NEET | JEE ESSENTIALS

Class XII

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Unit 4 *d*- and *f*-Block Elements | Coordination Compounds

d- AND *f*-BLOCK ELEMENTS

- The *d*-block of the periodic table contains the elements of the group-3 to 12 in which the *d*-orbitals are progressively filled in each of the four long periods.
- In *f*-block, 4*f*- and 5*f*-orbitals are progressively filled. These elements are formal members of group-3 but they have taken out to form a separate *f*-block of the periodic table.

CHEMISTRY OF *d*-BLOCK ELEMENTS

Elements which have incompletely filled *d*-subshell in their ground state or in any one of their oxidation states, are called *d*-block elements. All the *d*-block elements except Zn, Cd and Hg, are transition elements. These elements have completely filled *d*-subshell in their ions, that is why they are not considered as transition elements.

ELECTRONIC CONFIGURATION

General configuration : $(n-1)d^{1\text{-}10}\ ns^{0-2}$
Here, $(n-1)$ stands for inner shell and n for outermost shell or *s*-orbital.
As half-filled (d^5) and fully filled (d^{10}) configurations are more stable. So, Cr and Cu show exceptional electronic configuration in 3*d*-series.

First Transition Series	Second Transition Series	Third Transition Series	Fourth Transition Series
Sc (21) $\Rightarrow$ [Ar]$3d^1 4s^2$	Y(39) $\Rightarrow$ [Kr] $4d^1 5s^2$	La(57) $\Rightarrow$ [Xe] $4f^0\ 5d^1 6s^2$	Ac(89) $\Rightarrow$ [Rn]$5f^0\ 6d^1 7s^2$
Ti (22) $\Rightarrow$ [Ar]$3d^2 4s^2$	Zr(40) $\Rightarrow$ [Kr] $4d^2 5s^2$	Hf(72) $\Rightarrow$ [Xe]$4f^{14} 5d^2 6s^2$	Rf(104) $\Rightarrow$ [Rn] $5f^{14}\ 6d^2 7s^2$
V(23) $\Rightarrow$ [Ar]$3d^3 4s^2$	Nb(41) $\Rightarrow$ [Kr]$4d^4 5s^1$	Ta(73) $\Rightarrow$ [Xe]$4f^{14} 5d^3 6s^2$	Db(105) $\Rightarrow$ [Rn] $5f^{14}\ 6d^3 7s^2$
Cr(24) $\Rightarrow$ [Ar]$3d^5 4s^1$	Mo(42) $\Rightarrow$ [Kr]$4d^5 5s^1$	W (74) $\Rightarrow$ [Xe] $4f^{14} 5d^4 6s^2$	Sg(106) $\Rightarrow$ [Rn]$5f^{14}\ 6d^4 7s^1$
Mn(25) $\Rightarrow$ [Ar]$3d^5 4s^2$	Tc(43) $\Rightarrow$ [Kr]$4d^5 5s^2$	Re(75) $\Rightarrow$ [Xe]$4f^{14} 5d^5 6s^2$	Bh(107) $\Rightarrow$ [Rn]$5f^{14}\ 6d^5 7s^2$
Fe(26) $\Rightarrow$ [Ar]$3d^6 4s^2$	Ru(44) $\Rightarrow$ [Kr]$4d^7 5s^1$	Os(76) $\Rightarrow$ [Xe] $4f^{14} 5d^6 6s^2$	Hs(108) $\Rightarrow$ [Rn] $5f^{14}\ 6d^6 7s^2$
Co(27) $\Rightarrow$ [Ar]$3d^7 4s^2$	Rh(45) $\Rightarrow$ [Kr]$4d^8 5s^1$	Ir(77) $\Rightarrow$ [Xe] $4f^{14} 5d^7 6s^2$	Mt(109) $\Rightarrow$ [Rn] $5f^{14}\ 6d^7 7s^2$
Ni(28) $\Rightarrow$ [Ar]$3d^8 4s^2$	Pd(46) $\Rightarrow$ [Kr]$4d^{10} 5s^0$	Pt(78) $\Rightarrow$ [Xe] $4f^{14}\ 5d^9 6s^1$	Ds(110) $\Rightarrow$ [Rn]$5f^{14} 6d^9 7s^1$
Cu(29) $\Rightarrow$ [Ar]$3d^{10} 4s^1$	Ag(47) $\Rightarrow$ [Kr]$4d^{10}\ 5s^1$	Au(79) $\Rightarrow$ [Xe] $4f^{14}\ 5d^{10} 6s^1$	Rg(111) $\Rightarrow$ [Rn]$5f^{14} 6d^{10} 7s^1$
Zn(30) $\Rightarrow$ [Ar]$3d^{10} 4s^2$	Cd(48) $\Rightarrow$ [Kr]$4d^{10} 5s^2$	Hg(80) $\Rightarrow$ [Xe] $4f^{14} 5d^{10} 6s^2$	Cn(112) $\Rightarrow$ [Rn]$5f^{14} 6d^{10} 7s^2$

