

Using data to make your own simple Redox table

Example problem:

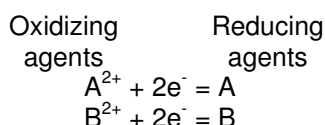
- 1) Four metals A, B, C, & D were tested with separate solutions of A^{2+} , B^{2+} , C^{2+} & D^{2+} .
Some of the results are summarized in the following table:

Solution				
Metal	A^{2+}	B^{2+}	C^{2+}	D^{2+}
A		(1) no reaction	(2) reaction	
B				(4) no reaction
D	(3) reaction			

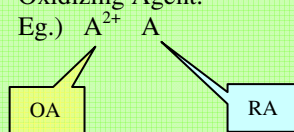
List the ions in order from the strongest to weakest oxidizing agent.

Using data

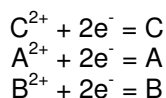
- 1) – Since B^{2+} does not oxidize A : B^{2+} must be below A on the table.



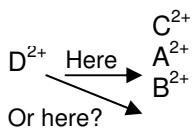
NOTE: For the same element: The more positive species is always the Oxidizing Agent.



- 2) – Since C^{2+} reacts with A: C^{2+} must be above A:



- 3) – Since A^{2+} reacts with D: A^{2+} must be above D on the table. But is D^{2+} above or below B^{2+} ? We don't know yet.



Let's look at the next information:

- 4) – D^{2+} does not react with B

- Now we know that D^{2+} must be below B on the table

So now we have our complete table:

Oxidizing agents	Reducing agents
$C^{2+} + 2e^- = C$	
$A^{2+} + 2e^- = A$	
$B^{2+} + 2e^- = B$	
$D^{2+} + 2e^- = D$	

- At this point its good to go back and recheck that all the data given is consistent with your table.
- So now we have our answer; The ions in order of strongest to weakest ox agent is: C^{2+} , A^{2+} , B^{2+} , D^{2+}
- Just in case you're asked, you can see that the order of reducing agent from strongest to weakest is D, B, A, C.

Another example –

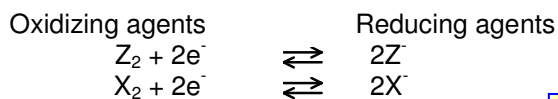
Four non-metal oxidizing agents X_2 , Y_2 , Z_2 and W_2 are combined with solutions of ions: X^- , Y^- , Z^- and W^- .

The following results were obtained:

- (1) X_2 reacts with W^- and Y^- only.
- (2) Y^- will reduce W_2

List the reducing agents from strongest to weakest

- (1) X_2 will be above W^- & Y^- , but below Z^-

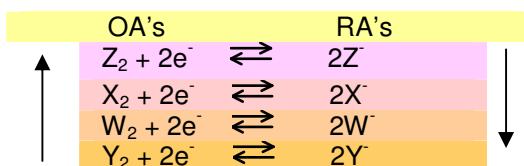


} W^- & Y^- }
 Are both below X_2 ,
 but we don't know in
 which order yet.

NOTE: For the same element: The more positive species is always the Oxidizing Agent.
 Eg.) X_2 X^-



- (2) Since Y^- reduces W_2 , Y^- must be lower on the right of W_2 .



To answer the question:

The reducing agents from strongest to weakest are: Y^- , W^- , X^- , Z^-

Question:

Four solutions $A(NO_3)_2$, $B(NO_3)_2$, $C(NO_3)_2$, and $D(NO_3)_2$ are added to metals, A, B, C, & D

The following information is found:

- (1) The metal A will not react with any of the solutions
- (2) $C(NO_3)_2$ reacts spontaneously with B
- (3) B will not react with $D(NO_3)_2$

- (a) Make a small reduction table showing reductions of the metallic ions. (Don't forget to **discard** the **spectator** nitrate ions.)

- (b) List the oxidizing agents in order of strongest to weakest:

- (c) List the reducing agent in order of strongest to weakest:

- (d) Would it be safe to store $A(\text{NO}_3)_2$ solution in a container made of the metal D? _____

Do Exercises 14,15,16 & 18 on p. 200 of SW.

Balancing half-reactions

-Some half-rx's are on the table, but not all.

