PRAYAS

FOR JEE 2022

Periodic Table

Lecture - 01

AMITABH SIR

TOPICS TO BE COVERED

1. Introduction

PERIODIC TABLE :

The arrangement of all the known elements according to their properties in such a way that the elements of similar properties are grouped together in tabular form is called periodic table.

DEVELOPMENT OF PERIODIC TABLE :

(a) LAVOISIER CLASSIFICATION :

- Lavoisier classified the elements simply in metals and non-metals.
- Metals are the one which have the tendency of losing the electrons.

$$M \longrightarrow M^{+} + e^{-}$$

- Non-metals are the one which have the tendency of gaining the electrons.

$$M + e^{-} \longrightarrow M^{-}$$

Drawbacks or Limitations :

(a) As the number of elements increased, this classification became insufficient for the study of elements.

(b) There are few elements which have the properties of both metals as well as nonmetals and they are called metalloids. Lavoisier could not decide where to place the metalloids.

(B) PROUT'S HYPOTHESIS (Unitary theory):

He simply assumed that all the elements are made up of hydrogen, so can say that

Atomic weight of element = n x (Atomic weight of one hydrogen atom)

Atomic weight of H = 1

where n = number of hydrogen atom = 1, 2, 3, ...

Drawbacks or Limitations :

(i) Every element cannot be formed by Hydrogen.

(ii) Atomic weight of all elements were not found as the whole numbers.

Ex. Chlorine (atomic weight 35.5) and Strontium (atomic weight 87 .6)

(C) DOBEREINER TRIAD RULE [1817]:

(i) He made groups of three elements having similar chemical properties called TRIAD.

Ex.
- Cl, Br, I
- Ca, Sr, Ba
- K, Rb, Cs
- P, As, Sb
- S, Se, Te
- H, F, Cl
- Sc, Y, La

Li Na K

7 (23) 39

$\frac{46}{2} = 23$

Difference of Z must be same.

Q.S.P. ✓

Drawbacks or Limitations :

All the known elements could not be arranged as triads.

It is not applicable for d and f-block elements.

Q Which of the following is not a dobereiner triad

A Li, Na, K

B Mg, Ca, Sr

C Cl, Br, I

D S, Se, Te

Sol. (B)

(D) NEWLAND'S OCTAVE. RULE [1865]

He arranged the elements in the increasing order of their atomic masses and observe that properties of every 8th element was similar to the 1st element (like in the case of musical vowels notation).

Sa	Re	Ga	Ma	Pa	Dha	Ni
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K	Ca					

Drawbacks or Limitations :

(a) This rule is valid only up to Ca, because after Ca due to presence of d-block elements there is difference of 18 elements instead of 8 element.

(b) After the discovery of Inert gases and including them into the periodic table it becomes the 8th element from Alkali metal so this law had to be dropped out.

