


## Oxidation and Reduction Questions

- \_\_\_ 1.  $2\text{CO} + \text{O}_2 = 2\text{CO}_2$  In the above reaction the oxidation number of carbon changes from  
(1) +2 to +1; (2) +2 to +4; (3) +4 to +1; (4) +4 to +2.
- \_\_\_ 2. Which metal will react spontaneously with the copper (+2) ion at 25 degrees Celsius?  
(1) Ag; (2) Au; (3) Mg; (4) Hg.
-  3. Given the reaction:  $\text{Al} + 3\text{Ag}^{1+} \rightleftharpoons \text{Al}^{3+} + 3\text{Ag}$ . What is the cell voltage (E) for the overall reaction at standard conditions? (1) 0.86 V; (2) 1.78 V; (3) 2.46 V; (4) 3.38 V.
- \_\_\_ 4. Given the reaction:  $\text{Mg} + \text{ZnCl}_2 \rightleftharpoons \text{MgCl}_2 + \text{Zn}$ . Which is true of the magnesium? (1) It is oxidized by losing electrons.; (2) It is oxidized by gaining electrons; (3) It is reduced by losing electrons.; (4) It is reduced by gaining electrons..
- \_\_\_ 5. Which half-reaction correctly represents oxidation? (1)  $\text{F}_2 \rightleftharpoons 2\text{F}^{1-} + 2\text{e}^{1-}$ ;  
(2)  $\text{F}_2 + 2\text{e}^{1-} \rightleftharpoons 2\text{F}^{1-}$ ; (3)  $\text{H}_2 \rightleftharpoons 2\text{H}^{1+} + 2\text{e}_1^{-}$ ; (4)  $\text{H}_2 + 2\text{e}^{1-} \rightleftharpoons 2\text{H}^{1+}$ .
- \_\_\_ 6. Given the reaction:  $\text{Ca} + \text{NiCl}_2 \rightleftharpoons \text{CaCl}_2 + \text{Ni}$ . The oxidation number of the chlorine (1) decreases; (2) increases; (3) remains the same.
- \_\_\_ 7. Given the reaction:  $\text{NH}_3 + \text{O}_2 \rightleftharpoons \text{N}_2 + \text{H}_2\text{O}$ . When the above equation is completely balanced using the smallest whole numbers the coefficient of the oxygen gas will be (1) 1; (2) 2; (3) 3; (4) 4.
- \_\_\_ 8. In the reaction of silver ions with copper metal when the concentration of silver ions increases the voltage (1) increases; (2) decreases; (3) remains the same..
- \_\_\_ 9. What is the oxidation state of phosphorus in the following:  $\text{Na}_3\text{PO}_3$ ? (1) 0; (2) -3; (3) +3; (4) +5.
- \_\_\_ 10. Which occurs in an electrolytic cell containing copper(II) chloride? (1) copper ions migrate toward the positive electrode.; (2) chloride ions migrate toward the negative electrode; (3) copper ions are reduced; (4) chloride ions are reduced..
- \_\_\_ 11. Which is an example of an oxidation-reduction reaction? (1)  $\text{HCl} + \text{NaOH} \rightleftharpoons \text{NaCl} + \text{H}_2\text{O}$ ; (2)  $\text{C}(\text{s}) + \text{H}_2\text{O} \rightleftharpoons \text{H}_2 + \text{CO}$ ; (3)  $\text{CaCO}_3 \rightleftharpoons \text{CaO} + \text{CO}_2$ ; (4)  $\text{BaCl}_2 + \text{Na}_2\text{SO}_4 \rightleftharpoons \text{BaSO}_4 + 2\text{NaCl}$ .
- \_\_\_ 12. An oxide ion is oxidized to an oxygen atom by (1) gaining electrons; (2) losing electrons; (3) gaining protons; (4) losing protons.
- \_\_\_ 13. Hydrogen would have a -1 oxidation state if it formed a compound with (1) N; (2) O; (3) F; (4) K.
