**AP Chem**

**Electrochemistry Unit Practice**

1.  Tell the oxidation state of each atom in the substance:

A. Fe

B. O2

C. NaI

D. BaO

E. MgSO4

F. CaH2

G. NH3

I. HCN

2.  Tell whether each reaction is a redox reaction:

A.  NaCl + AgNO3 = AgCl + NaNO3

B.  HCl + NaOH = NaCl + H2O

C.  K + H2O = KOH + H2

D. Cu + 2AgCl = CuCl2 + 2Ag

3.  Balance each of these half reactions:

A.  Cu = Cu2+

B.  Al3+ = Al

4.  Balance each of these half reactions in acid:

A.  NO3- = NO2-

B.  ClO- = ClO3-

5.  Balance each of these half reactions in base:

A.  Cl2 = ClO3-

B.  MnO4- = MnO2

6.  Determine the number of electrons transferred in these balanced redox equations:

A.  MnO4- + Cl2 = Cl- + Mn2+

B.  HNO3 + Cu = Cu2+ + H2O + NO2

7.  Given the two balanced half reactions, write the balanced redox reaction:

A.  Li = Li+ + e-; Zn2+ + 2e- = Zn

B.  Al = Al3+ + 3e-; Cu2+ + 2e- = Cu

8.  Balance these equations in acid using the half reaction method:

A.  Cr2O72- + NO2- = Cr3+ + NO3-

B.  ClO3- + SO2 = SO42- + Cl-

9.  Balance these equations in base using the half reaction method:

A.  Br- + MnO4- = BrO3- + MnO2

B.  H2O2 + Cl2O7 = ClO2- + O2

12.  Each set of two equations represents the half reactions present in an electrochemical cell.  Write the balanced equation for the cell and calculate its potential.

A.  S = SO2; NO3- = NO

B.  Fe2+ = Fe3+; MnO4- = Mn2+ (cell is in acid)

13.  Label the parts of the electrochemical cells on the schematic:



14.  Given the cell reaction, write the cell notation:

A. Cu + 2Ag+ = Cu2+ + Ag

B. 2Al + 3Zn2+ = 2Al3+ + 3Zn

15.  Convert the cell notation to two balanced half reactions, then the balanced cell reaction:

A. Na|Na+||Al3+|Al

B. Zn|Zn2+||Ag+|Ag

16.  Given the cell notation, calculate the cell potential:

A. Cu|Cu2+||Ag+|Ag

B. Zn|Zn2+||Cu2+|Cu

17.  Given the rate of reaction, find the current for the electrochemical cell.

A.  3Cu2+ + 2Al = 3Cu + 2Al3+

The rate of this reaction is 5 M/s when we look at it in terms of “moles of reaction.”  The rate would be 15 M/s in terms of copper and 10M/s in terms of aluminum.

B.  Na+ + Li = Na + Li+

The rate of the reaction is 3 M/s.

18.  Given the current of the electrochemical cell, find the rate of the reaction:

A. 2Ag+ + Co2+ = Ag + Co4+

The current in the in the cell running this reaction is 3A.

B. Fe2+ + Ag+ = Fe3+ + Ag

The current in the cell running this reaction is 2A

19.  An electrochemical cell utilizes the reaction below:

Li(s) + Mg2+(aq) = Li+(aq) + Mg(s)

The cell runs for 10 minutes at a current of 6A.  Find how much Mg metal is produced.

20.  How long must a 2A current operate to produce 100g of Mg metal in the cell in problem 19?

21.  A cell made from aluminum and magnesium metals runs at a current of 3A for 8 hours.  Find how much heavier the cathode is.

22.  The Daniell cell uses the reaction below:

Cu2+ + Zn = Cu + Zn2+

For each input, tell the effect on cell potential:
A.  Enlarge the anode

B.  Enlarge the cathode

C.  Add zinc ion

D.  Remove zinc ion

E.  Add copper ion

F.  Remove copper ion

G.  Increase T (the reaction is exothermic)

H.  Allow the cell to run for some time

23.  The statue of liberty is made of an iron frame with copper on the outside.  About 30 years ago the statue required repairs to prevent it from collapsing.  Explain why the statue’s iron frame corroded so much.

25. For a given galvanic cell, the following net reaction takes place:

 Zn(s) + 2Ag+(aq) 🡪 Zn2+(aq) + 2Ag(s)

Assuming standard conditions, do the following:

1. Write balanced half-reactions for this cell.
2. Identify which half-reaction occurs at the anode and which occurs at the cathode.
3. Draw a picture representation of this galvanic cell, being sure to label the solutions, the metals, cathode and anode, and the flow of electrons.
4. Write the line notation for this galvanic cell.
5. Calculate Eºcell for the cell.
6. Calculate ΔGº for the cell.
7. If the concentrations are changed to 0.05*M* Ag+ and 0.025*M* Zn2+ when the temperature rises to 300K, what is the cell potential (Ecell)?

