1. What is the oxidation number assigned to manganese in $KMnO_4$?
   1) +7 2) +2
   3) +3 4) +4

2. Given the reaction that occurs in an electrochemical cell:

   $$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

   During this reaction, the oxidation number of Zn changes from
   1) +2 to 0 2) 0 to −2
   3) −2 to 0 4) 0 to +2

3. In which substance does chlorine have an oxidation number of +1?
   1) HClO 2) HCl
   3) Cl_2 4) $HClO_2$

4. What is the oxidation number of chromium in $K_2Cr_2O_7$?
   1) +6 2) +3
   3) +12 4) +2

5. In which substance does hydrogen have an oxidation number of zero?
   1) H_2S 2) LiH
   3) H_2 4) H_2O

6. If element *X* forms the oxides *X*O and X_2O_3, the oxidation numbers of element *X* are
   1) +1 and +2 2) +2 and +3
   3) +1 and +3 4) +2 and +4

7. In which substance does sulfur have a negative oxidation number?
   1) $CaSO_4$ 2) Na_2S
   3) SO_2 4) S

8. What is the oxidation number of oxygen in OF_2?
   1) +1 2) +2
   3) −1 4) −2

9. Given the balanced ionic equation:

   $$2Al(s) + 3Cu^{2+}(aq) \rightarrow 2Al^{3+}(aq) + 3Cu(s)$$

   Compared to the total charge of the reactants. the total charge of the products is
   1) less 2) greater
   3) the same

10. Which type of reaction occurs when nonmetal atoms become negative nonmetal ions?
    1) condensation 2) substitution
    3) reduction 4) oxidation

11. Given the reaction:

    $$Mg(s) + 2\,H^+(aq) + 2\,Cl^-(aq) \rightarrow Mg^{2+}(aq) + 2\,Cl^-(aq) + H_2(g)$$

    Which species undergoes oxidation?
    1) Mg(s)
    2) $Cl^-(aq)$
    3) $H^+(aq)$
    4) $H_2(g)$

12. Given the electrochemical cell reaction:

    $$Zn(s) + Ni^{2+}(aq) \rightarrow Zn^{2+}(aq) + Ni(s)$$

    Which species is the reducing agent?
    1) Ni^{2+} 2) Zn
    3) Ni 4) Zn^{2+}

13. Given the reaction:

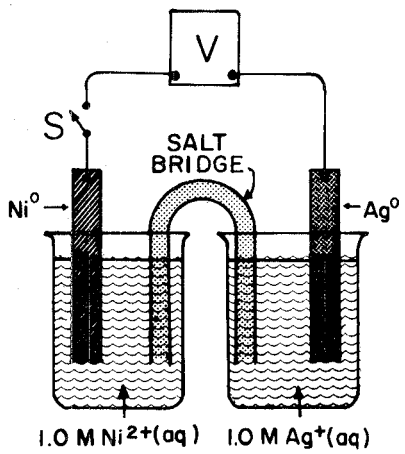
    $$F_2(g) + 2\,Br^-(aq) \rightarrow Br_2(\ell) + 2\,F^-(aq)$$

    Which species is reduced?
    1) $F^-(aq)$
    2) $Br^-(aq)$
    3) $F_2(g)$
    4) $Br_2(\ell)$

14. Which oxidation number change could occur during an oxidation of an element?
    1) +3 to + 1 2) −2 to −3
    3) +1 to −1 4) +2 to +3

15. Which half-reaction correctly represents oxidation?
    1) $F_2 \rightarrow 2\ F^- + 2e^-$
    2) $H_2 \rightarrow 2\ H^+ + 2e^-$
    3) $F_2 + 2e^- \rightarrow 2\ F^-$
    4) $H_2 + 2e^- \rightarrow 2\ H^+$

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



$$Ni^0(s) + 2Ag^+(aq) \rightarrow Ni^{2+}(aq) + 2Ag^0(s)$$

As the reaction in this cell takes place, the concentration of Ni^{2+} ions
    1) decreases and the concentration of Ag^+ ions decreases
    2) increases and the concentration of Ag^+ ions decreases
    3) decreases and the concentration of Ag^+ ions increases
    4) increases and the concentration of Ag^+ ions increases