- \_\_\_ 14. Given the reaction:  $\text{Mg} + \text{Fe}^{2+} = \text{Mg}^{2+} + \text{Fe}$ . The potential difference (E) of this cell at standard conditions is (1) 2.81 volts; (2) 2.37 volts; (3) 1.93 volts; (4) 0.44 volt.
- \_\_\_ 15. In the reaction between a 1.0 Molar solution of copper(II) ions and copper metal

when the amount of copper metal increases the voltage (1) increases;  
(2) decreases; (3) remains the same..

- \_\_\_ 16. Which metal will react spontaneously with chromium(III) ion but not with calcium (+2) ion? (1) Mg; (2) Co; (3) Ba; (4) Pb.
- \_\_\_ 17. The oxidation number of nitrogen is highest in (1) N<sub>2</sub>; (2) NH<sub>3</sub>; (3) NO<sub>2</sub>; (4) N<sub>2</sub>O.
- \_\_\_ 18. Given the reaction:  $\text{Zn} + \text{Cu}^{2+} \rightleftharpoons \text{Zn}^{2+} + \text{Cu}$  In the above reaction the reducing agent (1) gains protons; (2) loses protons; (3) gains electrons; (4) loses electrons.
- \_\_\_ 19. What is the oxidation potential (E) of the half reaction  $\text{Cu(s)} \rightleftharpoons \text{Cu}^{1+} + \text{e}^{-}$  when the Cu<sup>1+</sup> is 1.0 M at 25 °C? (1) +0.34 volt; (2) +0.52 volt; (3) -0.34 volt; (4) -0.52 volt.
- \_\_\_ 20. Which is not an oxidation-reduction reaction? (1)  $\text{KOH} + \text{HCl} \rightleftharpoons \text{KCl} + \text{H}_2\text{O}$ ; (2)  $2\text{KCl} + \text{Cl}_2 \rightleftharpoons 2\text{KCl}$ ; (3)  $2\text{KClO}_3 \rightleftharpoons 2\text{KCl} + 3\text{O}_2$ ; (4)  $2\text{K} + 2\text{H}_2\text{O} \rightleftharpoons 2\text{KOH} + \text{H}_2$ .
- \_\_\_ 21. Given the reaction:  $\text{HNO}_3 + \text{MnCl}_2 + \text{HCl} \rightleftharpoons \text{NO} + \text{MnCl}_4 + \text{H}_2\text{O}$ . The equation is completely balanced using the smallest whole number coefficients the coefficient of the nitric acid will be (1) 5; (2) 2; (3) 3; (4) 6.
- \_\_\_ 22. Which change in oxidation number represents reduction? (1) -1 to +1; (2) -1 to -2; (3) -1 to +2; (4) -1 to 0.
- \_\_\_ 23. In the compound hypochlorous acid, HClO, the chlorine has an oxidation number of (1) 1; (2) 0; (3) -1; (4) 3.
- \_\_\_ 24. In a redox reaction a reducing agent will always (1) lose electrons; (2) lose protons; (3) gain electrons; (4) gain protons.
- \_\_\_ 25. The Pb in the half-reaction:  $\text{Pb} \rightleftharpoons \text{Pb}^{2+} + 2\text{e}^{-}$ . (1) gains protons; (2) loses protons; (3) is oxidized; (4) is reduced.
- \_\_\_ 26. Given the chemical cell of Zn, Zn<sup>2+</sup> (1M) and Cu<sup>2+</sup> (1M), Cu. As the reaction in this cell takes place the mass of the copper electrode (1) decreases; (2) increases; (3) remains the same.
- \_\_\_ 27. In the reaction  $\text{Zn} + \text{Cu}^{2+} \rightleftharpoons \text{Zn}^{2+} + \text{Cu}$  the oxidizing agent is (1) Zn; (2) Cu; (3) Zn<sub>2</sub>; (4) Cu<sup>2+</sup>.
