Chapter 19 Worksheet 2 (galvanic cells, cell notation, cell potentials)

Name: ____________________ UGA ID: ____________

Instructions:

- Please enter your first and last name as it appears on the eLC roster (do not use a nickname).
- Your UGA myID is a combination of letters and numbers (example: mine is wpe28548). **Do not use your 81x number.**
- If you do not have a printer, type your answers in the then upload the worksheet template to Gradescope by Thursday, April 29 at 11:59 pm. Write your work on separate sheets of paper, convert to a PDF and upload to eLC.
- If you have a printer download the worksheet, convert it to a PDF and upload to Gradescope by Thursday, April 29 at 11:59 pm. You do not need to upload anything to eLC.

1. When a piece of copper metal is put into a solution of silver nitrate ($AgNO_3$), silver metal is produced along with Cu^{2+}, the latter of which is responsible for the blue color of the solution. Which of the following statements is false?

A. ΔG for the reaction is negative (the reaction is exergonic).

B. For every mole of Cu reacted, two moles of Ag is produced.

C. Cu is oxidized.

D. Ag is an oxidizing agent.

E. A solution of $CuSO_4$ will be blue.

2a. What is the strongest oxidizing agent?

A. MnO_4^-

B.

C. Hg_2^{2+}

D.

E. Fe^{2+}

D. K^+

Reduction Half-Reaction	E^o (V)
$MnO_4^-(aq) + 8 H^+(aq) + 5 e^- \rightarrow Mn^{2+}(aq) + 4 H_2O(l)$	1.51
$Hg_2^{2+}(aq) + 2 e^- \rightarrow 2 Hg(l)$	0.855
$Fe^{2+}(aq) + 2 e^- \rightarrow 2 Fe(s)$	-0.44
$K^+(aq) + e^- \rightarrow K(s)$	-2.925

b. Can the mercury(I) ion reduce the iron(II) ion to metallic iron?

A. Yes

B. No

3. Given the standard electrode potentials, which of these is spontaneous?

$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$ $E^o = 0.80$ V

$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$ $E^o = -0.44$V

$N_2(g) + 5H^+(aq) + 4e^- \rightleftharpoons N_2H_5^+(aq)$ $E^o = -0.23$ V

A. $N_2(g) + 2Fe(s) + 5\ H^+(aq) \rightleftharpoons N_2H_5^+(aq) + 2Fe^{2+}(aq)$

B. $N_2(g) + 4Ag(s) + 5\ H^+(aq) \rightleftharpoons N_2H_5^+(aq) + 4Ag^+(aq)$

C. $Fe^{2+}(aq) + 4Ag(s) \rightleftharpoons + 4Ag^+ + Fe(s)$

D. None of the above are spontaneous

4. You are given the following reduction half reactions in basic solution:

$2\ NO_2^-(aq) + 3\ H_2O(l) + 4\ e^- \rightarrow N_2O(g) + 6\ OH^-(aq)$ $E° = 0.1500$ V

$HgO(s) + H_2O(l) + 2\ e^- \rightarrow Hg(s) + 2\ OH^-(aq)$ $E° = +0.0984$ V

A. If this redox reaction occurs, how many total electrons will have to be transferred per mole of reaction?

$N_2O(g) + 2\ OH^-(aq) + 2\ HgO(s) \rightarrow 2\ NO_2^-(aq) + H_2O(l) + 2\ Hg(s)$

B. What is the $E°_{CELL}$ for this redox reaction?

5. A. It is desired to reduce mercury(I) at a mercury electrode in a voltaic electrochemical cell. Which of these reactions would do the trick for the anode reaction when combined with the mercury reduction at the cathode?

$Hg_2^{2+}(aq) + 2\ e^- \rightleftharpoons 2\ Hg(l)$ $E^o = 0.800$ V

A. $Zn^{2+}(aq) + 2\ e^- \rightleftharpoons Zn(s)$ $E^o = -0.760$ V

B. $Br_2(l) + 2\ e^- \rightleftharpoons 2\ Br^-(aq)$ $E^o = 1.070$ V

B. Calculate $E°_{CELL}$ for each of the reactions above.

C. In this case, we would say the zinc(s) is a good:

A. Oxidizing agent B. Reducing agent

C. Purging agent D. None of these

6. Which of these processes will occur at the cathode in an electrochemical cell?

A. $Cu^{2+}(aq) + 2\ e^- \rightleftharpoons Cu(s)$

B. $\frac{1}{2}\ H_2(g) \rightleftharpoons H^+(g) + e^-$

C. Neither of these

7. When pure iron is put into pure water, it produces H_2 gas, and when pure iron is put into an acidic solution it produces H_2 gas. Using the data below, state whether the above statement is true or false.

