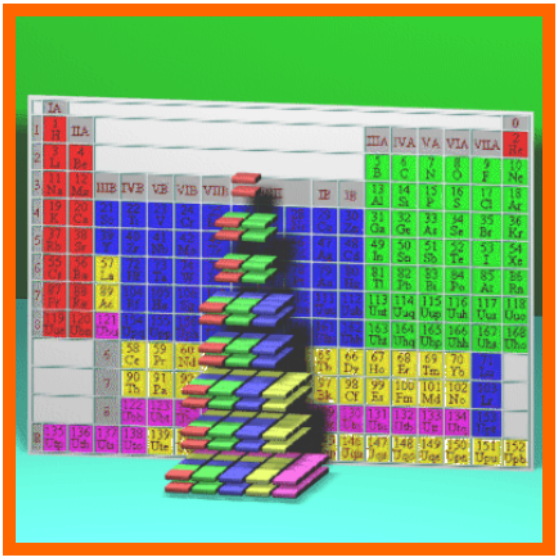
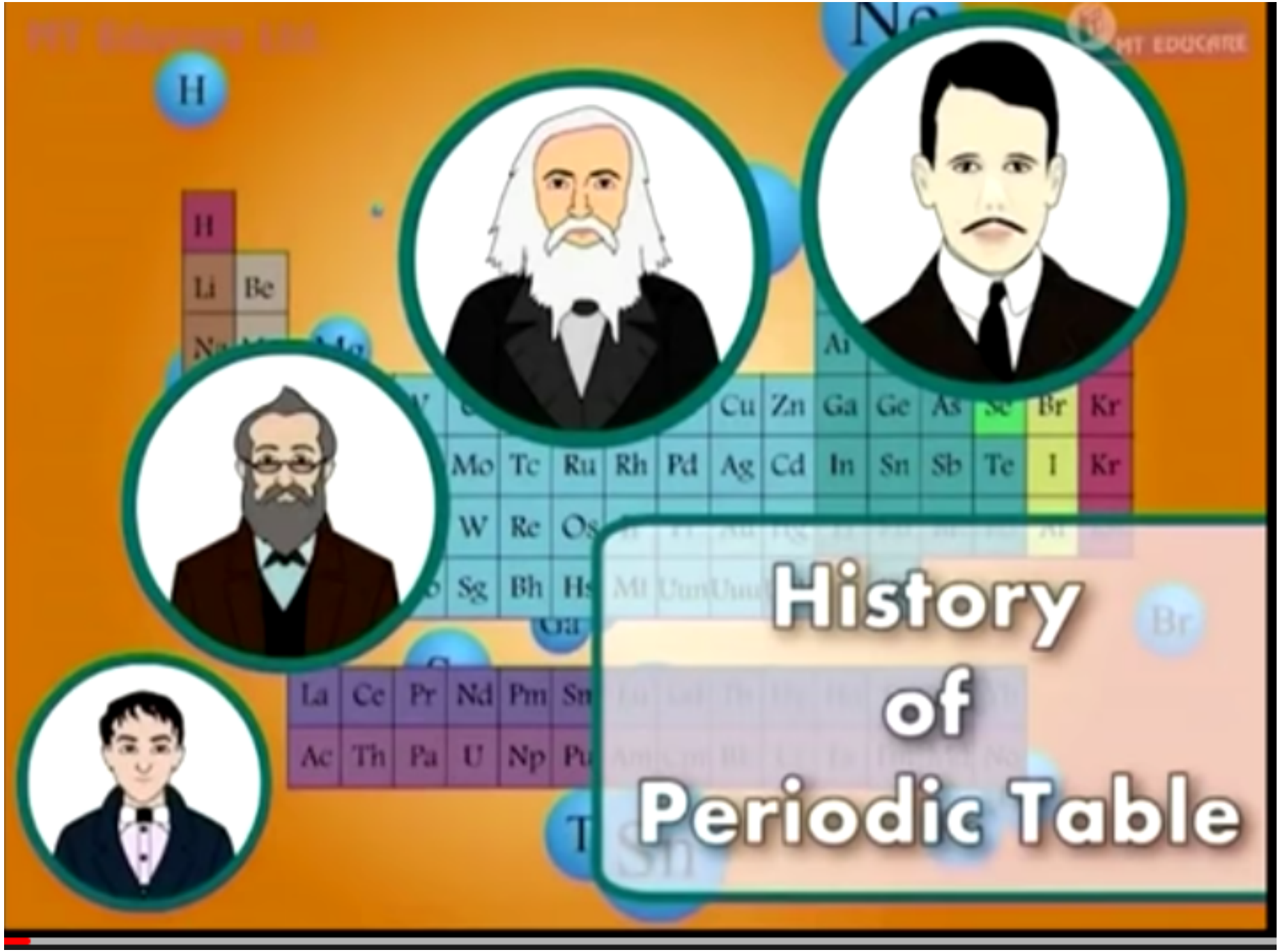
CHAPTER 3

