

Recitation 13 Worksheet (Electrochemistry)

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)
- Download this worksheet and print it if you have a printer. Write the answers in the answer boxes and show your work when appropriate. Using the instructions in the Welcome module on eLC, convert your worksheet to a PDF and then upload it to Gradescope. The pages must be in the correct order or Gradescope will not be able to read it.
- If you do not have a printer, download the worksheet and type your answers in the answer boxes and upload it to Gradescope. Write your work on separate sheets of paper, convert these pages to a PDF using the instructions in the Welcome module on eLC, then upload them to the dropbox on eLC for this worksheet.
- This worksheet is due no later than 11:59 pm on Sunday, May 2.
- The instructions for uploading worksheets to Gradescope can be found in the Content area of eLC in the Welcome Module.
- You must show your work to receive credit.

Match the following.

- A. $E^{\circ}_{\text{cell}} < 0$
- B. $E_{\text{cell}} = 0$
- C. $E^{\circ}_{\text{cell}} > 0$
- D. $E_{\text{cell}} > 0$
- E. $E_{\text{cell}} < 0$
- F. $E_{\text{cell}} = E^{\circ}_{\text{cell}}$

1. $Q = 1$

2. $Q > K$

3. $Q < K$



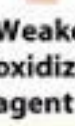
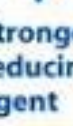
4. $\Delta G^{\circ} < 0$

5. $\Delta G^{\circ} > 0$

6. $Q = K$

Use the Standard Reduction Table to answer the questions on this worksheet.