Q Which of the following set of elements obey Newland's octave rule-

A Na, K, Rb

B F, Cl, Br

C Be, Mg, Ca

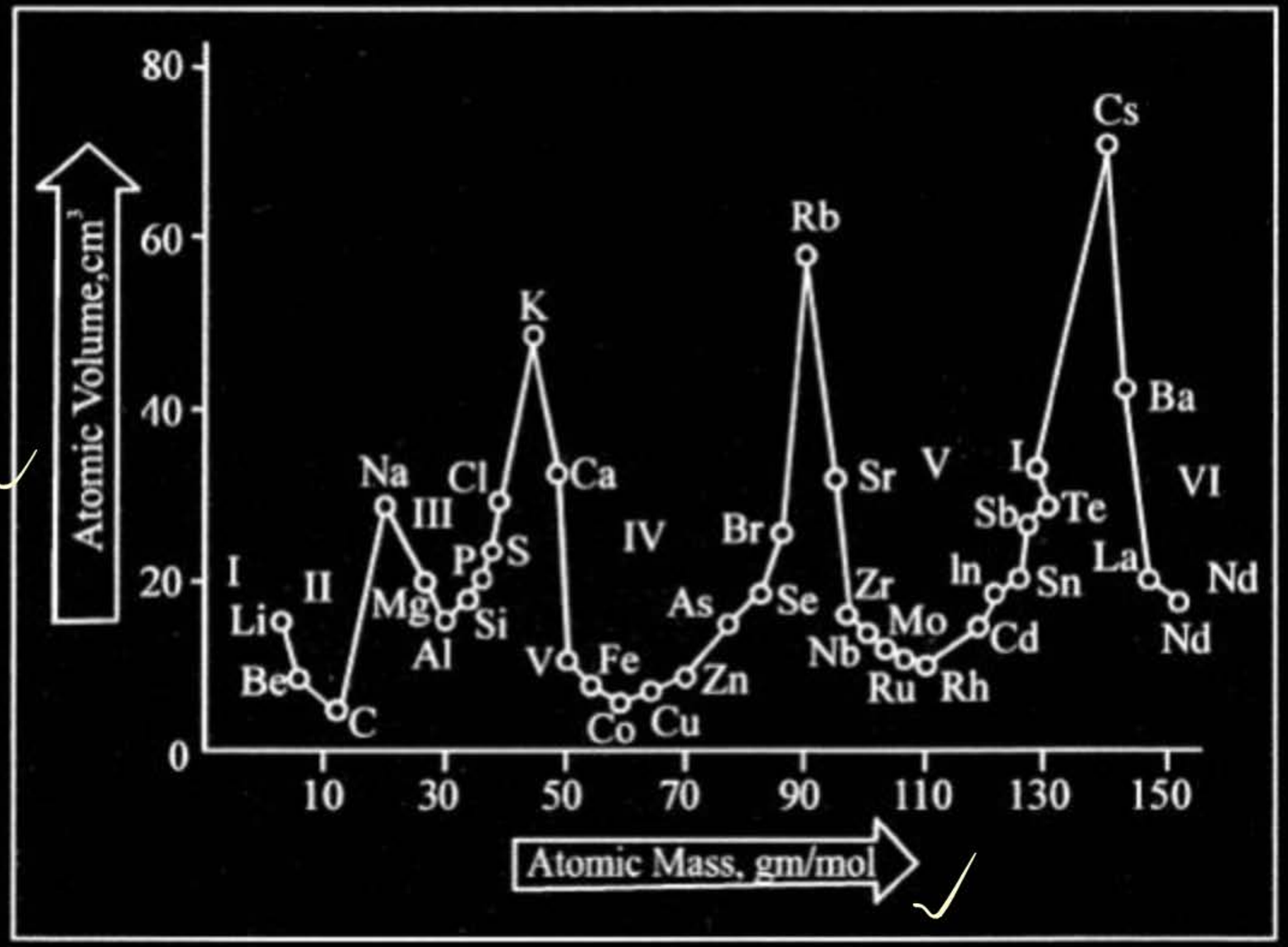
D B, Al, Ga

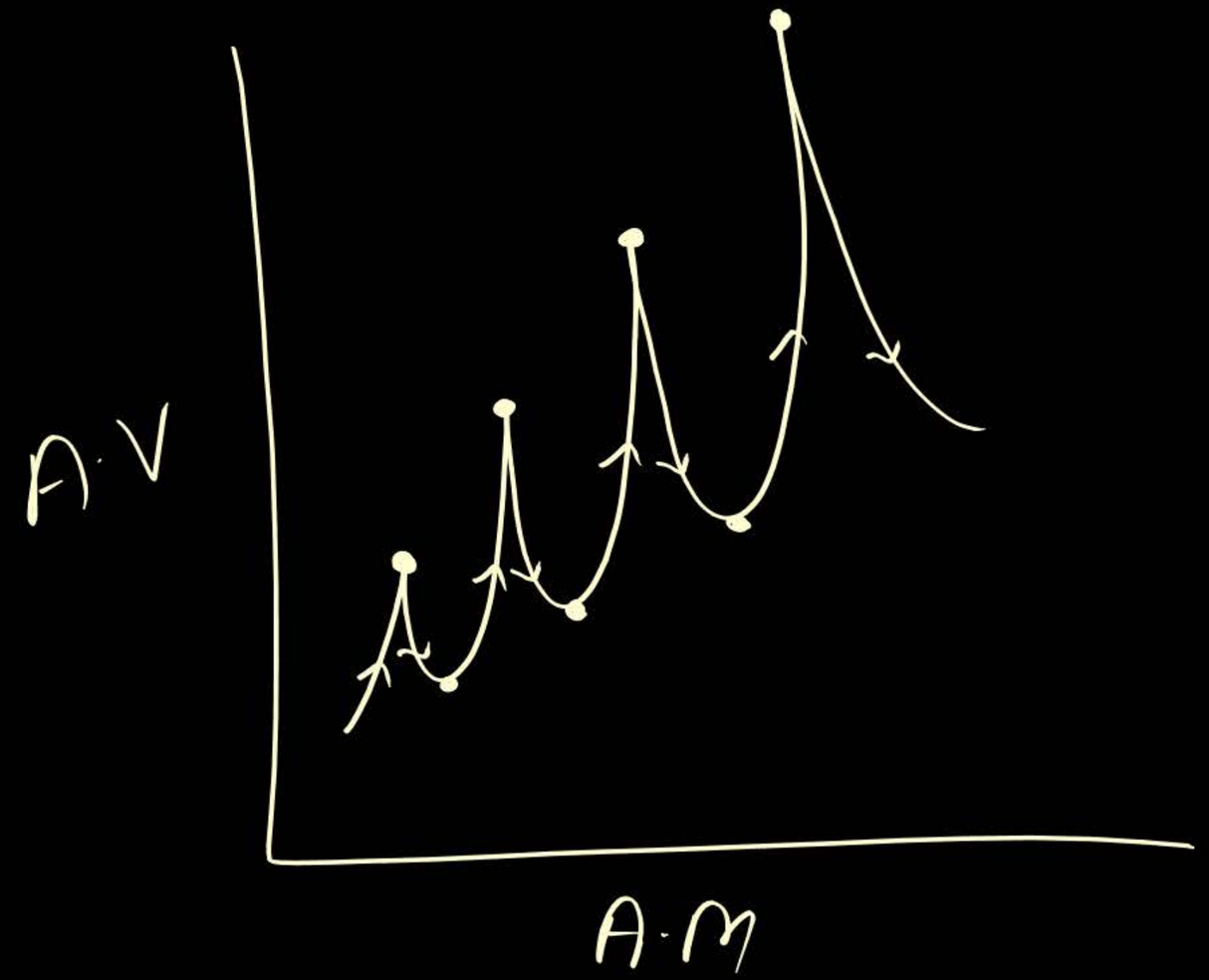
