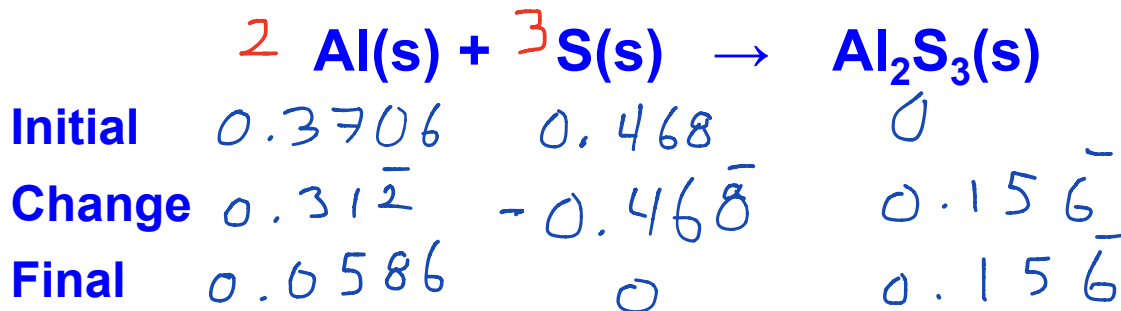


## LectureTools While You Wait...

In the last class we did a calculation for the reaction below, starting with 0.3706 mol of aluminum and 0.468 mol of S. Fill out the reaction table below (make sure to balance the equation first!) to answer this question: How many moles of the excess reagent will be left over?



- a) 0.185 mol
- b) 0.06 mol**
- c) 0.263 mol
- d) 0.156 mol
- e) None of the above.

To text in your answer, send  
'886202 A,B,etc' to (613) 699-8734

# Reaction Tables

- used to keep track of the quantities in a limiting-reactant problem
- top row shows balanced equation as the column headings.

The table contains rows for reactant and product:

**Initial** quantities (usually moles)

**Change** in quantities during the reaction

**Final** quantities remaining after the reaction

So for the previous example:

	$2\text{Al(s)} + 3\text{S(s)} \rightarrow$		$\text{Al}_2\text{S}_3\text{(s)}$
<b>Initial</b>	0.3706	0.468	$\emptyset$
<b>Change</b>	-0.312	-0.468	0.156
<b>Final</b>	0.06	$\emptyset$	0.156

$$n_{\text{product}} \times \frac{2 \text{ mol Al}}{1 \text{ mol Al}_2\text{S}_3}$$

$$n_{\text{Al}} = 0.156 \times 2$$

# Reaction Yield Calculation

For example, suppose in the preceding example with that only 19.8 g of aluminum sulfide was formed.

$$\begin{aligned}\% \text{ yield} &= \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\% \\ &= \frac{19.8 \text{ g}}{23.4 \text{ g}} \times 100\% \\ &= 84\%\end{aligned}$$

EXPERIMENTAL AMOUNT OF PRODUCT

**How do we calculate the yield for a multi-step reaction?**

e.g. The antidepressant sertraline is synthesized in 6 steps with the following yields: 80%, 80%, 50%, 100%, 48%, and 30%.

$$\begin{aligned}\text{OVERALL YIELD} &= 0.8 \times 0.8 \times 0.5 \times 1.0 \times 0.48 \times 0.3 \\ &= 4.6\%\end{aligned}$$

