f-BLOCK COMPOUNDS

Inner Transition Elements :

The elements in which the additional electron enters in (n – 2)f orbitals are called inner **transition elements or f-block elements.**

Position in the periodic table :

The lanthanides resemble with Yttrium in most of their properties. So it became necessary to accomodate all the fifteen elements together at one place. This has been done by placing the first element, lanthanum below yttrium and placing the remaining fourteen elements separately in the lower part of the periodic table.

Lanthanide series	(Z = 58 – 71)	(Ce – Lu)
Actinide series	(Z = 90 – 103)	(Th – Lr)

LANTHANIDES (RARE EARTHS OR LANTHANONES)

(i) Lanthanides are reactive elements so do not found in free state in nature.

(ii) Most important minerals for lighter Lanthanides are – Monazite, cerites and for heavier lanthanides – Gadolinite and Xenotime

Electronic configuration :

(i) The general configuration of lanthanides may be given as $4f^{1-14}5s^2 5p^6 5d^{0-1} 6s^2$.

Atomic Number	Element	Symbol	Outer electronic configuration	
			Atomic	+3 ion
58	**Cerium**	**Ce**	$\mathbf{4f^1\ 5d^1 6s^2}$	$\mathbf{4f^1}$
59	Praseodymium	Pr	$4f^3\ 6s^2$	$4f^2$
60	Neodymium	Nd	$4f^4\ 6s^2$	$4f^3$
61	Promethium	Pm	$4f^5\ 6s^2$	$4f^4$
62	Samarium	Sm	$4f^6\ 6s^2$	$4f^5$
63	Europium	Eu	$4f^7\ 6s^2$	$4f^6$
64	**Gadolinium**	**Gd**	$\mathbf{4f^7\ 5d^1\ 6s^2}$	$\mathbf{4f^7}$
65	**Terbium**	**Tb**	$\mathbf{4f^9\ 6s^2}$	$\mathbf{4f^8}$
66	Dysprosium	Dy	$4f^{10}\ 6s^2$	$4f^9$
67	Holmium	Ho	$4f^{11}\ 6s^2$	$4f^{10}$
68	Erbium	Er	$4f^{12}\ 6s^2$	$4f^{11}$
69	Thulium	Tm	$4f^{13}\ 6s^2$	$4f^{12}$
70	**Ytterbium**	**Yb**	$\mathbf{4f^{14}\ 6s^2}$	$\mathbf{4f^{13}}$
71	**Lutetium**	**Lu**	$\mathbf{4f^{14}\ 5d^1\ 6s^2}$	$\mathbf{4f^{14}}$

(ii) It is to be noted that filling of 4f orbitals in the atoms is not regular. A 5d electron appears in gadolinium (Z = 64) with an outer electronic configuration of $4f^7 5d^1 6s^2$ (and not $4f^8 6s^2$). This is because the 4f and 5d electrons are at about the same potential energy and that the atoms have a tendency to retain stable half filled configuration.

(iii) On the other hand, the filling of f-orbitals is regular in tripositive ions.

(iv) After losing outer electrons, the f-orbitals shrink in size and became more stable.

(v) **Pm** is the only synthetic radioactive lanthanide.

Oxidation states :

Lanthanides	Oxidation	Actinides	Oxidation state
Ce_{58}	+3, +4	Th_{90}	+4
Pr_{59}	+3, (+4)	Pa_{91}	(+4), +5
Nd_{60}	+3	U_{92}	(+3), (+4), (+5), +6
Pm_{61}	+3	Np_{93}	(+3), (+4), +5, (+6), (+7)
Sm_{62}	(+2), +3	Pu_{94}	(+3), +4, (+5), (+6), (+7)
Eu_{63}	+2, +3	Am_{95}	+2,(+3),(+4),(+5),(+6)
Gd_{64}	+3	Cm_{96}	+3, (+4)
Tb_{65}	+3, +4	Bk_{97}	+3, (+4)
Dy_{66}	+3, (+4)	Cf_{98}	+3
Ho_{67}	+3	Es_{99}	+3
Er_{68}	(+2), +3	Fm_{100}	+3
Tm_{69}	(+2), +3	Md_{101}	+3
Yb_{70}	+2, +3	No_{102}	+3
Lu_{71}	+3	Lr_{103}	+3

(Oxidation states in brackets are unstable states)

(i) The lanthanides contains two **s** electrons in the outermost shell, they are therefore expected to exhibit a characteristic oxidation state of +2. But for the lanthanides, the +3 oxidation is common.