upto Ca

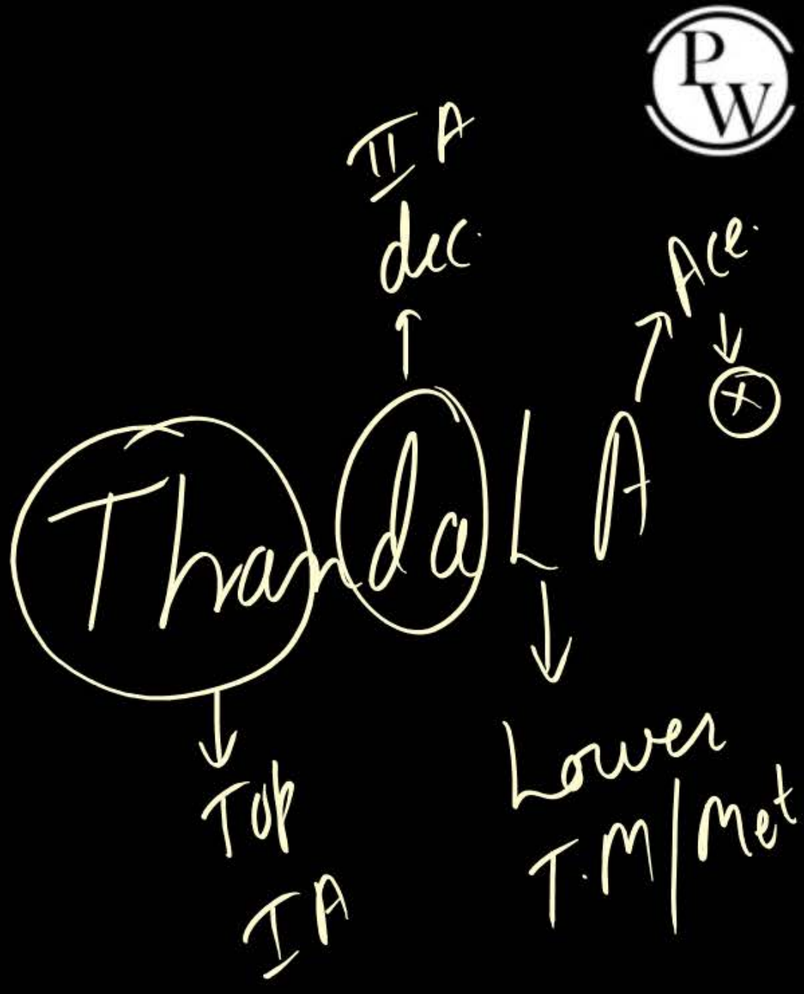
Sol. (C)

(E) LOTHER MEYER'S CURVE [1869]

(i) He plotted a curve between atomic weight and atomic volume of different elements.




