M}$$

	$[(CH_2)_2COO^-]$	$[(CH_2)_2COOH]$	$[OH^-]$
initial	3.46×10^{-2} M	0 M	0 M
change	$-x$ M	x M	x M
equilibrium	$3.46 \times 10^{-2} - x$ M	x M	x M

$$1.8 \times 10^{-10} = \frac{x^2}{3.46 \times 10^{-2} - x} \approx \frac{x^2}{3.46 \times 10^{-2}}$$

$$x = [OH^-] = 2.5 \times 10^{-6} \text{ M} \qquad \text{pOH} = 5.60 \qquad \text{pH} = 8.40$$

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