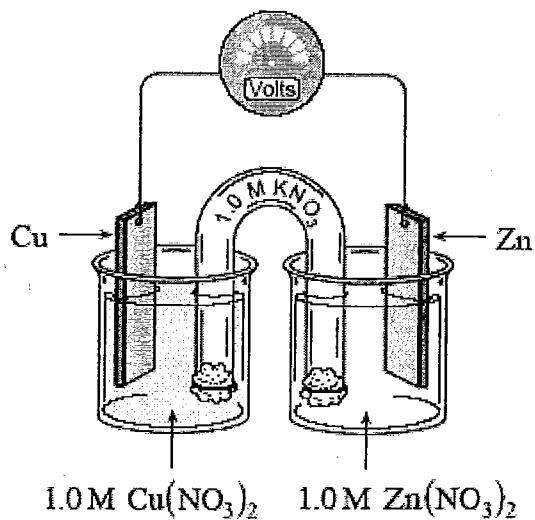
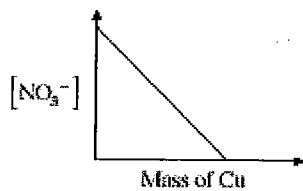


Consider the following cell:

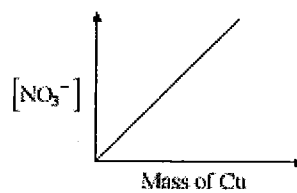


Which of the following represents the relationship between $[\text{NO}_3^-]$ and the mass of the Cu electrode in the copper half cell as it operates?

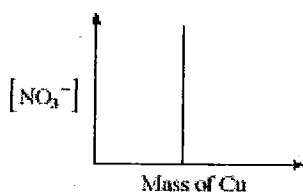
A.



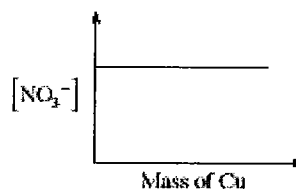
B.



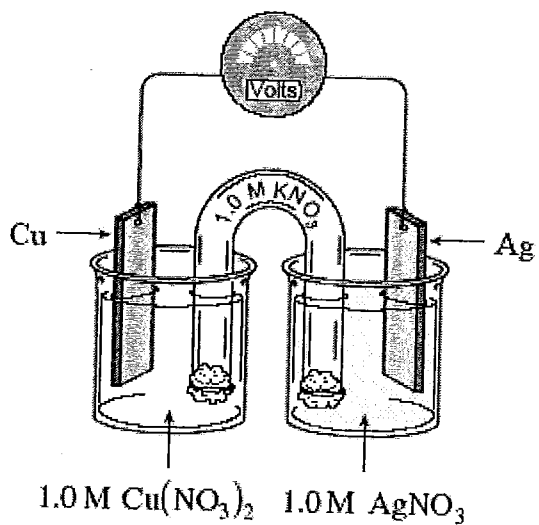
C.



D.

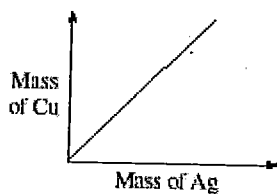


of the following cell:

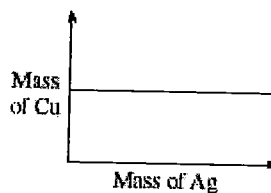


Which of the following diagrams represents the relationship between the mass of the Cu electrode and the mass of the Ag electrode as the cell is in operation?

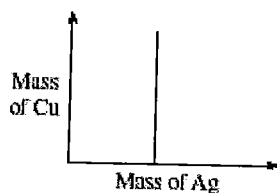
A.



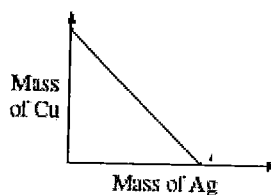
B.



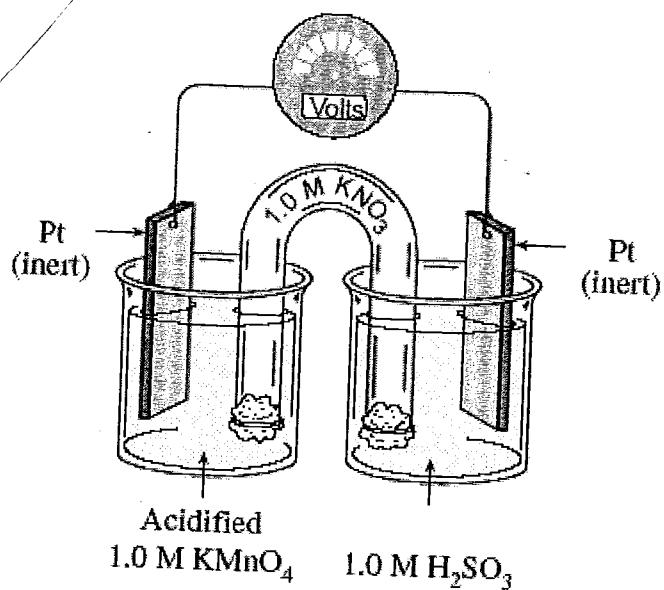
C.



D.



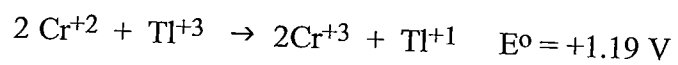
following:



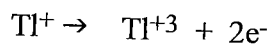
Which of the following best describes what happens to the mass of the anode and the mass of the cathode as the cell operates?

