

Electrochemical Cells

1. Shelby compares a Voltaic cell to an electrolytic cell. The statement below that is **false** is _____
- a Both cells have oxidation happening at the anode
 - b In a voltaic cell, anions go to the anode, while in the electrolytic cell, anions go to the cathode
 - c In an electrolytic cell electrical energy is converted to chemical energy, while in a voltaic cell, chemical energy is converted to electrical energy.
 - d A Voltaic cell is considered 'spontaneous' while an electrolytic cell is considered 'non-spontaneous'.
2. In a spontaneous cell, the electrons leave the _____ and travel in _____ to reach the _____.
- a Cathode Internal circuit Anode
 - b Anode Internal circuit Cathode
 - c Cathode External circuit Anode
 - d Anode External circuit Cathode
3. In an electrolytic cell, _____ travel to the anode and _____ travel to the cathode in the _____ circuit.
- a Anions Cations External
 - b Cations Anions External
 - c Anions Cations Internal
 - d Cations Anions internal

4. An electrolytic cell $\text{Zn(s)} \mid \text{Zn}^{2+}(\text{aq}) \parallel \text{Sn}^{2+}(\text{aq}) \mid \text{Sn(s)}$ has $1.0 \frac{\text{mol}}{\text{L}}$ solutions.

The net voltage of this cell is _____ V

- a -0.90
- b -0.62
- c +0.62
- d +0.90

5. Which cell is capable of recharging a 1.25 V battery?

- a $\text{Cu(s)} / \text{Cu}^{2+} // \text{Ag}^{+}(\text{aq}) / \text{Ag(s)}$
- b $\text{Al(s)} / \text{Al}^{3+}(\text{aq}) // \text{Sn}^{2+}(\text{aq}) / \text{Sn(s)}$
- c $\text{Co(s)} / \text{Co}^{2+}(\text{aq}) // \text{Pb}^{2+}(\text{aq}) / \text{Pb(s)}$
- d $\text{Fe(s)} / \text{Fe}^{2+}(\text{aq}) // \text{Ni}^{2+}(\text{aq}) / \text{Ni(s)}$

6. The E° value for the reaction that takes place when $\text{Cl}_2(\text{g})$ is added to $1.0 \frac{\text{mol}}{\text{L}}$ solution of $\text{NaI}(\text{aq})$ will be _____ V

- a -1.90
- b -0.82
- c +0.82
- d +1.90

7. Jon and Steve experimented with the following combination of reactants in a laboratory. Which combination will be non-spontaneous under standard conditions?

- a $\text{Ag}^{+}(\text{aq}) + \text{H}_2(\text{g})$
- b $\text{Cr(s)} + \text{Sn}^{2+}(\text{aq})$
- c $\text{Ba(s)} + \text{Fe}^{2+}(\text{aq})$
- d $\text{Al(s)} + \text{Ca}^{2+}(\text{aq})$

8. For the reaction, $\text{Fe(s)} + \text{Sn}^{4+}(\text{aq}) \rightarrow \text{Sn}^{2+}(\text{aq}) + \text{Fe}^{2+}(\text{aq})$, a **true** statement is ____
- a $\text{Sn}^{4+}(\text{aq})$ caused Fe(s) to be reduced
 - b Fe(s) causes $\text{Sn}^{4+}(\text{aq})$ to be reduced
 - c $\text{Sn}^{2+}(\text{aq})$ is the oxidizing agent
 - d Fe(s) is the oxidizing agent
9. In a Voltaic cell, reduction occurs ____.
- a In the salt bridge
 - b At the cathode
 - c At the anode
 - d In the porous cup
10. In an electrolytic cell, oxidation occurs ____.
- a In the salt bridge
 - b At the cathode
 - c At the anode
 - d In the porous cup
11. When a car battery produces electricity to start the engine, the battery is behaving as
- a An electrolytic cell
 - b A voltaic cell
 - c A system in which only oxidation is occurring
 - d A system in which only reduction is occurring
12. In a functioning Voltaic cell, electrons travel in the ____ circuit from the ____ to the ____.
- a Internal Anode Cathode
 - b Internal Cathode Anode
 - c External Anode Cathode
 - d external Cathode Anode

13. Which statement about electrochemical cells is **false**?
- a Anions go the anode, while cations go the cathode
 - b Oxidation occurs at the anode, reduction at the cathode
 - c Chemical energy will always be converted to electrical energy.
 - d E° for the cell will be negative.

