

LTE concerning the Chemical Educator article:

### Recreating a Periodic Table

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This paper seemed such a good idea when I first read it. Teachers in training take some data on properties of twelve elements that have been discovered on a planet in a “parallel universe,” whatever that may mean. The aliens on this planet manage to communicate to Earthlings some chemical and physical properties of the twelve elements they have discovered. Given these clues, the teacher-students are directed to try to “to collaborate in the analysis of the available data to characterize any existing physical and chemical trends and, if possible, derive the corresponding law.”

As I began to read the data given for these elements on another planet I first took the gas density data, assumed  $PV=nRT$ , and assumed the ambient conditions on the planet must be unknown, but that the molecular mass of the gases could still be approximated by the gas density multiplied by  $RT/P$ . If the least dense gas reported (dentrrium) were taken to be hydrogen  $M=2$ , then  $RT/P$  (the alien’s STP molar volume for gases) must be 30 L/mol. Now 30 L/mol multiplied by each given gas density yields the following table:

Molecular mass of dentrium (gas)	<i>Calculated molecular mass</i> 2 g/mol	<i>Atomic mass</i> 1 amu	<i>Probable element</i> diatomic hydrogen
Molecular mass of nostrrium (gas)	<i>Calculated molecular mass</i> 10 g/mol	<i>Relative atomic mass</i> 5	Probable element is Ne. Division by 2 is unnecessary because it is monoatomic.

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Molecular mass of icolium (gas)	<i>Calculated molecular mass 12 g/mol</i>	Relative atomic mass 6	Probable element diatomic lithium gas ? or monatomic carbon gas?
Molecular mass of fintrium (gas)	<i>Calculated molecular mass 18 g/mol</i>	Relative atomic mass 9	Probable element? monatomic fluorine? or ? diatomic beryllium?
Molecular mass of umnium (gas)	<i>Calculated molecular mass 28 g/mol</i>	Relative atomic mass 14	Probable element? diatomic nitrogen. Perfectly reasonable.
Molecular mass of orpium (gas)	<i>Calculated molecular mass 36 g/mol</i>	Relative atomic mass 18	Probable element? diatomic fluorine or monatomic chlorine?
Molecular mass of amplium (gas)	<i>Calculated molecular mass 62 g/mol</i>	Relative atomic mass 31	Probable element? The inert gas Cu.
Atomic mass of rastrium	This is a solid insulator.	Relative atomic mass 10	Probable element? Based on author's atomic mass this is B.
Atomic mass of ysprium	This is a solid semiconductor.	Relative atomic mass 22	Probable element? Based on author's atomic mass this is Na (a semiconductor?).
Atomic mass of huntium	This is a solid insulator.	Relative atomic mass 23	Probable element? Based on author's atomic mass this is Na (a semiconductor?)
Atomic mass of tortium	This is a solid insulator.	Relative atomic mass 28	Probable element? Based on author's atomic mass this is Si (an insulator?)
<b>Atomic mass of permium</b>	<b>This is a solid conductor.</b>	<b>Relative atomic mass 34</b>	Probable element? Based on author's atomic mass this is Cl (a solid conductor?)

**Table 1. Molar mass as calculated from data supplied by aliens. Column in red is calculated by the paper's author. Values in blue were calculated by Roy Clark.**

As you can see in the table I was unable to deduce the atomic masses from the alien data because could see no reason to assume all the gases were diatomic, especially the inert gases. As for the relative atomic masses of the solid elements, this calculation eluded me. Talanquer states in the paper that “given the relative atomic mass of one

element, the relative atomic mass of another element may be calculated if we have information about the chemical formula and composition of the associated binary compound.” The problem here is we do not have the formula for the compound, so we lack one of these three necessities. The last column notes the absurdities he produces.

It finally occurred to me that perhaps on this planet the atoms were not like our atoms, and the author intended no identification of these strange elements with ours. Perhaps these aliens and their universe perhaps have a completely different chemistry and physics from ours. **Yet that clearly could not be the case.** Should this “parallel universe” have a different chemistry and physics from our own we would not be able to communicate with them. We could never ask them about their world. Even if we could somehow communicate with them we would never be able to define a gram or a liter, the measurement units they sent back. Think how impossible would it be to describe electrical conduction and to define anode and cathode. Incidentally, the aliens got those words backwards when they sent Talanquer this hypothetical message.

If the aliens have the same atoms we have there is nothing wrong with calling a mole a mole. We have apparently told them what amount of mass is a gram, and their definition of a mole can be the same as ours. There are Avogadro’s number of amus per gram. A mole is Avogadro’s number of things, even though they may call it a mule.

Talanquer’s Table 1 contains so many confusing ideas that are so unlike the chemistry the students have already learned that I feel obligated to point them out.

1. The statement frequently appears in describing the combination of certain elements that “This compound conducts electricity.” The compound referred to is said to be a liquid which conducts electricity. In the chemistry that these students

have studied formation of such a liquid would be very unusual. Among common chemicals that are pure substances **almost none are liquids and also good conductors of electricity**. Pure water is not, and I cannot think of another liquid that the students might be familiar with that has the property of electrical conduction. Some conducting metals might be liquids at the temperature of the alien planet, but their compounds would not likely be, unless perhaps they were simply alloys. I think what Tanqier had in mind as he wrote this was the synthesis of **solid** electrolytes which do **not** conduct electricity, but are famous for conducting in solution in water (or gulunke).

2. Many electrolytes **when dissolved in gulunke** will deposit their cations on the cathode, their anions on the anode when a direct current is passed through the solution. There are also many other cases in which the electrolyte's cation or anion might not deposit because hydrogen (dentrion) or oxygen will evolve preferentially.
3. "It" is used ambiguously in the properties of umniun in Table 1. Is "it" the element or the compound produced?

As to the objective of finding trends in these fictional elements, that is pretty much a waste of time. The aliens probably write from bottom to top and from right to left. Our periodic table is based on X-ray determinations of the nuclear electrical charge, as should theirs be. Teach them about X-ray machines.

A letter to the editor should never be this long. I regret that I felt compelled to write at this length. I do it because I feel sorry for all the students that have been

subjected to this activity designed to “develop their **PCK**”, and as a consequence had their **pedagogical content knowledge** battered and bruised, rather than enhanced.

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