Chronological Evolution of Periodic Classification of Elements
(ମୌଳିକ ମାନଙ୍କର ପର୍ଯ୍ୟାୟ ଭିତ୍ତିକ ଶ୍ରେଣୀ ବିଭାଗର ସମାୟାନୁକ୍ରମିକ ବିକାଶ)

Sudhansu Tripathy, *PhD, DSc*
Chairman & Head, *The Uranium*

- Why National Periodic Table Day on 7th February ?
- (ଆମେରିକାରେ ଫେବ୍ରୁୟାରୀ 7ରେ ପ୍ରତି ବର୍ଷ କାହିଁକି ଜାତୀୟ ପର୍ଯ୍ୟାୟ ସାରଣୀ ଦିବସ ପାଳିତ ହୁଏ ?)
- Because on 7th February, 1863, John Newlands put forth the initial periodic Table with Law of Octaves
- (କାରଣ, 1863 ମସିହାରେ ଏହି ଦିନ ଜନ ନିଉଲାଣ୍ଡସ୍,ପ୍ରଥମ କରି ପର୍ଯ୍ୟାୟ ଭିତ୍ତିକ "ଅଷ୍ଟକ ସୂତ୍ର" ଉପସ୍ଥାପନ କରିଥିଲେ ।)
- (Initiated since 2016 by David T. Steinekar, Chemistry teacher from Kentucky, USA)
- ଆମେରିକା, କେଣ୍ଟକିର ରସାୟନ ଶାସ୍ତ୍ର ଶିକ୍ଷକ ଡ଼େଭିଡ୍ ଷ୍ଟେନେକର ଏହି ଦିବସ ପାଳନ କରିବା ଆରମ୍ଭ କରାଇ ଥିଲେ ।

- Robert Boyle in 1680 discovered Phosphorus from residue of human urine distillation(cold fire).
- (1680 ରେ ରବର୍ଟ ବଏଲ, ମନୁଷ୍ୟ ମୂତ୍ରର ପାତନ-ଅବ୍ଶେଷରୁ ଫସଫରସ ମୌଳିକ ଆବିଷ୍କାର କରିଥିଲେ । ଏହା ଆଲୋକ ଓ ନିଆଁ ପ୍ରଦାନ କରୁଥିବାରୁ ଏହାକୁ "ଶୀତଳ ନିଆଁ" କୁହାଯାଉଥିଲା ।)
- Lovoisier's Classification in 1789(*Elementary Treatise of Chemistry*) put forth his table containing 33 elements including light and caloric(heat) considered as elements.
- (ଲାଭୟେସିଆର, 1789 ରେ "*Elementary Treatise of Chemistry*" ପୁସ୍ତକରେ 33 ଟି ମୌଳିକ ଉଲ୍ଲେଖ କରିଥିଲେ ଓ ସେଥିରେ 'ଆଲୋକ' ଓ 'ତାପ' କୁ ମଧ ଦୁଇ ମୌଳିକ ନିଆଯାଇଥିଲା)

Antoine Lavoisier's classification of 33 elements into four element groups

Acid-making Elements	Gas-like Elements	Metallic Elements	Earthy Elements
Sulphur	Light	Antimony	Lime (calcium oxide)
Phosphorus	Caloric (heat)	Arsenic	Magnesia (magnesium oxide)
Charcoal (carbon)	Oxygen	Bismuth	Barytes (barium sulphate)
	Azote (Nitrogen)	Cobalt	Argilla (aluminium oxide)
	Hydrogen	Copper	Silex (silicon dioxide)
	Muriatic Radical	Gold	
	Fluoric Radical	Iron	
	Biracic Radical	Lead	
		Manganese	
		Mercury	
		Molybdena	
		Nickel	
		Platina	
		Silver	
		Tin	
		Tungstein	
		Zinc	

- Dalton(1808-1810), Thomas Thomson, Prout and Berzelius started to determine the atomic masses of elements taking H as 1.
[ବୈଜ୍ଞାନିକ ଡାଲଟନ(1808-1810), ଥୋମାସ ଥମସନ, ପ୍ରାଉଟ୍ ଏବଂ ବରଜିଲିୟସ ମୌଳିକ ମାନଙ୍କର ପାରମାଣବିକ ବସ୍ତୁତ୍ୱ(H କୁ 1 ଧରି) ନିରୂପଣ କରିଥିଲେ]
- 1829, Johann Wolfgang Dobereiner put forth this TRIAD of elements.
(1829 ମସିହାରେ ପ୍ରଥମ କରି ଡୋବେରିନର 4 ଟି "ମୌଳିକ ତ୍ରିପଦୀ(Triad of elements)" ଉପସ୍ଥାପନ କରିଥିଲେ ।)
- Stanislao Cannizzaro, 1860s, refined atomic mass determination by applying Avogadro's law and determining vapor density. O-16 was used as standard for defining relative atomic mass
(ବୈଜ୍ଞାନିକ କାନିଜାରୋ, 1860 ମସିହାରେ ମୌଳିକ ମାନଙ୍କର ବାଷ୍ପ ଘନତ୍ୱ(Vapour Density), ସାହାଯ୍ୟରେ ଅଧିକ ଗ୍ରହଣଯୋଗ୍ୟ ପାରମାଣବିକ ବାସ୍ତବ ନିରୂପଣ କରିଥିଲେ)
- 1960, C-12 was used as standard (cu/u/Da)
- (1960 ମସିହାରେ C-12 ଆଇସୋଟୋପ କୁ ପାରମାଣବିକ ବସ୍ତୁତ୍ୱ ନିରୂପଣର ମାନକ ଭାବରେ ଗୃହୀତ ହେଲା/ (cu/u/Da)

