INORGANIC CHEMISTRY

CHAPTER- The d-Block Elements

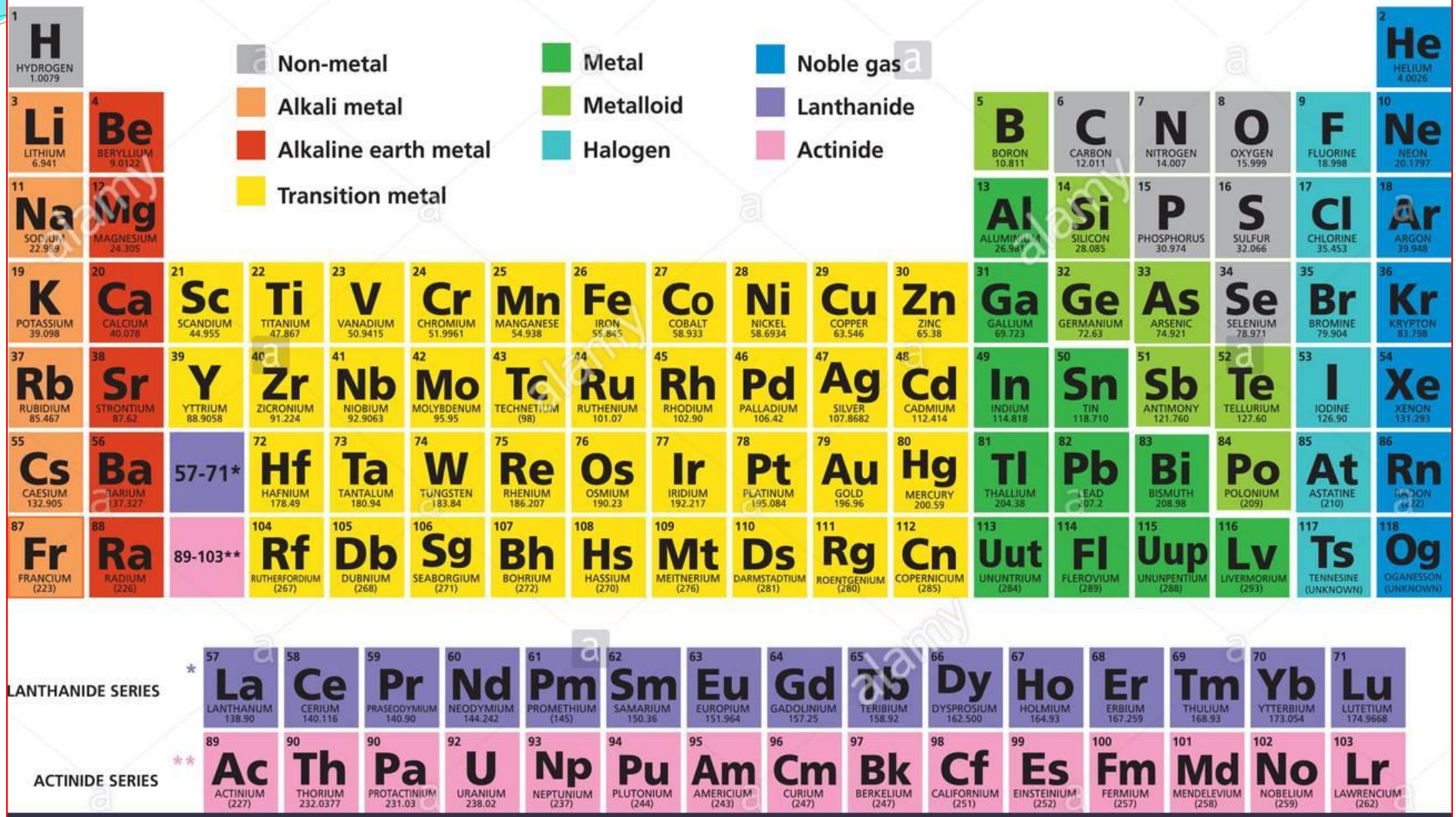
ONLINE LECTURE

NO. 6

DATE:- 16, SEPTEMBER 2020

TIME: (9.00A.M.)

Periodic Table of the Elements



There are two types of transition elements:

1) Main transition elements or d-block elements and

2) Inner transition elements or f-block elements

In d-block elements, the penultimate (or last but one) d-subshell is partly filled. While, in f-block elements, the antepenultimate (or last but two) f-subshell is partly filled.

The main transition elements:-

In periodic table, the d-block contains three series of ten elements and a fourth series which is incomplete.

1) The first transition series: - It consists of ten elements from Sc (21) to Zn (30). The 3d subshell is progressively filled in this series.

2) The second transition series: - It consists of ten elements from Yttrium (39) to Cd (48). The 4d subshell is progressively filled in this series.

3) The third transition series: - It consists of elements from Lanthanum (57) to Hg (80). The 5d subshell is progressively filled in this series.

4) The fourth transition series: - This series starts with Actinium (89) and the 6d subshell is progressively filled in this series, but it is incomplete.

The first transition series: -

Electronic configuration: -

In these elements, the last incoming electron is added in 3d subshell and it is progressively filled step by step.

