

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

- Which of the substances below is the strongest oxidizing agent, and which is the strongest reducing agent?
  - $Cd^{2+}(aq)$
  - $Cu^{2+}(aq)$
  - $Mg^{2+}(aq)$
  - $Cl^-(aq)$
  - $I^-(aq)$
- 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 is anode? Which is cathode?
  - What is oxidized? What is reduced?
  - Which electrode is the positive electrode? Which is the negative electrode?
  - In which direction do the electrons flow?
  - What is the standard cell potential?
- Solid copper will spontaneously reduce which of the following?
  - $Fe^{2+}$  and  $Ag^+$
  - $Fe^{2+}$
  - $Ag^+$
  - $Al^{3+}$
  - $Fe^{2+}$  and  $Al^{3+}$
- Which of the following is the best reducing agent under standard conditions at 25°C?
  - $Ni^{2+}(aq)$
  - $Ag(s)$
  - $Fe^{2+}(aq)$
  - $Zn(s)$
  - $Al^{3+}(aq)$
- Which of the following is the best oxidizing agent under standard conditions at 25°C?
  - $Ni^{2+}(aq)$
  - $Ag(s)$
  - $Fe^{2+}(aq)$
  - $Zn(s)$
  - $Al^{3+}(aq)$
- 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?
  - The electrons move through the wire toward the nickel electrode, which is the anode.
  - The electrons move through the wire towards the nickel electrode, which is the cathode.
  - The electrons move through the wire towards the silver electrode, which is the anode.
  - The electrons move through the wire towards the silver electrode, which is the cathode.
  - Electrons will not move through the wire, because this is not a spontaneous reaction.

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

- I.  $\text{Pb}^{2+}$  is reduced at the cathode.
- II.  $\text{Zn}^{2+}$  is reduced at the negative terminal.
- III.  $\text{Pb}$  is oxidized at the anode.
- IV.  $\text{Zn}$  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  $\text{Cu}/\text{Cu}^{2+}$  half-cell to a standard  $\text{Pb}/\text{Pb}^{2+}$  half-cell. Which of the following statements does not correctly describe this galvanic cell?

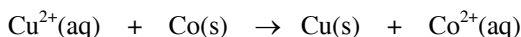
- a) The  $\text{Pb}/\text{Pb}^{2+}$  half-cell is the anode.
- b) The electrons travel through the external circuit from the lead electrode to the copper electrode.
- c) The copper electrode is assigned a positive sign.
- d) Cations move through the solution from the lead electrode to the copper electrode.
- 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  $25^\circ\text{C}$ ?



- 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  $\text{Cu}/\text{Cu}^{2+}$  half-cell to a standard  $\text{Co}/\text{Co}^{2+}$  half cell. The overall cell reaction for this voltaic cell is:



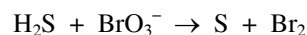
This voltaic cell has a standard potential at  $25^\circ\text{C}$  of 0.62 V. What is the standard reduction potential for  $\text{Co}^{2+}(\text{aq})$  at  $25^\circ\text{C}$ ?

- 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,  $\text{KBrO}_3$ ?

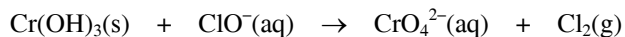
- a) -1
- b) +1
- c) +5
- d) +6
- e) +7

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  $\text{H}_2\text{O}$ , and on which side of the equation does  $\text{H}_2\text{O}$  appear?



- 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?



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