- \_\_\_ 28. Given the reaction:  $2\text{NaCl} + 2\text{H}_2\text{O} \rightleftharpoons 2\text{NaOH} + \text{H}_2 + \text{Cl}_2$ . Which electronic equation correctly represents the oxidation that occurs in the above reaction? (1)  $2\text{Na} \rightleftharpoons 2\text{Na}^{1+} + 2\text{e}^{-}$ ; (2)  $2\text{Cl}^{-} \rightleftharpoons \text{Cl}_2 + 2\text{e}_1^{-}$ ; (3)  $2\text{H}^{1+} + 2\text{e}^{-} \rightleftharpoons \text{H}_2$ ; (4)  $\text{O}_2 + 2\text{e}^{-} \rightleftharpoons 2\text{O}^{2-}$ .
- \_\_\_ 29. Which half-reaction occurs at the negative electrode in an electrolytic cell in which an object is being plated with silver? (1)  $\text{Ag} + 1\text{e}^{-} \rightleftharpoons \text{Ag}^{1+}$ ; (2)  $\text{Ag} \rightleftharpoons \text{Ag}^{1+} + 1\text{e}^{-}$ ; (3)  $\text{Ag}^{1+} + 1\text{e}^{-} \rightleftharpoons \text{Ag}$ ; (4)  $\text{Ag}^{1+} \rightleftharpoons \text{Ag} + 1\text{e}^{-}$ .
- \_\_\_ 30. Which molecule-ion pair will react spontaneously at 298 °K? (1) Cl<sub>2</sub> + F<sup>1-</sup>; (2) I<sub>2</sub> +

$\text{Br}^{-}$ ; (3)  $\text{F}_2 + \text{I}^{-}$ ; (4)  $\text{Br}_2 + \text{Cl}^{-}$ .

- \_\_\_ 31. In  $\text{KClO}_3$  what is the oxidation number of the chlorine? (1) +1; (2) +5; (3) +3; (4) +7.
- \_\_\_ 32. The potential for the standard hydrogen half-cell reaction is (1) -0.41 volt; (2) -0.83 volt; (3) 0.00 volts; (4) 0.78 volt.
- \_\_\_ 33. Which half-cell reaction correctly represents reduction? (1)  $\text{Sn} \rightleftharpoons \text{Sn}^{2+} + 2\text{e}^{-}$ ; (2)  $\text{Sn}^{2+} \rightleftharpoons \text{Sn} + 2\text{e}^{-}$ ; (3)  $\text{Sn} + 2\text{e}^{-} \rightleftharpoons \text{Sn}^{2+}$ ; (4)  $\text{Sn}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Sn}$ .
- \_\_\_ 34. Given the reaction:  $\text{Cl}_2(\text{aq}) + 2\text{KBr}(\text{aq}) \rightleftharpoons 2\text{KCl} + \text{Br}_2(\text{aq})$ . Which is the oxidizing agent in the above reaction? (1)  $\text{KCl}$ ; (2)  $\text{Cl}_2$ ; (3)  $\text{KBr}$ ; (4)  $\text{Br}_2$ .
- \_\_\_ 35. The element hydrogen will have a negative oxidation number when it forms a binary compound with (1) sulfur; (2) selenium; (3) oxygen; (4) potassium.
- \_\_\_ 36. In the half-reaction  $\text{Mg} \rightleftharpoons \text{Mg}^{2+} + 2\text{e}^{-}$  the magnesium (1) gains electrons and is oxidized; (2) gains electrons and is reduced; (3) loses electrons and is oxidized; (4) loses electrons and is reduced.
- \_\_\_ 37. How many mole(s) of electrons would be required to completely reduce a 0.50 mole of  $\text{Cu}^{2+}$  ions to  $\text{Cu}$ ? (1) 1.0; (2) 2.0; (3) 0.25; (4) 0.50.
- \_\_\_ 38. Given the reaction:  $\text{Zn}(\text{s}) + \text{Cu}^{2+}(\text{aq}) \rightleftharpoons \text{Zn}^{2+}(\text{aq}) + \text{Cu}(\text{s})$ . In this cell reaction, the negative electrode is (1)  $\text{Zn}(\text{s})$ ; (2)  $\text{Cu}^{2+}(\text{aq})$ ; (3)  $\text{Zn}^{2+}(\text{aq})$ ; (4)  $\text{Cu}(\text{s})$ .
