

# [The chemistry of fireworks chemistry essay](https://assignbuster.com/the-chemistry-of-fireworks-chemistry-essay/)

The chemistry behind fireworks is a series of oxidation and reduction reactions which result in the desired sound and light. This happens as propellants push the firework into the sky. Oxidation reactions ensure that the oxygen needed to exhaustively burn the mixture of reducing agents and excite the atoms in the light-emitting compounds is produced. Oxidizers used such as chlorates, nitrates and percolates and reducing agents such as carbon and sulfur are available of the shelf for home-made users. The combination of reducing agents with oxygen is there responsible for the energy dissipated during the reaction. Black powder, which mainly contains nitrates, is the most used oxidizer (Conkling, 1985). A look at an explosion under the use of potassium nitrate so as to provide nitrate ions (NO3-) after decomposition can be represented as: Potassium nitrate potassium oxide + nitrogen gas + oxygen gas.

The reaction is more controlled since when reacting, nitrates only release two in every three oxygen atoms, hence, the reaction is not exhaustive and vigorous since not all the oxygen atoms are actively used up. However, nitrates do not provide enough power to propel the firework into the sky and also ignite the package. Therefore, they cannot be used in star explosions since they cannot produce temperatures high enough to energize most color metal salts.

Star reactions need a temperature ranging from 1700 to 2000°C. This was enabled by the Italians in the 1830’s whereby they came across more explosive oxidizers, chlorates (ClO3-), which give up all their committed oxygen atoms upon reaction. This can be illustrated by the equation below which is highly spectacular, vigorous and releases more energy.

However, chlorates have the major demerit of being highly unstable, hence they can be dangerous to handle. On the merit side, chlorate can be easily ignited. For instance, dropping them on the ground can lead to a major explosion. This is since chlorates have the maximum potential of bonding with four oxygen atoms but they however bond with three. The fourth oxygen atom is left free, unsaturated and reactive. This makes chlorates better oxidizing agents. Further, in comparison to the slow-burning rate previously availed by nitrates, chlorates provide a faster reaction leading to a loud and exceedingly dangerous explosion. This was solved by the use of perchlorates which are more stable when releasing oxygen. The oxygen atoms in perchlorates are fully bonded hence stable. When reacting, perchlorates are able to release all their oxygen atoms. (Russell, 2009)

The chemistry of fireworks, so as to come up with a varying degree of colors has generated a lot of interest. Color is generated through two mainstream ways: Incandescence and luminescence. Incandescence entails the production of light by means of heat. When a substance glows as a result of heat, it first emits infrared wavelengths, then red light. Orange light is then produced as the object becomes progressively hotter, followed by yellow and finally white light. Under a controlled environment, the glow of reducing agents such as charcoal can be regulated at a certain temperature, hence emitting a particular color at the desired time. Temperature regulators that are most common are magnesium, aluminum and titanium. Luminescence is the production of light through other means other than heat. These can therefore occur at colder temperatures lower than room temperature since it is independent of any heat. An electron in an atom is first excited and destabilized by absorption of energy. The atom is then relegated to a lower energy state hence releasing the energy within via photons, the basics of light. The energy possessed by these photons consequently determines its wavelength or color. A major challenge in producing color through luminescence is that some salts used are unstable at room temperatures such as Barium chloride. Therefore, this problem must be solved by use of a combination of these salts with more stable compounds such as chlorinated rubber. For instance, in the combustion of the pyrotechnic composition between barium chloride and chlorinated rubber, a green color is produced. Other salts such as copper chloride which gives a blue color must be regulated not to attain high temperatures yet the brightness of the resultant blue color must be achieved. (Pressroom, 2010)

The quality of the resultant color produced by various factors can be compromised by various factors. First, pure colors require pure ingredients. No traces of impurities such as the dominant impurity, sodium, which gives a yellow-orange color, should be present since it easily overpowers all other colors. Secondly, the cost of the firework when the client is buying off the shelf often alludes to quality. Finally, it is important to note the date of manufacture and the skill and popularity attached to the manufacturer by other users. (Helmenstine, 2009)

It is crucial to evaluate how both sparklers, which ensure production of bright light, and firecrackers, which enable the production of explosions, function. Firecrackers consist of black powder, commonly referred to as gun powder in a tight tube made of paper and fuse at one end so as to set the powder alit. The main compounds and elements of black powder are sulfur, charcoal and potassium nitrate. Further, some explosions are brightened the more by use of aluminum. On the other hand, sparklers are used to produce exceptionally bright and showery light for a longer period of time that can last up to a minute. There are commonly referred to as ‘ snowball sparklers’ since they are accompanied by a ball of sparks surrounding the burning epicenter.

