

# Periodicity in the Periodic Table of the Elements

Rabbi Yitzhak Ginsburgh

## I. Theoretical Background

One of the most well known and ubiquitous symbols of modern science in general and chemistry in particular is the *Periodic Table of the Elements*. The modern periodic table has been almost 300 years in the making. Early efforts to group elements produced the tables of Geoffroy (1718) and Lavoisier (1787). The atomic theory formulated by Dalton in the early 1800s provided chemists with a solid basis to classify elements, and the theory stimulated vigorous experimentation that culminated in the development of the modern form of the periodic table in 1869 (See figure 1).

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac															

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

figure 1

From the early rudimentary groupings of chemical *compounds* to our modern classification that recognizes the periodicity of atomic *elements* together, chemical tables are usually based on an implicit theory of the composition of matter<sup>1</sup>. These theories have shared a common axiom: that all of the matter in the Universe is composed of a finite variety of basic building blocks. These building blocks have been known from the ancient Greeks to the present as **atoms**.

\* Based on two lectures given by Rabbi Ginsburgh, 9<sup>th</sup> of Elul 5753 (27/8/93) and 15<sup>th</sup> of Iyar 5761 (7/5/01); Transcribed and translated by Batya Eshel; edited and annotated by Moshe Genuth.

1. For a more thorough discussion of these ontological schemes in the 19<sup>th</sup> century see Nye, ch. 3.

In our modern table of the chemical elements, the different atoms are identified and ordered by their atomic number. Atoms are defined as the smallest unit of an element that can combine with another element. Atoms are theorized as composing of a nucleus, made of protons and neutrons, and electrons that move around the nucleus. The atomic number identifies the number of protons in an element's nucleus. Atoms can lose or gain electrons, and the ease with which they do so is a measure of their reactivity.

In our modern periodic table of elements, elements are arranged in columns and rows. As its name implies, the modern table is **periodic** in nature, meaning that elements are placed in it based on their shared and recurring (periodic) characteristics. Periodicity of element properties is found to be strongest down columns of the table. Primary among these periods is that of the 6 noble (or inert) gases which populate the far right column of the table. The property shared by the inert gases is a lack of reactivity ensuing from their inability to gain or lose electrons.

Another example: the first element in the table, Hydrogen (H) is a gas, the second, Helium (He), is a noble gas, and the third, Lithium (Li), is a soft, reactive metal. Going down the table, we find eight elements later Fluoride (F), Neon (Ne) and Sodium (Na), a gas, a noble gas, and a soft, reactive metal, and eight elements later, Chloride (Cl), Argon (Ar) and Potassium (K)—again: a gas, a noble gas, and a soft, reactive metal.

The remarkable predictability of element properties revealed by the periodic table allowed chemists to 'describe' as yet unidentified elements based on their supposed location in the table. Such was the case when in 1871 Dimitry Mendeleev, the Russian chemist who originally formulated the periodic law, correctly described the properties of the element between Silicon (14) and Tin (50) which he called *ekasilicon*. The element in question was not identified until 1886 by a German chemist who dubbed it Germanium.

## **2. The Kabbalistic counterparts to the Periodic Table**

It is our goal in this article to present an exact and full analogy to the modern periodic table within Torah. The motivation for this goal is explained in preceding chapters. To achieve do so in a methodological manner, we must first ascertain that the Torah does indeed include examples of the two central concepts underlying the content and form of the Periodic Table: (1) **atoms** and (2) **periodicity**.

The notion of the entirety of creation being constructed out of a finite variety of basic *building blocks* is central to the earliest Kabbalistic source known (and incidentally the first book of Hebrew grammar)—the *Book of Formation* (**Sefer Yetzirah**). From there this notion assumes a central role throughout the entire Kabbalistic and esoteric tradition within Torah.<sup>2</sup>

Specifically, the *Book of Formation* turns to Genesis and, following a (spiritually) linguistic perspective, identifies 32 non-corporal elements or atoms. They are the 10 **sefirot** [which correspond to the 10 *utterances* (**ma'amarim**, מאמרים)] 'spoken' by G-

---

2. Most notably in chapter 1 of part III of the Tanya, the basic work of Habad Hassidism.

No part of this publication or its contents may be used, applied or reproduced in any manner without prior consent from the Torah Science Foundation

d when creating the world<sup>3</sup> and the 22 letters of the Hebrew alphabet, out of which the *utterances* are constructed. Together, these 32 *atoms* form the basis for language and speech, the conduits of the creative act itself.

However, though the *Book of Formation* provides us with the notion of basic building blocks of the Universe, the atoms it identifies are ill suited for our purposes of correspondence. First, because they are of two separate categories, one (utterances) clearly hierarchically above the other (letters). Second, because we are searching for a one-to-one correspondence between the atoms of the periodic table and some corresponding unit in Torah.

However, one piece of valuable insight to be gained from the *Book of Formation* is the idea that should the Torah's equivalent of elements or atoms be found, it would be in the first chapter of Genesis, where the act of creation is described. What better place to search for the *Torah atoms* from which Creation is constructed?

\* \* \*

To explain the correspondence we *have* found, let us first mention that of the more than 100 elements, only 92 are naturally occurring. Atoms of elements with atomic number higher than 92 can be artificially synthesized, however, they are generally not stable<sup>4</sup> and undergo nuclear rearrangement resulting in radioactive decay shortly after being synthesized.

And now to our correspondence: one of the most important contributions to Jewish scholarship in the recent past has been the work of Rabbi Zalman Pinhas Horowitz<sup>5</sup>. Rabbi Horowitz was (to the best of our knowledge) the first to correctly count the number of times the Tetragrammaton (YHVH) appears in the Pentateuch: 1820 times. Even more surprising and innovative was Rabbi Horowitz's cataloging of all the distinct words<sup>6</sup> in the Pentateuch, which he also found to be exactly 1820 in number.

This equality still warrants much research, but here we will note a fact related to our own particular interest: of the total 1820 unique words in the Pentateuch, the section describing creation (Genesis 1:1 to 2:3, inclusive) contains *exactly* 92 distinct words. Indeed, as mentioned already, this section of the Torah literally describes the creation of matter in the universe—it is only fitting that it is here that we find our sought after parallel for the 92 natural elements identified by modern science.

Before proceeding let us copy the familiar periodic table of elements with the 92 distinct words of Genesis placed in order:

---

3. Mishnah Avot 5:1; see BT *Megillah* 21b and elsewhere. For the identification of the 10 **sefirot** with the 10 **ma'amarot**, see Alter Rebbe's *Torah Ohr* 53a, 82d and elsewhere.

For a correspondence between the the 10 **ma'amarot** and the 10 Aristotlean philosophical categories see Maimonides, *Introduction to Logic* 10§4. For a correspondence between these 10 philosophical categories and the **sefirot**, see our audiotape (Hebrew) "Ten Types of Consciousness," (Kfar Habad: Gal Einai Publications, 1998).

4. Recently, new experimentation has led to the discovery of so-called 'islands of stability' in the superheavy elements; see Oganessian et. al., "Voyage to Superheavy Island" in *Scientific American* 282:1 (January 2000), pp. 45-49.

5. See his volume *Ahavat Torah* (Podgorza, 1905).

6. Meaning words that stem from different roots (שרשים, **shorashim**), the 2 or 3 letter combinations which serve to form words in semitic languages like Hebrew [technically, 2 letter roots are known as gates (שערים, **sha'arim**)].