Periodic Table and Periodicity of Properties



Animation 3.1 : Periodic Table
Source & Credit : mi.sanu


MT EDUCARE
History
of
Periodic Table

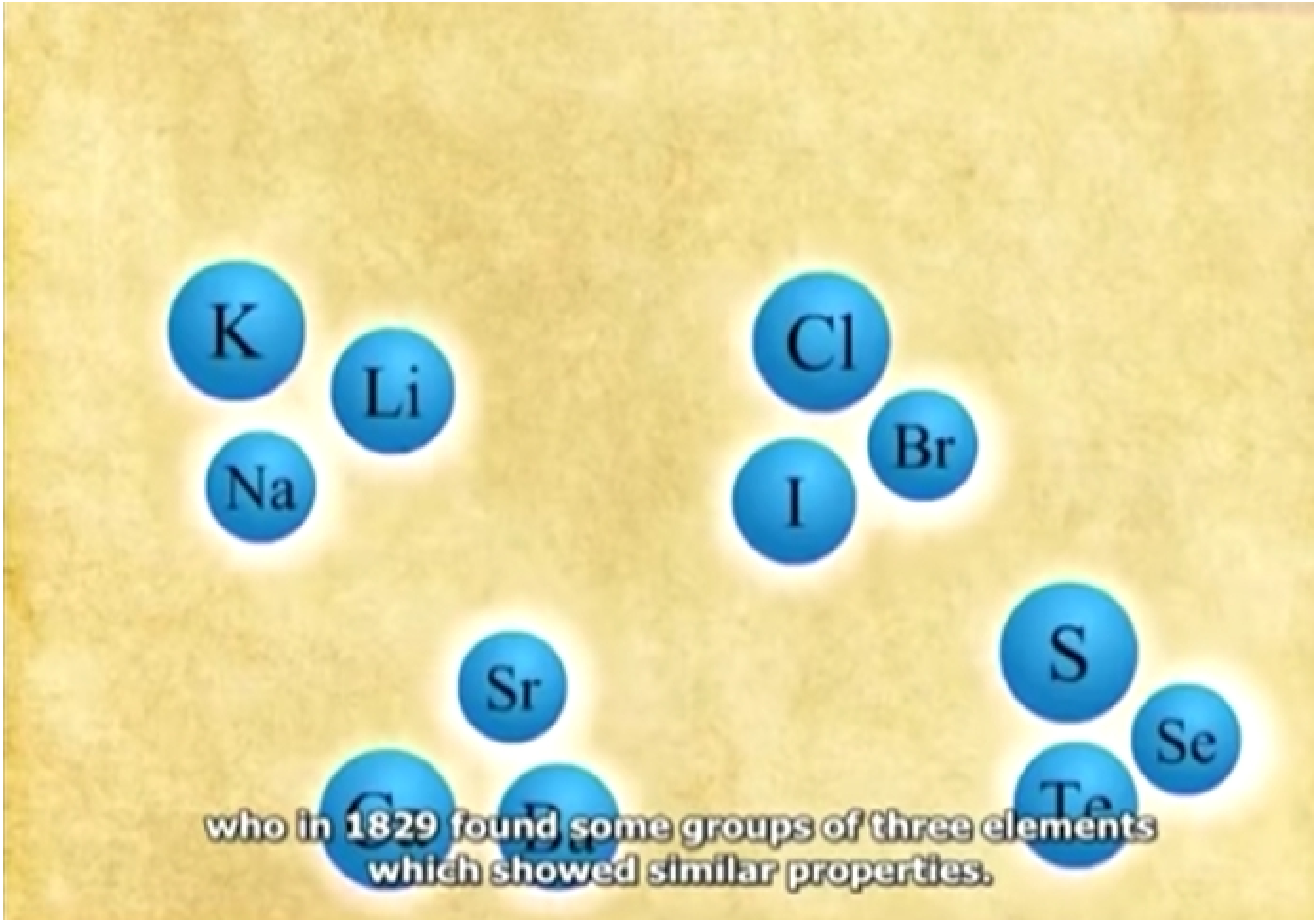
Dobereiner's Triads

Li 7
Na 23
K 39

$$\rightarrow \frac{7 + 39}{2} = 23$$

H							He
Li 7	Be	B	C	N	O	F	Ne
Na 23	Mg	Al	Si	P	S	Cl	Ar
K 39	Ca	Ga	Ga	As	Se	Br	Kr
Rb	Sr	In	Sn	Sb	Te	I	Xe
Cs	Ba	Tl	Pb	Bi	Po	At	Rn

we can see that the atomic mass of the middle element is approximately the mean of the atomic masses of the other two elements.

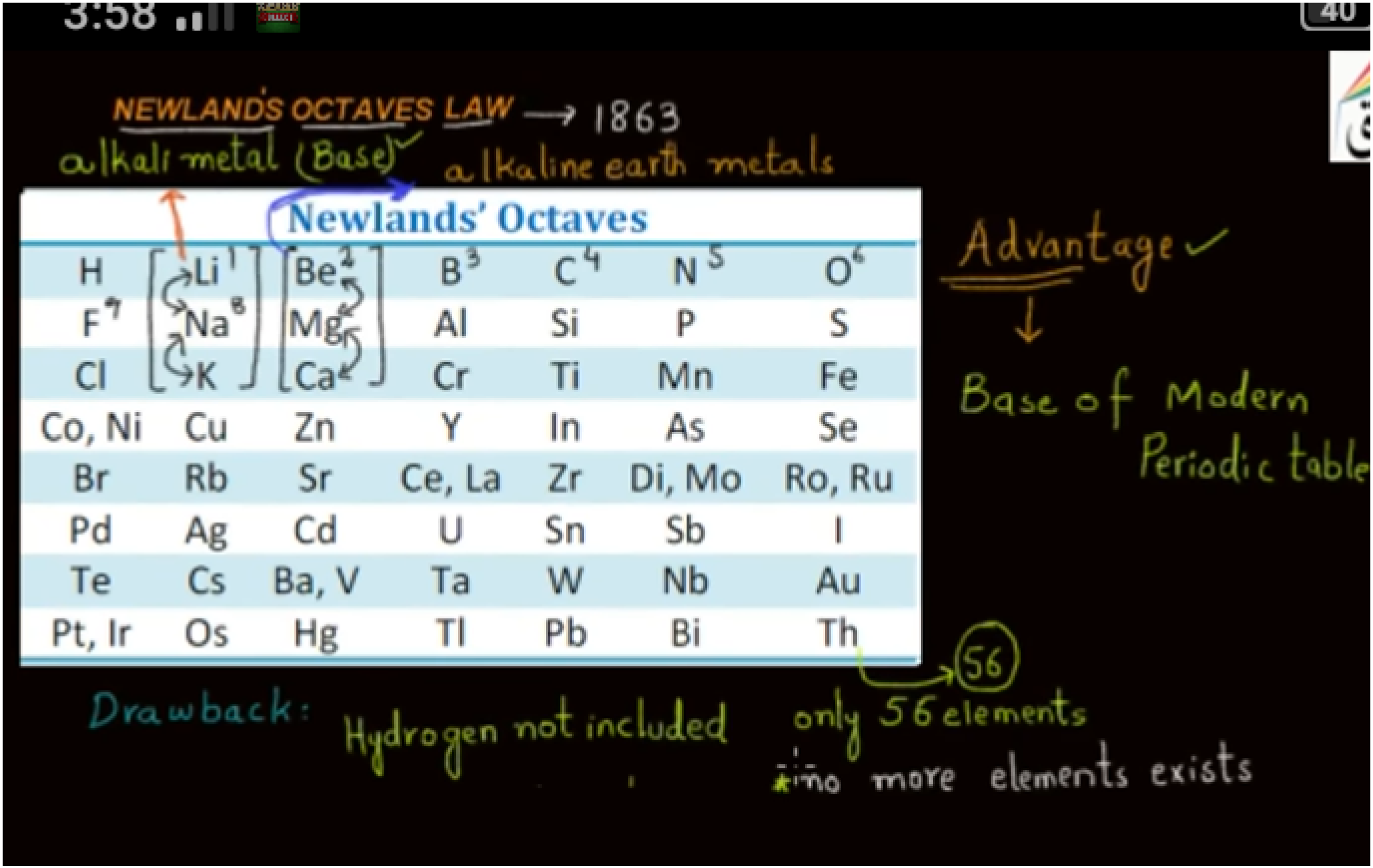

K
Li
Na
Cl
Br
I
Sr
S
Se
Te
who in 1829 found some groups of three elements
which showed similar properties.

