

Practice - Electrolysis

1. Consider the following:

I. Electrolysis of water

II. Electroplating of copper

III. Fuel cell

Which of the above involve non-spontaneous redox reactions?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

2. Which of the following best describes a car battery as it is being charged?

A. It is an electrolytic cell

B. It is an electrochemical cell

C. It is an example of a short circuit

D. It is a system moving to a state of lower potential energy

3. Which of the following describes an operating electrolytic cell?

E°	Type of reaction	Direction of Electron Flow
A. positive	spontaneous	from anode; to cathode
B. negative	non-spontaneous	from cathode; to anode
C. positive	spontaneous	from cathode; to anode
<u>D. negative</u>	non-spontaneous	from anode; to cathode

4. Which of the following describes an operating electrochemical cell?

E°	Type of reaction	Direction of Electron Flow
<u>A.</u> positive	spontaneous	anode to cathode
B. negative	spontaneous	cathode to anode
C. positive	non-spontaneous	anode to cathode
D. negative	non-spontaneous	cathode to anode

5. Which of the following best describes the term electrolysis?

A. a process that uses electrical energy to cause a spontaneous reaction

B. a process that generates electrical energy using a spontaneous reaction

C. a process that uses electrical energy to cause a non-spontaneous reaction

D. a process that generates electrical energy using a non-spontaneous reaction

6. Which of the following aqueous solution should not be used as an electrolyte in an electrolytic cell?

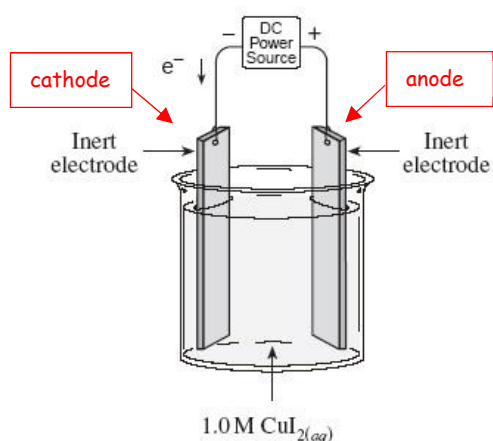
A. 1.0 M KOH

B. 1.0 M H_2SO_4

C. 1.0 M CuSO_4

D. 1.0 M $\text{C}_6\text{H}_{12}\text{O}_6$

7. a. On the diagram below, label anode and cathode.



b. Write out the half-reaction that occurs at the anode



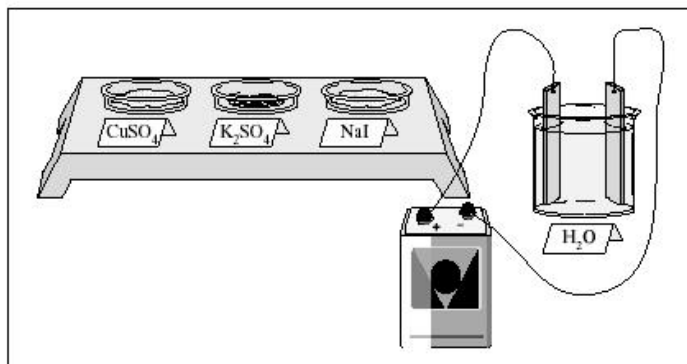
c. Write out the half-reaction that occurs at the cathode.



d. Calculate the E°_{cell} .



8. Consider the following diagram:



Students are asked to produce hydrogen and oxygen gas by the electrolysis of water. They are given three substances (CuSO_4 , K_2SO_4 and NaI) to choose from to prepare an electrolytic solution that will only produce hydrogen and oxygen gases.

a. Which substance should be selected.

Explain why. Substance K_2SO_4

Explanation: The potassium ion is less likely to be reduced (lower on LHS of chart) than the water and the sulphate ions are less likely to be oxidized than water (higher on RHS of chart).

b. Write the equation for the half-reaction that occurs at the anode in this electrolytic cell.



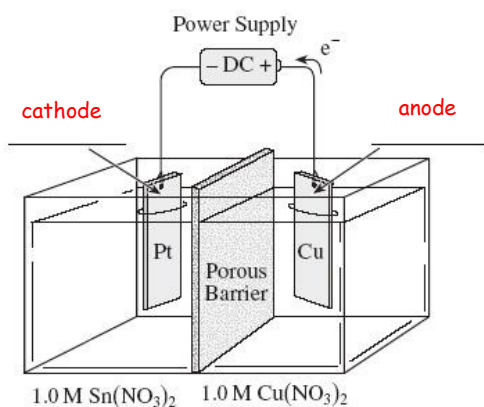
c. Explain why it would not be acceptable to use a copper anode in this cell.

