

\* Use Periodic Table & Table E if needed  
to find oxidation numbers.

Assigning oxidation numbers

Name \_\_\_\_\_

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Determine the oxidation states for each atom present in the given formulas.



$$\text{Cl} = \underline{0}$$



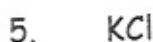
$$\text{Cl} = \underline{-1}$$



$$\text{Na} = \underline{0}$$



$$\text{Na} = \underline{+1}$$



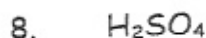
$$\begin{aligned} \text{K} &= \underline{+1} \\ \text{Cl} &= \underline{-1} \end{aligned}$$



$$\begin{aligned} \text{H} &= \underline{+1} \\ \text{S} &= \underline{-2} \end{aligned}$$



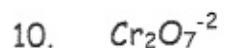
$$\begin{aligned} \text{Ca} &= \underline{+2} \\ \text{O} &= \underline{-2} \end{aligned}$$



$$\begin{aligned} &\swarrow \\ 2(+1) + 1(+6) + 4(-2) &= 0 \\ \text{H} &= \underline{+1} \\ \text{S} &= \underline{+6} \\ \text{O} &= \underline{-2} \\ +2 + 6 - 8 &= 0 \end{aligned}$$



$$\begin{aligned} \text{N} &= \underline{+5} & 1(+5) + 3(-2) &= -1 \\ \text{O} &= \underline{-2} & +5 - 6 &= -1 \\ & & -1 &= -1 \end{aligned}$$



$$\begin{aligned} \text{Cr} &= \underline{+6} & 2(+6) + 7(-2) &= -2 \\ \text{O} &= \underline{-2} & +12 - 14 &= -2 \\ & & -2 &= -2 \end{aligned}$$



$$\begin{aligned} \text{N} &= \underline{+5} \\ \text{H} &= \underline{+1} \\ \text{Cl} &= \underline{-1} \end{aligned}$$



$$\begin{aligned} \text{N} &= \underline{+4} \\ \text{O} &= \underline{-2} \end{aligned}$$



$$\begin{aligned} \text{N} &= \underline{-3} \\ \text{H} &= \underline{+1} \end{aligned}$$



$$\begin{aligned} \text{Na} &= \underline{+1} \\ \text{O} &= \underline{-1} \end{aligned}$$



$$\begin{aligned} \text{Ca} &= \underline{+2} \\ \text{H} &= \underline{-1} \end{aligned}$$

## Key Words

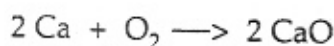
|                  |   |
|------------------|---|
| oxidation:       | the loss of electrons                           |
| reduction:       | the gain of electrons                           |
| oxidizing agent: | takes or gains electrons from another substance |
| reducing agent:  | gives or loses electrons to another substance   |

## KEY IDEAS

The electrons moving around the nuclei of atoms may also move from one atom to another. Such movement takes place during both oxidation reactions and reduction reactions. Both types of reactions happen at the same time. The loss of electrons is called oxidation. The gain of electrons is called reduction.

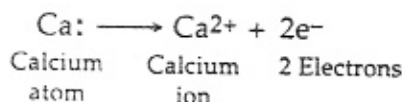
Firefighters need to be aware of the processes of oxidation and reduction. When materials burn, they combine with oxygen; thus, oxidation takes place. To prevent or stop fires, firefighters must know how to keep oxygen away from materials that can burn.

Oxidation has two meanings. One meaning is "the combining of a substance with oxygen." For example, calcium combines with oxygen in the oxidation reaction shown below.

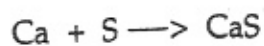


**Loss and Gain of Electrons.** Another meaning of **oxidation** (ahks-ih-DAY-shuhn) is the "loss of electrons." In the oxidation reaction shown above, the calcium loses electrons. See Fig. 40-1.

Fig. 40-1



Calcium can also react with sulfur in an oxidation reaction.



In this reaction, the calcium loses electrons just as it does in the calcium-oxygen reaction shown on page 198.

During oxidation, the electrons that are lost go to another substance. For example, electrons lost by calcium can go to sulfur. See Fig. 40-2.