Standard Reduction Table

| Reduction Half-Reaction | | | E° (V) | | | |
|---|---|--|---|---|---------------------------------------|-------|
| Stronger oxidizing agent  | $\text{F}_2(\text{g}) + 2 \text{e}^-$ | $\longrightarrow 2 \text{F}^-(\text{aq})$ | 2.87 | Weaker reducing agent  | | |
| | $\text{H}_2\text{O}_2(\text{aq}) + 2 \text{H}^+(\text{aq}) + 2 \text{e}^-$ | $\longrightarrow 2 \text{H}_2\text{O}(\text{l})$ | 1.78 | | | |
| | $\text{MnO}_4^-(\text{aq}) + 8 \text{H}^+(\text{aq}) + 5 \text{e}^-$ | $\longrightarrow \text{Mn}^{2+}(\text{aq}) + 4 \text{H}_2\text{O}(\text{l})$ | 1.51 | | | |
| | $\text{Cl}_2(\text{g}) + 2 \text{e}^-$ | $\longrightarrow 2 \text{Cl}^-(\text{aq})$ | 1.36 | | | |
| | $\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14 \text{H}^+(\text{aq}) + 6 \text{e}^-$ | $\longrightarrow 2 \text{Cr}^{3+}(\text{aq}) + 7 \text{H}_2\text{O}(\text{l})$ | 1.33 | | | |
| | $\text{O}_2(\text{g}) + 4 \text{H}^+(\text{aq}) + 4 \text{e}^-$ | $\longrightarrow 2 \text{H}_2\text{O}(\text{l})$ | 1.23 | | | |
| | $\text{Br}_2(\text{aq}) + 2 \text{e}^-$ | $\longrightarrow 2 \text{Br}^-(\text{aq})$ | 1.09 | | | |
| | $\text{Ag}^+(\text{aq}) + \text{e}^-$ | $\longrightarrow \text{Ag}(\text{s})$ | 0.80 | | | |
| | $\text{Fe}^{3+}(\text{aq}) + \text{e}^-$ | $\longrightarrow \text{Fe}^{2+}(\text{aq})$ | 0.77 | | | |
| | $\text{O}_2(\text{g}) + 2 \text{H}^+(\text{aq}) + 2 \text{e}^-$ | $\longrightarrow \text{H}_2\text{O}_2(\text{aq})$ | 0.70 | | | |
| | $\text{I}_2(\text{s}) + 2 \text{e}^-$ | $\longrightarrow 2 \text{I}^-(\text{aq})$ | 0.54 | | | |
| | $\text{O}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l}) + 4 \text{e}^-$ | $\longrightarrow 4 \text{OH}^-(\text{aq})$ | 0.40 | | | |
| | $\text{Cu}^{2+}(\text{aq}) + 2 \text{e}^-$ | $\longrightarrow \text{Cu}(\text{s})$ | 0.34 | | | |
| | $\text{Sn}^{4+}(\text{aq}) + 2 \text{e}^-$ | $\longrightarrow \text{Sn}^{2+}(\text{aq})$ | 0.15 | | | |
| | $2 \text{H}^+(\text{aq}) + 2 \text{e}^- \longrightarrow \text{H}_2(\text{g})$ | | | | 0 | |
| | $\text{Pb}^{2+}(\text{aq}) + 2 \text{e}^-$ | | | | $\longrightarrow \text{Pb}(\text{s})$ | -0.13 |
| | $\text{Ni}^{2+}(\text{aq}) + 2 \text{e}^-$ | | | | $\longrightarrow \text{Ni}(\text{s})$ | -0.26 |
| $\text{Cd}^{2+}(\text{aq}) + 2 \text{e}^-$ | | | $\longrightarrow \text{Cd}(\text{s})$ | -0.40 | | |
| $\text{Fe}^{2+}(\text{aq}) + 2 \text{e}^-$ | | | $\longrightarrow \text{Fe}(\text{s})$ | -0.45 | | |
| $\text{Zn}^{2+}(\text{aq}) + 2 \text{e}^-$ | | | $\longrightarrow \text{Zn}(\text{s})$ | -0.76 | | |
| $2 \text{H}_2\text{O}(\text{l}) + 2 \text{e}^-$ | | | $\longrightarrow \text{H}_2(\text{g}) + 2 \text{OH}^-(\text{aq})$ | -0.83 | | |
| $\text{Al}^{3+}(\text{aq}) + 3 \text{e}^-$ | | | $\longrightarrow \text{Al}(\text{s})$ | -1.66 | | |
| $\text{Mg}^{2+}(\text{aq}) + 2 \text{e}^-$ | | | $\longrightarrow \text{Mg}(\text{s})$ | -2.37 | | |
| $\text{Na}^+(\text{aq}) + \text{e}^-$ | | | $\longrightarrow \text{Na}(\text{s})$ | -2.71 | | |
| $\text{Li}^+(\text{aq}) + \text{e}^-$ | | | $\longrightarrow \text{Li}(\text{s})$ | -3.04 | | |
| Weaker oxidizing agent  | | | | Stronger reducing agent  | | |

7. This question consists of an **assertion** and a **reason**.

Assertion

Chlorine will cause iodine to form when chlorine is bubbled through a solution of potassium iodide.

Reason

Chlorine is a stronger oxidizing agent than iodine.

Select one of these statements.

☐

- A. both the assertion and reason are true statements, and the reason is a correct explanation of the assertion
- B. both the assertion and reason are true statements, but the reason is not a correct explanation of the assertion
- C. the assertion is true but the reason is false
- D. the assertion is false but the reason is a true statement
- E. both assertion and reason are false statements

8. This question consists of an **assertion** and a **reason**.

Assertion

Hydrogen ions react with metallic zinc and form hydrogen gas and zinc ions.

Reason

Zinc ions is a stronger oxidizing agent than hydrogen ions.

Select one of these statements:

☐

- A. both assertion and reason are true statements, and the reason is a correct explanation of the assertion
- B. both assertion and reason are true statements, but the reason is not a correct explanation for the assertion
- C. the assertion is true but the reason is false**
- D. the assertion is false but the reason is a true statement.
- E. both assertion and reason are false statements

9. This question consists of an **assertion** and a **reason**.

Assertion

Copper reacts spontaneously with zinc ions and forms copper ions and zinc.

