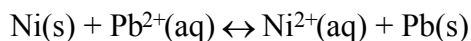
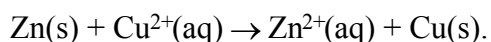


- In an operating voltaic cell, reduction occurs
  - at the anode
  - at the cathode
  - in the salt bridge
  - in the wire
- Which process occurs in an operating voltaic cell?
  - Electrical energy is converted to chemical energy.
  - Chemical energy is converted to electrical energy.
  - Oxidation takes place at the cathode.
  - Reduction takes place at the anode.
- What is the voltage for a chemical cell that has reached equilibrium?
  - 1.00 V
  - greater than 1.00 V
  - greater than 0.00 V and less than 1.00 V
  - 0.00 V
- Given the redox reaction in an electrochemical cell:



A salt bridge is used to connect

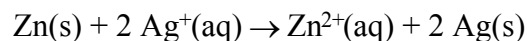
- Ni(s) and Pb(s)
  - Pb<sup>2+</sup>(aq) and Ni<sup>2+</sup>(aq)
  - Ni(s) and Ni<sup>2+</sup>(aq)
  - Pb<sup>2+</sup>(aq) and Pb(s)
- Which substance functions as the electrolyte in an automobile battery?
    - PbO<sub>2</sub>
    - PbSO<sub>4</sub>
    - H<sub>2</sub>SO<sub>4</sub>
    - H<sub>2</sub>O
  - The overall reaction in a electrochemical cell is



As the reaction in this cell takes place, the

- mass of the Zn(s) electrode decreases
- mass of the Cu(s) electrode decreases
- Cu<sup>2+</sup>(aq) concentration remains the same
- Zn<sup>2+</sup>(aq) concentration remains the same

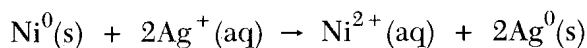
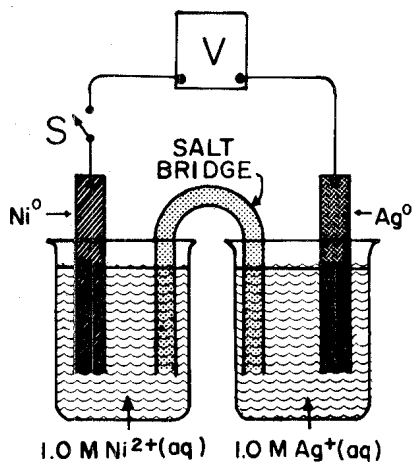
- A chemical cell differs from an electrolytic cell because in a chemical cell there is
  - a positive and negative electrode
  - an anode and a cathode
  - a redox reaction that produces an electric current
  - an electric current that causes a redox reaction
- In a chemical cell, electrical energy will be produced when
  - only oxidation occurs
  - only reduction occurs
  - both oxidation and reduction occur
  - neither oxidation nor reduction occurs
- The reaction that takes place in a chemical cell is best classified as
  - fusion
  - redox
  - transmutation
  - cracking
- Given the overall cell reaction:



Which will occur as the cell operates?

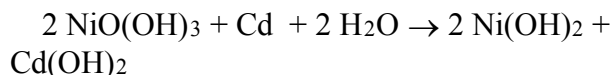
- The amount of Zn(s) will increase.
  - The amount of Ag(s) will decrease.
  - The concentration of Zn<sup>2+</sup>(aq) will increase.
  - The concentration of Ag<sup>+</sup>(aq) will increase.
- Which half-reaction can occur at the anode in a voltaic cell?
    - Ni<sup>2+</sup> + 2e<sup>-</sup> → Ni
    - Sn + 2e<sup>-</sup> → Sn<sup>2+</sup>
    - Zn → Zn<sup>2+</sup> + 2e<sup>-</sup>
    - Fe<sup>3+</sup> → Fe<sup>2+</sup> + e<sup>-</sup>
  - Which statement is true for any electrochemical cell?
    - Oxidation occurs at the anode, only.
    - Reduction occurs at the anode, only.
    - Oxidation occurs at both the anode and the cathode.
    - Reduction occurs at both the anode and the cathode.

13. Base your answer to the following question on the diagram of the chemical cell at 298 K and on the equation below.



In the given reaction, the  $\text{Ag}^+$  ions

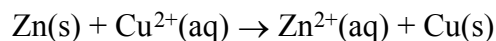
- A) gain electrons      B) lose electrons  
C) gain protons      D) lose protons
14. Given the nickel oxide–cadmium reaction:
- $$2 \text{NiO}(\text{OH})_3 + \text{Cd} + 2 \text{H}_2\text{O} \rightarrow 2 \text{Ni}(\text{OH})_2 + \text{Cd}(\text{OH})_2$$
- During discharge, the Cd electrode
- A) is oxidized      B) is reduced  
C) gains electrons      D) gains mass
15. Given the reaction for the nickel-cadmium battery:



Which species is oxidized during the discharge of the battery?