# Chemistry is Often Done in Solution: Concentration Calculations

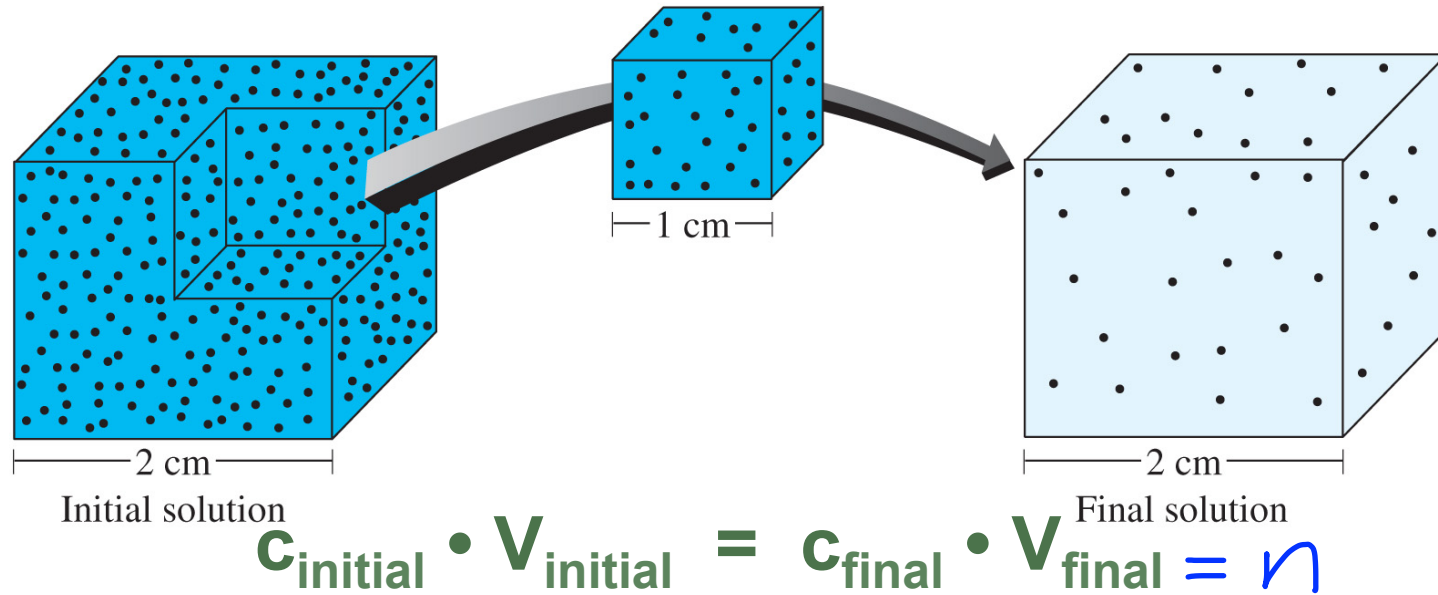
For example, suppose we want to prepare exactly 0.2500 L (250 mL) of an 0.250 M  $\text{K}_2\text{CrO}_4$  solution in water. What mass of  $\text{K}_2\text{CrO}_4$  ( $\mathcal{M}=194.2$  g/mol) should we use?

$$\begin{aligned} m &= nM = c \times V \times M & c &= \frac{n}{V} \\ &= 0.250 \frac{\text{mol}}{\text{L}} \times 0.2500 \text{L} \times 194.2 \text{g/mol} \\ &= 12.1 \text{g} \end{aligned}$$

# Different Forms of Concentration

General	Symbol	Equation
Molarity	$c$	$\frac{n_{\text{solute}}}{V_{\text{solution}}}$
Mass %	m/m%	$\frac{m_{\text{solute}}}{m_{\text{solution}}} = \frac{\text{mass of solute in g}}{100 \text{ g } \underline{\text{solution}}}$
Volume %	v/v%	$\frac{V_{\text{solute}}}{V_{\text{solution}}} = \frac{\text{volume of solute in mL}}{100 \text{ mL } \underline{\text{solution}}}$
Molality	$m$	$\frac{m_{\text{solute}}}{V_{\text{solution}}} = \frac{n_{\text{solute}}}{1 \text{ kg } \underline{\text{solvent}}}$

# Preparing Solutions by Dilution



e.g. You have 50.0 mL of 3.0 M NaOH and you want 0.50 M NaOH. What do you do?

