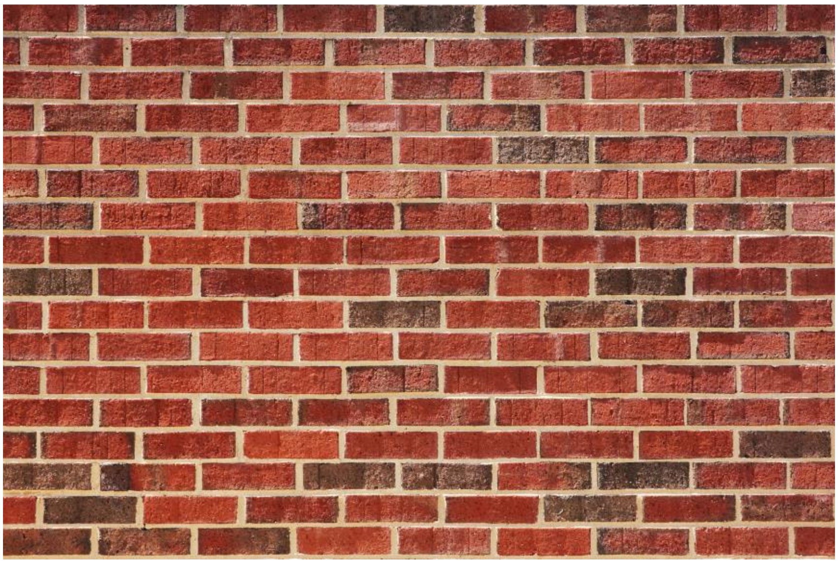


Periodic Wall of Elements

Randall Munroe

Q. What would happen if you made a periodic table out of cube-shaped bricks, where each brick was made of the corresponding element? —Andy Connolly

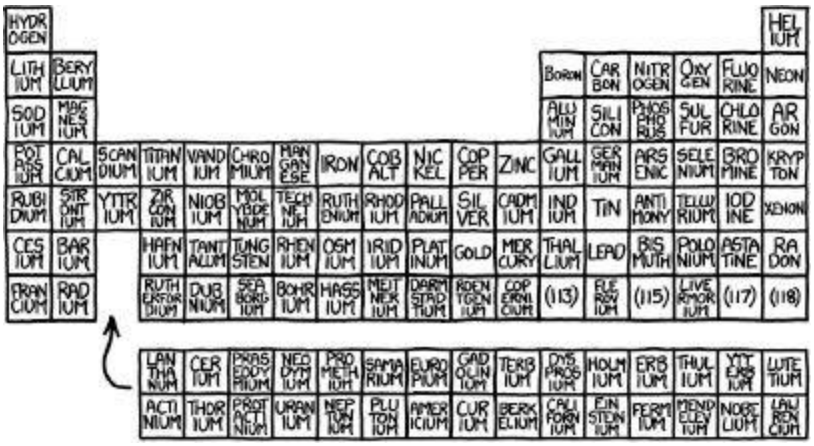
A. THERE ARE PEOPLE WHO collect elements. These collectors try to gather physical samples of as many of the elements as possible into periodic-table-shaped display cases.

Of the 118 elements, 30 of them—like helium, carbon, aluminum, iron, and ammonia—can be bought in pure form in local retail stores. Another few dozen can be scavenged by taking things apart (you can find tiny americium samples in smoke detectors). Others can be ordered over the Internet.

All in all, it’s possible to get samples of about 80 of the elements—90, if you’re willing to take some risks with your health, safety, and arrest record. The rest are too radioactive or short-lived to collect more than a few atoms of them at once.

But what if you *did*?

The periodic table of the elements has seven rows.



You could stack the top two rows without much trouble.

The third row would burn you with fire.

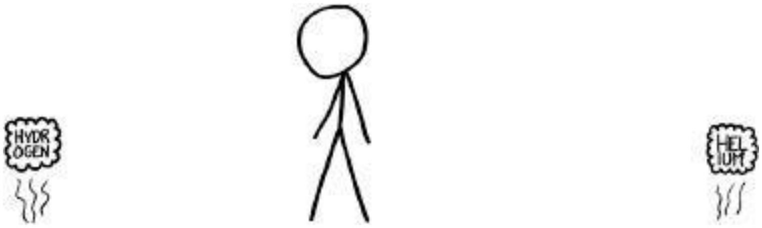
The fourth row would kill you with toxic smoke.

The fifth row would do all that stuff PLUS give you a mild dose of radiation.

The sixth row would explode violently, destroying the building in a cloud of radioactive, poisonous fire and dust.

