

Name: KEY
Exam #4

Chem. 115 Practice

Part 1: Multiple Choice

1. Calculate the solubility product constant for lead(II) iodide if 0.0024 mole of I⁻ ion is present in 2.0 L of a saturated lead(II) iodide solution

a. 1.4×10^{-5}

b. 8.6×10^{-10}

c. 5.2×10^{-8}

d. 3.5×10^{-6}

e. 4.6×10^{-9}

2. Calculate the number of moles of Ag⁺ ion present in 2.0 L of a saturated solution of silver chromate. For silver chromate, $K_{sp} = 1.1 \times 10^{-12}$.

a. 2.6×10^{-4}

b. 1.3×10^{-4}

c. 2.1×10^{-4}

d. 1.1×10^{-4}

e. 4.1×10^{-4}

3. Calculate the molar solubility of silver carbonate in 1.0 M sodium carbonate solution. For silver carbonate, $K_{sp} = 8.1 \times 10^{-12}$.

a. 8.1×10^{-12}

b. 2.8×10^{-6}

c. 1.4×10^{-6}

d. 1.4×10^{-8}

e. 2.0×10^{-4}

4. Calculate the pH of a solution necessary to just begin the precipitation of magnesium hydroxide when the concentration of magnesium ion = 0.001 M. For magnesium hydroxide $K_{sp} = 1.2 \times 10^{-11}$.

a. 11

b. 10

c. 9

d. 8

e. 4

5. The line notation, $\text{Mg(s)} \mid \text{Mg}^{2+}(\text{aq}) \parallel \text{Fe}^{2+}(\text{aq}) \mid \text{Fe(s)}$, indicates that:

a. iron metal is the reducing agent

b. magnesium metal is the cathode

c. Fe^{2+} ions are oxidized

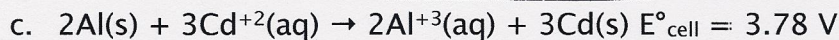
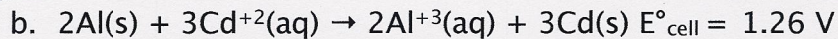
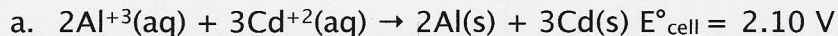
d. magnesium metal is the reducing agent

e. Mg^{2+} ion is the reducing agent

6. Consider the following two electrode reactions and their standard electrode potentials:



Write the cell reaction for a voltaic cell based on these two electrodes, and calculate the standard cell potential



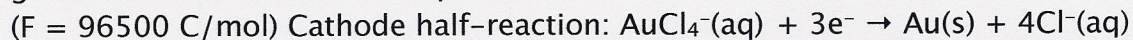
7. A voltaic cell consists of Mn/Mn²⁺ and Cd/Cd²⁺ half-cells with concentrations [Mn²⁺] = 0.75 M and [Cd²⁺] = 0.15 M. Calculate the cell potential at 25° C.



- a. 1.60 V
 - b. 1.56 V
 - c. 1.54 V
 - d. 0.80 V
 - e. 0.76 V
8. The standard reference electrode that is used to measure all other standard electrode potentials is called the "standard _____ electrode."

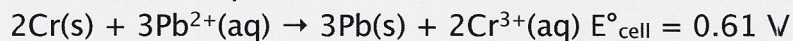
- a. sulfur
- b. oxygen
- c. hydrogen
- d. iron
- e. platinum

9. A constant current was passed through a solution of KAuCl₄ between gold electrodes. Over a period of 20.00 min, the cathode increased in mass by 2.664 g. What was the current in amperes?



- a. 1.08 A
- b. 3.26 A
- c. 2.17 A
- d. 6.52 A
- e. 3.48 A

10. Calculate the equilibrium constant K_c for this reaction at 25°C:



a. 6.7×10^{61}

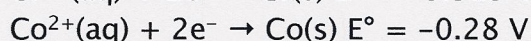
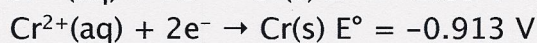
b. 8.1×10^{30}

c. 9.2×10^{45}

d. 3.2×10^{51}

e. 4.6×10^{22}

11. Consider the following half-reactions and select the strongest oxidizing agent present:



a. $\text{Cr}^{2+}(\text{aq})$

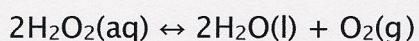
b. $\text{Sr}^{2+}(\text{aq})$

c. $\text{Co}^{2+}(\text{aq})$

d. $\text{Sr}(s)$

e. $\text{Co}(s)$

12. The standard free energy change for the following reaction is -210 kJ. What is the cell potential?



a. +0.640 V

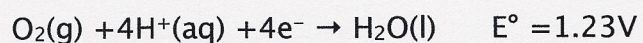
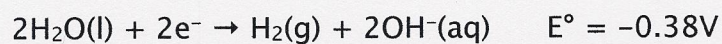
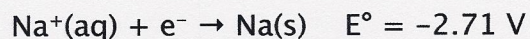
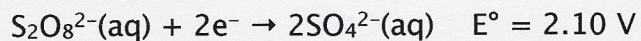
b. +1.09 V

c. +0.420 V

d. +0.547 V

e. +0.752 V

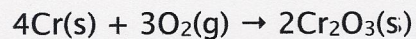
13. In the electrolysis of aqueous sodium sulfate, which one of the following species is oxidized?