Dobereiner's Triad(ଡୋବେରିନରଙ୍କ ତ୍ରିପଦୀ):1817

Element	Atomic Mass	Eement	Atomic Mass	Element	Atomic Mass	Element	Atomic Mass
Li	6.9	Ca	40.1	Cl	35.5	S	32
Na	23.0	Sr	87.4	Br	79.9	Se	79
K	39.1	Ba	137.3	I	126.9	Te	128

Triad Law(ତ୍ରିପଦୀ ନିୟମ):ପ୍ରତ୍ୟେକ ତ୍ରିପଦୀର ପ୍ରଥମ ଓ ତୃତୀୟ ମୌଳିକ ମାନଙ୍କର ପାରମାଣବିକ ବସ୍ତୁତ୍ୱର ହାରାହାରି ହେଲା ମଧ୍ୟବର୍ତ୍ତୀ ମୌଳିକର ପାରମାଣବିକ ବସ୍ତୁତ୍ୱ ।

23.0(Na) $= \frac{6.9(Li)+3\ \ .1(K)}{2}$; 87.4(Sr) $\approx \frac{40.1(Ca)+137.3(Ba)}{2}$=88.7

79.9(Br)=$\approx \frac{35.5(Cl)+126.9(I)}{2}$=81.2

Newlands' Octave(ନିଉଲାଣ୍ଡଙ୍କ ଅଷ୍ଟକ ସୂତ୍ର): 1866 (62 elements)

Sa(Do)	H	F	Cl	Co, Ni	Br	Pd	I	Pt, Ir
Re(Re)	Li	Na	K	Cu	Rb	Ag	Cs	Os
Ga(Mi)	G(Be)	Mg	Ca	Zn	Sr	Cd	Ba, V	Hg
Ma(Fa)	Bo(B)	Al	Cr	Y	Ce, La	U	Ta	Tl
Pa(So)	C	Si	Ti	In	Zr	Sn	W	Pb
Dha(La)	N	P	Mn	As	Di, Mo	Sb	Nb	Au
Ni(Ti)	O	S	Fe	Se	Ro, Ru	Te	Au	Th

Di: Didymium(found to be a mixture of two elements Praseodymium(Pr) and Neodymium(Nd), but considered as one element during Newland's period

Ro: Later named as Rh(Rhodium)

G: *Glucinium*(named as Beryllium in 1957)

No.	No.	No.	No.	No.	No.	No.	No.
H 1	F 8	Cl 15	Co & Ni 22	Br 29	Pd 36	I 42	Pt & Ir 50
Li 2	Na 9	K 16	Cu 23	Rb 30	Ag 37	Cs 44	Tl 51
G 3	Mg 10	Ca 17	Zn 25	Sr 31	Bd [sic-Cd] 38	Ba & V 45	Pb 54
Bo 4	Al 11	Cr 19	Y 24	Ce & La 33	U 40	Ta 46	Th 56
C 5	Si 12	Ti 18	In 26	Zr 32	Sn 39	W 47	Hg 52
N 6	P 13	Mn 20	As 27	Di & Mo 34	Sb 41	Nb 48	Bi 55
O 7	S 14	Fe 21	Se 28	Ro & Ru 35	Te 43	Au 49	Os 51