- | Anode Mass | Cathode Mass |
|-------------------|----------------|
| A. decreases | stays constant |
| B. stays constant | decreases |
| C. stays constant | stays constant |
| D. decreases | increases |

125. Consider the following:

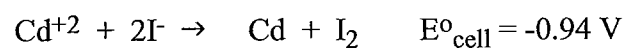


Identify the standard potential for the half-cell reaction:



- A. +1.60 V
- B. -0.78 V
- C. +1.19 V
- D. +0.78 V

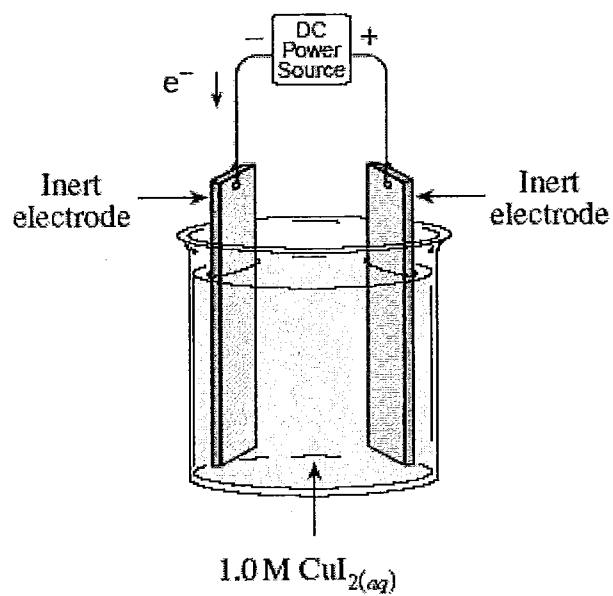
126. Consider the following equation: $E^\circ_{\text{cell}} = -0.94 \text{ V}$



What is the E° for the reduction of Cd^{2+}

- A. -0.40 V
- B. $+0.40 \text{ V}$
- C. -1.48 V
- D. $+1.48 \text{ V}$

127. On the diagram below, label the following:



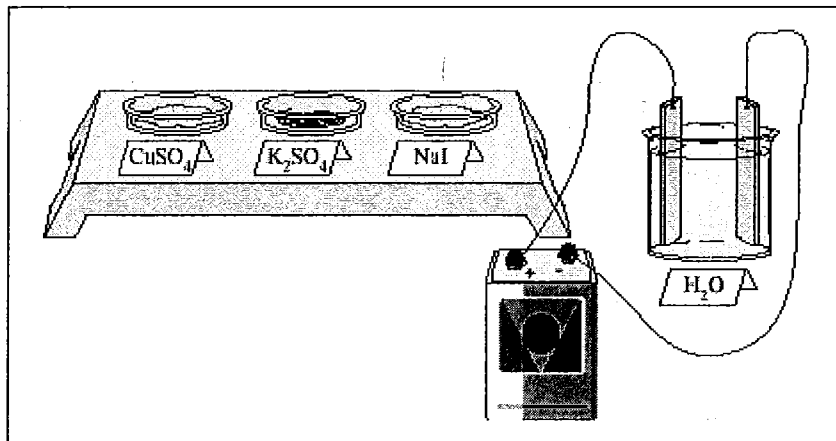
- anode and cathode

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} .

128. 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.

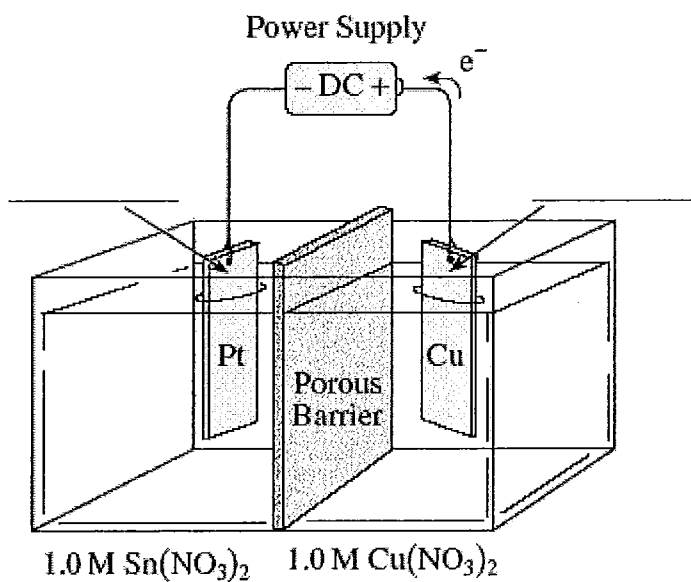
a. Which substance should be selected. Explain why.

Substance _____ Explanation:

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

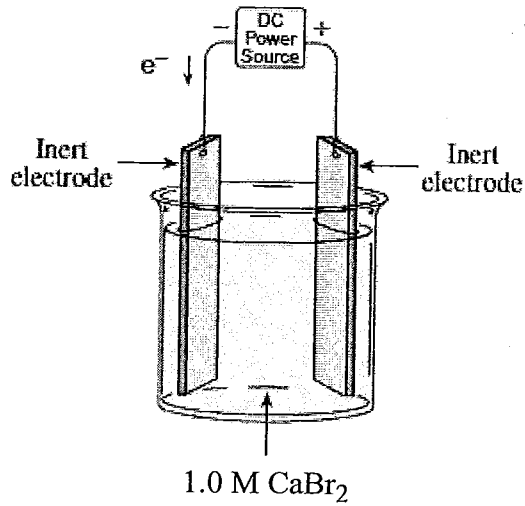
c. Explain why it would not be acceptable to use a copper anode in this cell.

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



- Label the anode and cathode in the space provided on the diagram above.
- Write an equation for the overall cell reaction.
- Calculate the minimum theoretical voltage required for this reaction under standard conditions.

