Reduction Potentials at 25°C			E° (V)
$F_2(g) + 2\ e^-$	→	$2\ F^-(aq)$	2.87
$H_2O_2(aq) + 2\ H^+(aq) + 2\ e^-$	→	$2\ H_2O(l)$	1.78
$MnO_4^-(aq) + 8\ H^+(aq) + 5\ e^-$	→	$Mn^{2+}(aq) + 4\ H_2O(l)$	1.51
$Cl_2(g) + 2\ e^-$	→	$2\ Cl^-(aq)$	1.36
$Cr_2O_7^{2-}(aq) + 14\ H^+(aq) + 6\ e^-$	→	$2\ Cr^{3+}(aq) + 7\ H_2O(l)$	1.33
$O_2(g) + 4\ H^+(aq) + 4\ e^-$	→	$2\ H_2O(l)$	1.23
$Br_2(l) + 2\ e^-$	→	$2\ Br^-(aq)$	1.09
$Ag^+(aq) + e^-$	→	$Ag(s)$	0.80
$Fe^{3+}(aq) + e^-$	→	$Fe^{2+}(aq)$	0.77
$O_2(g) + 2\ H^+(aq) + 2\ e^-$	→	$H_2O_2(aq)$	0.70
$I_2(s) + 2\ e^-$	→	$2\ I^-(aq)$	0.54
$O_2(g) + 2\ H_2O(l) + 4\ e^-$	→	$4\ OH^-(aq)$	0.40
$Cu^{2+}(aq) + 2\ e^-$	→	$Cu(s)$	0.34
$Sn^{4+}(aq) + 2\ e^-$	→	$Sn^{2+}(aq)$	0.15
$2\ H^+(aq) + 2\ e^-$	→	$H_2(g)$	0.00
$Pb^{2+}(aq) + 2\ e^-$	→	$Pb(s)$	–0.13
$Ni^{2+}(aq) + 2\ e^-$	→	$Ni(s)$	–0.26
$Cd^{2+}(aq) + 2\ e^-$	→	$Cd(s)$	–0.40
$Fe^{2+}(aq) + 2\ e^-$	→	$Fe(s)$	–0.45
$Zn^{2+}(aq) + 2\ e^-$	→	$Zn(s)$	–0.76
$2\ H_2O(l) + 2\ e^-$	→	$H_2(g) + 2\ OH^-(aq)$	-0.83
$Al^{3+}(aq) + 3\ e^-$	→	$Al(s)$	–1.66
$Mg^{2+}(aq) + 2\ e^-$	→	$Mg(s)$	–2.37
$Na^+(aq) + e^-$	→	$Na(s)$	–2.71
$Li^+(aq) + e^-$	→	$Li(s)$	–3.04

1. Which of the substances below is the strongest oxidizing agent, and which is the strongest reducing agent?
   Cd^{2+}(aq)
   Cu^{2+}(aq)
   Mg^{2+}(aq)
   Cl^-(aq)
   I^-(aq)

2. A half-cell consisting of a solution of Pb^{2+}(aq, 1 M) and a Pb(s) electrode is connected to a half-cell consisting of a solution of Zn^{2+}(aq, 1 M) and a Zn(s) electrode to form a galvanic cell.
   a) Which is anode? Which is cathode?
   b) What is oxidized? What is reduced?
   c) Which electrode is the positive electrode? Which is the negative electrode?
   d) In which direction do the electrons flow?
   e) What is the standard cell potential?