INORGANIC CHEMISTRY

CHAPTER- The d-Block Elements

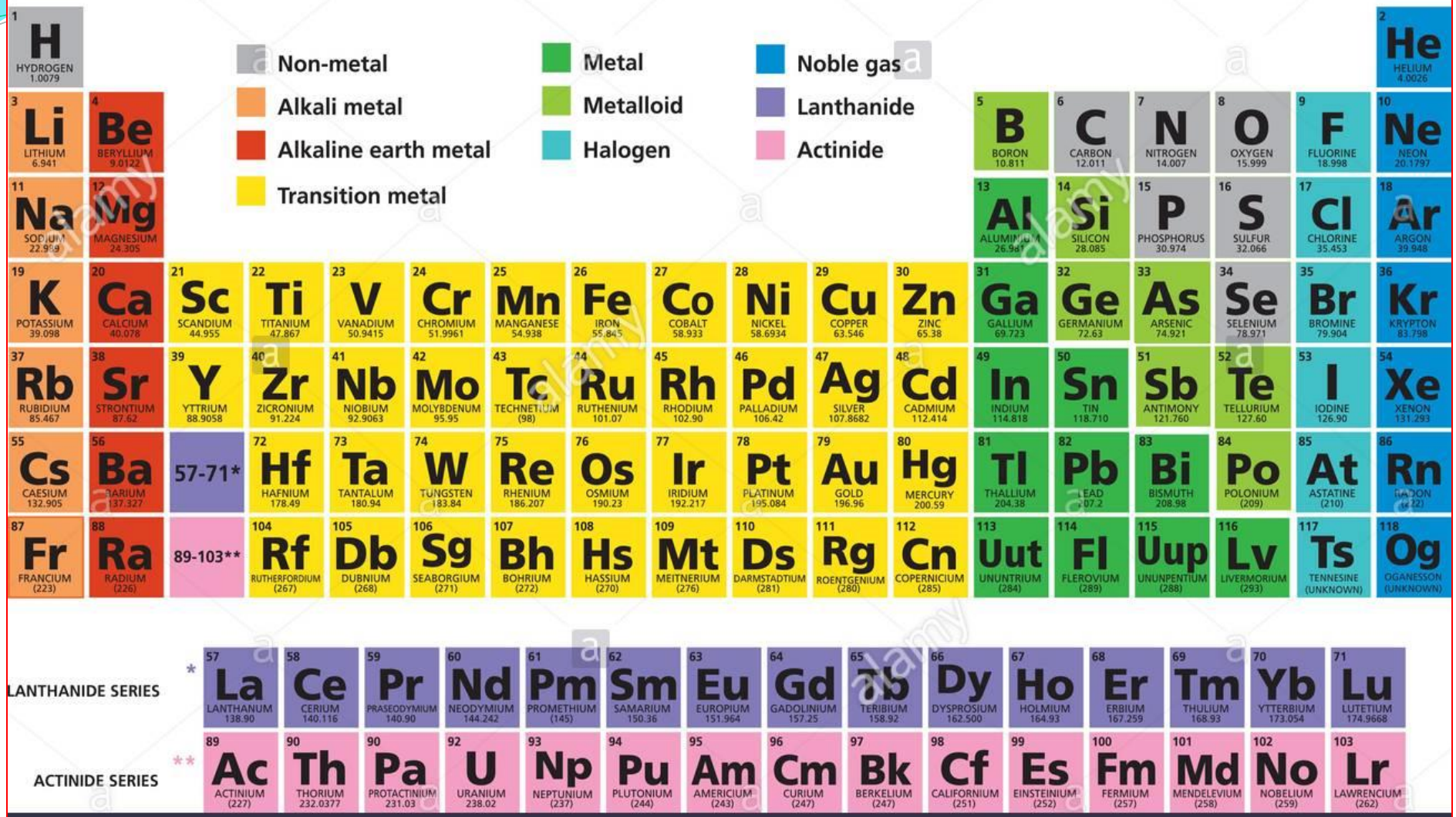
ONLINE LECTURE

NO. 7

DATE:- 18, SEPTEMBER 2020

TIME: (8.00A.M.)

Periodic Table of the Elements



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The first transition series: -

Electronic configuration: -

In these elements, the last incoming electron is added in 3d subshell and it is progressively filled step by step.

Elements	Symbol	At. number	Electronic configuration
Scandium	Sc	21	$1S^2\ 2S^2 2P^6\ 3S^2 3P^6\ 4S^2 3d^1$ or [Ar] $4S^2\ 3d^1$
Titanium	Ti	22	[Ar] $4S^2$ 3d2
Vanadium	V	23	[Ar] $4S^2$ 3d3
Chromium	Cr	24	[Ar] $4S^1\ 3d^5$
Manganese	Mn	25	[Ar] $4S^2$ 3d5
Iron	Fe	26	[Ar] $4S^2\ 3d^6$
Cobalt	Co	27	[Ar] $4S^2\ 3d^7$
Nickel	Ni	28	[Ar] $4S^2\ 3d^8$
Copper	Cu	29	[Ar] $4S^1\ 3d^{10}$
Zinc	Zn	30	[Ar] $4S^2\ 3d^{10}$

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CHAPTER- The d-Block Elements