Answer - copper is a stronger reducing agent than water. This would result in the copper being reduced instead of water.

9. Sodium metal is produced commercially by the electrolysis of molten $\text{NaCl}_{(l)}$. Explain why sodium metal $\text{Na}_{(s)}$ cannot be produced by electrolysis of aqueous $\text{NaCl}_{(aq)}$.

Answer - The sodium metal ion is less likely to be reduced (lower on LHS of chart) than water and the chloride ions are MORE likely to be oxidized than water (over potential effect).

10. Consider the following electrolytic cell which contains a porous barrier to prevent general mixing of solutions.



a. Label the anode and cathode in the space provided on the diagram.

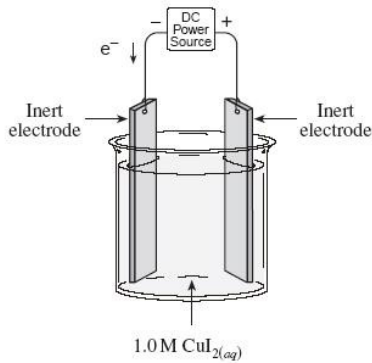
b. Write an equation for the overall cell reaction.



c. Calculate the minimum theoretical voltage required for this reaction under standard conditions.



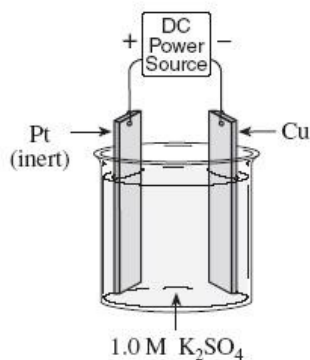
11. Consider the following cell:



What happens to the $[I^-]$ and the pH in the operating cell?

- | $[I^-]$ | pH |
|---------------------|----------------|
| A. increases | decreases |
| B. decreases | stays constant |
| C. stays constant | increases |
| D. stays constant | decreases |

12. Consider the following diagram:



Which of the following best describes the mass of the copper electrode and the direction of the cation movement as the cell operates?

- | <u>Mass of copper electrode</u> | <u>Cation movement</u> |
|---------------------------------|------------------------|
| A. increases | to the left |
| B. stays the same | to the left |
| C. stays the same | to the right |
| D. decreases | to the right |

13. The products of the electrolysis of molten $MgCl_2$ using inert electrodes are

- | | |
|--------------------------|----------------------------------|
| A. hydrogen and oxygen | C. magnesium and oxygen |
| B. hydrogen and chlorine | D. magnesium and chlorine |

14. When 1.0 M Na_2SO_4 is electrolyzed, the solution near the anode becomes

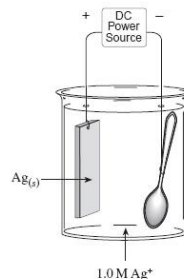
- | | |
|-----------------------------------|-------------------------------|
| A. basic and bubbles form | C. basic and no bubbles form |
| B. acidic and bubbles form | D. acidic and no bubbles form |

15. Which of the following is formed at the anode during the electrolysis of 1.0 M KF?

- | | | | |
|------|----------|----------------------------|----------|
| A. K | B. F_2 | C. H_2 | D. O_2 |
|------|----------|----------------------------|----------|

16. What is the reaction at the anode?

- A. $Ag \rightarrow Ag^+ + e^-$**
 B. $Ag^+ + e^- \rightarrow Ag$
 C. $Cu \rightarrow Cu^{2+} + 2 e^-$
 D. $Cu^{2+} + 2 e^- \rightarrow Cu$



17. An aqueous solution of $CuSO_4$ is electrolyzed using copper electrodes. Which of the following would correctly describe the changes in the mass of each electrode and the $[Cu^{2+}]$ in solution?

- | <u>Mass of anode</u> | <u>Mass of cathode</u> | <u>$[Cu^{2+}]$</u> |
|----------------------|------------------------|-------------------------------|
| A. stays the same | increases | decreases |
| B. stays the same | stays the same | stays the same |
| C. decreases | increases | stays the same |
| D. decreases | stays the same | increases |

18. Which of the following are produced at the anode and cathode in the electrolysis of aqueous potassium sulphate using carbon electrodes?

<u>Anode</u>	<u>Cathode</u>
A. potassium	oxygen
B. hydrogen	oxygen
C. oxygen	hydrogen
D. sulphur	potassium

19. The electrolysis of aqueous Rb_2SO_4 using carbon electrodes produces changes in the solution around the electrodes. How will the pH change around the anode and cathode?