- A)  $\text{Ni}^{3+}$     B)  $\text{Ni}^{2+}$     C) Cd    D)  $\text{Cd}^{2+}$

16. Given the balanced ionic equation representing the reaction in an operating voltaic cell:



The flow of electrons through the external circuit in this cell is from the

- A) Cu anode to the Zn cathode  
B) Cu cathode to the Zn anode  
C) Zn anode to the Cu cathode  
D) Zn cathode to the Cu anode
17. When a voltaic cell operates, ions move through the
- A) anode      B) cathode  
C) salt bridge      D) external circuit
18. A student collects the materials and equipment below to construct a voltaic cell:

- two 250-mL beakers
- wire and a switch
- one strip of magnesium
- one strip of copper
- 125 mL of 0.20 M  $\text{Mg}(\text{NO}_3)_2(\text{aq})$
- 125 mL of 0.20 M  $\text{Cu}(\text{NO}_3)_2(\text{aq})$

Which additional item is required for the construction of the voltaic cell?

- A) an anode      B) a battery  
C) a cathode      D) a salt bridge
19. Given the balanced equation representing the reaction occurring in a voltaic cell:
- $$\text{Zn}(\text{s}) + \text{Pb}^{2+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Pb}(\text{s})$$
- In the completed external circuit, the electrons flow from
- A)  $\text{Pb}(\text{s})$  to  $\text{Zn}(\text{s})$   
B)  $\text{Pb}^{2+}(\text{aq})$  to  $\text{Zn}^{2+}(\text{aq})$   
C)  $\text{Zn}(\text{s})$  to  $\text{Pb}(\text{s})$   
D)  $\text{Zn}^{2+}(\text{aq})$  to  $\text{Pb}^{2+}(\text{aq})$
20. Which statement is true about oxidation and reduction in an electrochemical cell?
- A) Both occur at the anode.  
B) Both occur at the cathode.  
C) Oxidation occurs at the anode and reduction occurs at the cathode.  
D) Oxidation occurs at the cathode and reduction occurs at the anode.

21. What is the purpose of the salt bridge in a voltaic cell?
- It blocks the flow of electrons.
  - It blocks the flow of positive and negative ions.
  - It is a path for the flow of electrons.
  - It is a path for the flow of positive and negative ions.
22. Which component of an electrochemical cell is correctly paired with its function?
- external conductor – allows the solutions to mix
  - external conductor – permits the migration of ions
  - salt bridge – allows the solutions to mix
  - salt bridge – permits the migration of ions

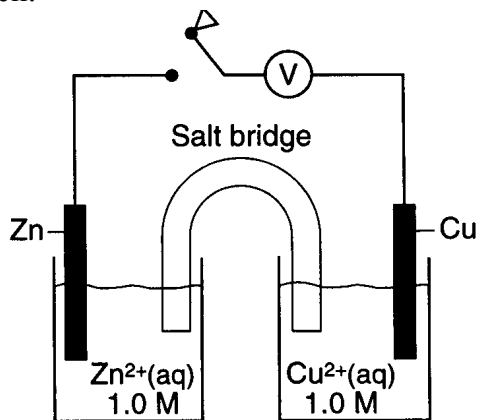
23. An electrochemical setup consists of two half-cells, an anode, a cathode, an external circuit, and a salt bridge. When a reaction occurs, ion migration takes place through the

- anode
- cathode
- salt bridge
- external circuit

24. A redox reaction is set up so that both half reactions take place in separate beakers that are connected by a salt bridge and an external conductor. A path for the transfer of ions is provided by the

- anode
- cathode
- salt bridge
- external conductor

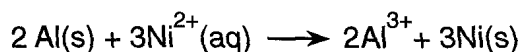
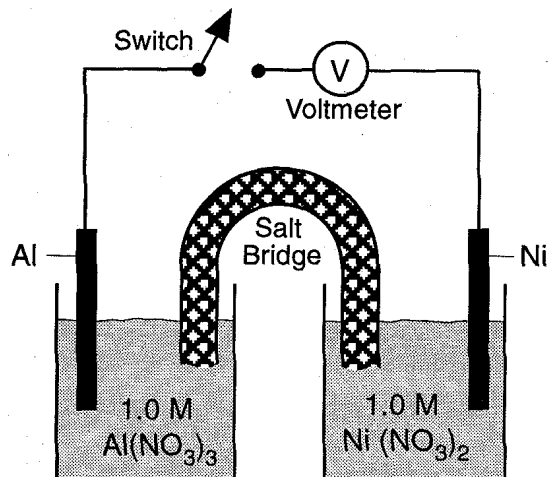
25. The diagram below represents an electrochemical cell.