A·V
A·M


II A
dec.
Ace.
Thanda
LA
Top
IA
Lower
T·M/Met

Observations

(a) Most electropositive elements i.e. alkali metals (Li, Na, K, Rb, Cs etc.) occupy the peak positions on the curve.

(b) Less electropositive i.e. alkaline earth metal (Be, Mg, Ca, Sr, Ba) occupy descending positions on the curve.

(c) Metalloids (Si, As, Te, etc.) and transition metals occupy bottom part of curve.

(d) Most electronegative i.e. halogens (F, Cl, Br, I) occupy the ascending positions on the curve.

(F) MENDELEEV'S PERIODIC TABLE [1869] :

63

	G	I		II		III		IV		V		VI		VII		VIII			0
P	S	A	B	A	B	A	B	A	B	A	B	A	B	A	B				
I	1	H																	He
II	2	Li		Be		B		C		N		O		F					Ne
III	3	Na		Mg		Al		Si		P		S		Cl					Ar
IV	4	K		Ca			Sc		Ti		V		Cr		Mn	Fe	Co	Ni	
	5		Cu		Zn	Ga		Ge		As		Se		Br					Kr
V	6	Rb		Sr			Y		Zr		Nb		Mo		Tc	Ru	Rh	Pd	
	7		Ag		Cd	In		Sn		Sb		Te		I					Xe
VI	8	Cs		Ba			La		Hf		Ta		W		Re	Os	Ir	Pt	
	9		Au		Hg	Tl		Pb		Bi		Po		At					Rn
VII	10	Fr		Ra			Ac												

Merits of Mendeleev's periodic table :

(a) It was based on atomic weight.

(b) 63 elements were known, noble gases were not discovered.

(c) Horizontal rows were called periods and there were 7 periods in Mendeleev's Periodic table.

(d) Vertical columns are called groups and there were 8 groups in Mendeleev's Periodic table.

(e) Each group upto VII was divided into A & B.

(f) Sub groups 'A' sub group element were called normal elements and 'B' sub group elements were called transition elements.

(g) The VIII group was consisted of 9 elements in three rows (Transition metal group).

(h) The elements belonging to same group exhibit similar properties.

Merits of Mendeleev's periodic table :

(a) Study of elements :

(b) Prediction of new elements :

Eka Al
Eka B
Eka Si
Eka Mn

Ga | Sc | Ge | Tc

Al
$AlCl_3$
Al_2O_3
+1, +3
Amp

Ga
$GaCl_3$
Ga_2O_3
+1, +3
Amp

(c) Correction of doubtful atomic weights :

Atomic weight = Valence × Equivalent weight.

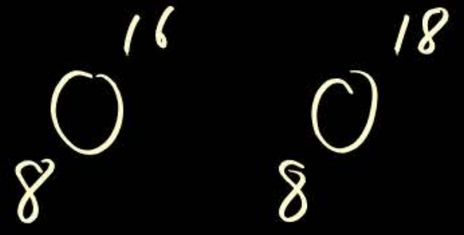
Be^{+2} ✓ Be^{+3} ✗ × (4.5)

U | Be | In | Au | Pt

Demerits of Mendeleev's periodic table :

(a) Position of hydrogen:

(b) Position of isotopes:



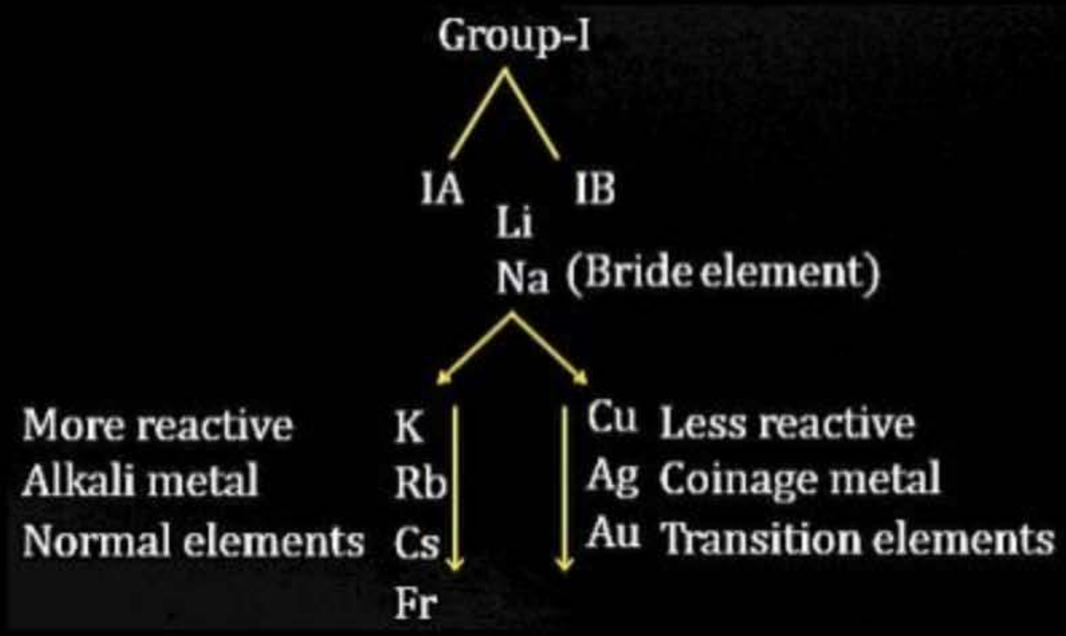
(c) Anomalous pairs of elements:

Ar	>	K	Te	>	I	Co	>	Ni	Th	>	Pa
39.9		39.1	127.5		127	58.9		58.6	232		231

(d) Like elements were placed in different groups :

Pt	Au
VIE	IB

(e) Unlike elements were placed in same group :



(f) It was not clear that 'lanthanides and Actinides' are related with IIIA groups or IIIB group.

MODERN PERIODIC TABLE (MODIFIED MENDELEEV PERIODIC TABLE) :

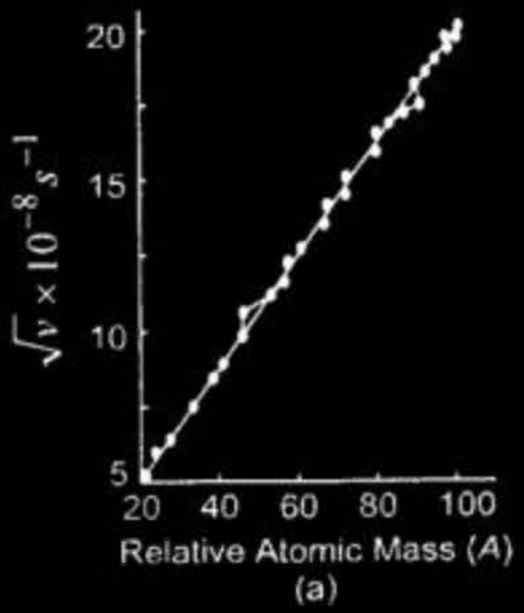
(i) Modern periodic table is based on atomic number.

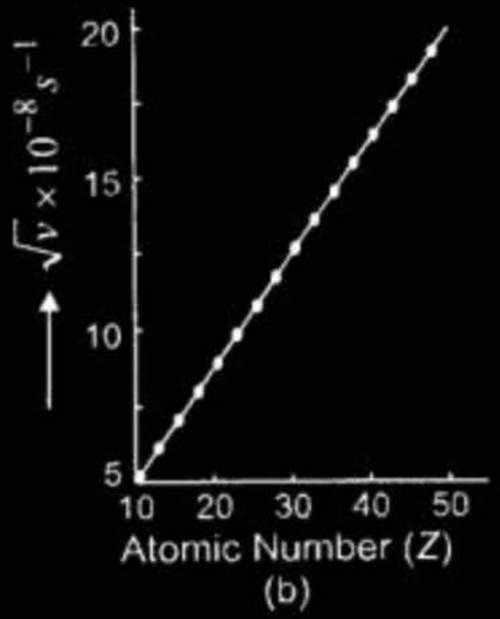
(ii) Moseley did an experiment in which he bombarded high speed electron on different metal surface and obtained X-rays.