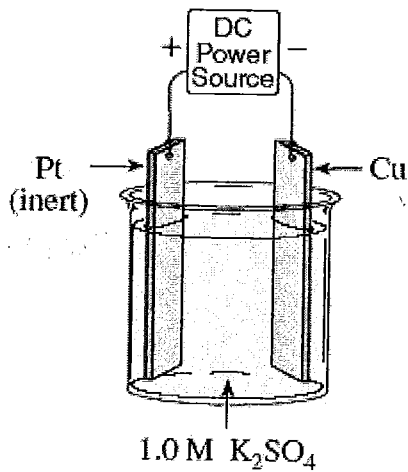
Consider the following cell:



What happens to the $[\text{Br}^-]$ and the pH in the operating cell?

- | $[\text{Br}^-]$ | pH |
|-------------------|----------------|
| A. stays constant | stays constant |
| B. decreases | stays constant |
| C. stays constant | increases |
| D. decreases | increases |

131. 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?

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

products of the electrolysis of molten MgCl_2 using inert electrodes are

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

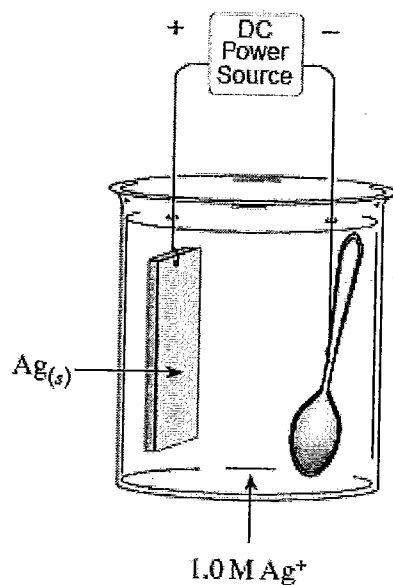
133. When 1.0 M Na_2SO_4 is electrolyzed, the solution near the anode becomes

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

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

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

135. Consider the following electrolytic cell:



What is the reaction at the anode?

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

136. An aqueous solution of NiSO_4 is electrolyzed using nickel electrodes. Which of the following would correctly describe the changes in the mass of each electrode and the $[\text{Ni}^{+2}]$ in solution?

	Mass of anode	Mass of cathode	$[\text{Ni}^{+2}]$
A.	decreases	stays the same	increases
B.	decreases	increases	stays the same
C.	stays the same	stays the same	stays the same
D.	stays the same	increases	decreases

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

	Anode	Cathode
A.	oxygen	hydrogen
B.	hydrogen	oxygen
C.	sulfur	potassium
D.	potassium	oxygen

138. The electrolysis of aqueous RbNO_3 using carbon electrodes produces changes in the solution around the electrodes. How will the pH change around the anode and cathode?

	pH around the anode	pH around the cathode
A.	decrease	increase
B.	increase	decrease
C.	decrease	decrease
D.	increase	increase

139. The same amount of electricity (same number of moles of electrons) is used to carry out the electrolysis of PdCl_2 (aq) and AgNO_3 (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 twice that of Ag.
- C. The mass of Pd produced is approximately the same as that of Ag.
- D. The mass of Pd produced is approximately half that of Ag.

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

	Anode	Cathode
A.	hydrogen	oxygen
B.	oxygen	hydrogen
C.	iodine	hydrogen
D.	iodine	calcium

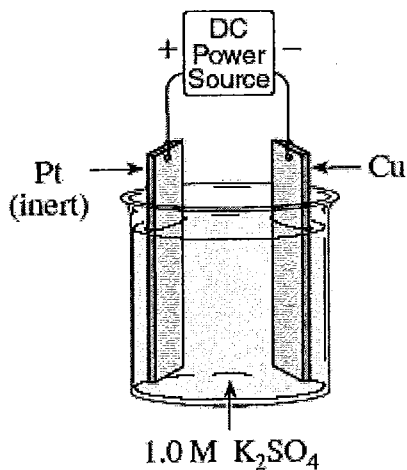
141. Which of the following are produced at the anode and the cathode in the electrolysis of molten lithium chloride using platinum inert electrodes?

- | Anode | Cathode |
|-------------|----------|
| A. chlorine | lithium |
| B. hydrogen | oxygen |
| C. lithium | chloride |
| D. oxygen | hydrogen |

142. 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. H_2 and O_2
- C. Mg and O_2
- D. Mg and I_2

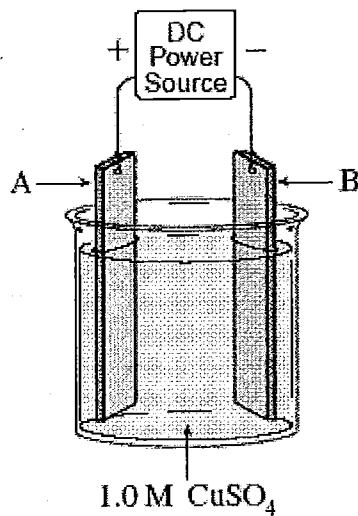
143. Consider the following diagram:



What is the equation for the anode reaction?

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

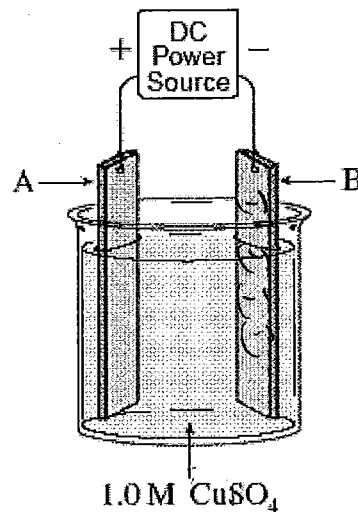
144. Consider the following diagram:



A student tries to use the above apparatus to copper plate a zinc object. What will happen if the student places the zinc object at A and the copper electrode at B?

