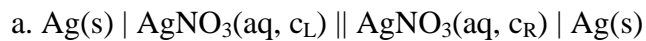


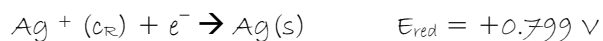
Chemistry 360
CORRECTED WORKSHEET for Lecture 22

1 Write the cell reactions and electrode half-reactions for the following cells:



Cell reaction $\text{Ag}^+ (c_R) \rightarrow \text{Ag}^+ (c_L)$

Reduction on the RHS

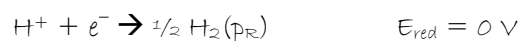


Oxidation on LHS

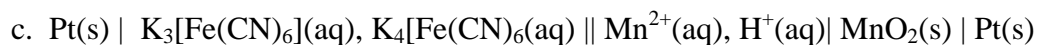
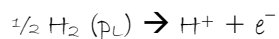


Cell reaction : $\frac{1}{2} \text{H}_2 (p_L) \rightarrow \frac{1}{2} \text{H}_2 (p_R)$

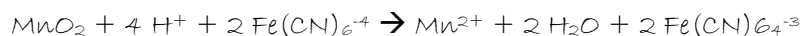
Reduction on RHS



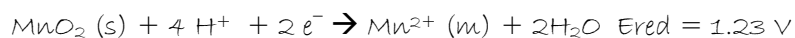
Oxidation



Cell reaction



Reduction on RHS



Oxidation on LHS



2 Write the Nernst equations for the cells in problem 1

(a) The way the reaction was written, one electron was transferred. Therefore, $n = 1$. We look to the overall cell reaction to determine Q .

$$\begin{aligned} E_{\text{cell}} &= E_{\text{cell}}^{\circ} - (RT/nF) \ln Q \\ &= E_{\text{cell}}^{\circ} - (8.31 \text{ J mol}^{-1} \text{ K}^{-1} \cdot 298 \text{ K} / 96,485 \text{ coul mol}^{-1}) \cdot \ln (c_L/c_R) \\ &= E_{\text{cell}}^{\circ} - (0.026 \text{ V}) \cdot \ln (c_L/c_R) \end{aligned}$$

(b) $n = 1$

$$\begin{aligned} E_{\text{cell}} &= E_{\text{cell}}^{\circ} - (0.026 \text{ V}) \cdot \ln (p_R/p_L)^{1/2} \\ \text{NOTE: It's equally valid to have } n &= 2 \text{ and use} \\ E_{\text{cell}} &= E_{\text{cell}}^{\circ} - 1/2 \cdot (0.026 \text{ V}) \ln (p_R/p_L) \end{aligned}$$

(c) $n = 2$

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - 1/2 (0.026 \text{ V}) \cdot \ln \left\{ \frac{[\text{Mn}^{2+}] a_{\text{H}_2\text{O}} [\text{Fe}(\text{CN})_6^{-3}]^2}{(a_{\text{MnO}_2} \cdot [\text{H}^+]^4 [\text{Fe}(\text{CN})_6^{-4}]^2)} \right\}$$

where $a_{\text{H}_2\text{O}}$ is approximately 1, a_{MnO_2} is 1.

3 Use the standard potentials for the electrodes to calculate the standard potentials of the cells in problem 1.

The standard cell potentials are simply $E_{\text{red, LHS}}^\circ - E_{\text{red, RHS}}^\circ$

(a) E_{red}° for $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag(s)}$ is 0.7991 V

same reaction is happening on LHS, so $E_{\text{cell}}^\circ = 0.7991 \text{ V} - 0.7991 \text{ V} = 0 \text{ V}$

(b) $E_{\text{cell}}^\circ = 0 \text{ V} - 0 \text{ V} = 0 \text{ V}$

(c) $E_{\text{cell}}^\circ = 1.23 \text{ V} - (0.36 \text{ V}) = 0.87 \text{ V}$

4 The rate of formation of C in the reaction $2\text{A} + \text{B} \rightarrow 3\text{C} + 2\text{D}$ is $2.2 \text{ mol L}^{-1} \text{ s}^{-1}$. State the rates of formation and consumption of A, B, and D.

$$\text{rate} = \frac{1}{3} \frac{d[\text{C}]}{dt} = \frac{1}{2} \frac{d[\text{D}]}{dt} = -\frac{1}{2} \frac{d[\text{A}]}{dt} = -\frac{d[\text{B}]}{dt};$$

$$\frac{d[\text{C}]}{dt} = \frac{3}{2} \frac{d[\text{D}]}{dt} = -\frac{3}{2} \frac{d[\text{A}]}{dt} = -3 \frac{d[\text{B}]}{dt}$$

So formation of D = $(2/3) \cdot 2.2 \text{ mol L}^{-1} \text{ s}^{-1} = 1.5 \text{ mol L}^{-1} \text{ s}^{-1}$

Rate of CONSUMPTION (negative of formation) of A is $1.5 \text{ mol L}^{-1} \text{ s}^{-1}$

Rate of CONSUMPTION of B = $(1/3) \cdot 2.2 \text{ mol L}^{-1} \text{ s}^{-1} = 0.73 \text{ mol L}^{-1} \text{ s}^{-1}$

5 The rate law for the reaction in 4 was reported as $\text{rate} = k[\text{A}][\text{B}][\text{C}]$. What are the units of k ?

rate has units of $\text{mol L}^{-1} \text{s}^{-1}$, so k has units of $\text{mol L}^{-1} \text{s}^{-1} / (\text{mol L}^{-1})^3 = \text{L}^2 \text{mol}^{-2} \text{s}^{-1}$

6 The rate of the reaction $\text{A} + 3\text{B} \rightarrow \text{C} + 2\text{D}$ was reported as $1 \text{ mol L}^{-1} \text{ s}^{-1}$. State the rates of formation or consumption of the participants.

$$1 \text{ mol L}^{-1} \text{ s}^{-1} = \frac{d[\text{C}]}{dt} = \frac{1}{2} \frac{d[\text{D}]}{dt} = -\frac{d[\text{A}]}{dt} = -\frac{1}{3} \frac{d[\text{B}]}{dt}$$

$$\frac{d[\text{A}]}{dt} = -1 \text{ mol L}^{-1} \text{ s}^{-1}$$

$$\frac{d[\text{B}]}{dt} = -3 \text{ mol L}^{-1} \text{ s}^{-1}$$

$$\frac{d[\text{C}]}{dt} = 1 \text{ mol L}^{-1} \text{ s}^{-1}$$

$$\frac{d[\text{D}]}{dt} = 2 \text{ mol L}^{-1} \text{ s}^{-1}$$

Note that when we say “rate of consumption,” of A, we’re actually referring to $-d[\text{A}]/dt$, which (consistently with above) is $+1 \text{ mol L}^{-1} \text{ s}^{-1}$.