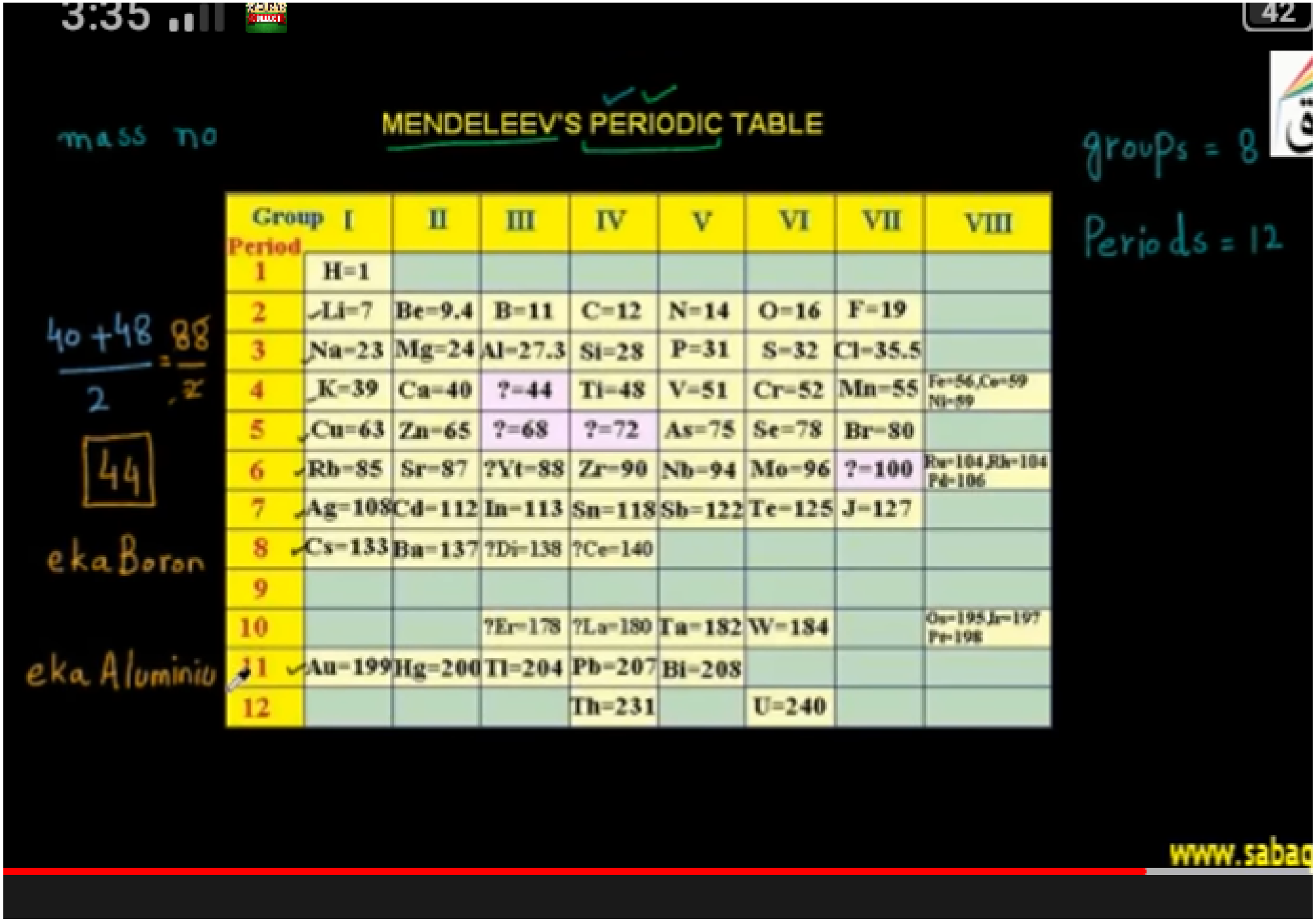
DOBEREINER'S TRIADS CLASSIFICATION

1817 — 3 elements groups → Base of Modern Periodic Table

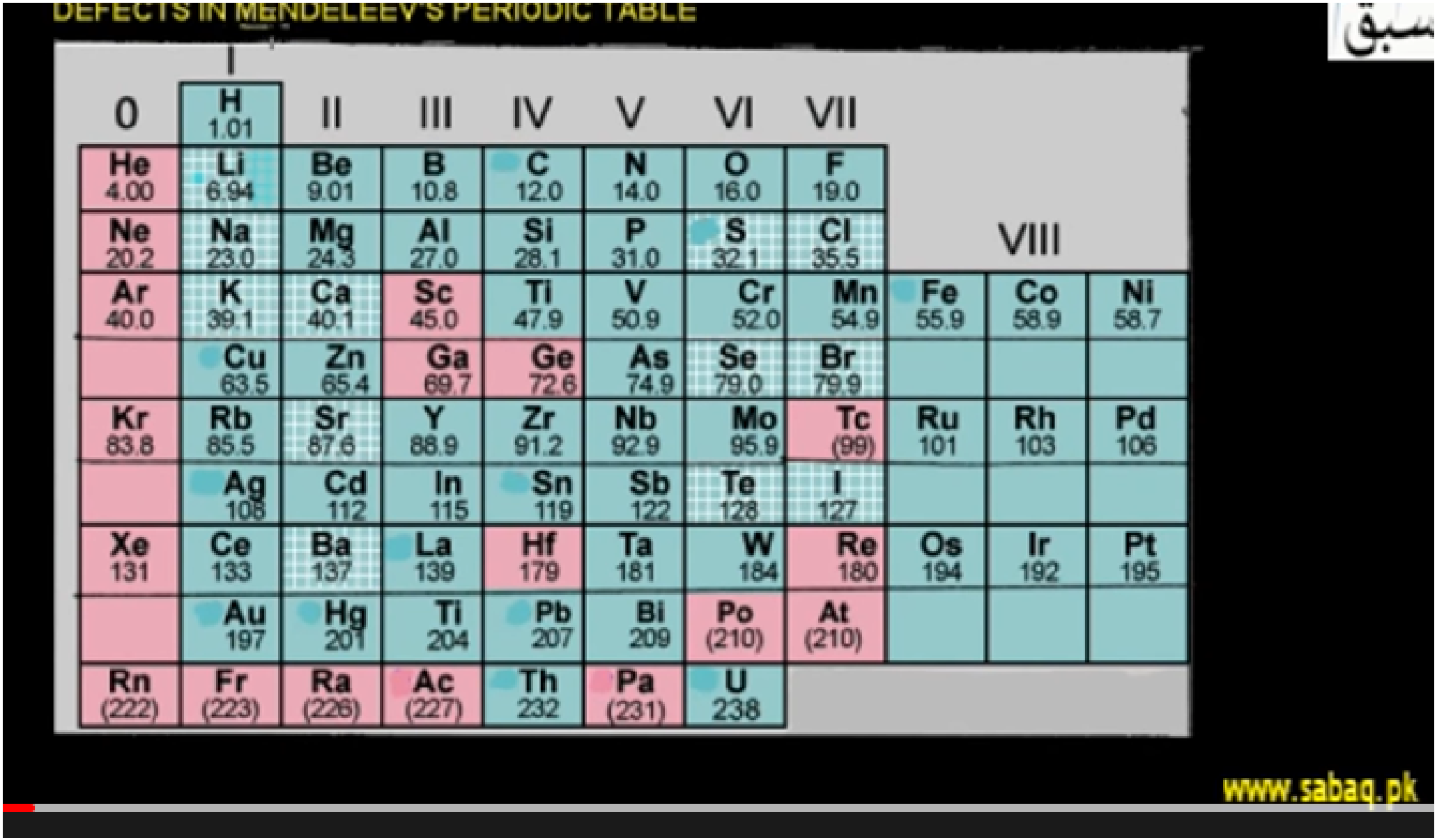
Properties, Atomic mass

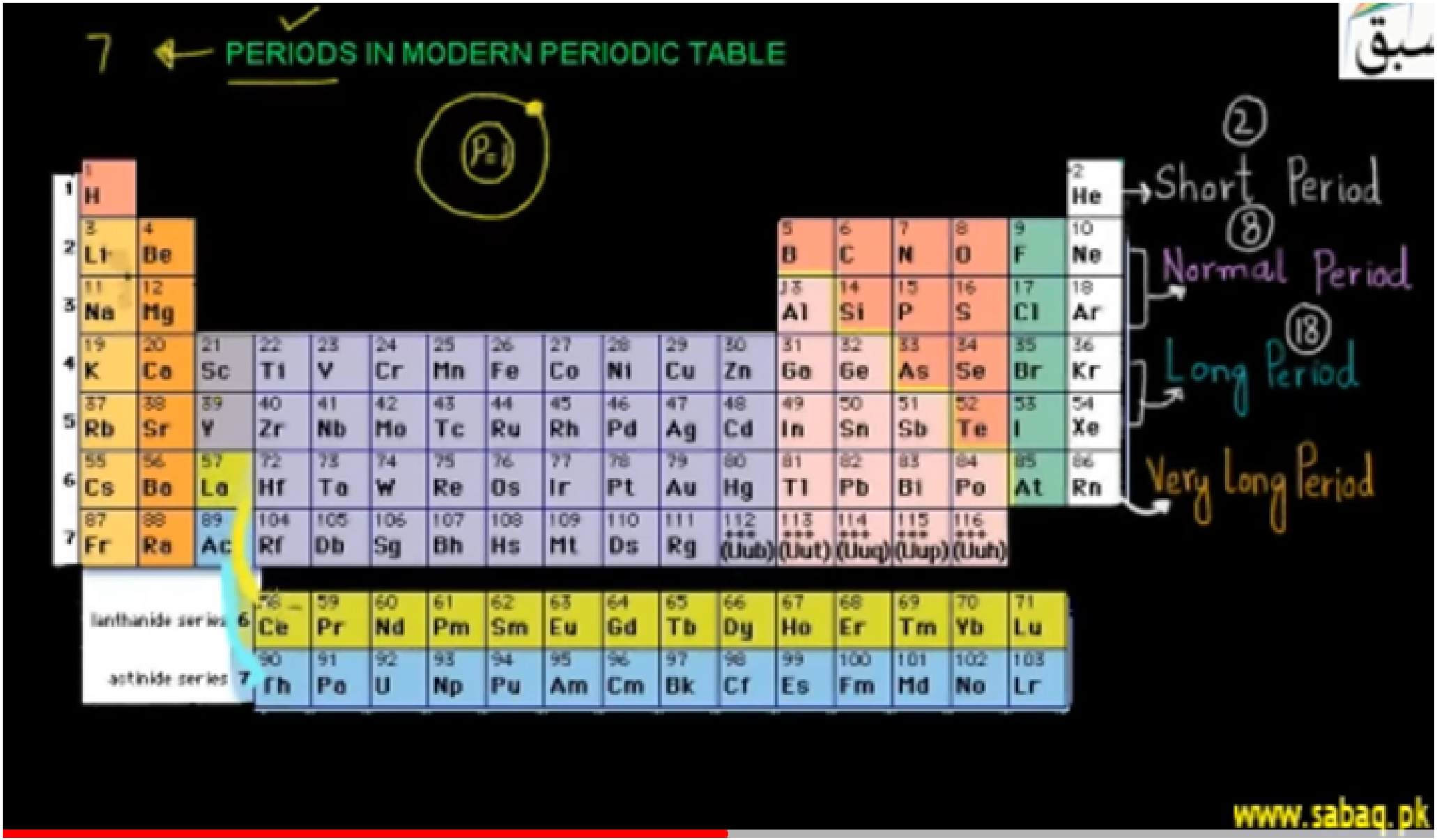
Elements	Atomic Mass	Arithmetic Mean
Lithium	7	$\frac{7+39}{2} = 23$
Sodium	23	
Potassium	39	
Chlorine	35.5	$\frac{35.5 + 126.5}{2} = 81$
Bromine	80	
Iodine	126.5	
Calcium	40	$\frac{137+40}{2} = 88$
Strontium	87	
Barium	137	


NEWLANDS OCTAVES LAW → 1863
alkali metal (Base)
alkaline earth metals
Newlands' Octaves
H Li Be B C N O
F Na Mg Al Si P S
Cl K Ca Cr Ti Mn Fe
Co, Ni Cu Zn Y In As Se
Br Rb Sr Ce, La Zr Di, Mo Ro, Ru
Pd Ag Cd U Sn Sb I
Te Cs Ba, V Ta W Nb Au
Pt, Ir Os Hg Tl Pb Bi Th
Advantage
Base of Modern Periodic table
56
only 56 elements
no more elements exists
Drawback:
Hydrogen not included



Group / Period	I	II	III	IV	V	VI	VII	VIII
1	H=1							
2	Li=7	Be=9.4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27.3	Si=28	P=31	S=32	Cl=35.5	
4	K=39	Ca=40	?=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59 Ni=59
5	Cu=63	Zn=65	?=68	?=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	?=100	Ru=104, Rh=104 Pd=106
7	Ag=108	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140				
9								
10			?Er=178	?La=180	Ta=182	W=184		Os=195, Ir=197 Pt=198
11	Au=199	Hg=200	Tl=204	Pb=207	Bi=208			
12				Th=231		U=240		


DEFECTS IN MENDELEEV'S PERIODIC TABLE
سبق
I
