

Chemistry 255
Spring 2011
Problem Set #7
Answer Key

1. $E^\circ = 0.224$ pH = 4.25; $[H^+] = 5.623 \times 10^{-5}$; assuming 25°C

$$\text{a) } E = E^\circ - \frac{0.05916}{n} \log \frac{[\text{lactate}]}{[\text{pyruvate}][H^+]^2}$$

$$E = 0.224 - \frac{0.05916}{2} \log \frac{3.4 \times 10^{-2}}{[8.6 \times 10^{-3}][5.623 \times 10^{-5}]^2} = -4.5 \times 10^{-2} \text{ V}$$

$$\text{b) } -0.060 \text{ V} = 0.224 - \frac{0.05916}{2} \log \frac{3.4 \times 10^{-2}}{[8.6 \times 10^{-3}][H^+]^2}$$

$$9.601 = \log \frac{3.4 \times 10^{-2}}{(8.6 \times 10^{-3})x^2} \quad 3.990 \times 10^9 = \frac{3.4 \times 10^{-2}}{(8.6 \times 10^{-3})x^2}$$

$$3.43 \times 10^7 x^2 = 3.4 \times 10^{-2} \quad x^2 = 9.906 \times 10^{-10}$$

$$x = 3.147 \times 10^{-5} = [H^+]$$

$$\text{pH} = 4.50$$

2. Right electrode: $\text{Ca}^{2+} + 2e^- \rightarrow \text{Ca(s)}$ $E_+^0 = -2.868$

Left electrode: $\text{Mg}^{2+} + 2e^- \rightarrow \text{Mg(s)}$ $E_-^0 = -2.360$

$$\text{Nernst for Right Electrode: } E_+ = -2.868 - \frac{0.05916}{2} \log \left(\frac{1}{[\text{Ca}^{2+}]} \right)$$

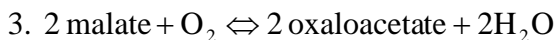
$$= -2.868 - 0.02958 \log \left(\frac{1}{0.40} \right) = -2.8798$$

$$\text{Nernst for Left Electrode: } E_- = -2.360 - 0.02958 \log \left(\frac{1}{0.65} \right) = -2.3655$$

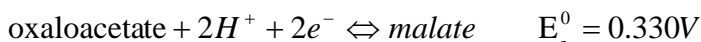
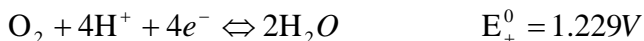
$$\text{cell voltage: } E = E_+ - E_- = -2.8798 - (-2.3655) = -0.5143 \text{ V} \approx -0.51 \text{ V}$$

b) No, the cell will not provide energy as written because E is negative.

The reaction is spontaneous in the reverse direction.



individual reactions :



Sum of reactions : $E^0 = 1.229 - (0.330) = 0.899\text{V}$

a) $K = 10^{4(0.899)/0.05916} = 6.09 \times 10^{60}$

b) Yes, E^0 is positive and $K > 1$.

4.a) $E_{\text{cath}} = 0.222 - \frac{0.05916}{2} \log([\text{Cl}^-]^2) = 0.281\text{V}$

$$E_{\text{an}} = -0.350 - \frac{0.05916}{2} \log([\text{F}^-]^2) = -0.291\text{V}$$

cell voltage : $E = E_{\text{cath}} - E_{\text{an}} = 0.281 - (-0.291) = 0.572\text{V}$

b) for Pb^{+2} : $K_{\text{sp}} = [\text{Pb}^{+2}][\text{F}^-]^2 = 3.6 \times 10^{-8} = (x)(0.10 + 2x)^2$

$$x = [\text{Pb}^{+2}] = 3.6 \times 10^{-6} \text{ M}$$

for Ag^+ : $K_{\text{sp}} = [\text{Ag}^+][\text{Cl}^-] = 1.8 \times 10^{-10} = (x)(0.10 + x)$

$$x = [\text{Ag}^+] = 1.8 \times 10^{-9} \text{ M}$$

$$E_{\text{cath}} = 0.799 - \frac{0.05916}{2} \log\left(\frac{1}{[\text{Ag}^+]^2}\right) = 0.281\text{V}$$

$$E_{\text{an}} = -0.126 - \frac{0.05916}{2} \log\left(\frac{1}{[\text{Pb}^{+2}]^2}\right) = -0.287\text{V}$$

cell voltage : $E = E_{\text{cath}} - E_{\text{an}} = 0.281 - (-0.287) = 0.568\text{V}$

5. a) $A = 0.500 = (1.12 \times 10^4)(1.00 \text{ cm})[\text{Ox}] + (3.82 \times 10^3)(1.00 \text{ cm})[\text{RED}]$

$$A = 0.500 = (1.12 \times 10^4)(1.00 \text{ cm})[x] + (3.82 \times 10^3)(1.00 \text{ cm})[5.70 \times 10^{-5} - x]$$

$$x = [\text{Ox}] = 3.82 \times 10^{-5} \text{ M} \quad [\text{RED}] = 1.88 \times 10^{-5} \text{ M}$$

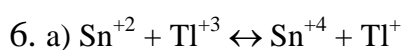
b) $[\text{S}] = [\text{RED}]$, $[\text{Ox}] = [\text{S}^-]$

$$c) E^{o'} = \frac{0.05916}{1} \log K$$

$$K = \frac{[Ox][S^-]}{[RED][S]} = \frac{(3.82 \times 10^{-5})(3.82 \times 10^{-5})}{(1.88 \times 10^{-5})(1.88 \times 10^{-5})} = 4.129$$

$$E^{o'} = \frac{0.05916}{1} \log 4.129 = 0.036V = E_{cath}^{o'} - E_{an}^{o'} = E_{cath}^{o'} - (-0.128)$$

$$E_{cath}^{o'} = -0.092V$$



$$c) E = 0.139 - \frac{0.05916}{2} \log \left(\frac{[Sn^{+2}]}{[Sn^{+4}]} \right) - 0.241V$$

$$E = 0.77 - \frac{0.05916}{2} \log \left(\frac{[Tl^{+}]}{[Tl^{+3}]} \right) - 0.241V$$

d)

<u>Volume</u>	<u>Potential</u>
1.00 mL	-0.120 V
2.50 mL	-0.102 V
4.90 mL	-0.052 V
5.00 mL	0.21 V
5.10 mL	0.48 V
10.0 mL	0.53 V