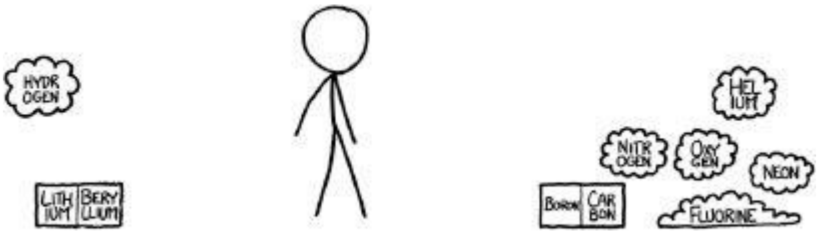
Do not build the seventh row.

We'll start from the top. The first row is simple, if boring:



The cube of hydrogen would rise upward and disperse, like a balloon without a balloon. The same goes for helium.

The second row is trickier.



The lithium would immediately tarnish. The beryllium is pretty toxic, so you should handle it carefully and avoid getting any dust in the air.

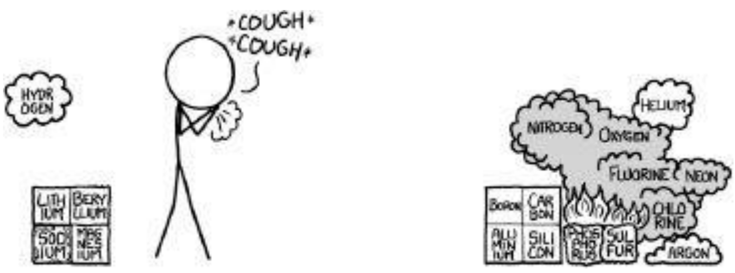
The oxygen and nitrogen drift around, slowly dispersing. The neon floats away.

The pale yellow fluorine gas would spread across the ground. Fluorine is the most reactive, corrosive element in the periodic table. Almost any substance exposed to pure fluorine will spontaneously catch fire.

I spoke to organic chemist Derek Lowe about this scenario.[4] He said that the fluorine wouldn't react with the neon, and "would observe a sort of armed truce with the chlorine, but everything else, sheesh." Even with the later rows, the fluorine would cause problems as it spread, and if it came in contact with any moisture, it would form corrosive hydrofluoric acid.

If you breathed even a trace amount, it would seriously damage or destroy your nose, lungs, mouth, eyes, and eventually the rest of you. You would definitely need a gas mask. Keep in mind that fluorine eats through a lot of potential mask materials, so you would want to test it first. Have fun!

On to the third row!



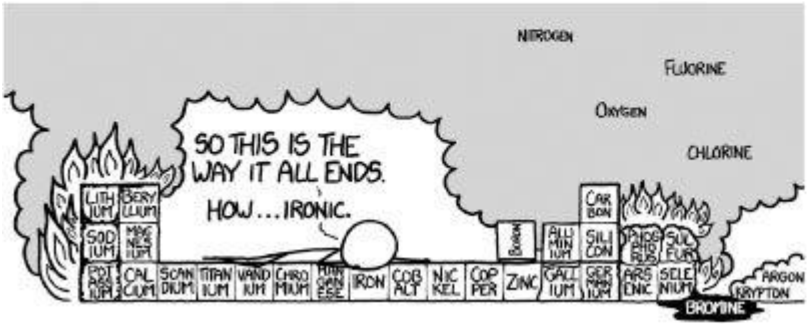
The big troublemaker here is phosphorus. Pure phosphorus comes in several forms. Red phosphorus is reasonably safe to handle. White phosphorus spontaneously ignites on contact with air. It burns with hot, hard-to-extinguish flames and is, in addition, quite poisonous.

The sulfur wouldn't be a problem under normal circumstances; at worst, it would smell bad. However, our sulfur is sandwiched between burning phosphorus on the left … and the fluorine and chlorine on the right. When exposed to pure fluorine gas, sulfur—like many substances—catches fire.

The inert argon is heavier than air, so it would just spread out and cover the ground. Don't worry about the argon. You have bigger problems.

The fire would produce all kinds of terrifying chemicals with names like sulfur hexafluoride. If you're doing this inside, you'd be choked by toxic smoke and your building might burn down.

And that's only row three. On to row four!



"Arsenic" sounds scary. The reason it sounds scary is a good one: It's toxic to virtually all forms of complex life.

Sometimes this kind of panic over scary chemicals is disproportionate; there are trace amounts of natural arsenic in all our food and water, and we handle those fine. This is not one of those times.