GENERAL PROPERTIES OF *d*-BLOCK ELEMENTS

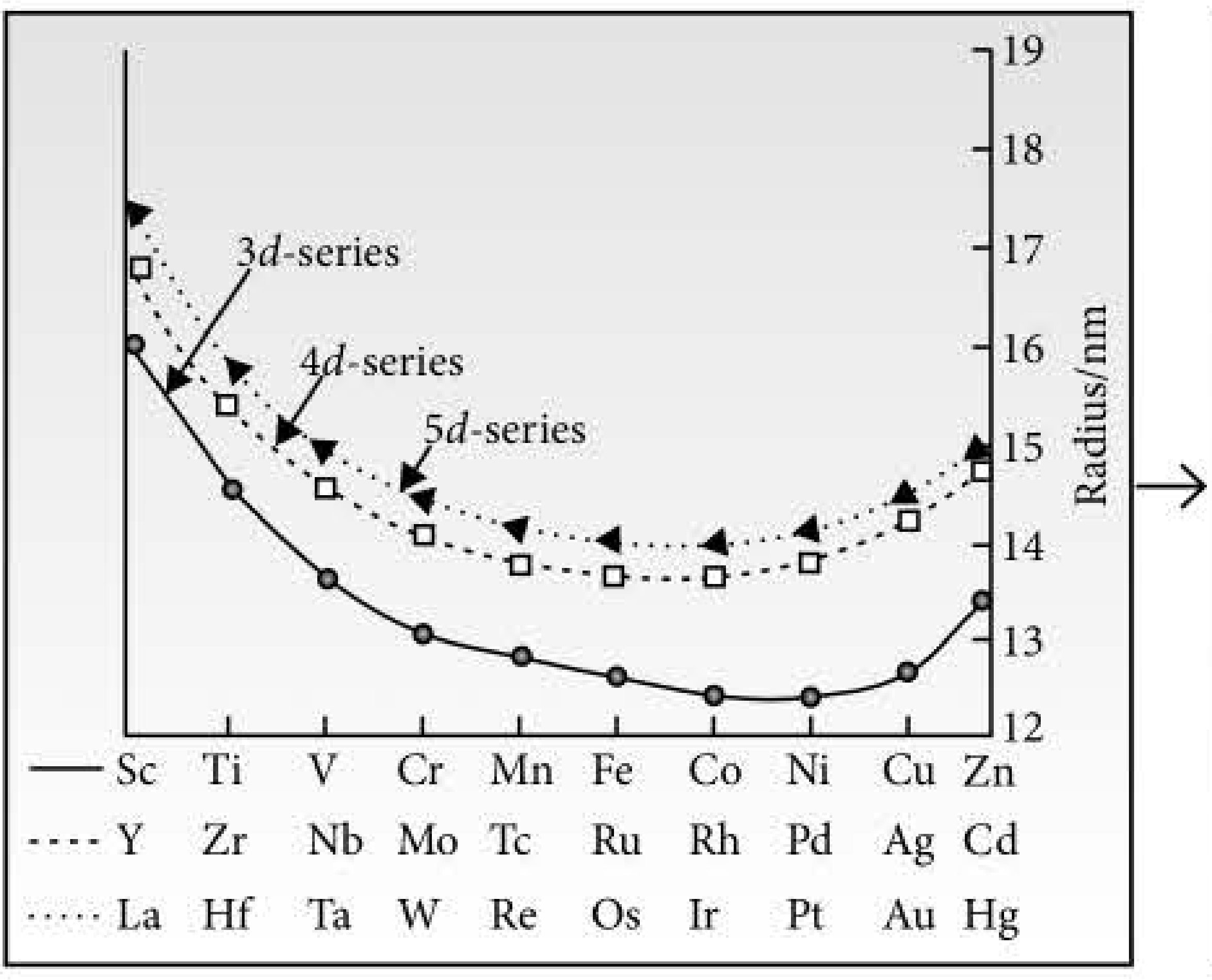
Metallic Character

Due to presence of strong metallic bonds, the transition metals are hard, possess high densities and high enthalpies of atomisation. Scandium has least density whereas Iridium has the highest density among the transition metals.

Atomic and Ionic Sizes

Trends in atomic radii of transition elements

The atomic radii first decreases, at the middle becomes almost constant and then increases towards the end of the period.
In first transition series, atomic radii decrease from Sc to Cr, remain almost constant till Cu and then increase.



The elements of second and third transition series belonging to a particular group have almost equal atomic radii. This is due to the intervention of the 4*f*-orbitals which must be filled before the 5*d* series of elements begins. The filling of 4*f*-orbitals before 5*d*-orbitals results in a regular decrease in atomic radii known as **lanthanoid contraction**.

Ionisation Enthalpy

- The ionisation enthalpy of *d*-block elements are higher than those of *s*-block elements and are lower than those of *p*-block elements.
- In a particular transition series, ionisation enthalpy increases gradually but quite slowly among *d*-block elements.
- Extra stability of half filled and fully filled orbital give rise to high ionisation enthalpy.

Oxidation state

- Variable oxidation states arise due to participation of $(n-1)d$ and *ns*-electrons.