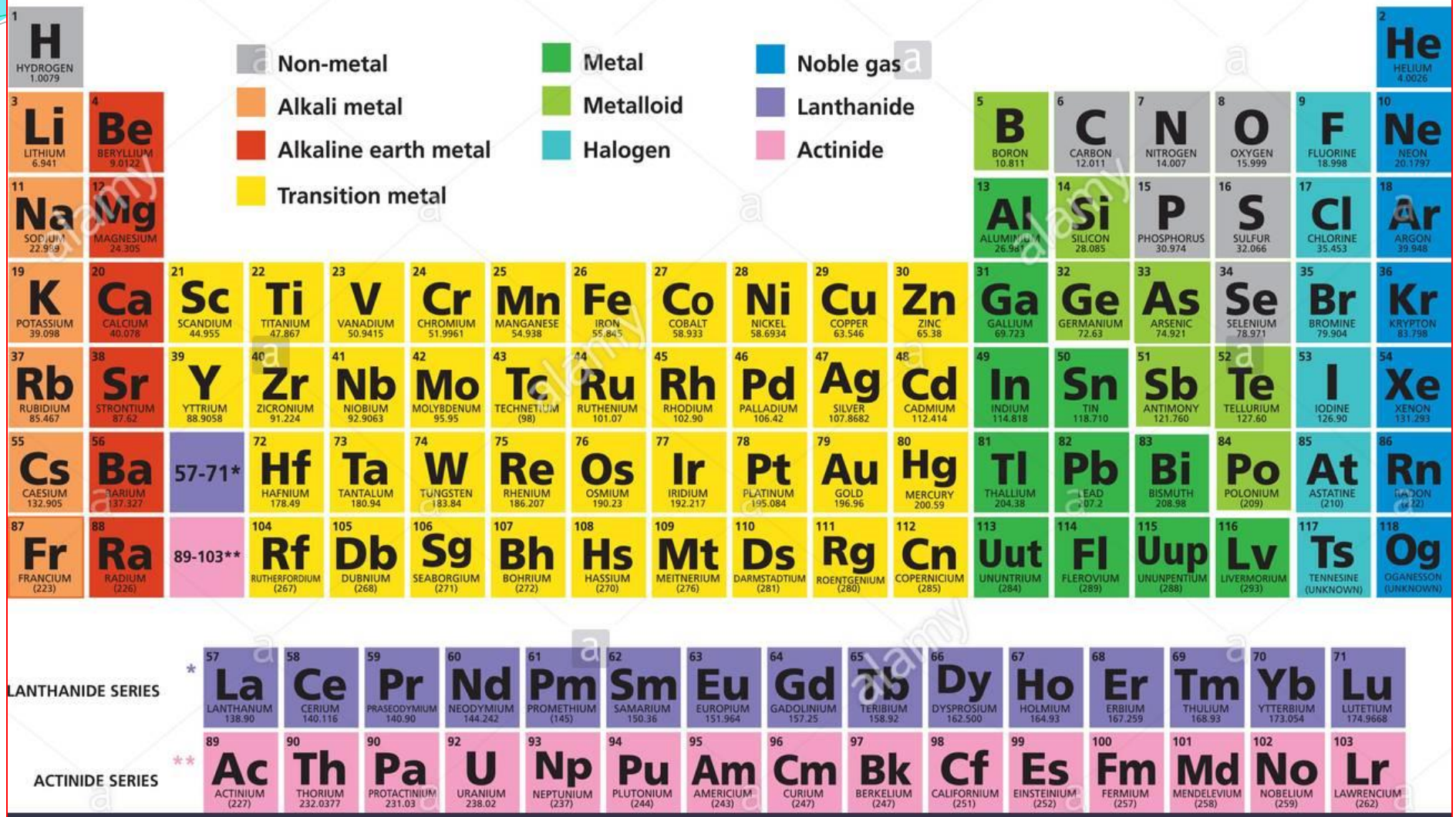
ONLINE LECTURE

NO. 8

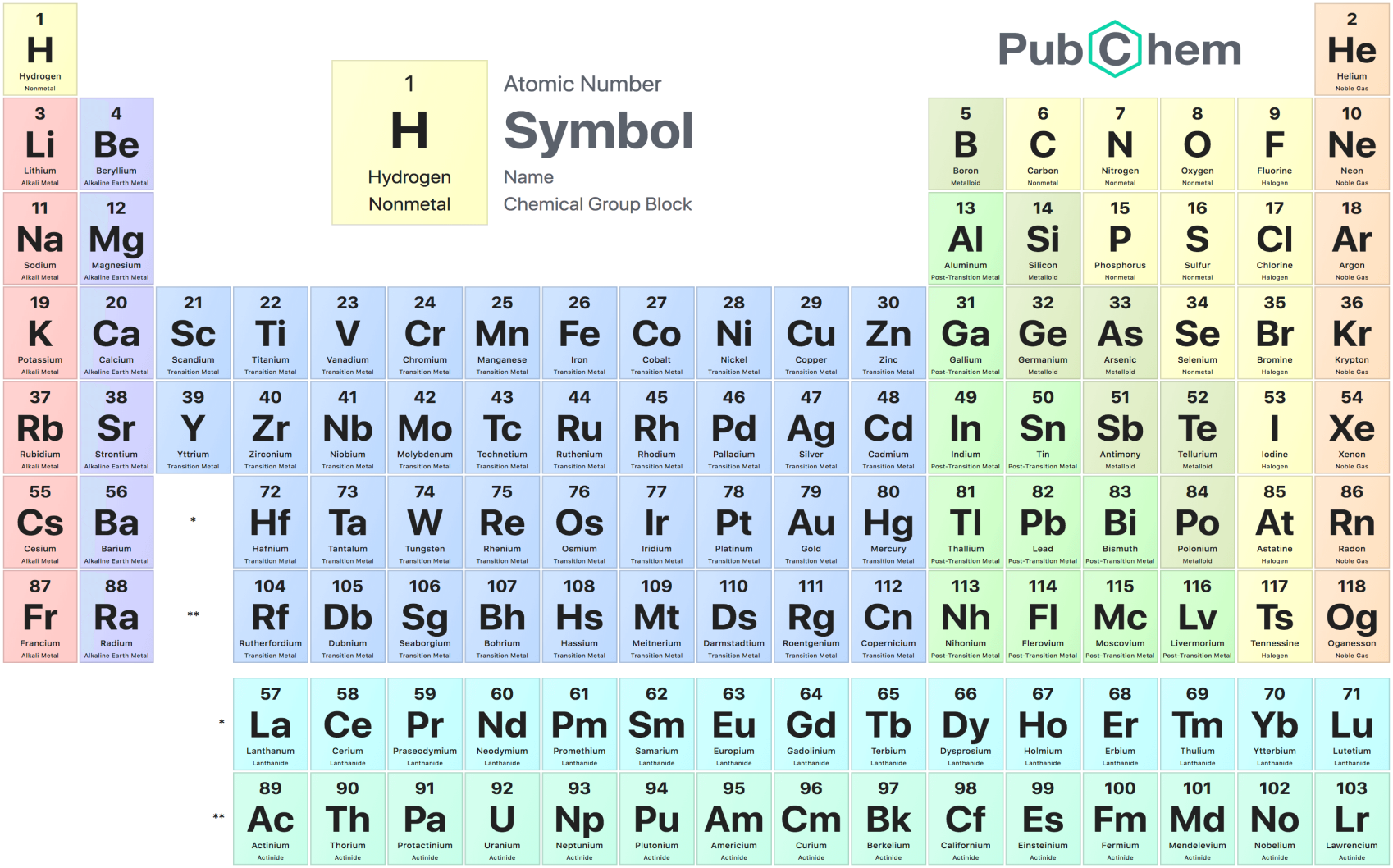
DATE:- 23, SEPTEMBER 2020

TIME: (9.00A.M.)

Periodic Table of the Elements



PERIODIC TABLE OF ELEMENTS



The second transition series: -

Electronic configuration: - In these elements, the last incoming electrons are added in 4d subshell and it is progressively filled step by step.

Elements	Symbol	At. number	Electronic configuration
Yttrium	Y	39	[Kr] $5S^2$ $4d^1$
Zirconium	Zr	40	[Kr] $5S^2$ 4d2
Niobium	Nb	41	[Kr] $5S^1$ $4d^4$
Molybdenum	Mo	42	[Kr] $5S^1$ $4d^5$
Technetium	Tc	43	[Kr] $5S^2$ $4d^5$
Ruthenium	Ru	44	[Kr] $5S^1$ $4d^7$
Rhodium	Rh	45	[Kr] $5S^1$ $4d^8$
Palladium	Pd	46	[Kr] $5S^0$ $4d^{10}$
Silver	Ag	47	[Kr] $5S^1$ $4d^{10}$
Cadmium	Cd	48	[Kr] $5S^2$ $4d^{10}$

$CdSO_4$, $CdCl_2$, CdS, $Cd(NO3)_2$

$Cd \rightarrow Cd^{+2} + 2e^-$

$5S^2, 4d^{10} \rightarrow 5S^0, 4d^{10}$

Mo(42) → $5S^2, 4d^4$ (expected)