- \_\_\_ 39. How many moles of electrons are needed to reduce 1 mole of  $\text{Fe}^{3+}$  to  $\text{Fe}^{2+}$ ? (1) 1; (2) 2; (3) 3; (4) 5.
- \_\_\_ 40. Which change in oxidation number represents reduction? (1) -3 to 0; (2) -2 to -3; (3) 0 to +1; (4) +1 to +2.
- \_\_\_ 41. Which pair will react spontaneously at 298 °K? (1)  $\text{Cu} + \text{water}$ ; (2)  $\text{Ag} + \text{water}$ ; (3)  $\text{Ca} + \text{water}$ ; (4)  $\text{Au} + \text{water}$ .
- \_\_\_ 42. In  $\text{Na}_2\text{S}_2\text{O}_3$ , what is the oxidation number of the sulfur? (1) -2; (2) +2; (3) +6; (4) 0.
- \_\_\_ 43. The  $\text{Cl}_2$  in  $\text{Cl}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HClO} + \text{HCl}$  is (1) oxidized, only; (2) reduced, only; (3) both oxidized and reduced; (4) neither oxidized nor reduced.
- \_\_\_ 44. As a sodium atom is oxidized the number of protons in its nucleus (1) decreases; (2) increases; (3) remains the same.
- \_\_\_ 45. When an atom of bromine forms a bromide ion, the radius (1) decreases; (2) increases; (3) remains the same.
- \_\_\_ 46. Which metal will react with 1 molar  $\text{HCl}$ ? (1)  $\text{Au}$ ; (2)  $\text{Ag}$ ; (3)  $\text{Cu}$ ; (4)  $\text{Zn}$ .
- \_\_\_ 47. A reducing agent is a substance that (1) gains protons; (2) loses protons; (3) gains electrons; (4) loses electrons.

- \_\_\_ 48. Which element in Period 3 is the strongest oxidizing agent? (1) Na; (2) Al; (3) S; (4) Cl.
- \_\_\_ 49. In  $\text{H}_2\text{S}_2\text{O}_7$ , the oxidation number of sulfur is (1) -2; (2) +2; (3) +6; (4) +4.
- \_\_\_ 50. For the reaction,  $\text{Mg} + \text{CuO} \rightleftharpoons \text{MgO} + \text{Cu}$ , the electron equation for the oxidation that takes place is (1)  $\text{Cu}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{CuO}$ ; (2)  $\text{CuO} \rightleftharpoons \text{Cu}^{2+} + 2\text{e}^{-}$ ; (3)  $\text{Mg}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{MgO}$ ; (4)  $\text{Mg} \rightleftharpoons \text{Mg}^{2+} + 2\text{e}^{-}$ .
- \_\_\_ 51. Chlorine has an oxidation number of +5 in the compound (1)  $\text{HClO}_4$ ; (2)  $\text{HClO}_3$ ; (3)  $\text{HClO}_2$ ; (4)  $\text{HClO}$ .
- \_\_\_ 52. Which element can only have oxidation states of +1, 0, or -1? (1) Cs; (2) F; (3) H; (4) He.
- \_\_\_ 53. How many moles of electrons are required to deposit one mole of copper from a copper(II) sulfate solution? (1) 1.0; (2) 2.0; (3) .5; (4) 4.0.
- \_\_\_ 54. Which halogen is the best oxidizing agent? (1)  $\text{I}_2$ ; (2)  $\text{Br}_2$ ; (3)  $\text{Cl}_2$ ; (4)  $\text{F}_2$ .
- \_\_\_ 55. As an aluminum-nickel chemical cell approaches equilibrium the mass of the nickel electrode (1) decreases; (2) increases; (3) remains the same.
- \_\_\_ 56. Which halogen would not be expected to have a positive oxidation state when combined with oxygen? (1) F; (2) Cl; (3) Br; (4) I.