- The element which shows the greatest number of oxidation state occur in or near the middle of the series, *e.g.*, Mn
- In + 2 and +3 oxidation states, the bonds formed are mostly ionic.
- In a group of *d*-block elements, the higher oxidation states are more stable for heavier elements.
- Low oxidation states such as +1, 0 or negative are also possible.

Sc	$+\underline{3}$
Ti	$(+2), +3, +\underline{4}$
V	$+2, +3, +4, +\underline{5}$
Cr	$(+1), +2, +3, (+4), (+5), +\underline{6}$
Mn	$+\underline{2}, +3, +4, (+5), +6, +7$
Fe	$+2, +\underline{3}, (+4), (+5), (+6)$
Co	$+\underline{2}, +3, (+4)$
Ni	$+\underline{2}, +3, +4$
Cu	$+1, +\underline{2}$
Zn	$+\underline{2}$

Y	$+\underline{3}$
Zr	$(+3), +\underline{4}$
Nb	$(+2), +\underline{3}, (+4), +5$
Mo	$+2, +3, +4, +5, +\underline{6}$
Tc	$+2, +\underline{4}, (+5), +\underline{7}$
Ru	$+2, +3, +\underline{4}, (+5), (+6), (+7), (+8), 0, -2$
Rh	$+2, +\underline{3}, +\underline{4}, (+6)$
Pd	$+\underline{2}, (+3), +4$
Ag	$+\underline{1}, (+2), (+3)$
Cd	$+\underline{2}$

La	$+\underline{3}$
Hf	$(+3), +\underline{4}$
Ta	$(+2), (+3), (+4), +\underline{5}$
W	$+2, (+3), +4, +5, +\underline{6}$
Re	$(-1), (+1), (+2), (+3), +4, +5, (+6), +\underline{7}$
Os	$+2, +3, +\underline{4}, +6, +\underline{8}$
Ir	$+2, +3, +\underline{4}, (+6)$
Pt	$+2, (+3), +\underline{4}, (+5), (+6)$
Au	$+1, +\underline{3}$
Hg	$+1, +\underline{2}$

*Oxidation states, which are in brackets, are unstable while underlined oxidation states are stable.