https://web.lemoyne.edu/giunta/newlands.html

- **Law of Octaves:** Every eighth element was found to be similar to the first element, just like musical octave (Sa Re Ga Ma Pa Dha Ni Sa) or in the C-Major scale C-D-E-F-G-A-B-[C]
- (ନିଉଲାଣ୍ଡସ୍ ଙ୍କ ଅଷ୍ଟକ ସୂତ୍ର : ସଙ୍ଗୀତରେ ସା, ରେ, ଗା, ମା, ପା,ଧା, ନି ପରେ ପୁଣି ସା ଆସିଲା ଭଳି ପ୍ରତି ଅଷ୍ଟମ (ସାତଟି ମୌଳିକ ପରବର୍ତ୍ତୀ) ମୌଳିକଟିର ଧର୍ମଗୁଣ ପ୍ରଥମ ସହିତ ସାମଞ୍ଜସ୍ୟ ରହିଲା ।)
- This gave the concept of Periodic Law propounded by Mendeleev in terms of atomic masses of elements.
- [ଏହା ପରବର୍ତ୍ତୀ କାଳରେ ମେଣ୍ଡେଲିଭଙ୍କ ପର୍ଯ୍ୟାୟୀ ସୂତ୍ର(Periodic Law) ଦେବାରେ ବହୁତ ସାହାଯ୍ୟ କରିଥିଲା]
- Noble Gases not Discovered.
- (ସେତେବେଳ ସୁଦ୍ଧା ନିଷ୍କ୍ରିୟ ଗ୍ୟାସ ମାନଙ୍କର ଆବିଷ୍କାର ହୋଇ ନଥିଲା)
- Only 62 elements arranged.
- (କେବଳ 62 ଟି ମୌଳିକକୁ ସଜା ଯାଇଥିଲା)

- Elements having similar properties were then put in rows and having different properties were put in columns, which was opposite to Mendeleev's Table and the Long form.
- (ସାମଞ୍ଜସ୍ୟ ଥିବା ମୌଳିକ ମାନେ ଗୋଟିଏ ଧାଡ଼ି ବା ପର୍ଯ୍ୟାୟରେ ପଡିଥିଲେ । କିନ୍ତୁ ପରବର୍ତ୍ତୀ କାଳରେ ମେଣ୍ଡେଲିଭ ସେହିଭଳି ମୌଳିକ ମାନଙ୍କୁ ଶ୍ରେଣୀ ବା ସ୍ତମ୍ଭରେ ରଖିଥିଲେ ।)
- He was first to arrange elements in their relative atomic masses.
- (ନିଉଲାଣ୍ଡସ୍ ପ୍ରଥମ କରି ମୌଳିକ ମାନଙ୍କର ପାରମାଣବିକ ବସ୍ତୁତ୍ୱର ବର୍ଦ୍ଧିତ କ୍ରମରେ ସେମାନଙ୍କୁ ସଜାଇଥିଲେ)
- Drawback(ଦୁର୍ବଳତା): No room for new elements and dissimilar elements were put to the same family.
- (ନୂଆ ମୌଳିକ ମାନଙ୍କ ପାଇଁ ସ୍ଥାନ ନଥିଲା ଓ କେତେକ ଭିନ୍ନ ପ୍ରକୃତିର ମୌଳିକ ମଧ୍ୟ ଗୋଟିଏ ଧାଡ଼ିରେ ସ୍ଥାନ ପାଇଥିଲେ)

John Newlands

- Born November 26, 1837 in London, from a Scottish father and Italian mother in England and died on July 29, 1898 in London (Lived for 61 years). He studied in Royal College of Chemistry (Imperial College London). Died during a surgery at home when he was 61. He used the *musical analogy of Pythagoras* in his chemical theory.

Mendeleev's Periodic Table in 1969

- Put forth on 6th March 1969 on the basis of increasing atomic masses. But in 1871, his Period Law and Periodic Table Table got wide reconition.
- 66 elements: Playing like a CARD GAME(Chemical Solitaire-Card game in train journeys) Arranged according the formula of their oxides and hydrides(valencies).
- Made three switches : (Co & Ni), (K, Ar), (I, Te)
- Father of Periodic Table.
- Similar elements were put in columns called GROUPS and horizontal rows were called Period in which change in properties occurred to produce dissimilar elements.
- There were 8 groups and 12 periods.

ମେଣ୍ଡେଲିଭଙ୍କ ପର୍ଯ୍ୟାୟ ସାରଣୀ(1969)