- a. sodium ion
- b. oxygen
- c. sulfate ion
- d. water
- e. hydronium ion

14. Calculate ΔS° for the following reaction:

Standard molar entropies, S° (J/mol·K): Cr(s), 23.8; O₂(g), 205.1; Cr₂O₃(s), 81.2



- a. 548.1 J/K
- b. 147.7 J/K
- c. -147.7 J/K
- d. -548.1 J/K
- e. -66.5 J/K

15. When crystalline solid barium hydroxide octahydrate and crystalline solid ammonium nitrate are mixed in a beaker at room temperature, a spontaneous reaction occurs. The temperature of the beaker contents rapidly falls to below 0°C . Use this information to decide whether the reaction is exothermic or endothermic and what the signs of ΔH and ΔS are.

- a. endothermic; $\Delta H > 0$; $\Delta S > 0$
- b. exothermic; $\Delta H < 0$; $\Delta S > 0$
- c. endothermic; $\Delta H < 0$; $\Delta S < 0$
- d. endothermic; $\Delta H < 0$; $\Delta S > 0$
- e. exothermic; $\Delta H > 0$; $\Delta S < 0$

16. A certain reaction has $\Delta H^{\circ} = -14.2 \text{ kJ}$ and $\Delta S^{\circ} = +87.9 \text{ J/K}$. What is the value of ΔG° for this reaction? (Temperature is 25°C)

- a. $+40.4 \text{ kJ}$
- b. -16.4 kJ
- c. -26200 kJ
- d. -40.4 kJ
- e. -7820 kJ

17. A reaction has an equilibrium constant $K_c = 7.0$ at 35°C . Calculate the value of ΔG° for the reaction

- a. -4.98 kJ
- b. -2.46 kJ
- c. -5.66 kJ
- d. -2.16 kJ
- e. none of the above

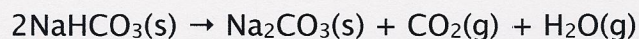
18. The compound 1-pentanol has an enthalpy of vaporization of 55.5 kJ/mol and an entropy of vaporization of 148 J/K·mol. Calculate its approximate boiling point.

- a. 45°C
- b. 102°C**
- c. 93°C
- d. 210°C
- e. 375°C

19. Which of the following statements about entropy and enthalpy of a system is correct?

- a. The absolute entropy of pure oxygen at 25°C and 1 atm is zero.
- b. When ice melts, ΔS is positive and ΔH is negative.
- c. When a candle burns, ΔS is positive and ΔH is negative.**
- d. The entropy of a system must increase for the reaction to be spontaneous.
- e. None of the above statements are correct.

20. Sodium carbonate can be made by heating sodium bicarbonate carbonate:



For this reaction, $\Delta H^\circ = 128.9 \text{ kJ}$ and $\Delta S^\circ = 321 \text{ J/K}$. At approximately what temperature will $K = 1$?

- a. 401.6° C
- b. 401.6 K**
- c. 33.1° C
- d. 33.1 K
- e. None of the above

Part 2: Free Response. Please show all work.

1. Will a precipitate form when 125 ml of 0.0250 M aluminum nitrate and 25.0 ml of 0.000100 M calcium hydroxide are mixed together? Why? K_{sp} of aluminum hydroxide = 3.7×10^{-15}

$$Q_{sp} = [Al^{3+}][OH^-]^3$$

$$[Al^{3+}]_i = [Al(NO_3)_3]_i = 0.0250 \text{ M}$$

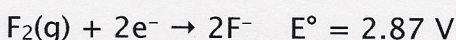
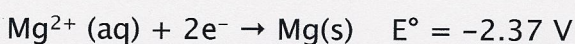
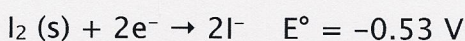
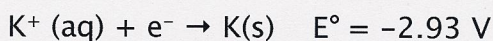
$$[OH^-]_i = 2 \cdot [Ca(OH)_2] = 2(0.000100 \text{ M}) = 0.000200 \text{ M}$$

$$Q_{sp} = \left[\frac{(0.0250 \text{ M})(125 \text{ mL})}{(150 \text{ mL})} \right] \left[\frac{(0.000200 \text{ M})(25.0 \text{ mL})}{(150 \text{ mL})} \right]^3 \quad \text{* remember to dilute!}$$

$$Q_{sp} = 7.7 \times 10^{-16}$$

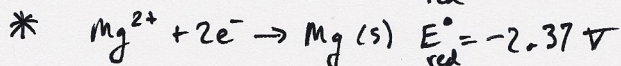
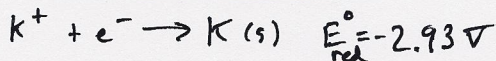
$$Q_{sp} < K_{sp} \quad \therefore \boxed{\text{No precipitate.}}$$