Standard Reduction Potential

- Lower the electrode potential *i.e.*, more negative the standard reduction potential of the electrode, more stable is the oxidation state of the transition metal in the aqueous medium.

Element	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
$E^\circ_{(M^{2+}/M)}$ in volts (V)	—	–1.63	–1.18	–0.91	–1.18	–0.44	–0.28	–0.25	+0.34	–0.76
$E^\circ_{(M^{3+}/M^{2+})}$ in volts (V)	–2.08	–0.37	–0.26	–0.41	+1.57	+0.77	+1.97	—	—	—

Trends in $E^\circ_{M^{2+}/M}$:

- No regular trend due to irregular variation of ionisation energies and sublimation energies.
- Except copper, all other elements have negative reduction potential values.
- The values of E° for Mn, Zn and Ni are more negative than expected from general trend.

Trends in $E^\circ_{M^{3+}/M^{2+}}$:

- E° value for Sc^{3+}/Sc^{2+} is very low reflect the stability of Sc^{3+} which is due to noble gas configuration.
- E° value for Mn^{3+}/Mn^{2+} is high shows that Mn^{2+} is very stable which is due to d^5 configuration.
- E° values for the redox couple M^{3+}/M^{2+} indicate Mn^{3+} and Co^{3+} are strongest oxidising agents.

SOME MORE PROPERTIES

Formation of Interstitial Compounds

- Small non-metallic atoms such as, H, B, C, N etc. are able to occupy interstitial spaces of the lattices of the *d*-block elements to form interstitial compounds.

Colour

- Most of the compounds of transition metals are coloured in the solid as well as in aqueous solution.
- Colour arises due to *d*-*d* transition.
- Transition elements with completely filled or completely empty *d*-orbitals are colourless, *e.g.*, Cu^+, Ag^+, Au^+, Zn^{2+}, Cd^{2+}, etc.

Catalytic properties

- Catalytic properties are due to unpaired electrons in their *d*-orbitals, *e.g.*, V_2O_5, cobalt, Ni, etc.

Tendency to form complexes

Due to small size, high nuclear charge and vacant *d*-orbitals they can accept lone pairs of electrons donated by the ligands, *e.g.*, $[Fe(CN)_6]^{3-}$, etc.

Magnetic properties

- Most of the compounds are paramagnetic due to presence of unpaired electrons.
- $\mu_{\text{eff}} = \sqrt{n(n+2)}$ B.M. where, n = number of unpaired electrons.
- Magnetic moment first increases from d^1 to d^5 and then decreases.

Alloy formation

Due to similar atomic radii and other characteristics, they form alloy very readily.

