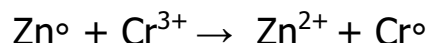
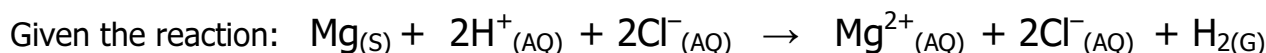


Redox/Electrochemistry Regents Unit Review. In chemistry we will sometimes see ions written as  $\text{Zn}^{+2}$  but sometimes as  $\text{Zn}^{2+}$ . I mixed them up here so you don't get "surprised". Sometimes  $\text{Na}^{+1}$  will be written as  $\text{Na}^+$ , without the "one".  $\text{Cl}^{-1}$  might be "just"  $\text{Cl}^-$ . It's okay, relax, you're smart.

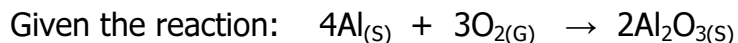
Base your answers on the following redox reaction, which occurs spontaneously in an electrochemical cell:



1. Write the half-reaction for the reduction that occurs.
2. Write the half-reaction for the oxidation that occurs.
3. Balance the equation using the smallest whole-number coefficients.
4. Which species loses electrons and which species gains electrons?
5. Which half-reaction occurs at the cathode?
6. What happens to the number of protons in a Zn atom when it changes to  $\text{Zn}^{2+}$  in the redox reaction.



7. Which species undergoes oxidation?    A.  $\text{Mg}_{(s)}$     B.  $\text{H}^{+}_{(aq)}$     C.  $\text{Cl}^{-}_{(aq)}$     D.  $\text{H}_{2(g)}$
8. Which particles are gained and lost during a redox reaction?  
A. electrons    B. neutrons    C. protons    D. positrons
9. As a Ca atom undergoes oxidation to  $\text{Ca}^{2+}$ , the number of neutrons in its nucleus  
A. increases    B. decreases    C. remains the same    D. no one knows this, me either



10. Write the balanced oxidation half-reaction for this oxidation-reduction reaction.
11. What is the oxidation number of oxygen in  $\text{Al}_2\text{O}_3$ ?
12. In any redox reaction, the substance that undergoes reduction will  
A. lose electrons and have a decrease in oxidation number  
B. gain electrons and have a decrease in oxidation number  
C. lose electrons and have an increase in oxidation number  
D. gain electrons and have an increase in oxidation number
14. When a neutral atom undergoes oxidation, the atom's oxidation state  
A. decreases as it gains electrons    B. decreases as it loses electrons  
C. increases as it gains electrons    D. increases as it loses electrons
15. Given the equation:  $\text{C}_{(s)} + \text{H}_2\text{O}_{(g)} \rightarrow \text{CO}_{(g)} + \text{H}_{2(g)}$  Which species undergoes reduction?  
A.  $\text{C}_{(s)}$     B.  $\text{H}^+$     C.  $\text{C}^{2+}$     D.  $\text{H}_{2(g)}$