17. Which half-reaction correctly represents reduction?
    1) $S^{2-} \rightarrow S^0 + 2e^-$
    2) $Mn^{7+} \rightarrow Mn^{4+} + 3e^-$
    3) $Mn^{7+} + 3e^- \rightarrow Mn^{4+}$
    4) $S^{2-} + 2e^- \rightarrow S^0$

18. Which balanced equation represents a redox reaction?
    1) $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
    2) $CuO + CO \rightarrow Cu + CO_2$
    3) $BaCl_2 + K_2CO_3 \rightarrow BaCO_3 + 2KCl$
    4) $HCl + KOH \rightarrow KCl + H_2O$

19. Which statement correctly describes a redox reaction?
    1) The oxidation half-reaction occurs after the reduction half-reaction.
    2) The oxidation half-reaction and the reduction half-reaction occur simultaneously.
    3) The oxidation half-reaction occurs spontaneously but the reduction half-reaction does not.
    4) The oxidation half-reaction occurs before the reduction half-reaction.

20. Given the reaction:

    $$Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

    Which statement correctly describes what occurs when this reaction takes place in a closed system?
    1) There is a net gain of mass.
    2) Atoms of Zn(s) lose electrons and are oxidized.
    3) Atoms of Zn(s) gain electrons and are reduced.
    4) There is a net loss of mass.

21. Which is a redox reaction?
    1) $Fe + 2\ HCl \rightarrow FeCl_2 + H_2$
    2) $H^+ + Cl^- \rightarrow HCl$
    3) $MgO + H_2SO_4 \rightarrow MgSO_4 + H_2O$
    4) $NaOH + HCl \rightarrow NaCl + H_2O$

22. Which is a redox reaction?
    1) $2\ HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$
    2) $4\ HCl + MnO_2 \rightarrow MnCl_2 + 2\ H_2O + Cl_2$
    3) $2\ HCl + FeS \rightarrow FeCl_2 + H_2S$
    4) $HCl + KOH \rightarrow KCl + H_2O$

23. The oxidation number of a reducing agent can change from
    1) –1 to –3
    2) –2 to –1
    3) 3 to –1
    4) 4 to –3

24. In a redox reaction, the species reduced
    1) gains electrons and is the oxidizing agent
    2) loses electrons and is the oxidizing agent
    3) loses electrons and is the reducing agent
    4) gains electrons and is the reducing agent

25. Which of the following elements is the poorest reducing agent?
    1) Al
    2) Zn
    3) H_2
    4) Ba

26. As the elements in Period 3 of the Periodic Table are considered in order of increasing atomic number, the ability of each successive element to act as a reducing agent
    1) decreases 2) increases
    3) remains the same

27. Which metal reacts spontaneously with a solution containing zinc ions?
    1) magnesium 2) silver
    3) nickel 4) copper

28. According to Reference Table *J*, which of these metals will react most readily with 1.0 M HCl to produce $H_2(g)$?
    1) Ca 2) K
    3) Zn 4) Mg

29. According to Reference Table J, which of these ions is most easily reduced?
    1) Cu^+
    2) Cr^{3+}
    3) Ca^{2+}
    4) Ag^+

30. Referring to Reference Table J, which reaction will not occur under standard conditions?
    1) $Sn(s) + 2\ HCl(aq) \rightarrow SnCl_2(ag) + H_2(g)$
    2) $Mg(s) + 2\ HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$
    3) $Cu(s) + 2\ HCl(aq) \rightarrow CuCl_2(aq) + H_2(g)$
    4) $Ba(s) + 2\ HCl(aq) \rightarrow BaCl_2(aq) + H_2(g)$

31. Based on Reference Table J, which of the following elements will replace Pb from $Pb(NO_3)_2(aq)$?
    1) Mg(s) 2) Cu(s)
    3) Ag(s) 4) Au(s)

