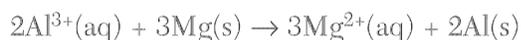


1. What is the oxidation number of chromium in the chromate ion, CrO_4^{2-} ?
- A. +6
B. +2
C. +3
D. +8
2. What is the oxidation number assigned to manganese in KMnO_4 ?
- A. +7
B. +2
C. +3
D. +4
3. Which changes occur when Pt^{2+} is reduced?
- A. The Pt^{2+} gains electrons and its oxidation number increases.
B. The Pt^{2+} gains electrons and its oxidation number decreases.
C. The Pt^{2+} loses electrons and its oxidation number increases.
D. The Pt^{2+} loses electrons and its oxidation number decreases.
4. Given the balanced ionic equation representing a reaction:



In this reaction, electrons are transferred from

- A. Al to Mg^{2+}
B. Al^{3+} to Mg
C. Mg to Al^{3+}
D. Mg^{2+} to Al
5. Half-reactions can be written to represent all
- A. double-replacement reactions
B. neutralization reactions
C. fission and fusion reactions
D. oxidation and reduction reactions
6. In an oxidation-reduction reaction, reduction is defined as the
- A. loss of protons
B. gain of protons
C. loss of electrons
D. gain of electrons
7. In which reaction are electrons transferred from one reactant to another reactant?
- A. $2\text{Ca}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{CaO}(\text{s})$
B. $\text{AgNO}_3(\text{aq}) + \text{KCl}(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{KNO}_3(\text{aq})$
C. $\text{HCl}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\ell)$
D. $\text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\ell)$
8. Which balanced equation represents a redox reaction?
- A. $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$
B. $\text{BaCl}_2 + \text{K}_2\text{CO}_3 \rightarrow \text{BaCO}_3 + 2\text{KCl}$
C. $\text{CuO} + \text{CO} \rightarrow \text{Cu} + \text{CO}_2$
D. $\text{HCl} + \text{KOH} \rightarrow \text{KCl} + \text{H}_2\text{O}$
9. Which metal reacts spontaneously with a solution containing zinc ions?
- A. magnesium
B. nickel
C. copper
D. silver

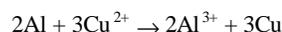
10. Which reaction is an example of an oxidation-reduction reaction?
- A. $\text{AgNO}_3 + \text{KI} \rightarrow \text{AgI} + \text{KNO}_3$
B. $\text{Cu} + 2\text{AgNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{Ag}$
C. $2\text{KOH} + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$
D. $\text{Ba}(\text{OH})_2 + 2\text{HCl} \rightarrow \text{BaCl}_2 + 2\text{H}_2\text{O}$

11. Given the reaction:



Which species undergoes reduction?

- A. Al
B. Fe
C. Al^{+3}
D. Fe^{+3}
12. According to Reference Table J, which of these metals will react most readily with 1.0 M HCl to produce $\text{H}_2(\text{g})$?
- A. Ca
B. K
C. Mg
D. Zn
13. Given the balanced equation representing a redox reaction:

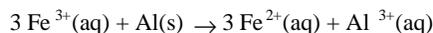


Which statement is true about this reaction?

- A. Each Al loses 2e^- and each Cu^{2+} gains 3e^- .
B. Each Al loses 3e^- and each Cu^{2+} gains 2e^- .
C. Each Al^{3+} gains 2e^- and each Cu loses 3e^- .
D. Each Al^{3+} gains 3e^- and each Cu loses 2e^- .
14. Given the redox reaction:
- $$\text{Cr}^{3+} + \text{Al} \rightarrow \text{Cr} + \text{Al}^{3+}$$
- As the reaction takes place, there is a transfer of
- A. electrons from Al to Cr^{3+}
B. electrons from Cr^{3+} to Al
C. protons from Al to Cr^{3+}
D. protons from Cr^{3+} to Al
15. Which half-reaction correctly represents reduction?
- A. $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$
B. $\text{F}_2 \rightarrow 2\text{F}^- + 2\text{e}^-$
C. $\text{Au}^{3+} + 3\text{e}^- \rightarrow \text{Au}$
D. $\text{Fe}^{2+} + \text{e}^- \rightarrow \text{Fe}^{3+}$
16. Which equation shows conservation of both mass and charge?
- A. $\text{Cl}_2 + \text{Br}^- \rightarrow \text{Cl}^- + \text{Br}_2$
B. $\text{Cu} + 2\text{Ag}^+ \rightarrow \text{Cu}^{2+} + \text{Ag}$
C. $\text{Zn} + \text{Cr}^{3+} \rightarrow \text{Zn}^{2+} + \text{Cr}$
D. $\text{Ni} + \text{Pb}^{2+} \rightarrow \text{Ni}^{2+} + \text{Pb}$
17. Which half-reaction can occur at the anode in a voltaic cell?
- A. $\text{Ni}^{2+} + 2\text{e}^- \rightarrow \text{Ni}$
B. $\text{Sn} + 2\text{e}^- \rightarrow \text{Sn}^{2+}$
C. $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$
D. $\text{Fe}^{3+} \rightarrow \text{Fe}^{2+} + \text{e}^-$

Redox Worksheet

18. Given the balanced equation:



What is the total number of moles of electrons lost by 2 moles of Al(s)?

