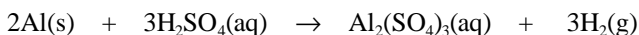


1. What is the oxidation state of bromine in potassium bromate,  $\text{KBrO}_3$ ?

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

2. Which element is reduced in the following reaction?

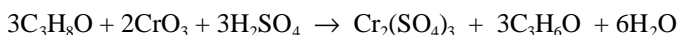


- a) aluminum
- b) hydrogen
- c) sulfur
- d) oxygen
- e) none of these; this is not a redox reaction

3. In which of the following reactions does the oxidation number of chlorine remain unchanged?

- a)  $\text{PbCl}_4 \rightarrow \text{PbCl}_2 + \text{Cl}_2$
- b)  $\text{MnO}_2 + 4\text{HCl} \rightarrow \text{MnCl}_2 + \text{Cl}_2 + 2\text{H}_2\text{O}$
- c)  $\text{KClO}_3 + \text{NO}_2 \rightarrow \text{KNO}_3 + \text{ClO}_2$
- d)  $\text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaClO} + \text{NaCl} + \text{H}_2\text{O}$
- e)  $3\text{AgCl} + \text{Na}_3\text{PO}_4 \rightarrow \text{Ag}_3\text{PO}_4 + 3\text{NaCl}$

4. What is the oxidizing agent in the reaction below?



- a)  $\text{C}_3\text{H}_8\text{O}$
- b)  $\text{CrO}_3$
- c)  $\text{H}_2\text{SO}_4$
- d)  $\text{Cr}_2\text{(SO}_4\text{)}_3$
- e)  $\text{C}_3\text{H}_6\text{O}$

5. 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

6. Balance the following redox reaction which occurs in *acidic* 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) 4, on the product side
- b) 8 on the product side
- c) 20 on the product side
- d) 4 on the reactant side
- e) 6 on the reactant side

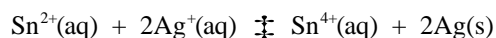
7. Which of the following is the best oxidizing agent under standard conditions at  $25^\circ\text{C}$ ?

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

8. Which of the following is the best reducing agent under standard conditions at  $25^\circ\text{C}$ ?

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

9. If the following redox reaction is used for a voltaic cell under standard conditions at  $25^\circ\text{C}$ , which of the following reactions occurs at the anode?

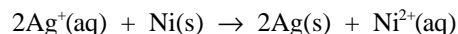


- a)  $\text{Sn}^{2+}\text{(aq)} \rightleftharpoons \text{Sn}^{4+}\text{(aq)} + 2\text{e}^-$
- b)  $2\text{Ag}^+\text{(aq)} + 2\text{e}^- \rightleftharpoons 2\text{Ag(s)}$
- c)  $\text{Sn}^{4+}\text{(aq)} + 2\text{e}^- \rightleftharpoons \text{Sn}^{2+}\text{(aq)}$
- d)  $2\text{Ag(s)} \rightleftharpoons 2\text{Ag}^+\text{(aq)} + 2\text{e}^-$

10. Suppose that a voltaic 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 voltaic cell?

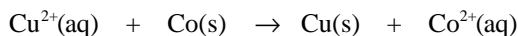
- a) The  $\text{Pb}/\text{Pb}^{2+}$  half-cell is the anode.
- b) The electrons travel through the external circuit from the lead electrode to the copper electrode.
- c) The copper electrode is assigned a positive sign.
- d) Cations move through the solution from the lead electrode to the copper electrode.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