0
H 1.01
II
III
IV
V
VI
VII
VIII
He 4.00
Li 6.94
Be 9.01
B 10.8
C 12.0
N 14.0
O 16.0
F 19.0
Ne 20.2
Na 23.0
Mg 24.3
Al 27.0
Si 28.1
P 31.0
S 32.1
Cl 35.5
Ar 40.0
K 39.1
Ca 40.1
Sc 45.0
Ti 47.9
V 50.9
Cr 52.0
Mn 54.9
Fe 55.9
Co 58.9
Ni 58.7
Cu 63.5
Zn 65.4
Ga 69.7
Ge 72.6
As 74.9
Se 79.0
Br 79.9
Kr 83.8
Rb 85.5
Sr 87.6
Y 88.9
Zr 91.2
Nb 92.9
Mo 95.9
Tc (99)
Ru 101
Rh 103
Pd 106
Ag 108
Cd 112
In 115
Sn 119
Sb 122
Te 128
I 127
Xe 131
Ce 133
Ba 137
La 139
Hf 179
Ta 181
W 184
Re 180
Os 194
Ir 192
Pt 195
Au 197
Hg 201
Tl 204
Pb 207
Bi 209
Po (210)
At (210)
Rn (222)
Fr (223)
Ra (226)
Ac (227)
Th 232
Pa (231)
U 238
www.sabaq.pk


7 ← PERIODS IN MODERN PERIODIC TABLE
Pd
2
Short Period
8
Normal Period
18
Long Period
Very Long Period
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 104 Rf 105 Db 106 Sg 107 Bh 108 Hs 109 Mt 110 Ds 111 Rg 112 *** (Uub) 113 *** (Uut) 114 *** (Uuq) 115 *** (Uup) 116 *** (Uuh)
lanthanide series 6
actinide series 7
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
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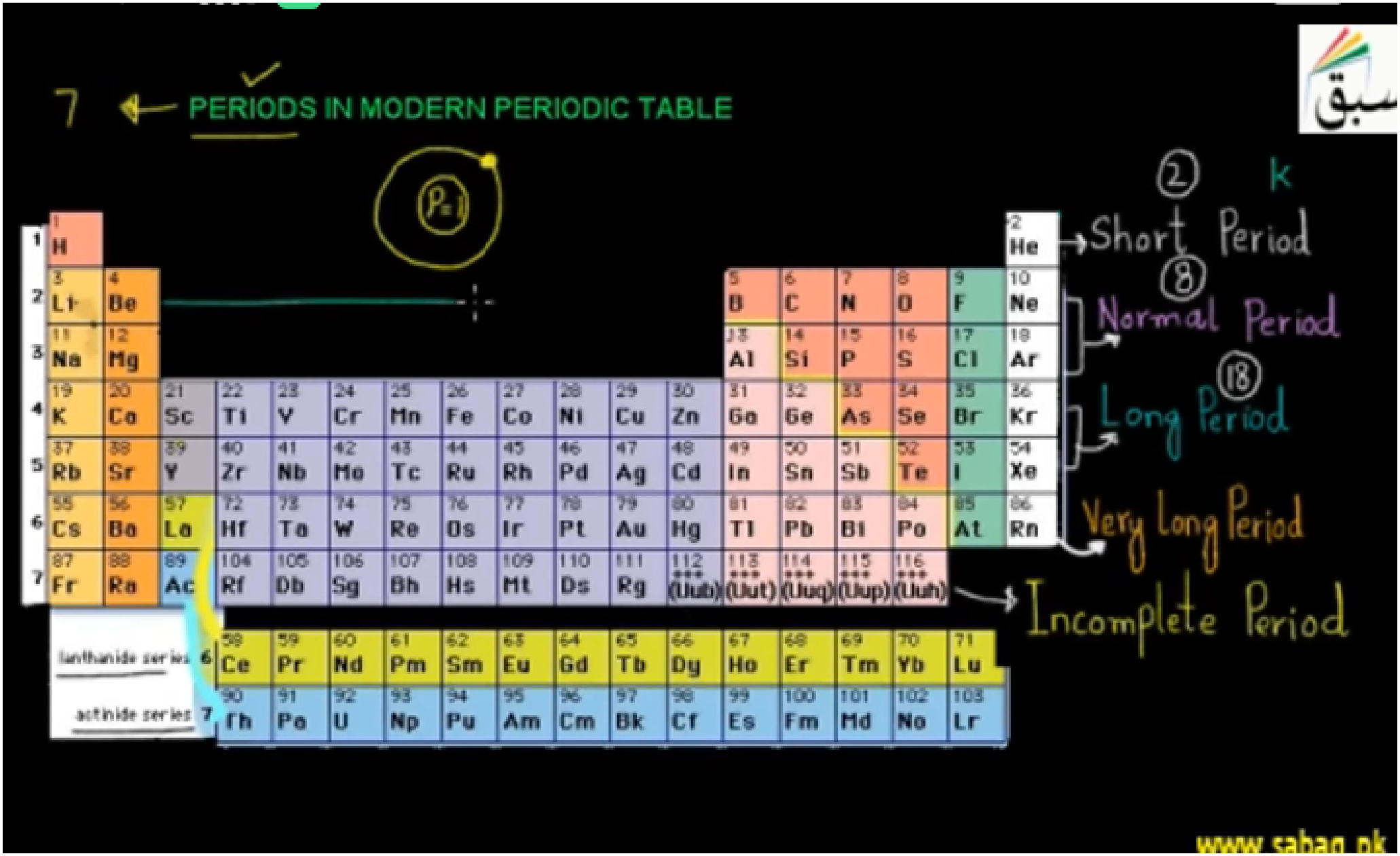
7 ← PERIODS IN MODERN PERIODIC TABLE
سبق
2 k
Short Period
8
Normal Period
18
Long Period
Very Long Period
Incomplete Period
lanthanide series 6
actinide series 7
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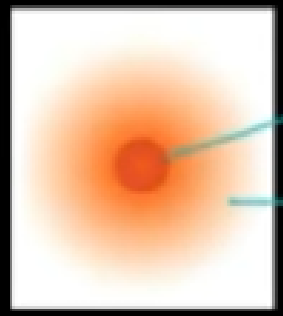
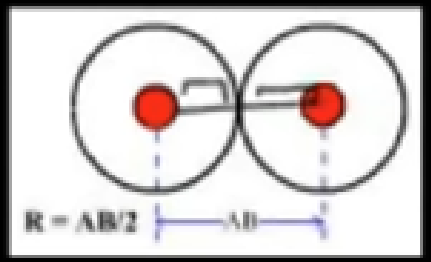
ATOMIC SIZE AND ATOMIC RADIUS