$$V_f = \frac{c_i V_i}{c_f} = \frac{\left(3.0 \frac{\text{mol}}{\text{L}}\right)(0.050 \text{ L})}{0.5 \frac{\text{mol}}{\text{L}}}$$

$$= 0.30 \text{ L} \Rightarrow 300 \text{ mL}$$

Stoichiometry

24

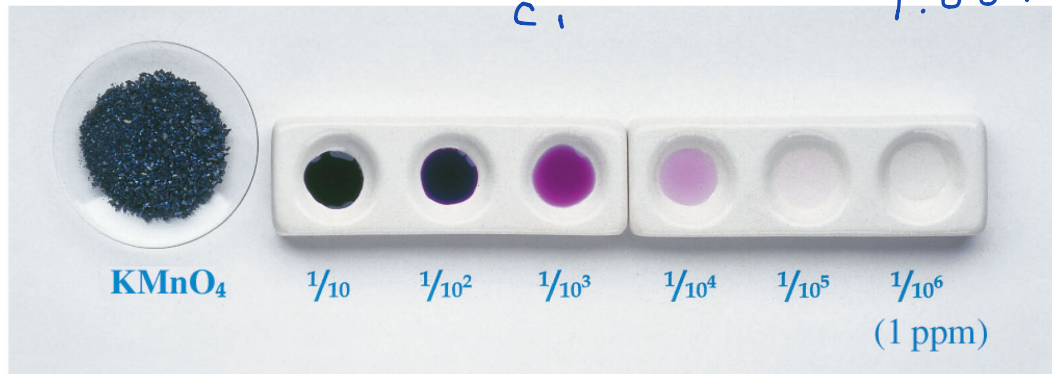
ADD 250 mL OF WATER TO STOCK SOLUTION.

# A Dilution Calculation For You...

You have a standard solution of 1.00 mol/L  $\text{KMnO}_4$ . To prepare a solution of 100 mL of 0.100 mol/L  $\text{KMnO}_4$ , how many mL of the standard solution will you need?

- A. 0.10 mL
- B. 1 mL
- C. 10 mL
- D. 100 mL

$$C_1 V_1 = C_2 V_2$$
$$V_1 = \frac{C_2 V_2}{C_1} = \frac{(0.100 \text{ M}) 100 \text{ mL}}{1.00 \text{ M}}$$



To text in your answer, send '871228 A,B,etc' to (613) 699-8734

# Limiting Reactants in Solution



## Example Problem:

Despite the toxicity of lead, many mass-produced toys are still found to contain a significant proportion of this metal.

When 268 mL of 1.50 mol/L lead(II) acetate ( $\text{Pb}(\text{OAc})_2$ ) reacts with 130. mL of 3.40 mol/L sodium chloride, what mass (g) of solid lead(II) chloride can form? (Sodium acetate solution also forms.)

What is the balanced equation?



**What is the limiting reagent?**

$$n_{\text{PbCl}_2} = cV = (1.5 \text{ M})(0.268 \text{ L}) \\ = 0.402 = n_{\text{PbCl}_2}$$

$$n_{\text{NaCl}} = cV = (3.4 \text{ M})(0.130 \text{ L}) \\ = 0.442 \text{ mol}$$

$$n_{\text{PbCl}_2} = n_{\text{NaCl}} \times \frac{1 \text{ mol PbCl}_2}{2 \text{ mol NaCl}} = 0.221 \text{ mol}$$

