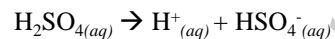
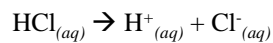


## Redox Reactions 7.2

REDOX Reactions in  
Acid and Basic Solutions

## Acids

Acids donate protons in aqueous solutions



Strong acid like HCl and H<sub>2</sub>SO<sub>4</sub> experience  
~100% dissociation in polar solvents, just  
like soluble ionic compounds.

## Redox Reactions in Acidic Solutions (I)

Reactions between metals and all strong acids  
except Nitric Acid

H<sup>+</sup> ions can oxidize many metals (X).



H<sup>+</sup><sub>(aq)</sub> pulls electrons out of the metal to form H<sub>2(g)</sub>.

## Ex) Redox Reactions in Acidic Solutions (I)

Ex) Write the balanced net ionic equation for the  
reaction that occurs when a solid piece of  
magnesium is placed in a solution of  
hydrochloric acid?

## Redox Reactions in Acidic Solutions (II)

Reactions between metals and Nitric Acid.

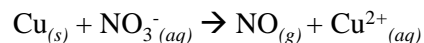
NO<sub>3</sub><sup>-</sup> is a stronger oxidizing agent than H<sup>+</sup>.

Thus, NO<sub>3</sub><sup>-</sup> will oxidize metals that H<sup>+</sup> cannot.



## Ex1) Redox Reactions in Acidic Solutions (II)

Ex1) A solid copper penny is placed in a solution of  
nitric acid.



This must be balanced using a special procedure.

### Balancing REDOX Reactions in Acidic Solutions

1) Write the two unbalanced half-reactions.

- Oxidation half-reaction
- Reduction half-reaction

**For each of the half-reactions:**

- 2) Balance all atoms except for O and H.
- 3) Balance for O by adding H<sub>2</sub>O molecules.
- 4) Balance for H by adding H<sup>+</sup> ions.
- 5) Balance the charge by adding electrons.
- 6) Cross multiply to cancel electrons.
- 7) Add half reactions and cancel things that are the same.

### Ex1) The Reduction Half-Reaction



Step 1)

Step 2)

Step 3)

Step 4)

Step 5)

### Ex1) The Oxidation Half-Reaction



Step 1)

Step 2)

Step 3)

Step 4)

Step 5)

### Ex1) Step 6. Cross Multiply

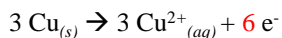
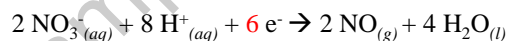
Reduction half-reaction



Oxidation half reaction



### Ex1) Step 7. Add the Two ½ Reactions



### Strong oxidizing agents that act in acidic solutions



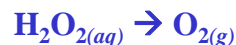
All of the above oxidize p and d-block metals, sulfite ions, peroxides, and substances that have a lower (less positive) oxidation state than usual in acidic solutions.

### Oxidation of Sulfite



The oxidation number of sulfur increases from +4 to +6

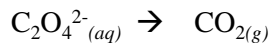
### Oxidation of Hydrogen Peroxide



The oxidation number on oxygen increases from -1 to 0.

### Substances with Lower (less positive) Oxidation States than Usual.

- In  $\text{C}_2\text{O}_4^{2-}$ , Carbon has an oxidation state of +3.
- As Carbon is in Group 4A, it would rather have an oxidation state of +4.
- It will oxidize (lose electrons) to raise its oxidation state.

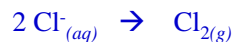


### Substances with Lower (less positive) Oxidation States than Usual.

Some non-metals can raise their oxidation states by bonding with like elements.

This happens when hydrochloric acid is combined with a strong oxidizing agent.

e.g.) Chlorine Ion,  $\text{Cl}^-$



### What if you have a choice of two species that can be oxidized?

When compounds contain p-block or d-block metals and non-metals with less positive than usual oxidation states...

**The metal will be oxidized!!**

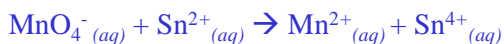
e.g.)  $\text{SnCl}_2$

$\text{Sn}^{2+}$  will be oxidized to  $\text{Sn}^{4+}$

### Ex2) Redox Reactions in Acidic Solutions (II)

Ex2) An acidic solution containing tin (II) chloride is mixed with a solution of potassium permanganate.

## Ex2) The Reduction Half-Reaction



Step 1)

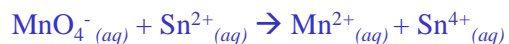
Step 2)

Step 3)

Step 4)

Step 5)

## Ex2) The Oxidation Half-Reaction



Step 1)

Step 2)

Step 3)

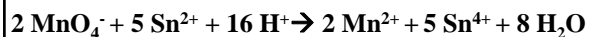
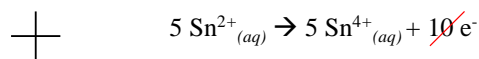
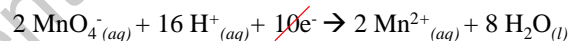
Step 4)

Step 5)

## Ex2) Step 6. Cross Multiply

Reduction half-reactionOxidation half reaction

## Ex2) Step 7. Add the Two 1/2 Reactions

**The balanced redox reaction**

## Basic Solutions

- Basic solutions have a high concentration of hydroxide ions  $[\text{OH}^-]$ .

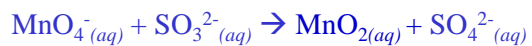
Strong oxidizing agent that acts in Basic Solutions

Permanganate will oxidize p or d-block metals, sulfite ions, and substances that have a lower (less positive) oxidation state than usual in basic solutions.

### Ex) Redox Reactions in Basic Solutions

Ex) A basic solution containing magnesium sulfite is mixed with a solution of potassium permanganate.

### Ex) The Reduction Half-Reaction



Step 1)

Step 2)

Step 3)

Step 4)

Step 5)

### Ex) The Oxidation Half-Reaction



Step 1)

Step 2)

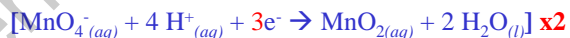
Step 3)

Step 4)

Step 5)

### Ex) Step 6. Cross Multiply

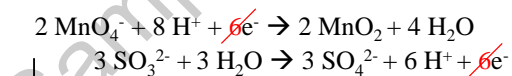
#### Reduction half-reaction



#### Oxidation half reaction



### Ex) Step 7. Add the Two 1/2 Reactions



### Ex) Step 8. Add OH<sup>-</sup> to Eliminate H<sup>+</sup>