(ii) This corresponds to the use of two outermost electrons ($6s^2$) alongwith one inner electron. The inner electron used is a 5d electron (in La, Gd and Lu), or one of the 4f electron if no 5d electrons present.

(iii) All the lanthanides attains +3 oxidation state and only **Cerium, Praseodymium,** and **Terbium** exhibit **higher oxidation state (+4). Eu and Yb** exhibit **+2** oxidation state.

(iv) Oxidation states +2 and +4 occur particularly when they lead to -

(a) A noble gas configuration **Ex.** Ce^{4+} (f^0). The formation of Ce^{IV} is favoured by its noble gas configuration, but it is a strong oxidant reverting to the common +3 state. The E° value for Ce^{4+}/Ce^{3+} is + 1.74 V which suggests that it can oxidise water. However, the reaction rate is very slow and hence Ce(IV) is a good analytical reagent.

(b) A half filled 'f ' orbital **Ex.** Eu^{2+}, (f^7), Pr, Nd, Tb and Dy also exhibit +4 state but only in oxides, MO_2. Eu^{2+} is formed by losing the two s electrons and its f^7 configuration accounts for the formation of this ion. However, Eu^{2+} is a strong reducing agent changing to the common +3 state. Similarly Yb^{2+} which has f^{14} configuration is a reductant.

(c) A completely filled 'f ' orbital **Ex.** Yb^{2+} (f^{14})

(v) Therefore, in higher oxidation state, they act as oxidising while in lower state as reducing agents.

Magnetic properties :

(i) In tripositive lanthanide ions the number of unpaired electrons regularly increases from lanthanum to Gadolinium (0 to 7) and then continuously decreases upto lutecium (7 to 0).

(ii) lanthanum and lutecium ions are diamagnetic, while all other tripositive lanthanide ions are paramagnetic. (Exception – Neodyomium is the most paramagnetic lanthanide).

(iii) Ce^{+4} and Yb^{+2} are also diamagnetic ions.

Colour :

(i) The lanthanide ions have unpaired electrons in their 4f orbitals. Thus these ions absorbs visible region of light and undergo f–f transition and hence exhibit colour.

(ii) The colour exhibited depends on the number of unpaired electrons in the 4f orbitals.

(iii) The ions often with $4f^n$ configuration have similar colour to those ions having $4f^{14-n}$ configuration.

(iv) Lanthanide ions having $4f^0$, $4f^{14}$ are colourless.

Other Properties :

- All the lanthanoids are silvery white soft metals and tarnish rapidly in air.
- The hardness increases with increasing atomic number, samarium being steel hard. Their melting points range between 1000 to 1200 K but samarium melts at 1623 K.
- They have typical metallic structure and are good conductors of heat and electricity.
- Highly dense metals with high m.pts. do not show any regular trend.
- **Ionisation Energies :** Lanthanides have fairly low ionisation energies comparable to alkaline earth metals.
- **Electro positive character :** High due to low I.P.
- **Complex formation :** Do not have much tendency to form complexes due to low charge density because of their large size. Lu^{+3} is smallest in size can only form complex.
- **Reducing Agent :** They readily lose electrons so are good reducing agent.
- **Alloy :** Alloys of lanthanides with Fe are called Misch **metals**, which consists of a lanthanoid metal (~ 95%) and iron (~ 5%) and traces of S, C, Ca and Al.
- **Basic Nature :** $La(OH)_3$ is most basic in nature while $Lu(OH)_3$ least basic.
- **Carbide :** Lanthanides form MC_2 type carbide with carbon, which on hydrolysis gives C_2H_2.
- The lanthanide elements Eu and Yb dissolve directly in very high concentration in liquid ammonia.