Mo(42) → $5S^1, 4d^5$ (observed)

The third transition series: -

Electronic configuration: -

In these elements, the last incoming electrons are added in 5d subshell and it is progressively filled step by step

Elements	Symbol	At. number	Electronic configuration
Hafnium	Hf	72	[Xe] $4f^{14}$ $6S^2$ $5d^2$
Tantalum	Ta	73	[Xe] $4f^{14}$ $6S^2$ 5d3
Tungsten	W	74	[Xe] $4f^{14}$ $6S^2$ $5d^4$
Rhenium	Re	75	[Xe] $4f^{14}$ $6S^2$ $5d^5$
Osmium	Os	76	[Xe] $4f^{14}$ $6S^2$ $5d^6$
Iridium	Ir	77	[Xe] $4f^{14}$ $6S^2$ $5d^7$
Platinum	Pt	78	[Xe] $4f^{14}$ $6S^0$ $5d^{10}$
Gold	Au	79	[Xe] $4f^{14}$ $6S^1$ $5d^{10}$
Mercury	Hg	80	[Xe] $4f^{14}$ $6S^2$ $5d^{10}$

Lanthanum (Z=57), with outer electronic configuration $5d^1 6S^2$ is by definition a d-block element and should be member of this series. But, its physical and chemical properties are similar to the series of f-block elements (i.e. Lanthanides) and hence excluded here.

La (57) $\rightarrow 1S^2, 2S^2, 2P^6, 3S^2, 3P^6, 4S^2, 3d^{10}, 4P^6, 5S^2, 4d^{10}, 5P^6, 6S^2, 4f^1$

The fourth transition series: -

This series starts with Actinium (89). In these elements, 6d-subshell is begins to fill and get progressively filled step by step. This series is incomplete.

Ac (89) $\rightarrow 1S^2, 2S^2, 2P^6, 3S^2, 3P^6, 4S^2, 3d^{10}, 4P^6, 5S^2, 4d^{10}, 5P^6, 6S^2, 4f^{14}, 5d^{10}, 6P^6, 7S^2, 5f^1$.

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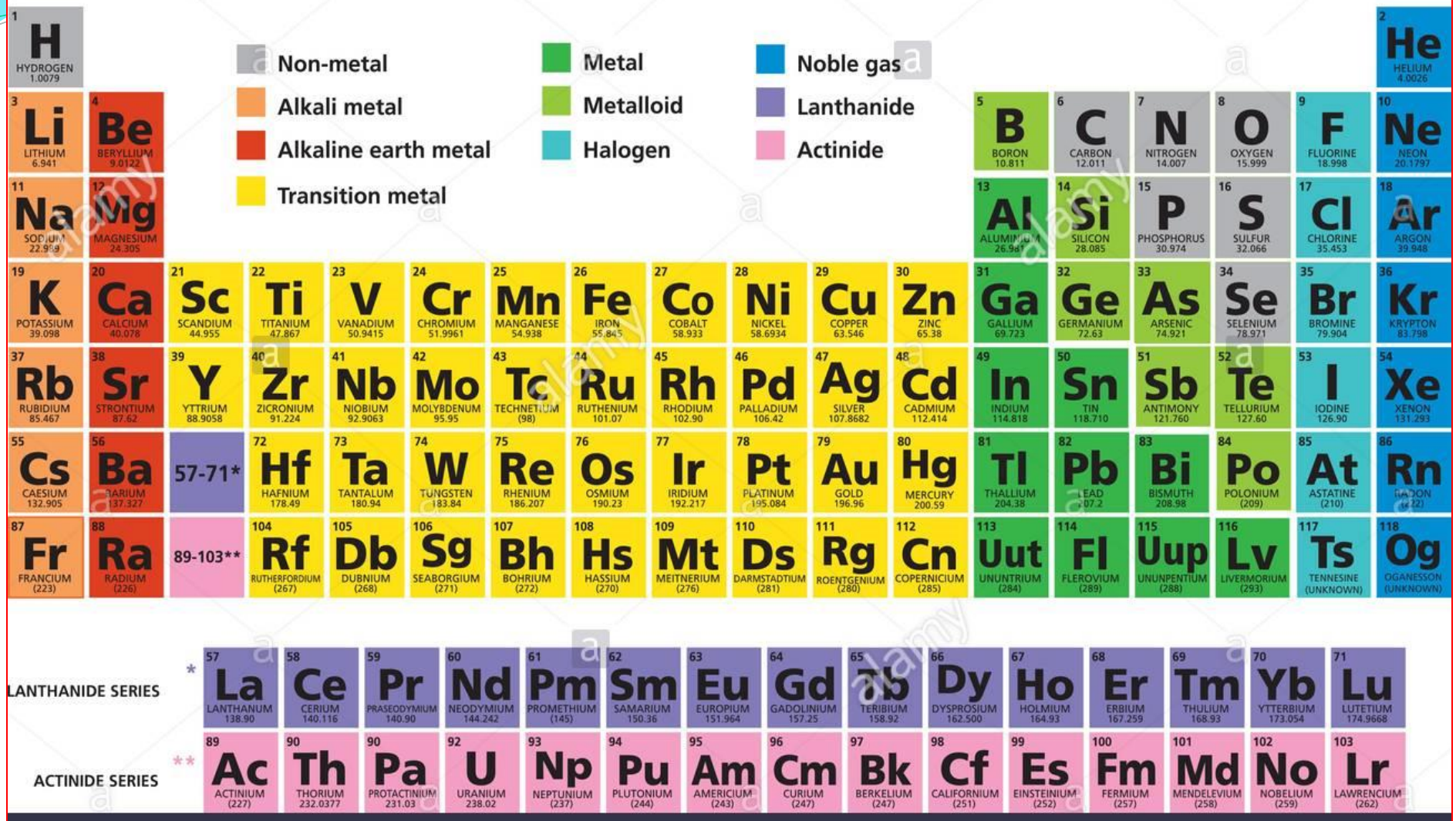
NO. 9

