

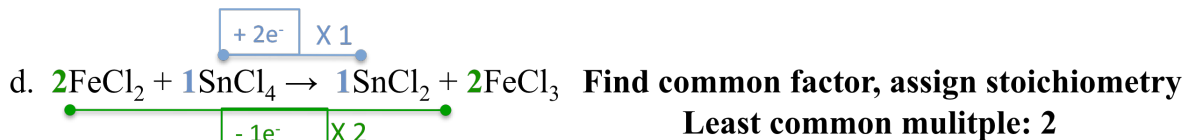
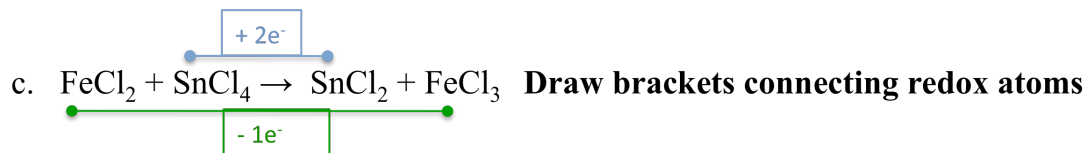
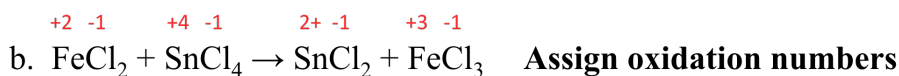
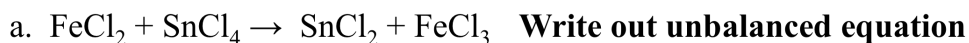
## KEY Review: Worksheet on Balancing Redox Equations

Two methods are often mentioned for balancing redox reactions: the half reaction method and the change in oxidation method. They actually involve the same procedure. In the first case you separate out the oxidation and reduction half reaction and in the second case, you do it all at once. I prefer the latter. The half reaction method is shown in the text but I will explain the change in oxidation method here.

Change in Oxidation Procedure:

- Write out as much of the unbalanced reaction as possible
- Assign oxidation numbers
- Draw brackets to connect the atoms that are oxidized and the atoms that are reduced. Write the net increases and decreases in electrons.
- Find the factors that create the least common multiple and use these to assign balanced stoichiometry for the reaction.

### Example 1: No O or H atoms in equation



### Complication: pH-dependent redox reactions.

Very often we will work with redox reactions that are dependent on the acidity or basicity of a reaction. When this occurs, we need to balance the numbers of O and H atoms that appear in  $H^+$ ,  $OH^-$  and  $H_2O$  species in the reaction.

For example, in acid  $MnO_4^- \rightarrow Mn^{2+}$  is a 5 electron process  
in base  $MnO_4^- \rightarrow MnO_2$  is a 3 electron process

Note the change in oxidation number means a different equivalent weight for the  $MnO_4^-$  depending on the reaction.

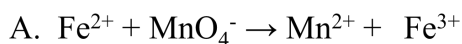
So we need to add an additional step in balancing redox reactions:

**e/f.** Rules for acid solution: balance O by adding  $H_2O$ , then balance H by adding  $H^+$

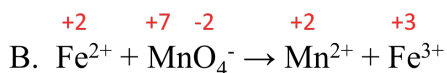
Rules for basic solution: for each O, add two  $OH^-$  to side needing O and one  $H_2O$  to other side for each  $H^+$ , add one  $H_2O$  to side needing  $H^+$  and one  $OH^-$  to other side.

[Alternatively for base simply first balance in acid, then add enough  $OH^-$  to neutralize all the  $H^+$  followed by cancelling out any  $H_2O$  that appears on each side of the reaction.]

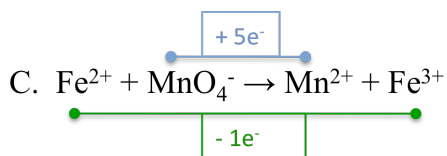
#### Example 2. Balancing redox reactions in acid.



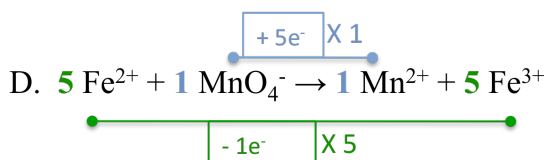
Write out unbalanced equation



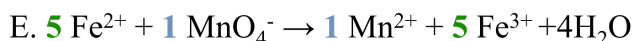
Assign oxidation numbers



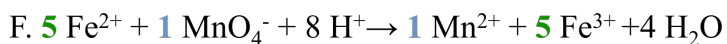
Draw brackets connecting redox atoms



Find common factor, assign stoichiometry  
LCM: 5

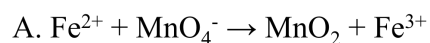


Acidic solution balance of O atoms

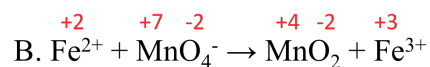


Acidic solution balance of H atoms

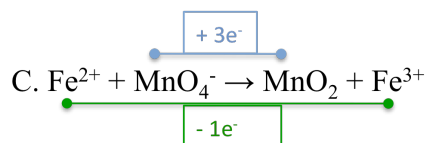
### Example 3. Balancing redox in a basic solution



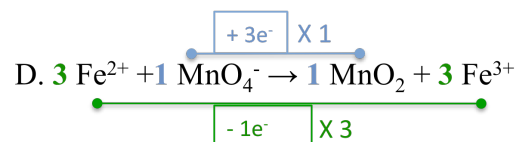
Write out unbalanced equation



Assign oxidation numbers



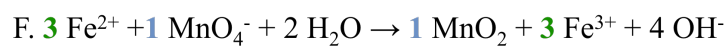
Draw brackets connecting redox atoms



Find common factor, assign stoichiometry  
LCM: 3



Basic solution balance of  
O atoms



Basic solution balance of  
H atoms