Earlier Attempts at Classification of Elements

Science has made some giant leaps in the last century. Some stunning discoveries and inventions. In the field of chemistry also startling discoveries have been made. But none as significant as the Modern Periodic Table. But it was a long road to get here. Let us take a journey and look at the earlier attempts at classification of elements.

Earlier Attempts at Classification of Elements

As said before the journey to our current periodic table was a long and arduous one. Many scientists and chemists tried to attempt to classify the elements in a logical way. The first and most apparent one was to classify all elements into metals and non-metals. The concept of metalloids was still non-existent. But many scientists and chemists went a step further to find a more sophisticated system of classifying the elements. Some were more successful than others. Let us take a look at few of these attempts.

Dobereiner’s Triads

A German chemist and professor, Dobereiner's attempt at classification of elements are generally considered the first recorded attempt. He identified elements with similar properties and grouped them into groups of three, hence the name "triads". He realized when you arrange these three elements according to their atomic weight, the atomic weight of the second element was roughly the average of the atomic weights of the first and third element.

So Doberiener had clubbed Lithium (Li), Sodium (Na) and Potassium (K) together in a triad. The atomic weights of Li and K are 6.9 and 39. And the atomic weight of Na is in fact 23 which is very close to the average of the other two. However, Dobereiner soon found out that this was not uniform across all elements, and so this system had very short-lived and limited success.

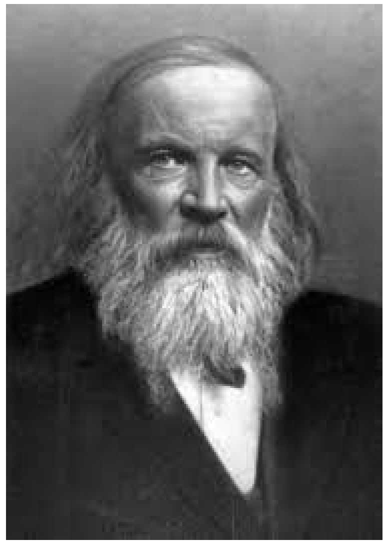
Newland's Law of Octaves

Will you believe that chemistry and music have a connection? That's right. An English scientist by the name of John Newlands tried to classify the elements in a unique manner. He first started by arranging all the elements in a ascending order according to their atomic weights. Hydrogen being the lightest was obviously first. And at that time only 56 elements were known, the last one being thorium.

After arranging the elements so, Newland discovered that the first and the eight elements showed similar properties and characteristics. He compared this to the eight octaves of music (do, re, mi, fa, sol, la, ti) where every eight note is similar to the first. Hence this classification came to be known as Newland’s Law of Octaves.

However, there were a number of faults with the classification. To begin with, the law was only applicable up till Calcium. After calcium, every eighth element did not share similar properties to the first one. Also as new elements were discovered and the number expanded from 56, they did not fit into the law. Newland had also adjusted two elements into one slot and paired together some very unlike elements in order to make the classification work. Ultimately this classification also failed to leave a lasting impression.

Mendeleev’s Periodic Table



Now, this was the most successful attempt among all the earlier attempts at classification of Elements. In fact, Dmitri Mendeleev is known as the "*father of the periodic table*". It was due to his endeavours at classification that we have our current periodic table. Mendeleev started his work in the 1800's when 63 elements were known to chemists. So Mendeleev first noted down the chemical properties of all the 63 elements on cards.

He had noticed a relation between atomic masses of elements and their chemical and also physical properties. He observed that there was a periodic re-occurrence of elements with similar properties. So Mendeleev arranged these elements in a grid, that we today know as a periodic table. Mendeleev stated that "properties of elements are the periodic function of their atomic masses” and this came to be known as Periodic Law.

One of the most successful aspects of this Mendeleev Table was that he was able to identify a few missing elements whose discovery still had to happen. After careful study of the atomic masses of elements, Mendeleev could actually recognize a few elements occurring between the known elements.