Lanthanide contraction :

(i) In the lanthanide series with increasing atomic number, there is a progressive decrease in the size from lanthanum to lutetium or from La^{+3} to Lu^{+3}. This contraction in size is known as lanthanide contraction.

(ii) The general electronic configuration of these elements is $4f^{1-14}5s^2p^6d^{0-1}6s^2$. In these elements the added electron enters the deep seated f-orbitals and therefore experiences considerable pull by the nucleus.

(iii) Due to very poor shielding effect of (n-2)f electrons, they exert very little screening effect on the outermost $6s^2$ electrons.

Hence, with increasing atomic number, the enhanced nuclear charge leads to contraction in the size of atoms and ions.

(iv) The atomic volumes of Europium and Ytterbium are unexceptely large. The large atomic size of Eu and Yb suggest weaker bonding in the solid elements. Both these elements have only two electrons extra than the stable configurations (half filled, f^7, and completely filled, f^{14}), hence they utilise two electrons in metallic bonding as in the case with barium.

Effects of Lanthanide Contraction :

Close resemblance of Lanthanides : The general decrease in the sizes of the lanthanides with an increase in their nuclear charges result in a small increase in their ionisation energies. Hence their basic and ionic nature gradually decreases from La to Lu.This also explains the variations in properties such as increased tendency for hydrolysis and formation of complex salts and decreased thermal stability, solubility of their salts.

Similarity of Yttrium with lanthanides : The properties of Yttrium are so similar to the lanthanides that it is considered more a member of the lanthanide series than a congener of scandium.

Anomalous behaviour of post-lanthanides : The following anomalies may be observed in the behaviour of post-lanthanide elements.

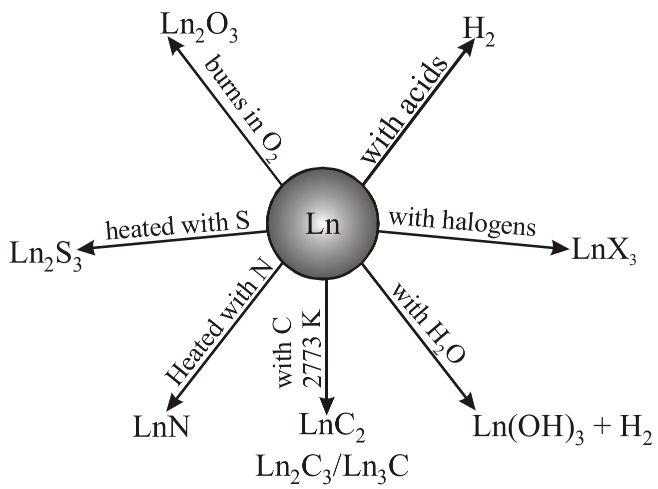
(a) **Atomic size :** The ionic radii of Zr^{+4} is about 9% more than Ti^{+4}. Similar trend is not maintained on passing from the second to third transition series. The ionic radius of Hf^{+4}, instead of increasing (because of inclusion of one more electronic shell), decreases (or is virtually equal to Zr^{+4}) as a consequence of the lanthanide contraction.This explains the close similarities between the members of the second and third transition series than between the elements of the first and second series.

(b) **Ionisation potential and electronegativity :** The effect of lanthanide contraction is also seen in the increase in the ionisation potential values and electronegativities of the elements of the third transition series, contrary to the general trend.Because of the lanthanide contraction, the post-lanthanide elements have stronger positive field and thus the electrons are held more tightly.

The greater effective nuclear charge of the former make them more electronegative than the latter.

