



TRANSITION &

INNER TRANSITION ELEMENTS



Lecture 5.

Q. 1 – What is the general outermost electronic configuration of F-Block Elements?



Answer:

1. $ns^2 (n-1)d^{0-2} (n-2)f^{0-14}$



	1A (1)															8A (18)		
1		2A (2)										3A (13)	4A (14)	5A (15)	6A (16)	7A (17)		
2			TRANSITION ELEMENTS <i>d</i> block															
3			3B (3)	4B (4)	5B (5)	6B (6)	7B (7)	8B (8) (9) (10)		1B (11)	2B (12)							
4			21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn						
5			39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd						
6			57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg						
7			89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110	111	112						

INNER TRANSITION ELEMENTS

f block

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

INNER TRANSITION ELEMENTS

Lanthanide Series	57 La Lanthanum 138.906	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
Actinide Series	89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]

Element	Symbol	Atomic number
Lanthanum	La	57
Cerium	Ce	58
Praseodymium	Pr	59
Neodymium	Nd	60
Promethium	Pm	61
Samarium	Sm	61
Europium	Eu	63
Gadolinium	Gd	64
Terbium	Tb	65
Dysprosium	Dy	66
Holmium	Ho	67
Erbium	Er	68
Thulium	Tm	69
Ytterbium	Yb	70
Lutetium	Lu	71

- ${}_{57}\text{La} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^0 5d^1$
- ${}_{58}\text{Ce} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^1 5d^1$
- ${}_{59}\text{Pr} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^3 5d^0$
- ${}_{60}\text{Nd} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^4 5d^0$
- ${}_{61}\text{Pm} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^5 5d^0$
- ${}_{62}\text{Sm} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^6 5d^0$
- ${}_{63}\text{Eu} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^7 5d^0$
- ${}_{64}\text{Gd} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^7 5d^1$

- ${}_{65}\text{Tb} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^9 5d^0$
- ${}_{66}\text{Dy} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{10} 5d^0$
- ${}_{67}\text{Ho} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{11} 5d^0$
- ${}_{68}\text{Er} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{12} 5d^0$
- ${}_{69}\text{Tm} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{13} 5d^0$
- ${}_{70}\text{Yb} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^0$
- ${}_{71}\text{Lu} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^1$

They have general valence shell electronic configuration of $ns^2 (n-1)d^{0-2} (n-2)f^{0,2-14}$.

MNEMONIC TO MEMORIZE LANTHANOIDS.

- Ladkiyon Ce Pareshan Nadaan Pandit Sameer Ehsaan ne Gardan Tod Dy Hogi Esha Tomar ki Yunhi, Lu!
- Elements covered = La, Ce, Pr, Nd, Pm, Sm, Eu Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu.

Element	Symbol	Atomic number	Electronic configuration				Atomic radii, pm	Ionic radii (Ln ⁺³ , 6-coordinate), pm
			Expected (ground state)	Observed (ground state)	(+2 oxidation state)	(+3 oxidation state)		
Lanthanum	La	57	[Xe]4f ⁰ 5d ¹ 6s ²	[Xe]4f ⁰ 5d ¹ 6s ²	4f ⁰	4f ⁰	187	103
Cerium	Ce	58	[Xe]4f ² 6s ²	[Xe]4f ¹ 5d ¹ 6s ²		4f ¹	183	102
Praseodymium	Pr	59	[Xe]4f ³ 6s ²	[Xe]4f ³ 6s ²	4f ²	4f ²	182	99
Neodymium	Nd	60	[Xe]4f ⁴ 6s ²	[Xe]4f ⁴ 6s ²			181	98.3
Promethium	Pm	61	[Xe]4f ⁵ 6s ²	[Xe]4f ⁵ 6s ²	4f ⁴		181	97
Samarium	Sm	61	[Xe]4f ⁶ 6s ²	[Xe]4f ⁶ 6s ²	4f ⁵	4f ⁵	180	95.8
Europium	Eu	63	[Xe]4f ⁷ 6s ²	[Xe]4f ⁷ 6s ²		4f ⁶	199	94.7
Gadolinium	Gd	64	[Xe]4f ⁸ 6s ²	[Xe]4f ⁷ 5d ¹ 6s ²	4f ⁷		178	93.8
Terbium	Tb	65	[Xe]4f ⁹ 6s ²	[Xe]4f ⁹ 6s ²		4f ⁸	177	92.3
Dysprosium	Dy	66	[Xe]4f ¹⁰ 6s ²	[Xe]4f ¹⁰ 6s ²		4f ⁹	176	91.2
Holmium	Ho	67	[Xe]4f ¹¹ 6s ²	[Xe]4f ¹¹ 6s ²	4f ¹⁰	4f ¹⁰	175	90.1
Erbium	Er	68	[Xe]4f ¹² 6s ²	[Xe]4f ¹² 6s ²			174	89
Thulium	Tm	69	[Xe]4f ¹³ 6s ²	[Xe]4f ¹³ 6s ²	4f ¹²	4f ¹²	173	88
Ytterbium	Yb	70	[Xe]4f ¹⁴ 6s ²	[Xe]4f ¹⁴ 6s ²	4f ¹³			86.8
Lutetium	Lu	71	[Xe]4f ¹⁴ 5d ¹ 6s ²	[Xe]4f ¹⁴ 5d ¹ 6s ²		4f ¹⁴		86.1

Why F-block Elements Placed Outside Separately?

- The reason for this is the remarkable similarities among the chemical properties of the Lanthanoids and also among the various members of Actinoids.
- The similarities in properties, in turn, is due to the similar electronic configuration of the outermost shell.
- These elements differ only in the number of f-electrons which do not take part in chemical bonding.

PROPERTIES OF LANTHANOIDS:

1. They are soft metals with silvery-white colour & moderate densities.
2. They are good conductors of heat and electricity.
3. Except Promethium all the remaining elements are non-radioactive.
4. Atomic & ionic radii decreases from Lanthanum (La) to Lutetium (Lu).
{This effect is called as Lanthanoid Contraction}
5. Binding to water is common.
6. Co-ordination number is usually higher than 6 (8/9/..12) eg:
 $[\text{La}(\text{H}_2\text{O})_9]^{3+}$
7. They are strongly paramagnetic.
8. Magnetic & optical properties are independent of environment.
9. They show a common oxidation state of +3.
10. Basic nature of the oxides reduces from $\text{La}(\text{OH})_3$ to $\text{Lu}(\text{OH})_3$.

Any Question



“It is not the answer that enlightens, but the question.”

- Eugene Ionesco