Geek Trivia: Elements of surprise

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Takeaway:
What are the only two synthetic elements with atomic numbers lower than uranium?

For an occupation ostensibly dedicated to clarifying the nature of the empirically observed universe, science (or, rather, scientists) often has a devil of a time speaking plainly. Take, for example, the phrase *synthetic element*, which would seem to describe an element that someone has manufactured.

In actuality, however, *synthetic element* is misleading techno-jargon for an element with a half-life so short that it's unlikely to exist in the natural environs of our planet. And by *short half-life*, we mean any half-life less than several million years—clear as mud, isn't it?

Now, it's understandable how the elements classified as synthetic came to be so; none currently occur naturally on Earth. The only places scientists would encounter them are within the confines of nuclear reactors and particle accelerators, which synthesize these elements as products of their reactions.

So the synthetic label would seem to fit. But to say these elements don't occur naturally on Earth today is not to say that they don't occur naturally—or that they've never occurred on Earth.

The truth is that so-called synthetic elements have likely occurred in nature at some point, both in the Earth's past and the universe's present. In fact, several synthetic elements are present in stars, created as byproducts of stellar fusion. When these stars erupt or explode, the process flings "synthetic" elements out into the cosmos, occasionally finding their way into planetary bodies, where they live out their brief lives before decaying into other "non-synthetic" elements.

Perhaps a better name for the items on the synthetic portion of the periodic table would be *non-terrestrial elements*. Then again, that might suggest that aliens put the elements here, rather than the physicists who conjured them up during atomic experiments.

Besides, when we're talking about synthetic elements, we're really discussing all those exotic metals with high atomic numbers, otherwise known as the *transuranic elements*—as in, they have a higher atomic number than uranium's 92—right? In fact, isn't *transuranic* just a more explicit term for *synthetic element*?

Not quite: Two synthetic elements have atomic numbers lower than uranium, and this pair of unconventional metals actually filled "holes" in the otherwise terrestrial lineup of the periodic table.

WHAT ARE THE ONLY TWO SYNTHETIC ELEMENTS WITH ATOMIC NUMBERS LOWER THAN URANIUM?

What two so-called synthetic elements—elements that don't occur naturally on Earth—actually have atomic numbers lower than uranium, rather than the traditional three-figure atomic numbers that characterize the bulk of synthetic elements?

Technetium, which has an atomic number of 43, and promethium, which has an atomic number of 61, both qualify as synthetic elements. Neither element presents a stable isotope, and none of their unstable isotopes present a half-life long enough for any significant samples of these metals to be present on Earth.

In the 19th and early 20th centuries, there was something of a tacit race among chemists and physicists to find the "missing" elements 43 and 61. These elements had obvious places on the periodic table, but scientists had yet to recover samples of either. The confirmed discovery of technetium didn't occur until 1937, and promethium eluded scientists until 1945.

Technetium is the more "common" of the two metals, with technetium-98 being its most stable isotope, having a half-life of 4.2 million years. (With the Earth being a few billion years old, all the original technetium decayed long ago.)

Technically, you can find minute traces of technetium within natural uranium deposits, as technetium is a byproduct element of some types of uranium fission. You can also find it in hospitals, as synthesized technetium isotopes are part of some common nuclear medicine treatments.

Promethium is almost impossible to track down, as its most stable isotope, promethium-145, has a half-life of just less than 18 years. Only three possible promethium isotopes have half-lives longer than one year, and the majority of the remaining ones are less than 30 seconds!

It's also fairly dangerous, since it's a fairly hefty beta emitter, which in the right circumstances can result in serious X-ray emissions. We're actually rather lucky there isn't a lot of promethium around.

For the record, it's possible for an element to have a lower atomic number than uranium, have no stable isotopes, and still not qualify as synthetic. Tungsten, employed in light bulb filaments (among countless other applications), has no stable isotopes, but the half-lives of these isotopes are so long that element is, for all practical purposes, stable—and a staple of some chemically reactive Geek Trivia.

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The Quibble of the Week

If you uncover a questionable fact or debatable aspect of this week's Geek Trivia, just post it in the discussion area of the article. Every week, yours truly will choose the best post from the assembled masses and discuss it in the next edition of Geek Trivia.

This week's quibble comes from the August 9 edition of Geek Trivia, "Pulp fission." TechRepublic member **Gsquared** questioned my arithmetic when it came to counting nuclear weapons.

"[You wrote] 'But what you won't find in most of those history books is a mention of the third bomb from the Fat Man/Little Boy development series—one that never saw completion due to the technical limitations of the era and the inherent flaws of the bomb's design.' Um, [the] *third bomb* was the Mark 2, which makes it the second of four designs. Little Boy, Thin Man, Trinity Test (can't remember the code name for that one), [and] Fat Man were the bombs in sequence of design."

Well, here's where we get into semantics. First, I should have said "*a* third bomb" rather than "*the* third bomb" because Thin Man was the Mark II weapon design—the second of three *designs*,not *devices*, to come out of The Manhattan Project. Little Boy was Mark I, and Fat Man was Mark III. The Trinity test device, Gadget, was a prototype of the Mark III design, not a distinct weapon concept. That's why it never received its own Mark classification. So you're half-right: I did misspeak, but I didn't miscount.

For the record, the U.S. has kept the Mark weapon classification system going since Manhattan, and the number of nuclear weapon designs is now well into the 80s. Thanks for the feedback, and keep those quibbles coming.

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The Trivia Geek, also known as Jay Garmon, is a former advertising copywriter and Web developer who's duped TechRepublic into underwriting his affinity for movies, sci-fi, comic books, technology, and all things geekish or subcultural.

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