- \_\_\_ 57. In the compound  $\text{K}_2\text{Cr}_2\text{O}_7$  what is the algebraic sum of the oxidation numbers of all the atoms? (1) 0; (2) -5; (3) +9; (4) -14.
- \_\_\_ 58. As the number of particles oxidized during a chemical reaction increases the number of particles reduced (1) decreases; (2) increases; (3) remains the same.
- \_\_\_ 59. Oxygen has an oxidation number of zero in (1)  $\text{H}_2\text{O}_2$ ; (2)  $\text{OF}_2$ ; (3)  $\text{H}_2\text{O}$ ; (4)  $\text{O}_2$ .
- \_\_\_ 60. Which occurs when calcium chloride is fused during electrolysis? (1) Calcium ions are reduced.; (2) Calcium atoms are reduced.; (3) Chloride ions are reduced.; (4) Chloride atoms are reduced..
- \_\_\_ 61. How many moles of electrons would be required to completely reduce 1.5 moles of  $\text{Al}^{3+}$  to Al? (1) 0.50; (2) 1.5; (3) 3.0; (4) 4.5.
- \_\_\_ 62. In the electrolytic process used to plate copper onto a material the material is the (1) cathode which is positive; (2) cathode which is negative; (3) anode which is positive; (4) anode which is negative.
- \_\_\_ 63. In which compound does hydrogen have a negative oxidation number? (1)  $\text{CaH}_2$ ; (2)  $\text{H}_3\text{PO}_4$ ; (3)  $\text{NaOH}$ ; (4)  $\text{NH}_3$ .
- \_\_\_ 64. In a chemical cell the function of the salt bridge is to provide a path for the migration of (1) electrons; (2) neutrons; (3) molecules; (4) ions.
- \_\_\_ 65. Given the reaction:  $\text{Cl}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HClO} + \text{HCl}$ . The oxygen is (1) oxidized only; (2) reduced only; (3) both oxidized and reduced; (4) neither oxidized nor

reduced.

- \_\_\_ 66. What are the products of the electrolysis of one mole of water at S.T.P.? (1) 11.2 liters of oxygen and 22.4 liters of hydrogen; (2) 22.4 liters of oxygen and 22.4 liters of hydrogen; (3) 16 grams of oxygen and 8 grams of hydrogen; (4) 32 grams of oxygen and 2 grams of hydrogen.
- \_\_\_ 67. Which halogen would not be expected to have a positive oxidation state when combined with oxygen? (1) F; (2) Cl; (3) Br; (4) I.
- \_\_\_ 68. When a reaction has a positive voltage the delta G (free energy) is (1) positive; (2) negative; (3) zero..
- \_\_\_ 69. In  $\text{Na}_2\text{HPO}_4$  the oxidation number of phosphorus is (1) +1; (2) +5; (3) +3; (4) +7.
- \_\_\_ 70. Which will occur when Sr is oxidized? (1) It will form an isotope.; (2) It will attain a positive oxidation number.; (3) It will become a negative ion.; (4) It will become radioactive..
- \_\_\_ 71. Which metal will not react with a dilute HCl solution? (1) Al; (2) Ag; (3) Mg; (4) Zn.
- \_\_\_ 72. A chemical cell differs from an electrolytic cell in that a chemical cell (1) produces an electric current by means of a chemical reaction; (2) produces a chemical reaction by means of an electric current; (3) has oxidation and reduction occurring at the electrodes; (4) has ions migrating between the electrodes.
- \_\_\_ 73. Given the reaction:  $2\text{KClO}_3 = 2\text{KCl} + 3\text{O}_2$ . The oxidation number of chlorine (1) decreases; (2) increases; (3) remains the same.
- \_\_\_ 74. When two chlorine atoms combine to form a molecule of chlorine the oxidation number of the chlorine (1) decreases; (2) increases; (3) remains the same.
- \_\_\_ 75. If redox reactions are forced to occur by use of an externally applied electric current the procedure is called (1) neutralization; (2) esterification; (3) electrolysis; (4) hydrolysis.
