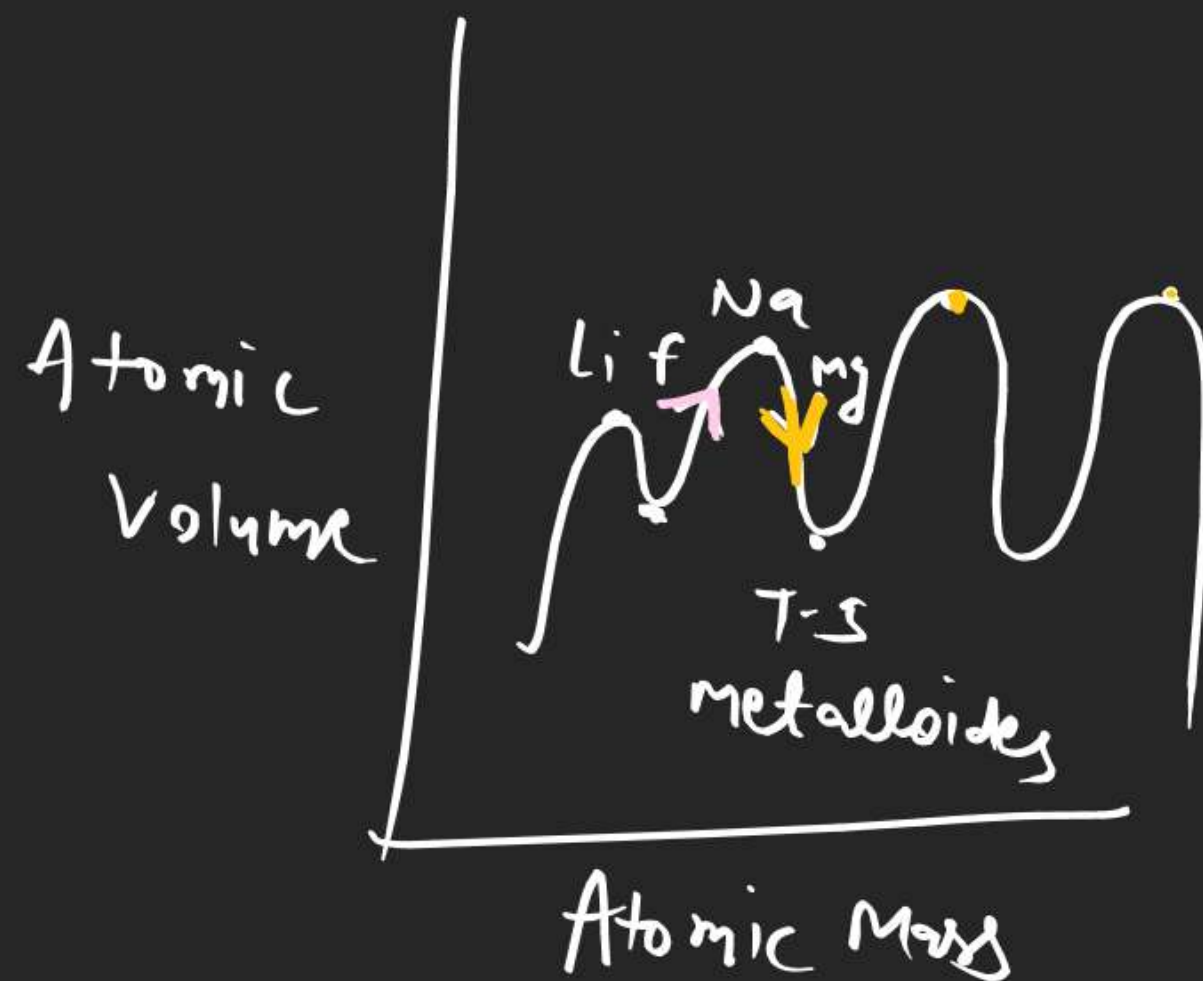


$\left\{ \begin{array}{ccccccc} \text{Li} & \text{Be} & \text{B} & \text{C} & \text{N} & \text{O} & \text{F} \\ \text{Na} & \text{Mg} & \text{Al} & \text{Si} & \text{P} & \text{S} & \text{Cl} \\ & & & & \text{As} & \text{Se} & \text{Br} \\ & & & & & & \text{I} \\ & & & & & & \text{At} \\ & & & & & & \text{Po} \\ & & & & & & \text{Bi} \\ & & & & & & \text{Po} \\ & & & & & & \text{At} \\ & & & & & & \text{Fr} \\ & & & & & & \text{Ra} \end{array} \right.$

