**CH302 Worksheet 10. Balancing Redox reactions and assigning cell convention**.

Use the **table of standard reduction potentials** below as required.

| Half reaction | $E^o$ |
|---|---|
| $Li^+ + e^- \rightarrow Li$ | -3.04 |
| $Na^+ + e^- \rightarrow Na$ | -2.71 |
| $Mg^{+2} + 2e^- \rightarrow Mg$ | -2.38 |
| $Al^{+3} + 3e^- \rightarrow Al$ | -1.66 |
| $2H_2O + 2e^- \rightarrow H_2(g) + 2OH^-$ | -0.83 |
| $Zn^{+2} + 2e^- \rightarrow Zn$ | -0.76 |
| $Cr^{+3} + 3e^- \rightarrow Cr$ | -0.74 |
| $Fe^{+2} + 2e^- \rightarrow Fe$ | -0.41 |
| $Cd^{+2} + 2e^- \rightarrow Cd$ | -0.40 |
| $Ni^{+2} + 2e^- \rightarrow Ni$ | -0.23 |
| $Sn^{+2} + 2e^- \rightarrow Sn$ | -0.14 |
| $Pb^{+2} + 2e^- \rightarrow Pb$ | -0.13 |
| $Fe^{+3}{}^{+3} + 3e^- \rightarrow Fe$ | -0.04 |
| $2H^+ + e^- \rightarrow H_2$ | 0.00 |

| Half reaction | $E^o$ |
|---|---|
| $Sn^{+4} + 2e^- \rightarrow Sn^{+2}$ | +0.15 |
| $Cu^{+2} + e^- \rightarrow Cu^+$ | +0.16 |
| $Cu^{+2} + 2e^- \rightarrow Cu$ | +0.34 |
| $I_2 + 2e^- \rightarrow 2I^-$ | +0.54 |
| $Fe^{+3} + e^- \rightarrow Fe^{+2}$ | +0.77 |
| $Ag^+ + e^- \rightarrow Ag$ | +0.80 |
| $Hg^{+2} + 2e^- \rightarrow Hg$ | +0.85 |
| $NO3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O$ | +0.96 |
| $Br_2 + 2e^- \rightarrow 2Br^-$ | +1.07 |
| $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ | +1.23 |
| $Cr_2O_7^{-2} + 14H^+ + 6e^- \rightarrow 2Cr^{+3} + 7H_2O$ | +1.33 |
| $Cl_2 + 2e^- \rightarrow 2Cl^-$ | +1.36 |
| $MnO_4^{-2} + 8H^+ + 5e^- \rightarrow Mn^{+2} + 4H_2O$ | +1.49 |
| $F_2 + 2e^- \rightarrow 2F^-$ | +2.87 |

**15 reactions to use in answering the questions below.**

Balance by inspection

1. $H_2 + O_2 \rightarrow \quad H_2O$
2. $Na + H_2O \rightarrow \quad Na^+ + OH^- + H_2$
3. $C_6H_{12}O_6 + O_2 \rightarrow \quad CO_2 + H_2O$

Simple redox reactions (use change of oxidation method)

4. $Cu + Zn^{+2} \rightarrow \quad Zn + Cu^{+2}$
5. $Al + Fe^{+3} \rightarrow \quad Al^{+3} + Fe^{+2}$
6. $Pb + Cr^{+3} \rightarrow \quad Pb^{+2} + Cr$
7. $Li + F_2 \rightarrow \quad Li^+ + F^-$

Acid (use change of oxidation method in acid)

8. $Mn^{+2} + I_2 \rightarrow \quad MnO^- + I^-$
9. $BrO_3^- + N_2H_4 \rightarrow \quad Br^- + N_2$
10. $Fe^{+3} + H_2O \rightarrow \quad O_2 + Fe^{+2}$
11. $P_4 + NO_3^- \rightarrow \quad H_2PO_4^- + NO$
12. $Cr_2O_7^{-2} + Sn^{+2} \rightarrow \quad Cr^{+3} + Sn^{+4}$

Base (use change of oxidation method in base)

13. $CN^- + MnO_4^- \rightarrow \quad MnO_2 + CNO^-$
14. $Fe(OH)_2 + O_2 \rightarrow \quad Fe(OH)_3$
15. $C_2H_5OH + MnO_4^- \rightarrow \quad C_2H_3O_2^- + MnO_2$

**Part I**. Balance all of the electrochemical (redox) reactions above. Refer to Worksheet 9 for assistance in how to perform the "change of oxidation method" approach. For those who are more comfortable with the "half reaction method", feel free to use that. It yields the same result—but it can take more time.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

12.

13.

14.

15.

**Part II. Standard Cell Potential**. Assuming standard conditions, calculate the standard cell potential for reactions: 2, 4, 5, 6, 7, 8, 10 and 12 for the reaction as written, using the equation:

$E^{o}_{cell} = E^{o}_{cathode} - E^{o}_{anode}$

2.

4.

5.

6.

7.

8.

10.

12.

**Part III. Cell convention.** For reactions 2, 4, 5, 6, 7, 8, 10 and 12 as written above, find the following for the electrochemical cell assuming the reaction is as written:

| Reaction | Voltaic or Electrolytic | Half reaction at + electrode | Half reaction at - electrode |
|---|---|---|---|
| 2 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 10 | | | |
| 12 | | | |

**Part IV. Cell shorthand notation.** No one likes to draw all those beakers and wires in an electrochemical cell (except people who like to draw), so electrochemists have developed shorthand electrochemical notation. Use it to draw the electrochemical cells of reactions 2, 4, 5, 6, 7, 8, 10 and 12.

| **Reaction:** | **Cell Shorthand:** |
| --- | --- |
| 2. | |
| 4. | |
| 5. | |
| 6. | |
| 7. | |
| 8. | |
| 10. | |
| 12. | |