Metallic compounds

In addition to gunpowder, fireworks are packed with heavy metals and other toxins that produce their sparkling shower of colors. Like perchlorates, the exact effect of fireworks' heavy-metal fallout is still mainly a mystery, but scientists do know that the metals themselves can wreak havoc in the human body.

• **Strontium (red):** This soft, silvery-yellow metal turns red when it burns, and it's extremely reactive with both air and water. Some strontium compounds dissolve in water, and others can move deep into soil and groundwater. While low levels of stable strontium have not been shown to affect human health, the metal can be dangerous at high doses. The main health threat posed by non-radioactive strontium is for children, since it can impair their bone growth.

• **Aluminum (white):** Since aluminum is the most abundant metal in Earth's crust — and one of humanity's most widely used — avoiding exposure is almost impossible. Virtually all food, water, air and soil contain some amount of aluminum — the average adult eats about 7 to 9 milligrams of the silvery-white metal every day in food. It's generally safe at these levels, but it can affect the brain and lungs at higher concentrations. People and animals exposed to large amounts of aluminum have performed poorly on mental and physical tests, and some studies suggest aluminum exposure may lead to Alzheimer's disease, although that connection has yet to be proven.

• **Copper (blue):** Fireworks' blue hues are produced by copper compounds. These aren't very toxic on their own, but the copper jump-starts the formation of dioxins when perchlorates in the fireworks burn. Dioxins are vicious chemicals that don't occur naturally; they're the unwelcome byproducts of certain chemical reactions, one of which happens in blue fireworks. The most noted health effect of dioxin exposure is chloracne, a severe skin disease with acne-like lesions mostly on the face and upper body. Dioxin doesn't stop there, though — the World Health Organization has identified it as a human carcinogen, and it's also been shown to disrupt hormone production and glucose metabolism.

• **Barium (green):** Fish and other aquatic organisms can accumulate barium, which means it can move up the food chain. The silvery-white metal naturally bonds with other elements to form a variety of compounds that all have different effects — none are known to be carcinogenic, but they can cause gastrointestinal problems and muscular weakness when exposure exceeds EPA drinking water standards. Symptoms may include vomiting, diarrhea, breathing trouble, changes in blood pressure, numbness around the face, general muscle weakness and cramps. High levels of barium exposure can lead to changes in heart rhythm, paralysis or death.

• **Rubidium (purple):** This soft, silvery metal is one of the most abundant elements on Earth. It burns purple, melts to a liquid at 104 degrees Fahrenheit and is highly reactive with water, capable of igniting fires even far below the freezing point. It hasn't been reported to cause any major environmental damage, but it can cause skin irritation since it's so reactive with moisture, and it's moderately toxic when ingested, reportedly able to replace calcium in bones.

• **Cadmium (various):** Used to produce a wide range of fireworks colors, this mineral is also a known human carcinogen. Breathing high levels of cadmium can seriously damage the lungs, and consuming it can fluster the stomach, often resulting in vomiting and diarrhea. Long-term exposure can lead to kidney disease, lung damage and fragile bones. Plants, fish and other animals take up cadmium from the environment, meaning that any released into waterways from a fireworks show can be passed up the food chain.

Alternative fireworks

The eco-friendliest alternative to fireworks is to forgo explosions altogether — go to a parade, go fishing, grill out, camp out or help out.

If you must see the sky festively illuminated, you might want to try a laser light show, which create dazzling displays of color without launching dangerous chemicals into the air. They may consume lots of energy, but so does the rampant production of single-use fireworks. Here's an example of lasers in lieu of fireworks on the Fourth of July, from Stone Mountain, Georgia, in 2017:

Many fireworks are imported from China which is scary because they have a proven track record of cutting corners by using cheaper, more toxic materials. Some of the metals also have radioactive isotopes... hopefully they aren't being used in any fireworks. The American Fireworks Standards Laboratory (AFSL) has established a testing and certification program for Chinese and U.S. fireworks to determine if they are being produced according to AFSL Standards (which meet all U.S. federal requirements). There is a list of prohibited toxic chemicals in the standards but unfortunately participation in the program is voluntary for manufacturers and importers. Firework shipments that pass standards only assure that one random sample from the lot has been tested and met all requirements [2]. Will you trust the quality of your air to China??

The Toxic Elements of Fireworks - Pick Your Poison

Toxic Element	Fireworks Usage	Toxic Effect of Fallout Dust & Fumes
Aluminum	brilliant whites	Contact dermatitis, bioaccumulation
Antimony sulfide	glitter effects	Toxic smoke, possible carcinogen
Arsenic compounds	Used as colorants. Sadly still out there. [3]	Toxic ash can cause lung cancer, skin irritation and wart formation.
Barium Nitrate	glittering greens	Poisonous. Fumes can irritate respiratory tract. Possible radioactive fallout. [4]
Copper compounds	blues	Polychlorinated dioxins and dibenzofurans. [5] Can bioaccumulate. Cancer risk.
Hexachlorobenzene (HCB) [5]	Use was supposed to be banned globally.	Persistent environmental toxin. Is a carcinogen, mutagen and a reproductive hazard [13].
Lead Dioxide / Nitrate / Chloride	oxidizer	Bioaccumulation, developmental danger for kids & unborn babes, may remain airborne for days, poisonous to plants & animals
Lithium compounds	blazing reds	Toxic and irritating fumes when burned
Mercury (Mercurous chloride)	chlorine donor	Toxic heavy metal. Can bioaccumulate.
Nitric oxide	fireworks byproduct [6]	Toxic by inhalation. Is a free radical
	fireworks byproduct [6]	Highly toxic by inhalation. SIDS risk [8].

Nitrogen dioxide		
Ozone	fireworks byproduct [7]	Greenhouse gas that attacks & irritates lungs
Perchlorate - Ammonium & Potassium	propellant / oxidizer	Can contaminate ground & surface waters, can cause thyroid problems in humans & animals
Potassium Nitrate	in black powder	Toxic dusts, carcinogenic sulfur-coal compounds
Strontium compounds	blazing reds	Can replace calcium in body. Strontium chloride is slightly toxic.
Sulfur Dioxide	gaseous byproduct of sulfur combustion	Acid rain from sulphuric acid affects water sources, vegetation & causes property damage. SIDS risk [8].

Fireworks Research

A case study has shown that within 1 hour of fireworks displays levels of Strontium in the air increased 120 times, Magnesium 22 times, Barium 12 times, Potassium 11 times, and Copper 6 times more than the amount present in the air before the event. Strontium was found to be the best tracer in this study because it measured very high during the event and much lower at other time intervals which indicated that it was mostly a result of the fireworks display. [9]

Another study found that firework events brought air pollution spikes in suspended particles, Nitric oxide (NO), Sulfur dioxide (SO_2), and created and dispersed an aerosol cloud hosting a range of metallic elements. The researchers found that although the "recreational pollution" from fireworks is transient in nature, the pollutants are highly concentrated and add significantly to the total yearly metal emissions and the particles are on average small enough to be easily inhaled which poses a health risk to sensitive individuals. [10]

Researchers have found that fireworks can create a burst of ozone which is an extremely reactive greenhouse gas molecule that can attack and irritate the lungs. The ozone is believed to be caused by ultraviolet light released by chemicals in fireworks... which in this study were sparklers. [7]