Despite its success, there were still a few shortfalls in the Mendeleev’s Table. Firstly he failed to place the Hydrogen correctly on his table. Hydrogen exhibits properties of both alkali metals as well as those of halogens, so to assign it one position was difficult. Also, isotopes of elements were proving to be a problem. They would occupy multiple positions on the table since all their atomic masses are different.

So although Mendeleev came very close there were still improvements that were made, and many years to pass till we arrived at the modern periodic table that we know and learn today.

Solved Example for You

Q: Mendeleev used a Sanskrit numeral before the names of the predicted elements. What is this term?

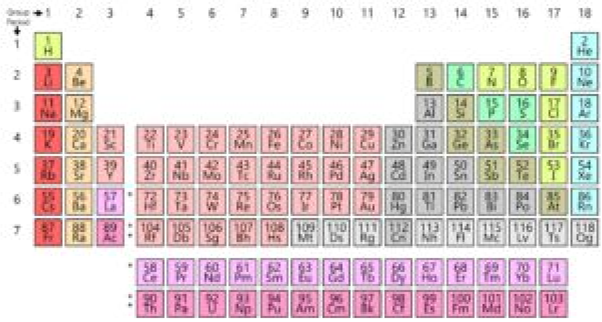
a. Sasi
b. Eka
c. Astana
d. Pancan

Sol: The correct answer is option “b”. The Sanskrit numeral used before the names of the predicted elements was Eka, which means one.

Modern Periodic Table

So as you know, Dmitri Mendeleev is the father of the periodic table. But did you know the Modern Periodic Table that we use was in fact developed by a scientist named Henry Moseley? Let us learn the fascinating history behind the periodic table.

Modern Periodic Table



As you know, all the elements found on earth are arranged in a grid or matrix called the Modern Periodic Table. These elements' arrangement is according to a pattern. The periodic table was actually developed and by Mendeleev in the early 1800's. However, it was in fact perfected by Henry Moseley, an English physicist in 1913. By making adjustments to the periodic law, he improved on all the flaws of the Mendeleev table. Let us take a look at this development.

Using Atomic Number

First, let us take a look at an atom's structure. Every atom is made up of a nucleus that consists of protons and neutrons. Here the protons have a positive charge and a neutron has no charge. Now electrons (carrying a negative charge) surround the nucleus. Now the atomic mass number is the total number of protons and neutrons in an atom. And the atomic number is the number of protons in an atom. This atomic number is completely unique to every element which means that every element on the planet has its own unique atomic number.

It was Henry Moseley who suggested a better arrangement than Mendeleev. He arranged the elements according to their Atomic Number rather than their Atomic mass. By doing so he improved upon the previous table and removed some of its difficulties and anomalies.

Position of Hydrogen

Mendeleev could never figure out the correct position of Hydrogen in his table. Since hydrogen can either gain or lose an electron it can find a place in Group 1 or 17. Its electronic configuration resembles that of alkali metals. Although it can also combine with metals and non-metals forming covalent bonds like Halogens.

But in the modern periodic table, there is no dilemma. Since the Atomic Number of hydrogen is 1 that is where it finds its appropriate place at the start of the table.

Isotopes

Isotopes are different atoms of an element each of which has the same number of protons, but a different number of neutrons in their nuclei.

This implies that although their atomic mass varies, their atomic number is the same. Like for example, Carbon-14 is a radioactive isotope of the carbon atom that has eight neutrons.

Whereas this presented a problem for Mendeleev, since the table depended on atomic mass, it is not an issue with the Modern Periodic table. All isotopes of the elements do not have separate places on the table.

Order of certain elements

Mendeleev when using atomic mass to arrange elements faced another problem. There were certain cases where there was a breaking of this arrangement so elements with similar properties were in a group together. Take the example of Iodine and Tellurium. Now iodine’s atomic mass is lower than tellurium. And yet Mendeleev put it after tellurium so it could be in the same group as fluorine and chlorine.