Fig. 40-2

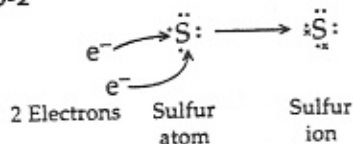
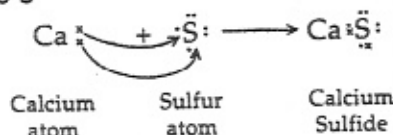


Fig. 40-3



In the calcium-sulfur reaction, shown in Fig. 40-3, the electrons that are lost by the calcium are gained by the sulfur. The gain of electrons by a substance in a reaction is called **reduction** (rih-DUK-shuhn).

**Oxidizing and Reducing Agents.** In the calcium-sulfur reaction, shown in Fig. 40-3, the sulfur is the **oxidizing agent** (AHKS-ih-dyz-ihng AY-juhnt) because it causes the loss of electrons. The oxidizing agent is reduced because it gains electrons.

The calcium is the **reducing agent** (rih-DOOS-ihng AY-juhnt) because it causes the gain of electrons. The reducing agent is oxidized because it loses electrons.

- ✓ 1. What is oxidation? the loss of electrons
- ✓ 2. What is reduction? gain of electrons

**Changing Charges.** During oxidation reactions, charges on atoms change. Look again at the reaction of calcium and sulfur.

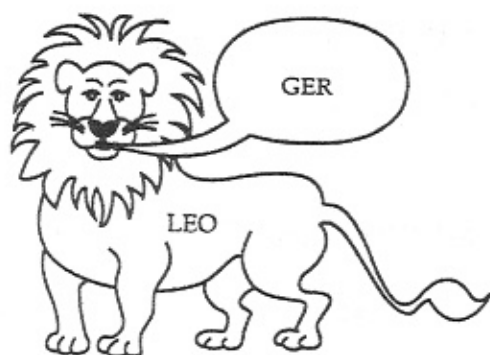


Here is how the charges change: Calcium ( $\text{Ca}^0$ ), the reducing agent, becomes more positive ( $\text{Ca}^{2+}$ ); sulfur ( $\text{S}^0$ ), the oxidizing agent, becomes more negative ( $\text{S}^{2-}$ ).

# TAKE ANOTHER LOOK

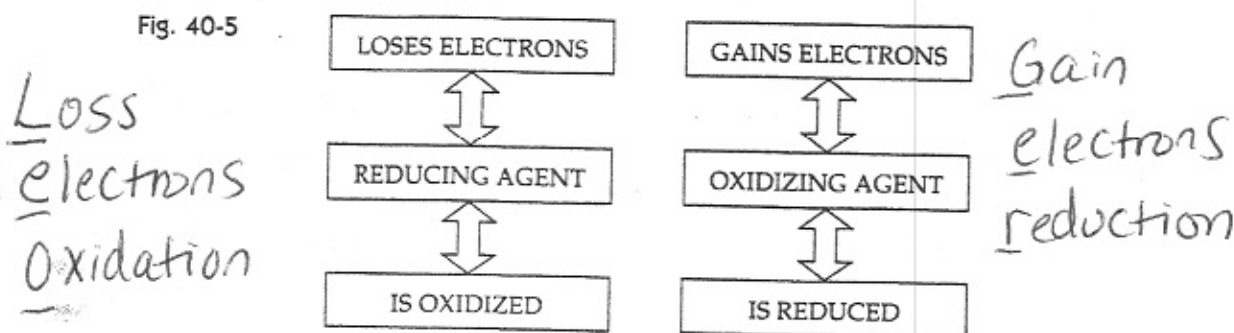
To remember what reactions involve losses and gains of electrons, think about this story. There once was a lion named LEO, which means Loss of Electrons is Oxidation. This king of the beasts was a little different from others. Instead of saying "roar," he said "GER", which means Gain of Electrons is Reduction. See Fig. 40-4.

Fig. 40-4



Look at Fig. 40-5. It shows the gain and loss of electrons by oxidizing agents and by reducing agents.

Fig. 40-5



## Check Your Understanding

3. Use the terms *reducing agent*, *reduction*, and *substance oxidized* to complete the table comparing oxidation and reduction.

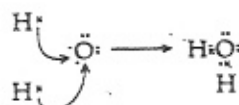
| Loss of Electrons             | Gain of Electrons     |
|-------------------------------|-----------------------|
| (a) oxidation                 | (a) <u>reduction</u>  |
| (b) <u>reducing agent</u>     | (b) oxidizing agent   |
| (c) <u>substance oxidized</u> | (c) substance reduced |

Fill in the blanks with the proper terms.

