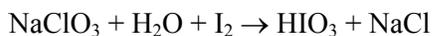


## General Chemistry II Exam 4 Practice Problems

1. In which of the following is the oxidation number of the underlined element given **incorrectly**?  
oxidation number

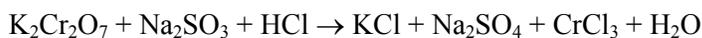
- a.  $K_2\text{Cr}_2O_7$  +6
- b.  $Na\text{Al}(\text{OH})_4$  +3
- c.  $\text{HIO}_4$  +5
- d.  $(\text{NH}_4)_2\text{SO}_4$  +6
- e.  $\text{NaHSO}_3$  +4

2. What is the coefficient of NaCl in the balanced formula unit equation?



- a. 1
- b. 2
- c. 3
- d. 4
- e. 5

3. Balance the following equation. How many HCl are there on the left side of the balanced equation?



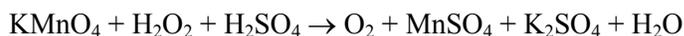
- a. 1
- b. 2
- c. 3
- d. 4
- e. 8

4. Balance this equation for a reaction in basic solution. What is the coefficient of  $\text{H}_2\text{O}$ ?



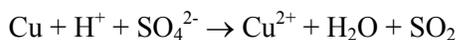
- a. 8
- b. 2
- c. 3
- d. 4
- e. 6

5. Balance the following formula unit equation. What is the sum of **all** of the coefficients?



- a. 22
- b. 24
- c. 26
- d. 28
- e. 30

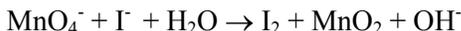
6. Balance the following equation. What is the sum of all coefficients?



- a. 9
- b. 10
- c. 11

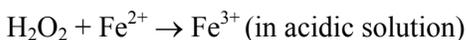
- d. 12
- e. 13

7. Balance the following net ionic equation. What is the sum of the coefficients?



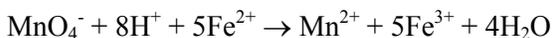
- a. 21
- b. 23
- c. 25
- d. 27
- e. 29

8. Balance the following net ionic equation. Use  $\text{H}^+$  rather than  $\text{H}_3\text{O}^+$ . What is the sum of the coefficients?



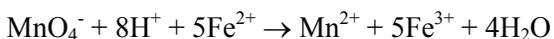
- a. 13
- b. 15
- c. 7
- d. 9
- e. 11

9. What volume of 0.0100 M  $\text{KMnO}_4$  solution is required to oxidize 42.5 mL of 0.0100 M  $\text{FeSO}_4$  sulfuric acid solution?



- a. 16.0 mL
- b. 8.5 mL
- c. 21.3 mL
- d. 80.0 mL
- e. 31.9 mL

10. What is the molarity of a solution of  $\text{FeSO}_4$  if 25.06 mL of it reacts with 38.19 mL of 0.1214 M  $\text{KMnO}_4$ ?



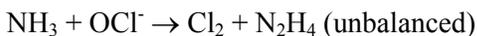
- a. 0.1854 M
- b. 0.3992 M
- c. 0.07985 M
- d. 0.4267 M
- e. 0.9250 M

11. What volume of 0.1084 M  $(\text{COOH})_2$  solution would be required to react with 0.1268 grams of  $\text{KMnO}_4$ ?



- a. 18.50 mL
- b. 37.02 mL
- c. 55.51 mL
- d. 24.02 mL
- e. 66.61 mL

12. When household ammonia is mixed with bleach,  $\text{NaOCl}$ , toxic chlorine gas and hydrazine,  $\text{N}_2\text{H}_4$  is produced. What volume of 0.75 M  $\text{NH}_3$  would react with 100 mL of 0.35 M  $\text{NaOCl}$ ?