1 H בראשית																	2 He ברא
3 Li אלהים	4 Be את											5 B השמים	6 C הארץ	7 N היתה	8 O תהו	9 F ובהו	10 Ne וחשך
11 Na על	12 Mg פני											13 Al תהום	14 Si ורוח	15 P מרחפת	16 S המים	17 Cl ויאמר	18 Ar אור
19 K וירא	20 Ca כי	21 Sc טוב	22 Ti ויבדל	23 V בין	24 Cr ויקרא	25 Mn יום	26 Fe לילה	27 Co ערב	28 Ni בקר	29 Cu אחד	30 Zn רקיע	31 Ga בתוך	32 Ge ויעש	33 As אשר	34 Se מתחת	35 Gr כן	36 Kr שני
37 Rb יקוו	38 Sr אל	39 Y מקום	40 Zr היבשה	41 Nb ימים	42 Mo תדשא	43 Tc עשב	44 Ru מזריע	45 Rh עץ	46 Pd פרי	47 Ag למינו	48 Cd בו	49 In ותוצא	50 Sn שלישי	51 Sb לאותות	52 Te למועדים	53 I ושנים	54 Xe המזלים
55 Cs למשלת	56 Ba הקטן	57 La הסכים	72 Hf בהמה	73 Ta האדמה	74 W בצלמנו	75 Re כמוהו	76 Os וירדו	77 Ir בדגת	78 Pt זכר	79 Au ונקבה	80 Hg להם	81 Tl וכבשה	82 Pb הנה	83 Bi לאכלה	84 Po ירק	85 At מאד	86 Rn הששי
87 Fr ויכלו	88 Ra צבאם	89 Ac השביעי															

58 Ce ויתן	59 Pr רביעי	60 Nd ישרצו	61 Pm נפש	62 Sm חיה	63 Eu ועוף	64 Gd התמימים	65 Tb כל	66 Dy הרמשת	67 Ho כנף	68 Er ויברך	69 Tm ורבו	70 Yb ומלאו	71 Lu חמישי
90 Th מלאסו	91 Pa וישבת	92 U ויקדש	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Following our methodology, we should now seek periodicity, the second organizing principle identified above. To do so, we will first examine and understand in-depth the periodic nature of the structure and form of the table of elements and the model used to explain this periodicity. We will then explore parallel spiritual models found in Kabbalah and Hassidism. In a forthcoming article we will use our findings to examine the periodicity inherent in our parallel Torah table of elements pictured above.

### 3. On the relationship between spiritual and mundane in the Torah

Before starting our analysis, let's take a few steps back to say a few words about the rationale for looking to the Torah for models that can describe (directly or indirectly) natural phenomena.

The physical world and its attributes are often spoken of as a reflection or manifestation of the spiritual realm, and as such, by studying the physical we may come to know more about the spiritual worlds, and ultimately our Creator<sup>7</sup>.

7. Mar'eh Ha-adam ch. 3 folio 2a.

It is explained in Jewish tradition that there are two ways to describe the relationship between the Torah and physical reality:

The first, more commonly held view, is that the Torah speaks of mundane matters (e.g. laws of commerce, liability, etc.) but as it were, these mundane matters are also to be found reflected in the higher (or inner) spiritual dimensions of the universe. So we might say that the Torah can be interpreted as saying something about the spiritual worlds as well as the mundane. This interpretation can be as simple as talking about the spirit of the law (as opposed to the letter or the law). Or, it can form the basis of a complex and intricate (anthropomorphic) analysis of the Divine, based on the Torah.

The second approach, advocated by Hassidism, holds that the Torah's actual subject matter are the higher (or inner) spiritual dimensions of the universe, and it is actually they that are also reflected, or mimicked, in the lower mundane material dimensions<sup>8</sup>. Thus we may say that the literal meaning of the Torah is spiritual, while a non-literal, or allegorical interpretation of this meaning teaches about the mundane physical world.<sup>9</sup>

The second approach may seem troubling, because the Torah does not seem to employ 'spiritual' language (note the lack of mention of angels or any other 'heavenly' artifacts). In fact, the opposite is more the case—the stories related and the commandments of G-d found in it all seem to speak directly about physical reality as it was a few thousand years ago. The response to this point comes in the shape of the Talmudic dictum that "Torah speaks in the language of men"<sup>10</sup>. In other words, though the subject matter of the Torah is indeed spiritual, its language is mundane—"the language of men"—such that it employs language that refer to objects and states of affair familiar to humans.<sup>11</sup>

Armed with these two basic notions regarding the subject matter and language of Torah, we argue that by studying the physical world using scientific methods (which should hopefully give us a clear picture of physical phenomena) we expect to find parallels between the Torah's 'physical' terminology and the findings of experimental science regarding those phenomena. Relating our knowledge about such physical phenomena to the Torah's vocabulary (or other non-linguistic forms of communication, as will be explained) will, in turn, lead us to a better understanding of the 'spiritual' issues, which are the Torah's 'actual' subject matter. Thus we come to learn more about the spiritual realm using scientific knowledge.

---

8. Based on this view, R. Israel Ba'al Shem Tov (a.k.a. the Besht), the founder of Hassidism in 18<sup>th</sup> century Ukraine, taught that the Torah is universal in the sense that it is "relevant to every person at every moment in every location" (quoted ubiquitously in **Toldot Yaakov Yosef** by the Besht's student, R. Yaakov Yosef the Maggid of Polona).

9. In the original hebrew these two viewpoints are: 1) תורה מדברת בתחתונים ורומזת בעליונים 2) תורה מדברת בעליונים ורומזת בשניות בתחתונים; these specific idioms are from **Asarah Ma'amarot, Ma'amar Hikur Din**, III, ch. 23 by R. Moshe Azaria (Ramah) of Pano. They are originally based on R. Yishaya Horowitz, author of the **Shnei Luhot Habrit** (Biozepaf, 5639) folios 10c – 11a.

The second, Hassidic, approach seems to fit much better with the well known midrash (hermeneutic) statement: "He [G-d] looked in the Torah and created the world" (see *Bereishit Rabba* 1:1)

10. "דברה תורה בלשון בני אדם"; BT **Berahot** 31b and elsewhere.

11. Note that following the first viewpoint, where the Torah is literally speaking of the mundane, this Talmudic dictum has no (or at most trivial) meaning.

The Torah contains varied types of communicable information, alluded to by the famous acronym: PaRDeS. PaRDeS stands for the four types of textual analysis traditionally used to explore the Torah in order to recover its informative content. These are: **pshat** (literal analysis), **remez** (symbolic, or numerical analysis), **drash** (hermeneutic analysis) and **sod** (associative, or model-based analysis). In order to quickly orient the reader we will note that **drash** (hermeneutic analysis) was utilised in the study and development of Halaha (Jewish Law). **Sod** (associative, model-based) analysis was most fully developed in Lurianic Kabbalah. Our present study will make use of all four types of textual analysis. At times, we refer to the knowledge arrived at using **remez** and **sod** analysis as the ‘inner (or esoteric) wisdom of the Torah’.

#### **4. Nature and the Divine**

One of the most basic findings in the Torah using remez analysis (numerical, in this case) is that the numerical value of the hebrew word for nature (הַטֵּבַע<sup>12</sup>, **hateva**) = 86 – is equal to the numerical value of the name of G-d associated with the creation of the natural world: **Elohim**<sup>13</sup> (אֱלֹהִים) = 86. This numerical equivalency is usually understood to indicate that there is an aspect of Divinity that is encloded within the natural world.

As we shall see, this basic equivalency will form the backdrop for much of our present discussion.

#### **5. 92 naturally occurring elements**

The first possibility would be to map each element to its corresponding Hebrew root, simply based on order of appearance (see Table 1 in Appendix A).

Further reflection though reveals an alternative. The 92 distinct roots of the story of creation are divided such that the first 86 appear in the verses relating the first six days of creation (Genesis 1:1 through 1:31), while the last 6 are found in the verses relating the Sabbath (ibid 2:1 through 2:3). This motivates us to correspond the 6 noble gases with the 6 distinct roots found in the Sabbath section in Genesis, while the remaining 86 elements will be corresponded in order to the distinct roots found in the 6 Days section of Genesis.