<u>pH around the anode</u>	<u>pH around the cathode</u>
A. increase	increase
B. decrease	decrease
C. increase	decrease
D. decrease	increase

20. The same amount of electricity (same number of moles of electrons) is used to carry out the electrolysis of $\text{PdCl}_2(\text{aq})$ and $\text{AgNO}_3(\text{aq})$ solutions in separate cells. The masses of Pd and Ag produced were measured and compared. Which of the following is true about the mass of Pd produced?

- A. The mass of Pd produced is not related to the mass of Ag.
B. The mass of Pd produced is approximately half that of Ag.
 C. The mass of Pd produced is approximately twice that of Ag.
 D. The mass of Pd produced is approximately the same as that of Ag.

21. Which of the following are produced at the anode and cathode during the electrolysis of aqueous calcium iodide using carbon electrodes?

<u>Anode</u>	<u>Cathode</u>
A. iodine	calcium
B. hydrogen	oxygen
C. oxygen	hydrogen
D. iodine	hydrogen

22. Which of the following are produced at the anode and the cathode in the electrolysis of molten lithium chloride using platinum inert electrodes?

<u>Anode</u>	<u>Cathode</u>
A. oxygen	hydrogen
B. hydrogen	oxygen
C. chlorine	lithium
D. lithium	chloride

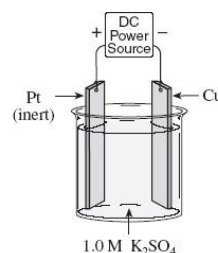
23. What are the most likely products of the electrolysis of 1.0 M MgI_2 using inert electrodes?

- A.** H_2 and I_2 B. Mg and I_2 C. H_2 and O_2 D. Mg and O_2

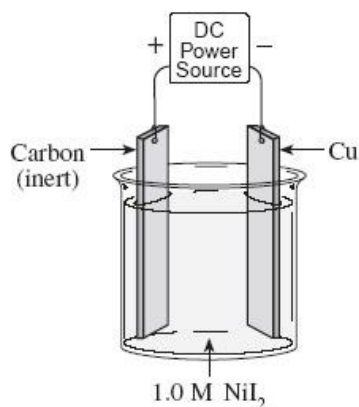
24. Consider the following diagram:

What is the equation for the anode reaction?

- A. $\text{K} \rightarrow \text{K}^+ + \text{e}^-$
 B. $\text{Cu} \rightarrow \text{Cu}^{+2} + 2 \text{e}^-$
 C. $2 \text{SO}_4^{2-} \rightarrow \text{S}_2\text{O}_8^{2-} + 2 \text{e}^-$
D. $\text{H}_2\text{O} \rightarrow \frac{1}{2} \text{O}_2 + 2 \text{H}^+(10^{-7} \text{ M}) + 2 \text{e}^-$



25. Consider the following:



What products would form at the anode and cathode as this cell operates?

<u>Anode</u>	<u>Cathode</u>
A. I_2	Ni
B. Ni	I_2
C. O_2	H_2
D. Cu^{2+} Ni	

26. A 1.0 M HCl solution is electrolyzed using a copper anode and an inert carbon cathode. Predict the half reactions that will occur and describe what you would observe at each electrode.

Anode half reaction: $Cu + \rightarrow Cu^{+2} + 2 e^{-}$

Anode observation: Copper anode slowly degrades as the copper metal is oxidized into Cu^{+2} ions.

Cathode half reaction: $2 H^{+} + 2 e^{-} \rightarrow H_2$

Cathode observation: Bubbles (hydrogen gas) form on the cathode and float up

27. A 1.0 M solution of $CoSO_4$ is electrolyzed using inert electrodes.

a. Write the anode and cathode half-reactions that would occur.

Anode: $H_2O \rightarrow \frac{1}{2} O_2 + 2 H^{+} + 2 e^{-}$

Cathode: $Co^{+2} + 2 e^{-} \rightarrow Co$

b. What is observed when bromthymol blue is added to the solution?

Colour of the bromthymol blue: Yellow

Explanation: The hydrogen ions produced lower the pH causing an acidic condition.