SOME IMPORTANT COMPOUNDS OF *d*-BLOCK ELEMENTS

Potassium Dichromate ($K_2Cr_2O_7$)	Potassium Permanganate ($KMnO_4$)
Preparation : $Na_2Cr_2O_7 + 2KCl \longrightarrow K_2Cr_2O_7 + 2NaCl$	**Preparation :** $2MnO_2 + 4KOH + O_2 \longrightarrow 2K_2MnO_4 + 2H_2O$ $3K_2MnO_4 + 4HCl \longrightarrow 2KMnO_4 + MnO_2 + 2H_2O + 4KCl$
Properties : • Orange coloured crystalline compound which is soluble in water. • On strong heating, it decomposes with the evolution of oxygen. $4K_2Cr_2O_7 \longrightarrow 4K_2CrO_4 + 2Cr_2O_3 + 3O_2$ • On heating with alkalies, a yellow solution results due to formation of chromate. $\underset{\text{(Orange)}}{K_2Cr_2O_7} + 2KOH \longrightarrow \underset{\text{(Yellow)}}{2K_2CrO_4} + H_2O$ • In the solution, dichromate ions exist in equilibrium with chromate ions. $\underset{\text{(Orange)}}{Cr_2O_7^{2-}} + H_2O \underset{H^+}{\overset{OH^-}{\rightleftharpoons}} \underset{\text{(Yellow)}}{2CrO_4^{2-}} + 2H^+; pH = 4$ • In acidic medium, it acts as a strong oxidising agent. $\overset{(+6)}{Cr_2O_7^{2-}} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$ • **Chromyl chloride test :** Test for chloride ion. When a mixture of a metal chloride and potassium dichromate is heated with conc. H_2SO_4, orange-red vapours of chromyl chloride are evolved. $K_2Cr_2O_7 + 6H_2SO_4 + 4NaCl \longrightarrow 2KHSO_4 + 4NaHSO_4 + \underset{\text{chromyl chloride}}{2CrO_2Cl_2} + 3H_2O$ $CrO_2Cl_2 + 4NaOH \longrightarrow \underset{\text{Yellow soln.}}{Na_2CrO_4} + 2NaCl + 2H_2O$ $Na_2CrO_4 + (CH_3COO)_2\,Pb \longrightarrow 2CH_3COONa + \underset{\text{Yellow ppt.}}{PbCrO_4}$	**Properties :** • Deep purple coloured crystalline solid, moderately soluble in water. • On heating, it decomposes to give O_2. $2KMnO_4 \xrightarrow[513\ K]{\Delta} K_2MnO_4 + MnO_2 + O_2$ • With conc. H_2SO_4, it gives Mn_2O_7 which on heating decomposes to MnO_2. $2KMnO_4 + 2H_2SO_4 \longrightarrow 2KHSO_4 + Mn_2O_7 + H_2O$ $2Mn_2O_7 \xrightarrow{\Delta} 4MnO_2 + 3O_2$ • In alkaline solution, it acts as an oxidising agent. $2KMnO_4 + H_2O \xrightarrow{\text{Weakly alkaline}} 2MnO_2 + 2KOH + 3[O]$ • In neutral solution, it acts as a moderate oxidising agent. $2KMnO_4 + H_2O \longrightarrow 2MnO_2 + 2KOH + 3[O]$ • In acidic solution, it acts as a strong oxidising agent. $2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$
Uses : • As a volumetric reagent. • Preparation of several chromium compounds. • In dyeing, chrome tanning, photography, etc.	**Uses :** • As a strong oxidising agent in laboratory. • Alkaline potassium permanganate is known as Baeyer's reagent used for the testing unsaturation. • As a disinfectant and germicide.

CONCEPT MAP
CLASS XI

Trends and Anomalies in *s*- and *p*-Block Elements

Generally in a group, elements show a regular trend in their physical and chemical properties with increase in their atomic numbers. But some of the elements show exceptional behaviour and anomalies.

General Trends in Properties of *s*- and *p*-Block Compounds

Carbonates and Bicarbonates Stability

- $Li_2CO_3 < Na_2CO_3 < K_2CO_3 < Rb_2CO_3 < Cs_2CO_3$
- $LiHCO_3 < NaHCO_3 < KHCO_3 < RbHCO_3 < CsHCO_3$
- $BeCO_3 < MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$

Basic Strength, Solubility and Stability of Hydroxides

- $LiOH < NaOH < KOH < RbOH < CsOH$
- $Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$
- $\underbrace{B(OH)_3}_{\text{Acidic}} < \underbrace{Al(OH)_3 < Ga(OH)_3}_{\text{Amphoteric}} < \underbrace{In(OH)_3 < Tl(OH)_3}_{\text{Basic}}$

Solubility and Basic Strength of Oxides

- $Li_2O < Na_2O < K_2O < Rb_2O < Cs_2O$
- $\underset{\text{Amphoteric}}{BeO} < \underset{\text{Weakly basic}}{MgO} < \underbrace{CaO < SrO < BaO}_{\text{Strongly basic}}$
- $\underset{\text{Weakly acidic}}{B_2O_3} < \underbrace{Al_2O_3 < Ga_2O_3}_{\text{Amphoteric}} < \underbrace{In_2O_3 < Tl_2O_3}_{\text{Basic}}$