He found out that $\sqrt{v} \propto Z$ where

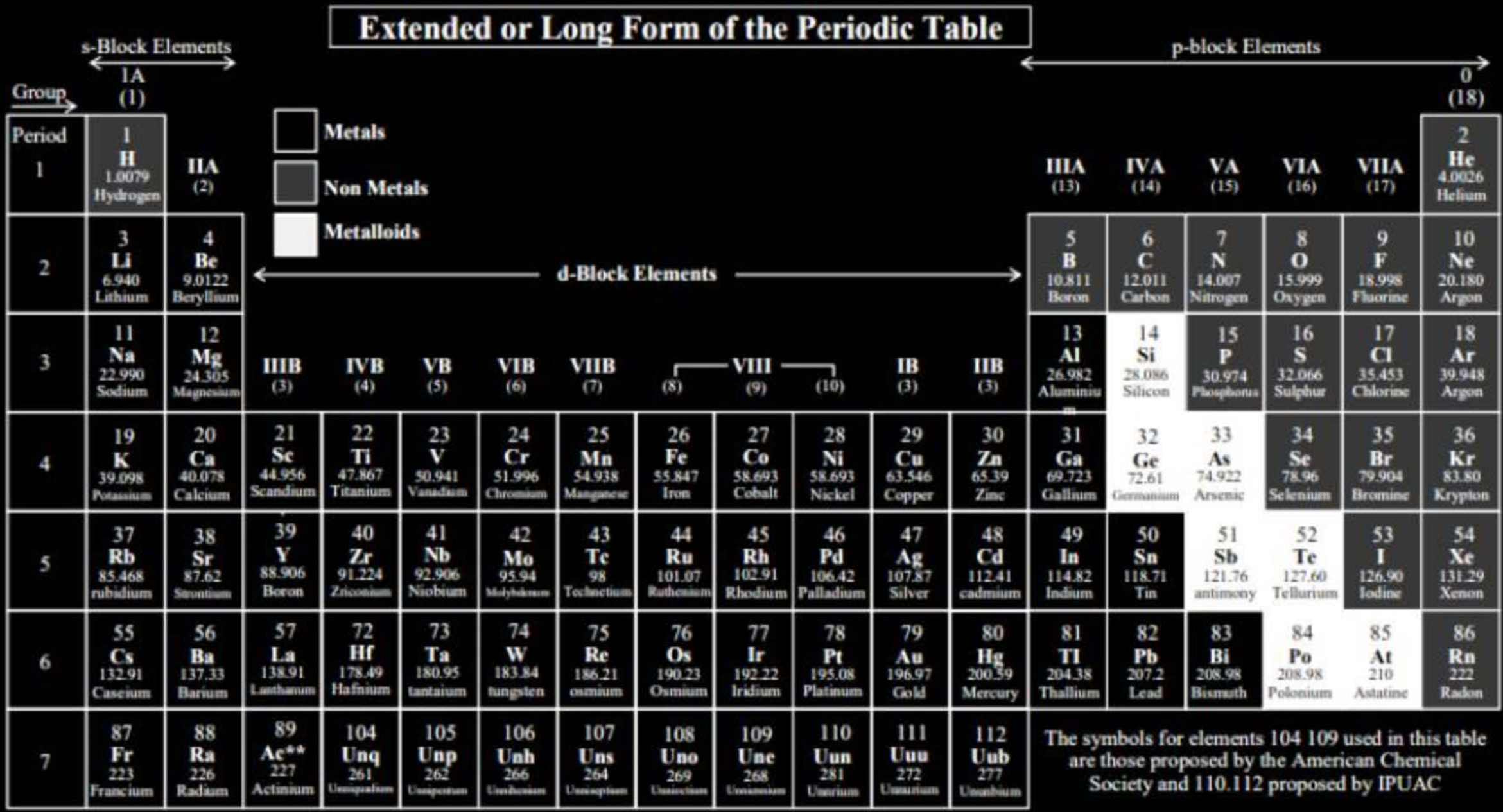
v = frequency of X-rays

Z = atomic number.





Extended or Long Form of the Periodic Table



The symbols for elements 104 109 used in this table are those proposed by the American Chemical Society and 110.112 proposed by IPUAC

LONG FORM / PRESENT FORM OF MODERN PERIODIC TABLE :

(It is also called as 'Bohr, Bury, Rang and Werner Periodic Table)

(i) It is based on the Bohr-Bury electronic configuration concept and atomic number.

(ii) This model is proposed by Rang & Werner

(iii) 7 periods and 18 groups

(iv) According to I. U. P. A. C. 18 vertical columns are named as 1st to 18th group.