We mention this second possible mapping here because of our interest in the inert gases, as follows.

#### **6. Inert and non-Inert Elements**

Scientifically speaking, there are many ways in which the chemical elements can be arranged to accent different attributes of their periodicity. Briefly, when looking at a

---

12. The source of this non-Biblical word to describe nature warrants a discussion to itself, which is unfortunately beyond the scope of the present article.

13. As this name is considered one of the 7 sacred names of G-d, in most circumstances, it should not be pronounced as it is written. We have thus used the usual substitution Elokim for the original lettering Elohim (אֱלֹהִים), wherever there is no loss of clarity. Where the numerical value of specific letters in this name are used, we have resorted to the original lettering, so as not to unnecessarily confuse the reader.



periodic table, the elements are normally presented with their name, atomic number, and often their valence electron configuration. The commonly found table of elements highlights various types of periodicity, one of the most central ones being that of the noble or inert gases.

One of the most important and outstanding features of the 92 naturally occurring elements is that they may be divided into two groups, based upon their ability to form compounds: there are 6 which do not form compounds, also known as inert (or noble) gases, while the other 86 do form compounds with other elements.

On the periodic table in *Figure 1*, the inert gases form the far right hand column. Graphically, our modern version of the table of elements is structured such that the periodicity of the inert gases is highlighted, though, as we shall see below, the table could be (and historically was) arranged *entirely* around this periodicity.

This basic division into 6 and 86 observed in the naturally occurring elements is to be found (again, using a non-literal analysis of the Torah text) in the very first verse of the Torah: בראשית ברא אלקים את השמים ואת הארץ (usually translated as “In the beginning G-d created the heavens and the earth”). The first chapter of the Torah recounts the act of creation of the natural world. It is important to note that G-d here is referred to as **Elokim** alone (and not by His other names), thus leading to the association of this name with ‘nature’.

The 6 letters of the first word, **Bereishit** (בראשית) can be split into 2 separate words, each with 3 letters and read as ‘**barah sheet**’ (ברא שית), meaning “created six” (in Aramaic, the *lingua franca* of the ancient near-east).

The next two words in the verse are ‘**barah Elokim**’. As noted above, the numerical value of **Elokim**, one of the names of G-d is 86. We have then that the first 3 words can be understood to say: ‘six were created’ (“**barah sheet**”) and ‘86 were created’ (“**barah Elokim**”). The sum of these two acts of creation is  $86 + 6 = 92$ , the number of the naturally occurring elements.

As mentioned above, 86, the value of **Elokim**, is also the numerical value of the word **hateva** in Hebrew, or ‘nature’. Thus “**barah Elokim**” can be read as “created nature” as well.

There is yet another appearance of the name **Elokim** regarding the 6 inert gases:

The atomic numbers of the inert gases are 2, 10, 18, 36, 54, 86. The heaviest inert gas, radon (Rn), has an atomic number of 86 = **Elokim**.

## 7. Spiritual ‘Wholeness’

We now turn to reflect on the spiritual parallel to the presence of both inert and non-inert elements in the natural world.

The spiritual (or psychological) counterpart of physical inertness in the elements can be found in the Torah’s description of Jacob and Lavan’s (Jacob’s father-in-law) working relationship. Regarding the wages that Jacob received for tending Lavan’s flocks the Torah writes (*Genesis* 30:42):

וְהָיָה הָעֲטָפִים לְלָבָן וְהַקְּשָׁרִים לְיַעֲקֹב:

This is usually translated literally as:

the weaker (**atufim**) [flocks] were to Lavan and the stronger (**k'shurim**) [flocks] were to Jacob.

The literal meaning is that the sheep were divided into the stronger and the weaker; the weaker remaining Lavan's property, the stronger given to Jacob as wages.

However, *Rashi*, the basic (literal) Medieval commentary on the Torah interprets the meaning of **atufim** differently<sup>14</sup>. This Hebrew word can be analyzed to stem from the root **atf** (עֲטַף) that yields the infinitive **la'atof**, to wrap. It would then mean “those that are wrapped”.

Likewise, **K'shurim** the word used to describe the type of flocks given to Jacob, can be analyzed to stem from the root **ksr** (קָשַׁר) and the infinitive **likshor**, to bind. Its meaning would then be “those that are bound”

If these characteristics of the sheep are seen as metaphors for two different types of personalities, then an **atuf** describes one who is wrapped in wool, keeping warm all to himself, while a **kashur** symbolizes one who is incomplete without forming bonds with others outside of himself. A ‘wrapped’ (**atuf**) individual is not in need of a mate and finds sufficient warmth alone. Such an individual needs not receive from nor give to another. On the other hand, a person with a ‘tied’ (**kashur**) personality seeks completion in relationships with others, at times giving at times receiving.

For the sake of rigor we note that spiritually speaking, these two types of personalities are usually associated with negative and positive qualities, respectively. An **atuf** attitude (especially in the present case where these flocks are indicated as being the property of Lavan) is considered analogous to that found in Biblical Sodom<sup>15</sup>: “That which belongs to me is mine, that which belongs to you is yours”<sup>16</sup>. While a **kashur** attitude is normally associated with holiness (though at times it can drift to an extreme form of wantonness which is of course negative).

However, in *Hassidic* writings it is explained that a truly whole individual is one who has both qualities. To better understand why how this is so we may take the kabalistic principle stated by Rabbi Abraham Abulafia<sup>17</sup> (1240 – c.1291), the 13<sup>th</sup> century philosopher and mystic: “being *whole* is being *one and a half*”. Or in the famous words of Rebbe Nachman of Breslov: “nothing is more *whole* than a *broken* heart”. We coin the term *whole and half* (שֵׁלֶם וְחֶצִי, **shalem va'hetzi**) to designate this special quality of wholeness.

A truly *whole* (and holy) person is does not feel self sufficient, thereby not requiring others, but rather one who is, existentially speaking, both complete and incomplete at the same time. By virtue of their *half*-ness, they need to connect or bond with others. By virtue of their *whole*-ness they are able to offer support and help to others. Real wholeness (and holiness) comes by virtue of an existential feeling of incompleteness –

---

14. Rashi, ad. loc.

15. *Genesis* 18:16 – 19:28.

16. See Mishnah *Avot* 5:10.

17. Need source.



of insufficiency and inadequacy to single-handedly prevail, empowered and strengthened by a sense of *whole*-ness which saves one from a sense of an inability to rise to the task at hand.

Scientifically speaking, we can immediately note the analogy between these two basic definitions of **atuf** and **kashur** and the distinction between inert and non-inert elements. Bond formation is possible only when an electron orbital is *half* or incomplete. But when an orbital is *whole* or filled, the element in question is not in need of accepting or receiving electrons and thus does not form bonds. Yet, both exist in nature. Nature reflects these two basic qualities.

The inert gases are also called the Noble gases. The mark of nobility is the air of *whole*-ness surrounding it. The ‘nobility’ of the elements do not react with any other elements. It is only the 86, **Elokim**, elements that can do so. Nonetheless, the six noble gases form a sort of axis around which the other 86 elements revolve.

## 8. Whole-ness of the Patriarchs

The attribute of bonding is found to be associated with the name Elokim in another manner: Elokim is the name of G-d related most closely with the Patriarch Isaac as both manifest the quality of judgment (or **din** – דין). When departing from Lavan, his father-in-law, Jacob says<sup>18</sup>:

לולי אלקי אבי אברהם ופחד יצחק היה לי, כי  
עתה ריקם שלחתיני...