- \_\_\_ 76. In the reaction  $3\text{Cu} + 2\text{NO}_3^{1-} + 8\text{H}^{1+} \text{---->} 3\text{Cu}^{2+} + 2\text{NO}_2 + 4\text{H}_2\text{O}$  the substance oxidized is (1)  $\text{H}^{1+}$ ; (2)  $\text{O}^{2-}$ ; (3)  $\text{N}^{2+}$ ; (4) Cu.
- \_\_\_ 77. When  $\text{Fe}^{3+}$  is reduced to  $\text{Fe}^{2+}$  the  $\text{Fe}^{3+}$  ion (1) gains 1 proton; (2) loses 1 proton; (3) gains 1 electron; (4) loses 1 electron.
- \_\_\_ 78. The reaction  $\text{BaCO}_3 \text{---->} \text{BaO} + \text{CO}_2$  involves (1) oxidation only; (2) reduction only; (3) both oxidation and reduction; (4) neither oxidation nor reduction.
- \_\_\_ 79. In the reaction  $\text{Al} + \text{Cr}^{3+} \text{---->} \text{Al}^{3+} + \text{Cr}$ , the reducing agent is (1) Al; (2)  $\text{Cr}_3^+$ ; (3)  $\text{Al}^{3+}$ ; (4) Cr.
- \_\_\_ 80. In the reaction  $\text{MnO}_2 + 4\text{HCl} \text{---->} \text{MnCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2$ , the oxidation number of the manganese (1) decreases; (2) increases; (3) remains the same.
- \_\_\_ 81. Which ion will react spontaneously with silver (Ag)? (1)  $\text{Mn}^{2+}$ ; (2)  $\text{Mg}^{2+}$ ; (3)  $\text{Al}^{3+}$ ; (4)  $\text{Au}^{3+}$ .

- \_\_\_ 82. In the chemical cell reaction  $2\text{Al} + 3\text{Ni}^{2+} \rightarrow 2\text{Al}^{3+} + 3\text{Ni}$ , which species is reduced?  
 (1) Al; (2)  $\text{Ni}^{2+}$ ; (3)  $\text{Al}^{3+}$ ; (4) Ni.
- \_\_\_ 83. Given the reaction  $2\text{Cr}(\text{s}) + 3\text{Cu}^{2+} \rightarrow 3\text{Cu}(\text{s}) + 2\text{Cr}^{3+}$ . The cell potential ( $E_0$ ) for the overall reaction is (1) +0.40 V; (2) -0.40 V; (3) +1.08 V; (4) -1.08 V.
- \_\_\_ 84. Which molecule is most easily reduced? (1)  $\text{Br}_2$ ; (2)  $\text{Cl}_2$ ; (3)  $\text{F}_2$ ; (4)  $\text{I}_2$ .
- \_\_\_ 85. What is the oxidation number of iodine in  $\text{KIO}_4$ ? (1) +1; (2) -1; (3) +7; (4) -7.
- \_\_\_ 86. A redox reaction always involves (1) a change in oxidation number; (2) a change of phase; (3) the transfer of protons; (4) the formation of ions.
- \_\_\_ 87. In the reaction  $\text{Cu}(\text{s}) + 2\text{Ag}^{1+}(\text{aq}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{Ag}(\text{s})$ , the oxidizing agent is (1) Cu; (2)  $\text{Ag}^{1+}$ ; (3)  $\text{Cu}^{2+}$ ; (4) Ag.
- \_\_\_ 88. Which of the following elements will replace Pb from  $\text{Pb}(\text{NO}_3)_2(\text{aq})$ ? (1)  $\text{Mg}(\text{s})$ ; (2)  $\text{Au}(\text{s})$ ; (3)  $\text{Cu}(\text{s})$ ; (4)  $\text{Ag}(\text{s})$ .
- \_\_\_ 89. In an electrolytic cell,  $\text{Cu}^{2+}$  ions will (1) migrate to the positive electrode; (2) migrate to the negative electrode; (3) be reduced at the positive electrode; (4) be oxidized at the negative electrode.