$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons H_2O(l)$	$E^o = 1.24$ V
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$	$E^o = 0.00$ V
$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$	$E^o = -0.44$ V
$2H_2O(l) + 2e^- \rightleftharpoons H_2(g) + OH^-(aq)$	$E^o = -0.83$ V

A. True

B. False

8. Which species would be able to reduce iron(II) ion to elemental iron? (Multiple Answer)

A. Nickel metal

A. Manganese(II) ion (acidic)

B. Aluminum metal

C. Silver metal

D. Zinc metal

Standard Potential (V)	Reduction Half-Reaction
2.87	$F_2(g) + 2e^- \longrightarrow 2F^-(aq)$
1.51	$MnO_4^-(aq) + 8H^+(aq) + 5e^- \longrightarrow Mn^{2+}(aq) + 4H_2O(l)$
1.36	$Cl_2(g) + 2e^- \longrightarrow 2Cl^-(aq)$
1.33	$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \longrightarrow 2Cr^{3+}(aq) + 7H_2O(l)$
1.23	$O_2(g) + 4H^+(aq) + 4e^- \longrightarrow 2H_2O(l)$
1.06	$Br_2(l) + 2e^- \longrightarrow 2Br^-(aq)$
0.96	$NO_3^-(aq) + 4H^+(aq) + 3e^- \longrightarrow NO(g) + H_2O(l)$
0.80	$Ag^+(aq) + e^- \longrightarrow Ag(s)$
0.77	$Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$
0.68	$O_2(g) + 2H^+(aq) + 2e^- \longrightarrow H_2O_2(aq)$
0.59	$MnO_4^-(aq) + 2H_2O(l) + 3e^- \longrightarrow MnO_2(s) + 4OH^-(aq)$
0.54	$I_2(s) + 2e^- \longrightarrow 2I^-(aq)$
0.40	$O_2(g) + 2H_2O(l) + 4e^- \longrightarrow 4OH^-(aq)$
0.34	$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$
0	$2H^+(aq) + 2e^- \longrightarrow H_2(g)$
− 0.28	$Ni^{2+}(aq) + 2e^- \longrightarrow Ni(s)$
− 0.44	$Fe^{2+}(aq) + 2e^- \longrightarrow Fe(s)$
− 0.76	$Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s)$
− 0.83	$2H_2O(l) + 2e^- \longrightarrow H_2(g) + 2OH^-(aq)$
− 1.66	$Al^{3+}(aq) + 3e^- \longrightarrow Al(s)$
− 2.71	$Na^+(aq) + e^- \longrightarrow Na(s)$
− 3.05	$Li^+(aq) + e^- \longrightarrow Li(s)$

9.

Half-reaction	E° (V)
$Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$	−0.74
$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$	−0.440
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(s)$	+0.771
$Sn^{4+}(aq) + 2e^- \rightarrow Sn^{2+}(aq)$	+0.154

The standard cell potential ($E°_{cell}$) for the voltaic cell based on the reaction below is ________ V.

$Sn^{2+}(aq) + 2Fe^{3+}(aq) \rightarrow 2Fe^{2+}(aq) + Sn^{4+}(aq)$

10. Calculate the cell potential (in volts) for the voltaic cell indicated at 25 ^oC. (Use the table in your textbook for the reduction half reaction potentials.)

$Ga / Ga^{3+} (10^{-6}\ M) \,||\, Ag^{+} (10^{-4}\ M) / Ag$

11. From the information given, which of the following statements is true?

Substance	Reduction Potential (V)
$F_2 \rightarrow 2\ F^-$	2.85
$Cl_2 \rightarrow 2\ Cl^-$	1.36
$Br_2 \rightarrow 2\ Br^-$	1.09
$I_2 \rightarrow 2\ I^-$	0.54

A. F_2 is the best oxidizing agent, F^- is the best reducing agent

B. I_2 is the best oxidizing agent, F^- is the best reducing agent

C. I_2 is the best oxidizing agent, I^- is the best reducing agent

D. F_2 is the best oxidizing agent, I^- is the best reducing agent

E. F_2 is the best oxidizing agent, I_2 is the best reducing agent

12. The two electrodes $Cr(s)/Cr^{3+}(aq)$ and $Sn(s)/Sn^{2+}(aq)$ are combined to afford a product– favored electrochemical equation. The standard reduction potentials in V for $Cr^{3+}(aq)$ and $Sn^{2+}(aq)$ are –0.74V and –0.14V, respectively. E° in V is:

A. +0.88V

B. –0.88V

C. +0.60V

D. –0.60V

E. +2.50V