If the G-d of my father, the G-d of Abraham, the fear of  
Isaac, was not with me, then you would have sent me  
away empty-handed...

Jacob refers to the way in which Isaac (his father) knew G-d as ‘the fear of Isaac’ (**paḥad Yitzhak**, פחד יצחק). The numerical value of **paḥad**, or fear, is 92, which is again Elokim (86) plus six – the total number of naturally occurring elements.

Yet, Isaac was not always *whole* in the sense of being both *whole* and *half* at the same time. Our sages tell us that Isaac was actually 37 years old at the time that Abraham (his father) was commanded to sacrifice him to G-d (see Genesis 22), known as the ‘test of the **Akeida**’ – the test of the binding of Isaac. The Zohar<sup>19</sup>, the basic book of the inner teachings of the Torah, relates that Isaac was entirely whole, exclusively of ‘noble’, or inert, character and was therefore not suited for marriage, not suited to bond with another. It was the **Akeida** – literally, ‘the binding’ – which brought him to complete his character with the quality of *half*-ness. It was only then that he became suited for marriage, to bond with a wife. Thus **paḥad Yitzhak** (= 92) can be understood as the attribute of **Elokim** (86) plus another 6, the addition of something to Yitzhak’s own *wholeness*.

By the same token the Zohar explains that Abraham was not truly *whole* either, as he did not have the quality of *Might* or *Judgment*. It was the act of the **Akeida** – the

18. Genesis 31:42.

19. See Zohar I, 120a-b.



No part of this publication or its contents may be used, applied or reproduced in any manner without prior consent from the Torah Science Foundation

4f, 5s, 5p, 5d, 5f, 6s, 6p, 7s. The number of electrons that can fit in each orbital is: 2 in s orbitals, 6 in p orbitals, 10 in d orbitals, 14 in f orbitals

To truly understand the theoretical basis for Bohr's model is beyond our scope. However, we would like to take a closer look at the mathematical regularities that this model produces. So let us order the elements in a table that will show us how their electrons 'fill' the various shells and orbitals:

Shells	1 (2)	1 H	2 He															
	2 (8)	3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne									
	3 (18)	11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	21 Sc	—	30 Zn						
	4 (32)	19 K	20 Ca	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	39 Y	—	48 Cd	57 La	—	70 Yb			
	5 (50)	37 Rb	38 Sr	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	71 Lu	—	80 Hg	89 Ac	—	92 U			
	6 (72)	55 Cs	56 Ba	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn									
	7 (98)	87 Fr	88 Ra															
	Orbitals	s(2)		p(6)						d(10)		f(14)		g(18)		h(22)		i(26)

Table 2

The rows designate the Shells, while the columns the orbitals in each shell. Thus for instance, the first shell (K) can accommodate up to 2 electrons and therefore has room for 2 elements. The second shell (L) can accommodate 8 electrons and therefore has room for 8 elements, and so on. In the K shell, all the electrons are available in the s orbital only. In the L shell, electrons 'spots' are available in both the s and p orbitals.

Note that shells are not filled entirely before the next shell is started, due to the fact that electrons in elements always seek the lowest possible energy state they can reach. This is clear if we follow the elements in this table. Up to Argon (Ar), the first shell (K) and second shell (L) are filled completely. Then the s orbital of the third shell (M) is filled, followed by a complete filling of its p orbital. Argon then is the 18<sup>th</sup> element in the table with electrons completely filling the 3p [3<sup>rd</sup> shell (M), p orbital] orbital. But the next element, Potassium (K) does not continue to fill the 3<sup>rd</sup> shell's d orbital, but rather skips to the 4<sup>th</sup> shell's (N) s orbital, because electrons in that orbital actually have a lower energy level than electrons in the 4d orbital. This is due to the interactions between the electrons themselves, an effect known as 'shielding'. So Potassium's 'extra' electrons do not locate in the 3d orbital but rather in the lower-energy orbital 4s. The rest of the table follows this general trend, with electrons always vying for the lowest energy level orbitals.

There are two interesting facts about this table that should be noted are:

- that the number of 'spots' in each orbital is equal to the differences between the total number of elements that can populate each shell.

- all the orbitals that are used are ‘filled’ or ‘populated’ to capacity by elements except for the 5<sup>th</sup> shell’s f orbital. Though 5f has room for 14 electrons, only 4 ‘spots’ are used by the heaviest naturally occurring elements from Actinium (89) to Uranium (92).

The first fact is the reason that we have drawn the table as 7 x 7 even though the entire g, h and i orbitals have been left blank. Let us explicitly write the first fact out: The total numbers of electrons in the shells are (We designate these as set A):

$$A = \{2, 8, 18, 32, 50, 72, 98\}$$

The numbers of electrons in each orbital are (we will designate these as set B):

$$B = \{2, 6, 10, 14, 18, 22, 26\}$$

Now note that the numbers in set B are the differences between the numbers in set A. This can be clearly illustrated by writing the two sets, A and B, one beneath the other, as follows:

total electrons in shells	2	8	18	32	50	72	98
electrons in orbitals	6	10	14	18	22	26	

This is truly one of the most astonishing mathematical properties of the periodic table. But, arranging the elements in the above table also reveals an interesting property of the inert gases and that is that an inert gas is formed each time the p orbital fills. The p orbital of each and every shell has room for 6 electrons. That is to say that each time 6 electrons fill the p orbital, an inert gas is created (excluding Helium, which does not use the p orbital).

Recollect that above we noted that in the story of creation, the first word of the Torah, **Bereishit**, which can be understood to mean ‘created 6’, should be seen as corresponding to the formation of the 6 inert gases! In fact, the excluded inert gas Helium, is hinted to in the word **Bereishit** as the letter **bet**, the first letter of the word is written in the Torah scroll as a large **bet** (בית רבתי, **bet rabbati**) and the numerical value of the letter **bet** is 2.

## 11. Mathematical Patterns in Inert Elements

Let us now look at the numbers of the inert gases from another perspective. If we take the atomic numbers of the inert elements and note the differences between them we can construct the following table:

element	atomic number	difference in atomic number	n, where difference = 2n <sup>2</sup>
<b>He (Helium)</b>	2	2	1
<b>Ne (Neon)</b>	10	8	2
<b>Ar (Argon)</b>	18	8	2
<b>Kr (Krypton)</b>	36	18	3
<b>Xe (Xenon)</b>	54	18	3
<b>Rn (Radon)</b>	86	32	4

*Table 3*

The rightmost column shows that the differences between the elements are all values, in order, of the mathematical series  $f[n] = 2n^2$  ( $n$  starting at 0).

These numbers are known in the inner teachings of the Torah as the *double squares* (רבועים כפולים, **ribu'im k'fulim**). Their significance is related to the *32 paths of Wisdom* (ל"ב נתיבות חכמה, **lamed beit netivot hohma**). *The Book of Formation*, mentioned above, begins:

ב-לב נתיבות פליאות חכמה חקק י"ה הוי'  
צבאות וברא את עולמו בשלשה ספרים בסופר  
וספר וסיפור

Using 32 wondrous paths of wisdom Kah Havayah [G-d]  
Lord of Hosts engraved... and created His world, using  
three books: author and book and story.<sup>21</sup>

It is known that the textual source in the Torah for these *32 paths of Wisdom* is to be found in the 32 times that the name **Elokim** is used in the verses describing the six days of Creation<sup>22</sup>. This, again, is the Name which we have recognized as central in our discussion of the periodic table. We note that no other Name of the Almighty appears in the creation story<sup>23</sup>, and it appears exactly 32 times.