LIMITING

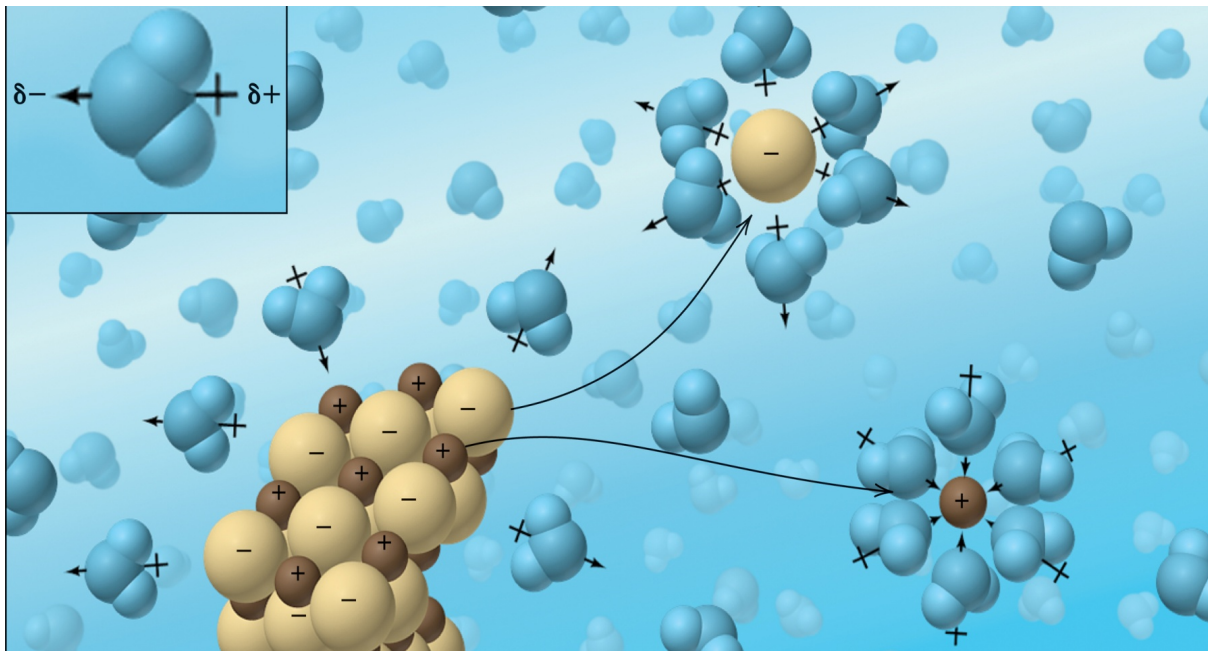
**Mass of  $\text{PbCl}_2$  ( $M = 270.1$  g/mol)?**

$$m = n_{\text{PbCl}_2} M = 0.221 \text{ mol} \times 278.1 \text{ g/mol} \\ = 61.5 \text{ g}$$

**To try on your own:**

**Can you write the reaction table for this example?**

# The Nature of Ionic Solutions



If you have a 0.30 M  $\text{KMnO}_4$ , this means that

$$[\text{K}^+] = [\text{MnO}_4^-] = 0.30 \text{ M}$$

# What happens if $\text{Na}_2\text{CO}_3$ is dissolved in water?

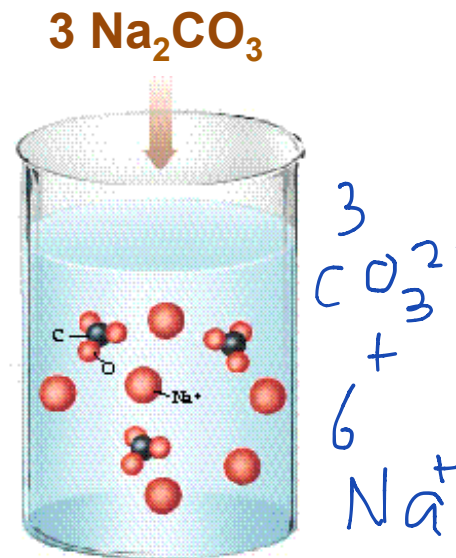
- This is a strong electrolyte  $\therefore$  IT CAN CARRY CHARGE - IT CONDUCTS
- Complete dissociation occurs when dissolved in water



