
OpenCourseWare (2023)

CHEMISTRY II

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EXERCISES OF ELECTROCHEMISTRY I



Exercise 1. Iron (II) is oxidized by dichromate ion in acidic solution to yield Fe^{3+} and Cr^{3+} . Write the balanced ionic equation.

Exercise 2. In the oxidation of CN^- by permanganate ion in basic medium, the following products are generated: CNO^- and MnO_2 . Write the balanced ionic equation.

Exercise 3. A galvanic cell consists of a Mg electrode in a 1 M $\text{Mg}(\text{NO}_3)_2$ solution and a Ag electrode in a 1 M AgNO_3 solution. Calculate the standard cell potential of this cell at 25 °C.

Data: $E^\circ (\text{Mg}^{2+}/\text{Mg}) = -2.37 \text{ V}$; $E^\circ (\text{Ag}^+/\text{Ag}) = +0.80 \text{ V}$.

Exercise 4. Given the following cell diagram: $\text{Pt} | \text{Fe}^{2+}, \text{Fe}^{3+} | | \text{Ag}^+ | \text{Ag}$

- Write the overall reaction in the cell. Indicate the oxidizing and reducing species.
- Calculate the equilibrium constant at 25 °C if the standard potential of the cell at this temperature is 0.028 V.

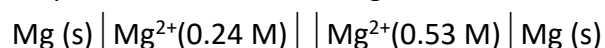
Data: $E^\circ (\text{Fe}^{3+}/\text{Fe}^{2+}) = +0.77 \text{ V}$; $E^\circ (\text{Ag}^+/\text{Ag}) = +0.80 \text{ V}$; $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$; $F = 96500 \text{ C mol}^{-1}$.

Exercise 5. A cell built with an electrode of solid MnO_2 introduced in a solution of Mn^{2+} (0.05 M) connected to another electrode of solid Zn in a solution of Zn^{2+} (0.01 M) generates a potential of 1.947 V at 25 °C and $\text{pH} = 4$.

- Write the half-reactions that take place at the anode and at the cathode and balance the global redox process. Identify the reducing and the oxidizing agents.
- Reason qualitatively how the cell potential varies if pH increases.

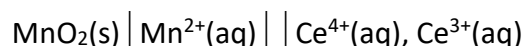
Data: $E^\circ (\text{Zn}^{2+}/\text{Zn}) = -0.76 \text{ V}$; $E^\circ (\text{MnO}_2/\text{Mn}^{2+}) = +1.23 \text{ V}$.

Exercise 6. Calculate the potential of the following cell at 25 °C:



Data: $E^\circ (\text{Mg}^{2+}/\text{Mg}) = -2.37 \text{ V}$.

Exercise 7. Given the following cell diagram in acidic medium and at 25 °C:



- Write the oxidation and reduction half-reactions and the adjusted overall redox equation.
- If the electrochemical cell works under standard conditions, would it be spontaneous? Would it be working as a galvanic cell or an electrolytic cell? Justify your answers.

If $[\text{Ce}^{3+}] = 10^{-2} \text{ M}$, $[\text{Ce}^{4+}] = 10^{-1} \text{ M}$, and $[\text{Mn}^{2+}] = 10^{-1} \text{ M}$:

- Calculate the pH at which the electrochemical cell is able to generate a potential of +0.65 V.
- Calculate the concentration of a HF solution necessary to reach the pH obtained in d).

Data: $E^\circ (\text{MnO}_2/\text{Mn}^{2+}) = +1.23 \text{ V}$; $E^\circ (\text{Ce}^{4+}/\text{Ce}^{3+}) = +1.61 \text{ V}$; $K_a (\text{HF}) = 6.6 \times 10^{-4}$, $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$; $F = 96500 \text{ C mol}^{-1}$.