- \_\_\_ 90. Given the reaction;  $\_\_\text{Cu}(\text{s}) + \_\_\text{HNO}_3(\text{aq}) \rightarrow \_\_\text{Cu}(\text{NO}_3)_2(\text{aq}) + \_\_\text{NO}_2(\text{g}) + \_\_\text{H}_2\text{O}(\text{l})$  When the reaction is completely balanced using smallest whole numbers the coefficient of  $\text{HNO}_3(\text{aq})$  will be (1) 1; (2) 2; (3) 3; (4) 4.
- \_\_\_ 91. Which metal is not obtained from its ore by electrolytic reduction? (1) Na; (2) Li; (3) Au; (4) K.
- \_\_\_ 92. Which metal will undergo the greatest degree of corrosion if left unprotected from its surroundings? (1) nickel; (2) zinc; (3) chromium; (4) iron.
- \_\_\_ 93. Given the reaction;  $\text{Sn}^{2+}(\text{aq}) + 2\text{Fe}^{3+}(\text{aq}) = \text{Sn}^{4+}(\text{aq}) + 2\text{Fe}^{2+}(\text{aq})$  The total number of moles of electrons lost by 1 mole of  $\text{Sn}^{2+}$  is (1) 1; (2) 2; (3) 3; (4) 4.
- \_\_\_ 94. What is the oxidation number of sulfur in  $\text{H}_2\text{SO}_4$ ? (1) 0; (2) -2; (3) +6; (4) +4.
- \_\_\_ 95. In the reaction  $4\text{HCl} + \text{MnO}_2 \rightarrow \text{MnCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2$ , the manganese is (1) reduced and the oxidation number changes from +4 to +2; (2) oxidized and the oxidation number changes from +4 to +2; (3) reduced and the oxidation number changes from +2 to +4; (4) oxidized and the oxidation number changes from +2 to +4.
- \_\_\_ 96. In the reaction  $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{Na}^{1+} + 2\text{OH}^{1-} + \text{H}_2$ , the substance oxidized is (1)  $\text{H}_2$ ; (2)  $\text{H}^{1+}$  ion; (3) Na; (4)  $\text{Na}^{1+}$  ion.
- \_\_\_ 97. Given the reaction;  $3\text{Cu} + 8\text{HNO}_3 \rightarrow 3\text{Cu}(\text{NO}_3)_2 + 2\text{NO} + 4\text{H}_2\text{O}$  The reducing agent is (1) Cu; (2)  $\text{N}^{5+}$ ; (3)  $\text{Cu}^{2+}$ ; (4)  $\text{N}^{2+}$ .
- \_\_\_ 98. How many moles of electrons are needed to reduce one mole of  $\text{Cu}^{2+}$  to  $\text{Cu}^{1+}$ ? (1) 1; (2) 2; (3) 3; (4) 4.

- \_\_\_ 99. What is the voltage for a chemical cell that has reached equilibrium? (1) 1; (2) greater than 1; (3) between 0 and 1; (4) 0.
- \_\_\_ 100. Which atom-ion pair will react spontaneously under standard conditions? (1) Mg + Li<sup>1+</sup> (aq); (2) Mg + Ba<sup>2+</sup> (aq); (3) Mg + Ag<sup>1+</sup> (aq); (4) Mg + Sr<sup>2+</sup> (aq).
- \_\_\_ 101. During the electrolysis of fused KBr, which reaction occurs at the positive electrode? (1) Br<sup>1-</sup> ions are oxidized; (2) Br<sup>1-</sup> ions are reduced; (3) K<sup>1+</sup> ions are reduced; (4) K<sup>1+</sup> ions are oxidized.
- \_\_\_ 102. Which oxide will react with carbon (coke) to produce a free metal? (1) MgO; (2) ZnO; (3) Na<sub>2</sub>O; (4) Li<sub>2</sub>O.
- \_\_\_ 103. Which represents the positive electrode of a nickel-cadmium battery? (1) Ni(OH)<sub>3</sub>; (2) Cd; (3) Ni; (4) Cd(OH)<sub>2</sub>.