Note →

Noble gas and d-block  
(transition  
element)

## Lothar Mayer Curve



Peak  $\Rightarrow$  alkali metal

lowest point  $\Rightarrow$  Transition metal  
and metalloides

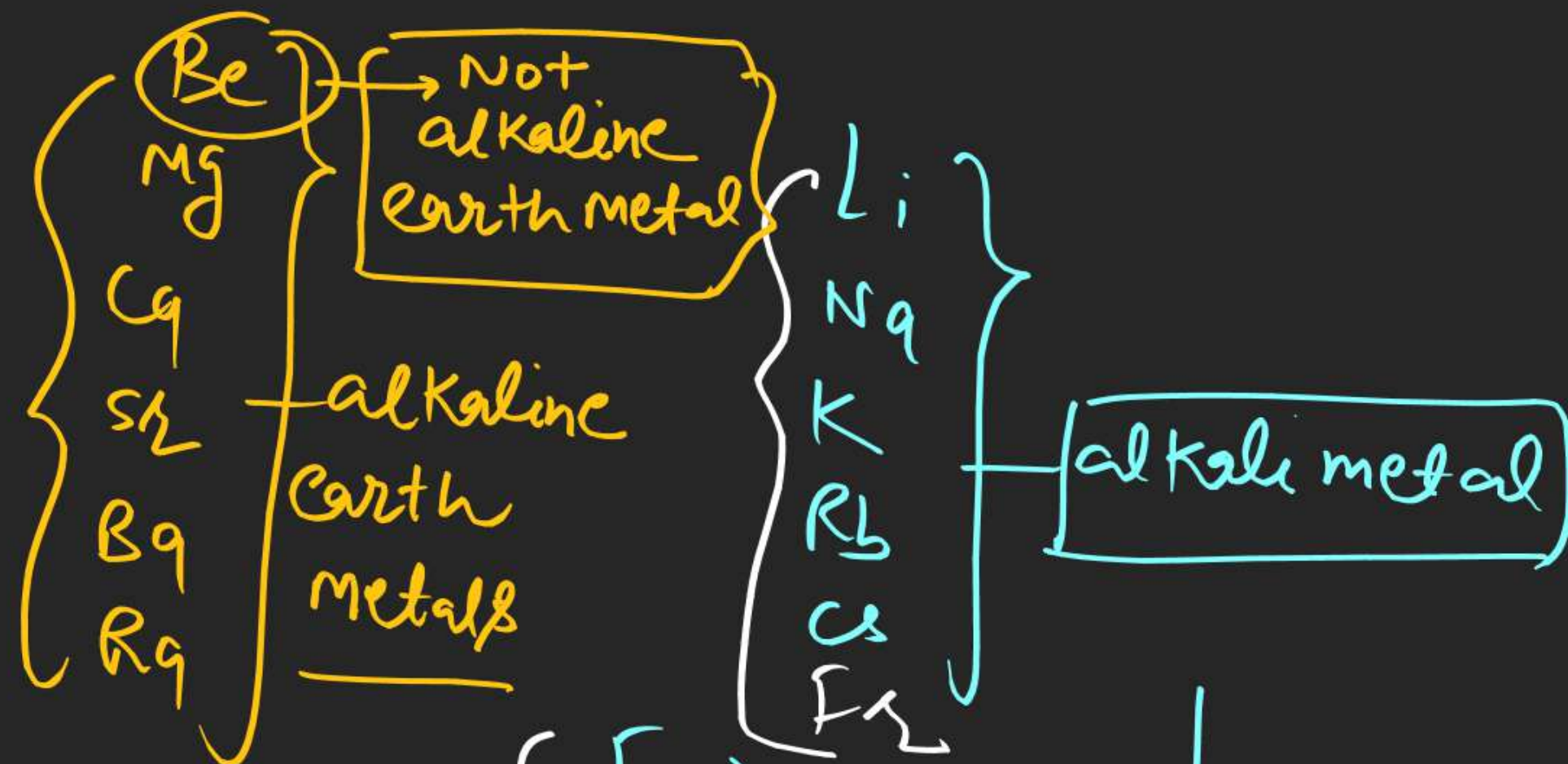
ascending position  $\rightarrow$  Halogens