- nucleus
- Shells

1 m = 1

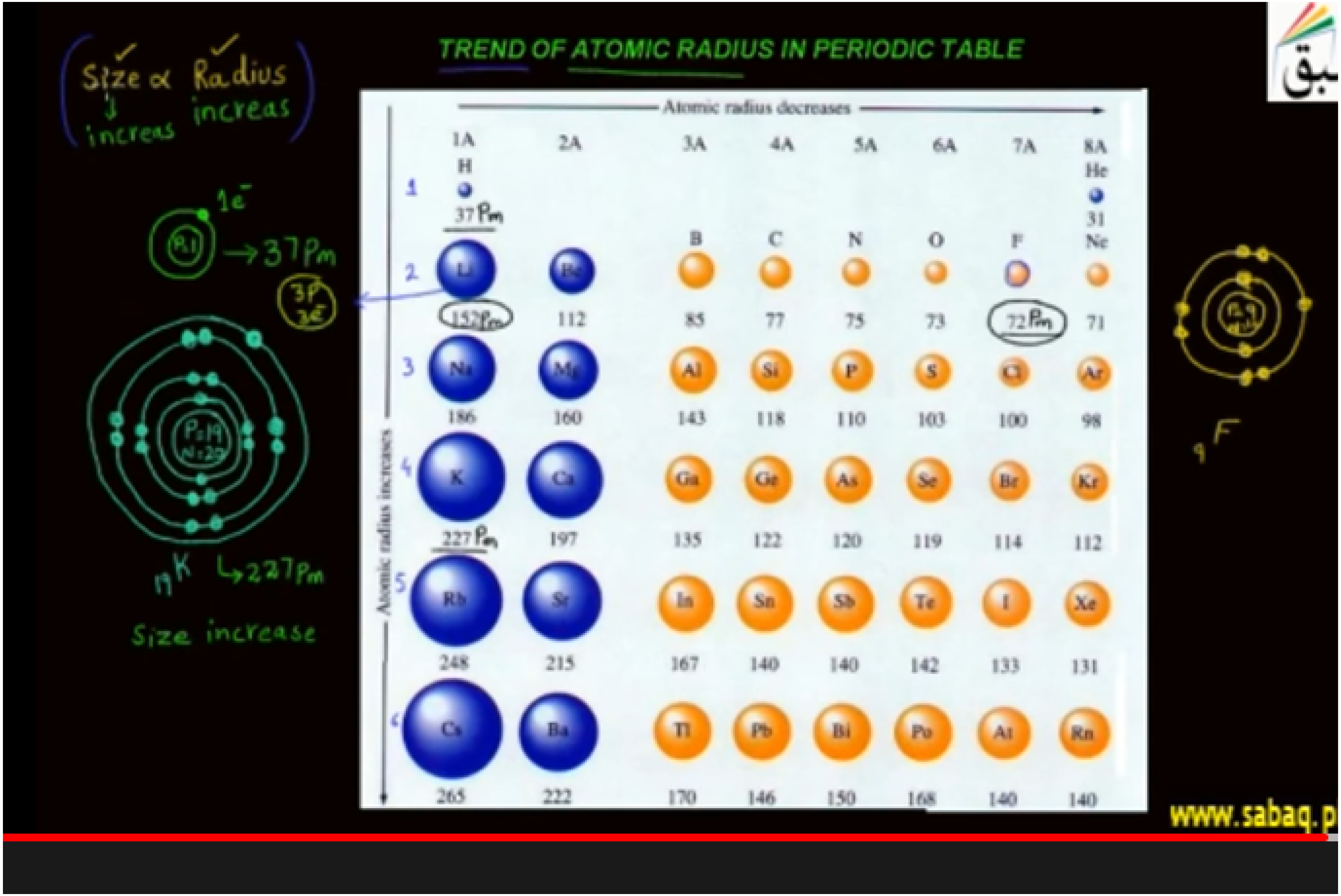
$\frac{AB}{2} = R$



- Angstrom = A°
- Picometer = Pm

Carbon = $\frac{154}{2}$ = 77 Pm

1 A° = 100 Pm


TREND OF ATOMIC RADIUS IN PERIODIC TABLE
Size ∝ Radius
increas increas
1e⁻
→ 37 Pm
19 K ↳ 227 Pm
Size increase
9 F
Atomic radius decreases
Atomic radius increases
1A 2A 3A 4A 5A 6A 7A 8A
1 H 37 Pm He 31
2 Li 152 Pm Be 112 B 85 C 77 N 75 O 73 F 72 Pm Ne 71
3 Na 186 Mg 160 Al 143 Si 118 P 110 S 103 Cl 100 Ar 98
4 K 227 Pm Ca 197 Ga 135 Ge 122 As 120 Se 119 Br 114 Kr 112
5 Rb 248 Sr 215 In 167 Sn 140 Sb 140 Te 142 I 133 Xe 131
6 Cs 265 Ba 222 Tl 170 Pb 146 Bi 150 Po 168 At 140 Rn 140
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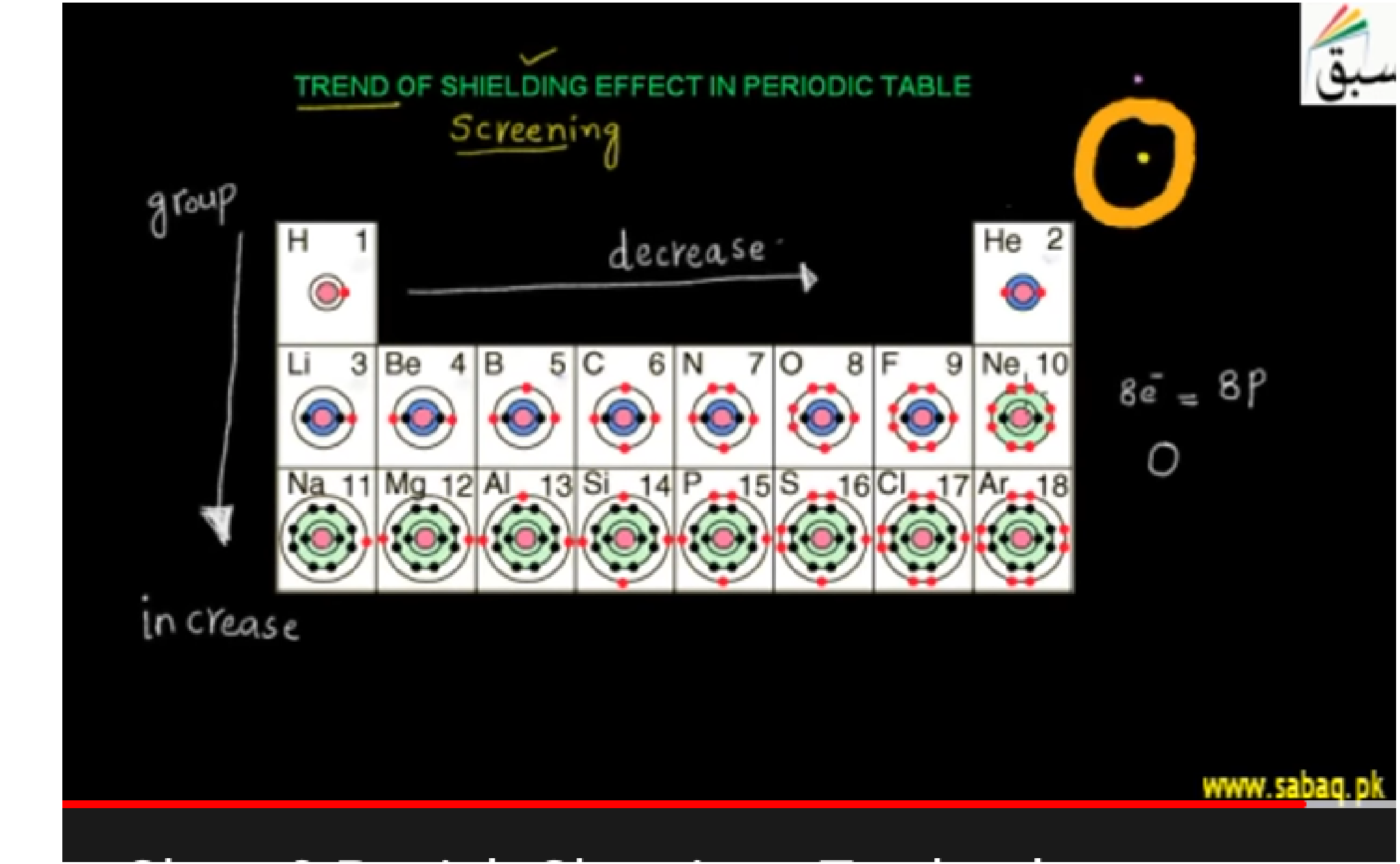
SHIELDING EFFECT

