

Name: K E Y
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} = 1.1×10^{-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} = 8.1×10^{-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, $Mg(s) | Mg^{2+}(aq) || Fe^{2+}(aq) | Fe(s)$, indicates that:

a. iron metal is the reducing agent

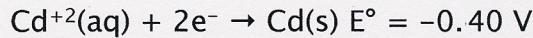
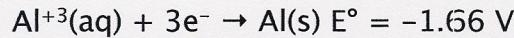
b. magnesium metal is the cathode

c. Fe^{2+} ions are oxidized

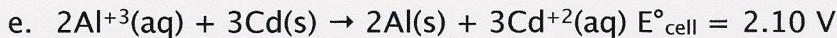
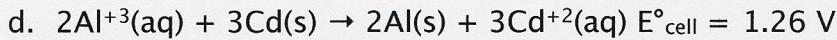
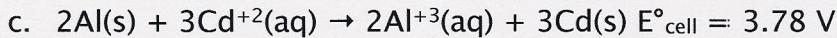
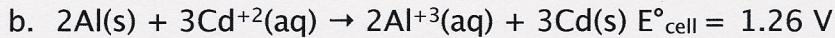
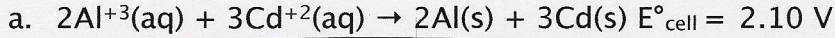
d. magnesium metal is the reducing agent

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

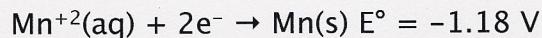
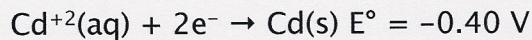
6. Consider the following two electrode reactions and their standard electrode potentials:



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 KAuCl_4 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?

(F = 96500 C/mol) Cathode half-reaction: $\text{AuCl}_4^-(\text{aq}) + 3\text{e}^- \rightarrow \text{Au}(\text{s}) + 4\text{Cl}^-(\text{aq})$

a. 1.08 A

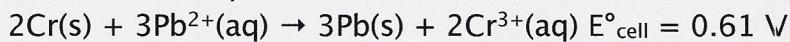
b. 3.26 A

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}

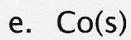
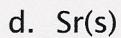
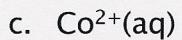
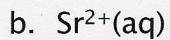
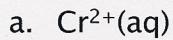
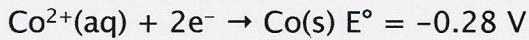
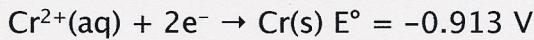
b. 8.1×10^{30}

c. 9.2×10^{45}

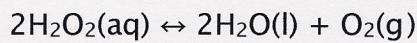
d. 3.2×10^{51}

e. 4.6×10^{22}

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



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



a. +0.640 V

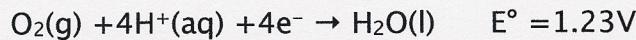
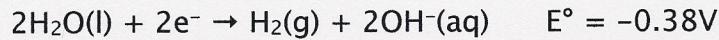
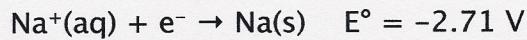
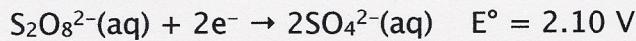
b. +1.09 V

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

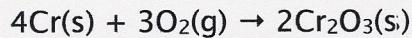
c. sulfate ion

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 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.

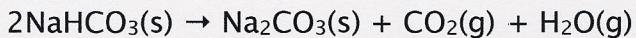
b. When ice melts, ΔS is positive and ΔH is negative.

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}

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

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

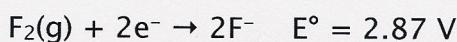
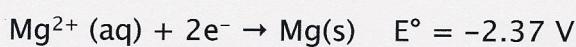
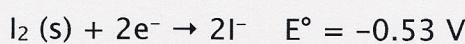
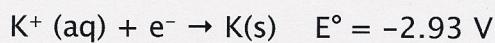
$$[OH^-]_i = 2 \cdot [Ca(OH)_2] = 2(0.000100 \text{ M}) = 0.000200 \text{ M}$$

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

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

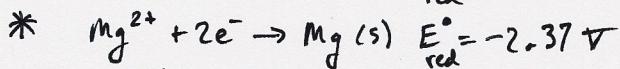
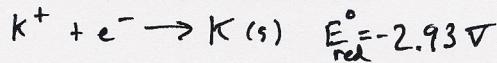
$Q_{sp} < K_{sp}$ \therefore No precipitate.

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.



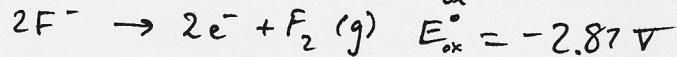
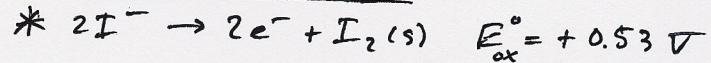
In our mixture we have: K^+ , I^- , Mg^{2+} , and F^- . Let's use the given E_{red}° values to determine which half-reactions occur most easily (require the least amount of energy).

Possible reductions:

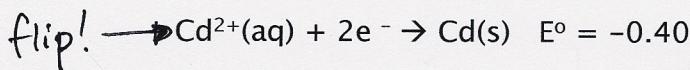
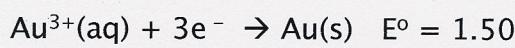


The 2 reactions with a * next to them will occur (higher E_{red}° 's). \therefore $Mg(s)$ and $I_2(s)$ will form.

Possible oxidations:



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.



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

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

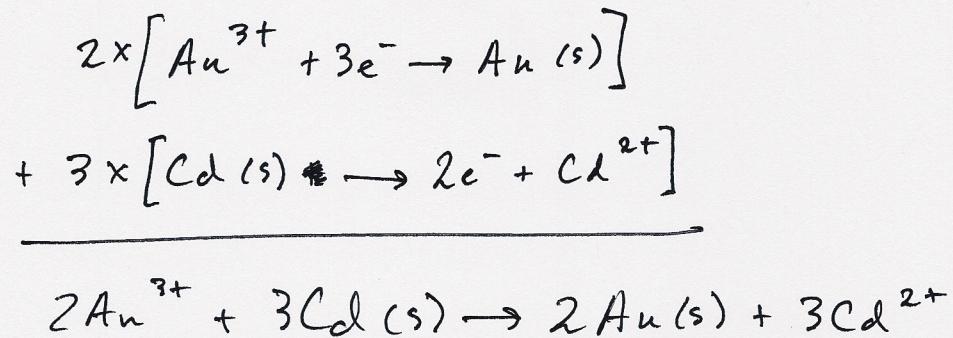
$$E_{cell} = E_{cell}^\circ - \frac{RT}{nF} \ln Q$$

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

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

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

The overall rxn is:



note: number of e^- transferred is
 $n = 6$. ————— (2)

and, $Q = \frac{[Cd^{2+}]^3}{[Au^{3+}]^2}$ ————— (3)

(2); (3) ~~plug into~~ (1)

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

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

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

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

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

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

Always double check your calculator's answers!