14. Jason and Kyle read the line notation for a **Voltaic cell**.



They decide that the Zn(s) acts as the _____ and _____, while Cu(s) acts as the _____

- a Anode Oxidizing agent Cathode
 - b Anode Reducing agent Cathode
 - c Cathode Oxidizing agent Anode
 - d Cathode Reducing agent Anode
15. Consider the seven statements given below.
- 1 Oxidation occurs at the anode where electrons are lost.
 - 2 Oxidation occurs at the cathode where electrons are gained.
 - 3 Reduction occurs at the anode where electrons are lost.
 - 4 The oxidizing agent undergoes reduction at the cathode.
 - 5 The reducing agent undergoes oxidation at the anode.
 - 6 The oxidation number of the reducing agent goes up as oxidation occurs.
 - 7 The oxidation number of the oxidizing agent goes down as reduction occurs.

Choose the **FALSE** statement(s) from the statements listed above.

- a 1,4,5,6,7
- b 2,3,6
- c 2,3
- d 6,7

16. Consider the seven statements given below.

- 1 Oxidation occurs at the anode where electrons are lost.
- 2 Oxidation occurs at the cathode where electrons are gained.
- 3 Reduction occurs at the anode where electrons are lost.
- 4 The oxidizing agent undergoes reduction at the cathode.
- 5 The reducing agent undergoes oxidation at the anode.
- 6 The oxidation number of the reducing agent goes up as oxidation occurs.
- 7 The oxidation number of the oxidizing agent goes down as reduction occurs.

The total number of TRUE statements given above is _____

- a 2
- b 4
- c 5
- d 6

17. Consider the seven statements given below.

- 1 Oxidation occurs at the anode where electrons are lost.
- 2 Oxidation occurs at the cathode where electrons are gained.
- 3 Reduction occurs at the anode where electrons are lost.
- 4 The oxidizing agent undergoes reduction at the cathode.
- 5 The reducing agent undergoes oxidation at the anode.
- 6 The oxidation number of the reducing agent goes up as oxidation occurs.
- 7 The oxidation number of the oxidizing agent goes down as reduction occurs.

The total number of FALSE statements given above is _____

- a 2
- b 4
- c 5
- d 6

18. If the oxidizing agent is higher on the reduction table than the reducing agent, then the cell is called a _____ cell and the net voltage will be _____
- Voltaic Positive
 - Electrolytic Negative
 - Voltaic Negative
 - Electrolytic Positive

19. Samantha and Ashleigh study the line notation for an electrochemical cell.



They predict the reaction at the cathode of this cell to be _____

- $\text{Fe}^{3+}(\text{aq}) + \text{e}^{-} \rightarrow \text{Fe}^{2+}(\text{aq})$
 - $\text{Cr}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cr(s)}$
 - $\text{Cr}^{2+}(\text{aq}) \rightarrow \text{Cr}^{3+}(\text{aq}) + \text{e}^{-}$
 - $\text{Fe}^{3+}(\text{aq}) + 3\text{e}^{-} \rightarrow \text{Fe(s)}$
20. Colbe and Mike write a series of statements about electrochemical cells. Some of their statements are true for both Voltaic and Electrolytic cells, some are true only for one type of cell, and some are not true for either type of cell.

Consider the statements given below.

Number	Statement
1	Reduction happens at the cathode.
2	Electrons travel in the external circuit of the cell.
3	Anions travel to the cathode and cations travel to the anode.
4	Electrical energy is converted to chemical energy.
5	The reducing agent is higher on the reduction table than the oxidizing agent.
6	Electrons are gained at the anode.
7	Metals are plated at the anode.
8	The cathode has a positive charge.