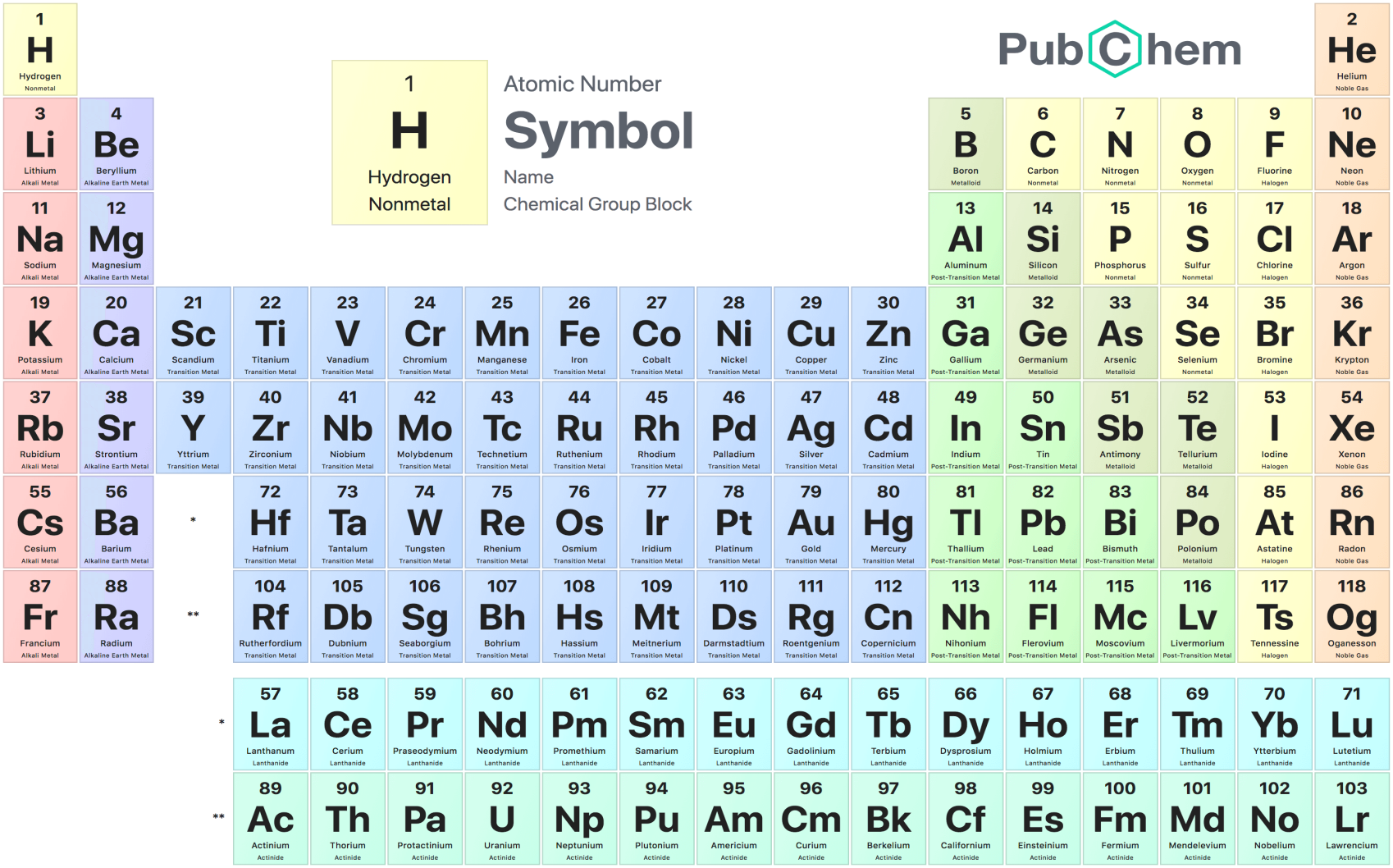
DATE:- 25, SEPTEMBER 2020

TIME: (8.00A.M.)

Periodic Table of the Elements



PERIODIC TABLE OF ELEMENTS



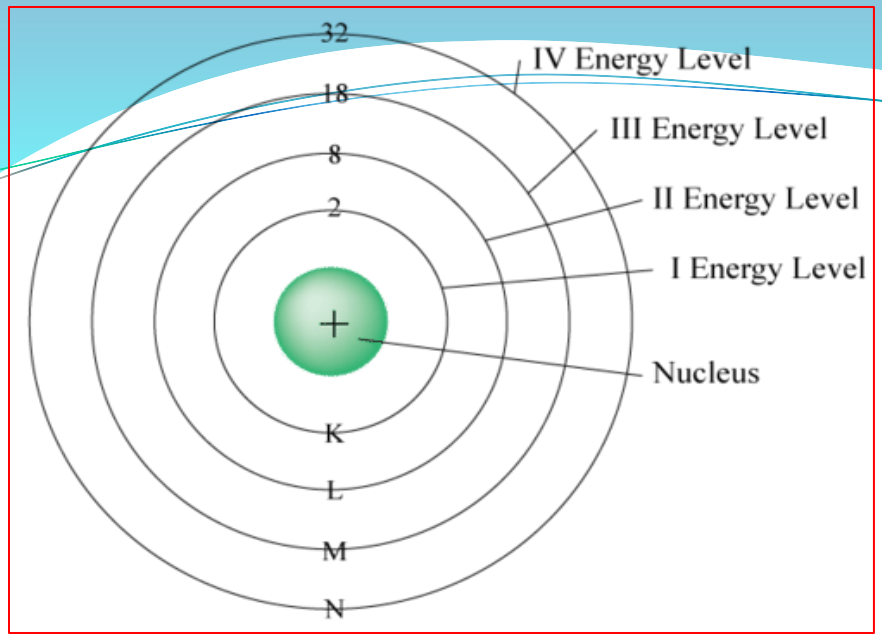
General characteristics of d-block elements: -