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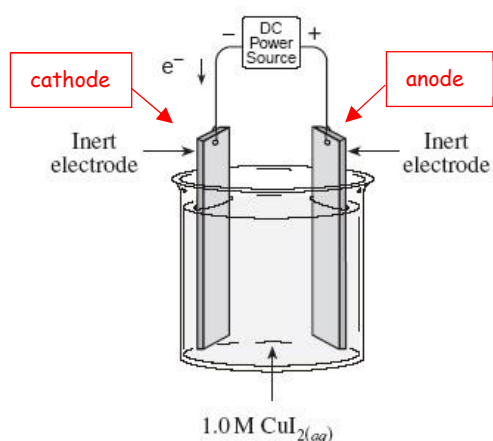
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7. a. On the diagram below, label anode and cathode.



b. Write out the half-reaction that occurs at the anode



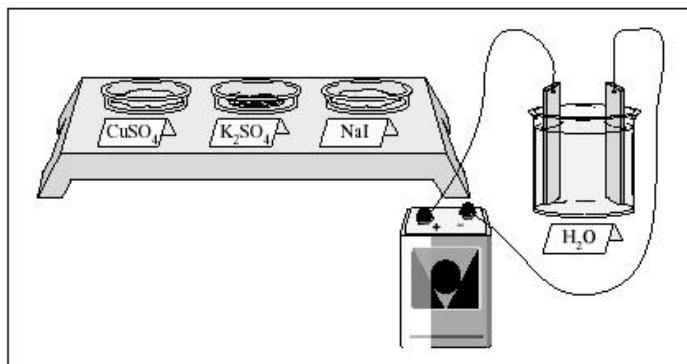
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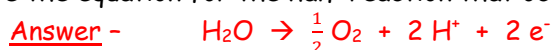
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a. Which substance should be selected.

Explain why. Substance K_2SO_4

Explanation: The potassium ion is less likely to be reduced (lower on LHS of chart) than the water and the sulphate ions are less likely to be oxidized than water (higher on RHS of chart).

b. Write the equation for the half-reaction that occurs at the anode in this electrolytic cell.



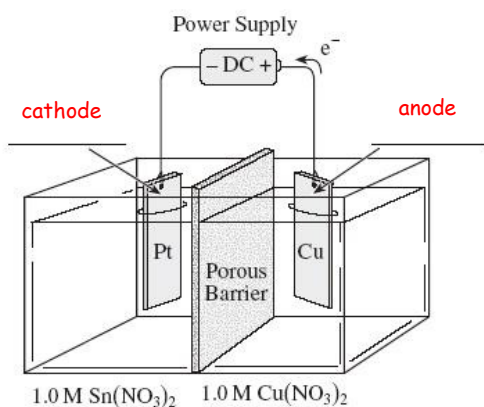
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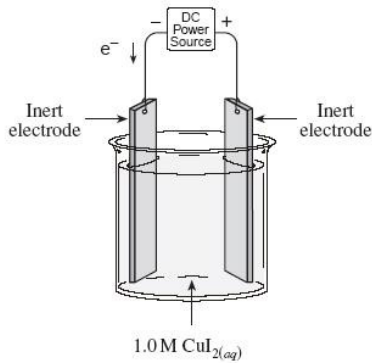
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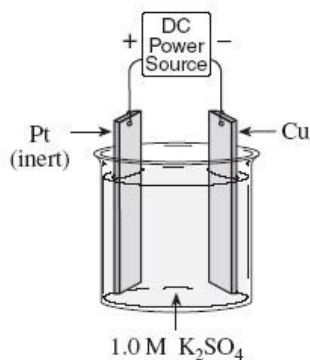
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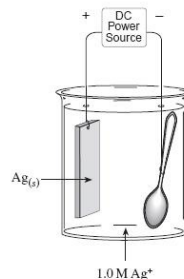
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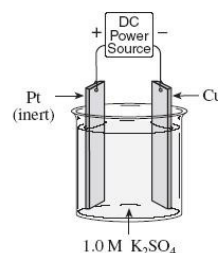
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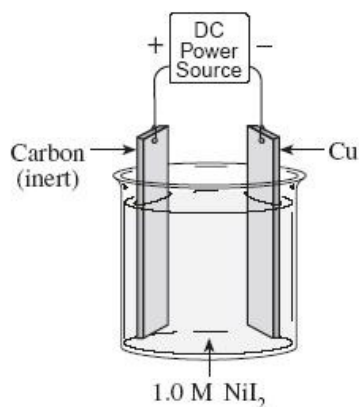
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What products would form at the anode and cathode as this cell operates?

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B. Ni	I_2
C. O_2	H_2
D. Cu^{2+} Ni	

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Cathode: $Co^{+2} + 2 e^{-} \rightarrow Co$

b. What is observed when bromthymol blue is added to the solution?

Colour of the bromthymol blue: Yellow

Explanation: The hydrogen ions produced lower the pH causing an acidic condition.