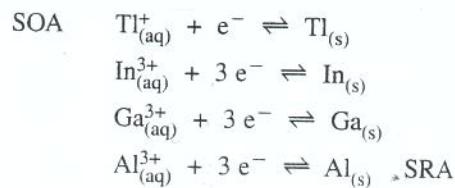
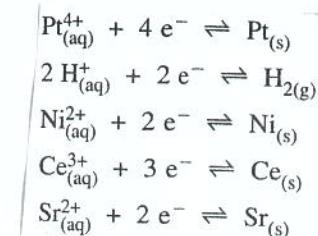
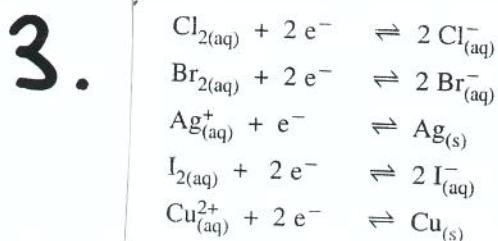
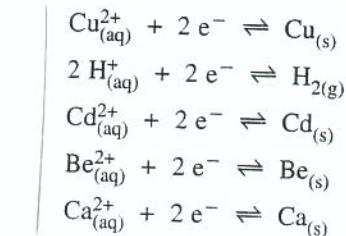


The following table of reduction half-reaction equations is based on the evidence presented in Table 4.

### Relative Strengths of Oxidizing and Reducing Agents

decreasing reactivity of oxidizing agents	SOA	$\text{Cl}_{2(\text{aq})} + 2 \text{e}^- \rightleftharpoons 2 \text{Cl}_{(\text{aq})}^-$	$\uparrow$	decreasing reactivity of reducing agents
	$\downarrow$	$\text{Br}_{2(\text{aq})} + 2 \text{e}^- \rightleftharpoons 2 \text{Br}_{(\text{aq})}^-$	$\uparrow$	
	$\downarrow$	$\text{I}_{2(\text{aq})} + 2 \text{e}^- \rightleftharpoons 2 \text{I}_{(\text{aq})}^-$	SRA	

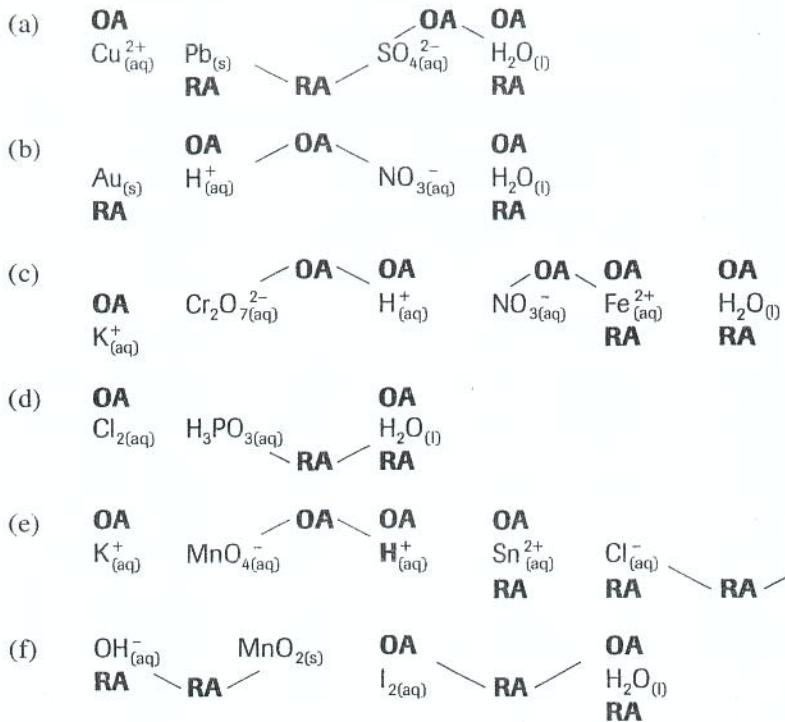


5.

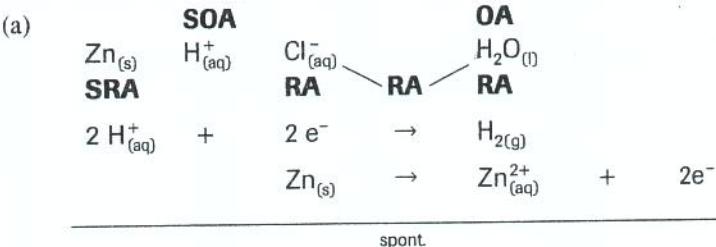
6.