- 6th March 1969 ରେ ମେଣ୍ଡେଲିଭ ତାଙ୍କର ପ୍ରଥମ ପର୍ଯ୍ୟାୟ ସାରଣୀ ଉପସ୍ଥାପନ କରିଥିଲେ । ମୌଳିକ ମାନଙ୍କୁ ସେମାନଙ୍କର ପାରମାଣବିକ ବସ୍ତୁତ୍ୱର ବର୍ଦ୍ଧିତ କ୍ରମରେ ସଜାଇ ଥିଲେ । 1871 ରେ ତାଙ୍କର ସାରଣୀ ବହୁତ ଲୋକପ୍ରିୟ ହୋଇଥିଲା ।
- 66 ଟି ମୌଳିକମାନଙ୍କର ସବୁ ଧର୍ମଗୁଣ ଅନୁଯାୟୀ, 66 ଟି ଏକା ଆକାରର କାର୍ଡରେ ଲେଖି, କାର୍ଡ ଖେଳ(CARD GAME) ଭଳି ସେଥିରେ ସବୁବେଳେ ଖେଳୁଥିଲେ । ସେ ଯେଉଁଆଡେ ଯାଉଥିଲେ(ରେଳ ଯାତ୍ରାରେ ମଧ୍ୟ),ସେ ସେହି କାର୍ଡ ମାନଙ୍କୁ ଏକ ଭଳି ଧର୍ମ ଗୁଣ ସମ୍ପନ୍ନ (ଯଥା ଯୋଜ୍ୟତା, ଅକ୍ସାଇଡ, ହାଇଡ୍ରାଇଡ, କ୍ଲୋରାଇଡ ଆଦି ଯୌଗିକର ଧର୍ମଗୁଣ ଆଦି) ମୌଳିକ ମାନଙ୍କୁ ତଳକୁ ତଳ ଏକ ସ୍ତମ୍ଭରେ ରଖୁ ଥିଲେ)
- ଧର୍ମଗୁଣ ମେଳ ନଖାଉଥିବା ତିନୋଟି ଯୁଗଳ ମଧ୍ୟରେ ଅଦଳ ବଦଳ କରିଥିଲେ । (Co & Ni), (K, Ar), (I, Te)
- ତାଙ୍କୁ ପର୍ଯ୍ୟାୟ ସାରଣୀର ଜନକ କୁହାଯାଏ ।
- ଏକା ଭଳି ମୌଳିକମାନେ ସ୍ତମ୍ଭ ବା ଗ୍ରୁପ ରେ ଓ ଅସମାନ ମୌଳିକ ମାନେ ଧାଡ଼ି ବା ପିରିୟଡ୍ ରେ ରଖି ଥିଲେ ।
- 8 ଟି ଗ୍ରୁପ ଓ 12 ଟି ପିରିୟଡ୍ ଥିଲା ।

- **Mendeleev's Periodic Law:** Properties of elements are periodic functions of their atomic masses.
- In 1904, noble gases were discovered, as a result of which a new 9th group was appended to the PT.
- Empty Spaces and Prediction of New elements:
- Eka Boron: Scandium(III)-1879; Eka Aluminium: Gallium(III)-1875
- Eka Silicon : Germanium(IV)-1886
- Eka-Tellurium : Polonium(VI), Eka Cs: Francium; Eka Mn : Tc Technetium
- Dvi-Mn : Re ; Eka Xe: Radon;

- **ମେଣ୍ଡେଲିଭଙ୍କ ପର୍ଯ୍ୟାୟୀ ସୂତ୍ର** : ମୌଳିକ ମାନଙ୍କର ଧର୍ମଗୁଣ ସେମାନଙ୍କର ପାରମାଣବିକ ବସ୍ତୁତ୍ୱର ପର୍ଯ୍ୟାୟ ଫଳନ ।
- 1904 ରେ, ନିଷ୍କ୍ରିୟ ଗ୍ୟାସ ମାନଙ୍କର ଆବିଷ୍କାର ପରେ ଆଉ ଏକ ଗ୍ରୁପ(9 ମ) ଯୋଗ କରି ଦେଇଥିଲେ ।
- ବହୁତ ଖାଲି ସ୍ଥାନ ତାଙ୍କ ସାରଣୀରେ ଥିଲା ଯାହା ନୂଆ ମୌଳିକମାନେ ଗ୍ରହଣ କରିବେ ବୋଲି ସେ ଭବିଷ୍ୟତ ବାଣୀ କରିଥିଲେ ।
- Eka Boron(ଏକା-ବୋରନ): Scandium(III)(ସ୍କାଣ୍ଡିୟମ)-1879;
- Eka Aluminium(ଏକା-ଏଲୁମିନିୟମ): Gallium(III)(ଗାଲିୟମ)-1875
- Eka Silicon(ଏକା-ସିଲିକନ) : Germanium(IV)(ଜର୍ମାନିୟମ)-1886
- Eka-Tellurium(ଏକା-ଟେଲୁରିୟମ) : Polonium(VI)(ପୋଲୋନିୟମ),
- Eka Caesium(ଏକା-ସିଯିୟମ୍): Francium(ଫ୍ରାନସିୟମ);
- Eka Mn(ଏକା-ମାଙ୍ଗାନିଜ) : Tc, Technetium(ଟେକନେସିୟମ)
- Dvi-Mn(ଦ୍ୱି-ମାଙ୍ଗାନିଜ) : Re(ରେନିୟମ୍) ;
- Eka-Xe (ଏକା- ଜେନନ): Radon-Rn(ରେଡନ);