32. According to Reference Table J, which species is the strongest oxidizing agent?
    1) Li^+ 2) $F_2(g)$
    3) Li(s) 4) F^-

33. Which metal is used as a coating on steel to limit corrosion?
    1) Zn 2) Na
    3) Ca 4) K

34. Given the nickel-cadmium battery reaction:

$$2NiOOH + Cd + 2H_2O \underset{\text{charge}}{\overset{\text{discharge}}{\rightleftharpoons}} 2Ni(OH)_2 + Cd(OH)_2$$

During the discharge of the battery, Ni^{3+} ions are
1) oxidized, and cadmium metal is oxidized
2) reduced, and cadmium metal is oxidized
3) reduced, and cadmium metal is reduced
4) oxidized, and cadmium metal is reduced

35. Given the reaction:

$$2\ Al^0(s) + 3\ Ni^{2+}(aq) \rightarrow 2\ Al^{3+}(aq) + 3\ Ni^0(s)$$

What is the total number of moles of electrons lost by 2 moles of $Al^0(s)$?
1) 6
2) 2
3) 3
4) 8

36. Given the unbalanced equation:

$$___Ag_2S + 8HNO_3 \rightarrow ___AgNO_3 + 2NO + ___S + ___H_2O$$

What is the coefficient of Ag_2S when the equation is completely balanced using the smallest whole numbers?
1) 6
2) 2
3) 3
4) 4

37. Which simple oxidation-reduction reaction is *not* correctly balanced?
1) $Ni(s) + Sn^{2+}(aq) \rightarrow Sn(s) + Ni^{2+}(aq)$
2) $2\ I^-(aq) + Fe^{3+}(aq) \rightarrow Fe^{2+}(aq) + I_2(s)$
3) $Sn(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Sn^{2+}(aq)$
4) $2\ I^-(aq) + Hg^{2+}(aq) \rightarrow Hg(\ell) + I_2(s)$

38. Iron corrodes more easily than aluminum and zinc because aluminum and zinc both
1) form oxides
2) are oxidizing agents
3) are reduced
4) form oxides that are self-protective

39. Iron corrodes according to the equation

$$4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3.$$

This redox process occurs because
1) iron loses electrons and is oxidized
2) oxygen loses electrons and is reduced
3) iron gains electrons and is reduced
4) oxygen gains electrons and is oxidized

40. Which two metals resist corrosion by forming self-protective coatings?
1) Al and Fe
2) Fe and Zn
3) Al and Zn
4) Fe and Na

41. The chemical reaction that causes corrosion of metals in contact with water and oxygen is
1) a substitution reaction
2) an addition reaction
3) a reduction and oxidation reaction
4) a neutralization and ionization reaction

42. Which of the following metals forms a self-protective coating when exposed to air and moisture?
1) zinc
2) iron
3) sodium
4) calcium

43. Which conversion of energy always occurs in a voltaic cell?
1) electrical energy to chemical energy
2) chemical energy to light energy
3) light energy to chemical energy
4) chemical energy to electrical energy

44. A voltaic cell spontaneously converts
    1) chemical energy to electrical energy
    2) nuclear energy to electrical energy
    3) electrical energy to chemical energy
    4) electrical energy to nuclear energy

45. A voltaic cell differs from an electrolytic cell in that in a voltaic cell
    1) neither oxidation nor reduction occurs
    2) energy is required for the reaction to occur
    3) energy is produced when the reaction occurs
    4) both oxidation and reduction occur

46. What is the voltage for a chemical cell that has reached equilibrium?
    1) 1.00 V
    2) greater than 1.00 V
    3) greater than 0.00 V and less than 1.00 V
    4) 0.00 V