Tin(II), copper(II), and chromium(II) ions can act as both oxidizing and reducing agents. These entities can gain or lose electrons. For example, tin(II) ions can either lose electrons to produce tin(IV) ions or gain electrons to produce tin atoms. The explanation for copper(II) and chromium(II) ions is similar, but there is no simple explanation for the behaviour of water molecules, which can also act as both oxidizing and reducing agents.

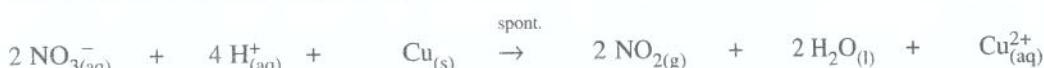
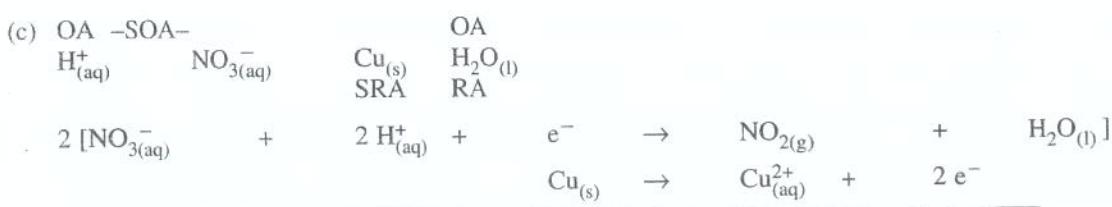
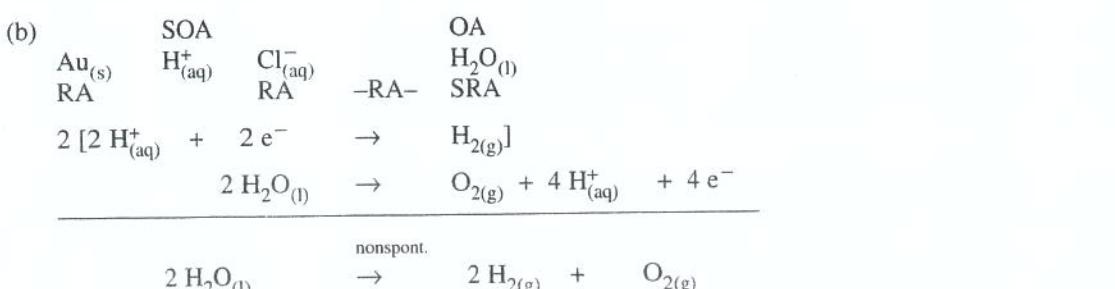
7.



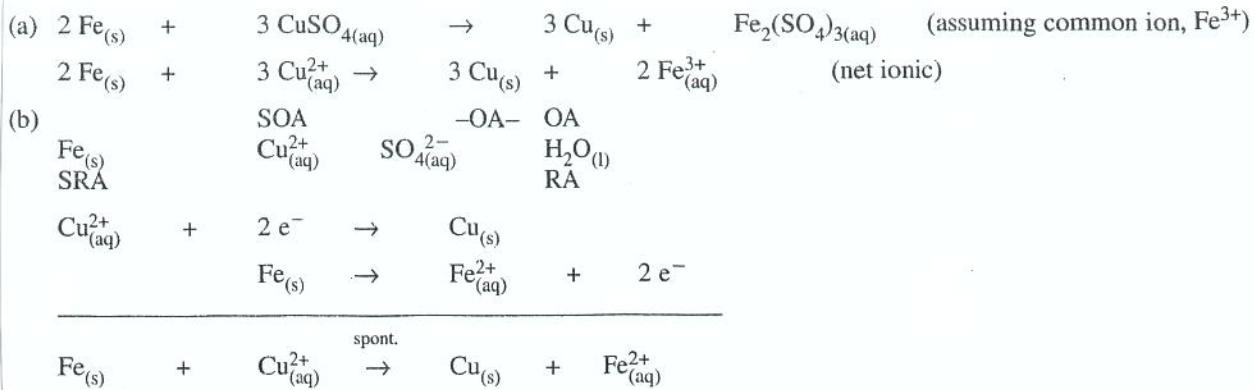
9.



If a flame is inserted into a sample of the gas produced and a "pop" sound is heard, then hydrogen gas is likely present.  
(Other diagnostic tests include pre- and post-tests for pH, mass measurement of zinc, and a flame test for  $\text{Zn}^{2+}_{(\text{aq})}$ .)



If the colour of the final solution near the copper surface is blue, then it is likely that copper(II) ions are produced. If a brown gas is produced during the course of the reaction, then nitrogen dioxide is likely produced.  
(Other diagnostic tests include pre- and post-tests for pH, mass measurement of copper, and a flame test for  $\text{Cu}^{2+}_{(\text{aq})}$ .)



