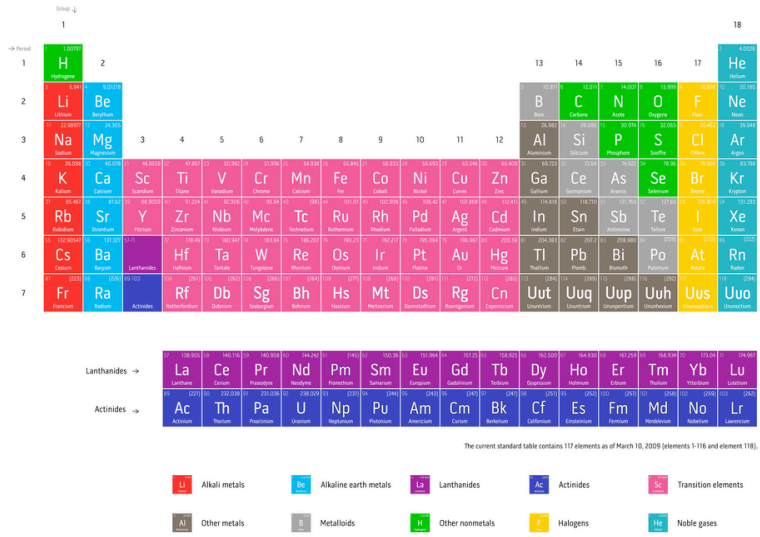
The Science of Fireworks

Fireworks are believed to have originated in China for use in spiritual ceremonies. The invention of black powder, the main explosive ingredient of fireworks, is accredited to Chinese alchemists in the 9th century.

Colorful Chemicals

Most of the elements that produce the vivid colors come from the alkali metal and alkaline earth metal groups. These are the first two columns on the periodic table. To produce the colorful display, these elements are combined with chlorine, or carbon and oxygen (as carbonate), to form metallic salt compounds.

Lithium and strontium produce the vivid red in fireworks. Sodium gives off a gold or yellow color when combusted in fireworks. To produce the greens, barium is used. Copper, a transition metal, burns blue in fireworks. Calcium is used in fireworks to deepen the colors of other elements.



The first two groups of the periodic table are so reactive because they only have one or two electrons in their outermost electron shell.

When heated, each element absorbs energy and releases it as light of a specific color. The amount of energy given off and the resulting color is a defining characteristic of the element. Higher energy produces shorter wavelengths, as found on the violet and blue end of the spectrum. Lower energy creates longer wavelengths on the orange and red end of the spectrum.

Exploding Elements

Black powder is the main ingredient of fireworks, providing their explosion. It is a mixture of sulfur, charcoal, and

saltpeter (potassium nitrate). Black powder is considered a low explosive because it burns slower than other explosives like dynamite, and can be controlled by changing the grain size. Larger grains burn slower than small grains.

Carbon is the most common element found in fireworks, and comprises the charcoal in black powder. Sulfur is another component of black powder and provides the firework's fuel source. Different forms of phosphorus exist. Some forms are highly reactive and can spontaneously ignite when in contact with air! For this reason phosphorus is stored under water. Phosphorus acts as another fuel source for fireworks and can also produce bright white colors because, when heated, it burns bright white.

Dazzling Displays

Firework shapes are created by the careful construction of the firework and time-delayed fuses.

Fireworks are more than just pretty colors and explosions. Pyrotechnicians, the people who make fireworks, use other elements to create glittering effects and well-timed sparks or strobe light flashes. Antimony is a metalloid that produces a glittery effect when it burns. Aluminum, another metalloid, creates white and silver sparks and is one of the main components of sparklers. Iron and titanium, both transition metals, are also used to produce sparks. Magnesium burns bright white and can be used to produce a strobe light effect.

Fireworks Anatomy 101

At the base of the firework is a lift charge. Black powder is compacted into a small space so the gas and heat push hard against the sides of the launch tube until an explosion occurs. This explosion can launch a firework more than 1,000 feet

into the air. Above the lift charge is the main fuse. In professional displays, electrical wires connect the fireworks to a main control board. The main fuse simultaneously lights the lift charge and the time-delayed fuse in the firework's payload. The payload of the firework contains more black powder, as well as stars. Stars are the elements and compounds that produce colors and effects. Fireworks with more than one payload contain cardboard breaks to separate each payload. Timing these breaks is crucial for optimal display and safety. The loud booms are created using an explosive compound similar to black powder, called perchlorate. Sound travels slower than light, meaning spectators will hear the firework's boom after seeing its flash of light.

Thicker tubes and tighter packing and wrapping of firecrackers produce louder and more explosive effects.

Fireworks Safety

Thousands of people, mainly children, are injured every year due to fireworks. Sparklers burn at about 1,200° F, and are a common cause of burns when fireworks are involved. Outlined by the National Council on Fireworks Safety (NCFS), the following is a list of safety tips to consider when handling fireworks:

- Parents and caretakers should always closely supervise teens if they are using fireworks.
- Fireworks should only be used outdoors.
- Always have water ready if you are shooting fireworks.
- Know your fireworks. Read the caution label before igniting.
- Wear safety glasses whenever using fireworks.
- Never relight a "dud" firework. Wait 20 minutes and then soak it in a bucket of water.