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
Period 1	H = 1							
Period 2	Li = 7	Be = 9.1	B = 11	C = 12	N = 14	O = 16	F = 19	
Period 3	Na = 23	Mg = 24.4	Al = 27	Si = 28	P = 31	S = 32	Cl = 35.5	
Period 4	K = 39.1	Ca = 40	? = 44	Ti = 48.1	V = 51.2	Cr = 52.3	Mn = 55	Fe = 56, Ni = 58.5, Co = 59.1, Cu = 63.3
Period 5	(Cu) = 63.3	Zn = 65.4	? = 68	? = 72	As = 75	Se = 79	Br = 80	
Period 6	Rb = 85.4	Sr = 87.5	Y = 89	Zr = 90.7	Nb = 94.2	Mo = 95.9	? = 100	Rh = 103, Ru = 103.8, Pd = 108, Ag = 107.9
Period 7	(Ag) = 107.9	Cd = 112	In = 113.7	Sn = 118	Sb = 120.3	Te = 125.2	I = 126.9	
Period 8	Cs = 132.9	Ba = 137	La = 138.5	Ce = 141.5	Di = 145			
Period 9								
Period 10			Yb = 173.2		Ta = 182.8	W = 184		Ir = 193.1, Pt = 194.8, Os = 200, Au = 196.7
Period 11	(Au) = 196.7	Hg = 200.4	Tl = 204.1	Pb = 206.9	Bi = 208			
Period 12				Tb = 233.4		U = 239		

Group	I	II	III	IV	V	VI	VII	VIII
Oxide / Hydride	R_2O / RH	RO / RH_2	R_2O_3 / RH_3	RO_2 / RH_4	R_2O_5 / RH_3	RO_3 / RH_2	R_2O_7 / RH	RO_4
Periods	A B	A B	A B	A B	A B	A B	A B	
1	H 1.008							
2	Li 6.93	Be 9.01	B 10.81	C 12.01	N 14.00	O 15.99	F 18.99	
3	Na 22.99	Mg 24.31	Al 26.98	Si 28.09	P 30.97	S 32.06	Cl 35.45	
4 1st Series	K 39.10	Ca 40.08	— 44	Ti 47.90	V 50.94	Cr 52.10	Mn 54.9	Fe 55.85, Co 58.93, Ni 58.71
4 2nd Series	Cu 63.5	Zn 65.4	— 68	— 72	As 74.9	Se 79.0	Br 79.9	
5 1st Series	Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.91	Mo 95.94	Tc 99.0	Ru 101.0, Rh 102.9, Pd 106.4
5 2nd Series	Ag 107.9	Cd 112.4	In 114.82	Sn 118.69	Sb 121.75	Te 127.60	I 126.9	
6 1st Series	Cs 132.9	Ba 137.3						
6 2nd Series	Au 196.97	Hg 200.59						

Demerits(ଦୁର୍ବଳତା)

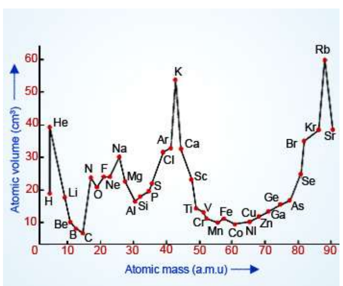
- କେତେକ ଗ୍ରୁପରେ ଭିନ୍ନ ଧର୍ମୀ ମୌଳିକ ମାନେ ସ୍ଥାନ ପାଇଥିଲେ । ଉଦାହରଣ ସ୍ୱରୂପ, କ୍ଷାର ଧାତୁ/alkali metals (Li, Na, K, Rb..IA) ସହିତ, ମୁଦ୍ରା ଧାତୁ/coinage metals (Cu, Ag, Au-Group IB) ଏକ ଗ୍ରୁପ ରେ ରହିଥିଲେ ।
- ଯେହେତୁ ମୌଳିକ ମାନନଙ୍କର ପାରମାଣବିକ ବସ୍ତୁତ୍ୱର ନିୟମିତ ବୃଦ୍ଧି(ଏକକ ବୃଦ୍ଧି) ନଥିଲା, ଦୁଇ ମୌଳିକ ମଧ୍ୟରେ ଥିବା ଫାଙ୍କା ସ୍ଥାନ ମାନଙ୍କରେ କେତୋଟି ମୌଳିକ ରହିପାରିବ, ତାହା କହି ହୋଇପାରୁନଥିଲା ।
- H ପାଇଁ ଏକ ନିର୍ଦ୍ଦିଷ୍ଟ ସ୍ଥାନ ନଥିଲା ।
- ଆଇସୋଟୋପସ୍ ମାନଙ୍କ ପାଇଁ ସ୍ଥାନ ନ ଥିଲା ।

Lothar Mayer Classification
(ଲୋଦର ମେଏରଙ୍କ ଶ୍ରେଣୀବିଭାଗ)

- German Chemist (19th August 2830 – 11th April 1895)
- 1864, he published his first table containing 28 elements with six families according to valencies.
- In 1970, he published his second table similar to Mendeleev's table.