p e

Z_{eff} = effective nuclear charge

TREND OF SHIELDING EFFECT IN PERIODIC TABLE

Screening



12:47

18

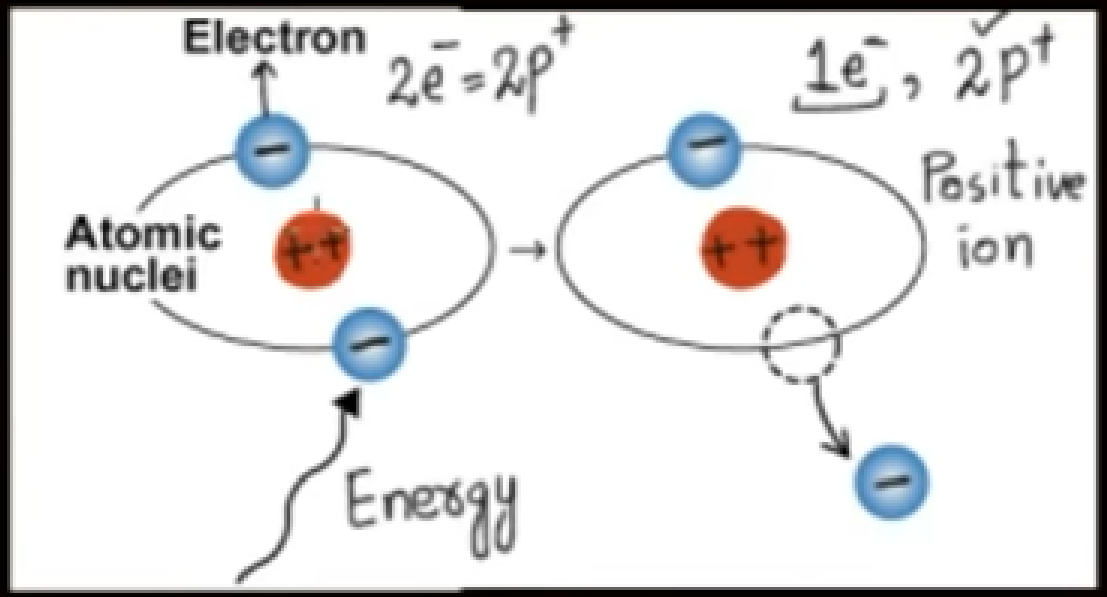
IONIZATION ENERGY

Ion

↓

Positive ion

- Heat
- Light
- Electricity



* gaseous

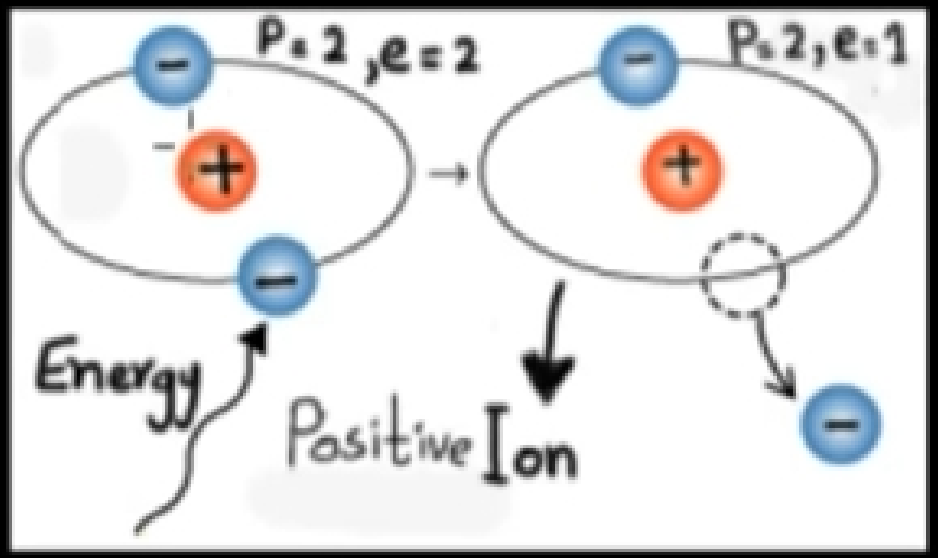
K.E

$_3Li \longrightarrow Li^+ + e^-$

Change $\Delta H = +520\ kJmol^{-1}$

IONIZATION ENERGY

$e^- = P^+$



- heat
- radiation
- electric current

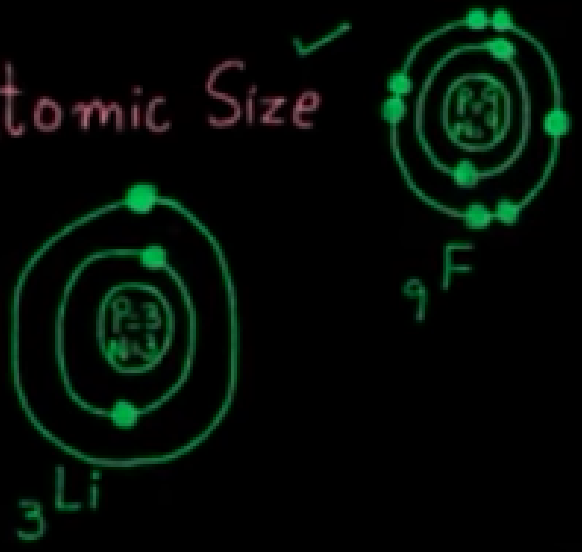
form of energies

Unit = $kJ\,mol^{-1}$

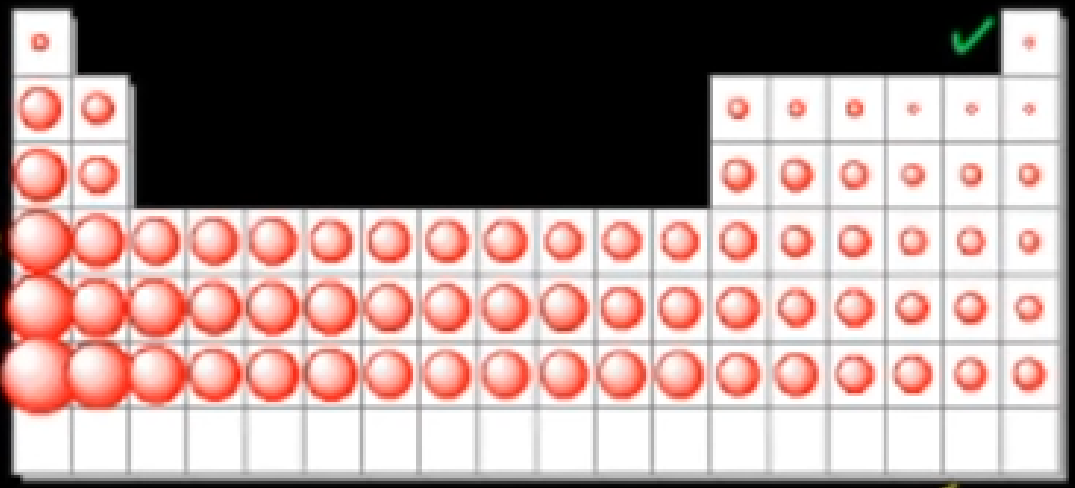
TREND OF IONIZATION ENERGY IN PERIODIC TABLE