Reason

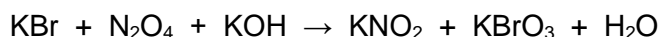
Copper ions are a stronger oxidizing agent than zinc ions.

Select one of these statements:

☐

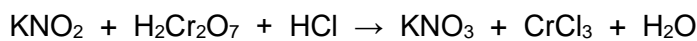
- A. both the assertion and reason are true statements, and the reason is a correct explanation of the assertion
- B. Both the assertion and reason are true statements, but the reason is not a correct explanation of the assertion
- C. the assertion is true but the reason is false
- D. the assertion is false but the reason is a true statement.**
- E. both assertion and reason are false statements

10. Consider the unbalanced reaction:



When the equation is balanced with the smallest whole-number coefficients, the coefficient of H_2O will be:

11. What is the sum of the coefficients in this balanced oxidation-reduction reaction and which element is reduced? What is the oxidation number of Cr in $\text{H}_2\text{Cr}_2\text{O}_7$ and N in KNO_3 ?



in is reduced.

Sum of coefficients:

12. This question consists of an **assertion** and a **reason**.

Assertion

In the electrochemical cell:

$\text{Zn(s)} \mid \text{Zn}^{2+}(\text{aq}) (1.0 \text{ M}) \parallel \text{Ag}^+(\text{aq}) (1.0 \text{ M}) \mid \text{Ag(s)}$
the zinc electrode is the negative terminal of the cell.

Reason

At the zinc electrode, zinc atoms are oxidized to zinc ions and electrons are released.

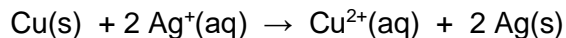
Select one of these statements:

- ☐ A. both the assertion and reason are true statements, and the reason is a correct explanation of the assertion
☐ B. both the assertion and reason are true statements, but the reason is not a correct explanation of the assertion
☐ C. the assertion is true but the reason is false
☐ D. the assertion is false but the reason is a true statement
☐ E. both assertion and reason are false statements

13. In an electrochemical cell, the combination of electrodes (and corresponding electrolytes) that would produce the highest voltage is

- ☐ A. Co – Ni
☐ B. Fe – Co
☐ C. Pt – Zn
☐ D. Zn – Fe
☐ E. Pt – Ni

14. An electric cell consists of a silver electrode in 1.0 mol/L solution of silver nitrate, a copper electrode in 1.0 mol/L solution of copper(II) nitrate, and a salt bridge. The spontaneous cell reaction is

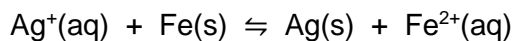


When the two electrodes are connected by a wire, which of the following does not take place?

☐

- A. electrons flow in the wire from the copper electrode to the silver electrode
- B. the silver electrode increases in mass as the cell operates
- C. there is a net movement of silver ions through the salt bridge from the silver half-cell to the copper half-cell
- D. there is a net movement of copper ions through the salt bridge from the copper half-cell to the silver half-cell
- E. the copper electrode decreases in mass as the cell operates

15. What is the standard free energy change and equilibrium constant for the following reaction at 25 °C?



$$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$$

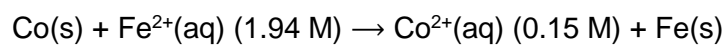
$$E^\circ_{\text{cell}} = \frac{0.0592 \text{ V}}{n} \log K$$

$$\Delta G^\circ = -n F E^\circ_{\text{cell}}$$

$$F = \frac{96,485 \text{ J}}{\text{V} \cdot \text{mol}}$$

kJ/mol

16. Consider the following reaction at room temperature:



$$E^{\circ}_{\text{cell}} = E^{\circ}_{\text{cathode}} - E^{\circ}_{\text{anode}}$$

$$E_{\text{cell}} = E^{\circ}_{\text{cell}} - \frac{0.0592 \text{ V}}{n} \log Q$$

☐

- A. The process is spontaneous.
B. The process is non-spontaneous.