Stability of Peroxides and Superoxides

- $Na_2O_2 < K_2O_2 < Rb_2O_2 < Cs_2O_2$
- $NaO_2 < KO_2 < RbO_2 < CsO_2$
- $MgO_2 < CaO_2 < SrO_2 < BaO_2$

Solubility in Water

- $LiF < NaF < KF < RbF < CsF$
- $LiCl < NaCl < KCl < RbCl < CsCl$
- $NaF < NaCl < NaBr < NaI$
- $BeCl_2 > MgCl_2 > CaCl_2 > SrCl_2 > BaCl_2$
- $BF_3 < BCl_3 < BBr_3$

Stability of Halides

- $CX_4 > SiX_4 > GeX_4 > SnX_4 > PbX_4$
- $CF_4 > CCl_4 > CBr_4 > CI_4$
- $PbX_2 > SnX_2 > GeX_2 > SiX_2$

Solubility of Sulphates

- $BeSO_4 > MgSO_4 > CaSO_4 > SrSO_4 > BaSO_4$

Stability of Sulphate

- $BeSO_4 < MgSO_4 < CaSO_4 < SrSO_4$

Anomalous Behaviour of First Element of Group

Due to

- Small size
- High electronegativity
- High ionization enthalpy
- Absence of *d*-orbitals in valence shell

Anomalous Behaviour of Lithium

- Melting and boiling points are comparatively high.
- Lithium forms nitride while other alkali metals do not.
$6Li + N_2 \rightarrow 2Li_3N$
- Lithium hydroxide and carbonate decompose on heating, while other alkali metal hydroxides and carbonates do not.
$2LiOH \xrightarrow{\Delta} Li_2O + H_2O \qquad Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2\uparrow$

Anomalous Behaviour of Beryllium

- Beryllium is harder than other group members.
- Beryllium does not react with water even at high temperature.
- Beryllium forms covalent compounds. Because of covalent character salts of beryllium are easily hydrolysed.
$BeCO_3 + 4H_2O \rightarrow [Be(H_2O)_4]^{2+} + CO_3^{2-}$

Anomalous Behaviour of Boron

- Boron is hard and has high melting and boiling points.
- Boron forms only covalent compounds while others form both ionic and covalent compounds.
- The oxide and hydroxide of boron are weakly acidic.
$B_2O_3 + 2NaOH \rightarrow 2NaBO_2 + H_2O$
$B(OH)_3 + NaOH \rightarrow NaBO_2 + 2H_2O$

Anomalous Behaviour of Carbon

- Due to small size and high electronegativity, carbon has a strong tendency to form $p\pi$-$p\pi$ multiple bonds.
- Carbon has high tendency of catenation. Tendency for catenation : $C >> Si > Ge \approx Sn >> Pb$

Stability of Hydrides

- $LiH > NaH > KH > RbH > CsH$
- $CH_4 > SiH_4 > GeH_4 > SnH_4 > PbH_4$

Lewis Acid Character

- $BI_3 > BBr_3 > BCl_3 > BF_3$

Stability of Nitrates

- $Be(NO_3)_2 < Mg(NO_3)_2 < Ca(NO_3)_2 < Sr(NO_3)_2 < Ba(NO_3)_2$

CONCEPT MAP
CLASS XII

Surface Chemistry

Surface chemistry is the study of chemical reactions at interfaces. It is closely related to surface engineering which aims at modifying the chemical composition of a surface for desired improvement. Surface science has importance in catalysis, electrochemistry and geochemistry.

Applications of Colloids

Colloids have very vast applications from food products to industries like rubber etc.

In Nature and Everyday Life

Food Articles

Number of food articles that we eat, are colloidal in nature, *e.g.*,

- **Milk** : Fat dispersed in water.
- **Bread** : Air dispersed in baked dough.

