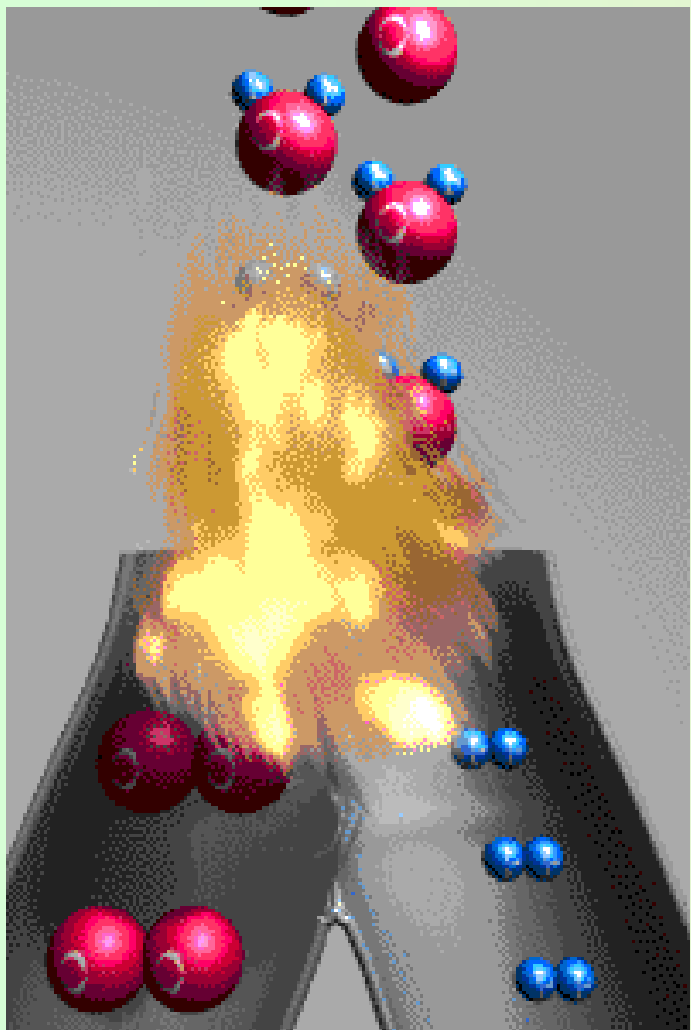


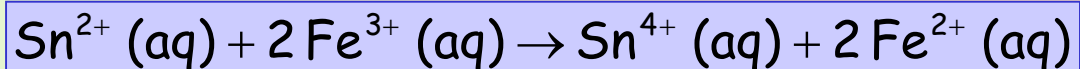
# Balancing Oxidation-Reduction Equations



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## Half-Reactions

Although oxidation and reduction must take place simultaneously, it is often convenient to consider them as separate processes. For example, the oxidation of  $\text{Sn}^{2+}$  by  $\text{Fe}^{3+}$

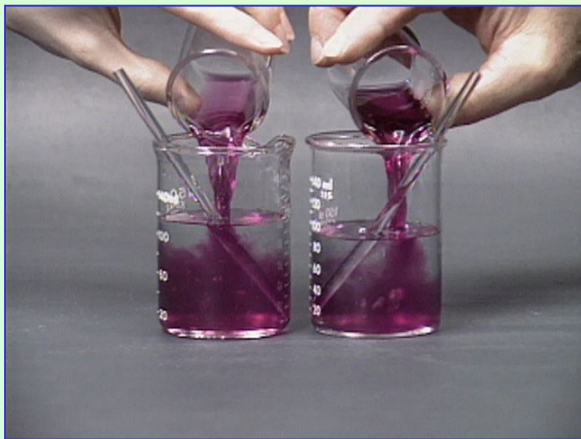


can be considered to consist of two processes: 1) the oxidation of  $\text{Sn}^{2+}$  and 2) the reduction of  $\text{Fe}^{3+}$



Equations that show either oxidation or reduction alone are called **half-reactions**.

# Balancing Oxidation-Reduction Equations



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## Balancing Equations by the Method of Half-Reactions

The use of half-reactions provides a general method for balancing oxidation-reduction equations.

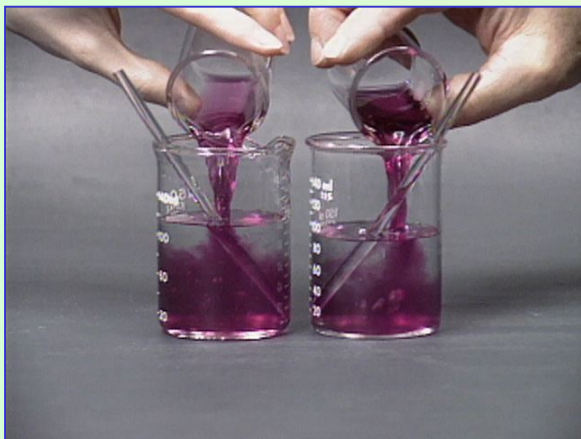
In general, we begin with a "skeleton" ionic reaction, which shows only the species that are oxidized and reduced. If the oxidized form of a species is on the left side of the skeleton reaction, the reduced form is on the right, and vice versa.