In the modern periodic table, the atomic mass becomes irrelevant and elements are grouped with similar elements based on their atomic number.

Rare Earth Elements

The modern periodic table solved another problem by placing the rare earth elements such as Cerium, Lanthanum, Erbium etc in a separate table at the bottom of the Periodic table, so as not to interfere with the Periodic Law.

Solved Example for You

Q: Out of all the 118 elements known to us, how many elements occur naturally?

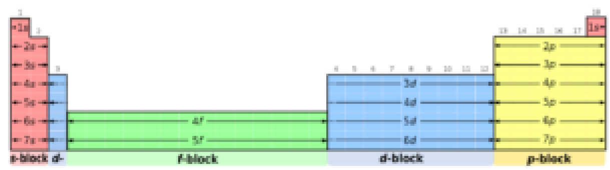
a. 98
b. 88
c. 100
d. 107

Sol: The correct answer is option "a". Out of the 118 elements known to us, 98 occur naturally. Out of these 80 are stable and 18 are radioactive.

Position of Elements in Modern Periodic Table

By now you already know about the periodic table. You have seen the colour coded grid and can perhaps recite the first few elements by memory. But have you ever wondered why the elements are so arranged? Now let us learn a few facts about the periodic table of elements.

Modern Periodic Table of Elements



The arrangement of elements in the periodic table follows a certain rule known as the periodic law, which is:

"Properties of elements are a periodic function of their atomic number"

So the periodic table of elements has been arranged in increasing order of their atomic numbers. The arrangement of these elements is in a grid or matrix format. There are 118 elements in total, spread out on the periodic table. Now, this matrix divides itself into rows and columns. Let us learn about these in detail.

Periods

- Horizontal rows of the periodic table of elements are the periods.
- There are seven such periods in the table, each numbered from 1 to 7.
- All the elements in the period have the same number of shells. The number of electrons in this last shell increase by one across any given period
- The first period is the shortest having only two elements, namely Hydrogen and Helium. The next two rows or periods, that is the second and the third, are known as short periods. They both contain eight elements each. The next two periods have 18 elements each. And finally, the last (sixth) period is the very long period and has 32 elements.

Groups

- The vertical columns of the periodic chart are what we call Groups.

- There are 18 groups in the periodic table.
- Elements belonging to a particular group make a family and are generally named after the first element in that particular group
- If you notice the electronic configuration of all elements in one group you will see they all have the same number of valence electrons. Take Chlorine and Fluorine for example. Both belong to group 17 and both have seven valence electrons.
- As you go down the group the valence electrons remain same but the number of shell increase.
- On the extreme left of the table is Group 1 which consists of alkali metals (Li, Na, K, Rb, Cs, Fr). They are highly reactive metals that form strong alkaline hydroxides.
- The last group is occupied by noble gases (He, Ne, Ar, Kr, Xe, Rn). These are highly nonreactive. The eighteenth group they occupy is also called Group 0.

Inner Transition Elements

- These are Lanthanides and Actinides.
- Lanthanides are rare earth metals. They are fifteen in number and found deep in the earth's crust.

- These elements are placed below the periodic table of elements and are called the 4f series.
- Actinides are all radioactive elements. Some of them are not found in nature but are man-made.
- These actinides are also placed below the table in a row after lanthanides.

Learn more about D Block and F Block elements here in detail here.

Solved Example for You

Q: Electronic configuration of element T is 2, 8, 7. What is the period number of T?