If  $[\text{Na}_2\text{CO}_3] = 0.100 \text{ M}$ , then

$$[\text{Na}^+] = 0.200 \text{ M}$$

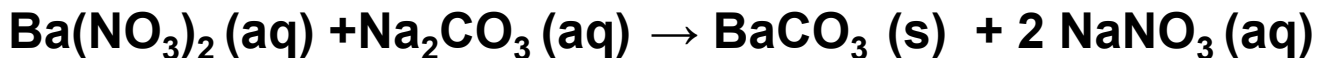
$$[\text{CO}_3^{2-}] = 0.100 \text{ M}$$



# Equations for Aqueous Ionic Reactions

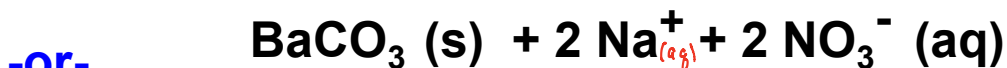
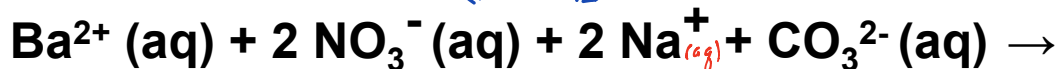
Chemical equations can be written in the form of a:

1) **Molecular Equation** - INCLUDES ALL SPECIES IN NON-DISSOCIATED FORM



-or-

2) **Total Ionic Equation** - INCLUDES ALL SPECIES IN DISSOCIATED STATE

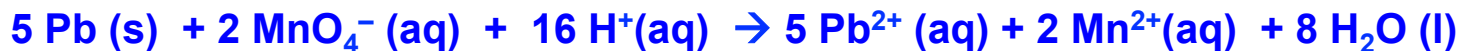


3) **Net Ionic Equation**



## An ionic stoichiometry question for you...

In an environmental test for lead (207.2 g/mol) in soil, the lead is oxidized using permanganate ions in acidic solution, according to the following (balanced) reaction:



A 25.0 g sample of soil was found to react with  $2.24 \times 10^{-3}$  mol of  $\text{KMnO}_4$ . What was the percent composition by mass of lead in the soil sample?

- A. 4.6%
- B. 1.2%
- C. 7.4%
- D. 0.46%
- E. I don't know



TEXT 879500

$$\% \text{ COMPOSITION} = \frac{m_{\text{Pb}}}{m_{\text{SOIL}}} \times 100\%$$

WHAT IS MASS OF Pb?

→ WE CAN FIND OUT FROM REACTION WITH  $\text{KMnO}_4$

$$n_{\text{MnO}_4^-} = 2.24 \times 10^{-3} \text{ mol}$$

$$\begin{aligned} n_{\text{Pb}} &= n_{\text{MnO}_4^-} \times \frac{5 \text{ mol Pb}}{1 \text{ mol MnO}_4^-} \\ &= 0.0056 \text{ mol} \end{aligned}$$

$$\begin{aligned} m_{\text{Pb}} &= n_{\text{Pb}} \times M_{\text{Pb}} \\ &= 0.0056 \text{ mol} \times 207.2 \text{ g/mol} \\ &= 1.16 \text{ g} \end{aligned}$$

$$\% \text{ MASS Pb} = \frac{m_{\text{Pb}}}{m_{\text{SOIL}}} \times 100\% = \frac{1.16 \text{ g}}{25 \text{ g}} \times 100\% = 4.6\%$$

# Suggested Problems

## Chapter 3:

**3.1, 3.9, 3.12, 3.16, 3.23, 3.25, 3.27, 3.38, 3.40, 3.44,  
3.47, 3.54, 3.60, 3.66, 3.70, 3.76, 3.78, 3.84, 3.88, 3.99,  
3.101, 3.103, 3.105, 3.113, 3.129, 3.133, 3.135, 3.141,  
3.142, 3.148, 3.150, 3.155, 3.172, 3.176, 3.182**