11. What is the cell potential for the following voltaic cell at standard conditions and  $25^\circ\text{C}$ ?



- a) 0.54 V
- b) 1.34 V
- c) 1.86 V
- d) 1.06 V
- e) 0.93 V

12. 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
13. A concentration cell can be prepared using a half cell consisting of a Cu(s) electrode in a 0.30 M solution of  $\text{Cu}^{2+}(\text{aq})$  and a half cell consisting of a Cu(s) electrode in a 0.10 M solution of  $\text{Cu}^{2+}(\text{aq})$ . What is the cell potential at 25°C and which electrode is the cathode?
- a) 0.014 V, Cu(s) electrode in the 0.30 M solution of  $\text{Cu}^{2+}(\text{aq})$   
b) 0.028 V, Cu(s) electrode in the 0.30 M solution of  $\text{Cu}^{2+}(\text{aq})$   
c) -0.014 V, Cu(s) electrode in the 0.10 M solution of  $\text{Cu}^{2+}(\text{aq})$   
d) -0.028 V, Cu(s) electrode in the 0.10 M solution of  $\text{Cu}^{2+}(\text{aq})$   
e) 0.014 V, Cu(s) electrode in the 0.10 M solution of  $\text{Cu}^{2+}(\text{aq})$
14. For a voltaic cell to spontaneously produce a voltage under standard conditions, then
- a)  $\Delta G^\circ_{\text{cell}} < 0$   
b)  $E^\circ_{\text{cell}} > 0$   
c)  $\Delta S_{\text{univ}} > 0$   
d) all of the above  
e) none of the above
15. Consider the following voltaic cell:
- $$2 \text{Al}(\text{s}) + 3 \text{Zn}^{2+}(\text{aq}) \rightarrow 2 \text{Al}^{3+}(\text{aq}) + 3 \text{Zn}(\text{s})$$
- Under standard conditions at 25°C, how many moles of electrons are transferred in the reaction?
- a) 1  
b) 2  
c) 3  
d) 5  
e) 6
16. A half-cell consisting of a solution of  $\text{Pb}^{2+}(\text{aq}, 1 \text{ M})$  and a Pb(s) electrode is connected to a half-cell consisting of a solution of  $\text{Zn}^{2+}(\text{aq}, 1 \text{ M})$  and a Zn(s) electrode to form a voltaic 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. 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
17. How many grams of solid nickel will be obtained when an aqueous solution of nickel(II) nitrate,  $\text{Ni}(\text{NO}_3)_2$ , is electrolyzed for 30 minutes with a constant current of 5.00 A?
- a) 5.48 g Ni  
b) 0.00318 g Ni  
c) 11.0 g Ni  
d) 0.00159 g Ni  
e) 2.74 g Ni
18. Consider a voltaic cell that uses the reaction
- $$\text{Cu}(\text{s}) + 2\text{Fe}^{3+}(\text{aq}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{Fe}^{2+}(\text{aq})$$
- What is the potential of the cell at 25°C, given the following ion concentrations?
- $[\text{Fe}^{3+}] = 0.80 \text{ M}$   
 $[\text{Cu}^{2+}] = 0.010 \text{ M}$   
 $[\text{Fe}^{2+}] = 0.010 \text{ M}$
- a) 0.26 V  
b) 0.77 V  
c) 0.55 V  
d) 0.60 V  
e) 0.66 V
19. What substances are produced at the anode and cathode when an aqueous solution of NaBr is electrolyzed? (Assume that overvoltage can be neglected.)
- a)  $\text{H}_2(\text{g})$  is produced at the anode and  $\text{Br}_2(\text{l})$  is produced at the cathode.  
b)  $\text{O}_2(\text{g})$  is produced at the anode and Na(s) is produced at the cathode.  
c)  $\text{O}_2(\text{g})$  is produced at the anode and  $\text{H}_2(\text{g})$  is produced at the cathode.  
d)  $\text{Br}_2(\text{l})$  is produced at the anode and Na(s) is produced at the cathode.  
e)  $\text{Br}_2(\text{l})$  is produced at the anode and  $\text{H}_2(\text{g})$  is produced at the cathode.
20. How long would it take (in minutes) to plate out 5.00 g of Cu by the electrolysis of an aqueous solution of  $\text{CuSO}_4$  using a current of 10.0 A?
- a) 12.7 min  
b) 25.3 min  
c) 6.33 min  
d) 50.6 min  
e) 2530 min

### Answers

- |      |       |       |       |
|------|-------|-------|-------|
| 1. c | 6. b  | 11. d | 16. c |
| 2. b | 7. a  | 12. c | 17. e |
| 3. e | 8. d  | 13. a | 18. d |
| 4. b | 9. a  | 14. d | 19. e |
| 5. d | 10. e | 15. e | 20. b |