OXIDATION-REDUCTION (REDOX) REACTIONS

A. Oxidation States:

B. Rules for assigning oxidation states:

1. Assign an oxidation state to each atom in a compound or polyatomic ion according to the table below.

Substance	Oxidation State	Examples
Element atom	Zero	Na, Fe, F_2
Monatomic ion	Charge of ion	Na^+: +1 oxidation state S^{2-}: -2 oxidation state
F in compounds	-1	HF, PF_3
O in most compounds/ions	-2	H_2O, NO_2, ClO_4^-
O in peroxides	-1	H_2O_2
H in covalent compounds	+1	HCl, NH_4^+
H as an anion (hydride)	-1	NaH

2. For atoms not listed in the table, solve for their oxidation state using the following formula:

   Charge on compound/polyatomic ion = sum of oxidation states of all atoms in the compound/ion

   Example: ClO_4^-

C. Oxidation-Reduction Reaction (REDOX)

1. Oxidation:

2. Reducing Agent:

3. Reduction:

4. Oxidizing Agent:

BALANCING OXIDATION-REDUCTION REACTIONS
HALF-REACTION METHOD

A. ACIDIC SOLUTION (excess H^+ ions present)

1. Split the complete reaction into 2 half-reactions (oxidation and reduction). Perform steps 2 through 4 for each half-reaction.

2. Balance your atoms first! Don't worry about electrons yet. Perform the following in order:

   a. Balance everything EXCEPT H and O first.
   b. Balance any O using H_2O.
   c. Balance any H using H^+ ions.

   Double-check that all of your atoms are balanced!

3. Balance your charges using electrons. The total charge of the reactant side must equal the total charge on the product side. Add electrons to the more positive side of the arrow until this occurs. Each electron has a -1 charge.

4. Compare the two half-reactions. The number of electrons present in each half-reaction must be equal before they may be recombined! Multiply each reaction by the appropriate number to make this happen.

5. Recombine the 2 half-reactions to form a single reaction.

6. Cancel any species that are on both sides of the arrow.

   ~~10~~A + 2B → 3C + D +~~5A~~ (A is on both sides of the arrow)
   5A + 2B → 3C + D (Cancel 5A on each side)

   Make sure your electrons completely cancel! If they don't, something is not right and the equation won't be balanced.

Yeah!! The equation should now be balanced (acidic solutions).
Atoms balanced + charges balanced = equation balanced

B. BASIC SOLUTION (excess OH^- ions present)

1. To balance an equation in basic solution, first perform steps 1 – 6 from above.

2. Count the number of H^+ ions in the equation. To both sides of the arrow, add # OH^- ions that equal # H^+ ions.

   $5H^+ + A + 3B \rightarrow C + 5D + 8H_2O$ (there are 5 H^+ on left side of arrow)
   $\boxed{5OH^- + 5H^+} + A + 3B \rightarrow C + 5D + 8H_2O + 5OH^-$ (add 5 OH^- ions to both sides)

3. Combine H^+ and OH^- to form H_2O ($5H^+ + 5OH^- = 5H_2O$)

   $5H_2O + A + 3B \rightarrow C + 5D + 8H_2O + 5OH^-$

4. Cancel any duplicate species (like in step 6 above).

   ~~$5H_2O$~~ + A + 3B → C + 5D +~~8~~H_2O + $5OH^-$
   A + 3B → C + 5D +$3H_2O$ + $5OH^-$

The equation should now be balanced (in basic solution)

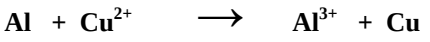
For each of the following: **Assign Oxidation States (Numbers) to each atom**

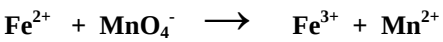
Identify the species being reduced and the species being oxidized

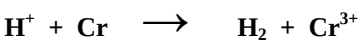
Identify the reducing agent and the oxidizing agent

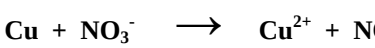
Balance each redox reaction using the Half-Reaction method

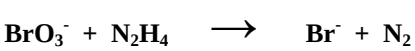
ACIDIC SOLUTIONS (excess H^+ ions present):











BASIC SOLUTIONS (excess OH^- ions present):