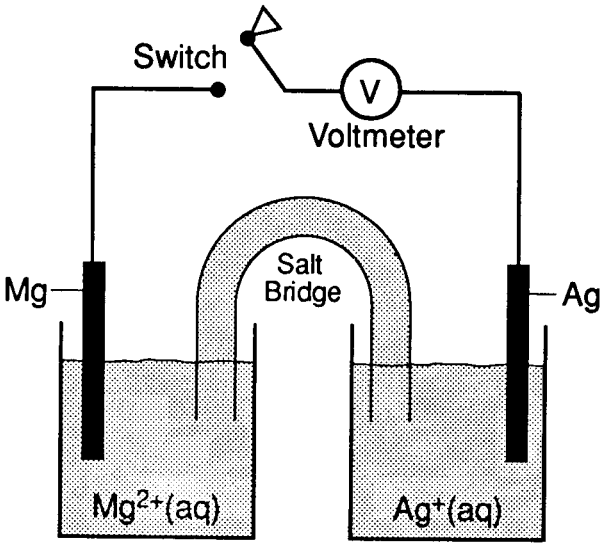
47. Which substance functions as the electrolyte in an automobile battery?
    1) H_2O 2) PbO_2
    3) H_2SO_4 4) $PbSO_4$

48. The type of reaction in an electrochemical cell is best described as a
    1) non-spontaneous oxidation-reduction reaction
    2) spontaneous oxidation reaction, only
    3) spontaneous oxidation-reduction reaction
    4) non-spontaneous oxidation reaction, only

49. Which statement is true about oxidation and reduction in an electrochemical cell?
    1) Both occur at the anode.
    2) Both occur at the cathode.
    3) Oxidation occurs at the anode and reduction occurs at the cathode.
    4) Oxidation occurs at the cathode and reduction occurs at the anode.

50. Which component of an electrochemical cell is correctly paired with its function?
    1) external conductor – allows the solutions to mix
    2) external conductor – permits the migration of ions
    3) salt bridge – permits the migration of ions
    4) salt bridge – allows the solutions to mix

51. Base your answer to the following question on the equation and diagram below represent an electrochemical cell at 298 K and 1 atmosphere.



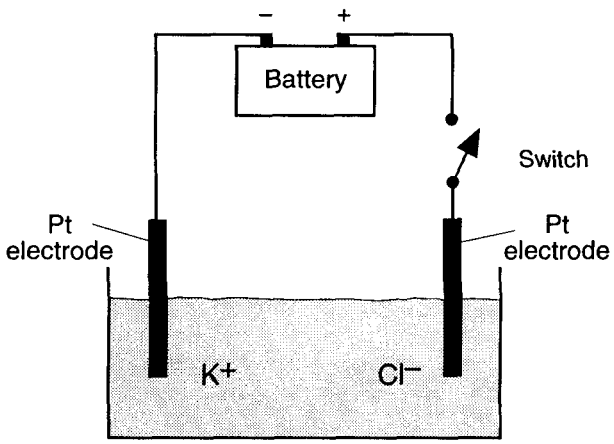
$$Mg(s) + 2Ag^{+}(aq) \longrightarrow Mg^{2+}(aq) + 2Ag(s)$$

Which species is oxidized when the switch is closed?
    1) $Ag(s)$
    2) Mg^{2+} (aq)
    3) $Mg(s)$
    4) $Ag^{+}(aq)$

52. 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
    1) external conductor 2) salt bridge
    3) cathode 4) anode

53. In an electrolytic cell, the negative electrode is called the
    1) anode, at which oxidation occurs
    2) anode, at which reduction occurs
    3) cathode, at which oxidation occurs
    4) cathode, at which reduction occurs