What occurs when the switch is closed?

- Zn is reduced.
- Cu is oxidized.
- Electrons flow from Cu to Zn.
- Electrons flow from Zn to Cu.

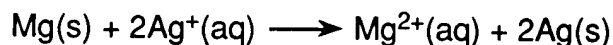
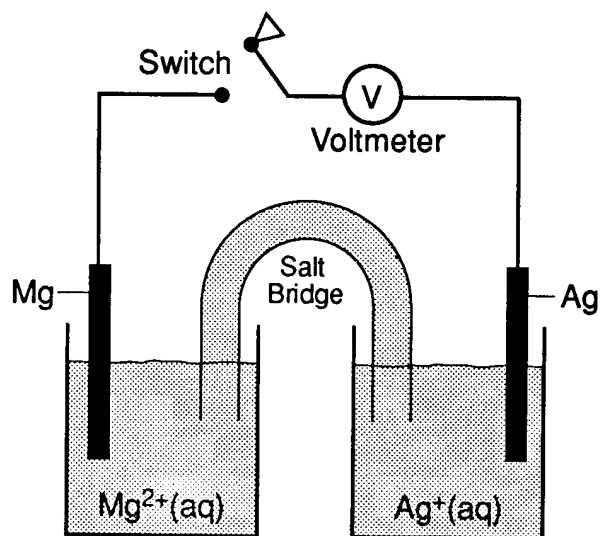
26. The diagram below represents a chemical cell at 298 K.



When the switch is closed, electrons flow from

- Al(s) to Ni(s)
- Ni(s) to Al(s)
- Al<sup>3+</sup>(aq) to Ni<sup>2+</sup>(aq)
- Ni<sup>2+</sup>(aq) to Al<sup>3+</sup>(aq)

Base your answers to questions 27 and 28 on the equation and diagram below represent an electrochemical cell at 298 K and 1 atmosphere.



27. Which species is oxidized when the switch is closed?

- A) Mg(s)                      B)  $\text{Mg}^{2+}(\text{aq})$   
 C) Ag(s)                      D)  $\text{Ag}^+(\text{aq})$

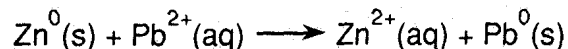
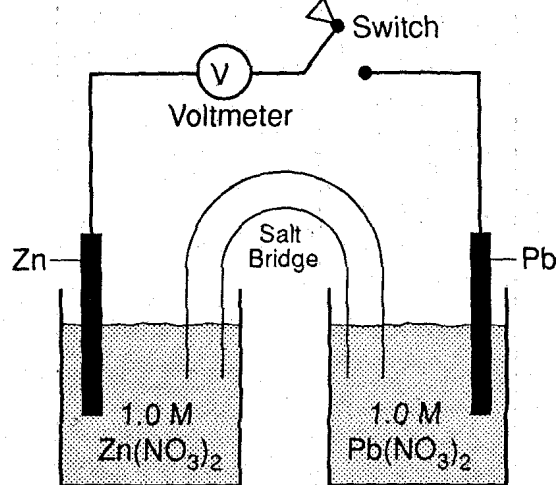
28. When the switch is closed, electrons flow from

- A) Mg(s) to Ag(s)  
 B) Ag(s) to Mg(s)  
 C)  $\text{Mg}^{2+}(\text{aq})$  to  $\text{Ag}^+(\text{aq})$   
 D)  $\text{Ag}^+(\text{aq})$  to  $\text{Mg}^{2+}(\text{aq})$

29. What is the electron flow in a wire connecting the Zn and Cu electrodes of a zinc-copper chemical cell at standard conditions?

- A) from negative Zn to positive Cu  
 B) from positive Zn to negative Cu  
 C) from negative Cu to positive Zn  
 D) from positive Cu to negative Zn

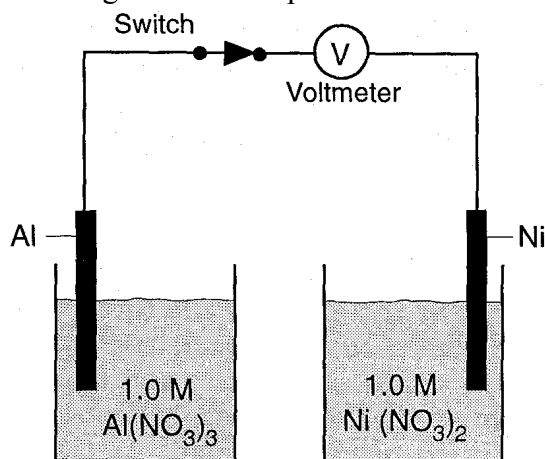
30. Base your answer to the following question on the diagram of the chemical cell shown below. The reaction occurs at 1 atmosphere and 298 K.