16. Given the equation:  $2\text{Al} + 3\text{Cu}^{2+} \rightarrow 2\text{Al}^{3+} + 3\text{Cu}$  The reduction half-reaction is...
- A.  $\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^-$     B.  $\text{Al} + 3\text{e}^- \rightarrow \text{Al}^{3+}$     C.  $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$     D.  $\text{Cu}^{2+} \rightarrow \text{Cu} + 2\text{e}^-$
17. Which type of reaction occurs when nonmetal atoms become negative nonmetal ions?
- A. oxidation    B. substitution    C. reduction    D. condensation
18. Given the reaction:  $\text{Zn}_{(\text{s})} + 2\text{HCl}_{(\text{aq})} \rightarrow \text{ZnCl}_{2(\text{aq})} + \text{H}_{2(\text{g})}$   
Which statement correctly describes what occurs when this reaction takes place in a closed system?
- A. Atoms of  $\text{Zn}_{(\text{s})}$  lose electrons and are oxidized.    B. Atoms of  $\text{Zn}_{(\text{s})}$  gain electrons and are reduced.  
C. There is a net loss of mass.    D. There is a net gain of mass.
19. Given the reaction:  $\text{Cl}_2 + 2\text{HBr} \rightarrow \text{Br}_2 + 2\text{HCl}$   
Write a correctly balanced reduction half-reaction for this equation.
20. Given the reaction:  $2\text{Al}_{(\text{s})} + \text{Fe}_2\text{O}_{3(\text{s})} \rightarrow \text{Al}_2\text{O}_{3(\text{s})} + 2\text{Fe}_{(\text{s})}$   
Which species undergoes reduction?    A. Al    B.  $\text{Al}^{3+}$     C.  $\text{Fe}^{3+}$     D. Fe
21. 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.  $\text{Ni} + \text{Pb}^{2+} \rightarrow \text{Ni}^{2+} + \text{Pb}$
22. Given the reaction that occurs in an chemical cell:  $\text{Zn}_{(\text{s})} + \text{CuSO}_{4(\text{aq})} \rightarrow \text{ZnSO}_{4(\text{aq})} + \text{Cu}_{(\text{s})}$   
During this reaction, the oxidation number of Zn changes from
- A. 0 to +2    B. 0 to -2    C. +2 to 0    D. -2 to 0
23. Given the reaction for the corrosion of aluminum:  $4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_{3(\text{s})}$   
Which half-reaction correctly represents the oxidation that occurs?
- A.  $\text{Al} + 3\text{e}^- \rightarrow \text{Al}^{3+}$     B.  $\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^-$     C.  $\text{O}_2 + 4\text{e}^- \rightarrow 2\text{O}^{2-}$     D.  $\text{O}_2 \rightarrow 2\text{O}^{2-} + 4\text{e}^-$
24. Balance this *unbalanced* redox reaction:  $\text{Cu}_{(\text{s})} + \text{AgNO}_{3(\text{aq})} \rightarrow \text{Cu}(\text{NO}_3)_{2(\text{aq})} + \text{Ag}_{(\text{s})}$
25. Write the reduction half reaction from it now.
26. Besides redox, what kind of chemical reaction is the reaction in question 24?
27. 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.  $\text{Fe}^{2+} + \text{e}^- \rightarrow \text{Fe}^{+3}$

28. In a redox reaction, how does the total number of electrons lost by the oxidized substance compare to the total number of electrons gained by the reduced substance?

- A. The number lost is always greater than the number gained.
- B. The number lost is always equal to the number gained.
- C. The number lost is sometimes equal to the number gained.
- D. The number lost is sometimes less than the number gained.

29. Which reaction is an example of an oxidation-reduction reaction?

- A.  $\text{AgNO}_3 + \text{KI} \rightarrow \text{AgI} + \text{KNO}_3$
- B.  $2\text{KOH} + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$
- C.  $\text{Cu} + 2\text{AgNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{Ag}$
- D.  $\text{Ba}(\text{OH})_2 + 2\text{HCl} \rightarrow \text{BaCl}_2 + 2\text{H}_2\text{O}$

30. Which change in oxidation number indicates oxidation?

- A.  $-1$  to  $+2$
- B.  $-1$  to  $-2$
- C.  $+2$  to  $-3$
- D.  $+3$  to  $+2$

31. 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  $\text{Cr}^{3+}$
- B. protons from Al to  $\text{Cr}^{3+}$
- C. electrons from  $\text{Cr}^{3+}$  to Al
- D. protons from  $\text{Cr}^{3+}$  to Al

32. 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

33. Because tap water is slightly acidic, water pipes made of iron corrode over time, as shown by this balanced ionic equation:  $4\text{Fe}_{(s)} + 6\text{H}_2\text{O}_{(l)} \rightarrow 2\text{Fe}_2\text{O}_3_{(s)} + 3\text{H}_2_{(g)}$

Explain, in terms of chemical reactivity, why copper pipes are less likely to corrode than iron pipes.