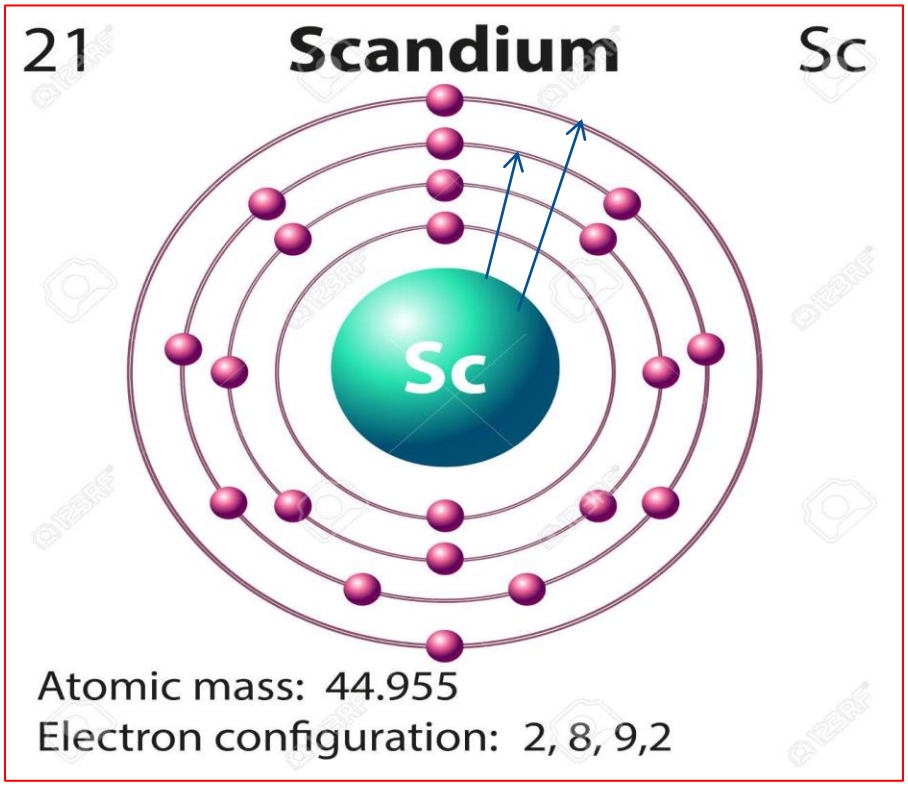
1) **Atomic radii: -** Generally, the atomic radii of the transition elements decreases from left to right with increase in atomic number. This is due to the combined effect of

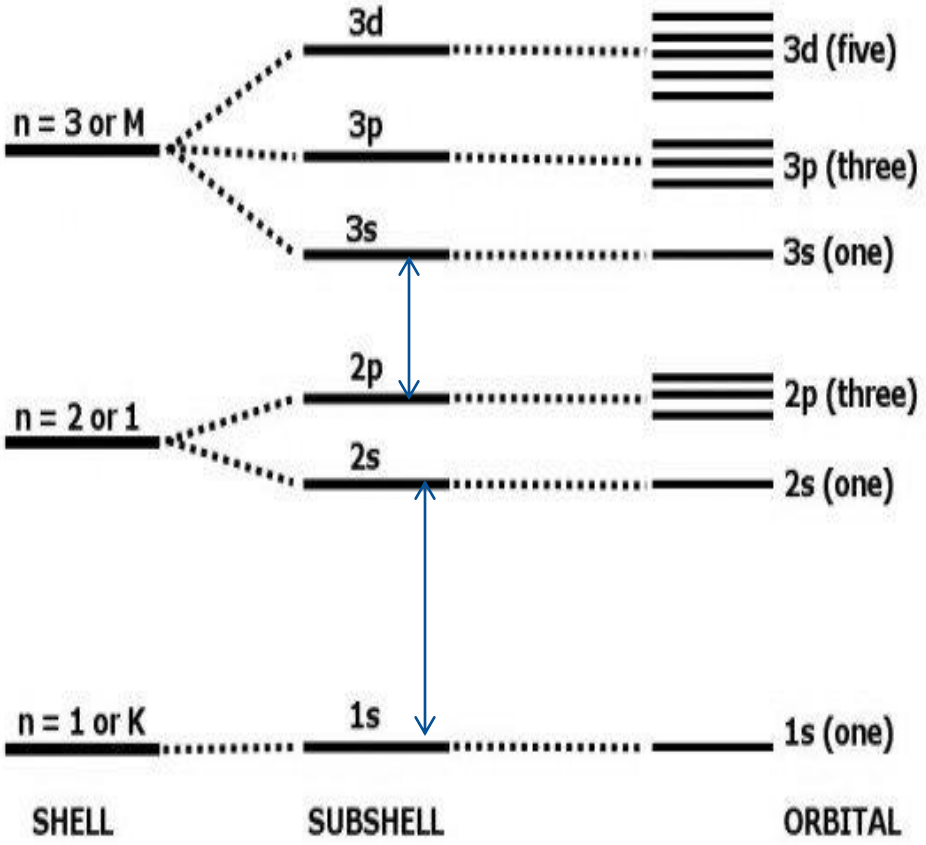
i) Addition of electrons in the inner d-subshell and

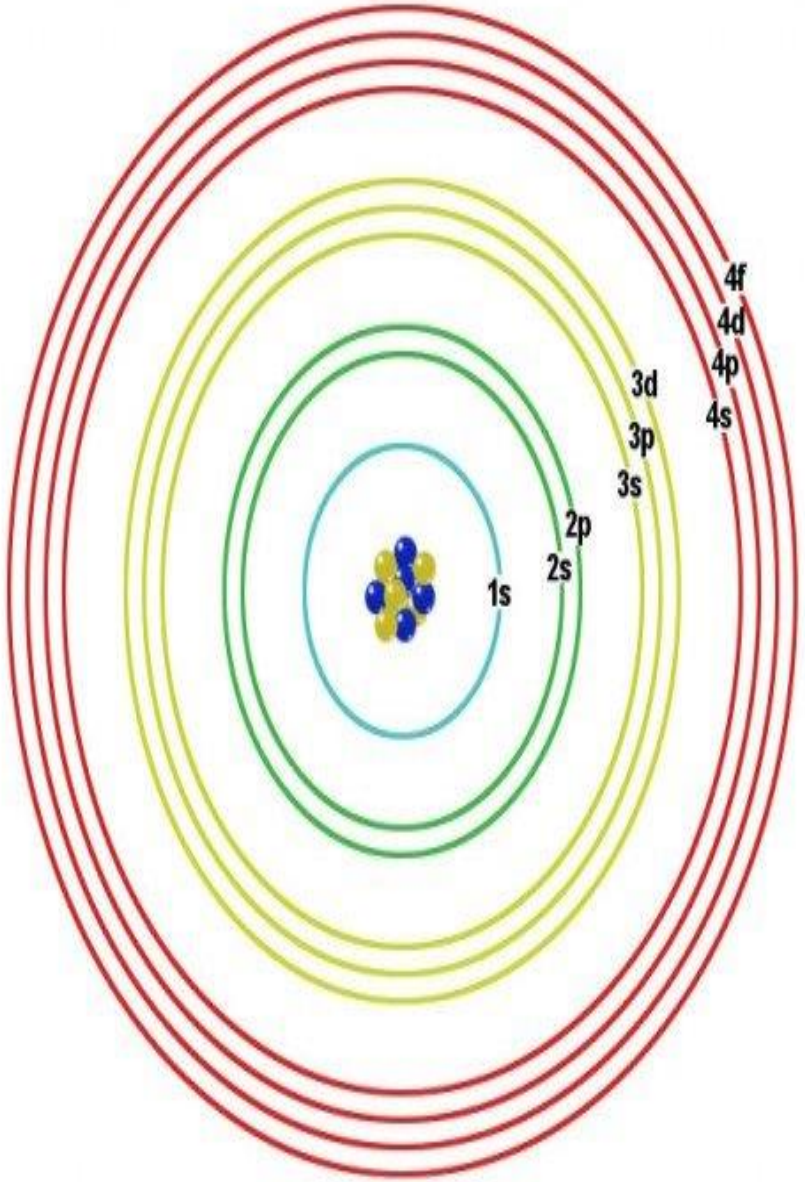
ii) Increase in the nuclear charge from left to right. The increase in nuclear charge, attracts the electron cloud inwards. However, there are few exceptions.