(c) **High density :** Because of lanthanide contraction, the atomic sizes of the post lanthanide elements become very small. Consequently, the packing of atoms in their metallic crystals become so much compact that their densities are very high.The densities of the third transition series elements are almost double to those of the second series elements.

(d) **Chemical reactions of the lanthanoids.**



Application of lanthanides :

Cerium is most useful element in the lanthanides –

- Ceramic application – CeO_2, La_2O_3, Nd_2O_3 and Pr_2O_3 are used as decolourizing agents for glasses.
- CeS (m.p. – 2000^0C) is used in the manufacture of a speciel type of crucibles and refractories.
- Lanthanide compounds like cerium molybdate, cerium tungstate are used as paints and dyes.
- In textile and leather industries (Ce salts).
- Mish metal is pyropheric and is used in cigarette & gas lighter.

ACTINIDES (5f - BLOCK ELEMENTS)

(i) The elements in which the extra electron enters 5f-orbitals of (n – 2)th main shell are known as actinides.

(ii) The man-made eleven elements Np_{93} – Lr_{103} are placed beyond uranium in the periodic table and are collectively called trans-uranium elements.

(iii) Th, Pa and U first three actinides are natural elements.

Electronic configuration :

The general configuration of actinides may be given as $5f^{1-14}\ 6d^{0-1}, 7s^2$.

Atomic No.	Elements	Symbol	Electronic Configuration
90	**Thorium**	**Th**	$\mathbf{5f^0 6d^2 7s^2}$
91	Protactinium	Pa	$5f^2 6d^1 7s^2$
92	**Uranium**	**U**	$\mathbf{5f^3 6d^1 7s^2}$
93	**Neptunium**	**Np**	$\mathbf{5f^4 6d^1 7s^2}$
94	**Plutonium**	**Pu**	$\mathbf{5f^6 6d^0 7s^2}$
95	Americium	Am	$5f^7 6d^0 7s^2$
96	**Curium**	**Cm**	$\mathbf{5f^7 6d^1 7s^2}$
97	Berkelium	Bk	$5f^9 6d^0 7s^2$
98	Californium	Cf	$5f^{10} 6d^0 7s^2$
99	Einstenium	Es	$5f^{11} 6d^0 7s^2$
100	Fermium	Fm	$5f^{12} 6d^0 7s^2$
101	Mandelevium	Md	$5f^{13} 6d^0 7s^2$
102	**Nobelium**	**No**	$\mathbf{5f^{14} 6d^0 7s^2}$
103	**Lawrencium**	**Lr**	$\mathbf{5f^{14} 6d^1 7s^2}$

Oxidation states :

(i) In lanthanides and actinides +3 oxidation is the most common for both of the series of elements.

(ii) This oxidation state becomes increasingly more stable as the atomic number increases in the actinide series.

(iii) Highest oxidation states in the actinides is +7 exhibited by Np_{93} & Pu_{94}, it is unstable.

(iv) Highest stable oxidation state is +6 shown by U_{92}.

Other Properties :

- **Physical appearance :** Acitinides are silvery white metals. They get tarnished when exposed to the attack of alkalies.
- **Density :** All the actinides except **thorium** and **americium** have high densities.
- **Colour :** Actinide ions are generally coloured. The colour of actinide ions depends upon the number of 5f-electrons. The ions containing no unpaired 5f-electrons (exactly full filled f-subshell) are colourless, as expected.
- **Ionisation energies :** Ionisation energies values of actinides are low.
- **Electropositive character :** All the known actinide metals are **highly electropositive**. They resemble lanthanide series in this respect.
- **Melting Boiling properties :** They have **high melting and boiling points.** They do not follow regular gradation of melting or boiling points with increase in atomic number.
- **Magnetic properties :** The actinide elements are paramagnetic due to the presence of unpaired electrons.
- **Radioactive nature :** All the actinides are radiaoactive in nature.
- **Actinide contraction :** The size of atom/cation decrease regularly along the actinides series. The steady decrease in ionic radii with increase in atomic number is referred to as **actinide contraction.** This is due to poor shielding of 5f-electrons.