- a. 23.5 mL

- b. 100 mL  
c. 94 mL  
d. 26 mL  
e. 47 mL
13. A 50.0-mL sample of  $\text{K}_2\text{Cr}_2\text{O}_7$  solution oxidizes 1.500 g of  $\text{Na}_2\text{SO}_3$  to  $\text{Na}_2\text{SO}_4$ .  $\text{Cr}_2(\text{SO}_4)_3$  is also produced. What is the molarity of the  $\text{K}_2\text{Cr}_2\text{O}_7$  solution?
- a. 0.0794 M  
b. 0.476 M  
c. 2.96 M  
d. 0.0952 M  
e. 0.0158 M
14. In **any** electrochemical cell, the anode is **always** .
- a. the positive electrode  
b. the negative electrode  
c. the electrode at which some species gains electrons  
d. the electrode at which some species loses electrons  
e. the electrode at which reduction occurs
15. During the electrolysis of molten sodium bromide, sodium ions move .
- a. to the anode, which is positively charged  
b. to the anode, which is negatively charged  
c. to the cathode, which is positively charged  
d. to the cathode, which is negatively charged  
e. through the wire to the battery
16. The electrolysis of an aqueous sodium chloride solution using inert electrodes produces gaseous chlorine at one electrode. At the other electrode gaseous hydrogen is produced, and the solution becomes basic around the electrode. Which of the following is the equation for the cathode half-reaction in this electrolytic cell?
- a.  $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$   
b.  $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$   
c.  $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$   
d.  $\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2\text{e}^-$   
e. none of these
17. How many coulombs of charge pass through a cell if 2.40 amperes of current are passed through the cell for 85.0 minutes?
- a.  $2.04 \times 10^2$  C  
b.  $1.33 \times 10^{-1}$  C  
c.  $1.22 \times 10^4$  C  
d.  $2.12 \times 10^3$  C  
e. 3.40 C
18. How many moles of chromium would be electroplated by passing a current of 5.2 amperes through a solution of  $\text{Cr}_2(\text{SO}_4)_3$  for 45.0 minutes?
- a. 0.048 mol  
b. 2.9 mol  
c. 0.15 mol  
d. 6.9 mol  
e. 0.073 mol
19. How many grams of metallic nickel can be produced by the electrolysis of aqueous nickel(II) chloride,  $\text{NiCl}_2$ , with a 0.350 ampere current for 5.00 hours?
- a. 1.19 g  
b. 1.92 g  
c. 7.66 g  
d. 2.76 g  
e. 3.83 g

20. How long would a constant current of 4.5 amperes be required to flow in order to plate out 15 g of chromium from a chromium(III) sulfate solution?
- 268 hr
  - 309 hr
  - 5.15 hr
  - 23.2 hr
  - 1.72 hr
21. Molten  $\text{AlCl}_3$  is electrolyzed for 5.0 hours with a current of 0.40 ampere. Metallic aluminum is produced at one electrode and chlorine gas,  $\text{Cl}_2$ , is produced at the other. How many liters of  $\text{Cl}_2$  measured at STP are produced at the other electrode?
- 0.56 L
  - 0.63 L
  - 0.84 L
  - 0.98 L
  - 1.02 L
22. Calculate the quantity of charge necessary to produce 10 liters of  $\text{H}_2(\text{g})$  at STP from the electrolysis of water.
- $8.6 \times 10^4$  coulombs
  - $3.7 \times 10^4$  coulombs
  - $1.7 \times 10^4$  coulombs
  - $5.3 \times 10^4$  coulombs
  - $4.8 \times 10^4$  coulombs
23. Oxidation occurs at the \_\_\_\_\_ in a voltaic cell and oxidation occurs at the \_\_\_\_\_ in an electrolytic cell.
- anode, anode
  - cathode, cathode
  - anode, cathode
  - cathode, anode
  - anode, salt bridge
24. A current of 15.0 amperes electroplated 50.0 g of hafnium (Hf) metal from an aqueous solution in 2.00 hours. What is the oxidation number (charge) of hafnium in the solution?
- |       |       |
|-------|-------|
| a. +1 | d. +4 |
| b. +2 | e. +5 |
| c. +3 |       |
25. A voltaic cell is constructed by immersing a strip of copper metal in 1.0 M  $\text{CuSO}_4$  solution and a strip of aluminum in 0.50 M  $\text{Al}_2(\text{SO}_4)_3$  solution. A wire and a salt bridge complete the circuit. The aluminum strip loses mass, and the concentration of aluminum ions in the solution increases. The copper electrode gains mass, and the concentration of copper ions decreases. Which of the following are applicable to the copper electrode?
- The anode
  - The cathode
  - The positive electrode
  - The electrode at which electrons are produced
  - The negative electrode
  - The electrode at which electrons are used up
- I, III, and V
  - I, IV, and V
  - II, IV, and V
  - II, III, and VI
  - None of the first four responses contains all the correct choices and no others.
26. Which of the following species is the strongest oxidizing agent?
- $\text{Sn}^{2+}$
  - $\text{Sn}^{4+}$
  - $\text{Br}_2$

