CONCEPT: CELL POTENTIAL: THE NERNST EQUATION

The Reaction Quotient

- Recall, the reaction quotient (__) is _________ of product to reactant concentrations at a particular time.
  - □ It can be calculated by setting up an expression and ignoring ____ and ____.
  - □ For electrochemical cells, it helps find the ________ potential at the exact moment the cell circuit is connected.

EXAMPLE: What is the reaction quotient for the following redox reaction with the given concentrations?

Pb^{2+} (aq) + 2 K (s) $\rightleftharpoons$ Pb (s) + 2 K^{+} (aq) $[Pb^{2+}]$ = 0.0880 M $[K^{+}]$ = 0.0015 M

Calculate Nonstandard Cell Potential

- Recall, standard cell potential is calculated when ions in half-cells have values of _____ M, _____ atm and pH = _____.
  - □ The **Nernst Equation** is used to find the cell potential when ion concentration(s) ____ ____ M.

The Nernst Equation Formula

$$E_{Cell} = \_\_\_\_\_\_ - \frac{\qquad}{\qquad} \log Q$$

- □ _______ = Nonstandard Cell Potential
- □ _______ = Standard Cell Potential
- □ _______ = moles of e^- transferred
- □ _______ = Reaction Quotient

EXAMPLE: Calculate the cell potential for a reaction at 25.0°C when given the following ionic concentrations and standard reduction potentials.

2 Co^{3+} (aq) + 3 Mg (s) $\rightleftharpoons$ 2 Co (s) + 3 Mg^{2+} (aq) $[Co^{3+}]$ = 1.0 M $[Mg^{2+}]$ = 0.0033 M

Standard Reduction Potentials

Co^{3+} (aq) + 3 e^- $\longrightarrow$ Co (s) $E°_{red}$ = + 1.82 V

Mg^{2+} (aq) + 2 e^- $\longrightarrow$ Mg (s) $E°_{red}$ = – 2.37 V

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PRACTICE: If [Br^-] = 0.010 M and [Al^{3+}] = 0.022 M, predict whether the following reaction would proceed spontaneously as written at 25ºC:

$$Al\ (s) + Br_2\ (l) \rightleftharpoons Al^{3+}\ (aq) + Br^-\ (aq)$$

Standard Reduction Potentials

Al^{3+} (*aq*) + 3 e^- $\longrightarrow$ Al (s) $E°_{red} = -1.66\ V$

Br_2 (l) + 2 e^- $\longrightarrow$ 2 Br^- (aq) $E°_{red} = +1.09\ V$

PRACTICE: Determine [Fe^{2+}] for the following galvanic cell at 25ºC if given [Sn^{2+}] = 0.072 M, [Fe^{3+}] = 0.0219 M, and [Sn^{4+}] = 0.00345 M.

$$Sn^{2+}\ (aq) + 2\ Fe^{3+}\ (aq) \rightleftharpoons Sn^{4+}\ (aq) + 2\ Fe^{2+}\ (aq) \qquad E_{cell} = +0.68\ V$$

Standard Reduction Potentials

Sn^{4+} (*aq*) + 2 e^- $\longrightarrow$ Sn^{2+} (*aq*) $E°_{red} = +0.151\ V$

Fe^{3+} (*aq*) + e^- $\longrightarrow$ Fe^{2+} (*aq*) $E°_{red} = +0.771\ V$