The **TOTAL** number of statements that is /are true **ONLY** for electrolytic cells is/are _____

- a 1
- b 2
- c 3
- d 4

21. Colbe and Mike write a series of statements about electrochemical cells. Some of their statements are true for both Voltaic and Electrolytic cells, some are true only for one type of cell, and some are not true for either type of cell.

Consider the statements given below.

Number	Statement
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- | | |
|---|---|
| 1 | Reduction happens at the cathode. |
| 2 | Electrons travel in the external circuit of the cell. |
| 3 | Anions travel to the cathode and cations travel to the anode. |
| 4 | Electrical energy is converted to chemical energy. |
| 5 | The reducing agent is higher on the reduction table than the oxidizing agent. |
| 6 | Electrons are gained at the anode. |
| 7 | Metals are plated at the anode. |
| 8 | The cathode has a positive charge. |

The number of statements that are **NOT** true for any cell is/are _____

- a 1
- b 2
- c 3
- d 4

22. Colbe and Mike write a series of statements about electrochemical cells. Some of their statements are true for both Voltaic and Electrolytic cells, some are true only for one type of cell, and some are not true for either type of cell.

Consider the statements given below.

Number	Statement
1	Reduction happens at the cathode.
2	Electrons travel in the external circuit of the cell.
3	Anions travel to the cathode and cations travel to the anode.
4	Electrical energy is converted to chemical energy.
5	The reducing agent is higher on the reduction table than the oxidizing agent.
6	Electrons are gained at the anode.
7	Metals are plated at the anode.
8	The cathode has a positive charge.

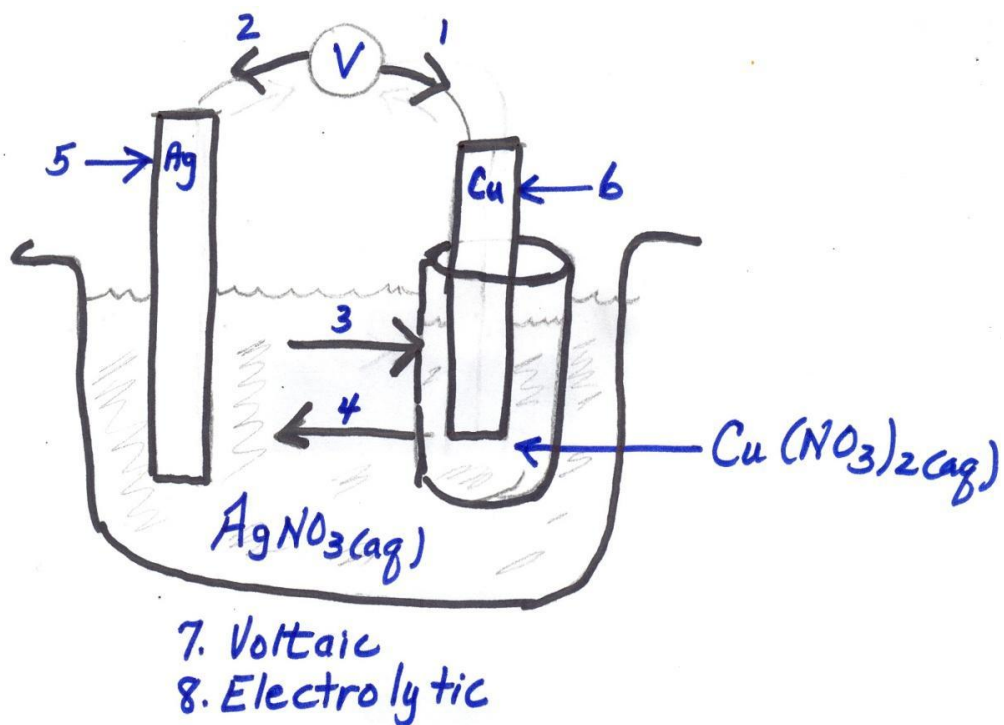
The **TOTAL** number of statements that is /are true for both types of cells is/are _____