- | Electrode A | Electrode B |
|-----------------|--------------|
| A. Zn dissolves | Zn (s) forms |
| B. Zn dissolves | Cu (s) forms |
| C. bubbles form | bubbles form |
| D. Cu (s) forms | Cu dissolves |

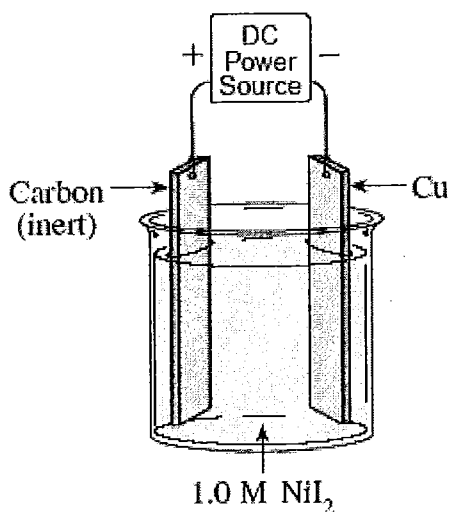
145. Consider the following diagram:



A student tries to use the above apparatus to copper plate a zinc object. What will happen if the student places the zinc object at B and the copper electrode at A?

- | Electrode A | Electrode B |
|---------------------|------------------|
| A. Cu (s) dissolves | Cu forms |
| B. Cu (s) forms | Zn (s) dissolves |
| C. Zn dissolves | bubbles form |
| D. Zn dissolves | Cu (s) forms |

146. Consider the following:



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

- | Anode | Cathode |
|---------------------|----------------|
| A. I ₂ | Ni |
| B. O ₂ | H ₂ |
| C. Cu ⁺² | Ni |
| D. Ni | I ₂ |

147. 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: _____

Anode observation: _____

Cathode half reaction: _____

Cathode observation: _____

148. 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 : _____

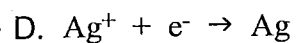
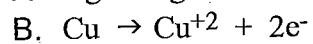
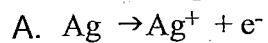
Cathode: _____

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

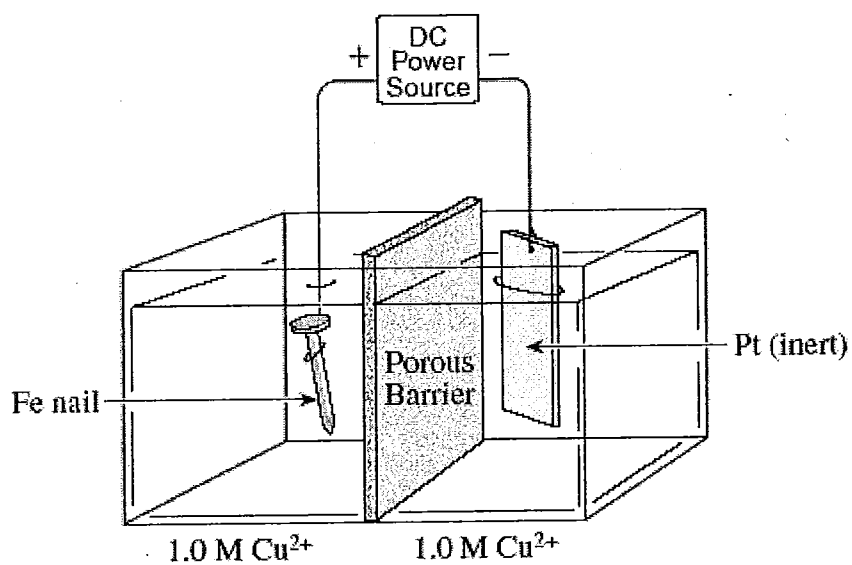
Color of the bromthymol blue: _____

Explanation: _____

149. A copper spoon was electroplated with silver. Which of the following reactions occurred at the cathode during electroplating?



150. Consider the following:



Why would this cell fail to electroplate the Fe nail with copper?

- A. The porous barrier prevents reaction.
- B. The Fe nail is the cathode.
- C. The Fe nail is the anode.
- D. The Pt is inert.

151. Draw and label the apparatus needed to electroplate a zinc statue with copper. The statue is suspended in a $\text{Cu}(\text{NO}_3)_2$ solution.

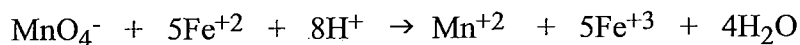
b. Explain why it is a good idea to turn on the power supply before immersing the electrodes in the solution.

Review

152. What is a typical characteristic of a strong oxidizing agent?

- A. It easily loses electrons.
- B. It has a positive reduction potential.
- C. It has a negative oxidation number.
- D. It is readily oxidized.

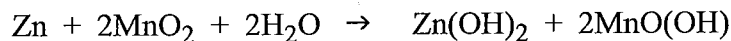
153. Consider the following redox equation:



Which of the following statements is true?

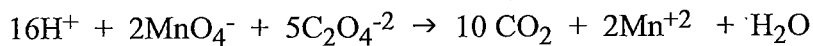
- A. The equation is balanced.
- B. The Fe^{+3} is oxidized.
- C. The H^+ is reduced.
- D. The oxidation number of manganese is raised by +3.

154. Identify the reactant being reduced in the following equation:



- A. Zn(OH)_2
- B. MnO_2
- C. H_2O
- D. Zn

155. Consider the following equation:



Identify the chemical species which is oxidized.

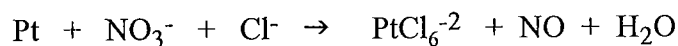
- A. CO_2
- B. H^+
- C. $\text{C}_2\text{O}_4^{-2}$
- D. MnO_4^-

156. When U_3O_8 (Pitchblende) is dissolved in nitric acid, it changes into $UO_2(NO_3)_2$ (uranyl nitrate).

What is the change in oxidation number for uranium?

