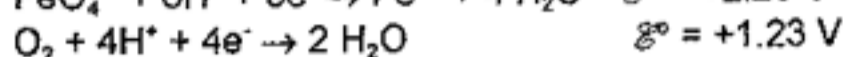
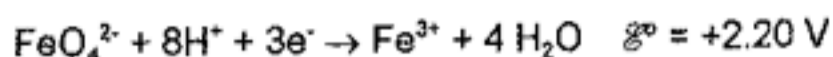


1. (12) What is a galvanic cell? Calculate $\mathcal{E}_{\text{cell}}^{\circ}$ for a galvanic cell based on the following half-reactions at 25 °C.



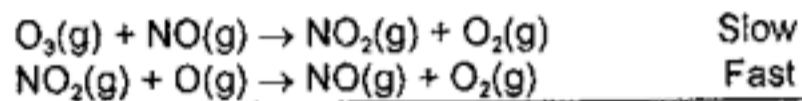
$$\text{Where } [\text{FeO}_4^{2-}] = 2.0 \times 10^{-3} \text{ M} \quad [\text{O}_2] = 1.0 \times 10^{-5} \text{ atm}$$

$$[\text{Fe}^{3+}] = 1.0 \times 10^{-3} \text{ M} \quad \text{pH} = 5.2$$

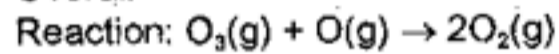
2. (10) A volume of 2.0 L of He at 46 °C, and 1.2 atm pressure, was added to a vessel that contained 4.5 L of N₂ at STP. What is the total pressure and partial pressure of each gas at STP after the He is added?
3. (8) What are the definitions of acids and bases according to Arrhenius concept and Brønsted-Lowry concept.
4. (8) Describe the first and second law of thermodynamics. You may use equations in your descriptions.
5. (15) Classify the following as either ionic, molecular, or atomic crystalline solids.
 a. dry ice b. graphite c. CaF₂(s)
 d. MnO₂(s) e. C₁₀H₈(s) (naphthalene).
6. (9) What are the allotropes of carbon? Describe their properties.
7. (10) A solution of [Cu(en)₂]²⁺ is green. The color of a [CuBr₄]²⁻ solution is violet. What does this tell you about the relative crystal field splitting energies? What ligand causes the greater splitting, en or Br?
8. (10) Calculate the pH of a 0.500 L solution that contains 0.15 M HCOOH (K_a = 1.8 × 10⁻⁴) and 0.20 M NaCOOH. Then, calculate the pH of the solution after the addition of 10.0 mL of 12.0 M NaOH.
9. (6) What is the maximum number of electrons that can be accommodated in the following?

- a. all orbitals with $n = 4$
- b. all the $4f$ orbitals
- c. all the $5g$ orbitals

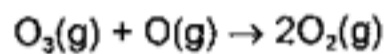
10. (12) One pathway for the destruction of ozone in the upper atmosphere is



Overall



- a. Which species is a catalyst?
- b. Which species is an intermediate?
- c. E_a for the uncatalyzed reaction



is 14.0 kJ. E_a for the same reaction when catalyzed is 11.9 kJ. What is the ratio of the rate constant for the catalyzed reaction to that for the uncatalyzed reaction at 25 °C? Assume the frequency factor A is the same for each reaction.