CONCEPT: BASIC REDOX CONCEPTS

OXIDATION-REDUCTION (REDOX) reactions deal with the transfer of electrons from one reactant to another.

$$Li\,(s) \;+\; Cl_2\,(g) \longrightarrow Li^+\,(aq) \;+\; 2\,Cl^-\,aq)$$

Lose **Electrons** **Oxidation** } Element becomes more positive } Oxidation Number Increases

Gain **Electrons** **Reduction** } Element becomes more negative } Oxidation Number Decreases

Reducing Agent (Reductant)

$$Li\,(s) \longrightarrow Li^+\,(aq) + e^-$$

Oxidizing Agent (Oxidant)

$$Cl_2\,(g) + 2\,e^- \longrightarrow 2\,Cl^-\,(aq)$$

Electrical Charge

The units for electrical charge are measured in _____ (C).

$$\underbrace{(1.602\times10^{-19}\,C)}_{\text{Charge of 1 electron}}\cdot(6.022\times10^{23}\,mol^{-1}) = \underbrace{\frac{9.647\times10^{4}\,C}{1\ mole\ e^-}}_{\text{Faraday Constant}}$$

$$\underset{\text{charge}}{q} = \underset{\text{mole } e^-}{n} \cdot \underset{\text{Faraday Constant}}{F}$$

Electrical Current

The units for electrical current are in _____ (A).

$$\underset{\text{Current}}{I} = \frac{\overset{\text{Charge}}{q}}{\underset{\text{Time}}{t}}$$

Electrical Voltage

The relationship between work and voltage can be expressed as:

$$\underset{\text{Work}}{w} = \underset{\text{Voltage}}{E} \cdot \underset{\text{Charge}}{q}$$

The relationship between Gibbs Free Energy and electric potential can be expressed as:

$$\underset{\text{Gibbs Free Energy}}{\Delta G} = -\,\underset{\text{mole } e^-}{n} \cdot \underset{\text{Faraday Constant}}{F} \cdot \underset{\text{Voltage}}{E}$$

Ohm's Law

The units for resistance are in _____ (Ω).

$$\underset{\text{Current}}{I} = \frac{\overset{\text{Voltage}}{E}}{\underset{\text{Resistance}}{R}}$$

Power

Power represents work done per unit of time. The units for power are in _____ (W).

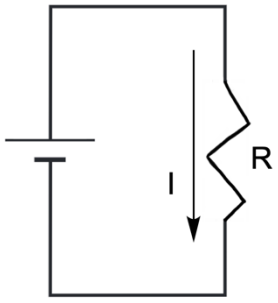
$$\underset{\text{Power}}{P} = \underset{\text{Voltage}}{E} \cdot \underset{\text{Current}}{I}$$

PRACTICE: BASIC REDOX CONCEPTS CALCULATIONS 1

EXAMPLE 1: What happens to the current in a circuit if a 3.0 V battery is removed and replaced by a 1.0 V battery?

EXAMPLE 2: If the voltage of a TE Series Enhanced Balance has a 240 V battery, what is the resistance in the circuit if the current is 0.80 A?

PRACTICE 1: Solve for the missing variable in the following circuit.

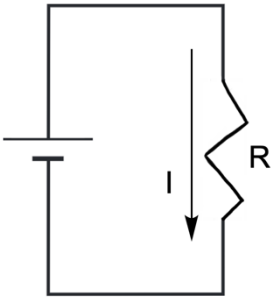


R = 320 ohms

I = ?

V = 24 V

PRACTICE 2: Solve for the missing variable in the following circuit.



R = 100 ohms

I = 1.5 A

V = ?

PRACTICE: BASIC REDOX CONCEPTS CALCULATIONS 2

EXAMPLE 1: Calculate $\Delta G°_{rxn}$ and $E°_{cell}$ for a redox reaction with n = 4 that has an equilibrium constant of K = 0.130 (at 25 °C).

EXAMPLE 2: Copper can be electroplated at the cathode of an electrolysis cell by the half-reaction:

$$Cu^{2+}\,(aq) + 2\,e^- \longrightarrow Cu\,(s)$$

How much time would it take for 525 mg of copper to be plated at a current of 4.3 A?

PRACTICE: A metal forms the salt MCl_3. Electrolysis of the molten salt with a current of 0.700 A for 6.63 h produced 3.00 g of the metal. What is the molar mass of the metal?

PRACTICE: BASIC REDOX CONCEPTS CALCULATIONS 3

EXAMPLE 1: In the following reaction:

$$Zn\,(s) + CuSO_4\,(aq) \rightarrow ZnSO_4\,(aq) + Cu\,(s)$$

What is the maximum energy produced when 15.0 g of Zn is completely reacted in a Zn-Cu electrochemical cell that has an average cell potential of 1.10 V?

EXAMPLE 2: A chemist weighing 110 lb takes her NMR sample from the first floor to the second floor, which is 12 meters up, in 25 seconds. How much power has she generated?

EXAMPLE 3: Determine the amount of time (in mins) needed to produce 1.7×10^2 watts from 1500 J of work committed.

CONCEPT: BALANCING REDOX REACTIONS

Generally, you will need to balance a redox reaction in an acidic or basic solution.

Balancing A Redox Reaction in Acidic Reactions:

STEP 1: Write the equation into 2 half-reactions.

STEP 2: Balance elements that are not oxygen or hydrogen.

STEP 3: Balance **Oxygens** by adding _____.

STEP 4: Balance **Hydrogens** by adding _____**.**

STEP 5: Balance overall charge by adding electrons (e^-) to the more _____ side. Both half reactions must have an _____ number of electrons.

STEP 6: Combine the half-reactions and cross out reaction intermediates.

Balancing A Redox Reaction in Basic Reactions:

Follow Steps 1-6 from above.

STEP 7: Balance remaining H^+ by adding an equal amount _____ ions to both sides of the chemical reaction.

EXAMPLE: Balance the following redox reaction in acidic solution.

$$Br^-(aq) + MnO_4^-(aq) \longrightarrow Br_2(l) + Mn^{2+}(aq)$$

PRACTICE: BALANCING REDOX REACTIONS CALCULATIONS 1

EXAMPLE: Balance the following redox reaction in acidic solution.

$$Cr_2O_7^{2-}(aq) + H_2O_2(aq) \longrightarrow Cr^{3+}(aq) + H_2O(l) + O_2(g)$$

PRACTICE: Balance the following redox reaction in basic solution.

$$Cr_2O_7^{2-}(aq) + SO_3^{2-}(aq) \longrightarrow Cr^{3+}(aq) + SO_4^{2-}(aq)$$