The burning phosphorus (now joined by burning potassium, which is similarly prone to spontaneous combustion) could ignite the arsenic, releasing large amounts of arsenic trioxide. That stuff is pretty toxic. Don't inhale.

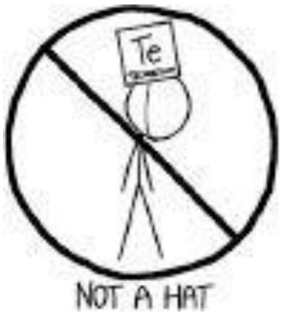
This row would also produce hideous odors. The selenium and bromine would react vigorously, and Lowe says that burning selenium "can make sulfur smell like Chanel."

If the aluminum survived the fire, a strange thing would happen to it. The melting gallium under it would soak into the aluminum, disrupting its structure and causing it to become as soft and weak as wet paper.

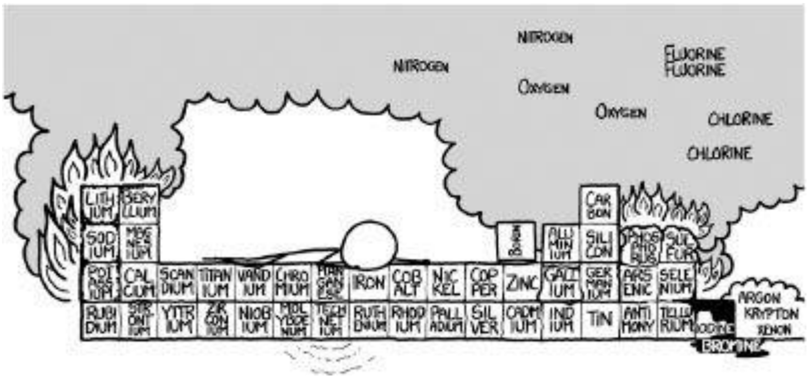
The burning sulfur would spill into the bromine. Bromine is liquid at room temperature, a property it shares with only one other element—mercury. It's also pretty nasty stuff. The range of toxic compounds that would be produced by this blaze is, at this point, incalculably large. However, if you did this experiment from a safe distance, you might survive.

The fifth row contains something interesting: technetium-99, our first radioactive brick.

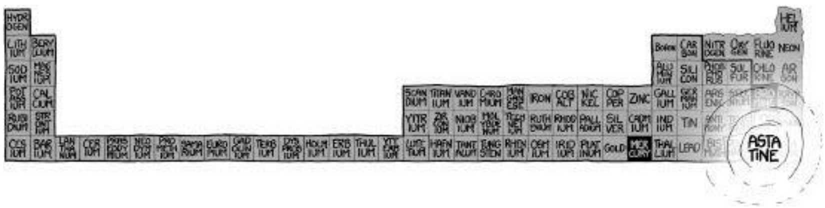
Technetium is the lowest-numbered element that has no stable isotopes. The dose from a 1-liter cube of the metal wouldn’t be enough to be lethal in our experiment, but it’s still substantial. If you spent all day wearing it as a hat—or breathed it in as dust—it could definitely kill you.



Techneteium aside, the fifth row would be a lot like the fourth.



On to the sixth row! No matter how careful you are, the sixth row would definitely kill you.



This version of the periodic table is a little wider than you might be used to, since we’re inserting the lanthanide and actinide elements into rows 6 and 7. (These elements are normally shown separately from the main table to avoid making it too wide.)

The sixth row of the periodic table contains several radioactive elements, including promethium, polonium, astatine, and radon. Astatine is the bad one.

We don’t know what astatine looks like, because, as Lowe put it, “that stuff just doesn’t want to exist.” It’s so radioactive (with a half-life measured in hours) that any large piece of it would be quickly vaporized by its own heat. Chemists suspect that it has a black surface, but no one really knows.

There’s no material safety data sheet for astatine. If there were, it would just be the word “NO” scrawled over and over in charred blood.

Our cube would, briefly, contain more astatine than has ever been synthesized. I say “briefly” because it would immediately turn into a column of superheated gas. The heat alone would give third-degree burns to anyone nearby, and the building would be demolished. The cloud of hot gas would rise rapidly into the sky, pouring out heat and radiation.