The following steps are used in balancing a redox reaction by the half-reaction method:



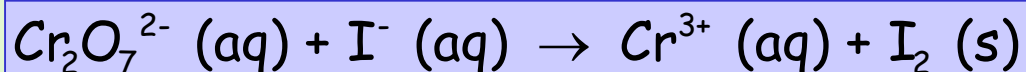
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# Balancing Oxidation-Reduction Equations

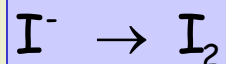
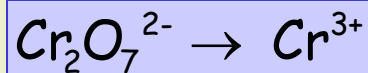


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## Balancing Equations by the Method of Half-Reactions



**Step #1.** Divide the skeleton reaction into two half-reactions, each of which contains the oxidized and reduced forms of one of the species



**Step #2.** Balance the atoms and charges in each half-reaction.

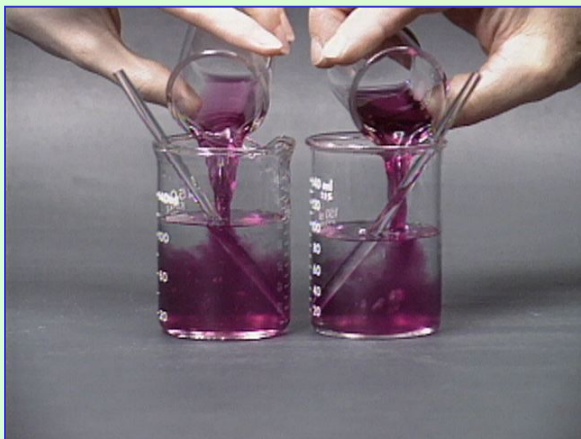
- Atoms are balanced in the following order: atoms other than O and H, then O, and then H.
- Charge is balanced by adding electrons.



<http://jchemed.chem.wisc.edu/JCeSoft/CCA/CCA3/STILLS/AUTOCAT/AUTOCAT/64JPG48/10.JPG>



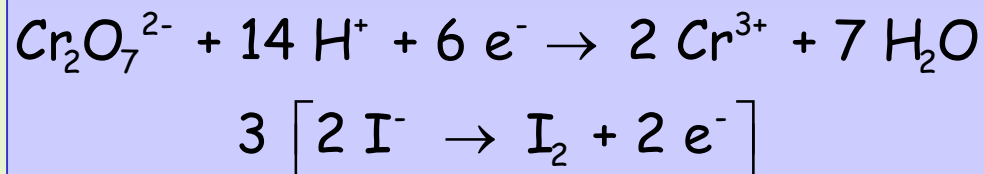
# Balancing Oxidation-Reduction Equations



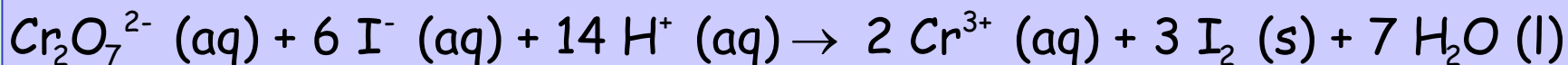
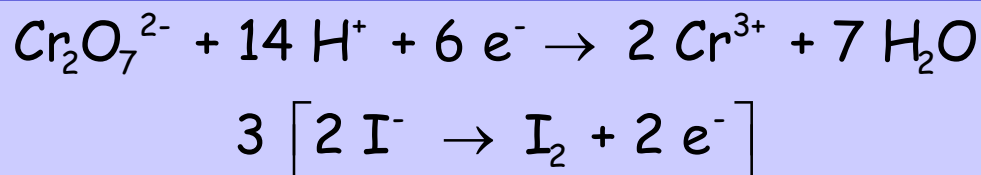
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## Balancing Equations by the Method of Half-Reactions

**Step #3.** Multiply each half-reaction by some integer, if necessary, to make the number of  $e^-$  gained equal to the number of  $e^-$  lost.



**Step #4.** Add the balanced half-reactions and include states of matter.

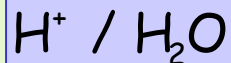


# Balancing Oxidation-Reduction Equations

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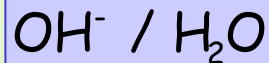
## Balancing Redox Reactions in Acidic Solution

In the balancing process these species can be used:



## Balancing Redox Reactions in Basic Solution

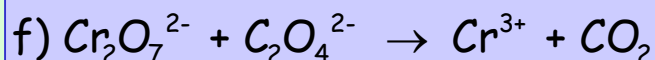
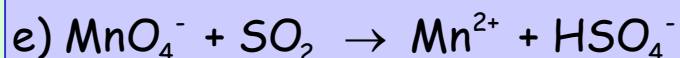
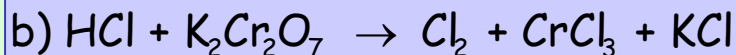
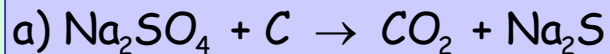
In the balancing process these species can be used:



# Balancing Oxidation-Reduction Equations

## EXERCISES:

1. Balance the following equations (in acidic solution):



2. Balance the following equations (in basic solution):