32 is thus the number associated with *Wisdom* (**hohma**). Both in the Talmud and in the inner teachings of the Torah we find the number 50 associated with *Understanding: 50 Gates of Understanding* (חמשים שערי בינה, **hamishim sha'arei binah**)<sup>24</sup>. There is also another, less well known concept of *72 Bridges*<sup>25</sup> (ע"ב גשרים, **ayin beit gesharim**).

Actually, all three of these concepts are closely related and are part of one larger picture. This basic conceptual scheme identifies the type of energy related to each **sefira** and the type of conduit through which it flows:

Thus the energy of *Wisdom* is identified as 'mind' that flows through a *path* (נתיב, **nativ**); the energy of *Understanding* is identified as 'intelligence' that flows through a *gate* (שער, **sha'ar**); finally the energy of *Knowledge* is termed 'psyche' and flows through a *bridge* (גשר, **gesher**). This model is summarized in *Table 2*.

sefirah	energy type	conduit type	number of conduits
<i>Wisdom</i>	mind	path	32
<i>Understanding</i>	intelligence	gate	50
<i>Knowledge</i>	psyche	bridge	72

*Table 4*

Of course, 72 is also a *double square* (particularly,  $72 = 2 \cdot 6^2$ ). We have thus, so far, found the mental significance of the *double squares* for  $n = 4$ ,  $n = 5$  and  $n = 6$ . To

21. *Sefer Yetzirah* 1:1, according to the textual tradition adopted in H̄assidut.

22. *Genesis* 1:1-31.

23. Most traditional commentaries on the Torah assert that chapter 2 of Genesis does not relate an 'alternate' story of creation, but chronologically continues the first chapter.

24. BT Rosh Hashana 21b; Nedarim 38a; *Zohar* III, 245b, 253b.

25. See *Zohar* III, 227a; Alter Rebbe's *Likutei Torah* III, 36d.

No part of this publication or its contents may be used, applied or reproduced in any manner without prior consent from the Torah Science Foundation

complete our understanding of the significance of *double squares* we need to complete the series beginning with  $n = 1$ .

The basic model of the **sefirot** in Kabbalah indicates that above *Wisdom* resides the *Crown* (כתר, **keter**) that is explained in the Zohar to consist of *three heads*<sup>26</sup> (תלת רישין) שבכתר, **tlat reishin sheba'keter**). In our present model we will map these 3 parts of the *Crown* to correspond to the first 3 values of  $n$ .

Continuing our previous discussion regarding the various mental powers we note that *Wisdom* marks the first conscious mental power. Thus, the *Crown* – which resides, both figuratively and in our Kabbalistic model, above the head – corresponds to the super-conscious faculties. The *three heads of the Crown*, or the 3 super-conscious mental powers are known as: *Belief* (אמונה, **emunah**), *Pleasure* (תענוג, **ta'anug**) and *Will* (רצון, **ratzon**).

Table 3 illustrates the *double squares* for values of  $n$  from 1 to 6 with their corresponding mental faculties.

sefirah	mental faculty	n	f[n] = 2n <sup>2</sup>
Crown	belief	1	2
	pleasure	2	8
	will	3	18
Wisdom	mind	4	32
Understanding	intelligence	5	50
Knowledge	psyche	6	72

Table 5

Using the **sefirot** as a model for the series of *double squares*, we could continue the series until  $n = 13$ . For example, corresponding to the *double square* 128 ( $n = 8$ ) we would have the sefira of *Might* (גבורה, **gevurah**). For 338 ( $n = 13$ ) we would have the **sefira** of *Kingdom* (מלכות, **malhut**).

We have now taken a look at the series of *double squares*, the differences between the atomic numbers of the inert gases. This series is essentially the backbone of the whole periodic table of the elements.

Extrapolating from our knowledge of double squares in the periodicity of inert elements we would expect the next inert element to be of quantum number:

$86$  (Radon)  $\pm 32 = 118$ . This element has been dubbed Uuo (Ununoctium) by the International Union of Applied Chemists (IUPAC) until its existence is proven at which time its properties will be ascertained.

We would expect to find the next inert element at quantum number:

$118 \pm 50 = 168$ . This element has been dubbed Uho (Unhexoctium).

26. The source for the **sefira** of *Crown* being sub-divided into 3 'heads' or 'crowns' is *Zohar* III, 288a ff. See also Mishnah *Avot* 4:13: "R. Shimon says: there are 3 crowns – the Crown of Torah, the Crown of Priesthood and the Crown of Sovereignty". In Hassidut it is explained that the 3 'heads' or 'crowns' in the sefira of *Crown* are alluded to in the 3 laurels found in the vessels of the Holy Sanctuary built by Moshe in the desert. These laurels were made to encircle the Ark of the Covenant (see *Exodus* 25:11), the Table (*ibid* 25:24) and the Altar of Incense (*ibid* 30:3).



## 12. Metals and non-metals

Another important periodicity represented in the periodic table is that of the non-metallic elements. Whereas the periodicity of the inert elements was defined by the *double squares* (as explained above), the periodicity of the non-metals is recognizable by the triangular shape they form on the periodic table, as highlighted in the next table (non-metals are shaded in turquoise).

1 H																	2 He																												
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne																												
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar																												
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr																												
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe																												
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn																												
87 Fr	88 Ra	89 Ac																																											
<table border="1"> <tbody> <tr> <td>58 Ce</td> <td>59 Pr</td> <td>60 Nd</td> <td>61 Pm</td> <td>62 Sm</td> <td>63 Eu</td> <td>64 Gd</td> <td>65 Tb</td> <td>66 Dy</td> <td>67 Ho</td> <td>68 Er</td> <td>69 Tm</td> <td>70 Yb</td> <td>71 Lu</td> </tr> <tr> <td>90 Th</td> <td>91 Pa</td> <td>92 U</td> <td>93 Np</td> <td>94 Pu</td> <td>95 Am</td> <td>96 Cm</td> <td>97 Bk</td> <td>98 Cf</td> <td>99 Es</td> <td>100 Fm</td> <td>101 Md</td> <td>102 No</td> <td>103 Lr</td> </tr> </tbody> </table>																		58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu																																
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr																																

Table 6

Of the 86 non-inert elements 15 are classified as non-metals. The other 71 elements are classified as metals. We note that hydrogen is sometimes placed in a class of its own, something we shall address below. Generally speaking, though not always, metals act as electron donors and non-metals as electron recipients in chemical compounds.

As mentioned above, the non-metals form a triangle in the right-hand side of the periodic table: 5 elements in the first row of the triangle, 4 in the second, 3 in the third, 2 in the fourth and finally 1 in the last.

5 B	6 C	7 N	8 O	9 F
	14 Si	15 P	16 S	17 Cl
		33 As	34 Se	35 Br
			52 Te	53 I
				85 At

15 is a triangular number. The function that generates triangular numbers is:

$$f[n] = \frac{n(n+1)}{2}$$

We<sup>27</sup> designate triangular numbers by the special symbol  $\Delta n$ . Thus  $\Delta 5 = 15$ . Another way to define the  $n^{\text{th}}$  triangular number is as the sum of all numbers from 1 to  $n$ . It is therefore also true that:

$$\Delta n = n + \Delta(n-1)$$

Therefore,

$$\Delta 5 = 5 + \Delta 4$$

But,  $\Delta 4 = 10$ , so that  $\Delta 5 = 5 + 10$ .

Thus, the 5<sup>th</sup> triangular number has the property of *whole and half* that we saw above (§5).

The number 10, the 4<sup>th</sup> triangular number (and the *whole* part of  $\Delta 5$ ), has a special reference in the inner teachings of the Torah. It is sometimes as designated as:

שיר פשוט, שיר כפול, שיר משולש, שיר מרובע

simple song, double song, triple song, quadruple song

This idiom alludes to the number 10 as the sum of 1 (simple), 2 (double), 3 (triple) and 4 (quadruple).