26. Consider the following chemical reaction:

 Cr(s) + 3Ag+(aq) 🡪 Cr3+(aq) + 3Ag(s)

1. Write balanced half-reactions for this cell.
2. Identify which half-reaction occurs at the anode and which occurs at the cathode.
3. Draw a picture representation of this galvanic cell, being sure to label the solutions, the metals, cathode and anode, and the flow of electrons.
4. Write the line notation for this galvanic cell.
5. Calculate Eºcell for the cell.
6. Calculate ΔGº for the cell.
7. A galvanic cell consists of a solid chromium electrode in a 0.500*M* solution of Cr3+(aq) and a silver electrode in a 0.250*M* solution of Ag+(aq). What is the voltage of this cell at 25ºC?

27. An electrochemical cell is created by placing a zinc electrode in a 1*M* solution of ZnSO4 and placing a copper electrode in a 1*M* solution of CuSO4. The two compartments were connected by a salt bridge, and the following reaction occurred at 25ºC:

 Zn(s) + Cu2+(aq) 🡪 Zn2+(aq) + Cu(s)

1. Write balanced half-reactions for this cell.
2. Identify which half-reaction occurs at the anode and which occurs at the cathode.
3. Draw a picture representation of this galvanic cell, being sure to label the solutions, the metals, cathode and anode, and the flow of electrons.
4. Write the line notation for this galvanic cell.
5. Calculate Eºcell for the cell.
6. Calculate ΔGº for the cell.
7. What is the value of *K* for this reaction?
8. At a certain point in the progress of the reaction, [Cu2+] drops to 0.1*M* and [Zn2+] increases to 1.9*M*. What is the cell potential at this point?
9. After a certain amount of time, the reaction in the cell reaches equilibrium. What is the value of Ecell at this point?
10. Explain what would occur if the salt bridge is removed from the cell. *Justify your answer*.

Answers:

1.

A.  0

B.  0

C.  +1/-1

D.  +2/-2

E.  +2/+6/-2

F.  +2/-1

G.  -3/+1

I.  +1/+2/-3

2.

A.  No

B.  No

C.  Yes

D.  Yes

3.

A.  Cu = Cu2+ + 2e-

B.  Al3+ + 3e- = Al

4.

A.  2H+ + 2e- + NO3- = H2O + NO2- +

B.  2H2O + ClO- = ClO3- + 4H+ + 4e-

5.

A.  12OH- + Cl2 = 2ClO3- + 6H2O + 10e-

B.  2H2O + MnO4- = MnO2 + 4OH-

6.

A. 10

B. 2

7.

A.  2Li + Zn2+ = 2Li+ + Zn

B.  2Al + 3Cu2+ = 2Al3+ + 3Cu

8.

A.  8H+ + Cr2O72- + 3NO2- = 2Cr3+ + 3NO3- + 4H2O

B.  3H2O + ClO3- + 3SO2 = 3SO42- + Cl- + 6H+

9.

A.  Br- + 2MnO4- + H2O = BrO3- + 2MnO2 + 2OH-

B.  4H2O2 + Cl2O7 + 2OH- = 2ClO2- + 4O2 + 5H2O

12.

A.  4 H+ + 3S + 4NO3- = 3SO2 + 4NO + 2H2O

B.  8H+ + 5Fe2+ + MnO4- = 5Fe3+ + Mn2+ + 4H2O

13.

1.  anode

2.  wire

3.  cathode

4.  cathode chamber filled with aqueous Cu2+ and a counterion

5.  salt bridge

6.  anode chamber filled with aqueous Zn2+ and a counterion

14.

A.  Cu|Cu2+||Ag+|Ag

B.  Al|Al3+||Zn2+|Zn

15.

A. 3Na + Al3+ = 3Na+ + Al

B. Zn + 2Ag+ = Zn2+ + 2Ag

16.

A.  .46V

B.  1.1V

17.

A.  2.9X106A

B.  289455A

18.

A.  .000031M/s for the reaction and cobalt, .000062M/s for silver

B.  .0000207M/s

19.

.45g

20.

397058s

21.  You must use an SRP table to find that Al is the cathode.  n = 6.

5.37g

22.

A. none

B. none

C. Lower

D. Higher

E. Higher

F. Lower

G. Lower

H. Lower

23.

The statue’s builders tried to isolate the iron frame from the copper cladding but inevitably there were places where the two metals came into contact.  A term we could throw out to make it look like we know the answer is “bimetallic corrosion”.  Bimetallic corrosion is when a less active (harder to oxidize) metal comes into contact with a more active (easier to oxidize) metal.  When the less active metal oxidizes, electrons travel from the more active metal to reduce the less active metal’s ions.  This removes electrons from the more active metal (it oxidizes).  The presence of the less active metal speeds the oxidation (corrosion) of the more active metal compared to the more active metal being present on its own.  I have read that wrought iron does not corrode easily in air, it’s actually cast iron and steel that corrode.  If the structure of the statue is wrought iron it is likely it could have lasted a much longer time if it had not come into contact with a less active metal.  Note that the answer “bimetallic corrosion” is inadequate for credit.  In physical science throwing terms around as a substitute for understanding is not acceptable.  Go ahead and explain the system rather than just writing words that sound good.