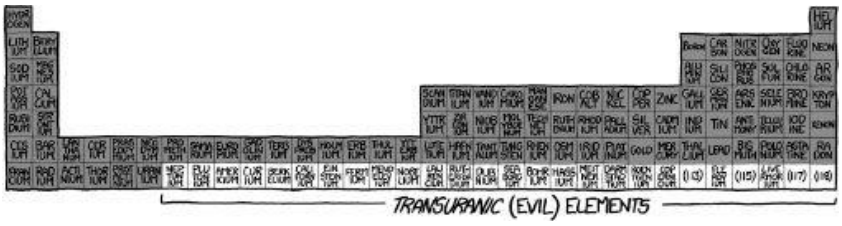
The explosion would be just the right size to maximize the amount of paperwork your lab would face. If the explosion were smaller, you could potentially cover it up. If it were larger, there would be no one left in the city to submit paperwork to.

Dust and debris coated in astatine, polonium, and other radioactive products would rain from the cloud, rendering the downwind neighborhood completely uninhabitable.

The radiation levels would be incredibly high. Given that it takes a few hundred milliseconds to blink, you would literally get a lethal dose of radiation in the blink of an eye.

You would die from what we might call “extremely acute radiation poisoning”—that is, you would be cooked.

The seventh row would be much worse.

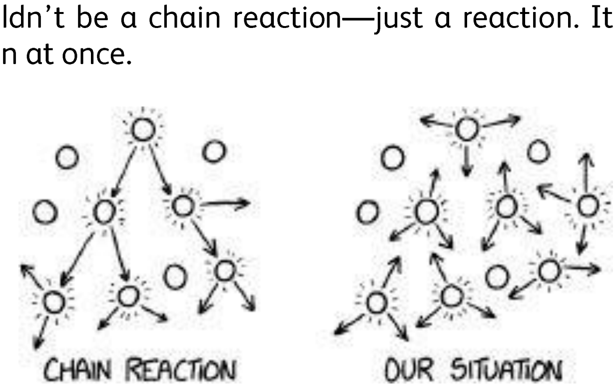


There are a whole bunch of weird elements along the bottom of the periodic table called **transuranic elements.** For a long time, many of them had placeholder names like “ununumium,” but gradually they’re being assigned permanent names.

There’s no rush, though, because most of these elements are so unstable that they can be created only in particle accelerators and don’t exist for more than a few minutes. If you had 100,000 atoms of Livermorium (element 116), after a second you’d have one left—and a few hundred milliseconds later, that one would be gone, too.

Unfortunately for our project, the transuranic elements don’t vanish quietly. They decay radioactively. And most of them decay into things that *also* decay. A cube of any of the highest-numbered elements would decay within seconds, releasing a tremendous amount of energy.

The result wouldn’t be like a nuclear explosion—it *would* be a nuclear explosion. However, unlike a fission bomb, it wouldn’t be a chain reaction—just a reaction. It would all happen at once.

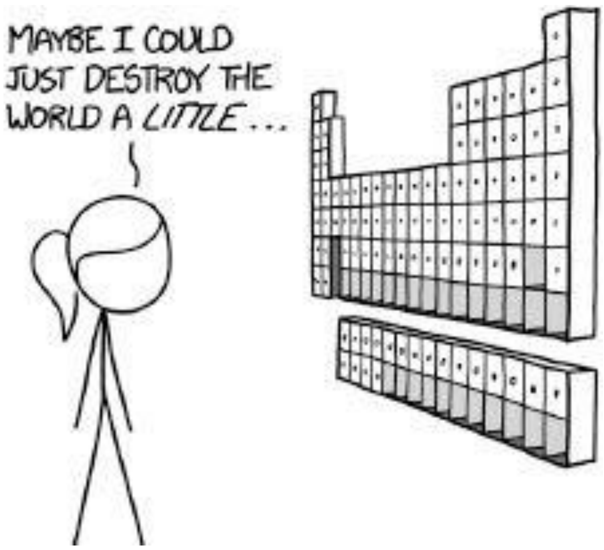


The flood of energy would instantly turn you—and the rest of the periodic table—to plasma. The blast would be similar to that of a medium-sized nuclear detonation, but the radioactive fallout would be much, much worse—a veritable salad of everything on the periodic table turning into everything else as fast as possible.

A mushroom cloud would rise over the city. The top of the plume would reach up through the stratosphere, buoyed by its own heat. If you were in a populated area, the immediate casualties from the blast would be staggering, but the long-term contamination from the fallout would be even worse.

The fallout wouldn't be normal, everyday radioactive fallout[9]—it would be like a nuclear bomb that *kept exploding*. The debris would spread around the world, releasing thousands of times more radioactivity than the Chernobyl disaster. Entire regions would be devastated; the cleanup would stretch on for centuries.

While collecting things is certainly fun, when it comes to chemical elements, you do *not* want to collect them all.



Taken from *What If?* by Randall Munroe.