descending position  $\Rightarrow$  alkaline earth metal

## **INTRODUCTION:**

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 a tabular form is called periodic table. Scientists from the very beginning have attempted to systematize the knowledge they gained through their observations and experiments. Development of the periodic law and the periodic table of the elements is one such attempt. This has brought order in the study of the vast chemistry of more than a hundred elements known now. Therefore, it is quite natural to begin your study of inorganic chemistry with the study of the periodic table in this unit.





d-Block elements → also called Transition element (except Zn, Cd, Hg)



Metalloids → elements which have properties of metal and non metal.

## DEVELOPMENT OF PERIODIC TABLE :

### (A) LAVOISIER CLASSIFICATION :

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



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



### (ii) 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 we can say that Atomic weight of element =  $n \times$  (Atomic weight of one hydrogen atom)

$$\boxed{\text{Atomic weight of H} = 1}$$

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.

(ii) In Dobereiner triad, atomic weight of middle element is nearly equal to the average atomic weight of first and third element.

Where  $x$  = average atomic weight

(iii) Other examples- (K, Rb, Cs), (~~P~~, As, ~~Sb~~), (S, Se, Te), (H, F, Cl), (Sc, Y, La)

Drawbacks or Limitations : All the known elements could not be arranged as triads. It is not applicable for  $d$  and  $f$ -block elements.

*sol* Illustration 1. Atomic weight of an element X is 39, and that of element Z is 132. Atomic weight of their intermediate element Y, as per Dobereiner's triad, will be

(A) 88.5

(B) 93.0

(C) 171

*✓* (D) 85.5

$$\frac{39 + 132}{2}$$



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

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

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

(ii) At that time inert gases were not known.

(iii) The properties of Li are similar to 8th element i.e. Na and properties of Be are similar to Mg and so on.

