

AP Chem Unit 3: Electrochem Review

OIL RIG – oxidation is loss, reduction is gain (of electrons)

Rules for Assigning Oxidation Numbers (in order of priority)

If any rules are in conflict, follow the rule that is _____ on the list!

Oxidation Rules:

- Free elements = 0
- All atoms in a neutral compound add up to 0.
- All atoms in a polyatomic ion add up to the ion's charge.
- The rules below apply to bonded elements:
 - Group 1A metals = +1
 - Group 2A = +2
 - Non-metals usually follow the chart to the right, in order:
 - Note: the carbon family (4A) isn't mentioned – you will ALWAYS have to solve for the oxidation number of group 4A elements in a compound.

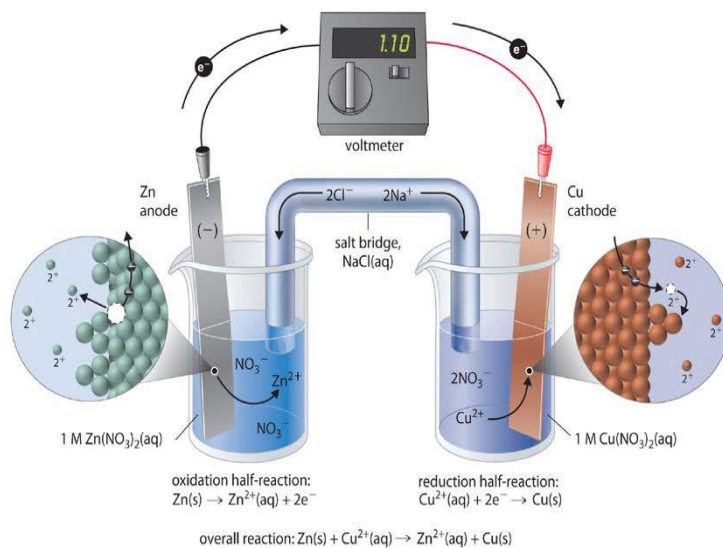
Nonmetal	Oxidation State	Example
Fluorine	-1	MgF ₂ -1 ox state
Hydrogen	+1	H ₂ O +1 ox state
Oxygen	-2	CO ₂ -2 ox state
Group 7A	-1	CCl ₄ -1 ox state
Group 6A	-2	H ₂ S -2 ox state
Group 5A	-3	NH ₃ -3 ox state

Electrochemistry Involves TWO MAIN TYPES Of Electrochemical Cells:

- Galvanic (voltaic) cells – thermodynamically favorable → **battery** (+E_{cell}, -ΔG, K > 1)
- Electrolytic cells – thermodynamically unfavorable and require external power source (-E_{cell}, +ΔG, K < 1)

GALVANIC or VOLTAIC CELL “ANATOMY”

- Anode – (An Ox) the electrode where oxidation occurs, loses mass into solution as the cell runs (“anode”-rexic)
- Cathode – (Red Cat) the electrode where reduction occurs, gains mass from solution as the cell runs (fat cat)
- Inert electrodes – used when a gas is involved OR ion to ion; Pt (expensive) or graphite (cheap)
- Salt bridge – used to maintain electrical neutrality in a galvanic cell: **anions to anode, cations to cathode**
- Electron flow – ALWAYS through the wire from anode to cathode (alphabetical order) **FAT CAT



CELL POTENTIAL, E_{cell}

- it is a measure of the electromotive force or the “pull” of the electrons as they travel from the anode to the cathode, measured in Volts (V)
- E_{cell} becomes E^o_{cell} when measurements are taken at standard conditions (1 atm, 1.0 M, and 25°C)

Standard Electrode Potentials (will be given as needed for each problem!)

- Galvanic/voltaic cells: **The MORE POSITIVE reduction potential is reduced**

Calculating Standard Cell Potential Symbolized by E°_{cell}

1. The Metal with the MORE POSITIVE REDUCTION POTENTIAL is be REDUCED, so the other is oxidized.
2. Reverse the equation that will be oxidized and change the sign of its voltage: this is now E°_{ox} .

$$E^\circ_{\text{cell}} = E^\circ_{\text{ox}} + E^\circ_{\text{red}}$$

DEPENDENCE OF CELL POTENTIAL ON CONCENTRATION

- Voltaic cells at NONstandard conditions: Le Chatlier's principle can be applied. An increase in the concentration of a reactant will favor the forward reaction and the cell potential will increase. The converse is also true!
 - \uparrow [reactants] or \downarrow [products]: $E_{\text{cell}} > E^\circ_{\text{cell}}$, \uparrow voltage
 - \downarrow [reactants] or \uparrow [products]: $E_{\text{cell}} < E^\circ_{\text{cell}}$, \downarrow voltage
- For free response, write out how you calculate the value of the reaction quotient, Q , and compare that value to when $Q = 1$ (standard conditions).
 - **$Q > 1$** : As the concentration of the products of a redox reaction increases, the value of the reaction quotient, Q , increases and therefore the voltage decreases as the reaction shifts to the left decreasing the driving force.
 - **$Q < 1$** : As the concentration of the reactants of a redox reaction increases, the value of the reaction quotient, Q , decreases and therefore the voltage increases as the reaction shifts to the right increasing the driving force.

ELECTROLYTIC CELLS

- Thermodynamically unfavorable, therefore $+\Delta G^\circ$ and $-\Delta E^\circ$
- Since an electrolytic cell is NOT spontaneous, it will undergo a redox reaction only if an outside power source is applied!
- AN OX and RED CAT still work
- Used to separate ores or plate out metals.

In an electrolytic cell, the amount of product made is related to the number of electrons transferred. Essentially, the electrons are a reactant.

You will need to be able to do two basic calculations for quantitative electrolysis:

1. Given time (sec) and current (A), calculate mass (g).
2. Given mass (g) and current (A), calculate time required (sec).

Quick Trick to remember the order of steps to calculate mass of a metal produced (given time and current):

Are you **SAFE**? **MMM**.