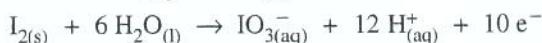
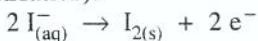
- (c) Both predictions cannot be correct; either iron(III) ions are formed or iron(II). The redox table and rules are more likely to be correct because these are based on extensive observations of relative strengths of oxidizing and



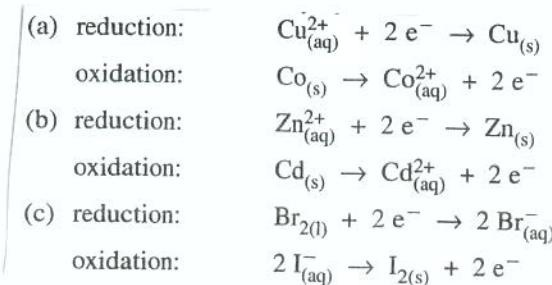
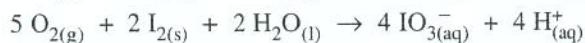
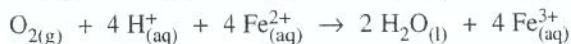
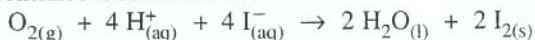
Because an excess of acid is present,  $\text{O}_{2(g)}$  and  $\text{H}^+{}_{(aq)}$  will remain as the strongest oxidizing agent throughout all of the reactions.



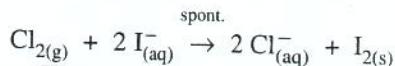
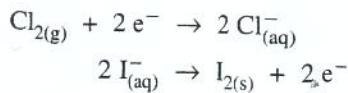
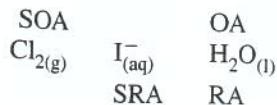
Oxygen in an acidic solution will spontaneously oxidize (in order) iodide ions, iron(II) ions, and lastly iodine (product of the iodide oxidation).



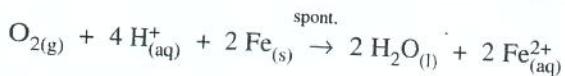
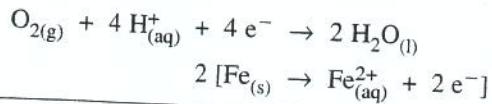
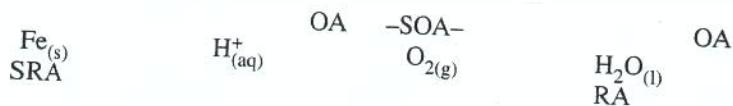
The spontaneous reactions are:



13.

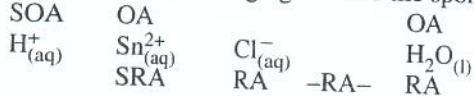


14.

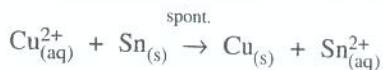
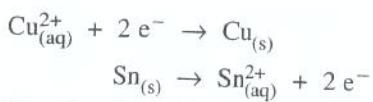
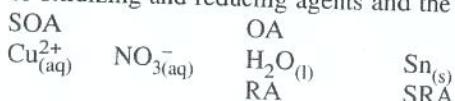


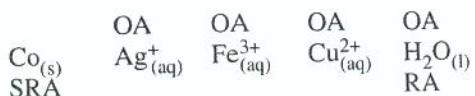
5.

- (a) The solution will be stable, because no spontaneous reaction occurs according to the table of relative strengths of oxidizing and reducing agents and the spontaneity rule.

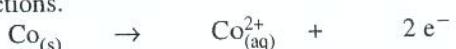


- (b) The solution will not be stable, because a spontaneous reaction occurs according to the table of relative strengths of oxidizing and reducing agents and the spontaneity rule.

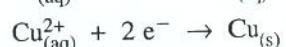
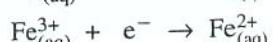
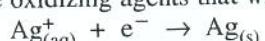




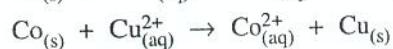
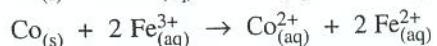
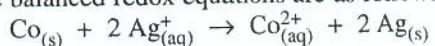
Because cobalt metal is in excess and it is the strongest reducing agent present, it will be the reducing agent in all reactions.



The oxidizing agents that will spontaneously react, in order of decreasing strength, are:  $\text{Ag}^+_{(\text{aq})}$ ,  $\text{Fe}^{3+}_{(\text{aq})}$ ,  $\text{Cu}^{2+}_{(\text{aq})}$ .



The balanced redox equations are as follows:



16.