### 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.



### **(E) LOTHER MEYER'S CURVE [1869] :**

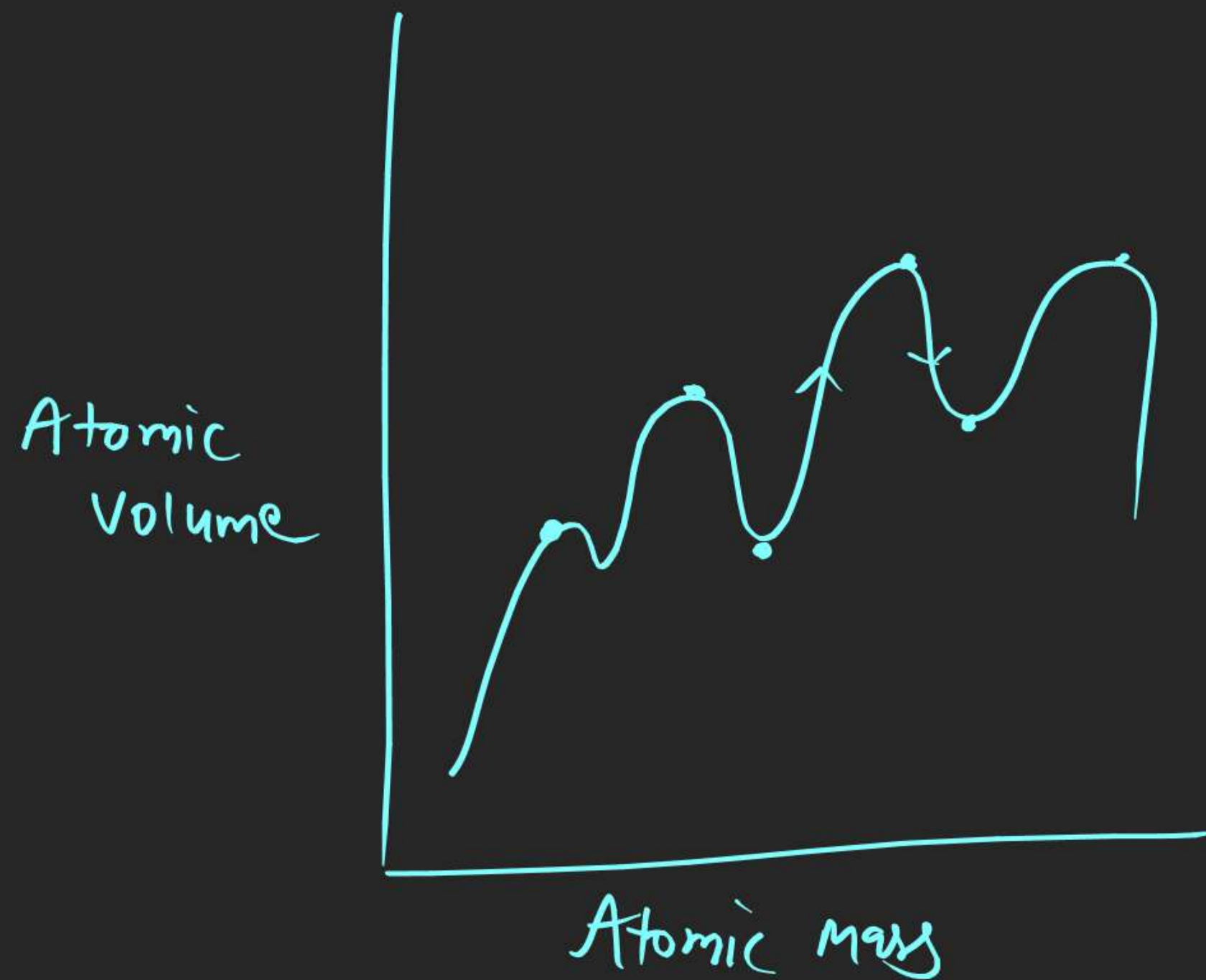
- (i) He plotted a curve between atomic weight and atomic volume of different elements.**
- (ii) The following observations can be made from the curve -**
  - (a) Most electropositive elements i.e. alkali metals (Li, Na, K Rb, Cs etc.) occupy the peak positions on the curve.**
  - (b) Less electropositive i.e. alkaline earth metal ( Be, Mg, Ca, Sr, Ba) occupy the descending positions on the curve.**
  - (c) Metalloids ( Si, As, Te, etc.) and transition metals occupy bottom part of the curve.**
  - (d) Most electronegative i.e. halogens ( F, Cl, Br, I) occupy the ascending positions on the curve.**

**Note: Elements having similar properties occupy similar positions on the curve.**

**Conclusion :** On the basis of this curve Lotther Meyer proposed that the physical properties of the elements are periodic function of their atomic weight and this became the base of Mendeleev's periodic table.

**Periodic function :** When the elements are arranged in the increasing order of their atomic weight, elements having similar properties gets repeated after a regular interval.





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

(i) Mendeleev's periodic law : The physical and chemical properties of elements are the periodic function of their atomic weight.

(ii) Characteristics of Mendeleev's periodic table:

(a) It was based on atomic weight.

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

(c) He was the first scientist to classify the elements in a systematic manner i.e. in horizontal rows and in vertical columns. *series (12)*

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

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

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

Normal  
element

↓  
sand p

Block  
Normal  
element



1	2						8	9	10	11	12	13	14	15	16	17	18
IA	IIA						VIII			IB	II B	IIIA	IVA	VA	VIA	VIIA	Zero
H	Li	Be										B	C	N	O	F	Ne
Na	Mg	3	4	5	6	7						Al	Si	P	S	Cl	Ar
K	Ca	III B	IV B	V B	VI B	VII B	8	9	10	IB	II B						
Rb	Sr	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Cs	Ba	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Fr	Ra	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
		Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	

$\xrightarrow{\text{Ce } 58} \text{La } 71$  4f series Lanthanides  
 $\xrightarrow{\text{Th } 90} \text{Ac } 103$  5f series Actinide



(iii) Merits or advantages of Mendeleev's periodic table :

(a) Study of elements: First time all known elements were classified in groups according to their similar properties. So study of the properties of elements become easier.