TREND OF IONIZATION ENERGY IN PERIODIC TABLE

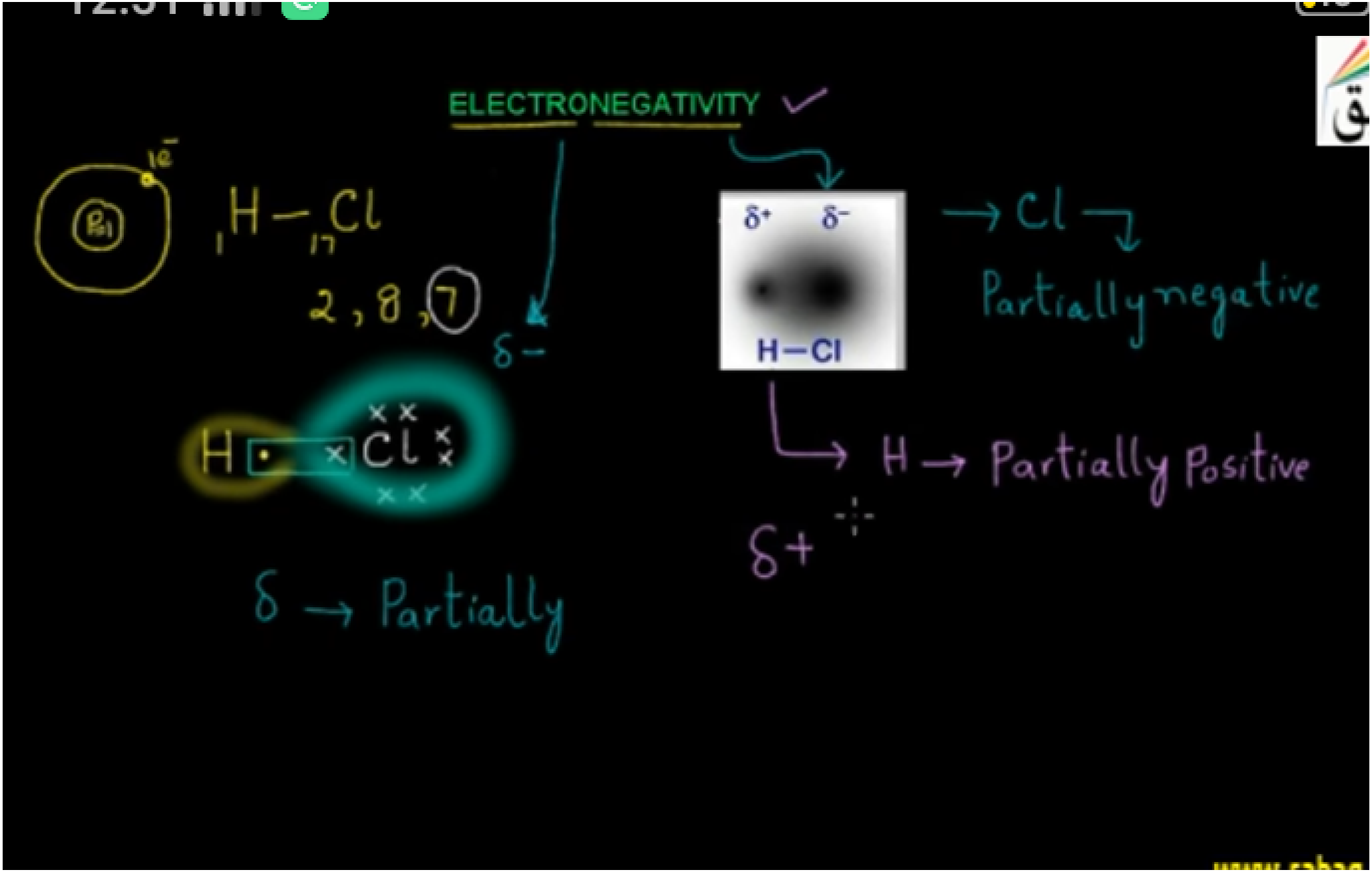
1. Atomic Size

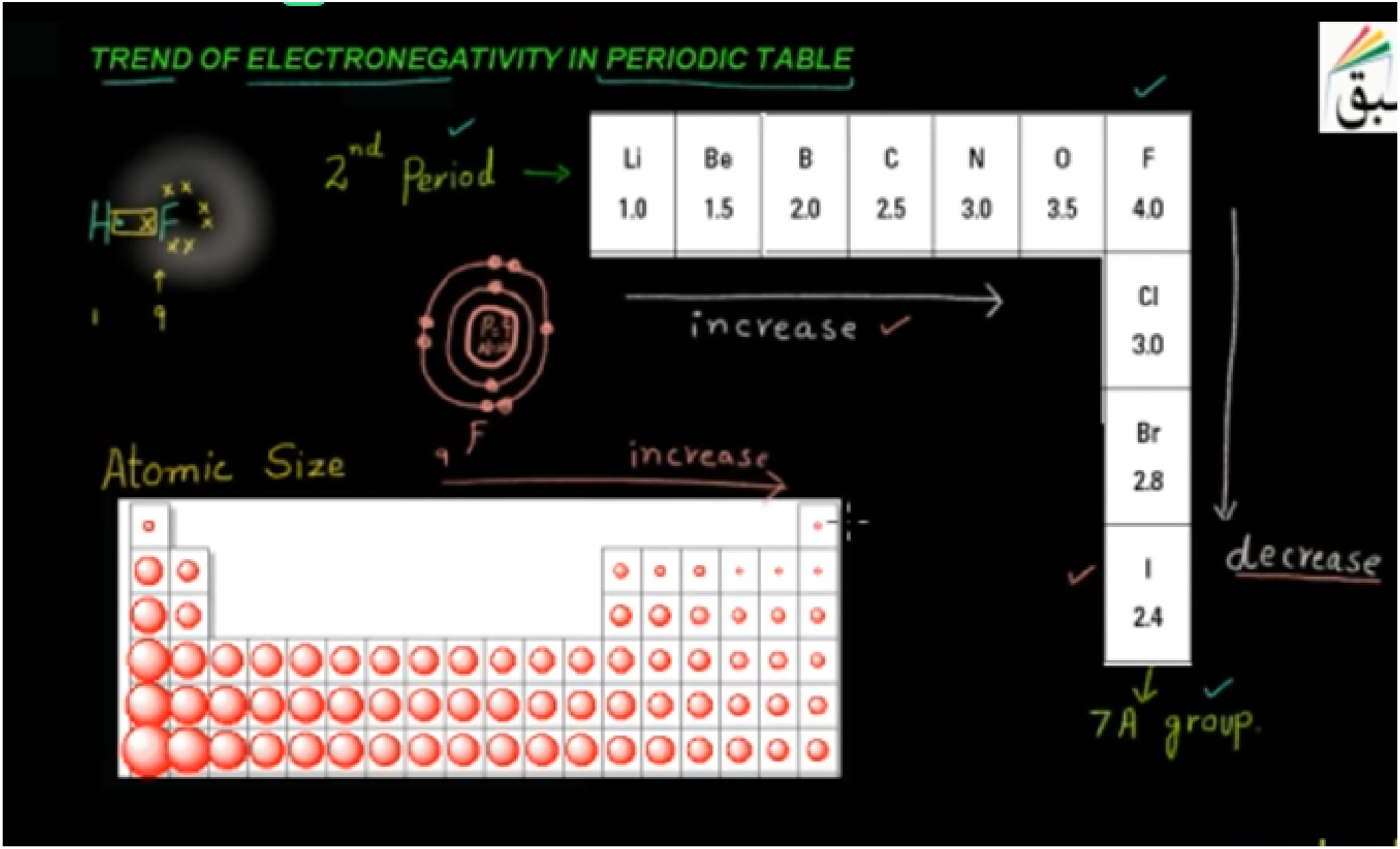


2. Nucleax Charge



Li	Be	B	C	N	O	F	Ne
520.3	899.5	800.7	1086.5	1402.4	1314.0	1681.1	2080.8
Na							
495.9							
K							
418.9							


ELECTRONEGATIVITY
1e⁻
P=1
₁H – ₁₇Cl
2, 8, 7
δ –
H Cl
δ → Partially
δ+ δ–
H–Cl
→ Cl → Partially negative
→ H → Partially Positive
δ+


TREND OF ELECTRONEGATIVITY IN PERIODIC TABLE
2nd Period
Li 1.0
Be 1.5
B 2.0
C 2.5
N 3.0
O 3.5
F 4.0
increase
Cl 3.0
Br 2.8
I 2.4
decrease
7A group
Atomic Size
increase
F

TREND OF ELECTRONAFFINITY IN PERIODIC TABLE

$Li + e^- \longrightarrow Li^-$ $\Delta H = -60\ kJmol^{-1}$