- \_\_\_ 104. Which metal is usually obtained by electrolytic reduction? (1) iron; (2) tin; (3) lead; (4) potassium.
- \_\_\_ 105. Oxygen has a positive oxidation number in the compound (1) H<sub>2</sub>O; (2) H<sub>2</sub>O<sub>2</sub>; (3) OF<sub>2</sub>; (4) IO<sub>2</sub>.
- \_\_\_ 106. In a chemical cell composed of two half-cells, ions are allowed to flow from one half-cell to another by means of (1) electrodes; (2) an external conductor; (3) a voltmeter; (4) a salt bridge.
- \_\_\_ 107. Which occurs in the half reaction Na(s) ---> Na<sup>1+</sup> + e<sup>1-</sup>? (1) Na(s) is reduced.; (2) Na(s) is oxidized.; (3) Na(s) gains electrons.; (4) Na<sup>1+</sup> is oxidized..
- \_\_\_ 108. What is the oxidizing agent in the reaction Zn + 2Ag<sup>1+</sup> ---> Zn<sup>2+</sup> + 2Ag (1) Zn; (2) Ag; (3) Zn<sup>2+</sup>; (4) Ag<sup>1+</sup>.
- \_\_\_ 109. Which is a redox reaction? (1) CaCO<sub>3</sub> ----> CaO + CO<sub>2</sub>; (2) NaOH + HCl ----> NaCl + H<sub>2</sub>O; (3) 2NH<sub>4</sub>Cl + Ca(OH)<sub>2</sub> ----> 2NH<sub>3</sub> + 2H<sub>2</sub>O + CaCl<sub>2</sub>; (4) 2H<sub>2</sub>O ----> 2H<sub>2</sub> + O<sub>2</sub>.
- \_\_\_ 110. Given the unbalanced equation: Ca + Al<sup>3+</sup> ---> Ca<sup>2+</sup> + Al. When the equation is completely balanced with the smallest whole-number coefficients, what is the coefficient of Ca? (1) 1; (2) 2; (3) 3; (4) 4.
- \_\_\_ 111. In order for a redox reaction to be spontaneous the potential voltage for the overall reaction must be (1) greater than zero; (2) zero; (3) between zero and -1; (4) less than -1.
- \_\_\_ 112. 2Au<sup>3+</sup> (aq) + 3Ni --> 2Au + 3Ni<sup>2+</sup> (aq) The cell potential (E<sub>o</sub>) for the above overall reaction is (1) 3.75 volts; (2) 2.25 volts; (3) 1.75 volts; (4) 1.25 volts.
- \_\_\_ 113. Which half-reaction occurs at the cathode in an electrolytic cell in which an object is being plated with copper? (1) Cu(s) ---> Cu<sup>2+</sup> (aq) + 2e<sup>1-</sup>; (2) Cu(s) + 2e<sup>1-</sup> ---> Cu<sup>2+</sup> (aq); (3) Cu<sup>2+</sup> (aq) ---> Cu(s) + 2e<sup>1-</sup>; (4) Cu<sup>2+</sup> (aq) + 2e<sup>1-</sup> ---> Cu(s).
- \_\_\_ 114. Which will oxidize Zn(s) to Zn<sup>2+</sup> but will not oxidize Pb(s) to Pb<sup>2+</sup>? (1) Al<sup>3+</sup>; (2) Au<sup>3+</sup>; (3) Co<sup>2+</sup>; (4) Mg<sup>2+</sup>.

- \_\_\_ 115. Which halogen will react spontaneously with Au(s) to produce Au<sup>3+</sup>? (1) Br<sub>2</sub>; (2) F<sub>2</sub>; (3) I<sub>2</sub>; (4) Cl<sub>2</sub>.
- \_\_\_ 116. Which type of chemical reaction is the corrosion of iron? (1) reduction-oxidation; (2) substitution; (3) polymerization; (4) decomposition.
- \_\_\_ 117. Which of the following metals forms a self protective coating when exposed to air and moisture? (1) zinc; (2) calcium; (3) iron; (4) sodium.