## Chapter 12.4:

**12.49, 12.53, 12.57, 12.59, 12.63, 12.65, 12.69, 12.119,  
12.133, 12.140a, 12.141**

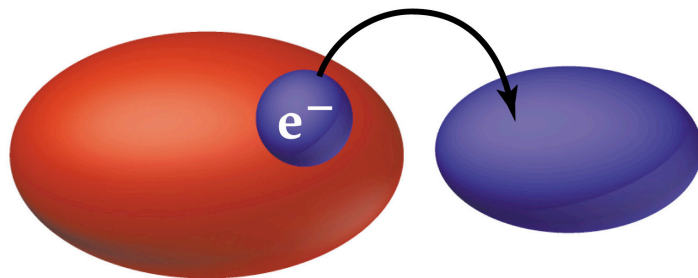
# Chapter 19.1: Redox Reactions

- an oxidation-reduction, or REDOX, reaction involves the transfer of electrons
- every redox reaction contains a reducing agent and an oxidizing agent

**Reducing agents:** OXIDIZED SPECIES  
IN REACTION

**Oxidizing agents:**  
REDUCED

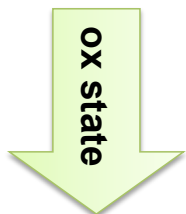
If something has been oxidized then something else has also been reduced.



Substance  
oxidized  
(loses  
electron)

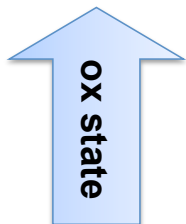
Substance  
reduced  
(gains  
electron)

# Some Redox Terminology



## Oxidizing agent (oxidant):

- Reduced in a redox reaction
- Its oxidation state decreases



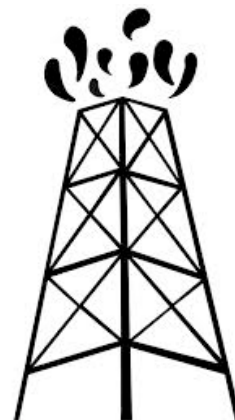
## Reducing agent (reductant):

- Oxidized in a redox reaction
- oxidation state increases in a redox reaction



**LEO says GER !**

**OIL RIG**



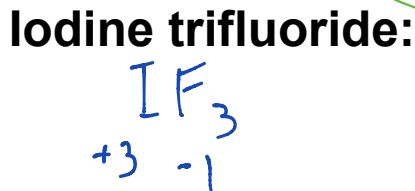
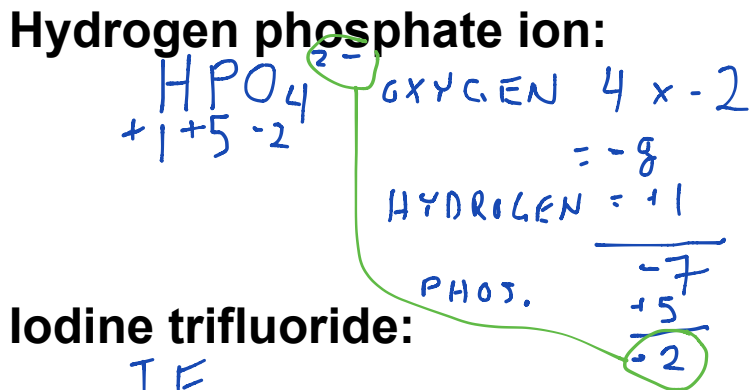
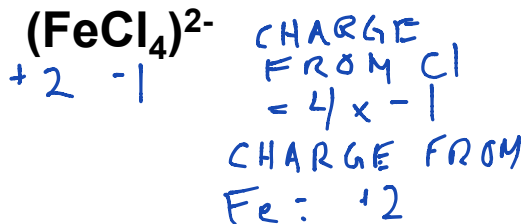
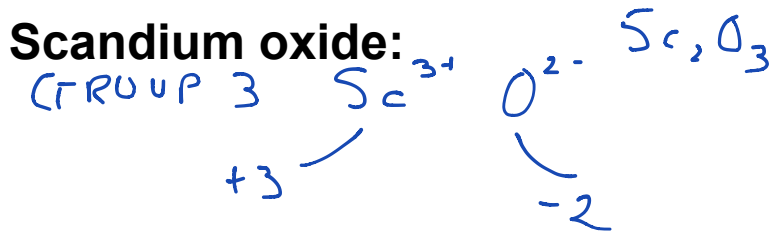
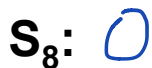
# Oxidation Numbers

The charge that the atom would have *if* the electrons were transferred completely.

