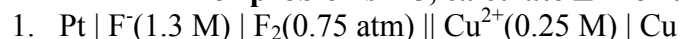


CH 302 Spring 2007 Worksheet 11

Half-reaction	ΔE_r^0 (V)
$\text{Li}^+(\text{aq}) + \text{e}^- \rightarrow \text{Li}(\text{s})$	-3.05
$\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Al}(\text{s})$	-1.68
$\text{TiO}(\text{s}) + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{Ti}(\text{s}) + \text{H}_2\text{O}$	-1.31
$\text{Ti}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Ti}(\text{s})$	-1.21
$\text{Ni}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Ni}(\text{s})$	-0.25
$\text{CO}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{HCOOH}(\text{aq})$	-0.11
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$	0
$\text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+ + 2\text{e}^- \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{SO}_2(\text{aq})$	+0.17
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$	+0.34
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{NO}_3^-(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{NO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$	+0.80
$\text{Au}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Au}(\text{s})$	+1.52
$\text{Ag}_2\text{O}_3(\text{s}) + 6\text{H}^+ + 4\text{e}^- \rightarrow 2\text{Ag}^+(\text{aq}) + 3\text{H}_2\text{O}$	+1.67
$\text{F}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{F}^-(\text{aq})$	+2.87

For problems 1-5, calculate ΔE for the given electrochemical cell.

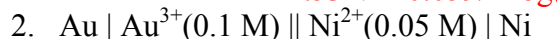


Answer: Balanced reaction: $\text{Cu}^{2+} + 2 \text{F}^- \rightarrow \text{Cu} + \text{F}_2$

$$\Delta E^0 = 0.34 - 2.87 = -2.53 \text{ V}$$

$$\Delta E = \Delta E^0 - 0.059/n \log(\text{pF}_2/[\text{Cu}^{2+}][\text{F}^-]^2)$$

$$= -2.53 \text{ V} - 0.059/2 \log(0.75 \text{ atm}/(0.25 \text{ M})(1.3 \text{ M})^2) = \underline{\underline{-2.54 \text{ V}}}$$



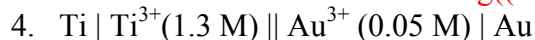
Answer: $3 \text{Ni}^{2+} + 2 \text{Au} \rightarrow 3 \text{Ni} + 2 \text{Au}^{3+}$

$$\Delta E = -1.77 \text{ V} - 0.059/6 \log((0.1 \text{ M})^2/(0.05 \text{ M})^3) = \underline{\underline{-1.79 \text{ V}}}$$



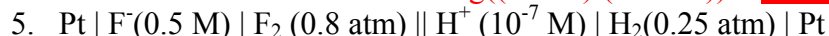
Answer: $2 \text{Fe}^{3+} + \text{Cu} \rightarrow 2 \text{Fe}^{2+} + \text{Cu}^{2+}$

$$\Delta E = 0.43 \text{ V} - 0.059/2 \log((2.05 \text{ M})^2(0.025 \text{ M})/(0.9 \text{ M})) = \underline{\underline{0.458 \text{ V}}}$$



Answer: $\text{Au}^{3+} + \text{Ti} \rightarrow \text{Au} + \text{Ti}^{3+}$

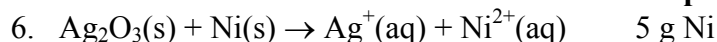
$$\Delta E = 2.73 \text{ V} - 0.059/3 \log((1.3 \text{ M})/(0.05 \text{ M})) = \underline{\underline{2.70 \text{ V}}}$$



Answer: $2 \text{H}^+ + 2 \text{F}^- \rightarrow \text{H}_2 + \text{F}_2$

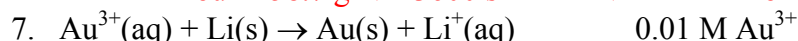
$$\Delta E = -2.87 \text{ V} - 0.059/2 \log((0.25 \text{ atm})(0.8 \text{ atm})/(0.5 \text{ M})^2(10^{-7} \text{ M})^2) = \underline{\underline{-3.28 \text{ V}}}$$

For problems 6-10, calculate the current generated by the reaction when the given amount of reactant is used up in one hour.



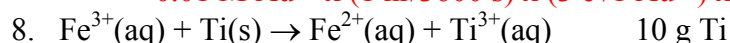
Answer: Balanced reaction: $\text{Ag}_2\text{O}_3 + 2 \text{Ni} \rightarrow 2\text{Ag}^+ + 2 \text{Ni}^{2+}$ (the O's aren't important)

$$\frac{5 \text{ g Ni} \times 1 \text{ mol Ni} \times 1 \text{ hour} \times 4 \text{ electrons} \times 96,483 \text{ C}}{1 \text{ hour} \quad 58.7 \text{ g Ni} \quad 3600 \text{ s} \quad 2 \text{ Ni} \quad 1 \text{ mol}} = 4.57 \text{ C/s} = \underline{\underline{4.57 \text{ amps}}}$$



