1. In the reaction $\text{MnO}_4^- + 8\text{H}^+ + 5e^- \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$, the manganese in 3.95 grams of $\text{KMnO}_4$ is reduced to $\text{Mn}^{2+}$. How many coulombs of charge must have been transferred to the permanganate ion?
   - (a) $1.60 \times 10^4 \text{ C}$
   - (b) $2.41 \times 10^3 \text{ C}$
   - (c) $1.20 \times 10^4 \text{ C}$

2. Calculate $E_0$ for the reaction $\text{MnO}_4^- + 8\text{H}^+ + 5\text{Fe}^{2+} \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O} + 5\text{Fe}^{3+}$.
   - (a) $+0.736 \text{ V}$
   - (b) $-2.35 \text{ V}$
   - (c) $-0.736 \text{ V}$

3. Write the balanced net equation for the following cell:
   $\text{Cd}(s) \ | \ \text{Cd}^{2+} (1 \text{ M}) \ | \ | \ \text{H}^+(\text{aq}, 1 \text{ M}), \ \text{Mn}^{2+} (1 \text{ M}), \ \text{MnO}_4^- (1 \text{ M}) \ | \ \text{Pt}$
   - (a) $2\text{MnO}_4^- + 16\text{H}^+ + 5\text{Cd}(s) \rightarrow 5\text{Cd}^{2+} + 2\text{Mn}^{2+} + 8\text{H}_2\text{O}$
   - (b) $\text{MnO}_4^- + 8\text{H}^+ + \text{Cd}(s) \rightarrow \text{Cd}^{2+} + \text{Mn}^{2+} + 4\text{H}_2\text{O}$
   - (c) $5\text{Cd}^{2+} + 2\text{Mn}^{2+} + 8\text{H}_2\text{O} \rightarrow 2\text{MnO}_4^- + 16\text{H}^+ + 5\text{Cd}(s)$

4. Which of these salts could be used in a salt bridge?
   - (a) $\text{NaNO}_3$
   - (b) $\text{KNO}_3$
   - (c) $\text{NaC}_2\text{H}_3\text{O}_2$

5. In the cell $\text{Cd}(s) \ | \ \text{Cd}^{2+} (1 \text{ M}) \ | \ | \ \text{H}^+(\text{aq}, 1 \text{ M}), \ \text{Mn}^{2+} (1 \text{ M}), \ \text{MnO}_4^- (1 \text{ M}) \ | \ \text{Pt}$,
   - (a) the salt bridge plays no role.
   - (b) Cations diffuse into the right half-cell, and anions diffuse into the left half-cell.
   - (c) Anions diffuse into the right half-cell, and cations diffuse into the left half-cell.

6. Which of the following shows the correct order of increasing strength as an oxidizing agent?
   - (a) $\text{Ag}^+ < \text{H}^+ < 0_3(\text{g})$
   - (b) $\text{K}^+ < \text{MnO}_4^- < 0_3(\text{g})$
   - (c) $\text{K}^+ < \text{Li}^+ < \text{H}^+$

7. Over time, the voltage of the cell S.C. E. || $\text{Ag}^+ (1 \text{ M}) \ | \ \text{Ag}(s)$ decreases and the concentration of $\text{Ag}^+$
decreases. Which of the following statements is true?
- (a) The concentration of the Cl\(^{-}\) in the S.C.E. will increase.
- (b) The concentration of the Cl\(^{-}\) in the S.C.E. will decrease.
- (c) The concentration of the Cl\(^{-}\) in the S.C.E. will remain essentially constant.

8. A cathode can always be defined as
- (a) the electrode at which oxidation occurs.
- (b) the electrode at which reduction occurs.
- (c) the negative electrode.

9. When \(F_2(g)\) is 0.50 bar and \([F^-]\) is 0.10 M, the half-cell potential for the half reaction \(F_2(g) + 2e^- \rightarrow 2F^-\) is
- (a) 2.931 V.
- (b) 2.840 V.
- (c) 2.940 V.

10. The equilibrium constant for the reaction \(\text{MnO}_4^- + 8H^+ + 5\text{Fe}^{2+} \leftrightarrow \text{Mn}^{2+} + 4H_2O + 5\text{Fe}^{3+}\) is approximately
- (a) \(2 \times 10^{62}\).
- (b) \(3 \times 10^{12}\).
- (c) \(1 \times 10^{-20}\).

11. Given the information below, calculate the voltage the cell.
\[
\text{Cu(s)} \mid \text{Cu}^{2+} (0.50 \text{ M}) \mid \mid \text{I}^- (0.30 \text{ M}) \mid \text{I}_3^- (0.15 \text{ M}) \mid \text{Pt}
\]
\[
\begin{align*}
\text{I}_3^- + 2e^- & \rightarrow 3\text{I}^- & \text{Eo} = 0.535 \text{ V} \\
\text{Cu}^{2+} + 2e^- & \rightarrow \text{Cu(s)} & \text{Eo} = 0.339 \text{ V}
\end{align*}
\]
- (a) -0.209 V
- (b) 0.209 V This is the correct answer. More information in section 14-4
- (c) 0.196 V

12. Using the standard reduction tables in the appendix of your textbook, identify the best reducing agent.
- (a) Li(s)
- (b) \(F_2(g)\)
- (c) \(\text{Cu}^{2+}\)
13. What is the line diagram for the following electrochemical cell?
  O (a) Zn(s) | ZnCl₂ || CuSO₄ | Cu(s)
  O (b) Cu(s) | CuSO₄ (aq, 0.1 M) || ZnCl₂ (aq, 0.1 M) | Zn(s) |
  O (c) Zn(s) | ZnCl₂ (aq, 0.1 M) || CuSO₄ (aq, 0.1 M) | Cu(s)

14. Given the following reduction potential for potassium, which statement is correct? K⁺ + e⁻ → K(s) \( E^0 = -2.936 \text{ V} \)
  O (a) K is a good reducing agent.
  O (b) K⁺ is a good oxidizing agent.
  O (c) K⁺ is a good reducing agent.

15. Calculate \( E_{\text{cell}} \) for the electrochemical cell shown below. The \( E_o \) for Fe³⁺/Fe²⁺ = 0.771 V and \( E_o \) for MnO₄⁻/Mn²⁺ = 1.51 V. Pt | Fe²⁺ (4.25 x 10⁻³ M), Fe³⁺ (1.50 x 10⁻³ M) || MnO₄⁻ (6.50 x 10⁻³ M), Mn²⁺ (2.00 x 10⁻² M), H⁺ (0.100 M) | Pt
  O (a) 1.41 V
  O (b) 0.667 V
  O (c) 1.48 V

16. Calculate the [H⁺], given the electrochemical cell shown below has an \( E_{\text{cell}} = 1.018 \text{ V} \). The \( E_o \) for Fe³⁺/Fe²⁺ = 0.771 V and \( E_o \) for UO₂²⁺/U⁴⁺ = 0.273 V. Pt | UO₂²⁺ (0.05 M), U⁴⁺ (0.05 M), HCO₂H (0.1 M), HCO₂Na (0.3 M) || Fe³⁺(0.05 M), Fe²⁺ (0.025 M) | Pt
  O (a) 2.6 molar
  O (b) 9.4 x 10⁻¹⁸ molar
  O (c) 5.5 x 10⁻⁵ molar

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