Review Unit 15

1. Calculate E° for the following reaction:

$$2Al^{3+}(aq) + 3Cd(s) \rightarrow 2Al(s) + 3Cd^{2+}(aq)$$

a) -2.06 V
b) +4.52 V
c) +2.06 V
d) -4.52 V
e) -1.26 V

2. Using data from the reduction potential table and the reaction

$2Ag(s) + Pt^{2+}(aq) \rightarrow Pt(s) + 2Ag^{+}(aq)$ $E° = 0.38$ V

calculate the standard reduction potential of the half-reaction

$$Pt^{2+}(aq) + 2e^- \rightarrow Pt(s)$$

a) -1.18 V
b) -0.40 V
c) 0.40 V
d) 1.18 V
e) 2.00 V

$.38 = (-.80) + x$ $x = 1.18$ V

$E°_{cell} = (-E_{oxidation}) + E_{reduction}$

3. Using data from the reduction potential table, predict which of the following is the best *oxidizing* agent.

a) F_2
b) Ag
c) Sn^{4+}
d) Ag^+
e) Al^{3+}

Standard Reduction Potentials at 25°C E° (volts)

$F_2(g) + 2e^- \rightarrow 2F^-(aq)$	+2.87
$Au^{3+} + 3e^- \rightarrow Au(s)$	+1.50
$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$	+1.36
$O_2(g) + 4H_3O^+(aq) + 4e^- \rightarrow 6H_2O(l)$	+1.23
$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$	+1.08
$Ag^+(aq) + e^- \rightarrow Ag(s)$	+0.80
$Hg_2^{2+}(aq) + 2e^- \rightarrow 2Hg(l)$	+0.79
$I_2(s) + 2e^- \rightarrow 2I^-(aq)$	+0.535
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	+0.337
$Sn^{4+}(aq) + 2e^- \rightarrow Sn^{2+}(aq)$	+0.15
$Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$	-0.14
$Cd^{2+}(aq) + 2e^- \rightarrow Cd(s)$	-0.40
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	-0.763
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	-0.828
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	-1.66
$K^+(aq) + e^- \rightarrow K(s)$	-2.93
$Li^+(aq) + e^- \rightarrow Li(s)$	-3.045

4. Which energy conversion shown below takes place in an electrolytic cell?

a. electrical to chemical
b. chemical to electrical
c. mechanical to electrical
d. mechanical to chemical
e. chemical to mechanical

5. How many electrons are transferred in the following reaction?

$SO_3\text{-}(aq) + MnO_4^-(aq) \rightarrow SO_4^{-2} + Mn^{+2}(aq)$

a. 6
b. 2
c. 10
d. 4
e. 3

6. What is the oxidation number of oxygen in H_2O_2?

a. +1
b. -1
c. 0
d. +2
e. -2

7. Which of the following is the strongest oxidizing agent?

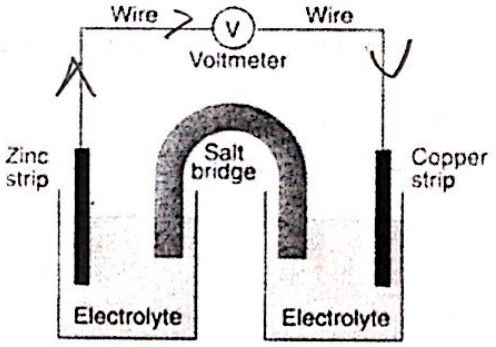
$MnO_4^- + 4H^+ + 3e^- \rightarrow MnO_2 + 2H_2O$	$E° = 1.68V$
$I_2 + 2e^- \rightarrow 2I^-$	$E° = 0.54\ V$
$Zn^{2+} + 2e^- \rightarrow Zn$	$E° = -0.76V$

a. MnO_4^-
b. I_2
c. Zn^{2+}
d. MnO_2

8. Which statement is true for any electrochemical cell?
a. Oxidation occurs at the anode, only.
b. Reduction occurs at the anode, only.
c. Oxidation occurs at both the anode and the cathode.
d. Reduction occurs at both the anode and the cathode.

= galvanic

Voltaic Cell



$Zn \rightarrow Zn^{+2} + 2e^-$

1M $ZnSO_4$ and
1M $CuSO_4$

9. On the diagram provided, indicate with one or more arrows the direction of electron flow through the wire.

10. Write an equation for the half-reaction that occurs at the zinc electrode. $Zn \rightarrow Zn^{+2} + 2e^-$

11. . Explain the function of the salt bridge. Keep voltages in compartments near zero

12. What is the E_{cell} given:

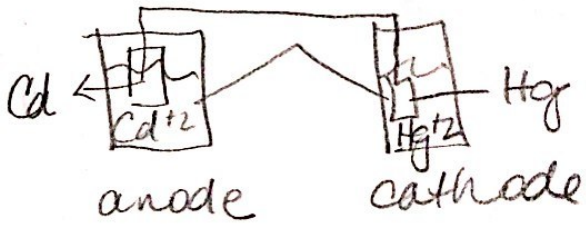
$Zn^{2+} + 2e^- \rightarrow Zn$	$E° = -.76V$
$Cu^{+2} + 2e^- \rightarrow Cu$	$E° = .34V$

$Zn \rightarrow Zn^{+2} + 2e^- = .76$
$Cu^{+2} + 2e^- \rightarrow Cu \quad .34$
1.1 OV

13. Which of the following is the correct cell notation for the reaction

$$Hg_2^{2+} + Cd(s) \rightarrow Cd^{2+} + 2Hg(l)$$

a) $Cd^{2+} \mid Cd \mid\mid Hg_2^{2+} \mid Hg$
b) $Cd^{2+} \mid Hg_2^{2+} \mid\mid Cd \mid Hg$
c) $Cd \mid Cd^{2+} \mid\mid Hg_2^{2+} \mid Hg$
d) $Cd^{2+} \mid Hg \mid\mid Hg_2^{2+} \mid Cd$
e) $Hg \mid Cd \mid\mid Hg_2^{2+} \mid Cd^{2+}$



$Cd \mid Cd^{+2} \mid\mid Hg^{+2} \mid Hg$

Assume galvanic

Questions 14 - 15. You make a cell with a nickel electrode in a solution of nickel nitrate and a zinc electrode in a solution of zinc nitrate.