34. 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

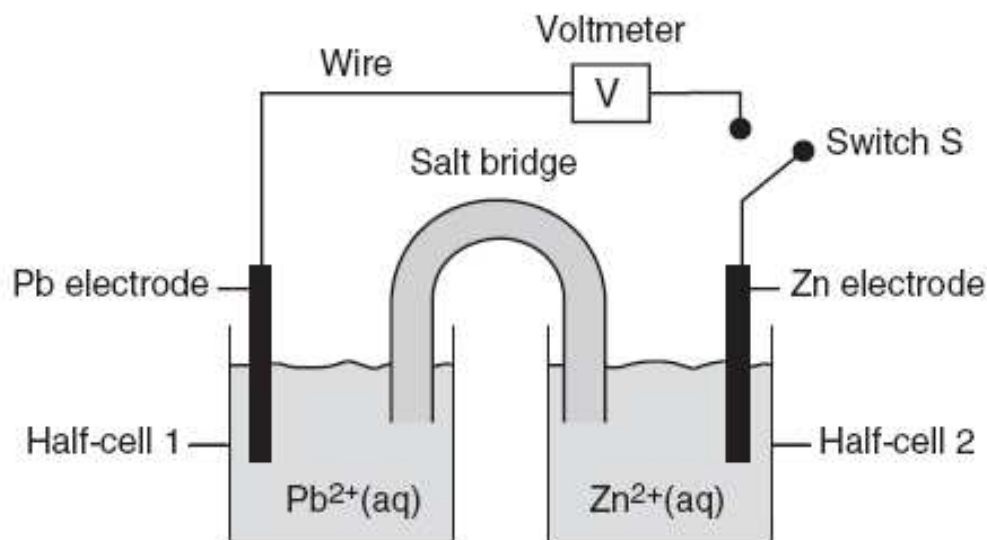
35. According to the Activity Series, which of these metals will react most readily with 1.0 M HCl to produce  $\text{H}_2_{(g)}$ ? A. Ca B. K C. Mg D. Zn

36. Which statement is true for any electrochemical cell?

- A. Oxidation occurs at the anode, only.
- B. Oxidation occurs at the anode and the cathode.
- C. Reduction occurs at the anode, only.
- D. Reduction occurs at the anode and the cathode.

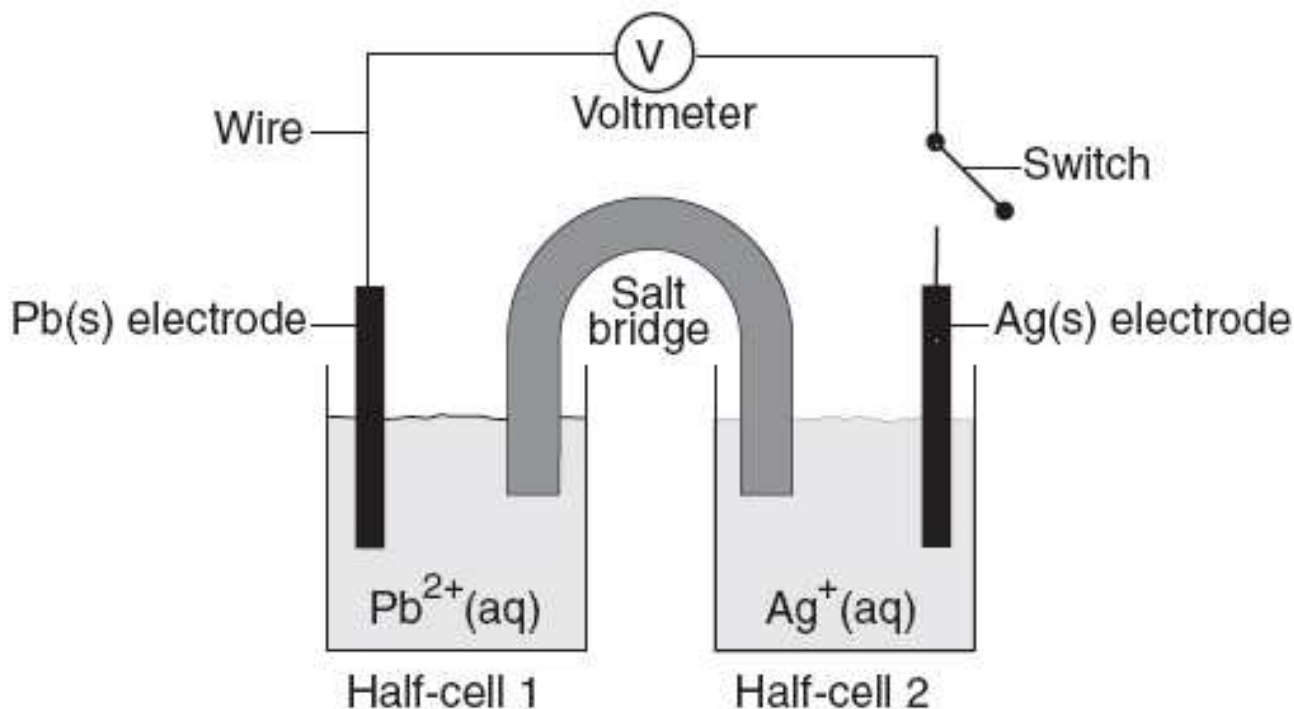
37. What is the purpose of the salt bridge in a voltaic cell?