(v) Modern periodic law :

The physical & chemical properties of elements are the periodic function of their atomic number.

Description of Periods :

Period No.	Period Sub shell	No. of Elements	Element	Name of Period
1	1s	2	$_{1}H - _{2}He$	Shortest
2	2s, 2p	8	$_{3}Li - _{10}Ne$	Short
3	3s, 3p	8	$_{11}Na - _{18}Ar$	Short
4	4s, 3d, 4p	18	$_{19}K - _{36}Kr$	Long
5	5s, 4d, 5p	18	$_{37}Rb - _{54}Xe$	Long
6	6s, 4f, 5d, 6p	32	$_{55}Cs - _{86}Rn$	Longest
7	7s, 5f, 6d, 7p	26	$_{87}Fr - _{112}Uub$	Longest

I

for odd

$$\frac{(n+1)^2}{4} \times 2^{e^-}$$

Q ⇒ 8th period ⇒ 50

II

for even

$$\frac{(n+2)^2}{4} \times 2$$

$$\frac{(8+2)^2}{4} \times 2 = 50$$

s-Block

$ns^1 \rightarrow$ IA

$ns^2 \rightarrow$ II A

(a) The last electron enters in s-orbital, are called s-block elements.

(b) s-orbital can accommodate a maximum of two electrons.

(c) General electronic configuration is ns^{1-2} n = (1 to 7)

(d) IA group elements are known as alkali metals because they react with water to form alkali.

(e) IIA group elements are known as alkaline earth metals because their oxides react with water to form alkali and these are found in the soil or earth crust.

(f) Radioactive elements Fr_{87} and Ra_{88}

(g) Gaseous elements H and He

(h) Liquid elements- Cs & Fr.

s-Block Elements

IA (1)	IIA (2)
1 H 1.0079 Hydrogen	
3 Li 6.940 Lithium	4 Be 9.0122 Beryllium
11 Na 22.990 Sodium	12 Mg 24.305 Magnesium
19 K 39.098 Potassium	20 Ca 40.078 Calcium
37 Rb 85.468 rubidium	38 Sr 87.62 Strontium
55 Cs 132.91 Caesium	56 Ba 137.33 Barium
87 Fr 223 Francium	88 Ra 226 Radium

(i) Notorious element — H

(j) Lightest element — H

(k) Liquid element of radioactive nature — Fr

(l) Elements kept in kerosene — IA group element

Q Total number of elements in s-block :

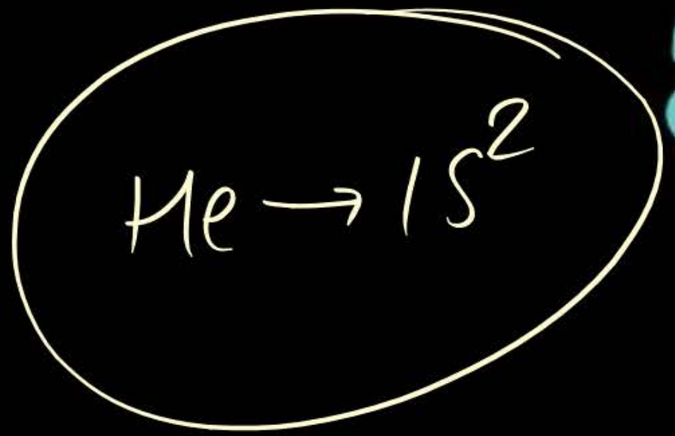
A 11

B 12

C 13 ✗

D 14 ✓

Sol. (D)



p-Block

(a) Last electron gets filled up in the p-orbital, called p-block elements.

(b) General electronic configuration ns^2, np^{1-6} (where n = 2 to 6)

(c) p-subshell can accommodate a maximum of six electrons.

(d) Therefore, p-block elements are divided into six groups which are IIIA, IVA, VA, VIA, VIIA and zero group.