In our particular case, we have 5 elements above 4, or in Hebrew letters we have a **heh** (ה = 5) over a **yud** (י = 10). Recall, that 86 – the number of natural elements excluding the inert gases – is numerically equivalent to the Divine name, **elohim** (אלהים). This name has five letters, with numerical values are as follows:

letter	in hebrew	value
aleph	א	1
lamed	ל	30
heh	ה	5
yud	י	10
mem	מ	40

The 15 non-metals thus correspond to the two letter **heh** (ה, 5) and **yud** (י, 10) of the five letters of the name **elohim**, the seminal name of the periodic table.

### 13. Metals and Hydrogen

After accounting for the 15 non-metals we now remain with 71—these are known as metals. However, in many renditions of the periodic table, hydrogen, the element with atomic number 1, is classified by itself. Implying that hydrogen is for various reasons ‘above’ the classification into metals and non-metals.

How should we understand the role of hydrogen among the elements? To give an answer, we must first reintroduce the classical model of the four elements of antiquity

27. Conway and Guy (1996: 33-8) designate triangular numbers in a somewhat different manner as:  $\Delta_n$ . We retain our original notation here and throughout.

and its modern-day correspondence. As explained elsewhere in length<sup>28</sup>, each of the four classic ‘elements’—fire, air, water and earth—corresponds with a specific modern chemical element (see table 6).

classical 'element'	modern element	atomic number	sefirah
air	oxygen	8	<i>Crown</i> (כתר, <b>keter</b> )
water	hydrogen	1	<i>Wisdom</i> (חכמה, <b>hohma</b> )
fire	carbon	6	<i>Understanding</i> (בינה, <b>binah</b> )
earth	nitrogen	7	<i>Knowledge</i> (דעת, <b>da'at</b> )

Table 7

This correspondence is based on the ‘essence’ that each of the classical ‘elements’ was meant to represent, and the major role that each of the modern-day elements plays in nature. Thus, oxygen is the most important component of Air for human beings; hydrogen, our subject of interest (together with oxygen, which we have already corresponded with Air) makes up water<sup>29</sup>, upon which we will elaborate in a moment; nitrogen is the earth’s major nutrient used by plant life; and the earliest human fires were of the type that burns carbon.

Looking at the atomic numbers of these elements we note that the sum of their ‘triangular’ numbers = 86:

$$\Delta 1 + \Delta 6 + \Delta 7 + \Delta 8 = 1 + 21 + 28 + 36 = 86!^{30}$$

The classical element ‘water’ naturally corresponds to hydrogen (e.g. in modern nomenclature, the prefix ‘hydro’ denotes a ‘watery’ characteristic). During the time period that Kabbalah was being developed, the accepted chemical analysis was based on the 4 classic elements. Classic water was brought down as corresponding to the **sefira** of *Wisdom*. Thus, in our modern chemical analysis, hydrogen that corresponds to classic water would also correspond to the **sefirah** of *Wisdom*. Regarding *Wisdom* we find an important verse (Psalms 104:24):

כולם בחכמה עשית

You made them all with Wisdom

Analyzing this using **sod**, where *Wisdom* is the **sefirah** of hydrogen, we can say that all chemical elements begin with hydrogen, but that hydrogen remains in a category of its own. Thus hydrogen would parallel the first letter, **aleph**, in the Name **Elokim**,

28. Israel Omer Fromansky, *The Four Elements and the Seven metals*. Audio Tape, (Rehovot, Israel: Gal Einai Publications, 1993).

29. **Meiman** (מימן), like its english equivalent—hydrogen, actually derives from the Hebrew word for water (מים, **mayim**).

30. Additional mathematical equivalencies to the Periodic Table arise from this equation:

Note that 86, the ‘sum of triangles,’ can be split:  $\Delta 1 + \Delta 6 + \Delta 7 = 50$ , while  $\Delta 8 = 36$ . This division of 86 into 50 and 36 plays a major role in the Kabbalistic exposition of the Name Elokim (see Tikunei Zohar §49, folio 85b; Zohar I, 1b; ibid II, 231b-232a), based on the verse: “Lift up your eyes on high and behold who has created these things” (Isaiah 40:26), or in the Hebrew original: שאו מרום עיניכם וראו מי ברא אלה מי (who) = 50 and אלה (these things) = 36.

Additionally, the ‘sum of squares’ of 1, 6, and 7 =  $1^2 + 6^2 + 7^2 = 86$ ; while  $8^2 = 64$ . This reveals the important relationship between 86 and 64: 86 = **Elohim** (אלהים) and 64 = **Din** (דין). The Name of Elokim is directly related to the the sefirah of *Might* (גבורה, **gevurah**)—it is sometimes even called the Name of *Might*—which is also referred to as *Judgment* (דין, **din**).

the essential Name of the Periodic Table. Moreover, the numerical value of **aleph** is 1, as is the atomic number of hydrogen, strengthening our identification.

As we have already accounted for the letters **aleph**, **heh** and **yud** of the name **Elokim** we are left with two letters: **lamed** and **mem**. We are also left with 70 elements not accounted for (as either inert gases, non-metals, or hydrogen). The numerical value of **lamed** is 30, the numerical value of **mem** is 40, their sum equal to 70. Thus we can complete our correspondence of the elements with the name **Elokim** by noting that the number of metals equals the letter **lamed** and **mem**. Our completed analysis is presented in Table 8.

letter(s) of name Elokim	in hebrew	numerical value	corresponding element(s)
<b>aleph</b>	א	1	hydrogen
<b>heh yud</b>	ה, י	15	non-metals
<b>lamed mem</b>	ל, מ	70	metals

Table 8

### **Elokim As Creative Consciousness**

Our analysis of the name **Elokim** as the central pivot of the periodic table would not be complete without us spending a few moments looking at the spiritual significance of this phenomenon.

Though the usual usage of the word **Elokim** is as the ‘natural’ name of G-d, it does have other uses in the Bible. In discussing civil suits, the Torah refers to the court or the judge as an ‘**Elokim**’ (Exodus 22:8, 22:27). In the Book of Psalms (82:6) we find another usage of the name **Elokim** to refer to Adam, the first human being:

אני אמרתי אלהים אתם ובני עליון כלכם

I had said, You are **Elokim** and all of you are sons of the Most High

This verse serves as the source from which the Arizal teaches that each and every Jew literally has a Divine element within them. The verb “said” (אמרתי) here does not mean that G-d literally commanded Adam to be ‘an **Elokim**’, but rather, as it at times means in Biblical Hebrew, that G-d had “wanted” or had “hoped” that man would ascend to the heights of being an **Elokim**—“sons of the Most High”.

The Edenic serpent, the catalyst for Adam and Eve’s downfall and transgression, clearly voiced this ‘destiny’ of mankind as a reason for eating from the Tree of Knowledge (Genesis 3:4-5):

ויאמר הנחש אל האשה לא מות תמתון. כי ידע אלהים כי ביום אכלכם ממנו ונפקחו עיניכם והייתם כאלהים ידעי טוב ורע

And the serpent said to the woman: You shall not surely die. For G-d knows that on the day you eat of it, then your eyes shall be opened, and you shall be as **Elokim**, knowing good and evil.

Without going in length into the difference between G-d's hope for mankind, and the serpent's description of mankind's destiny, let us merely say that due to Adam's sin, this desire of The Holy One Blessed Be He was not yet to be realized. G-d willing, in the times of the Messiah it will be fulfilled.