ΔH ↓ exothermic

Electron Affinities (kJ/mol)

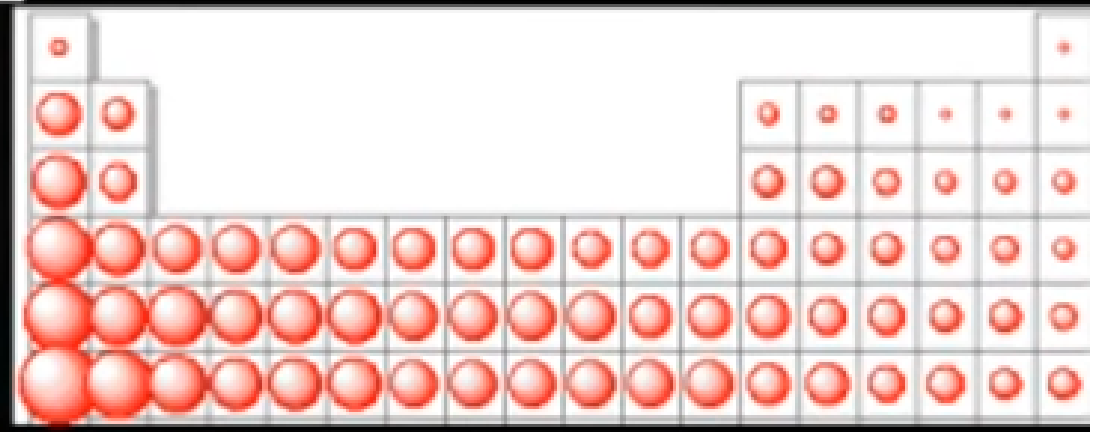
	1A	2A	3A	4A	5A	6A	7A	8A
1	H -73							He >0
2	Li -60	Be >0	B -27	C -122	N >0	O -141	F -328	Ne >0
3	Na -53	Mg >0	Al -43	Si -134	P -72	S -200	Cl -349	Ar >0
4	K -48	Ca -4	Ga -30	Ge -119	As -78	Se -195	Br -325	Kr >0
5	Rb -47	Sr -11	In -30	Sn -107	Sb -103	Te -190	I -295	Xe >0

decrease

Big size

increase

Atomic Size



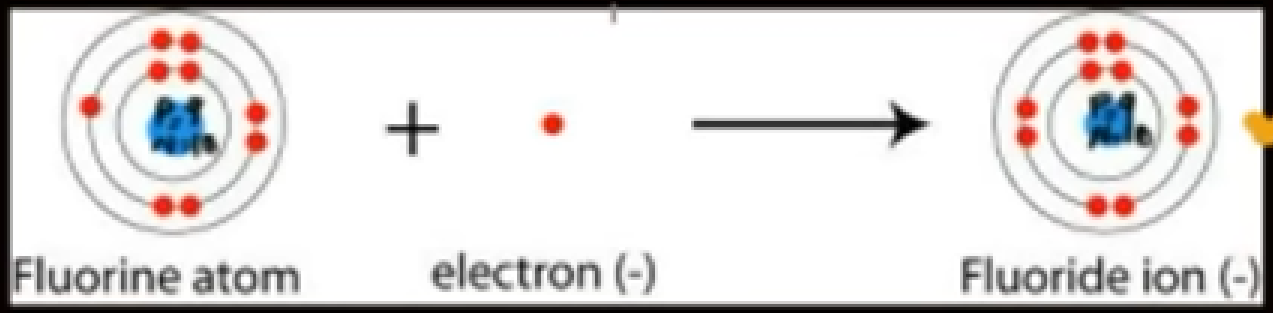
3 Li

9 F

$-328\ kJmol^{-1}$

ELECTRON AFFINITY → add , attraction

(−)



Energy

9e⁻
9p⁺

10e⁻
9 P⁺

$F + e^- \longrightarrow F^-$ $\quad \Delta H = -328\ kJ\,mol^{-1}$

. gas ✓
. isolated ✓