Comparision of lanthanides and Actinides

Points of Resemblance :

(i) Both lanthanides and actinides show a dominant oxidation state of +3.

(ii) Both are electropositive and act as strong reducing agents.

(iii) Cations with unpaired electrons in both of them are paramagnetic.

(iv) Most of the cations of lanthanides and actinides are coloured.

(v) Both of them show a steady decrease in their ionic radii along the series. Thus, lanthanides show **lanthanide contraction** and actinides show **actinide contraction.**

Difference between lanthanides & Actinides **:**

	Lathanides		Actinides
1.	Besides the most common oxidation state of +3 lanthanides show +2 and +4 oxidation states in case of certain elements.	1.	Besides the most common oxidation state of +3, actinides show +4, +5 and +6 oxidation states in case of certain elements.
2.	Lanthanides have less tendency towards complex formation.	2.	Actinides have a stronger tendency towards complex formation.
3.	Except promethium, they are non radioactive.	3.	All the actinides are radioactive.
4.	Oxides and hydroxide of lanthanides are less basic.	4.	Oxides and hydroxides of actinides are more basic

Some important uses of actinides are as follows –

Thorium : Thorium is used in atomic reactors as fuel rods and in the treatment of cancer.

Uranium : Uranium is used as nuclear fuel. Its salts are used in glass industry (for imparting green colour). textile industry and also in medicines.

Plutonium : Plutonium is used as fuel for atomic reactors as well as in atomic bombs.

EXERCISE # O-1

1. 5f-subshell is filled by electron(s) -

(A) In actinides
(B) After filling of 7s-subshell
(C) Before filling of electron in 6d series
(D) All are correct

FB0001

2. Ln (Lanthanide) $\xrightarrow[\text{Halogen}]{\text{With}}$ (X)

Ln (Lanthanide) $\xrightarrow[O_2]{\text{Burn With}}$ (Y)

Ln (Lanthanide) $\xrightarrow[N_2]{\text{Heated with}}$ (Z)

X, Y & Z are respectively -

(A) LnX_3, Ln_2O_3, Ln_3N
(B) LnX_3, Ln_2O_3, LnN
(C) LnX_2, LnO, LnN
(D) LnX_2, Ln_2O_3, Ln_3N

FB0002

3. Last element of lanthanide series is -

(A) Lawrencium (B) Lutetium (C) Thulium (D) Hafnium

FB0003

4. Which is consequence of lanthanide contraction -

(A) Size of Zr >> Hf (B) Size of Zr << Hf (C) Size of Zr $\approx$ Hf (D) Size of Zr > Zr^{4+}

FB0004

5. Select the ion which is larger than Ce^{3+}

(A) Lu^{3+} (B) Eu^{3+} (C) Ce^{4+} (D) La^{3+}

FB0005

6. Select the reducing agent out of given options-

(A) Ce^{4+} (B) Eu^{2+} (C) La^{3+} (D) Na^{+}

FB0006

7. The correct order of ionic radii of Y^{3+}, La^{3+}, Eu^{3+} and Lu^{3+} is :-

(A) $Y^{3+} < La^{3+} < Eu^{3+} < Lu^{3+}$
(B) $Y^{3+} < Lu^{3+} < Eu^{3+} < La^{3+}$
(C) $Lu^{3+} < Eu^{3+} < La^{3+} < Y^{3+}$
(D) $La^{3+} < Eu^{3+} < Lu^{3+} < Y^{3+}$

FB0007

8. Which of the following statement is **NOT CORRECT** ?

(A) $La(OH)_3$, is less basic than $Lu(OH)_3$
(B) In lanthanide series, ionic radius of Ln^{3+} ions decreases
(C) La is actually an element of transition series rather than lanthanide series
(D) Atomic radii of Zr and Hf are same because of lanthanide contraction.