- a 1
- b 2
- c 3
- d 4

23. Numerical response question: Left justify your answer in the boxes provided.

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Consider the electrochemical cell illustrated below



Using the numbers in the diagram, identify:

1. Type of cell _____
2. Anode _____
3. Direction of flow of electrons _____
4. Direction of flow of cations _____

24. **Numerical response question:** Left justify your answer in the boxes provided

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Students are given the following list of chemical reagents:

1. Strip of cadmium metal
2. Strip of nickel metal
3. Carbon rod(s)
4. Strip of zinc metal
5. Strip of copper metal
6. Nickel (II) sulfate solution
7. Cadmium sulfate solution
8. Potassium sulfate solution
9. Zinc sulfate solution

If asked to make the strongest possible Voltaic cell, the student should choose

Anode, Cathode, anion, cation

Box 1 Box 2 Box 3 Box 4

25. **Numerical response question:** Left justify your answer in the boxes provided.

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Consider the numbered statements about electrochemical cells given below.

1. Oxidation occurs at the cathode
2. The reducing agent reacts at the anode
3. Anions move through the external wire to the anode
4. Cations move through the electrolyte to the anode
5. Electrons move through the external wire to the cathode
6. Chemical energy is converted to thermal energy
7. Chemical energy is converted to electrical energy
8. Cations move through the internal circuit to the cathode.

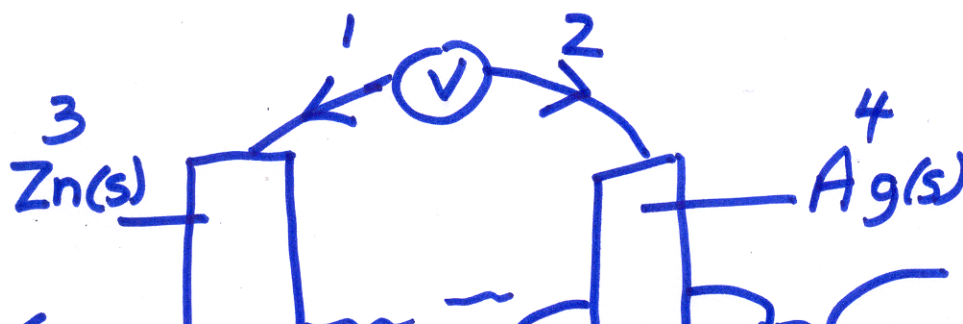
The statements numbered above that apply to both electrolytic cells and voltaic cells are ____, ____, ____, and ____.

26. **Numerical response question:** Left justify your answer in the boxes provided.

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Match the numbers in the diagram below with their appropriate labels.

1. ___ Reducing Agent,
2. ___ Cathode,
3. ___ direction of anion movement,
4. ___ direction of electron movement



27. **Numerical response question:** Left justify your answer in the boxes provided

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Consider the numbered statements about electrochemical cells given below.

1. the reaction is spontaneous
2. The cathode is the positive electrode
3. The anode is the positive electrode
4. Electrons travel from the anode to the cathode
5. Electrons travel from the cathode to the anode
6. Anions travel to the anode
7. Anions travel to the cathode
8. Cations travel to the cathode
9. Cations travel to the anode

List the statements numbered above that apply to both electrolytic cells and voltaic cells. Put the numbers in ascending order.

Solutions:

- | | | | |
|-----|---|-----|------------------|
| 1. | B | 23. | 7624 |
| 2. | D | 24. | 4269 |
| 3. | C | 25. | 258 in any order |
| 4. | C | 26. | 3461 |
| 5. | B | 27. | 468 |
| 6. | C | | |
| 7. | D | | |
| 8. | B | | |
| 9. | B | | |
| 10. | C | | |
| 11. | B | | |
| 12. | C | | |
| 13. | C | | |
| 14. | B | | |
| 15. | C | | |
| 16. | C | | |
| 17. | A | | |
| 18. | A | | |
| 19. | A | | |
| 20. | B | | |
| 21. | C | | |
| 22. | B | | |