When the switch is closed, what occurs?

- A) Pb is oxidized and electrons flow to the Zn electrode.  
 B) Pb is reduced and electrons flow to the Zn electrode.  
 C) Zn is oxidized and electrons flow to the Pb electrode.  
 D) Zn is reduced and electrons flow to the Pb electrode.

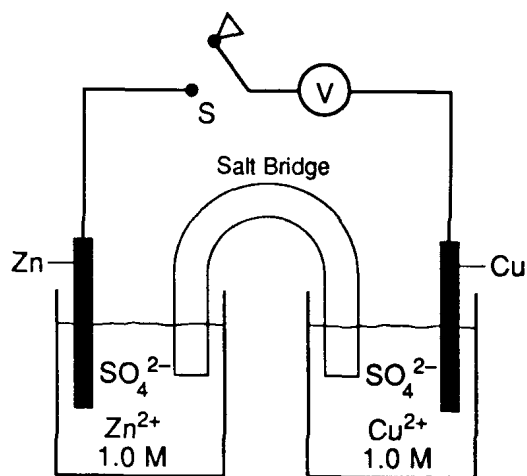
31. The diagram below represents a chemical cell.



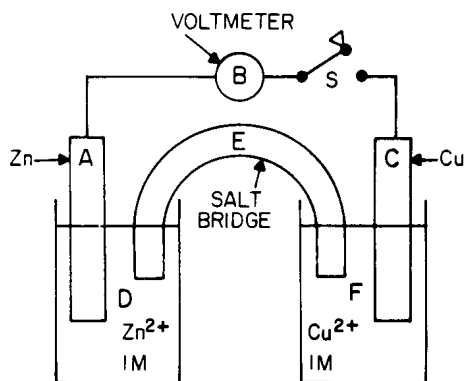
In order for the cell to operate, it should be provided with

- A) a cathode  
 B) an anode  
 C) a salt bridge  
 D) an external path for electrons

Base your answers to questions 32 and 33 on the diagram below which represents a chemical cell at 298 K and 1 atmosphere.



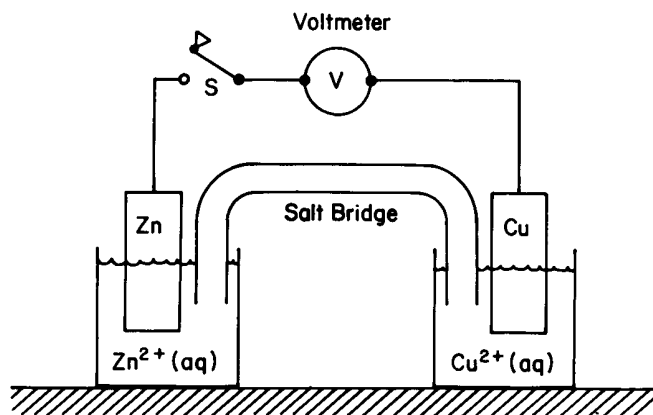
32. Which species represents the cathode?  
 A) Zn    B) Zn<sup>2+</sup>    C) Cu    D) Cu<sup>2+</sup>
33. When switch S is closed, electrons in the external circuit will flow from  
 A) Zn to Zn<sup>2+</sup>                      B) Zn to Cu  
 C) Cu to Zn<sup>2+</sup>                      D) Cu to Zn
- 
34. In a chemical cell, the function of the salt bridge is to provide a path for the migration of  
 A) electrons                      B) neutrons  
 C) molecules                      D) ions
35. On the diagram of the chemical cell below which is at 298 K and 1 atmosphere.



When switch S is closed, which series of letters show the path and direction of the Zn<sup>2+</sup> ion flow?

- A) ABC    B) CBA    C) DEF    D) FED

36. The diagram below represents an electrochemical cell.



When switch S is closed, which particles undergo reduction?

- A) Zn<sup>2+</sup> ions                      B) Zn atoms  
 C) Cu<sup>2+</sup> ions                      D) Cu atoms
37. Which statement best describes how a salt bridge maintains electrical neutrality in the half-cells of an electrochemical cell?  
 A) It prevents the migration of electrons.  
 B) It permits the migration of ions.  
 C) It permits the two solutions to mix completely.  
 D) It prevents the reaction from occurring spontaneously.