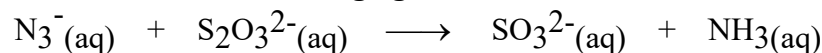


1. (10 points) Use the ion-electron method to balance the following redox reaction that occurs in *basic* solution. Write *complete, balanced equations* for the individual half-reactions and for the overall net ionic equation. Also, *circle the reducing agent* in this reaction.



Reduction Half Reaction:

Oxidation Half Reaction:

Net Ionic Equation:

2. (3 points) A compound sometimes called "calcium cerium selenate" has the formula $\text{CaCe}(\text{SeO}_4)_3$. Give the oxidation states of all four elements in this compound.

Ca = _____ O = _____ Ce = _____ Se = _____

3. (10 points) **SHOW ALL WORK.** A 100.0 mL sample of a solution of Sn^{2+} required 42.15 mL of 0.1100 M KMnO_4 to reach the equivalence point in a titration. Assuming that the main products of the redox reaction are Sn^{4+} and Mn^{2+} , determine the molarity of the Sn^{2+} solution. (*Note:* Your answer must include the *balanced, net-ionic equation* for the titration reaction.)

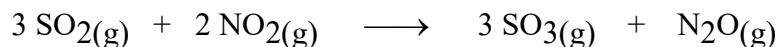
4. (6 points) Write **balanced ionic equations** for the half-reactions.

(a) The **cathode** reaction in the electrolysis of *aqueous* KNO_3 .

(b) The **anode** reaction in the electrolysis of *molten* Al_2O_3 .

(c) The **anode** reaction in the electrolysis of *aqueous* Na_2SO_4 .

5. Consider the following reaction and the related thermodynamic data below.

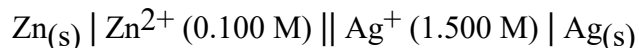


| Compound | Standard Heat of Formation (ΔH°_f) in kJ/mole | Standard Entropy (S°) in J/mole·K |
|--------------------------------|--|--|
| $\text{NO}_2(\text{g})$ | 33 | 240 |
| $\text{N}_2\text{O}(\text{g})$ | 82 | 221 |
| $\text{SO}_2(\text{g})$ | - 297 | 248 |
| $\text{SO}_3(\text{g})$ | - 396 | 257 |

(a) (10 points) **SHOW ALL WORK.** Is the above reaction spontaneous at 25 °C? Determine the appropriate thermodynamic quantity that is required in order to answer this question.

(b) (10 points) **SHOW ALL WORK.** Determine the **equilibrium constant** (K_p) for the above reaction at 600 °C.

6. A Zn/Ag **battery** is constructed based on the following electrochemical cell in which the volume of solution in each half-cell is 0.500 L.



- (a) (6 points) Write **balanced chemical equations** for the half-reactions and the overall **cell reaction** occurring in this device. Also, determine the **standard cell potential** (E°_{cell}).

cathode reaction:

anode reaction:

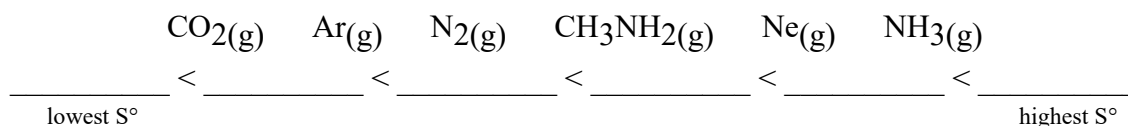
cell reaction:

- (b) (10 points) **SHOW ALL WORK.** This battery is pronounced "dead" when 98 % of its chemical capacity is used up (i.e., when the concentration of the major reactant has dropped to 2.00 % of its initial value). Calculate the cell potential (in volts) of the battery at this point.

- (c) (8 points) **SHOW ALL WORK.** Determine the current (in amps) that this battery could produce if it is operated continuously for 24 hours until it dies (based on the same 98 % definition of "dead"). (**Note:** The cell potentials from parts a and/or b above are not required here!)

7. (8 points) **SHOW ALL WORK.** A solution containing tungsten (W) ion in an unknown oxidation state was electrolyzed with a current of 1.25 amp for 6.00 hours. During this process, 12.86 g of metallic tungsten was deposited at the cathode. Determine the oxidation state of the tungsten ion in the original solution.

8. (4 points) Arrange the following substances in order of increasing standard molar entropy (S°).



9. (8 points) **SHOW ALL WORK.** Use appropriate electrochemical data to determine the *formation constant* (K_f) for $\text{PtCl}_4^{2-}(\text{aq})$. *Include balanced chemical equations for all relevant reactions.*

10. (7 points) **SHOW ALL WORK.** Acetone (a common organic liquid) has a normal boiling point of 56.1°C , a heat of vaporization of 31.3 kJ/mole , and a standard molar entropy [$S^\circ(\text{liq})$] of $200.4\text{ J/mole}\cdot\text{K}$. Calculate the standard molar entropy [$S^\circ(\text{g})$] of gaseous acetone (in $\text{J/mole}\cdot\text{K}$).