- d.  $\text{Br}^-$   
e.  $\text{Li}$

27. Which one of the following statements about the half-cell processes is true for the cell,



- a.  $\text{Cu}^{2+}$  is reduced at the anode.  
b.  $\text{Cu}^{2+}$  is reduced at the cathode.  
c.  $\text{Cd}^{2+}$  is reduced at the anode.  
d.  $\text{Cd}^{2+}$  is reduced at the cathode.  
e. The spontaneous reaction that occurs in this cell is not a redox reaction.

28. Which one of the following reactions is spontaneous (in the direction given) under standard electrochemical conditions?

- a.  $\text{Pb}^{2+} + 2\text{I}^- \rightarrow \text{Pb} + \text{I}_2$   
b.  $\text{Cu}^{2+} + \text{Fe} \rightarrow \text{Cu} + \text{Fe}^{2+}$   
c.  $2\text{Au} + \text{Pt}^{2+} \rightarrow 2\text{Au}^+ + \text{Pt}$   
d.  $\text{Mg}^{2+} + 2\text{Br}^- \rightarrow \text{Mg} + \text{Br}_2$   
e.  $2\text{Hg} + 2\text{Cl}^- + 2\text{H}^+ \rightarrow \text{Hg}_2\text{Cl}_2 + \text{H}_2$

29. What is the cell potential for a cell constructed by immersing a strip of manganese in a 1.0 M  $\text{MnSO}_4$  solution and a strip of iron in a 1.0 M  $\text{FeSO}_4$  solution and completing the circuit by a wire and a salt bridge?

- a. -1.62 V  
b. +1.62 V  
c. -0.74 V  
d. +0.74 V  
e. +1.21 V

30. A voltaic cell is constructed by immersing a strip of copper metal in 1.0 M  $\text{CuSO}_4$  solution and a strip of aluminum in 0.50 M  $\text{Al}_2(\text{SO}_4)_3$  solution. A wire and a salt bridge complete the circuit. The aluminum strip loses mass, and the concentration of aluminum ions in the solution increases. The copper electrode gains mass, and the concentration of copper ions decreases. What is the cell potential?

- a. +1.28 V  
b. +2.00 V  
c. +2.34 V  
d. +2.50 V  
e. +3.66 V

31. Given the following standard electrode potentials:

Half-Reaction	$E^0$
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}$	+1.23 V
$2\text{CO}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^- \rightarrow (\text{COOH})_2$	-0.49 V

Which response contains all the true statements and no others? (Assume all species are present under standard electrochemical conditions.)

- I.  $\text{H}_2\text{O}$  will spontaneously oxidize  $(\text{COOH})_2$  to form  $\text{CO}_2$ .  
II.  $\text{O}_2(\text{g})$  will spontaneously oxidize  $(\text{COOH})_2$  to form  $\text{CO}_2$ .  
III.  $(\text{COOH})_2$  will spontaneously reduce  $\text{O}_2(\text{g})$  to form  $\text{H}_2\text{O}$ .  
IV.  $\text{H}^+$  will spontaneously reduce  $(\text{COOH})_2$  to form  $\text{CO}_2$ .  
V.  $\text{CO}_2$  will spontaneously oxidize  $\text{H}_2\text{O}$  to form  $\text{O}_2(\text{g})$ .

- a. II, IV, and V  
b. I, III, and IV  
c. II and III  
d. I and IV

e. III and V

32. Which response lists all of the following reactions that are spontaneous?

- I.  $\text{F}_2(\text{g}) + \text{SO}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{F}^- + \text{SO}_4^{2-} + 4\text{H}^+$   
 II.  $\text{Cl}_2(\text{g}) + \text{Sn}^{2+} \rightarrow 2\text{Cl}^- + \text{Sn}^{4+}$   
 III.  $2\text{NO}(\text{g}) + 4\text{H}_2\text{O} + 3\text{Br}_2(\text{l}) \rightarrow 6\text{Br}^- + 2\text{NO}_3^- + 8\text{H}^+$   
 IV.  $\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{I}^- \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{I}_2(\text{s})$

- a. I and III  
 b. II and IV  
 c. I, II, and III  
 d. II, III, and IV  
 e. I, II, III, and IV

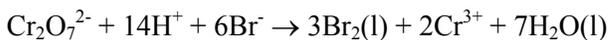
33. Calculate the reduction potential of the  $\text{Zn}^{2+}/\text{Zn}$  electrode when  $[\text{Zn}^{2+}] = 1.0 \times 10^{-8} \text{ M}$ .