But how would we describe the state of humanity hoped for by G-d and termed '**Elokim**'. Until now we have studied the natural (mundane) world as a reflection of the spiritual worlds of the Divine. Here we find that an element of the mundane world, albeit a spiritual element—the soul—shares the same name—**Elokim**—as the pivotal name of the Periodic Table. If until now we have seen the Periodic Table as reflecting the Divine, we now understand that it also reflects the spiritual element within man. This is not entirely surprising as we know that the soul is itself a 'part' of the Divine.

As the name **Elokim** is the central building block for the *Periodic Table* of the physical elements, so we say that within man the name **Elokim** is instrumental in the expansion and development of consciousness. Consciousness is to mankind as the physical world is to G-d, and both are constructed using the pivotal name of **Elokim**. This is the meaning of the saying of our sages:

"I create worlds, you also will create worlds. I wanted that just as I create, you will create." The serpent tricked Chava into thinking that she could reach this level of creative consciousness through theft. This could only fail. Yet The Holy One Blessed Be He wants this, for us to reach creative consciousness. Thus all of our meditation on the Name **Elokim** is really about our souls (נשמה, **neschama**). Each level, the **Aleph**, the **Hey**, the **Yud**, the **Lamed-Mem**, and the axis of six about which all the 86 (86 = **Elokim**) elements revolve, belongs to the soul of the Jew. By studying the periodic table, we are studying aspects of our own souls.

#### **14. Hydrogen As the Source of All Elements**

It was mentioned above that hydrogen corresponds to the **sefira** of *Wisdom*, and that by *Wisdom* G-d created all in the universe, as noted in the verse: You have made them all with *Wisdom* (Psalms 104:24).

This idea—that *Wisdom*, or its elemental parallel, hydrogen, is the source of all other matter in the universe—corresponds to the accepted contemporary theory of nucleosynthesis (element formation), which theorizes that all elements are created in the fusion reaction of hydrogen stars like our sun. In the cores of stars, hydrogen is fused into helium, helium into carbon (and sometimes into oxygen) and may include the formation of elements as heavy as iron (atomic number 26).

In our analysis of the *Periodic Table* we have seen that hydrogen corresponds to the letter **aleph** of the name **Elokim**. The Besh"t, the founder of Hassidism, taught that all the other 21 letters of the alphabet originate from the letter aleph, another parallel to the theory of nucleosynthesis.

#### **15. The Mathematical Series of the Element Groupings**

We now have a complete structural scheme for understanding the spiritual correspondence of each of the 92 naturally occurring elements in the Periodic Table.

We have seen that they can be divided into 4 basic groupings: hydrogen, the 6 inert gases, 15 non-metals and 70 metals. We now have a series of 4 numbers (which we have found by categorizing the 92 elements): 1, 6, 15, 70.

With this series in hand, we now turn to one of the most basic techniques of numerical analysis used in the inner wisdom of the Torah: series calculus<sup>31</sup>. Whenever we have a series of numbers such as this both mathematically and kaballistically it is important to find the *base* of the series. Doing this is technically very simple, as all that we need to do is find the differences between the numbers of the series, then the differences between the differences, and finally, in our case where we begin with 4 numbers, the difference between those, as follows:

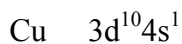
numbers in series	1	6	15	70
difference between numbers in series	5	9	55	
difference between differences		4	46	
final difference or base of series		42		

Thus the base of our series is 42. Our Sages tell us that the Name with which the universe was created, was the 42 letter Name. The very number that is the base of our analysis of the periodic table is the number that is the most related to the Creation by our Sages, of which it is said “this is the gate to G-d, the righteous will come through it”<sup>32</sup>, it is the name of 42 letters, with which the higher and the lower were created (*Zohar* II, 234a; III, 256b)<sup>33</sup>.

## 16. Group 1B Periodicity: Copper, Silver, and Gold

Following our analysis of the major periods in the *Periodic Table*, we now turn to a more local periodicity—that of the elements in Group 1B. Group 1B contains the three precious metals Copper (Cu), Silver (Ag) and Gold (Au). Apart from their being known as the 3 precious metals, these three elements were of particular significance in the construction of the Tabernacle (*Exodus* 25:1 – 26:30) as we shall see.

These elements’ group name—IB—signifies that the elements in the group share a similar orbital configuration to those in Group 1A (Hydrogen, Lithium, Sodium, etc.). More specifically, elements in Group 1B always have one electron to donate—or, in our terminology, they are always just a little bit more than *whole* (**shalem**). The outer orbital configurations of these elements are:



31. For a more rigorous discussion of this mathematical tool, see appendix B.

32. Psalms 118

33. One form [see *Tikunei Zohar*, §69 (fs. 103b-104a)] of the Name of 42 Letters is recited a number of times in the daily prayers. In the Talmud (Tractate *Kidushin* 71a) we find a direct reference to the *Name of 42 Letters*:

Said Rav Yehuda, said Rav: the *Name of 42 Letters* is not to be given but to one who is modest and is humble and stands in mid-life and does not anger nor get drunk, and does not act harshly. And he who knows the name, and is careful with it, and keeps it pure, is beloved above and liked below and is feared by all creatures and inherits two worlds, this world and the coming world.



We see from the orbital configuration that these metals, copper, silver and gold, have an aspect of finishing a cycle and beginning a new one. In each of them, the specific d orbital is filled (completed) while the next s orbital commences filling.

‘**Naye saider**’ is a Yiddish idiom that expresses this same sentiment—where one phenomenon is completed and a new one commences, particularly in regards to stages or cycles in history. We might say of the IB elements that they reflect such a point in the Periodic Table, where one orbital completes and a new one begins. At this point a new beginning is made, a new **derech**, path.

It is well known among H̄assidim that when the Ba’al Shem Tov was born, a new order began in the world. Likewise, when the Messiah will come (speedily and in our times), a new order will begin as well<sup>34</sup>.

By having only one electron in the s orbital, these elements, like their Group 1A counterparts, are the epitomal electron donors, or *influencers* (**mashpi’im**). Due to the outer s-orbital having only one electron, these three metals of Group IB which served to build the Holy Temple, combine in theory with oxygen in the same manner as hydrogen, as explained above. More specifically, they would combine with Oxygen at a ration of 2:1 (2 atoms from group IB, for every Oxygen atom).

Noting that each of the group IB metals commence the filling of another s orbital, we may take a closer look specifically at the *outer* orbital configurations of the transition metals before and after copper (Cu):

element	Sc (21)	Ti (22)	V (23)	Cr (24)	Mn (25)	Fe (26)	Co (27)	Ni (28)	Cu (29)	Zn (30)
orbital	$3d^14s^2$	$3d^24s^2$	$3d^34s^2$	$3d^54s^1$	$3d^54s^2$	$3d^64s^2$	$3d^74s^2$	$3d^84s^2$	$3d^{10}4s^1$	$3d^{10}4s^2$

Table 9

Preceding copper (Cu), orbitals which have been filled are 1s, 2s, 2p, 3s, and 3p. In copper we find that 3d—the sixth orbital is completed while 4s—the seventh orbital—begins to be filled. Thus the seventh orbital is started with copper.

There is a well-known principle in Torah that “all sevenths are beloved” (כל השביעין חביבין, **kol hashvi’in ḥavivin**). Here we see this principle beautifully applied. The Tabernacle signifies the most ‘beloved’ place for G-d to dwell in the mundane world. It is only fitting that it be constructed from copper—the element commencing the filling of the seventh orbital.

Continuing our examination of copper specifically, let us quote from Exodus, where the Torah describes the offering required by the Children of Israel for the construction of the Tabernacle:

And G-d spoke to Moses, saying: Speak to the Children of Israel that they should bring me an offering: of every man whose heart prompts him to give, you shall take

34. As is well known that the Messiah is destined to reveal a completely new understanding in the Torah, one of which our sages have said that “the Torah of our day is like naught when compared to the Torah of the Messiah” (need source). Of course, the text of the Torah will not change, only its understanding.

my offering. And this is the offer that you shall take from them: gold and silver and copper...

