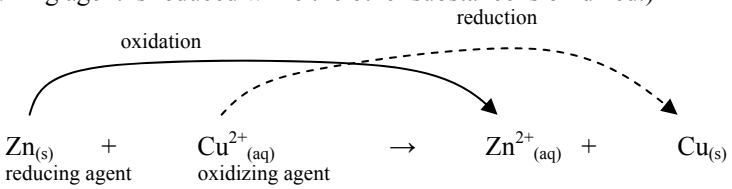
9.3 Predicting Redox Reactions

- In a redox reaction, electrons are transferred from one substance to another. Since atoms are stable, we need to think of this as a tug of war. One substance pulls electrons away from the other substance. If the substance doing the pulling is successful then the reaction is spontaneous.
- How do you tell if a reaction is spontaneous? You don't. You need to base your predictions on empirical evidence.
- See Appendix C11.

Oxidizing and Reducing Agents

- Reducing agent: a substance that loses or gives up electrons to another substance in a redox reaction. (The reducing agent is oxidized while the other substance is reduced.)
- Oxidizing agent: a substance that gains or removes electrons from another substance in a redox reaction. (The oxidizing agent is reduced while the other substance is oxidized.)
- E.g.



Developing a Redox Table

- Some single displacement reactions are spontaneous but most are not. How do you know which ones are spontaneous without actually doing the experiment? By creating a redox table.
- See tables 1,2,3 on page 675 and 676, showing the relativities of 4 metals and their ions.
- When creating a redox table always write the half reaction as a reduction. Also, use double headed arrows to show the reverse oxidation reaction (even if the reaction is not reversible and is not an equilibrium).

The Spontaneity Rule

- Redox Spontaneity Rule: a spontaneous redox reaction occurs only if the oxidizing agent is above the reducing agent in a table of relative strengths of oxidizing and reducing agents.
- In other words, once you develop a redox table containing the substances you plan to react, if the oxidizing agent is higher on the table than the reducing agent then the reaction will be spontaneous.

An Extended Redox Table

- Appendix C11 on page 805 has been developed with the input of many scientists over many years.

Predicting Redox Reactions in Solution

- In solutions molecules and ions act independently of each other and all must be considered.
- Table 5 on page 680 gives excellent hints on how to label the compounds. Also, the blue box at the bottom of page 680 give a good explanation of how to identify and label the various substances in the reaction.
- E.g. Should a copper pipe be used to transport hydrochloric acid solution?

All entities present in the reaction

$Cu_{(s)}$ $H^+_{(aq)}$ $Cl^-_{(aq)}$ $H_2O_{(l)}$

Using the hints from table 5 on page 680 and appendix C11 label the entities as OA (oxidizing agent) and RA (reducing agent). Show any linked entities

	OA		*OA*
$Cu_{(s)}$	$H^+_{(aq)}$	$Cl^-_{(aq)}$	$H_2O_{(l)}$
RA		*RA* \ RA /	*RA*

Using C11 determine the strongest oxidizing agent(SOA) and the strongest reducing agent(SRA).

	SOA		*OA*
$Cu_{(s)}$	$H^+_{(aq)}$	$Cl^-_{(aq)}$	$H_2O_{(l)}$
SRA		*RA* \ RA /	*RA*

Write the half reactions for the strongest oxidizing agent and the strongest reducing agent.

$2H^+_{(aq)} + 2\,e^- \rightarrow H_{2(aq)}$

$Cu_{(s)} \rightarrow Cu^{2+}_{(aq)} + 2\,e^-$

Put the equations together.

$2H^+_{(aq)} + Cu_{(s)} \rightarrow H_{2(aq)} + Cu^{2+}_{(aq)}$

Determine if the strongest oxidizing agent is higher on the table than the strongest reducing agent.

$H^+_{(aq)}$ is lower than $Cu_{(s)}$ therefore the reaction is not spontaneous. Copper can be used to transport hydrochloric acid.