(e) The zero group elements having general electronic configuration $ns^2\ np^6$ are inert, because their octets are complete.

p-block Elements

IIIA (13)	IVA (14)	VA (15)	VIA (16)	VIIA (17)	0 (18)
					2 He 4.0026 Helium
5 B 10.811 Boron	6 C 12.011 Carbon	7 N 14.007 Nitrogen	8 O 15.999 Oxygen	9 F 18.998 Fluorine	10 Ne 20.180 Argon
13 Al 26.982 Aluminium	14 Si 28.086 Silicon	15 P 30.974 Phosphorus	16 S 32.066 Sulphur	17 Cl 35.453 Chlorine	18 Ar 39.948 Argon
31 Ga 69.723 Gallium	32 Ge 72.61 Germanium	33 As 74.922 Arsenic	34 Se 78.96 Selenium	35 Br 79.904 Bromine	36 Kr 83.80 Krypton
49 In 114.82 Indium	50 Sn 118.71 Tin	51 Sb 121.76 antimony	52 Te 127.60 Tellurium	53 I 126.90 Iodine	54 Xe 131.29 Xenon
81 Tl 204.38 Thallium	82 Pb 207.2 Lead	83 Bi 208.98 Bismuth	84 Po 208.98 Polonium	85 At 210 Astatine	86 Rn 222 Radon

(e) Gaseous elements : N, O, He, Ne, Ar, Kr, Xe, Rn | F, Cl

(f) Liquid elements : Ga, Br

(g) Radio active : Po, At, Rn

(h) Metalloid : Si, Ge, As, Sb, Se, Te

(i) Oxidation state : equal or less than 2 to group number

(j) Boron family : Icosagens B12

Carbon family : Crystallogens

Nitrogen family : Pnictogens

Oxygen family : Chalcogens (Oxygen)

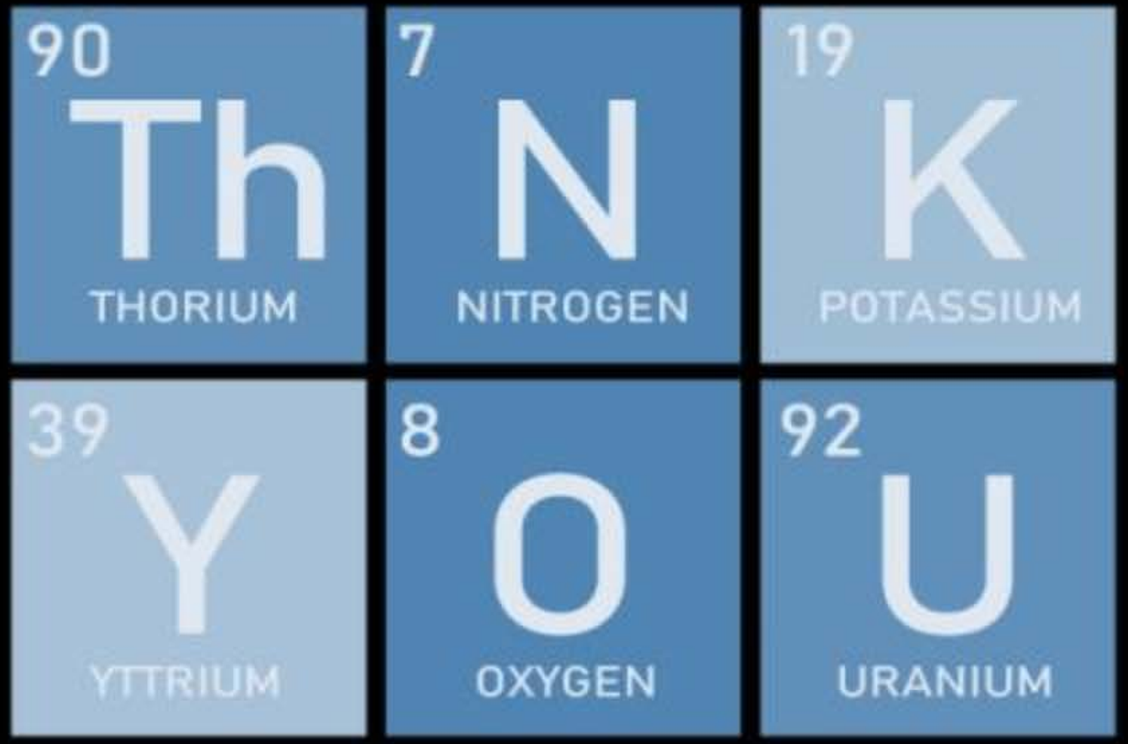
Halogen family : Halogens

Noble gas family : Aerogenes

(k) Best electricity conductor among non metals : graphite

Max O.S = +8 Xe

Cl, Br, I → +7


90
Th
THORIUM
7
N
NITROGEN
19
K
POTASSIUM
39
Y
YTTRIUM
8
O
OXYGEN
92
U
URANIUM