Lothar Meyer's Periodic Table in 1864
(28 elements- six families

	Valence IV	Valence III	Valence II	Valence I	Valence I	Valence II	Mass difference
I row					Li	Be	~16
II row	C	N	O	F	Na	Mg	~16
III row	Si	P	S	Cl	K	Ca	~45
IV row		As	Se	Br	Rb	Sr	~45
V row	Sn	Sb	Te	I	Cs	Ba	~90
VI row	Pb	Bi			Tl		~90



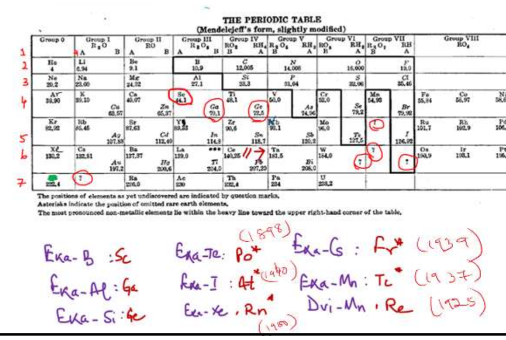
Lothar Meyer Atomic Mass(amu)-Atomic Volume(cm^3) Graph
(ଲୋଦର ମେଏରଙ୍କ ପାରମାଣବିକ ବସ୍ତୁତ୍ୱ ଓ ଆୟତନ ଗ୍ରାଫ)

- Alkali metals such as Na, K, Rb occur on the peaks.
- F, Cl, Br occur at the rising or the ascending part of the curve
- Noble gases Ne, Ar, Kr occur just before alkali metals.
- Be, Mg, Ca fall just before the dips(minimum points) .
- H and He show exception.

Mendeleev's Modified Table in 1904
(ମେଣ୍ଡେଲିଭଙ୍କ ସଂଶୋଧିତ ସାରଣୀ-1904)

- 1894 ପରେ, ନିଷ୍କ୍ରିୟ ଗ୍ୟାସ ମାନଙ୍କର ଆବିଷ୍କାର ପରେ He, Ne, Ar, Kr, Xe ଙ୍କୁ ନେଇ ଆଉ ଏକ ଗ୍ରୁପ(୨ମ) ପ୍ରଥମ ଗ୍ରୁପ ହିସାବରେ ସାରଣୀରେ ସ୍ଥାନ ପାଇଥିଲା ।

Mendelev's Modified Periodic Table: 1904

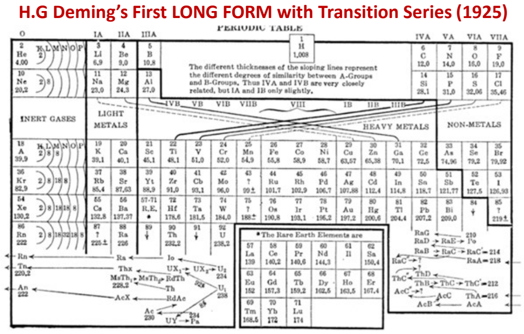


- 1897, JJ Thomson discovered electron. 1886, Eugen Goldstein, though discovered positive rays(canal rays) having different e/m ratio for different gases, only in 1917, Ernst Rutherford proved that hydrogen nucleus(PROTON) is present in all other nuclei.
- 1907, radioactivity was discovered in thorium and ISOTOPES were discovered.
- 1911, Ernst Rutherford discovered nucleus from his Gold foil experiment and gave the model of atom.
- 1913, Dutch Physicist Antonius van den Broek first proposed ATOMIC NUMBER(Nuclear Charge) is the basis of periodic classification.

