

Synthetic Elements.

Respected sir and my friends, Good Morning!

For many years now, we have been hearing “Uranium is heaviest naturally occurring element.” But, in the periodic table, there are so many elements even after “U”. So obviously it indicates that these elements are artificially produced or synthesized by man. Hence they are called ‘SYNTHETIC ELEMENTS’. This is the topic on which I am going to talk today.

As I said just now, all the trans – U elements are synthetic. But mind you, they are not the only once. There are some elements before ‘U’, too, which are synthetic. The places of these elements were kept blank in the periodic table for years. So, this is what in the periodic table looked like when man didn’t know how to synthesize new elements. (Slide1).

H																	He				
Li	Be															B	C	N	O	F	Ne
Na	Mg															Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr				
Rb	Sr	Y	Zr	Nb	Mo		Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe				
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn				
Fr	Ra	Ac																			

Ce	Pr	Nd		Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U											

But, in the 3rd decade of 20th century, everything changed and scientists, while trying to build nuclear bombs, also invented how to synthesize new elements. We now know very well that, new elements are produced by bombarding projectiles like neutrons, α -particles, deuteron or even lighter nuclei on heavy nuclei. The new elements produced are detected by recognizing the set of decay energies, which does not correspond to any known element and is unique to that new element.

The first synthetic element to be produced was Tc (at no. = 43) which was produced by bombarding Mo by ^2D . Till the date, 22 isotope of Tc are known. You might be surprised with the no. as we always hear of 2 or at the most 3 isotopes of an element. But, all the synthetic elements have isotopes more than 10. The 2nd one was Pm, with which we are quite familiar, as it is one of the Lanthenides.

So, you must have realized that, the 1st two synthetic elements produced were not trans – U but, ones which occur before it. Hence, the “Potholes” in the periodic table were filled and this was the new face of the periodic table. (Slide2).

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac															

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	Sg	Lk

But, the scientists were not going to stop as yet and they tried to complete “the map” of the periodic table as far as possible.

Enrico Fermi has found out that new elements can be synthesized by bombarding ‘U’ with neutrons and hence, working on his guide-lines, McMillan & Abelson found that, eventhough major portion of ‘U’ nuclei underwent fission, some ‘U’ nuclei showed β - decay and produced a new element. This new element was element 93, Np! Thus, the first synthetic, trans – U element was produced in the history of mankind. And once the scientist got a new technique and some new region to explore, elements, from Pu to Lr, were produced in just 20 years. This might sound easy to us, but the fact to be noted is that, 9 elements out of these 10 were produced under the able leadership of one man, Glenn Seaborg. And because of the great contribution of Seaborg, the periodic table looked almost complete, when the actinide series was completed. (Slide3).

Ele. ^s	Rxn ^s involved in prod ⁿ	Isotopes	Uses.
Np.	${}_{92}^{238}\text{U} + {}_0^1\text{n} \rightarrow {}_{92}^{239}\text{U} \rightarrow {}_{93}^{239}\text{Np} + {}_0^0\text{e}$	15.	—
Pu.	${}_{93}^{239}\text{Np} \rightarrow {}_{94}^{239}\text{Pu} + {}_0^{-1}\text{e}$	15.	Explosive in nuclear weapons
Am.	${}_{94}^{239}\text{Pu} + 2{}_0^1\text{n} \rightarrow {}_{94}^{241}\text{Pu} \rightarrow {}_{95}^{241}\text{Am} + {}_0^{-1}\text{e}$	—	Portable source of γ -radiography.
Cm.	${}_{95}^{241}\text{Am} + {}_0^1\text{n} \rightarrow {}_{95}^{242}\text{Am} \rightarrow {}_{96}^{242}\text{Cm} + {}_0^0\text{e}$ ${}_{94}^{239}\text{Pu} + {}_2^4\text{He} \rightarrow {}_{96}^{242}\text{Cm} + {}_0^1\text{n}$	14.	Generates 3 watt thermal energy per gram. \therefore Power source.
Bk.	${}_{95}^{241}\text{Am} + {}_2^4\text{He} \rightarrow {}_{97}^{243}\text{Bk} + 2{}_0^1\text{n}$	10.	No commercial or technical use.
Cf.	${}_{96}^{242}\text{Cm} + {}_2^4\text{He} \rightarrow {}_{98}^{245}\text{Cf} + {}_0^1\text{n}$	—	${}^{252}\text{Cf}$ in portable n-source.
Es.	This was 1 st found in debris of 1 st thermonuclear explosion. ${}_{94}^{239}\text{Pu} + 3{}_0^1\text{n} \rightarrow {}_{94}^{242}\text{Pu}$ Pu is made into Pu-oxide pellets, which are used to produce Es with Cf.	14.	Used to produce Mendelevium (Md).