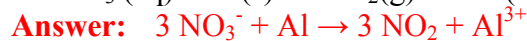
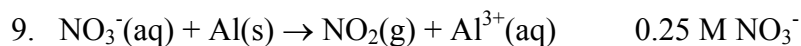
Answer: $\text{Au}^{3+} + 3 \text{Li} \rightarrow \text{Au} + 3 \text{Li}^+$

$$0.01 \text{ M Au}^{3+} \times (1 \text{ hr}/3600 \text{ s}) \times (3 \text{ e}^-/1 \text{ Au}^{3+}) \times (96,483 \text{ C/mol}) = \underline{\underline{0.804 \text{ amps}}}$$

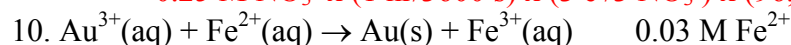


Answer: $3 \text{Fe}^{3+} + \text{Ti} \rightarrow 3 \text{Fe}^{2+} + \text{Ti}^{3+}$

$$10 \text{ g Ti} \times (1 \text{ hr}/3600 \text{ s}) \times (1 \text{ mol}/47.9 \text{ g}) \times (3 \text{ e}^-/1 \text{ Ti}) \times (96,483 \text{ C/mol}) = \underline{\underline{16.8 \text{ amps}}}$$

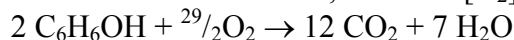


$0.25 \text{ M NO}_3^- \times (1 \text{ hr}/3600 \text{ s}) \times (3 \text{ e}^-/3 \text{ NO}_3^-) \times (96,483 \text{ C/mol}) = \underline{\underline{6.70 \text{ amps}}}$



$0.03 \text{ M Fe}^{2+} \times (1 \text{ hr}/3600 \text{ s}) \times (3 \text{ e}^-/3 \text{ Fe}^{2+}) \times (96,483 \text{ C/mol}) = \underline{\underline{0.804 \text{ amps}}}$

11. If the rate of the following reaction is $1.3 \times 10^{-5} \text{ M/s}$, what is $\Delta[\text{O}_2]/\Delta t$?



Answer: $\text{rate} = -\Delta[\text{O}_2]/(29/2\Delta t) \Rightarrow \Delta[\text{O}_2]/\Delta t = -1.3 \times 10^{-5} \times 29/2 = \underline{\underline{-1.88 \times 10^{-4} \text{ M/s}}}$

12. If $\Delta[\text{CO}_2]/\Delta t = 10^{-4} \text{ M/s}$ for the same reaction as in problem 11, what is the rate of the reaction?

Answer: $\text{rate} = \Delta[\text{CO}_2]/12\Delta t = 10^{-4}/12 = \underline{\underline{8.33 \times 10^{-6} \text{ M/s}}}$

13. Predict whether the rate of the reaction in problem 11 will increase, decrease, or stay the same if the following changes are made to the system.

a. Add $\text{C}_6\text{H}_6\text{OH}$

Answer: Increase

b. Remove O_2

Answer: Decrease

c. Increase the temperature

Answer: Increase

d. Keep the same amount of everything, but double the size of the reaction vessel.

Answer: Decrease – the same amount of stuff in a larger area gives a lower conc./pressure

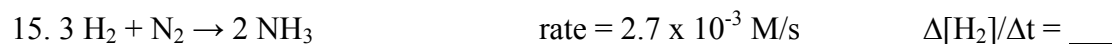
e. Add a catalyst

Answer: Increase

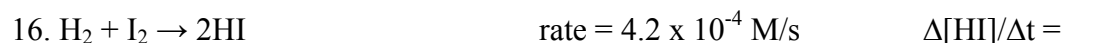
For the reactions in problems 14-20, calculate either the rate or the $\Delta[\text{ }]/\Delta t$ using the information given.



Answer: $\text{rate} = \Delta[\text{H}_2]/3\Delta t = 5.3 \times 10^{-5}/3 = \underline{\underline{1.77 \times 10^{-3} \text{ M/s}}}$



Answer: $\Delta[\text{H}_2]/\Delta t = -3(2.7 \times 10^{-3}) = \underline{\underline{-8.1 \times 10^{-3} \text{ M/s}}}$



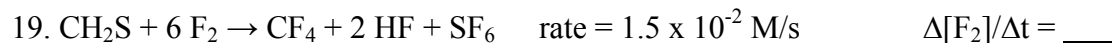
Answer: $\Delta[\text{HI}]/\Delta t = 2(4.2 \times 10^{-4}) = \underline{\underline{8.4 \times 10^{-4} \text{ M/s}}}$



Answer: $\text{rate} = -(-9.4 \times 10^{-3})/4 = \underline{\underline{2.35 \times 10^{-3} \text{ M/s}}}$



Answer: $\Delta[\text{H}_2\text{O}]/\Delta t = -(3.6 \times 10^{-5})(9/(25/2)) = \underline{\underline{2.59 \times 10^{-5} \text{ M/s}}}$



Answer: $\Delta[\text{F}_2]/\Delta t = -6(1.5 \times 10^{-2}) = \underline{\underline{0.090 \text{ M/s}}}$



Answer: $\text{rate} = (1.1 \times 10^{-4})/2 = \underline{\underline{5.5 \times 10^{-5} \text{ M/s}}}$