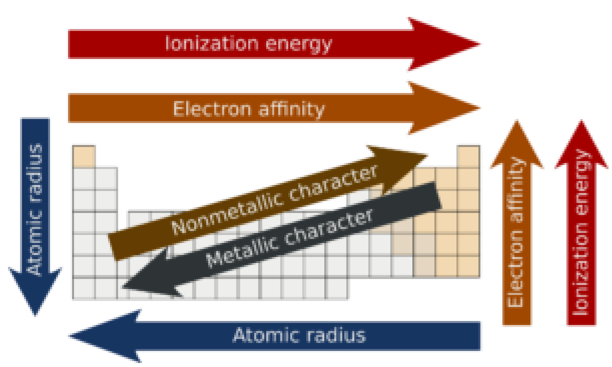
a. 2
b. 3
c. 5
d. 4

Sol: The correct answer is option “b”. Given configuration is 2, 8, 7. The first shell has 2 electrons and the second will have 8. Hence the remaining 7 will be in the third shell as the third shell has a capacity of 18 electrons. Since the valence shell is three, the period will also be 3.

Trends in the Modern Periodic Table

By now you know all about the periodic table. You now your periods and groups. But did you know the periodic table has some patterns and trends? Learning about these patterns will make your reading of the periodic table much easier. So let us learn more about the modern periodic table trends.

Modern Periodic Table Trends



There are specific patterns present in the arrangement of elements in the periodic table. These periodic table trends arise out of the specific arrangement of elements due to the Periodic Law. Studying these trends, allows chemists, scientists and even us to quickly identify certain properties of an element. They exist because our periodic table places elements that have similar characteristics together. There are certain exceptions to the trend also. Let us look at a few of these trends that we find in our periodic table.

Valency

One of the trends in the modern periodic table is that of the valency of an atom. As you already know, the valency of an atom is the number of electrons it has in its outermost shell or the number of atoms in requires to complete its outermost shell. However one can determine the valency of an element simply from its position in the periodic table. The group that the element is placed in usually indicates its valency. Let us look at a few examples to understand this trend.

- All alkali metals in group one, have the valency one and form monovalent bonds
- The alkali earth metals making up group two, have two electrons in the last orbit and are bivalent

- Similarly, all the Halogens in the group 17, have the valency of one (8-7 electrons) and are monovalent

Atomic Size

Atomic size is the distance between the centre of the nuclei and its outermost orbit. In simple terms, it is the radius of an atom. It is noticed that the atomic size of elements decrease as we move from left to right in a period. This is because the electrons increase hence increasing the nuclear charge.

When the nuclear charge is stronger, the nucleus pulls the electrons closer to itself so reducing the atomic radii. As opposed to this when one moves from the top to bottom of a group, the atomic size of elements increases. This is because the number of shells of the atom increase, increasing their radii.

Example: The atomic size of all elements in period 2 in picometer (pm)

Li	Be	B	C	N	O	F	Ne

145	105	85	70	65	60	50	38

Electronegativity

Electronegativity is the ability of an atom of any element to attract a shared pair of electrons in a chemical bond, towards itself. It is a measure of atom's tendency to form a molecule by attracting electrons to itself. The most electronegative element is Florine and the least is Caesium.

So by this, you can probably deduce that as you move in a row (period) from left to right the electronegativity increases. And from top to bottom in a column (group) it will decrease. This is because when the number of shells increases as we go down a group, so the pull of the nucleus to attract electrons decreases.

Metallic and Non-metallic Properties

In the periodic table a zigzag line, across the table, separates the metals from the non-metals. As you will be able to notice on the periodic table, the metals such as Magnesium, Aluminium, Iron etc are clustered towards the left side of the table. And the non-metals such as Fluorine and Sulphur are found on the right.

Then there are the metalloids also known as the semi-conductors. These borders the zigzag line on the periodic table. These have some properties of metals and some of the non-metals. Some examples are Boron, Arsenic, Tellurium etc.

And now we have seen the periodic table trends. However, it is important to remember that these trends do have some exceptions.

Solved Example for You

Q: Which among the following elements has largest atomic size?

a. B
b. Al
c. Ga
d. In

Sol: The correct answer is option “d”. On moving down the group the atomic size increases. Therefore Indium has the largest atomic size.