3. Solid copper will spontaneously reduce which of the following?

   a) Fe^{2+} and Ag^+
   b) Fe^{2+}
   c) Ag^+
   d) Al^{3+}
   e) Fe^{2+} and Al^{3+}

4. Which of the following is the best reducing agent under standard conditions at 25°C?

   a) Ni^{2+} (aq)
   b) Ag (s)
   c) Fe^{2+} (aq)
   d) Zn (s)
   e) Al^{3+} (aq)

5. Which of the following is the best oxidizing agent under standard conditions at 25°C?

   a) Ni^{2+} (aq)
   b) Ag (s)
   c) Fe^{2+} (aq)
   d) Zn (s)
   e) Al^{3+} (aq)

6. A galvanic cell is constructed using a Ni(s) | Ni^{2+}(aq) half-cell and a Ag(s) | Ag^+(aq) half-cell. The two solutions are connected with a salt bridge, and the Ni(s) electrode is connected to the Ag(s) electrode with a wire. Which statement below is correct?
   a) The electrons move through the wire toward the nickel electrode, which is the anode.
   b) The electrons move through the wire towards the nickel electrode, which is the cathode.
   c) The electrons move through the wire towards the silver electrode, which is the anode.
   d) The electrons move through the wire towards the silver electrode, which is the cathode.
   e) Electrons will not move through the wire, because this is not a spontaneous reaction.

7. A half-cell consisting of a solution of Pb^{2+}(aq, 1 M) and a Pb(s) electrode is connected to a half-cell consisting of a solution of Zn^{2+}(aq, 1 M) and a Zn(s) electrode to form a galvanic cell. Which of the statements below is/are *true*?

I. Pb^{2+} is reduced at the cathode.
II. Zn^{2+} is reduced at the negative terminal.
III. Pb is oxidized at the anode.
IV. Zn is oxidized at the negative terminal

a) I and III
b) II and IV
c) I and IV
d) II and III
e) III only

8. Suppose that a galvanic cell is made by attaching a standard Cu/Cu^{2+} half-cell to a standard Pb/Pb^{2+} half-cell. Which of the following statements does <u>not</u> correctly describe this galvanic cell?

a) The Pb/Pb^{2+} half-cell is the anode.
b) The electrons travel through the external circuit from the lead electrode to the copper electrode.
c) The copper electrode is assigned a positive sign.
d) Cations move through the solution from the lead electrode to the copper electrode.
e) The mass of the copper electrode decreases as the reaction proceeds.

9. What is the cell potential of the following cell under standard conditions at 25°C?

$$Al(s) \mid Al^{3+}(1\ M) \parallel Zn^{2+}(1\ M) \mid Zn(s)$$

a) 3.46 V
b) 0.45 V
c) 1.04 V
d) 0.90 V
e) 2.42 V

10. A copper/cobalt voltaic cell can be constructed by attaching a standard Cu/Cu^{2+} half-cell to a standard Co/Co^{2+} half cell. The overall cell reaction for this voltaic cell is:

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

This voltaic cell has a standard potential at 25°C of 0.62 V. What is the standard reduction potential for Co^{2+} (aq) at 25°C?

a) 0.96 V
b) -0.96 V
c) -0.28 V
d) 0.28 V
e) 0.31 V

11. What is the oxidation state of bromine in potassium bromate, $KBrO_3$?

a) -1
b) +1
c) +5
d) +6
e) +7

12. Balance the reaction below, which occurs in *acidic* solution. When this equation is balanced using the smallest whole-number coefficients, what is the coefficient on H_2O, and on which side of the equation does H_2O appear?

$$H_2S + BrO_3^- \rightarrow S + Br_2$$

a) 3, on the product side
*b) 6, on the product side
c) 9, on the product side
d) 4, on the reactant side
e) 5, on the reactant side

13. Balance the following redox reaction which occurs in basic solution. When this equation is properly balanced, using the smallest whole-number coefficients, what is the coefficient on water, and on which side of the equation does water appear?

$$Cr(OH)_3(s) + ClO^-(aq) \rightarrow CrO_4^{2-}(aq) + Cl_2(g)$$

a) 1, on the product side
b) 3, on the product side
c) 2, on the reactant side
d) 2, on the product side
e) 4, on the product side

Answers

1. ox agent: Cu^{2+}
   red agent: I^-
3. C
4. D
5. A
6. D
7. C
8. E
9. D
10. C
11. C
12. B
13. D