- 1913 ମସିହାରେ ବୈଜ୍ଞାନିକ ହେନେରୀ ମୋସିଲି, ବୈଜ୍ଞାନିକ ବ୍ରୋକଙ୍କ ପ୍ରରିକଳ୍ପନାକୁ ପରୀକ୍ଷା ଦ୍ୱାରା ସତ୍ୟ ପ୍ରତିପାଦନ କରିଥିଲେ ଯେ ମୌଳିକ ମାନନଙ୍କର ଧର୍ମଗୁଣ୍ ତାହାର ନିଉକ୍ଲିୟସରେ ଥିବା ପ୍ରୋଟୋନ ସଂଖ୍ୟା ବା ପରମାଣୁ ସଂଖ୍ୟା (Z) ଉପରେ ନିର୍ଭର କରେ ମାତ୍ର ପାରମାଣବିକ ବସ୍ତୁତ୍ୱ ଉପରେ ନୁହେଁ । ସେ x-ray spectra ପରୀକ୍ଷା ଦ୍ୱାରା ମୌଳିକ ମାନଙ୍କର ପରମାଣୁ ସଂଖ୍ୟା ନିରୂପଣ କଲେ ଓ ଏହାର ବୃଦ୍ଧି ନିୟମିତ ହେଉଥିବାରୁ, ନୂଆ ମୌଳିକ ମାନଙ୍କ ପାଇଁ ସଠିକ ଫାଙ୍କା ସ୍ଥାନ ପାଇପାରିଥିଲେ ।
- MODERN PERIODIC LAW(ଆଧୁନିକ ପର୍ଯ୍ୟାୟୀ ସୂତ୍ର). ମୌଳିକ ମାନଙ୍କର ଧର୍ମଗୁଣ ସେମାନଙ୍କର ପରମାଣୁ ସଂଖ୍ୟା(Z)ର ପର୍ଯ୍ୟାୟ ଫଳନ ।
- ସେ ଚାରିଟି ନୂଆ ମୌଳିକର ସୃଷ୍ଟିର ଭବିଷ୍ୟତ ବାଣୀ କରିଥିଲେ ।(43, 61, 72, 75)
- 1913, ରେ ବୈଜ୍ଞାନିକ ନିଲସ ବୋର' ତାଙ୍କ ପରମାଣୁ ଗଠନର ମଡେଲ ଦେଇଥିଲେ ।
- ପରମାଣୁ ମାନଙ୍କର ଇଲେକଟ୍ରନ ସଂରଚନା ଜଣାଗଲା ପରେ, ଇଲେକଟ୍ରନ ଭିତ୍ତିକ ଶ୍ରେଣୀ ବିଭାଗରୁ ଜଣାଗଲେ ଯେ ଏକ ଶ୍ରେଣୀ ବା ଗୃପ ରେ ଥିବା ମୌଳିକ ମାନଙ୍କର ବାହ୍ୟ କକ୍ଷର ଇଲେକଟ୍ରନ ସଂରଚନା ସମାନ ।

- Charles Bury, an English Chemist first used the word TRANSITION in 1921 for the transition series of elements in which the inner shell goes from 8 to 18 or from 18 to 32.
- H.G. Deming, USA in 1923 put forth the LONG FORM of Periodic Table, with (A) groups for Normal elements (Group Zero to Group VIIIA) with groups zero, IA, IIA in the left and IVA, VA, VIA and VIIA in the right. IIIA group also contained Sc, Yt, Rare Earths.
- The middle portion contain IIIA group and all (B) groups namely IVB, VB, VIB, VIIB, VIII(three series triads), IB, IIB, IIIB.
- Unfortunately, Sc, Y(t), Rare Earths, Some Actinides were in IIIA while IIIB contained Ga, In and Tl

H.G Deming's First LONG FORM with Transition Series (1925)

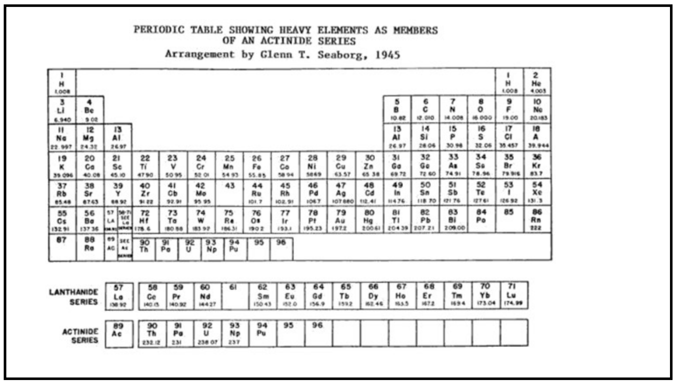


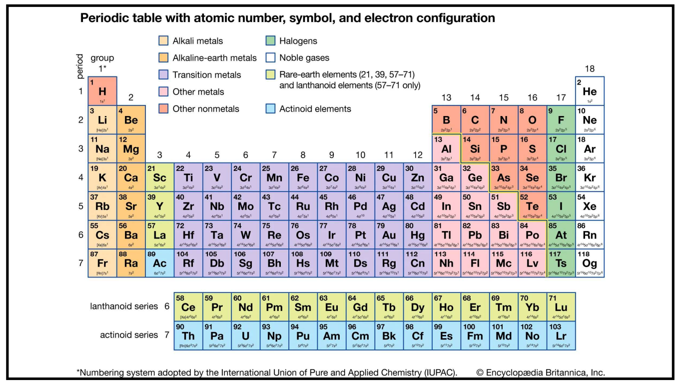
Moseley's Periodic Table Published in 1930

Group 0	I a b	II a b	III a b	IV a b	V a b	VI a b	VII a b	VIII
	H 1							
He 2	Li 3	Be 4	B 5	C 6	N 7	O 8	F 9	
Ne 10	Na 11	Mg 12	Al 13	Si 14	P 15	S 16	Cl 17	
Ar 18	K 19 / Cu 29	Ca 20 / Zn 30	Sc 21 / Ga 31	Ti 22 / Ge 32	V 23 / As 33	Cr 24 / Se 34	Mn 25 / Br 35	Fe 26, Co 27, Ni 28
Kr 36	Rb 37 / Ag 47	Sr 38 / Cd 48	Y 39 / In 49	Zr 40 / Sn 50	Nb 41 / Sb 51	Mo 42 / Te 52	– / I 53	Ru 44, Rh 45, Pd 46
Xe 54	Cs 55 / Au 79	Ba 56 / Hg 80	57-71* / Tl 81	Hf 72 / Pb 82	Ta 73 / Bi 83	W 74 / Po 84	Re 75 / –	Os 76, Ir 77, Pt 78
Rn 86	–	Ra 88	Ac 89	Th 90	Pa 91	U 92		