-Given if the soln. Is **acidic** or **basic**.

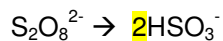
Pay attention!

-Think of **Major Hydroxide** (Major \rightarrow O \rightarrow H \rightarrow - (charge))

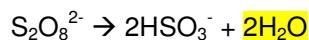
Major atoms \rightarrow atoms other than O & H

Acid Soln. E.g.) $\text{S}_2\text{O}_8^{2-} \rightarrow \text{HSO}_3^-$ (acid soln.)

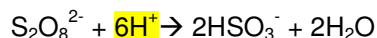
- (1) Balance Major Atoms (S in this case)



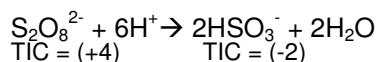
- (2) Balance "O" atoms, by adding H_2O (to the side with less O's)



- (3) Balance "H" atoms by adding H^+ (to the side with less H's)

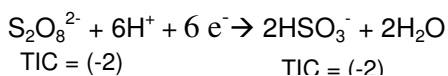


- (4) Balance charge by adding e^- 's (to the more + side)



The left side needs $6e^-$'s
to get a -2 charge

So the final balanced half-rx is:



-Always double-check these!

-Don't miscopy charges, etc.

Try this one: $\text{MnO}_4^- \rightarrow \text{Mn}^{2+}$ (acid soln)

In basic solution

-Do the first steps of the balancing just like an acid

E.g.) $\text{MnO}_2 \rightarrow \text{MnO}_4^-$ (basic solution)

Major (Mn already balanced)

Oxygen $2\text{H}_2\text{O} + \text{MnO}_2 \rightarrow \text{MnO}_4^-$

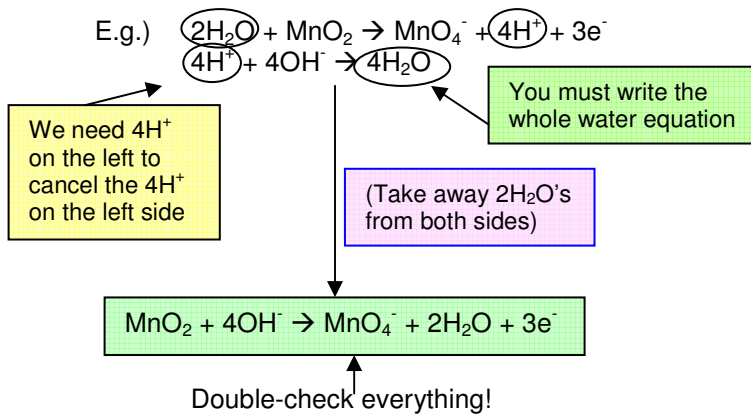
Hydrogen $2\text{H}_2\text{O} + \text{MnO}_2 \rightarrow \text{MnO}_4^- + 4\text{H}^+$

Charge $2\text{H}_2\text{O} + \text{MnO}_2 \rightarrow \text{MnO}_4^- + 4\text{H}^+ + 3\text{e}^-$

In basic solution: write the reaction $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$ or $\text{H}_2\text{O} \rightarrow \text{H}^+ + \text{OH}^-$

-In whichever way is needed to cancel out the H^+ 's

-Add to the half-rx

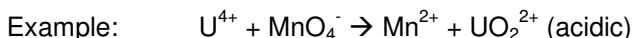


Try this one: $\text{Pb} \rightarrow \text{HPbO}_2^-$ (basic soln)

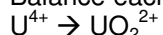
-Reactions without H's or O's are done in **neutral** soln -Do Ex 19 a-m p. 203

Balancing overall redox reactions using the half-reaction (half-cell) method

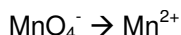
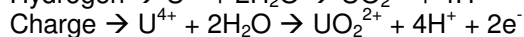
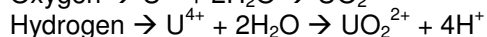
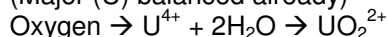
- (1) Break up Rx into 2 half-rx's.
- (2) Balance each one (in acidic or basic as given)
- (3) Multiply each half rx by whatever is needed to cancel out e⁻'s
(Note: balanced half-rx have e⁻'s (on left reduction on right oxidation) Balanced redox don't have e⁻'s)
- (4) Add the 2 half-rx's canceling e⁻'s and anything else (usually H₂O's, H⁺'s or OH⁻'s) in order to simplify.