In the original Hebrew text, the word for copper, **nehoshet**, is the 29<sup>th</sup> word from the beginning of the *Parsha*. 29 is, of course, the elemental number of copper.

In the Torah, in the text just quoted, the group IB elements are ordered by *heaviness* (atomic mass): gold (79) silver (47) copper (29), the heaviest—gold—listed first. This order corresponds to reading the group IB elements from bottom to top.

In Aramaic, the only non-Hebrew language to which our sages have contributed a measure of sanctity, the Hebrew word for heavy (**כבד**, **kaved**) means precious (in Hebrew **יקר**, *yakar*). Some of this meaning has also been retained in the Hebrew word *kavod*, which means importance or honor. In any case, it is established that in Hebrew that which is heavy is also precious.

We see this in the Group IB elements. The heavier the element, the more precious it is considered. Gold is the most treasured<sup>35</sup>, then silver, and, copper, the lightest is the least precious.

Another approach for analysing the significance of these three metals is their correspondence with the **sefirot**. In descending order of ‘heaviness’, gold is associated with the **sefira** of *Might* (**גבורה**, **gevurah**); silver associated with Lovingkindness (**חסד**, **hesed**); copper corresponds to Beauty (**תפארת**, **tiferet**). It is well known that the 3 patriarchs, Abraham Isaac and Jacob also correspond to these 3 **sefirot**, as follows:

Lovingkindness ( <b>hesed</b> )	Abraham	silver
Might ( <b>gevurah</b> )	Isaac	gold
Beauty ( <b>tiferet</b> )	Jacob	copper

Table 10

As we can see, gold the most precious corresponds with the patriarch Isaac. This parallel between Isaac and gold becomes meaningful when considering the future building of the 3<sup>rd</sup> Holy Temple. Of that time it is said (Isaiah 63:16):

כי אתה אבינו כי אברהם לא ידענו וישראל לא  
יכירונו אתה ידוד אבינו גאלנו מעולם שמך

For you are our father, for Abraham has not known us,  
and Israel has not recognized us, You G-d are our  
father, our savior, Your name is forever.

Our sages (BT *Shabbat* 89b) explain this verse to mean that of all 3 patriarchs (Jacob is also known as Israel), it will be Isaac that will show special mercy on the Jewish people, his offspring, and will thus be *the* primary patriarch. Our sages also relate that the 3<sup>rd</sup> Temple will be constructed entirely of gold.

35. It is interesting to note that the objective basis for the value we attribute to gold is not clear at all. For more on this question see “Puzzling Over Gold’s Allure” in Johns Hopkins Magazine, June 2000 (Baltimore: Johns Hopkins University) or internet, [www.jhu.edu/~jhumag/0600web/oncampus.html](http://www.jhu.edu/~jhumag/0600web/oncampus.html).

## **Appendix A: The Periodic Table of Elements with Corresponding Distinct Words in the Story of Creation**

Following is the same Table found in §2 of this article, with the distinct words having been reduced to their corresponding Hebrew roots.

In principle, there is much to be said about the actual identification of the distinct words, and perhaps even more in regards to the following reduction to corresponding Hebrew roots. Some of this discussion, in addition to more information and insights about this table will follow in future issues of *Wisdom*.

1 H ראש																	2 He ברא
3 Li אלה	4 Be את											5 B שם	6 C ארץ	7 N היה	8 O תהו	9 F בהו	10 Ne חשך
11 Na על	12 Mg פנה											13 Al תהם	14 Si רוח	15 P רחף	16 S מים	17 Cl אמר	18 Ar אור
19 K ראה	20 Ca כי	21 Sc טוב	22 Ti בדל	23 V בין	24 Cr קרא	25 Mn יום	26 Fe ליל	27 Co ערב	28 Ni בקר	29 Cu אחד	30 Zn רקע	31 Ga תוך	32 Ge עשה	33 As אשר	34 Se תחת	35 Gr כן	36 Kr שני
37 Rb קוה	38 Sr אל	39 Y קום	40 Zr יבש	41 Nb ים	42 Mo דשא	43 Tc עשב	44 Ru זרע	45 Rh עץ	46 Pd פרה	47 Ag מין	48 Cd בו	49 In יצא	50 Sn שלש	51 Sb אות	52 Te ועד	53 I שנה	54 Xe גדל
55 Cs משל	56 Ba קטן	57 La ככב	72 Hf בהם	73 Ta אדם	74 W צלם	75 Re דמה	76 Os רדה	77 Ir דגה	78 Pt זכר	79 Au נקב	80 Hg לו	81 Tl כבש	82 Pb הנה	83 Bi אכל	84 Po ירק	85 At מאד	86 Rn ששי
87 Fr כלה	88 Ra צבא	89 Ac שבע															

58 Ce נתן	59 Pr רבע	60 Nd שרץ	61 Pm נפש	62 Sm חיה	63 Eu עוף	64 Gd תגן	65 Tb כל	66 Dy רמש	67 Ho כנף	68 Er ברך	69 Tm רבה	70 Yb מלא	71 Lu חמש
90 Th לאך	91 Pa שבת	92 U קדש	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

## **Appendix B: Finite Differences and Series ‘Base’**

For equi-spaced arguments  $x_i$ , and associated  $y_i$ , the successive advancing  $y$ -differences are,

$$\Delta^0 y_i = y_i$$

$$\Delta y_i = y_{i+1} - y_i$$

$$\Delta^2 y_i = \Delta y_{i+1} - \Delta y_i = y_{i+2} - 2y_{i+1} + y_i, \dots, \Delta^m y_i = \Delta^{m-1} y_{i+1} - \Delta^{m-1} y_i = \sum_r (-1)^r \binom{m}{r} y_{i+m-r}$$

With arbitrary origin  $A$  and class-interval length,  $x_{i+1} - x_i = h$ , using  $u_i = (x_i - A)/h$ , write  $y(u_i)$  for  $y_i$ . Then if for some fixed  $m$ , for the portion of the table considered, the values of  $\Delta^{m+1} y_i$  be zero (or approximately, if these be regarded as negligible) Newton’s formula gives

$$y(u) = \sum_r \frac{u(r)}{r!} \Delta^r y(0) = y(0) + u \Delta y(0) + \frac{u(u-1)}{1 \cdot 2} \Delta^2 y(0) + \dots + \frac{u(u-1) \dots (u-m+1)}{m!} \Delta^m y(0)$$

This formula reduces to an identity for  $u = u_0, u_1, \dots, u_n$ , ( $u_i = i$ ), and may be used to interpolate for intermediate values.

Now, let us take as an example our series of numbers found in connection with the Periodic Table:

$$y_i = 1, 6, 15, 70$$

The successive  $y$ -differences would then be:

$$\Delta^0 y_i = 1, 6, 15, 70$$

$$\Delta y_i = 6 - 1 = 5, 15 - 6 = 9, 70 - 15 = 55$$

$$\Delta^2 y_i = 9 - 5 = 4, 55 - 9 = 46$$

$$\Delta^3 y_i = 46 - 4 = 42$$

In tabular format we can easily illustrate this process as follows:

<b>y-difference 0 (numbers in series)</b>	1	6	15	70
<b>y-diff 1 (difference between numbers in series)</b>	5	9	55	
<b>y-diff 2 (difference between differences)</b>		4	46	
<b>y-diff 3 (final difference or base of series)</b>		42		

Thus we only need find  $\Delta^3 y_i$  to complete our analysis of this series of numbers. The highest  $y$ -difference of the series we define as the ‘base’ of the series, and in our example is equal to 42.