- a. -0.73 V  
 b. -0.75 V  
 c. -0.76 V  
 d. -0.77 V  
 e. -1.00 V

34. A cell is constructed by immersing a strip of silver in 0.10 M  $\text{AgNO}_3$  solution and a strip of lead in 1.0 M  $\text{Pb}(\text{NO}_3)_2$  solution. A wire and salt bridge complete the cell. What is the potential of the silver electrode in the cell?

- a. 0.74 V  
 b. 0.80 V  
 c. 0.83 V  
 d. 0.86 V  
 e. 0.88 V

35. What is the cell potential for the reaction below if  $[\text{Cr}_2\text{O}_7^{2-}] = 0.0010 \text{ M}$ ,  $[\text{Cr}^{3+}] = 0.150 \text{ M}$ ,  $[\text{H}^+] = 1.00 \text{ M}$ , and  $[\text{Br}^-] = 0.450 \text{ M}$ , and some bromine is also present initially?



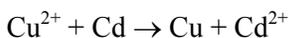
- a. +0.28 V  
 b. +0.31 V  
 c. 0.22 V  
 d. +0.24 V  
 e. +0.29 V

36. Calculate  $E_{\text{cell}}$  for the following voltaic cell.



- a. +0.78 V  
 b. +0.46 V  
 c. +0.88 V  
 d. +0.98 V  
 e. +2.58 V

37. What is  $\Delta G^0$  at 25°C for the reaction below? ( $F = 96,500 \text{ J/V}\cdot\text{mol e}^-$ )



- a. -71.1 kJ  
 b. -143 kJ  
 c. 597 kJ

- d. 193 kJ  
e. +71.1 kJ
38. What product is formed at the anode when molten sodium chloride, NaCl, is electrolyzed using a Downs cell?  
a. O<sub>2</sub>  
b. Cl<sub>2</sub>  
c. NaOH  
d. H<sub>2</sub>  
e. Na metal
39. How long would a constant current of 18.0 amperes be required to flow in order for 9000. coulombs of charge to pass through a cell?  
a. 200. s  
b. 500. s  
c. 0.002 s  
d. 50. s  
e.  $1.6 \times 10^5$  s
40. Current is passed through a cell where the half-reaction that occurs at the cathode is  $5e^- + \text{MnO}_4^- + 8\text{H}^+ \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$ . All the  $\text{MnO}_4^-$  ions present in 25.0 mL of solution have been reduced after a current of 0.600 ampere has passed for 844 seconds. What was the original concentration of  $\text{MnO}_4^-$  ions?  
a.  $7.10 \times 10^{-3} M$   
b.  $1.02 \times 10^{-1} M$   
c. 0.21 M  
d. 1.47 M  
e.  $4.20 \times 10^{-2} M$
41. A zinc bar weighing 3.0 kg is attached to a buried iron pipe to protect the pipe from corrosion. An average current of 0.020 A flows between the bar and the pipe. How many years will be required for the zinc bar to be entirely consumed? (1 yr =  $3.16 \times 10^7$  s)  
a. 600yr  
b. 14.0 yr  
c. 5.99 yr  
d. 7.00 yr  
e. 6.66 yr
42. Calculate  $\Delta G^0$  for the following reaction from its *E* value.
- $$F = 96,500 \text{ J/V}\cdot\text{mol } e^-$$
- $$3\text{Hg}_2\text{Cl}_2 + 2\text{Cr} \rightarrow 2\text{Cr}^{3+} + 6\text{Hg} + 6\text{Cl}^-$$
- a.  $-1.12 \times 10^3$  kJ  
b. -585 kJ  
c. -361 kJ  
d.  $1.62 \times 10^3$  kJ  
e.  $-1.78 \times 10^3$  kJ