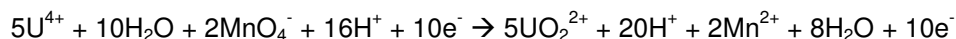
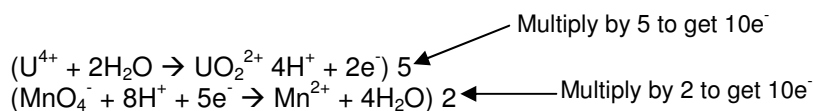
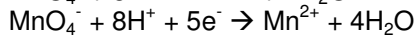
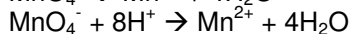
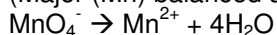
Balance each 1/2 rx



(Major (U) balanced already)

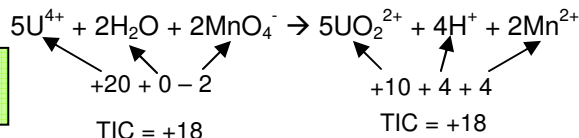


(Major (Mn) balanced already)



To simplify:

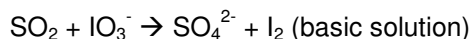
- Take away 10e⁻ from both sides
- Take away 16H⁺'s from both sides
- Take away 8H₂O's from both sides



Quick check by finding TIC's on both sides

- If you have time check all atoms also if TIC's are not equal you messed up! Somewhere! Find it!

Try this one:



-See examples p.205-207 in SW

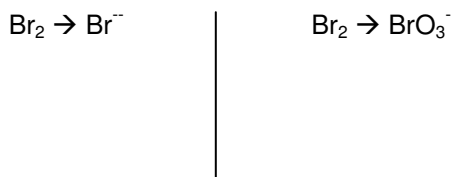
Quick notes

-Some redox equations have just **one reactant**

- Use this as the reactant in **both half-rx's**.
- These are called “self-oxidation-reduction” or **Disproportionation** reactions.

Eg) $\text{Br}_2 \rightarrow \text{Br}^- + \text{BrO}_3^-$ (basic) (found in some hot tubs)

Half rx's are:



Answer: _____

Do Ex 24 a-w p. 207

The more practice the better! See me if you want more!

Balancing redox equations using the oxidation number method

-This is optional

- As long as one method (not guessing!) works for you that's fine. (This method or half-rx method.)
- Read examples p. 271-272 SW
- Do any ex 10 a-n & check with key

Redox titrations

- same as in other units (solubility/acids-bases)
- coefficient ratios for the “mole bridge” are obtained by the balanced redox equation:

TITRATIONS	
<i>STANDARD</i>	<i>SAMPLE</i>
Conc. & Volume \rightarrow moles or Mass \rightarrow	<i>moles</i> \rightarrow Conc. or Volume
mol = M x L or: grams x $\frac{1 \text{ mol}}{\text{MM g}} = \text{mol}$	M = mol/L or L = mol/M

Eg) Acidified hydrogen peroxide (H_2O_2) is used to titrate a solution of MnO_4^- ions of unknown concentration. Two products are O_2 gas and Mn^{2+} .

a) Write the **balanced redox equation**:

b) It takes 6.50 mL of 0.200 M H_2O_2 to titrate a 25.0 mL sample of MnO_4^- solution. Calculate the original $[\text{MnO}_4^-]$.

Finding a suitable solution titrate a sample

Use redox table:

- If sample is on the **left** (OA)
Use something **below it on the right**. (RA)
- If sample is on the **right** (RA) use something **above it on the left** (OA)
- Good standards will **change colour** as they react

Acidified MnO_4^- (purple) = Mn^{2+} (clear)

Acidified $\text{Cr}_2\text{O}_7^{2-}$ (orange) = Cr^{3+} (pale green)

Read p. 210-212 carefully – go over the examples! Do ex 26 & 29 p. 213-214 SW.