

Exam III Key



| | | | |
|---|--------|----|----|
| I | .120 | -0 | 0 |
| C | -x | +x | +x |
| Σ | .120-x | x | x |

$\alpha = .100$

$$\log \delta_{\text{H}^+} = \frac{-.51 (+1) \sqrt{.100}}{1 + (900 \sqrt{.100} / 305)} = -.0834$$

$\delta_{\text{H}^+} = .8252$

$$\log \delta_{\text{NO}_2^-} = \frac{-.51 (+1) \sqrt{.100}}{1 + (300 \sqrt{.100} / 305)} = -.123$$

$\delta_{\text{NO}_2^-} = .7533$

$$K_a = \frac{A_{\text{H}^+} \cdot A_{\text{NO}_2^-}}{A_{\text{HNO}_2}} = \frac{\gamma_{\text{H}^+} [\text{H}^+] \gamma_{\text{NO}_2^-} [\text{NO}_2^-]}{\gamma_{\text{HNO}_2} [\text{HNO}_2]}$$

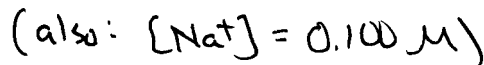
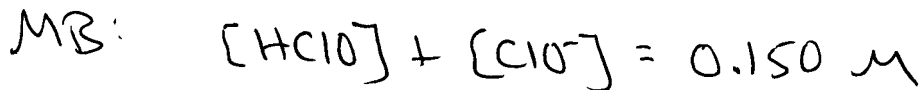
\uparrow
= 1

$$1.03 \times 10^{-3} = \frac{.8252(x) \cdot .7533(x)}{.120-x}$$

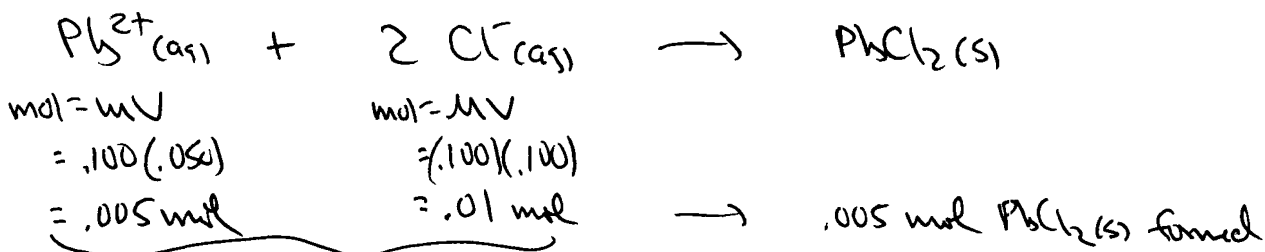
$x = .0133$

$\text{pH} = -\log A_{\text{H}^+} = -\log (.8252 \cdot .0133) = 1.96$

② See text & notes



④ First, consider the reaction that occurs:



stochiometrically
equivalent amounts
(no excess)

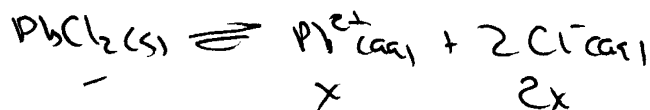
④ (cont.)

What is left over? .010 mol NO_3^- + .010 mol Na^+

$$[\text{Na}^+] = [\text{NO}_3^-] = \frac{.010 \text{ mol}}{.150 \text{ L}} = .0667 \text{ M}$$

$$\log \gamma_{\text{pb}^{2+}} = \frac{-.51(+2)^2 \sqrt{.0667}}{1 + \left(\frac{450 \sqrt{.0667}}{305}\right)} = -.3815 \Rightarrow \gamma_{\text{pb}^{2+}} = 0.415$$

$$\log \gamma_{\text{cr}^-} = \frac{-.51(-1)^2 \sqrt{.0667}}{1 + \left(\frac{300 \sqrt{.0667}}{305}\right)} = -.105 \Rightarrow \gamma_{\text{cr}^-} = 0.785$$



$$K_{\text{sp}} = A_{\text{pb}^{2+}} \cdot A_{\text{cl}^-}^2$$

$$1.7 \times 10^{-5} = (.415)(x)(.785)^2(2x)^2 = (x^3)(.415)(.785)^2(4)$$

$$x = .0255 \Rightarrow [\text{cr}^-] = 2x = .0510 \text{ M}$$

$$\text{pCl} = -\log A_{\text{cl}^-} = -\log(\gamma_{\text{cl}^-} [\text{Cl}^-]) = -\log(.785 \cdot .0510) = \boxed{1.40}$$

⑤ $L = 15.0 \text{ cm}$; $t_m = 31 \text{ s}$; $t_{rA} = 119 \text{ s}$; $t_{rB} = 123 \text{ s}$

$$\text{a) } k' = \frac{t_r - t_m}{t_m} \quad k'_A = \frac{119 - 31}{31} = \boxed{2.84} \quad k'_B = \frac{123 - 31}{31} = \boxed{2.97}$$

b) $N = 2000$

$$N = 16 \left(\frac{t_r}{W}\right)^2$$

$$2000 = 16 \left(\frac{119}{W_A}\right)^2 = 16 \left(\frac{123}{W_B}\right)^2$$

$$\boxed{W_A = 10.64 \text{ s} \quad W_B = 11.00 \text{ s}}$$

$$\text{c) } R_s = \frac{\Delta t_r}{W_{\text{ave}}} = \frac{123 - 119}{\left(\frac{10.64 + 11.00}{2}\right)} = \boxed{0.37}$$

d) $R \propto \sqrt{N}$

$$\Rightarrow \frac{R_1}{R_2} = \frac{\sqrt{N_1}}{\sqrt{N_2}} \quad \frac{.37}{1.50} = \frac{\sqrt{2000}}{\sqrt{N_2}} \Rightarrow N_2 = 32871 \text{ plates}$$

$$L \propto N \Rightarrow \frac{L_1}{L_2} = \frac{N_1}{N_2} \quad \frac{15}{L_2} = \frac{2000}{32871} \Rightarrow L_2 = \boxed{247 \text{ cm}}$$

e) $t_r \propto L$

$$\text{A: } \frac{t_{r1}}{t_{r2}} = \frac{L_1}{L_2} \quad \frac{119}{t_{r2}} = \frac{15}{247}$$

$$\boxed{t_{rA} = 1960 \text{ s}}$$

$$\text{B: } \frac{123}{t_{r2}} = \frac{15}{247}$$

$$\boxed{t_{rB} = 2025 \text{ s}}$$