Gaps at 43, 61, 72 and 75.
43: Technetium(Radioactive, 1937), 61: Promethium(Radioactive, 1945)
72: Hafnium(stable, 1923), 75: Rhenium(Stable, 1925)

- Glenn T. Seaborg, University of Berkeley, CA, in 1945, restructured the periodic Table by placing the Actinide Series below the Lanthanide Series. He was instrumental in the discovery of many synthetic elements post WWII.
- ଆଜିର ଦୀର୍ଘକାୟ ପର୍ଯ୍ୟାୟ ସାରଣୀ(Long Form of Periodic Table) ବୈଜ୍ଞାନିକ ଗ୍ଲେନ ସିବୋର୍ଗଙ୍କ ଦ୍ୱାରା ଉପସ୍ଥାପିତ ହୋଇଥିଲା । ଲାନ୍ଥାନଇଡ ଓ ଆକଟିନାଇଡ ସିରିଜ ସାରଣୀର ତଳେ ଦୁଇ ସ୍ୱତନ୍ତ୍ର ଧାଡ଼ିରେ ରଖାଯାଇଥିଲା ।
- In 1940, Neptunium and Plutonium were the first transuranic elements discovered.
- Superheavy elements in a transactinide series from 104 – 121 were synthesized one after the other.





Post WWII Scientists Discovered Synthetic Elements:

- Glenn T. Seaborg : Lawrence Berkeley National Lab, Berkeley, USA
- Ralph A. James : Lawrence Berkeley National Lab, Berkeley, USA
- Albert Ghiorso: Lawrence Berkeley National Lab, Berkeley, USA
- Enrico Fermi: Lawrence Berkeley National Lab, Berkeley, USA
- Lise Meitner, Austrian-Swedisch Nuclear Physicist, GSI, Darmstadt, Germany
- Yuri Oganessian, JINR, Dubna, Russia
- Flerov Laboratory of Nuclear Research, JINR, Dubna, Muscow, Russia
- GSI, Darmstadt, Germany
- RIKEN, Japan

Attempts to discover Ununennium(119) & Unbinilium(120)

- Hypothetical : Eka-francium
- Experiments started since 2018 I RIKEN, Japan and also JINR, Dubna, Russia lately

$$^{254}_{99}\mathrm{Es} + ^{48}_{20}\mathrm{Ca} \rightarrow ^{302}_{119}\mathrm{Uue}^* \rightarrow \text{no atoms}$$

$$^{249}_{97}\mathrm{Bk} + ^{50}_{22}\mathrm{Ti} \rightarrow ^{299}_{119}\mathrm{Uue}^* \rightarrow \text{no atoms}$$

$$^{249}_{98}\mathrm{Cf} + ^{50}_{22}\mathrm{Ti} \rightarrow ^{299}_{120}\mathrm{Ubn}^* \rightarrow \text{no atoms}$$

Life History of Dimitri Mendeleev, Father of Periodic Table

- Born on 8th February 1834 in Siberia to Ivan Mendeleev and Maria Mendeleeva. His father was school teacher of arts, politics and philosophy. Mother Maria was running the family glass factory.
- Dimitri was youngest of 17 siblings of whom 14 stayed alive.
- Studied Main Pedagogical Institute in St. Petersburg, Moscow.
- 1861, he published a text book named ‘Organic chemistry”.
- He married to Feozva Nikitichna Leshcheva on 17th April 1862.
- He became Professor at St. Petersburg Tech Institute and State university in 1864 and 1865 respectively. Got DSc in 1865.

- In 1876 (when he as 42) he fell in love with Anna Ivanova Popova and proposed her and threatened to commit suicide if she refused.
- He got divorce from Leshcheva and married Popova on April 2, 1882.
- He was technically a bigamist, much against orthodox law.
- Got umpteen number of awards and prizes.
- Nobel prize in 1906.
- Died in 1907(at 72) from influenza. His last words to doctor
- “Doctor, you have science, I have faith,”

Henry Moseley

- Died in battle as a WW1 volunteer at Gallipoli, Turkey on August 10 1915 at the age of 27 !!!!!
- He wrote, “We have here proof that there is in the atom a fundamental quantity, which increases by regular steps as one passes from one element to the next. This quantity can only be the charge on the central positive nucleus, of the existence of which we already have definite proof” (1913)