FB0008

9. In the lanthanide series, the basicity of the lanthanide hydroxides

(A) Increases
(B) Decreases
(C) First increase and then decrease
(D) First decrease and then increases

FB0009

10. The reason for the stability of Gd^{3+} ion is

(A) 4*f* subshell — half filled

(B) 4*f* subshell — completely filled

(C) Possesses the general electronic configuration of noble gases

(D) 4*f* subshell empty

FB0010

11. Which of the following pairs has the same size ?

(A) Zn^{2+}, Hf^{4+} (B) Fe^{2+}, Ni^{2+} (C) Zr^{4+}, Ti^{4+} (D) Zr^{4+}, Hf^{4+}

FB0011

12. Which of the following ions will exhibit colour in aqueous solutions ?

(A) Sc^{3+} (Z = 21) (B) La^{3+} (Z = 57) (C) Ti^{3+}(Z = 22) (D) Lu^{3+} (Z = 71)

FB0012

13. Which of the following exhibits only +3 oxidation state ?

(A) Ac (B) Pa (C) U (D) Th

FB0013

EXERCISE # JEE-MAIN

1. Arrange Ce^{3+}, La^{3+}, Pm^{3+} and Yb^{3+} in increasing order of their ionic radius - **[AIEEE-2002]**

(1) $Yb^{3+} < Pm^{3+} < Ce^{3+} < La^{3+}$ (2) $Ce^{3+} > Yb^{3+} < Pm^{3+} < La^{3+}$

(3) $Yb^{3+} > Pm^{3+} < La^{3+} < Ce^{3+}$ (4) $Pm^{3+} < La^{3+} < Ce^{3+} > Yb^{3+}$

FB0014

2. Most common oxidation states shown by cerium are : **[AIEEE-2002]**

(1) +2, +4 (2) +3, +4 (3) +3, +5 (4) +2, +3

FB0015

3. A reduction in atomic size with increase in atomic number is a characteristic of elements of :

(1) f-Block (2) Radioactive series **[AIEEE-2003]**

(3) High atomic masses (4) d-Block

FB0016

4. The radius of La^{3+} is 1.06Å, which of the following given values will be closest to the radius of Lu^{3+} (At no. of Lu = 71, La = 57)- **[AIEEE-2003]**

(1) 1.6 Å (2) 1.4 Å (3) 1.06 Å (4) 0.85 Å

FB0017

5. Cerium (Z = 58) is an important member of the lanthanoids. Which of the following statements about cerium is **INCORRECT** - **[AIEEE-2004]**

(1) Cerium (IV) acts as an oxidising agent

(2) The +3 oxidation state of cerium is more stable than the +4 oxidation state

(3) The +4 oxidation state of cerium is not known in solutions

(4) The common oxidation states of cerium are +3 and +4

FB0018

6. The lanthanoid contraction is responsible for the fact that - **[AIEEE-2005]**

(1) Zr and Y have about the same radius (2) Zr and Nb have similar oxidation state

(3) Zr and Hf have about the same radius (4) Zr and Zn have similar oxidation state

FB0019

7. Lanthanoid contraction is caused due to **[AIEEE-2006]**

(1) the same effective nuclear charge from Ce to Lu

(2) the imperfect shielding on outer electrons by 4f electrons from the nuclear charge

(3) the appreciable shielding on outer electrons by 4f electrons from the nuclear charge

(4) the appreciable shielding on outer electrons by 5d electrons from the nuclear charge

FB0020

8. Identify the **INCORRECT** statement among the following- **[AIEEE-2007]**

(1) d-block elements show irregular and erratic chemical properties among themselves

(2) La and Lu have partially filled d-orbitals and no other partially filled orbitals

(3) The chemistry of various lanthanoids is very similar

(4) 4*f* and 5*f*-orbitals are equally shielded

FB0021

9. The actinoids exhibits more number of oxidation states in general than the lanthanoids. This is because - **[AIEEE-2007]**