- A. $-3 \frac{1}{3}$
- B. $+2 \frac{2}{3}$
- C. -10
- D. $+3 \frac{2}{3}$

157. Consider the following unbalanced redox equation:



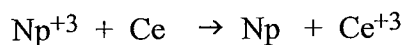
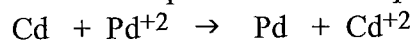
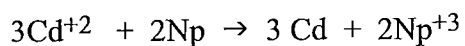
Which chemical species is neither oxidized nor reduced?

- A. Cl^-
- B. H_2O
- C. NO_3^-
- D. Pt

158. In an experiment Ag^+ reacts spontaneously with Ru but not with Pd. The relative strength of the metal ions from strongest to weakest oxidizing agent is

- A. $Ru^+ > Pd^+ > Ag^+$
- B. $Ag^+ > Ru^+ > Pd^+$
- C. $Ru^+ > Ag^+ > Pd^+$
- D. $Pd^+ > Ag^+ > Ru^+$

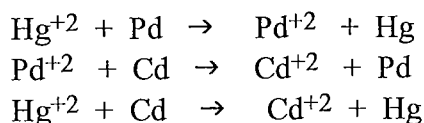
159. Consider the following spontaneous reactions:



Which is the weakest reducing agent?

- A. Ce
- B. Cd
- C. Pd
- D. Np

160. The metals Hg, Cd, and Pd reacts as follows:

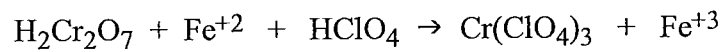


Put the metal ions in order from weakest oxidizing agents to strongest:

- A. $\text{Cd}^{+2} < \text{Hg}^{+2} < \text{Pd}^{+2}$
 - B. $\text{Pd}^{+2} < \text{Hg}^{+2} < \text{Cd}^{+2}$
 - C. $\text{Cd}^{+2} < \text{Pd}^{+2} < \text{Hg}^{+2}$
 - D. $\text{Hg}^{+2} < \text{Pd}^{+2} < \text{Cd}^{+2}$
161. A piece of Ag does not react spontaneously with 1.0 M Ti^{+2} because
- A. Ag is a stronger oxidizing agent than Ti
 - B. Ag is a weaker reducing agent than Ti
 - C. Ag is a weaker oxidizing agent than Ti
 - D. Ag is a stronger reducing agent than Ti
162. Which of the following can act as an oxidizing agent, but **not** as a reducing agent?
- A. Sn^{+2}
 - B. Ca^{+2}
 - C. Br^-
 - D. Fe^{+2}
163. Solid copper forms spontaneously in the following reaction:
- $$\text{V} + \text{Cu}^{+2} \rightarrow \text{Cu} + \text{V}^{+2}$$
- Based on these observations, Cu is a
- A. stronger oxidizing agent than V
 - B. weaker oxidizing agent than V
 - C. weaker reducing agent than V
 - D. stronger reducing agent than V
164. Which of the following is the strongest reducing agent?
- A. I_2
 - B. Sn^{+2}
 - C. H_2O
 - D. Fe^{+2}
165. Which of the following is the weakest oxidizing agent?
- A. Al^{+3}
 - B. Sn^{+2}
 - C. acidified $\text{Cr}_2\text{O}_7^{-2}$
 - D. Cl_2

166. A solution of AuCl_4^- is mixed with a solution Sn^{+2} under standard conditions. Which of the following best describes the result?
- A. $\text{AuCl}_4^- + \text{Sn}^{+2} \rightarrow \text{Sn}^{+4} + \text{Au}_{(s)} + 4\text{Cl}^-$
 - B. $\text{AuCl}_4^- + \text{Sn}^{+2} \rightarrow \text{Sn}^{+4} + \text{Au}_{(s)} + 4\text{Cl}^-$
 - C. $2\text{AuCl}_4^- + 3\text{Sn}^{+2} \rightarrow 3\text{Sn} + 2\text{Au}_{(s)} + 8\text{Cl}^-$
 - D. $2\text{AuCl}_4^- + 3\text{Sn}^{+2} \rightarrow 3\text{Sn}^{+4} + 2\text{Au}_{(s)} + 8\text{Cl}^-$
167. Which of the following could be used to determine the acidified $[\text{IO}_3^-]$ by a redox reaction?
- A. Cr^{+3}
 - B. Cu^{+2}
 - C. $\text{Cr}_2\text{O}_7^{-2}$ (acidified)
 - D. I^-
168. When the skeletal equation $\text{HPO}_4^{-2} \rightarrow \text{H}_3\text{P}_2\text{O}_7$ is balanced in acidic solution H^+ and e^- will appear. Which of the following best describes the H^+ and e^- for the balanced half-reaction?
- A. 4H^+ on the left and $6e^-$ on the left
 - B. 3H^+ on the left and $1e^-$ on the right
 - C. 3H^+ on the left and $1e^-$ on the left
 - D. 4H^+ on the right and $6e^-$ on the left

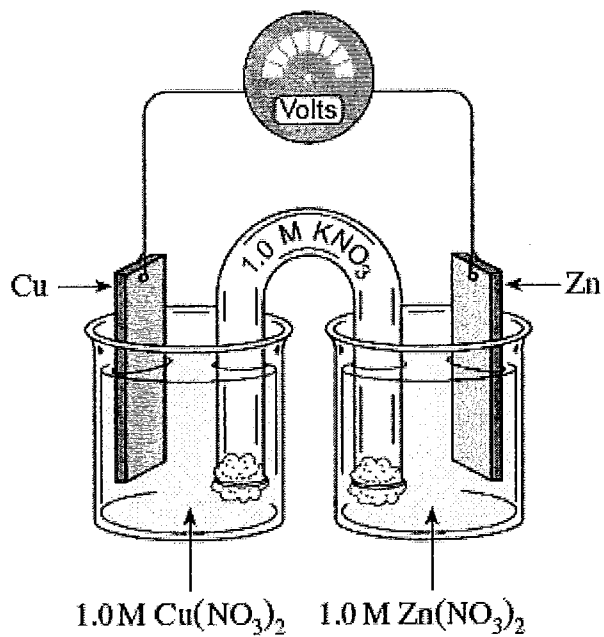
169. Consider the following redox reaction in acidic solution:



a. Balance the above redox reaction.