Elements	**Sc**	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Atomic radius(A^0)	1.62	1.47	1.34	1.27	1.26	1.26	1.25	1.24	1.28	1.38


32
18
8
2
IV Energy Level
III Energy Level
II Energy Level
I Energy Level
Nucleus
K
L
M
N


21
Scandium
Sc
Sc
Atomic mass: 44.955
Electron configuration: 2, 8, 9,2


3d
3d (five)
n = 3 or M
3p
3p (three)
3s
3s (one)
2p
2p (three)
n = 2 or 1
2s
2s (one)
n = 1 or K
1s
1s (one)
SHELL
SUBSHELL
ORBITAL


4f
4d
4p
4s
3d
3p
3s
2p
2s
1s

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CHAPTER- The d-Block Elements

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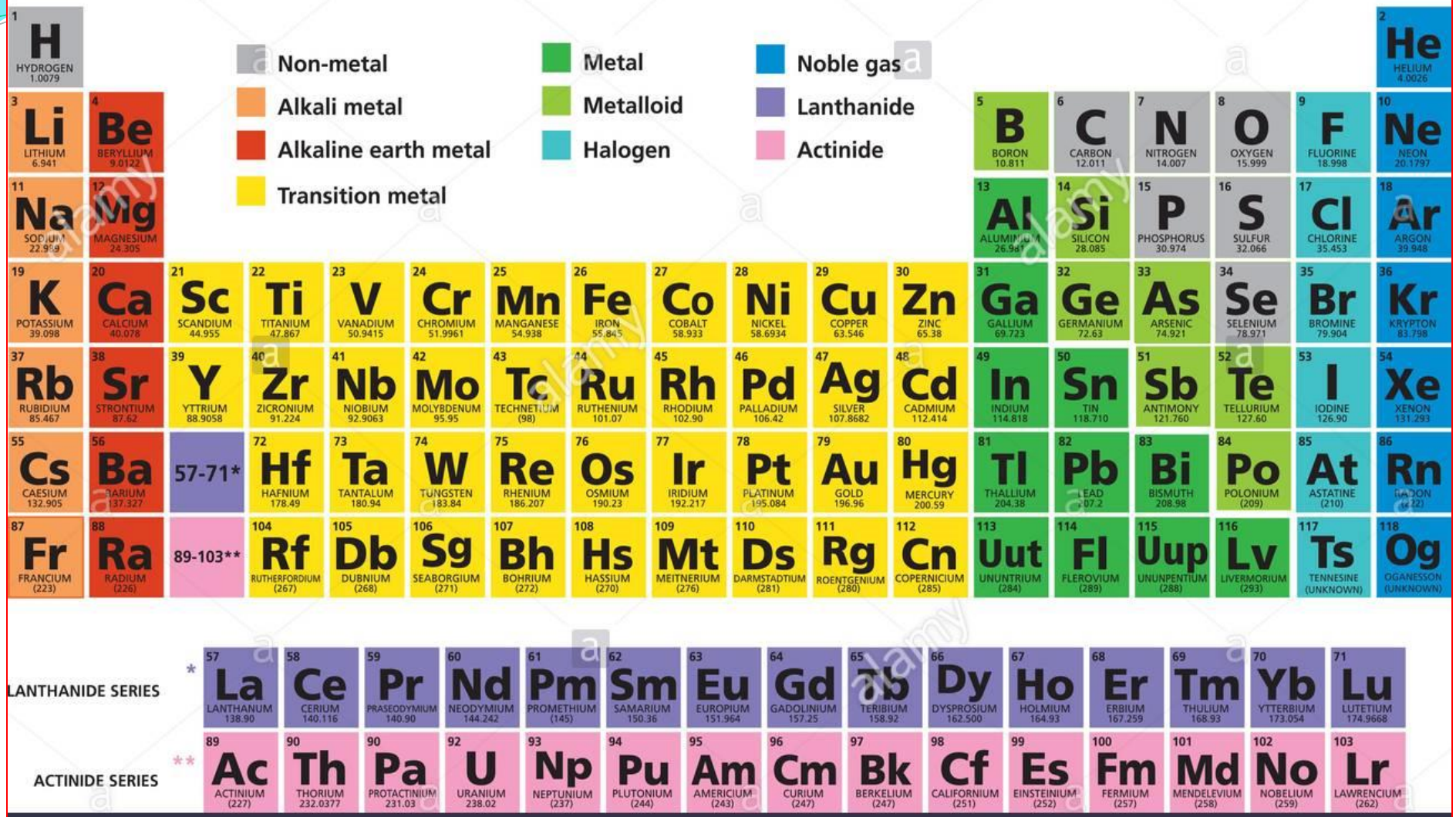
NO. 10