(1) The 5*f*-orbitals are more buried than the 4*f*-orbitals

(2) There is a similarly between 4*f*-and-5*f* in the their angular part of the wave function

(3) The actinoids are more reactive than the lanthanoids

(4) The 5*f*-orbitals extend further from the nucleus than the 4*f*-orbitals

FB0022

10. Larger number of oxidation states are exhibited by the actinoids than those by the lanthanoids, the main reason being **[AIEEE-2008]**

(1) 4f orbitals more diffused than the 5f orbitals

(2) lesser energy difference between 5f and 6d than between 4f and 5d orbitals

(3) more energy difference between 5f and 6d than between 4f and 5d orbitals

(4) more reactive nature of the actinides than the lanthanides

FB0023

11. Knowing that the chemistry of lanthanoids (Ln) is dominated by its +3 oxidation state, which of the following statements is **INCORRECT** ? **[AIEEE-2009]**

(1) Ln(III) compounds are generally colourless

(2) Ln(III) hydroxides are mainly basic in character

(3) Because of the large size of the Ln(III) ions the bonding in its compounds is predominently ionic in character

(4) The ionic sizes of Ln(III) decrease in general with increasing atomic number

FB0024

12. In context of the lanthanoids, which of the following statements is **NOT CORRECT** ? **[AIEEE-2011]**

(1) Because of similar properties the separation of lanthanoids is not easy

(2) Availability of 4f electrons results in the formation of compounds in +4 state for all the members of the series

(3) There is a gradual decrease in the radii of the members with increasing atomic number in the series

(4) All the members exhibit +3 oxidation state

FB0025

13. Which of the following forms stable +4 oxidation state ? **[Jee-Main 2012, Online]**

(1) La(Z = 57) (2) Eu(Z = 63) (3) Gd(Z = 64) (4) Ce(Z = 58)

FB0026

14. The number of unpaired electrons in Gadolinium [Z = 64] is :- **[Jee-Main 2012, Online]**

(1) 2 (2) 6 (3) 8 (4) 3

FB0027

15. The lanthanide ion that would show colour is- **[Jee-Main 2019, Online]**

(1) Sm^{3+} (2) La^{3+} (3) Lu^{3+} (4) Gd^{3+}

FB0028

16. The highest possible oxidation states of uranium and plutonium, respectively, are :-

(1) 6 and 4 (2) 7 and 6 **[Jee-Main 2019, Online]**

(3) 4 and 6 (4) 6 and 7

FB0029

17. The correct order of atomic radii is : **[Jee-Main 2019, Online]**

(1) Ce > Eu > Ho > N (2) N > Ce > Eu > Ho

(3) Eu > Ce > Ho > N (4) Ho > N > Eu > Ce

FB0030

18. The maximum number of possible oxidation states of actinoides are shown by **[Jee-Main 2020, Online]**

(1) berkelium (Bk) and californium (Cf) (2) nobelium (No) and lawrencium (Lr)

(3) actinium (Ac) and thorium (Th) (4) neptunium (Np) and plutonium (Pu)

FB0031

19. The electronic configurations of bivalent europium and trivalent cerium are

(atomic number : Xe = 54, Ce = 58, Eu = 63) **[Jee-Main 2020, Online]**

(1) [Xe] $4f^4$ and [Xe] $4f^9$ (2) [Xe] $4f^7$ and [Xe] $4f^1$

(3) [Xe] $4f^7$ $6s^2$ and [Xe] $4f^2$ $6s^2$ (4) [Xe] $4f^2$ and [Xe] $4f^7$

FB0032

ANSWERS KEY

EXERCISE # O-1

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13
Ans	D	B	B	C	D	B	B	A	B	A	D	C	A

EXERCISE # JEE-MAIN

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	**1**	**2**	**1**	**4**	**3**	**3**	**2**	**4**	**4**	**2**
Que.	11	12	13	14	15	16	17	18	19	
Ans.	**1**	**2**	**4**	**3**	**1**	**4**	**3**	**4**	**2**	