- A. It blocks the flow of electrons.
- B. It is a path for the flow of electrons.
- C. It blocks the flow of positive and negative ions.
- D. It is a path for positive and negative ions flow.



Use this voltaic cell set up, and your reference tables, to answer the following questions:

38. In this cell, electricity will flow    A. Zn to Pb    B. Pb to Zn    C. Zn to Zn<sup>2+</sup>    D. Pb<sup>2+</sup> to Pb
39. In this voltaic cell  
 A. the zinc electrode oxidizes, it's the anode    B. the zinc electrode oxidizes, it's the cathode  
 C. the lead electrode oxidizes, it's the anode    D. the lead electrode oxidizes, it's the cathode
40. When the switch is closed and the cell starts to produce electricity, the solution on the right side will  
 A. become negatively charged, so anions flow into it from the salt bridge  
 B. become positively charged, so cations flow into it from the salt bridge  
 C. becomes negatively charged, so cations flow into it from the salt bridge  
 D. becomes positively charged so anions flow into it from the salt bridge
41. While this electrochemical cell runs, producing electricity,  
 A. the zinc is the anode, it gets smaller    B. the zinc is the cathode, it gets bigger  
 C. the lead is the anode, it gets bigger    D. the lead is the cathode, it gets smaller
42. While this electrochemical cell runs, producing electricity,  
 A. the lead is the anode, it gets bigger    B. the lead is the cathode, it gets bigger  
 C. the zinc is the anode, it gets bigger    D. the zinc is the cathode, it gets bigger
43. Write the oxidation  $\frac{1}{2}$  reaction for this electrochemical cell
44. Write the reduction  $\frac{1}{2}$  reaction for this electrochemical cell
45. Write the net ionic equation for this redox reaction
46. Which species is oxidized?    A. Zn    B. Pb    C. Zn<sup>2+</sup>    D. Pb<sup>2+</sup>



For this electrochemical cell, write the oxidation  $\frac{1}{2}$  reaction

47. Write the reduction  $\frac{1}{2}$  reaction

48. Write the net ionic equation for this cell

49. If the salt in the salt bridge were to be aqueous KCl, which ion would flow into the beaker on the left?

50. Which ion would flow into the beaker on the right?

51. The electricity in this cell flows from... A. Pb to Ag B. Ag to Pb C. Pb to  $\text{Ag}^+$  D.  $\text{Pb}^{2+}$  to  $\text{Ag}^+$

52. The anode in this cell is

A. Pb, it gets smaller B. Ag, it gets smaller C. Pb, it gets bigger D. Ag, it gets bigger

53. The diagram represents an electrochemical cell called

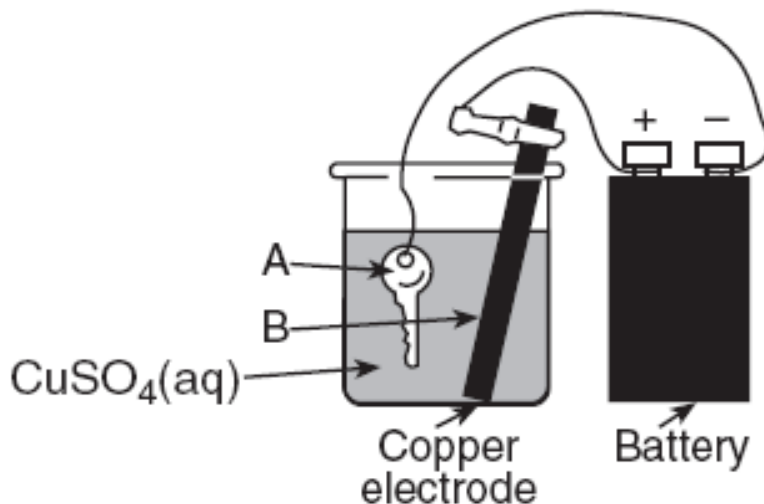
A. a voltaic cell, which uses electricity B. an electrolytic cell, which uses electricity  
C. a voltaic cell, which produces electricity D. an electrolytic cell, which produces electricity

54. The reasons that this cell would stop producing electricity include (many answers possible here: get them all)

A. running out of anode B. running out of cathode C. running out of anode side cations  
D. running out of cathode side cations E. running out of salt ions F. anode getting too big  
G. opening the switch, breaking the electric connection H. time for the Sopranos  
I. radioactive decay of anode resulting in radiation disrupting your brain wave pattern J. rain or snow

At right is an electrochemical cell, use the diagram and your knowledge of redox chemistry to answer the following questions.