Now, as per our human nature, you must be thinking, ok fine, this Seaborg produced all these elements in such less time! But what's their use to us, the human beings, the "creators" of these elements? So, here's a brief a/c of how these elements are produced and their uses, if any,
(Slide4)

Elets	Rx ⁿ s involved in prod ⁿ	Isotop	Uses.
Fm.	First found in debris of 1 st thermonuclear explosion with Es. ${}_{92}^{238}\text{U} + {}_8^{16}\text{O} \rightarrow {}_{100}^{250}\text{Fm} + 4{}_0^1\text{n}$	16.	—
Md.	${}_{99}^{253}\text{Es} + {}_2^4\text{He} \rightarrow {}_{101}^{256}\text{Md} + {}_0^1\text{n}$	14.	—
No.	Double-recoil technique (95% ${}^{244}\text{Cm}$ + 4.5% ${}^{246}\text{Cm}$). ${}_{96}^{246}\text{Cm} + {}_6^{12}\text{C} \rightarrow {}_{102}^{254}\text{No} + 4{}_0^1\text{n}$ ${}_{96}^{244}\text{Cm} + {}_6^{13}\text{C} \rightarrow {}_{102}^{257}\text{No}$	10.	—
Lr.	Bombardment of ${}^{249}\text{Cf}$ ${}^{250}\text{Cf}$, ${}^{251}\text{Cf}$, ${}^{252}\text{Cf}$ with ${}_{10}^2\text{B}$	—	—

But, the scientists didn't just stop here. They created more elements and are still doing so! The elements up till at no. 112 and also, 114, 116, 118 have been produced. In this periodic table (classroom), you can see the symbols Ku & Ha for the elements 104 & 105, respectively. The names 'Kurchatovium' was suggested by Russians in honor of a famous Russian nuclear scientist, Kurchatov. Also they suggested the name 'Dubnium' (Db) for element 105. But, the American – suggested names for these 2 elements are Rutherfordium (Rf) & Hahnium (Ha), respectively. None of these have been confirmed yet. In this periodic table, which I have, you can see the American – suggested names and symbols for the elements from 104 through 109 (Slide5),

H																He	
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fa	Ra	Ac	Rf	Ha	Sg	Bh	Hs	Mt	110	111	112		114		116		118

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

104: Rf = RUTHERFORDIUM.

105: Ha = HAHNIUM.

106: Sg = SEABORGIUM.

107: Bh = BOHRIUM.

108: Hs = HESSIUM.

109: Mt = MEITNERIUM.

104- Rutherfordium (Rf), 105-Hahnium (Ha), 106-Seaborgium(Sg), 107-Bohrium (Bh), 108-Hasseum(Hs), 109-Meitnerium (Mt).

Of these, we all of course know Rutherford, Bohr and Seaborg. Otto Hahn, after whom 105 is named, was the first person along with Frisch Strassmann, to discover that, when 'U' underwent fission, it was split into 2 halves of almost equal mass. Liesse Meitner, in whose honor element 109 is named, was the 1st one along with her nephew Otto Frisch, to give explanation of this 'U' splitting and to realize that large amount of energy can be released.

Next elements from 110 to 112 & 114, 116 & 118 are not yet named. But, all these are extremely shortlived and therefore, upto now, have not found any usage for us. But, on basis of theory of nuclear structure, physicists have predicted that isotope of element 110, having mass no. 184 should be very stable but, upto now, the efforts to synthesize these isotopes have failed. Let's hope our scientists succeed in doing so, one day! If, they continue in this manner, one day we might land up producing an element which doesn't exist in the whole solar system and that would be the greatest day in the history of mankind.

Thank You.