b. The above reaction was used for a redox titration. At the equivalence point 15.42 mL of a 0.0200M $\text{H}_2\text{Cr}_2\text{O}_7$ solution was required to titrate 25.00 mL of Fe^{+2} solution. Calculate $[\text{Fe}^{+2}]$

170. Consider the following cell:

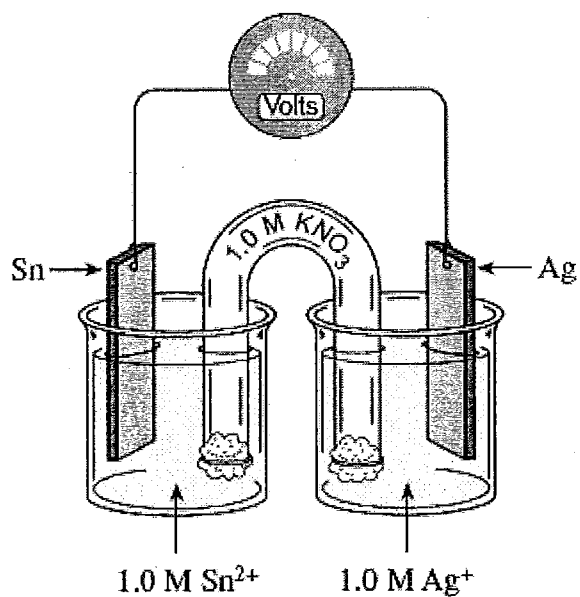


In what directions do the electrons and cations move?

- Direction of electrons
- A. towards the Zn electrode
 - B. towards the Cu electrode
 - C. towards the Cu electrode
 - D. towards the Zn electrode

- Direction of cations
- towards the Cu electrode
 - towards the Cu electrode
 - towards the Zn electrode
 - towards the Zn electrode

171. Consider the following cell:



What is the value for E°_{cell} ?

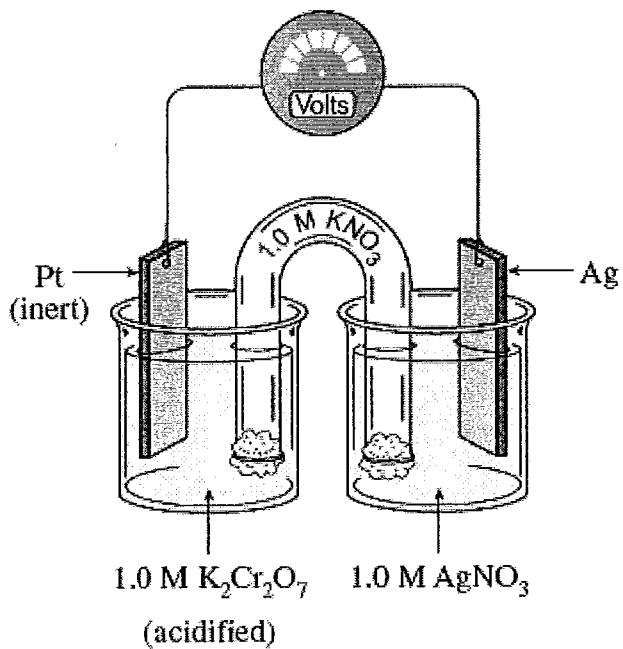
A. +0.94 V

B. +0.66 V

C. -0.66 V

D. -0.94 V

172. Consider the following electrochemical cell:



Calculate the E° for this cell at equilibrium.

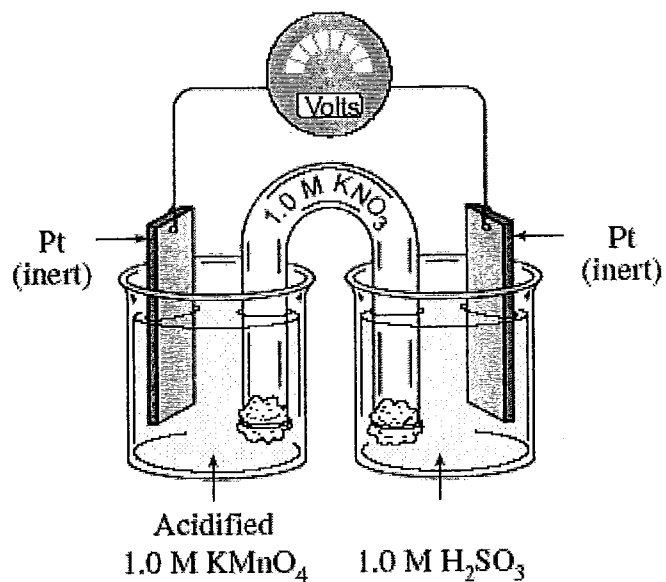
A. -0.43 V

B. +0.43 V

C. 0.00V

D. +2.03 V

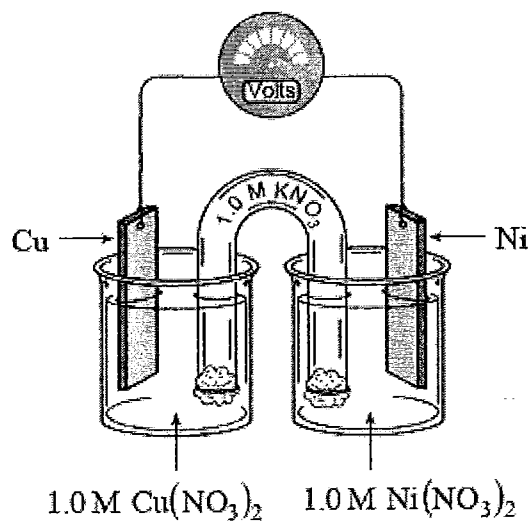
173. Consider the following:



In the above cell, what reactions occurs at the anode?