Oxidation is the (4) loss of electrons. Reduction is the (5) gain of electrons. The oxidizing agent (6) gains electrons. The reducing agent (7) loses electrons. The charge of the oxidizing agent becomes more (8) negative. The charge of the reducing agent becomes more (9) positive.

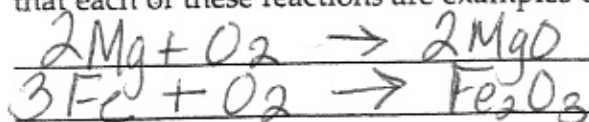
Two hydrogen atoms and one oxygen atom combine to form water as shown in Fig. 40-6.

Fig. 40-6

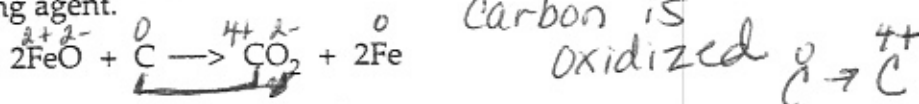


10. Which element is the oxidizing agent? oxygen <sup>reduced</sup>
11. Which element is the reducing agent? hydrogen <sup>oxidized</sup>

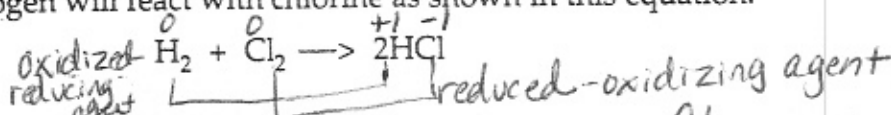
12. When magnesium burns, it combines quickly with oxygen. When iron rusts, the iron reacts slowly with oxygen. Write two equations to show that each of these reactions are examples of oxidation.



13. Iron ore is reduced to iron in the following reaction. Explain why carbon (C) is the reducing agent.



14. Hydrogen will react with chlorine as shown in this equation.



Write the formula for the oxidizing agent (a)  $\text{Cl}_2$ , the reducing agent (b)  $\text{H}_2$ , the substance oxidized (c)  $\text{H}_2$ , and the substance reduced (d)  $\text{Cl}_2$ .

15. Write a paragraph to explain why oxidation and reduction both take place at the same time.

The electrons lost by one substance must be accepted and transferred to another substance.