54. The diagram below shows the electrolysis of fused KCl.

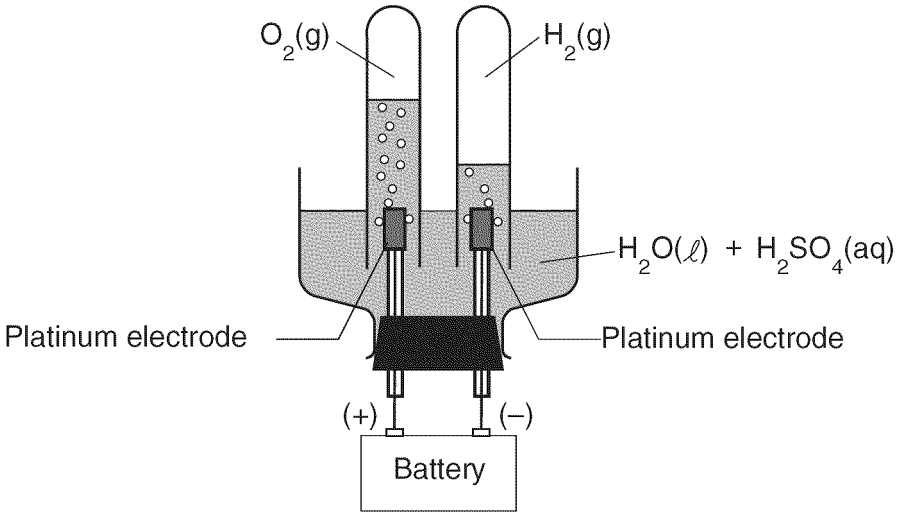


What occurs when the switch is closed?

1) Positive ions migrate toward the cathode, where they gain electrons.
2) Positive ions migrate toward the anode, where they gain electrons.
3) Positive ions migrate toward the anode, where they lose electrons.
4) Positive ions migrate toward the cathode, where they lose electrons.

Base your answers to questions **55** and **56** on the information and diagram below.

The apparatus shown in the diagram consists of two inert platinum electrodes immersed in water. A small amount of an electrolyte, H_2SO_4, must be added to the water for the reaction to take place. The electrodes are connected to a source that supplies electricity.

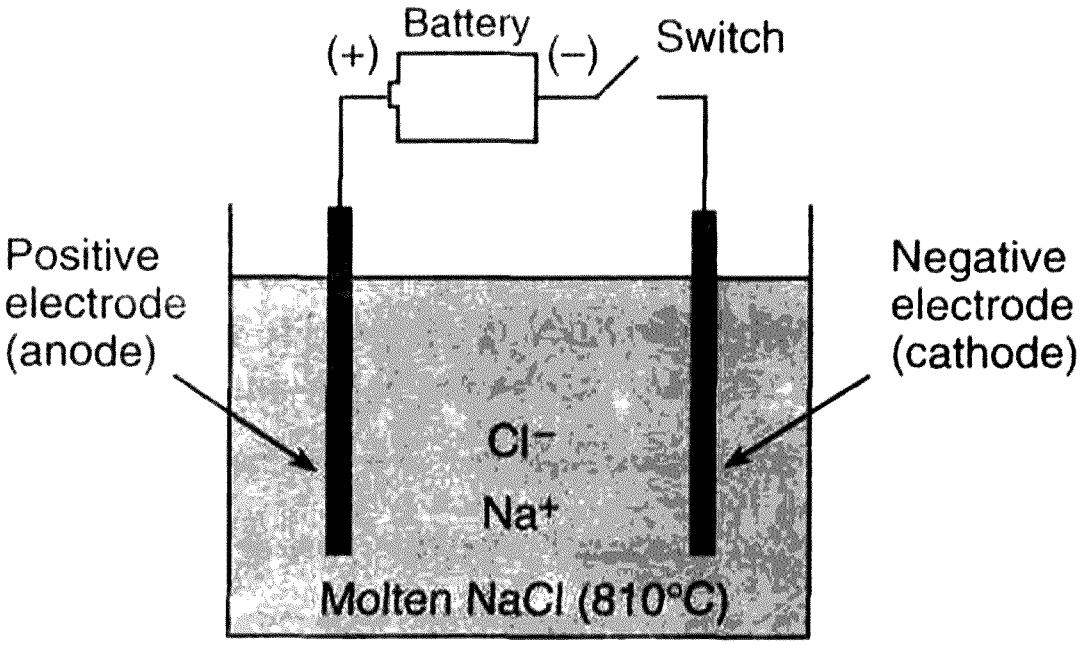


55. What type of electrochemical cell is shown?

56. What particles are provided by the electrolyte that allow an electric current to flow?

_____

Base your answers to questions **57** through **59** on the diagram and balanced equation below, which represent the electrolysis of molten NaCl.