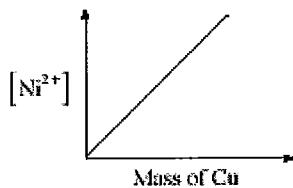
- A. $\text{Mn}^{+2} + 4\text{H}_2\text{O} \rightarrow \text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^-$
- B. $\text{H}_2\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{SO}_4^{-2} + 4\text{H}^+ + 2\text{e}^-$
- C. $\text{SO}_4^{-2} + 4\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2\text{SO}_3 + \text{H}_2\text{O}$
- D. $\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightarrow \text{Mn}^{+2} + 4\text{H}_2\text{O}$

174. Consider the following cell:

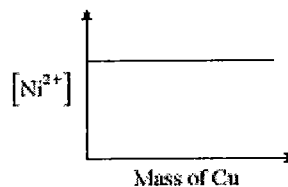


Which of the following diagrams represents the relationship between the $[\text{Ni}^{2+}]$ and the mass of the Cu electrode as the cell above is in operation?

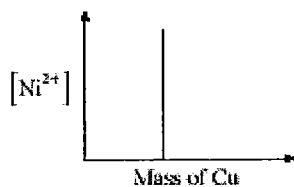
A.



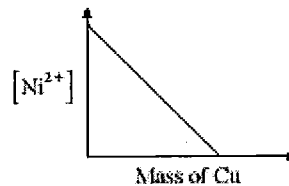
B.



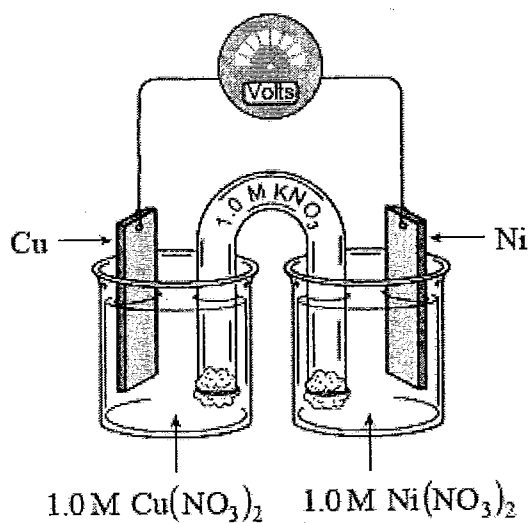
C.



D.



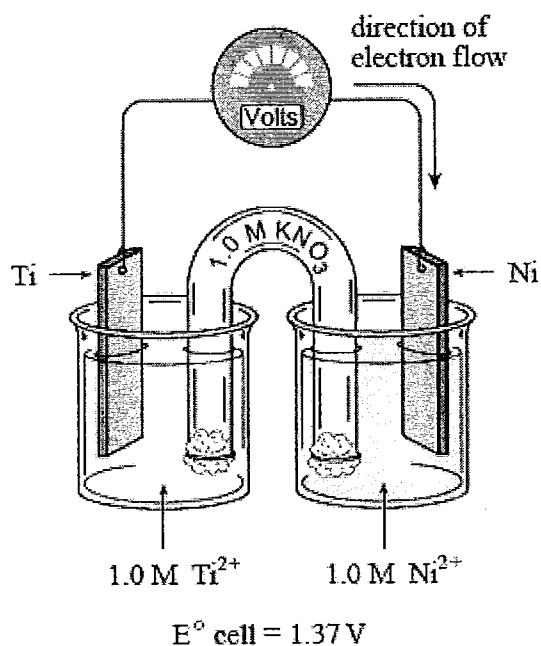
175. Consider the following cell:



As the cell operates, what happens to the ions in the salt bridge?

- A. K^+ will migrate to the nickel half-cell while the NO_3^- will migrate to the copper half-cell.
- B. K^+ and NO_3^- will both migrate to the nickel half-cell.
- C. K^+ will migrate to the copper half-cell while the NO_3^- will migrate to the nickel half-cell.
- D. K^+ and NO_3^- will both migrate to the nickel half-cell.

176. Consider the following electrochemical cell:



a. Identify which electrode is the anode and which electrode is the cathode:

Anode _____ Cathode _____

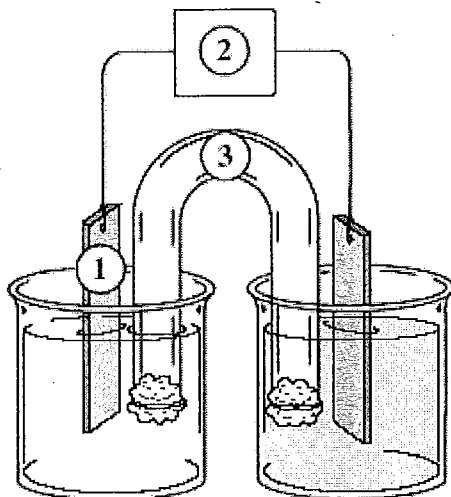
b. Write out the half-reaction that takes place at the cathode:

Cathode half-reaction _____

c. Calculate the E° value for the reduction of the Ti^{+2} ion.

$\text{Ti}^{+2} + 2e^- \rightarrow \text{Ti}$ $E^\circ =$ _____

177. Consider the numbered components in the following diagram:



Which of the following would best describe the components of this electrochemical cell

Component 1	Component 2	Component 3 (Contents)
A. metal	power supply	$\text{CH}_3\text{OH (aq)}$
B. metal	voltmeter	$\text{CH}_3\text{OH (aq)}$
C. metal	light bulb	$\text{NaNO}_3 \text{ (aq)}$
D. non-metal	power supply	$\text{NaNO}_3 \text{ (aq)}$

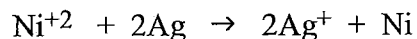
178. Which of the following describes an electrochemical cell?