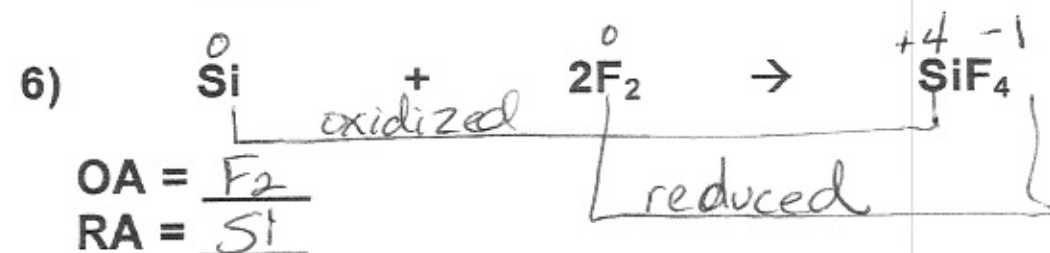
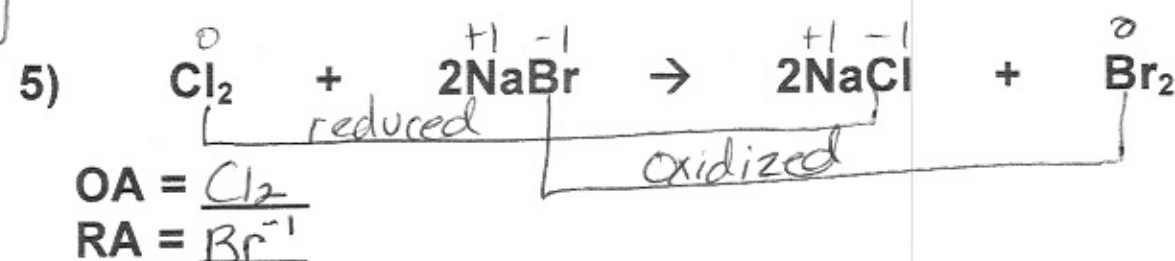
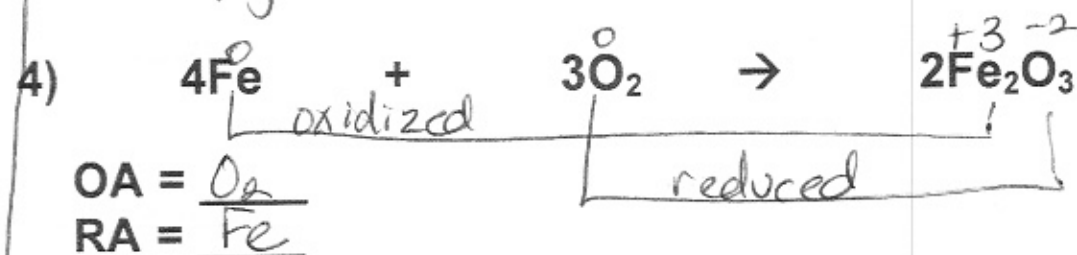
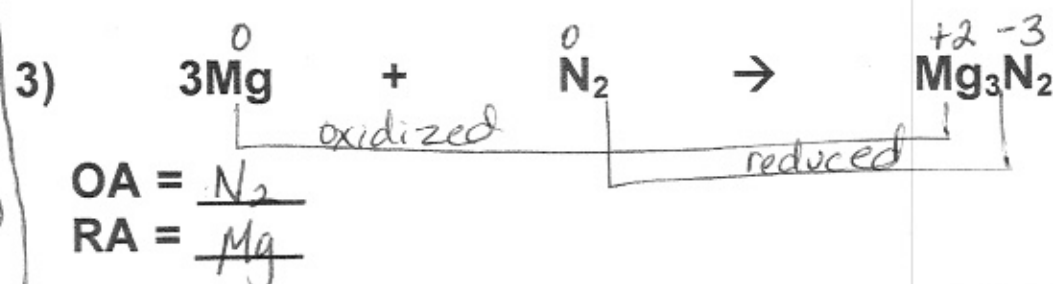
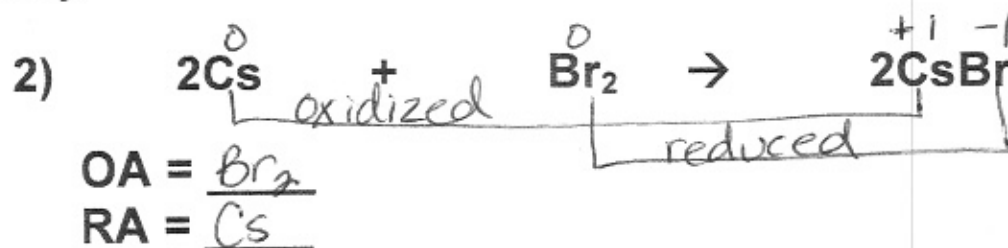
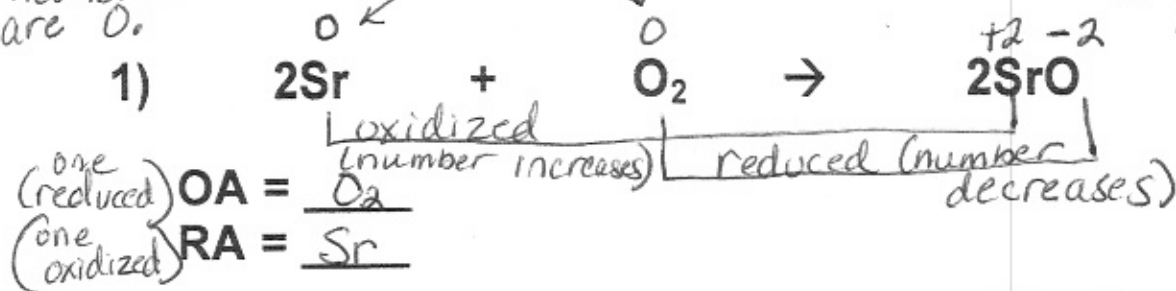


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Determine the oxidation states within each of the following compounds. Identify (using brackets) where oxidation and reduction take place, as well as which species is the reducing agent (RA) and the oxidizing agent (OA).

Uncombined elements are 0.

From Periodic Table



Loss  
electrons  
Oxidation



Gain  
electrons  
Reduction