2. In the electrolysis of a molten mixture of potassium iodide and magnesium fluoride, identify which product forms at the positive electrode, and what product forms at the negative electrode.

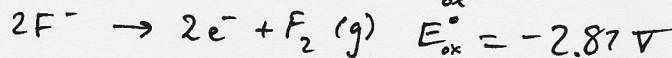
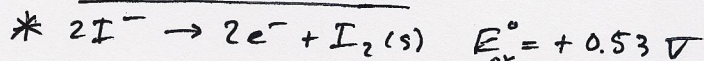


In our mixture we have: K^+ , I^- , Mg^{2+} , and F^- .
Let's use the given E_{red} values to determine which half-reactions occur most easily (require the least amount of energy).

Possible reductions:

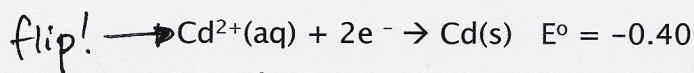


Possible oxidations:



The 2 reactions with a * next to them will occur (higher Emf's).
 $\therefore \boxed{Mg(s) \text{ and } I_2(s) \text{ will form.}}$

3. In a $Cd^{2+}/Cd(s)$ and $Au^{3+}/Au(s)$ voltaic cell the electronic voltmeter measures to be 1.92-Volts. What concentration of cadmium (II) ion must be present in the cell if the gold (III) ion concentration is known to be 0.10 M.



$$E_{cell}^\circ = 1.50 + 0.40 \text{ V}$$

$$E_{cell}^\circ = 1.90 \text{ V}$$

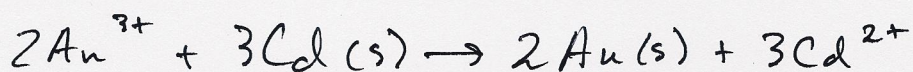
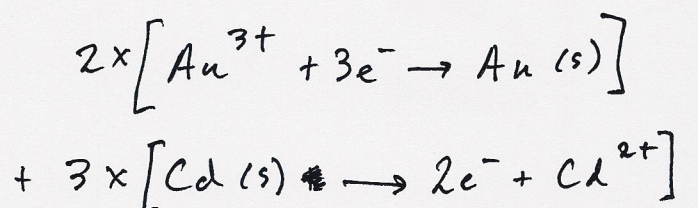
$$E_{cell} = E_{cell}^\circ - \frac{RT}{nF} \ln Q$$

$$\left(\ln Q\right) \frac{RT}{nF} = E_{cell}^\circ - E_{cell}$$

$$\ln Q = [E_{cell}^\circ - E_{cell}] \cdot \frac{nF}{RT}$$

$$Q = e^{[E_{cell}^\circ - E_{cell}] \cdot \frac{nF}{RT}} \quad \text{--- ①}$$

The overall rxn is:



note: number of e^- transferred is

$$n = 6, \text{ --- } \textcircled{2}$$

and, $Q = \frac{[Cd^{2+}]^3}{[Au^{3+}]^2}$ --- $\textcircled{3}$

$\textcircled{2}$ & $\textcircled{3}$ plug into $\textcircled{1}$

$$\frac{[Cd^{2+}]^3}{[Au^{3+}]^2} = e^{[E_{cell}^{\circ} - E_{cell}] \frac{nF}{RT}}$$

$$[Cd^{2+}]^3 = [Au^{3+}]^2 \cdot e^{[E_{cell}^{\circ} - E_{cell}] \frac{nF}{RT}}$$

$$[Cd^{2+}] = \left[[Au^{3+}]^2 \cdot e^{[E_{cell}^{\circ} - E_{cell}] \frac{nF}{RT}} \right]^{1/3}$$

$$[Cd^{2+}] = \left[(0.10M)^2 \cdot e^{[1.90 - 1.92V] \frac{(6 \text{ mol } e^-) \cdot (96500 \frac{C}{\text{mol } e^-})}{(8.314 \frac{J}{\text{mol } K}) \cdot (298K)}} \right]^{1/3}$$

~~$[Cd^{2+}] = 0.18 M$~~

$[Cd^{2+}] = 0.045 M$

Always double check your calculator's answers!