E°_{cell}	Type of reaction
A. positive	non-spontaneous
B. negative	spontaneous
C. positive	spontaneous
D. negative	non-spontaneous

179. Which of the following describes an electrolytic cell?

E°_{cell}	Type of reaction
A. positive	non-spontaneous
B. positive	spontaneous
C. negative	non-spontaneous
D. negative	spontaneous

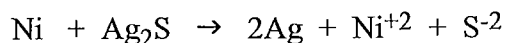
180. Consider the following reaction:



Which of the following is true?

- | | E° | Reaction |
|----|-------------|-----------------|
| A. | -0.54 V | non-spontaneous |
| B. | +0.54 V | spontaneous |
| C. | +1.06 V | spontaneous |
| D. | -1.06 V | non-spontaneous |

181. Consider the following reaction:



Which of the following is true?

- | | E° | Reaction |
|----|-------------|-----------------|
| A. | +1.06 V | spontaneous |
| B. | -0.95 V | non-spontaneous |
| C. | -0.45 V | non-spontaneous |
| D. | +0.45 V | spontaneous |

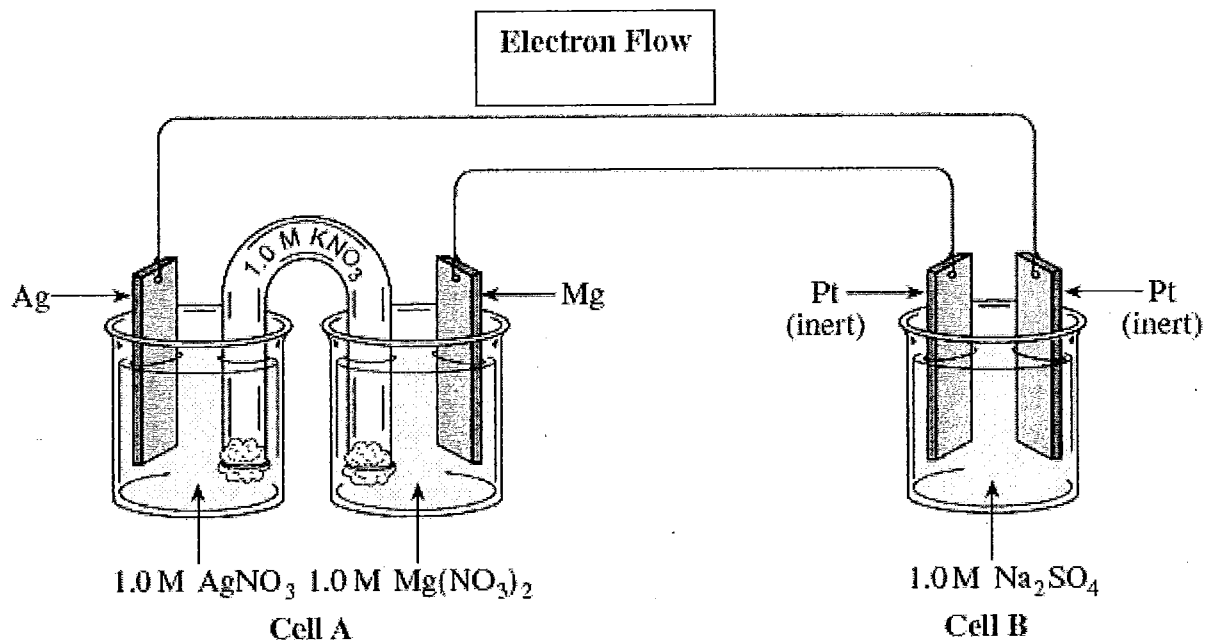
182. Which of the following describes an operating electrolytic cell?

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

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

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

184. Consider the following apparatus consisting of an electrochemical cell joined to an electrolytic cell:



a. On the diagram above, indicate the direction of electron flow in the top wire.

b. Write the anode and cathode half-reactions for cell A and calculate the standard reduction potential for this cell.

Anode _____

Cathode _____

$E^\circ =$ _____

c. Write the anode and cathode half-reactions for cell B and calculate the standard reduction potential for this cell.

Anode _____

Cathode _____

$E^\circ =$ _____

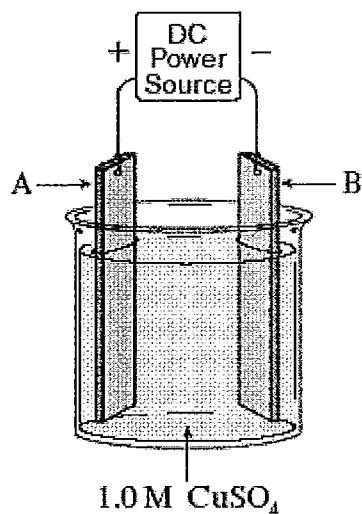
185. Which of the following is formed at the cathode during the electrolysis of 1.0 M KF?

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

186. The electrolysis of aqueous Rb_2SO_4 using carbon electrodes produces changes in the solution around the electrodes. How will the mass of the electrodes change?

- | | mass of anode | mass of cathode |
|----|----------------|-----------------|
| A. | decrease | increase |
| B. | stays the same | increase |
| C. | decrease | stays the same |
| D. | stays the same | stays the same |

187. Consider the following diagram:



The above cell is constructed in order to copper plate an object. For the best results, which of the following should be used for electrodes A and B?

- | Electrode A | Electrode B |
|------------------|---------------|
| A. any conductor | object |
| B. object | any conductor |
| C. pure copper | object |
| D. object | pure copper |