$$2NaCl \longrightarrow Cl_2 + 2Na$$

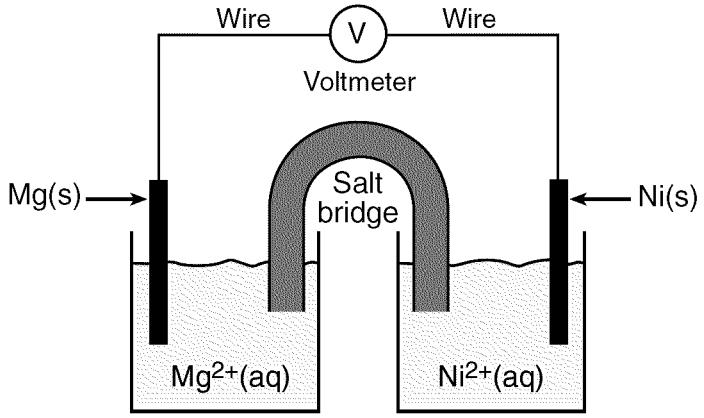
57. When the switch is closed, which electrode will attract the sodium ions?

58. What is the purpose of the battery in this electrolytic cell?

59. Write the balanced half-reaction for the reduction that occurs in this electrolytic cell.

_____

Base your answers to questions **60** and **61** on the diagram of a voltaic cell and the balanced ionic equation below.



$$Mg(s) + Ni^{2+}(aq) \longrightarrow Mg^{2+}(aq) + Ni(s)$$

60. What is the total number of moles of electrons needed to completely reduce 6.0 moles of $Ni^{2+}(aq)$ ions?

61. Explain the function of the salt bridge in the voltaic cell.

Base your answers to questions **62** and **63** on the unbalanced redox reaction below.

$$Cu(s) + AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + Ag(s)$$

62. Write the reduction half-reaction.

63. Balance the redox equation using the smallest whole-number coefficients.

Reference Tables

Table J
Activity Series**

Most	Metals	Nonmetals	Most
	Li	F_2	
	Rb	Cl_2	
	K	Br_2	
	Cs	I_2	
	Ba		
	Sr		
	Ca		
	Na		
	Mg		
	Al		
	Ti		
	Mn		
	Zn		
	Cr		
	Fe		
	Co		
	Ni		
	Sn		
	Pb		
	**H_2		
	Cu		
	Ag		
	Au		
Least			Least

**Activity Series based on hydrogen standard

Redox Practice Test 2008
Answer Key

1.	1	26.	1
2.	4	27.	1
3.	1	28.	2
4.	1	29.	4
5.	3	30.	3
6.	2	31.	1
7.	2	32.	2
8.	2	33.	1
9.	3	34.	2
10.	3	35.	1
11.	1	36.	3
12.	2	37.	2
13.	3	38.	4
14.	4	39.	1
15.	2	40.	3
16.	2	41.	3
17.	3	42.	1
18.	2	43.	4
19.	2	44.	1
20.	2	45.	3
21.	1	46.	4
22.	2	47.	3
23.	2	48.	3
24.	1	49.	3
25.	3	50.	3

Version A

Redox Practice Test 2008
Answer Key

51. 3

52. 2

53. 4

54. 1

55. electrolytic or electrolysis

56. Examples: – ions – charged particles – H_3O^+ - SO_4^{2-}

57. •negative electrode •cathode • the one on the right

58. •Electrolytic cells require energy. •The battery forces the non-spontaneous reaction to occur.

59. • $Na^+ + e^- \rightarrow Na$ or $2Na^+ + 2e^- \rightarrow 2Na$

60. 12 mol

61. The salt bridge allows ions to flow between the half-cells.

62. Acceptable responses: $Ag^+ + e^- \rightarrow Ag$; $2\ Ag^+ + 2e^- \rightarrow 2\ Ag$

63. $Cu(s) + 2\ AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2\ Ag(s)$

Redox Practice Test 2008

Name _____ Class _____ Date _____

Version A