Exercise 8.64 – Electrode potentials

Q864-01 Given the standard electrode (reduction) potentials:

$$Cd^{2+}(aq) + 2e \longrightarrow Cd(s) \qquad E^{\ominus} = -0.40\ V$$
$$Ag^{+}(aq) + e \longrightarrow Ag(s) \qquad E^{\ominus} = +0.80\ V$$

What would be the $E^{\ominus}$ for a cadmium-silver cell?

A. 0.4 V
B. 0.5 V
C. 1.2 V
D. 2.0 V

Q864-02 The standard electrode potentials for Al and Mn are given below:

$$Al^{3+}(aq) + 3e \longrightarrow Al(s) \qquad E^{\ominus} = -1.66\ V$$
$$Mn^{2+}(aq) + 2e \longrightarrow Mn(s) \qquad E^{\ominus} = -1.18\ V$$

What is the potential of a cell prepared with these metals in contact with 1.0 mol dm^{-3} solutions of their ions?

A. 0.22 V
B. 0.48 V
C. 2.84 V
D. 3.43 V

Q864-03 Use the data below to determine $E^{\ominus}$ cell for the reaction:

$$Cl_2 + 2Br^- \longrightarrow 2Cl^- + Br_2$$

$$I_2(s) + 2e^- \longrightarrow 2I^-(aq) \qquad +0.54\ V$$
$$Ag^+(aq) + e^- \longrightarrow Ag(s) \qquad +0.80\ V$$
$$Br_2(l) + 2e^- \longrightarrow 2Br^-(aq) \qquad +1.07\ V$$
$$O_2(g) + 4H^+(aq) + 4e^- \longrightarrow 2H_2O(l) \qquad +1.23\ V$$
$$Cl_2(g) + 2e^- \longrightarrow 2Cl^-(aq) \qquad +1.36\ V$$

The value is:

A. -2.45 V
B. -0.27 V
C. +0.27 V
D. +2.45 V

Q864-04 Consider these standard electrode potentials:

$$Cu^{2+}(aq) + 1e \longrightarrow Cu^{+}(aq) \qquad E^{\ominus} = +0.15\ V$$
$$Cu^{+}(aq) + 1e \longrightarrow Cu(s) \qquad E^{\ominus} = +0.52\ V$$

What is the standard cell potential when the two half cells are connected?

A. -0.67V
B. -0.37V
C. +0.37V
D. +0.67V

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Q864-05 The standard electrode potentials of two metals are given below. Using this information what are the equation and cell potential for the spontaneous reaction that occurs?

$Tl^{+}(aq) + e^- \longrightarrow Tl(s)$ $\quad E^{\ominus} = -0.336\ V$
$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$ $\quad E^{\ominus} = +0.339\ V$

A. $Tl^{+}(aq) + Cu^{2+}(aq) \longrightarrow Tl(s) + Cu(s)$ $\quad E^{\ominus} = 0.003\ V$
B. $2Tl(s) + Cu^{2+}(aq) \longrightarrow 2Tl^{+}(aq) + Cu(s)$ $\quad E^{\ominus} = 0.675\ V$
C. $2Tl(s) + Cu^{2+}(aq) \longrightarrow 2Tl^{+}(aq) + Cu(s)$ $\quad E^{\ominus} = 1.011\ V$
D. $Tl^{+}(aq) + Cu(s) \longrightarrow 2Tl(s) + Cu^{2+}(aq)$ $\quad E^{\ominus} = 0.333\ V$

Q864-06 Draw a cell diagram for the cell formed by connecting the following standard half cells.

Ni(s)/Ni2+(aq) || Cd2+(aq)/Cd(s)

Given:

$Ni^{2+}(aq) + 2e \longrightarrow Ni(s)$ $\quad E^{\ominus} = -0.2\ V$
$Cd^{2+}(aq) + 2e \longrightarrow Cd(s)$ $\quad E^{\ominus} = -0.4\ V$

a) Write an equation for the reaction in each half cell.
b) Identify the species which is oxidised and the oxidising agent.

Q864-07 An electrochemical cell is constructed from two half cells connected by a high resistance voltmeter. One half cell contains nickel in a solution of nickel nitrate and the other half cell contains silver in a solution of silver nitrate.
a) State the conditions that must be applied to the solutions for the measurements taken in the cell to be considered as standard. [2]
b) Outline how the two half-cells must be connected before any voltage readings can be made.[2]
Assuming that standard conditions apply use the values from the data below to calculate the potential of the cell.

$Ni^{2+}(aq) + 2e^- \longrightarrow Ni(s)$ -0.20 V
$Ag^{+}(aq) + e^- \longrightarrow Ag(s)$ +0.80 V

Write the shorthand notation for the cell including state symbols and give the equation for the reaction occurring in the cell. [2]

Exercise 8.64 – Electrode potentials

Q864-08 A half cell (A) is set up by placing a platinum electrode in a solution containing both Fe^{2+} and Fe^{3+} ions at a concentration of 1 mol dm^{-3}. This half cell is then connected by means of a salt bridge to another half cell (B) containing an iron electrode in a 1 mol dm^{-3} solution of Fe^{2+} ions.
a) State the function of the salt bridge [1]

The two electrodes are connected externally.

b) Use the data below to determine the cell potential. [2]

$$Fe^{3+}(aq) + 1e^- \longrightarrow Fe^{2+}(aq) \qquad +0.77\ V$$
$$Fe^{2+}(aq) + 2e^- \longrightarrow Fe(s) \qquad -0.41\ V$$

Give the redox reactions that occur in each half cell. [2]
State the direction of electron flow in the external circuit. [1]

Q864-09 The standard electrode potentials for three electrode systems are given below:

$$Ti^{3+}(aq) + 1e \longrightarrow Ti^{2+}(aq) \qquad E^\ominus = -0.37\ V$$
$$Fe^{3+}(aq) + 1e \longrightarrow Fe^{2+}(aq) \qquad E^\ominus = +0.77\ V$$
$$Ce^{4+}(aq) + 1e \longrightarrow Ce^{3+}(aq) \qquad E^\ominus = +1.45\ V$$

Write an equation including state symbols for the overall reaction with the greatest cell potential. [2]

Q864-10 Calculate the cell potential of a cell made by connecting standard copper and zinc electrodes, given the following values for standard redox potentials.

$$Zn^{2+}(aq) + 2e \longrightarrow Zn(s) \qquad E^\ominus = -0.76\ V$$
$$Cu^{2+}(aq) + 2e \longrightarrow Cu(s) \qquad E^\ominus = +0.34\ V$$

a) State the direction of electron flow in the external circuit when the cell produces current.
b) Outline the changes occurring at the electrodes and in the solutions during the process [5]