A sparkler constitutes various compounds. Key among them is oxidizers, fuel, binder such as starch or sugar and iron or steel powder. They are mixed in water to form slurry which is then coated on a wire through dipping. This is then dried. It is then ready for use whereby it can be lit in order to burn end to end like a cigarette. In sparklers, oxidizers and fuel are carefully proportioned with other compounds so as it burns slowly rather than explode as is the case with firecrackers.

## Fireworks however are more complex in their manufacture. Bright shimmering sparks have to be induced by adding steel or iron, aluminum, magnesium and zinc. These metal flaks heat up to attain high temperatures that ensure production of light by incandescence beyond which they burn exhaustively. To create a wide range of colors, various chemical addictives are used.

## Aerial Fireworks

These are large, conspicuous and colorful fireworks that can be observed on major celebrations such as the Fourth of July. The aerial firework shell contains: stars which are small cylinders, cubes or spheres that contain the compounds needed; container which has the pasted paper for instructions and things such as company name and an accompanying string; the bursting charge located at the center of the shell; and a fuse which ensures delay in time till the firecracker attains the right altitude. A lifting charge is located below the shell. A mortar is used to launch an aerial firecracker. This is a small, steel pipe containing black powder that serves as the lifting charge. When this is fired, the shell fuse is lit which burns progressively up to the desired height, then explodes. A simple shell, such as those used in an aerial display, contains stars in the blue balls, and a grey part containing black powder and the center tube containing the bursting charge. Multi-break shells burst over two or three phases. They have a variety of colors and compositions so as to contain various degrees of light and sparks. Multi-break shells have various compartments or sections in one with different fuses. Each shell bursts and consequently ignites the other through break charges, each with a different effect and possible color.

Fireworks Displays

The pattern painted in the sky by an aerial shell chiefly depends on the order and arrangement of star pellets in the shell. For instance, equally spaced pellets in a circle with the accompanying black powder produce a mid-air display of minor star explosions uniformly spaced in a circle. A specific figure can therefore be created by arranging the star pellets in the outline of the figure desired. Place explosive charges in the interior of the figure so as to blow them outside into a large figure as desired. Then, surround this with a layer of break charge so as to separate them with the rest of the shell contents. This break charges must be set to explode at the desired time. (Ashby, 2007)

There are several shell names in the market: C: UserssignalDesktopCapture. PNG

Firework Safety/ Conclusion

In conclusion, it is important to note that fireworks are sources of sun but they have however come along with various precautions that have to be adhered. Fireworks are used in most of today’s’ public celebrations. However, they are dangerous if mishandled. Over 8000 United States are reported to suffer every year due to fireworks. Of whom more than half are children. The most common hazard experienced by more than a third of the cases is burns which have been reported to occur from illegally acquired fireworks. Hence, there are a number of regulations that have been put in place to ensure mishandling reduces. The statute organization chiefly responsible for consumer fireworks is the National Council on Fireworks Safety. It educates the public on how to responsibly handle and use fireworks.

The National Fire Protection Association is responsible for enforcing rigorous safety regulations for big fireworks displays. Spectators are required to watch at least 840 feet from the launching zone based on the height and burst diameter of the largest of shells. Secondly, shells cannot be launched if the winds at that particular time are stronger than 20 miles per hour, since they would be carried away over the set diameter thereby causing harm to onlookers. However, despite all these regulations that have been put in place, many accidents still do occur at informal and poorly regulated places.

Manufacturers are also required by law to set up buildings in the manufacturing plants that are separated by concrete blast walls from any other buildings with roofs weakened so as any resultant explosion travels upwards instead of outwards. Further, mechanization in the industry is limited and work is mainly done by hand since machines may produce sparks or static charges that would be disastrous in causing explosions. However, some disasters have occurred between 1970 and 1995 resulting in the death of more than 20 factory employees.

Environmentally Friendly Fireworks

Most animals are scared by the explosions resulting from displays. Most regulations and rules bar people from attending such events with their pets in tow. Sadly, cases of pets getting lost at such events have been reported. Wide research is continuing on hoe to combine various elements into pyrotechnic compounds and mixtures have been made. This produces minimal smoke and particulate matter. This shall replace oxidizers such as perchlorates which are environmentally harmful.