(b) Prediction of new elements : It gave encouragement to the discovery of new elements as some gaps were left in it.

Sc (Scandium), Ga (Gallium), Ge (Germanium), Tc (Technetium)

These were the elements for whom position and properties were well defined by Mendeleev even before their discoveries and he left the blank spaces for them in his table.

Ex. Blank space at atomic weight 72 in silicon group was called Eka silicon (means properties like silicon) and element discovered later was named Germanium. Similarly other elements discovered after mendeleev periodic table were.

2 4 6 8 10 12 14

Eka aluminium	→	Gallium(Ga)	Eka Boron	→	Scandium (Sc)
Eka Silicon	→	Germanium(Ge)	Eka Manganese	→	Technitium (Tc)

*only* Illustration 1. Which of the following element was present in Mendeleev's periodic table?

- (A) Sc
- (B) Tc
- (C) Ge
- (D) None of these



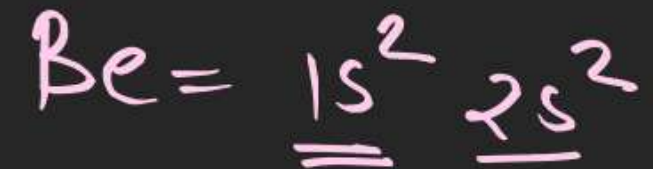
**(c) Correction of doubtful atomic weights : Correction were done in atomic weight of some elements.**

$$\text{Atomic weight} = \text{Valency} \times \text{Equivalent weight.}$$

**Initially, it was found that equivalent weight of Be is 4.5 and it is trivalent ( $V = 3$ ), so the weight of Be was 13.5 and there is no space in Mendeleev's periodic table for this element.**

**So, after correction, it was found that Be is actually bivalent ( $V = 2$ ). So, the weight of Be became  $2 \times 4.5 = 9$  and there was a space between Li and B for this element in Mendeleev's table.**





$$\text{Molecular mass} = \text{eq. weight} \times \text{valency}$$

$$= \underline{4.5} \times \underline{3}$$

$$\boxed{13.5}$$

$$\text{Molecular mass} = \text{eq. weight} \times \text{valency}$$

$$11 = 4.5 \times 2$$

$$= \underline{\underline{9}}$$

**Note: Corrections done in atomic weight of elements were - U, Be, In, Au, Pt.**

**Demerits of Mendeleev's periodic table:**

**(a) Position of hydrogen:** Hydrogen resembles both, the alkali metals (IA) and the halogens (VIIA) in properties so Mendeleev could not decide where to place it.

**(b) Position of isotopes:** As atomic weight of isotopes differs, they should have been placed at different position in Mendeleev's periodic table, But there were no such places for isotopes in Mendeleev's periodic table.

**(c) Anomalous pairs of elements :** There were some pairs of element which did not follow the increasing order of atomic weights.

Ex. Ar and Co were placed before K and Ni respectively in the periodic table, both having higher atomic weights.

