Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hour: \_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_

# AP Chemistry: *20HW*

***Directions: Complete the following problems.***

For the following reactions, indicate the oxidizing agent, the reducing agent, which species is oxidized, and which species is reduced.

1A. 2 Al + Co2O3 🡪 2 Co + Al2O3 1B. 2 AgNO3 + Zn 🡪 Zn(NO3)2 + 2 Ag

2 Cu+ + Pt3+ 🡪 2 Cu2+ + Pt+ Cr + 2 HCl 🡪 CrCl2 + H2

Balance the following by the method of half-reactions.

2A. Cu + NO3– 🡪 Cu2+ + NO (acidic)

Zn + HNO2 🡪 NO + Zn2+ (acidic)

O2 + Cr(OH)3 🡪 H2O2 + CrO42– (basic)

2B. Cr2O72– + I– 🡪 Cr3+ + I2 (acidic)

Mg + HO2– 🡪 Mg2+ + OH– (basic)

MnO4– + Ag + CrO42– 🡪 Ag2CrO4 + MnO2 (basic)

Sketch each galvanic cell. Identify the cathode and anode, and indicate the direction of electron flow.

3A. Cu2+(aq) + Ba(s) 🡪 Ba2+(aq) + Cu(s) 3B. Ag+(aq) + Mg(s) 🡪 Mg2+(aq) + Ag(s)

Calculate standard reduction potentials for the reactions in Q3.

4A. 4B.

ANSWERS: 4A. +3.24 V 4B. +3.17 V

A galvanic cell is based on the following half-reactions at 25oC: Li+ + e– 🡪 Li

H2O2 + 2 H+ + 2 e– 🡪 2 H2O

Space for preliminary work:

Predict whether Ecell is larger or smaller than Eocell for the following cases and state how you know.

5A. [Li+] = 1.2 M, [H2O2] = 2.8 M, [H+] = 1.0 M 5B. [Li+] = 1.8 M, [H2O2] = 0.6 M, [H+] = 1 x 10–6 M

6A. Consider the cell: Cr/Cr2+(1.00 M) // Cu2+(1.00 M)/Cu. Calculate the cell potential after the reaction has operated long enough for the chromium(II) ion concentration to change by 0.90 M. Assume 25oC.

6B. Consider the cell: Al/Al3+(1.00 M) // Cu2+(1.00 M)/Cu. Calculate the cell potential after the reaction has operated long enough for the aluminum ion concentration to change by 0.65 M. Assume 25oC.

ANSWERS: 5A. E > Eo 5B. E < Eo 6A. +1.21 V 6B. +1.95 V

A concentration cell using two thallium electrodes in two thallium ion solutions of differing concentration is at 25oC. Assuming that the [Tl+] = 1.0 M in the left compartment, calculate the cell potential when the [Tl+] in the right compartment is as follows. For each case, also identify the anode and cathode, and indicate which way the electrons travel.

Space for preliminary work:

7A. 0.54 M 7C. 2.5 M

7B. 1.75 M 7D. 3.0 x 10–4 M

Determine G and K at 25oC for the reactions in Q7.

8A. 8C.

8B. 8D.

ANSWERS: 7A. E = +0.016 V 7C. E = +0.024 V 8A. –1,500 J/mol, 1.9 8C. –2,300 J/mol, 2.5

7B. E = +0.014 V 7D. E = +0.21 V 8B. –1,400 J/mol, 1.7 8D. –2.0 x 104 J/mol, 3600

9A. Consider the galvanic cell based on: Cr3+ + 3 e– 🡪 Cr

Li+ + e– 🡪 Li

Complete each of the following: determine the overall reaction equation; determine Eocell; calculate Go and K under standard conditions; calculate Ecell at 25oC when [Cr3+] = 0.10 M and [Li+] = 0.0010 M.

9B. A galvanic cell at 25oC has the overall reaction: Ca(s) + Mn2+(aq) 🡪 Ca2+(aq) + Mn(s)

When [Ca2+] = 2.5 M and [Mn2+] = 0.12 M, then K = 6.5 x 1055. Calculate G and the cell potential for this cell under these conditions.

10A. For how many minutes must 58.5 A be passed through molten lithium chloride to produce 86.2 g of lithium?

ANSWERS: 9A. Eo = +2.31 V, G = –669 kJ, K = 1.6 x 10117, E = +2.47 V

9B. G = –318 kJ, E = +1.65 V 10A. 341 min

10B. What current is required to liberate 5.90 mol of nickel from molten nickel(III) chloride in 8.25 hours?

11A. Electrolysis of an alkaline earth metal chloride using a current of 3.50 A for 24 minutes, 20 seconds deposits 1.062 g of the metal at the cathode. Identify the metal.

11B. An unknown metal M is electrolyzed. It took 98.3 s for 6.75 A to plate out 0.447 g of the metal from a solution of M(NO3)3. Identify the metal.

ANSWERS: 10B. 57.5 A 11A. Ca 11B. Pt

**Standard Reduction Potentials (1 M solutions @ 1 atm and 25oC)**

***Half-Reaction Eo (V)***

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F2 + 2 e– 2 F– +2.87

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H2O2 + 2 H+ + 2 e– 2 H2O +1.78

8 H+ + MnO4– + 5 e– Mn2+ + 4 H2O +1.51

Au3+ + 3 e– Au +1.50

O2 + 4 H+ + 4 e– 2 H2O +1.23

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Ag+ + e– Ag +0.80

Fe3+ + e– Fe2+ +0.77

O2 + 2 H2O + 4 e– 4 OH– +0.40

Cu2+ + 2 e– Cu +0.34

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2 H+ + 2 e– H2 +0.00

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Pb2+ + 2 e– Pb –0.13

Tl+ + e– Tl –0.34

Cd2+ + 2 e– Cd –0.40

Fe2+ + 2 e– Fe –0.44

Cr3+ + 3 e– Cr –0.74

Zn2+ + 2 e– Zn –0.76

Cr2+ + 2 e– Cr –0.91

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Al3+ + 3 e– Al –1.66

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Mg2+ + 2 e– Mg –2.37

Ba2+ + 2 e– Ba –2.90

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Li+ + e– Li –3.05

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