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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 $Mg(NO_3)_2$ solution and a Ag electrode in a 1 M $AgNO_3$ solution. Calculate the standard cell potential of this cell at 25 ºC.
Data: $E°\ (Mg^{2+}/Mg) = -2.37$ V; $E°\ (Ag^{+}/Ag) = +0.80$ V.

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

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

Data: $E^0\ (Fe^{3+}/\ Fe^{2+}) = +0.77$ V; $E^0\ (Ag^{+}/\ Ag) = +0.80$ V; R = 8.314 J K^{-1} mol^{-1}; F = 96500 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 ºC and pH = 4.

a) 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 oxidazing agents.
b) Reason qualitatively how the cell potential varies if pH increases.

Data: $E^0\ (Zn^{2+}/Zn) = -0.76$ V; $E^0\ (MnO_2/Mn^{2+}) = +1.23$ V.

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

$$Mg\ (s)\ |\ Mg^{2+}(0.24\ M)\ ||\ Mg^{2+}(0.53\ M)\ |\ Mg\ (s)$$

Data: $E^0\ (Mg^{2+}/Mg) = -2.37$ V.

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

$$MnO_2(s)\ |\ Mn^{2+}(aq)\ ||\ Ce^{4+}(aq),\ Ce^{3+}(aq)$$

a) Write the oxidation and reduction half-reactions and the adjusted overall redox equation.
b) 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 $[Ce^{3+}] = 10^{-2}$ M, $[Ce^{4+}] = 10^{-1}$ M, and $[Mn^{2+}] = 10^{-1}$ M:

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

Data: $E^0\ (MnO_2/Mn^{2+}) = +1.23$ V; $E^0(Ce^{4+}/Ce^{3+}) = +1.61$ V; K_a (HF) = 6.6×10^{-4}, R = 8.314 J K^{-1} mol^{-1}; F = 96500 C mol^{-1}.