## General Chemistry II Exam 4 Practice Problems

### Answer Section

#### MULTIPLE CHOICE

1. ANS: C                   PTS: 1                   TOP: Balancing Redox Reactions
2. ANS: E                   PTS: 1                   TOP: Balancing Redox Reactions
3. ANS: E                   PTS: 1                   TOP: Balancing Redox Reactions
4. ANS: C                   PTS: 1                   TOP: Balancing Redox Reactions
5. ANS: C                   PTS: 1                   TOP: Balancing Redox Reactions
6. ANS: B                   PTS: 1                   TOP: Balancing Redox Reactions
7. ANS: C                   PTS: 1                   TOP: Balancing Redox Reactions
8. ANS: D                   PTS: 1                   TOP: Balancing Redox Reactions
9. ANS: B                   PTS: 1                   TOP: Stoichiometry of Redox Reactions
10. ANS: E                   PTS: 1                   TOP: Stoichiometry of Redox Reactions
11. ANS: A                   PTS: 1                   TOP: Stoichiometry of Redox Reactions
12. ANS: E                   PTS: 1                   TOP: Stoichiometry of Redox Reactions
13. ANS: A                   PTS: 1                   TOP: Stoichiometry of Redox Reactions
14. ANS: D                   PTS: 1                   TOP: Electrodes
15. ANS: D                   PTS: 1                   TOP: The Electrolysis of Molten Salts
16. ANS: B                   PTS: 1                   TOP: The Electrolysis of Aqueous Salt Solutions
17. ANS: C                   PTS: 1                   TOP: Faraday's Law of Electrolysis
18. ANS: A                   PTS: 1                   TOP: Faraday's Law of Electrolysis
19. ANS: B                   PTS: 1                   TOP: Faraday's Law of Electrolysis
20. ANS: C                   PTS: 1                   TOP: Faraday's Law of Electrolysis
21. ANS: C                   PTS: 1                   TOP: Faraday's Law of Electrolysis
22. ANS: A                   PTS: 1                   TOP: Faraday's Law of Electrolysis
23. ANS: A                   PTS: 1                   TOP: Voltaic or Galvanic Cells
24. ANS: D                   PTS: 1
25. ANS: D  
A table of standard electrode potentials may be necessary for this question.  
  
PTS: 1                   TOP: Voltaic or Galvanic Cells
26. ANS: C  
A table of standard electrode potentials may be necessary for this question.  
  
PTS: 1                   TOP: Standard Electrode Potentials
27. ANS: B  
A table of standard electrode potentials may be necessary for this question.  
  
PTS: 1                   TOP: Uses of Standard Electrode Potentials
28. ANS: B  
A table of standard electrode potentials may be necessary for this question.  
  
PTS: 1                   TOP: Uses of Standard Electrode Potentials
29. ANS: D  
A table of standard electrode potentials may be necessary for this question.  
  
PTS: 1                   TOP: Uses of Standard Electrode Potentials
30. ANS: B

A table of standard electrode potentials may be necessary for this question.

- PTS: 1                    TOP: Uses of Standard Electrode Potentials  
 31. ANS: C  
 A table of standard electrode potentials may be necessary for this question.
- PTS: 1                    TOP: Standard Electrode Potentials for Other Half-Reactions  
 32. ANS: E  
 A table of standard electrode potentials may be necessary for this question.
- PTS: 1                    TOP: Standard Electrode Potentials for Other Half-Reactions  
 33. ANS: E  
 A table of standard electrode potentials may be necessary for this question.
- PTS: 1                    TOP: The Nernst Equation  
 34. ANS: A  
 A table of standard electrode potentials may be necessary for this question.
- PTS: 1                    TOP: The Nernst Equation  
 35. ANS: C  
 A table of standard electrode potentials may be necessary for this question.
- PTS: 1                    TOP: The Nernst Equation  
 36. ANS: D  
 A table of standard electrode potentials may be necessary for this question.
- PTS: 1                    TOP: The Nernst Equation  
 37. ANS: B  
 A table of standard electrode potentials may be necessary for this question.
- PTS: 1                    TOP: The Relationship of E... to Delta G0 and K  
 38. ANS: B                    PTS: 1                    TOP: The Electrolysis of Molten Salts  
 39. ANS: B                    PTS: 1                    TOP: Faraday's Law of Electrolysis  
 40. ANS: E                    PTS: 1                    TOP: Faraday's Law of Electrolysis  
 41. ANS: B  
 A table of standard electrode potentials may be necessary for this question.
- PTS: 1                    TOP: Corrosion Protection  
 42. ANS: B                    PTS: 1                    TOP: The Relationship of E... to Delta G0 and K