- A. 1 mole
B. 6 moles
C. 3 moles
D. 9 moles
19. Given the unbalanced ionic equation:
- $$3\text{Mg} + __\text{Fe}^{3+} \rightarrow 3\text{Mg}^{2+} + __\text{Fe}$$
- When this equation is balanced, both Fe^{3+} and Fe have a coefficient of
- A. 1, because a total of 6 electrons is transferred
B. 2, because a total of 6 electrons is transferred
C. 1, because a total of 3 electrons is transferred
D. 2, because a total of 3 electrons is transferred
20. Which energy conversion occurs during the operation of a voltaic cell?
- A. Chemical energy is spontaneously converted to electrical energy.
B. Chemical energy is converted to electrical energy only when an external power source is provided.
C. Electrical energy is spontaneously converted to chemical energy.
D. Electrical energy is converted to chemical energy only when an external power source is provided.

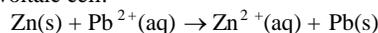
21. A student collects the materials and equipment below to construct a voltaic cell:

- 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?

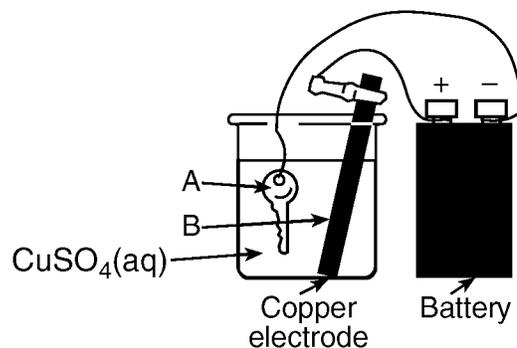
- A. an anode
B. a battery
C. a cathode
D. a salt bridge

22. Given the balanced equation representing the reaction occurring in a voltaic cell:



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 $\text{Pb}^{2+}(\text{aq})$
23. 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.
24. The diagram below shows a key being plated with copper in an electrolytic cell



Given the reduction reaction for this cell:

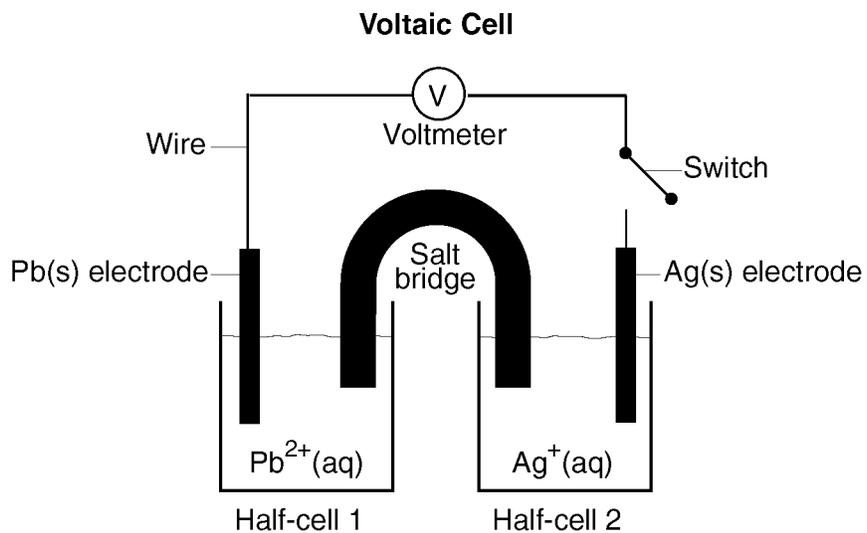


This reduction occurs at

- A. A, which is the anode
B. A, which is the cathode
C. B, which is the anode
D. B, which is the cathode

Redox Worksheet

Base your answers to questions 25 through 27 on the diagram of the voltaic cell below.