$Ni^{+2} + Zn \rightarrow Ni + Zn^{+2}$

$E_{cell} = .53V$

14. If you could increase the concentration of Zn^{+2}, which of the following is true about the cell potential?
a. It would increase.
(b.) It would decrease.
c. It would remain constant.
d. Cannot be determined.

shift left $E°_{cell}$ decrease

15. If you could increase the concentration of Ni^{2+}, which of the following is true about the cell potential?
(a.) It would increase.
b. It would decrease.
c. It would remain constant.
d. Cannot be determined.

shift right $E°_{cell}$ increase

16. If a current of 6.0 amps is passed through a solution of Ag^+ for 1.5 hours, how many grams of silver are produced?
a. 0.60 g
b. 3.0 g
(c.) 36 g
d. 1.0 g
e. 0.34 g

$\#g\,Ag = 1.5hr \times \frac{60min}{1hr} \times \frac{60sec}{1min} \times \frac{6.0coulomb}{1sec} \times \frac{1mole\,e^-}{96,485coul.} \times \frac{1mole\,Ag}{1mole\,e^-} \times \frac{108g}{1mole\,Ag}$

17. If K for a reaction is equal to 1.0, what is the E° for the oxidation- reduction reaction?
(a.) 0.0 volt
b. -1.0 volt
c. 1.0 volt
d. 0.059 volt
e. 0.030 volt

at equilibrium
$E°_{cell}$ = zero = dead battery

18. Sketch the galvanic cell based on the following overall reactions. Assume all concentrations are 1.0M and pressures are 1.0 atm .
$Zn(s) + Ag^+(aq) \rightarrow Zn^{2+}(aq) + Ag(s)$

$Zn + 2Ag^+ \rightarrow Zn^{+2} + 2Ag$

Show:
a. direction of electron flow
b. direction of ion migration through the salt bridge
c. identify the cathode and anode
d. Give the overall balanced reaction.
e. Using the standard reduction table, calculate E° for the reaction
f. Using line notation, describe the cell.

$Zn \rightarrow Zn^{+2} + 2e^- = .76V$
$2(Ag^+ + 1e \rightarrow Ag) = .80V$
$1.56V$

$Zn \mid Zn^{+2} \parallel Ag^+ \mid Ag$

19. How many grams of cobalt metal will be deposited when a solution of cobalt(II) chloride is electrolyzed with a current of 10. amperes for 109 minutes?
a) 0.66
b) 4.0
(c) 20
d) 40

$\#g = 109min \times \frac{60sec}{1min} \times \frac{10.0coul.}{1sec} \times \frac{1mole\,e^-}{96485C} \times \frac{1mole\,Co}{2mole\,e^-} \times \frac{59}{1mol\,Co} =$

20. Balance the following redox equation which occurs in acidic solution.

$$N_2H_4(g) + BrO_3^-(aq) \rightarrow Br^-(aq) + N_2(g)$$

a) $3N_2H_4 + BrO_3^- \rightarrow 3N_2 + Br^- + 3H_2O + 6H^+$

b) $N_2H_4 + BrO_3^- + 2H^+ \rightarrow 2Br^- + N_2 + 3H_2O$

c) $3N_2H_4 + 2BrO_3^- + 12H^+ \rightarrow 3N_2 + 2Br^- + 6H_2O + 12H^+$

d) $N_2H_4 + 2BrO_3^- + 8H^+ \rightarrow 2Br^- + N_2 + 6H_2O$

e) $3N_2H_4 + 2BrO_3^- \rightarrow 3N_2 + 2Br^- + 6H_2O$

$$\overset{-2}{N_2}\overset{+1}{H_4} + \overset{+5}{Br}\overset{-2}{O_3}^- \rightarrow Br^{-1} + \overset{0}{N_2}$$

ox $\left(\overset{-2}{N_2}H_4 \rightarrow N_2^0 + 4H^+ + 2e^-\right)$

red $\overset{+5}{Br}\overset{-2}{O_3}^- + 6H^+ + 6e^- \rightarrow Br^{-1} + 3H_2O$

$$3N_2H_4 + BrO_3^- + 6H^+ \rightarrow 3N_2 + 12H^+ + Br^{-1} + 3H_2O$$

$$\boxed{3N_2H_4 + BrO_3^- \rightarrow 3N_2 + 6H^+ + Br^{-1} + 3H_2O}$$

21. $E_{cell} =$

$Pb^{+2} + 2e^- \rightarrow Pb$ $\quad E = -.13V$

$Cu \rightarrow Cu^{+2} + 2e^-$ $\quad E = -.34V$

$-.47V$

It's an electrolytic cell

$$\Delta G = -nFE$$

$$\Delta G = -(2 \times 96485)(-.47) = 90695.9\ J = \boxed{91\ KJ}$$