The key, marked "A" is made of nickel metal, it's very strong.



55. If the battery were not present, the chemical reaction of putting nickel metal into  $\text{CuSO}_4(\text{aq})$  would be balanced this way:

\_\_\_\_\_ → \_\_\_\_\_

56. That reaction is called a \_\_\_\_\_ reaction.

57. Is that reaction also redox? \_\_\_\_\_ What proof do you have? \_\_\_\_\_

58. In this set up, the anode is

- A. the key      B. the copper electrode      C. the copper (II) sulfate solution      D. the wires

59. Electrons flow from the battery

- A. to the key, which is the anode      B. to the key, which is the cathode  
C. to the solution, which is neither the cathode or anode      D. to the air

60. Write the oxidation  $\frac{1}{2}$  reaction for this cell.

61. Write the reduction  $\frac{1}{2}$  reaction for this cell

62. LEO the Lion goes GER infers that the \_\_\_\_\_ of \_\_\_\_\_ is \_\_\_\_\_ and

63. ... that the \_\_\_\_\_ of \_\_\_\_\_ is \_\_\_\_\_

64. Which TWO of these statements are correct?

- A. a voltaic cell uses electricity to produce a chemical reaction  
B. A voltaic cell creates electricity from a chemical reaction  
C. an electrolytic cell uses electricity to produce a chemical reaction  
D. an electrolytic cell produces electricity from a chemical reaction.

65. True or False: All single replacement reactions are also redox.

66. True or False: All redox reactions are single replacement reactions.

Given this balanced reaction:  $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$

67. This is an example of a \_\_\_\_\_ chemical reaction that is also \_\_\_\_\_.
68. In this reaction, the \_\_\_\_\_ are oxidized into \_\_\_\_\_.
69. In this reaction, the \_\_\_\_\_ are reduced into \_\_\_\_\_.
70. The oxidation number for the magnesium atom in the reactants is: \_\_\_\_
71. The oxidation state for the magnesium cation in the product is: \_\_\_\_
72. The oxidation state for the oxide anion in the product is: \_\_\_\_
73. The oxidation state for each species in  $\text{CaSO}_4$  would be...  
A.  $\text{Ca}^{+2} \text{S}^0 \text{O}^{-2}$       B.  $\text{Ca}^0 \text{S}^0 \text{O}^0$       C.  $\text{Ca}^{+2} \text{S}^{+6} \text{O}^{-8}$       D.  $\text{Ca}^{+2} \text{S}^{+6} \text{O}^{-2}$
74. The oxidation state for each species in  $\text{Al}(\text{OH})_3$  would be...  
A.  $\text{Al}^{+3} \text{O}^{-6} \text{H}^{+3}$       B.  $\text{Al}^{+3} \text{O}^{-2} \text{H}^{+1}$       C.  $\text{Al}^0 \text{O}^0 \text{H}^0$       D.  $\text{Al}^{+1} \text{O}^{-2} \text{H}^{+1}$
75. The oxidation state for each species in  $\text{CO}_2$  would be...  
A.  $\text{C}^0 \text{O}^0$       B.  $\text{C}^0 \text{O}^{-2}$       C.  $\text{C}^{+2} \text{O}^{-2}$       D.  $\text{C}^{+4} \text{O}^{-2}$
76. The oxidation state for each species in  $\text{HCO}_3^{-1}$  would be...  
A.  $\text{H}^{+1} \text{C}^{+2} \text{O}^{-2}$       B.  $\text{H}^{+1} \text{C}^{+4} \text{O}^{-2}$       C.  $\text{H}^{+3} \text{C}^0 \text{O}^{-2}$       D.  $\text{H}^0 \text{C}^0 \text{O}^0$
77. When you place silver metal into hydrochloric acid, what are the products?
78. When you mix bromine into an aqueous solution of ammonium iodide, what are the products?
79. Is question 77 a redox reaction?
80. Is question 78 redox?
81. In question 78, what is the spectator ion?

On the next page is a drawing of the set up for a voltaic cell. Label the diagram properly, showing: flow of electrons, flow of ions, which is the anode, which is the cathode, which solution gets positively charged, which solution gets negatively charged, label what is in the solutions, what is in the salt bridge. The metal bar at left will be iron, and the bar on the right side will be aluminum. Also, tell exactly why the voltaic cell would stop producing electricity (three reasons, be specific). Write the half reactions and net ionic equation. Go.