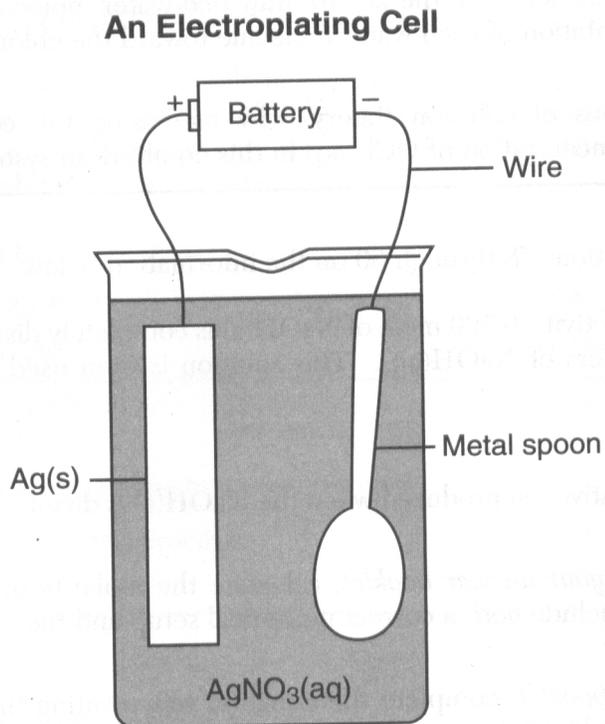


25. When the switch is closed, in which half-cell does oxidation occur?
26. When the switch is closed, state the direction that electrons will flow through the wire.
27. Based on the given equation, write the balanced half-reaction that occurs in half-cell 1.

Redox Worksheet

Base your answers to questions 28 and 29 on the information below.

Electroplating is an electrolytic process used to coat metal objects with a more expensive and less reactive metal. The diagram below shows an electroplating cell that includes a battery connected to a silver bar and a metal spoon. The bar and spoon are submerged in $\text{AgNO}_3(\text{aq})$.



28. Explain the purpose of the battery in this cell.
29. Explain why AgNO_3 is a better choice than AgCl for use in this electrolytic process.
- _____
30. Base your answer to the following question on the information below

The unbalanced equation below represents the decomposition of potassium chlorate.

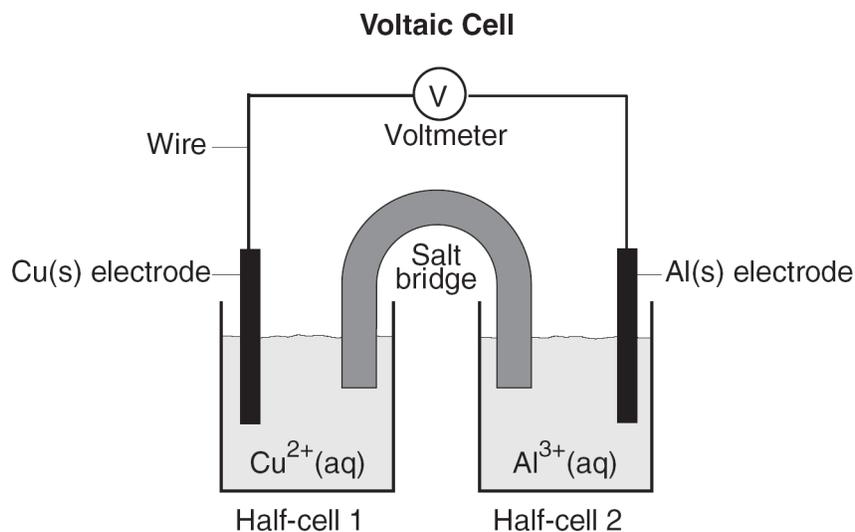


Balance the equation *below*, using the smallest whole-number coefficients.

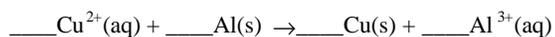


Redox Worksheet

Base your answers to questions 31 through 33 on the diagram below. The diagram shows a voltaic cell with copper and aluminum electrodes immediately after the external circuit is completed.



31. Explain the function of the salt bridge.
32. Balance the redox equation below, using the smallest whole-number coefficients.



33. As this voltaic cell operates, the mass of the Al(s) electrode decreases. Explain, in terms of particles, why this decrease in mass occurs.

Redox Worksheet
Answer Key

1. A

2. A

3. B

4. C
—prevents polarization

5. D

6. D

7. A

8. C

9. A

10. B

11. D

12. B

13. B

14. A

15. C

16. D

17. C

18. B

19. B

20. A

21. D

22. C

23. C

24. B

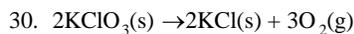
25. Acceptable responses: half-cell 1, Pb, left, lead.

26. Acceptable responses: from Pb electrode to Ag electrode, left to right, cell 1 → cell 2, Do not allow credit for a response that indicates that electrons flow through the salt bridge.

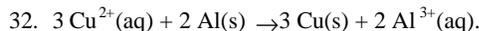
27. Allow credit for **Pb(s)** ® **Pb²⁺(aq)** + **2e⁻** even if the labels (s) and (aq) are not included.

28. *Examples:* – The battery provides the electrical energy necessary for the reaction to occur.

29. *Examples:* – Silver nitrate produces more ions than silver chloride in water. – AgNO₃ readily dissolves in H₂O; AgCl dissolves only slightly in H₂O.



31. *Examples:* —It allows migration of ions. —maintains neutrality



33. —Aluminum atoms are losing electrons and becoming aluminum ions that are entering the solution.