The Mystery of the Periodic Table

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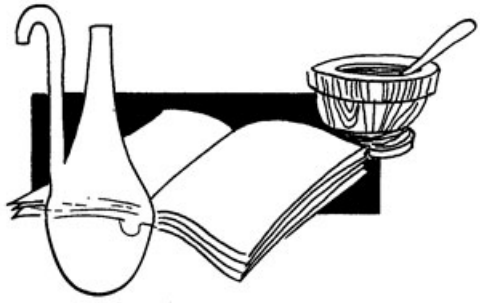

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Periodic Table of the Elements

1A												3A	4A	5A	6A	7A	8A
1 H 1.008	2A															1 H 1.008	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98.91	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs	109 Mt									

Lanthanide Series	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Actinide Series	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

1. The Puzzle

ALMOST ALL mystery books *end* with the solution. This mystery book begins with the solution. Here it is—on the facing page.

What on earth is it?

As it turns out, every material thing on earth—and in space as well.

This is the Periodic Table of the Elements. It is the solution to the mystery of what every material thing is ultimately made of—trees, rocks, dirt, cells, plants, your hair, your skin, the clouds, the air, the sun, the moon, and the stars.

Anything that has mass and takes up space is made from some of the elements.

But what is an element?

Elementary means the first, the very beginning. The elements are the first things out of which every material thing else is made. When you get to these elements, you have gotten to the bottom of things—although not quite the very bottom, as we shall see in a later chapter.

Modern chemists define an element as a substance that cannot be broken down by chemical change into simpler, purer substances.

While salt is on your table, you won't find salt on the Table of Elements. Why? Salt can be broken down further, into Sodium and Chlorine. Sodium is found on the Table, designated by the chemical symbol "Na." Chlorine is designated by "Cl." When we have gotten to Sodium and Chlorine, as far as chemistry is concerned we have gotten to the bottom of things, and cannot go any further.

As you can see, there are 109 elements on our Periodic Table. Some are very common. Some are very rare. Some occur in nature. Some are manmade. As we shall see in a later chapter, some more elements can be added even beyond the 109 you see here—manmade elements, not natural elements. But for now, let's focus on the 109 we see on our Table.

A little over 98½% of the earth is made up of only 8 of these elements: Iron (Fe), Oxygen (O), Silicon (Si), Magnesium (Mg), Nickel (Ni), Sulfur (S), Calcium (Ca), and Aluminum (Al). Oxygen and Iron by themselves make up about 65% of the earth.

If we look at the entire universe, about 97% of it is made up of only 2 elements, the two on the very top left and top right side of the Periodic Table, Hydrogen (H) and Helium (He).

Some of these elements are seen every day, although not in their purest form. The coins in your pocket or purse are (for the most part) made of Copper (Cu), Nickel (Ni), Silver (Ag), and if you are really lucky or really rich, Gold (Au).

Most of the elements were not easy to find. On the contrary, they were very difficult to find. They had to be discovered, and they certainly were not found conveniently labeled and stacked in such neat rows as we find them on the Periodic Table of Elements.

Indeed, when we look at these nice, neat, and straight rows of elements we might think that it was a nice, neat, and straight road to their discovery. Nothing could be further from the truth. It was a long and difficult journey much like the perilous wanderings of Odysseus in Homer's great epic tale, the *Odyssey*. Of course, the wandering made it an adventure, and an adventure is always an exciting thing to retell.

2. The First Chemists?

WHO WERE the first chemists? They were not scientists. They did not work in laboratories. They were workers of metal. They were not seeking to find out what the elements were, nor were they after truth for its own sake. They were quite practical men, interested in making beautiful jewelry and better weapons.

The ancient metal workers might be considered the very first chemists because instead of working with the elements in mixtures (as cloth dyers and medicine makers did), they worked with the pure elements, or to be exact, the pure metals.

In the pre-Christian era the ancients knew only seven basic metals: gold (Au), silver (Ag), copper (Cu), lead (Pb), tin (Sn), iron (Fe), and mercury (Hg).

Mercury was discovered last, about the 4^{th} century BC. Which element was discovered first?

More blood has been shed over the very first element discovered, more kingdoms have risen and fallen, and more dreams have been conjured and shattered as well. There is no more useless element—

certainly no more useless metal! It is too soft to make into any kind of durable tool or weapon, but it is more beautiful than any other element.

The first person to discover it probably caught sight of a luminous flash by the side of a riverbank while he was taking a walk. Curious, he walked over and dug it out with his toe, picked it up, and brushed this oddly heavy object off.

It was gold!

Gold is the metal that, more than any other, is found in a pure form, and often right out in the open. It is as if the most beautiful element was half-hidden by somebody, just waiting to be discovered. So brilliant, so glorious and pure, gold could not fail to attract man's attention. For that very reason, archaeologists have found gold ornaments dating all the way back to the Neolithic era (7000–4000 BC). But surely gold must have been noticed before that.

In any case, as the Neolithic men soon realized, gold makes a worthless hoe or spearhead. A common rock or stick would work better.

Gold is so soft that for thousands of years its use was purely decorative. And so while gold makes a very bad tool or weapon, it makes a breathtaking necklace or bracelet.

So back before there was writing, while people still used stone and wood tools, gold was known. And since gold was so soft, they could work it by pounding on it with stone tools. They did not even need fire.

It is also possible that silver and copper were known nearly as early, for while they are most likely to occur as ores (that is, mixed with other elements), they sometimes do occur in nature in their pure form. But not nearly as much as gold.

Gold, silver, and copper might have been the only pure elements humanity ever found had it not been for a very important discovery, a discovery of something that is not itself an element, but without which it is quite unlikely that any other elements would ever have been isolated and discovered. Indeed, without it, chemistry would have been completely impossible.

Fire.

The discovery of fire transformed the entire history of humanity. Without fire, there would have been no civilization. There would have been no chemistry. There would be no Periodic Table

of Elements because almost all the elements would have remained forever shrouded in mystery.

So maybe the real honor of the first chemist should go to the person who first realized that fire *changed* what it heated.

Sometime during the Neolithic period, fire was first tamed, and with the taming of fire, the *smelting* of metals became possible.

Smelting is necessary because most metals do not occur like gold (and sometimes silver and copper), in pure forms at or near the surface of the earth. They occur in the compounds called ores, the concentrated but impure deposits of metals in the earth's crust.

And by the way, we ought to be very thankful that such metal ores *do* occur in concentrated form. What if the metals were simply spread out uniformly in the earth's crust? We would never have found them! Or at least we never could have gathered enough gold, silver, copper, or any other metal to make anything.

Why?

Fill a glass container with a cup of sand. Add a teaspoonful of pepper, and a teaspoonful of sugar. Shake it very well.

Could you get the pepper and sugar back out again? It might take a thousand years! We are fortunate indeed that metals are gathered together in concentrated deposits.

But even with the concentration of metals in ores near the earth's surface, we would not have gotten very much of any metal, not even of gold, without smelting.

In its simplest form, smelting is the heating of ores to separate the desired metal from the undesirable elements of the ore.

How was smelting first discovered?

Perhaps a young Sumerian saw lightning hit an eroded hillside containing iron ore, and when he ran up to investigate, he found a gnarled piece of iron.

Or it could have been a curious Egyptian who found that the rocks he had placed around his fire the night before had been changed by morning—the copper hidden in the ore had been extracted by the fire!

However it began, by about 3500 BC the development of pottery kilns allowed for fire to be enclosed, and enclosing fire allowed the heat to reach temperatures hot enough and controlled enough for smelting. Archaeologists have found many larger copper items from this era—bowls, plates, ornaments—which show us