If atom is:	Oxidation Number:
In elemental form	0 <span style="margin-left: 100px;">HIGHER IN LIST</span>
Monoatomic ion:	Ion charge <span style="margin-left: 20px;">⇒ HIGHER IN</span>
From Group 1	+1 <span style="margin-left: 100px;">PRIORITY RULE</span>
From Group 2	+2
Hydrogen	+1 if in combination with non-metals -1 if with metals and boron
Fluorine	-1
Oxygen	-2 (usually) +2 or -1 if coupled to a more electronegative center (e.g. F, Group 1, 2 etc)
Group 17	-1 in combination with metals, non-metals (except O), and other halogens lower in group

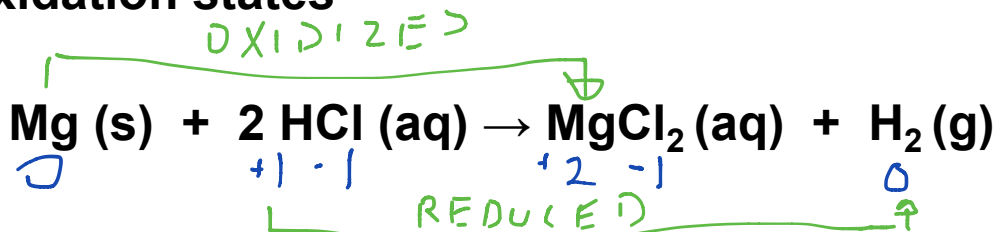
# Let's Try It Ourselves

Determine the oxidation number for each element in:

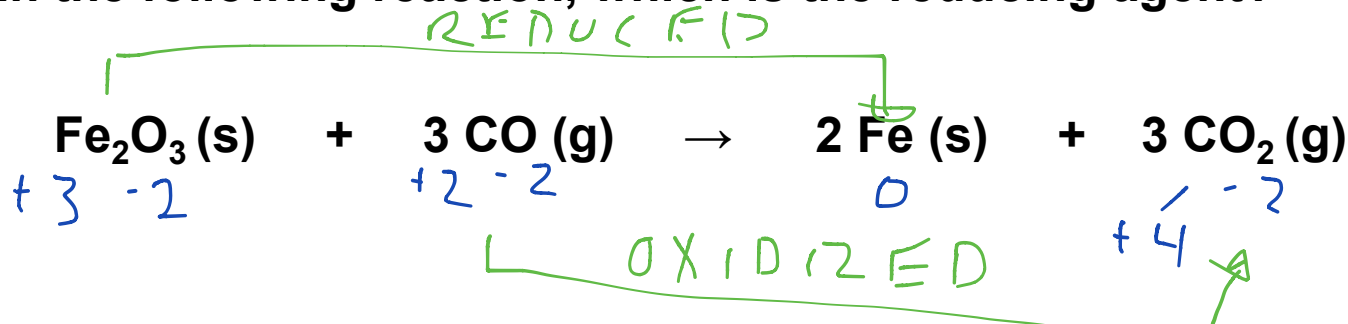


# What Gets Oxidized?

We can determine which species is oxidized and which species is reduced by looking at the oxidation states



In the following reaction, which is the reducing agent?



a) Fe<sub>2</sub>O<sub>3</sub>

b) CO

c) Fe

d) CO<sub>2</sub>

To text in your answer, send **879502 A,B,etc'** to (613) 699-8734