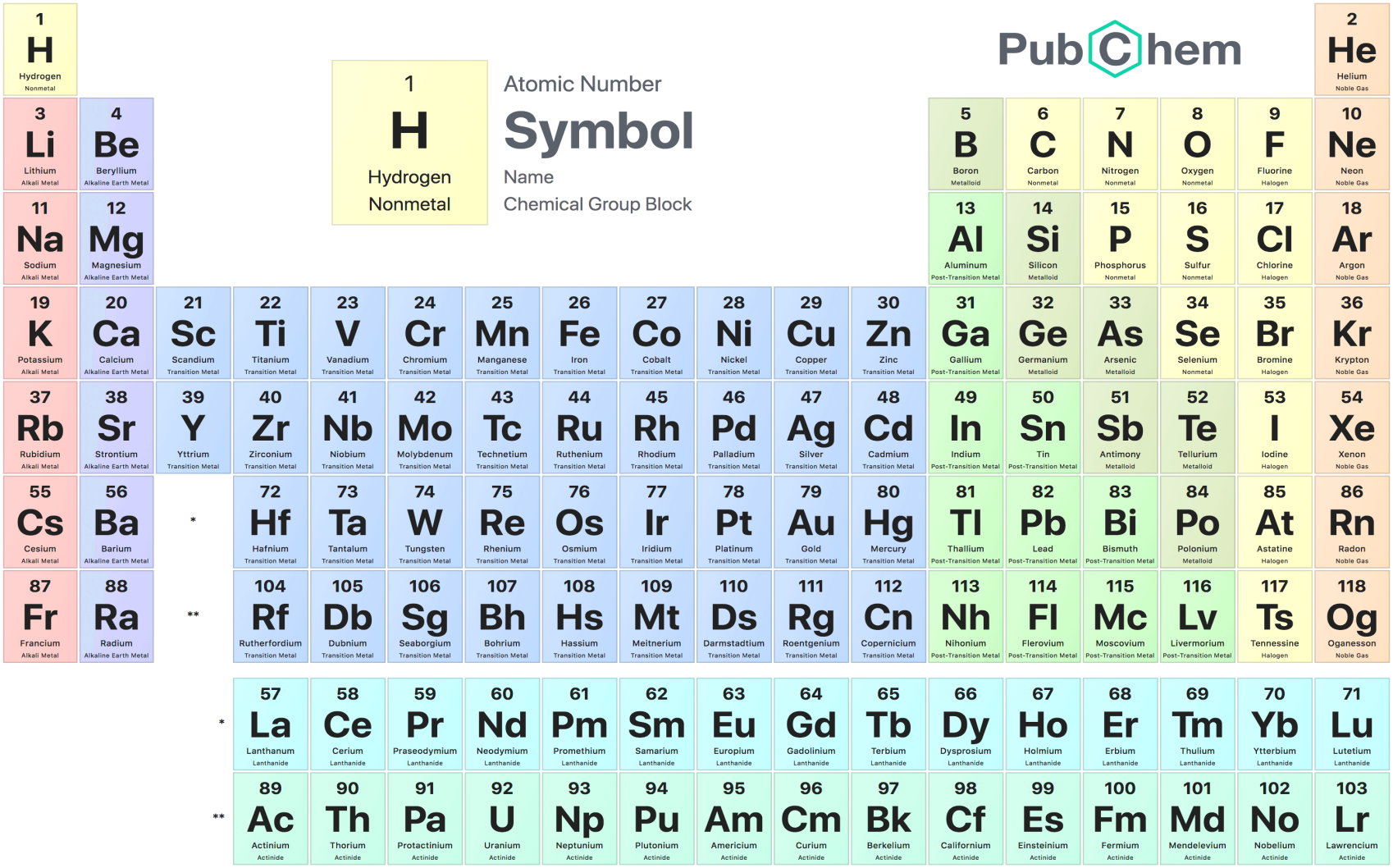
DATE:- 25, SEPTEMBER 2020

TIME: (8.00A.M.)

Periodic Table of the Elements



PERIODIC TABLE OF ELEMENTS



Objective test

https://forms.gle/wY7W8LFzbF5qmMK38

Feedback form

https://forms.gle/rDGKP1Uky5xTuLGW6

Atomic Size depends upon: -

1) Number of energy levels: - Greater the number of energy levels, larger is the size of atoms.

At. Size and no. of energy levels are directly proportional to each other.

i.e. At. Size α No. of energy levels

2) Nuclear charge: - There is a force of attraction between nucleus (Positively charged) and electrons (Negatively charged) in different energy levels.

$$\text{Atomic size } \alpha \frac{1}{\text{Nuclear charge}}$$

i.e. At. Size is inversely proportional to the nuclear charge.

As nuclear charge increases, force of attraction on electrons increases and hence they are attracted towards the nucleus and size decreases.

3) Shielding (Screening) effect: - The inner energy levels acts as screen and these protects the outer electrons from nuclear attraction. i.e. they decreases the force of attraction between outer electrons and nucleus.

Atomic Size α Shielding effect

As number of inner energy levels increases, the size of atom also increases and vice versa.

First group elements from top to bottom

Element	At. number	Valence shell Electronic Configuration	Total energy levels
Hydrogen (H)	1	$1S^1$	1
Lithium (Li)	3	$2S^1$	2
Sodium (Na)	11	$3S^1$	3
Potassium (K)	19	$4S^1$	4
Rubidium (Rb)	37	$5S^1$	5
Cesium (Cs)	55	$6S^1$	6
Francium (Fr)	87	$7S^1$	7

Third period from left to right

Element	Na	Mg	Al	Si	P	S	Cl	Ar
At no.	11	12	13	14	15	16	17	18
Congn.	$3S^1$	$3S^2$	$3S^23P^1$	$3S^23P^2$	$3S^23P^3$	$3S^23P^4$	$3S^23P^5$	$3S^23P^6$
Total energy levels	3	3	3	3	3	3	3	3
Nuclear charge	+11	+12	+13	+14	+15	+16	+17	+18

General characteristics of d-block elements: -

1) **Atomic radii: -** Generally, the atomic radii of the transition elements decreases from left to right with increase in atomic number. This is due to the combined effect of addition of electrons in the inner d-subshell and increase in the nuclear charge from left to right. The increase in nuclear charge, attracts the electron cloud inwards. However, there are few exceptions.

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Electronic Configuration	$4S^2$ $3d^1$	$4S^2$ $3d^2$	$4S^2$ $3d^3$	$4S^1$ $3d^5$	$4S^2$ $3d^5$	$4S^2$ $3d^6$	$4S^2$ $3d^7$	$4S^2$ $3d^8$	$4S^1$ $3d^{10}$	$4S^2$ $3d^{10}$
Nuclear Charge	+21	+22	+23	+24	+25	+26	+27	+28	+29	+30

2) Ionic radii: - The ionic radii of the transition elements of a given series also decrease with increasing atomic number. For the ions of the given charge, the radius decreases slowly with increase in atomic number. The radii of dipositive ions are close with the radius of Ca^{+2} ions.

Ions	Sc^{+2}	Ti^{+2}	V^{+2}	Cr^{+2}	Mn^{+2}	Fe^{+2}	Co^{+2}	Ni^{+2}	Cu^{+2}	Zn^{+2}
Ionic radius(A^0)	0.81	0.91	0.88	0.84	0.80	0.76	0.74	0.72	0.72	0.74