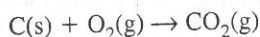


## Conceptual Chem

### Applying Scientific Methods

Combustion is the reaction of an element or compound with oxygen to form one or more oxides. For example, the combustion of charcoal produces carbon dioxide.

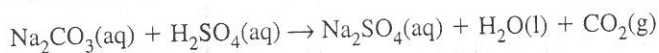


As charcoal burns, or combusts, chemical energy is converted into light and heat—enough heat to cook food. For combustion to continue, there must be material that combusts (fuel), oxygen, and heat energy. Combustion can be controlled or stopped by limiting each or all three.

One way to extinguish a charcoal fire is to douse the coals with water. As the liquid water reaches the hot coals, it absorbs energy from the coals and warms. Some water quickly changes into steam. As the water and steam continue to gain energy, the coals lose energy and cool. The loss of energy from the coals is sufficient to stop the combustion of the charcoal. In effect, the water robbed the charcoal of the energy needed to keep burning.

A less spectacular way to extinguish a charcoal fire is to cover the burning coals. If the coals are in a grill, you can put on the lid and close the air valves. This action makes oxygen the limiting reactant in combustion.

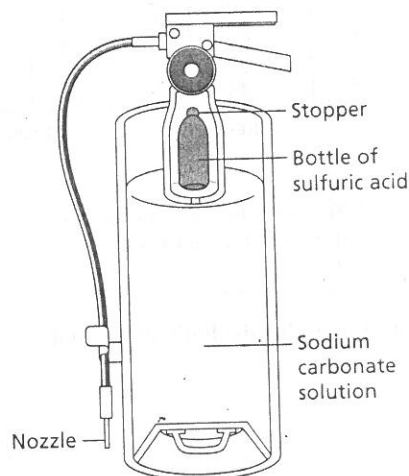
Some fire extinguishers control fires by cooling the fuel and limiting oxygen. For example, the fire extinguisher shown produces water and carbon dioxide. To activate the fire extinguisher, the canister must be inverted. Notice that the canister contains a bottle of sulfuric acid immersed in a solution of sodium carbonate. When the canister is inverted, the stopper on the bottle falls off, and the sulfuric acid mixes with the sodium carbonate solution. The reaction is represented by the following chemical equation.



The increased pressure caused by the carbon dioxide gas in the canister propels the water from the nozzle. The water cools the burning fuel. The carbon dioxide also does something else. Because its density is greater than the density of oxygen, carbon dioxide displaces the oxygen around the burning fuel. The displacement limits the oxygen available for combustion and thus aids in extinguishing the fire.

Other types of fire extinguishers cause the fuel to be the limiting reactant. They produce foams and powders that react with the fuel. These reactions produce noncombustible products.

Liquids, foams, and powders are also used to keep potential fuels from burning. For example, timber in the paths of forest fires can be sprayed with a variety of materials that retard fires. Some of these materials contain ammonium phosphate and ammonium sulfate. Heat from the oncoming fire causes the ammonium compounds to react with the cellulose in the timber and produce fire-retardant compounds. Other materials sprayed on timber produce noncombustible foams that coat the surface of the timber. These foams retard combustion by preventing oxygen from reacting with the timber.



Fire Extinguisher