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

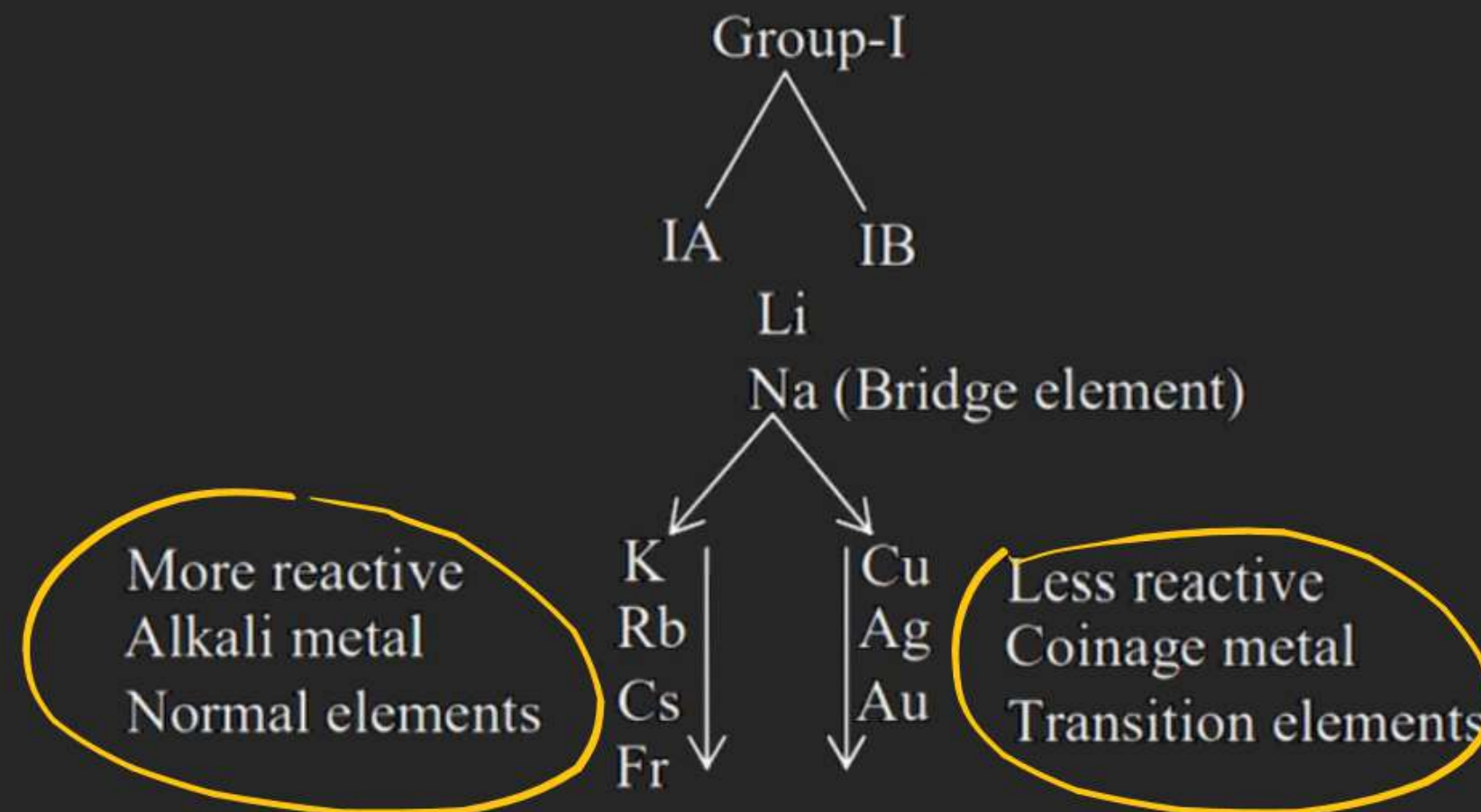
(d) Like elements were placed in different groups :

There were some elements like Platinum (Pt) and Gold (Au) which have similar properties but were placed in different groups in Mendeleev's table.

Pt	Au
<del>VIE</del>	IB <sub>1</sub>
VIII	

(e) Unlike elements were placed in same group :





**Cu, Ag and Au placed in I<sup>st</sup> group along with Na, K etc. while they differ in their properties**

**(Only similar in having  $ns^1$  electronic configuration)**

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

**(g) Cause of periodicity: Why physical and chemical properties repeated in a group.**

## DO YOURSELF – 1

1. Mendeleev's periodic law is based on -

(A) Atomic number


 (B) Atomic weight

(C) Number of neutrons

(D) None of the above



2. The first attempt to classify elements systematically was made by -

-  (A) Mendeleev
- (B) Newland
- (C) Lothar Meyer
- (D) Dobereiner

## (G) MODERN PERIODIC TABLE (MODIFIED MENDELEEV PERIODIC TABLE) :

NCERT and sheet  
↓  
up to Mendeleev