Medicines

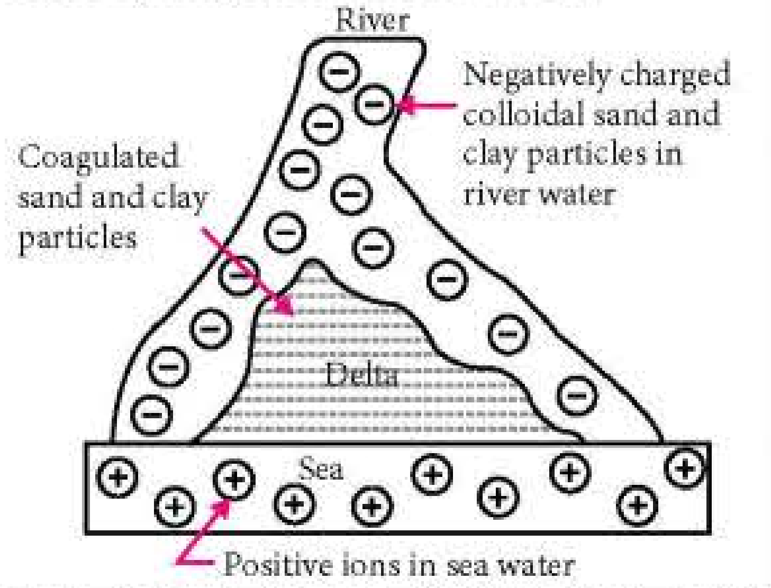
- Colloidal medicines are more effective as they are easily absorbed in the body, *e.g.*,
  - **Silver colloid** : Germicidal
  - **Copper colloid** : Anticancer
  - **Mercury colloid** : Antisyphilis
- Colloidal dispersion of gelatin is used in coating over tablets and granules.

Blood Coagulation

Blood consists of negatively charged colloidal particles (albuminoid substances). On applying ferric chloride solution, it causes coagulation of blood to form a clot which stops further bleeding.

Formation of Delta

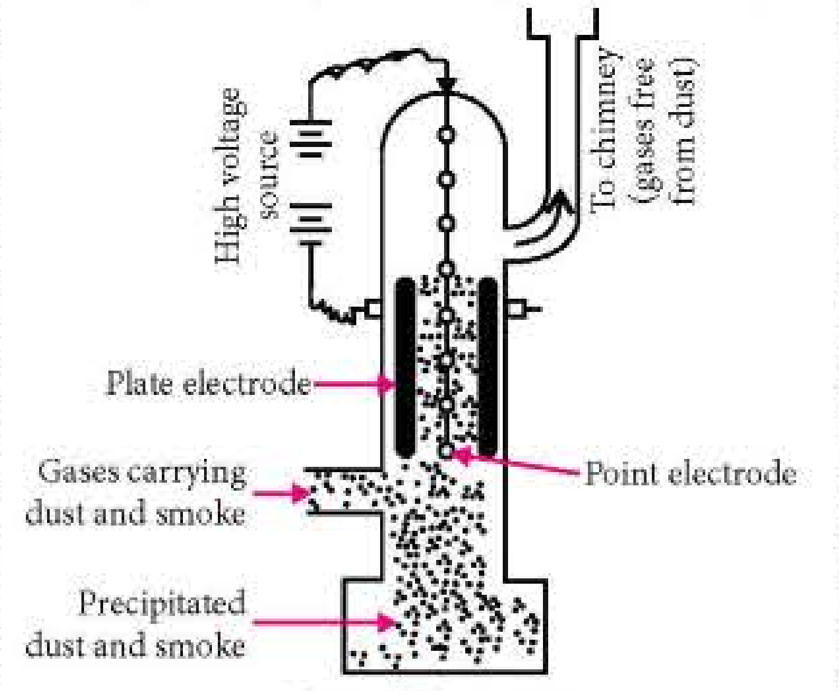
Formation of delta shaped heap of sand, clay, etc. where river falls into sea due to coagulation of sand/clay particles by electrolytes present in sea water.



In Industries

Smoke Precipitation

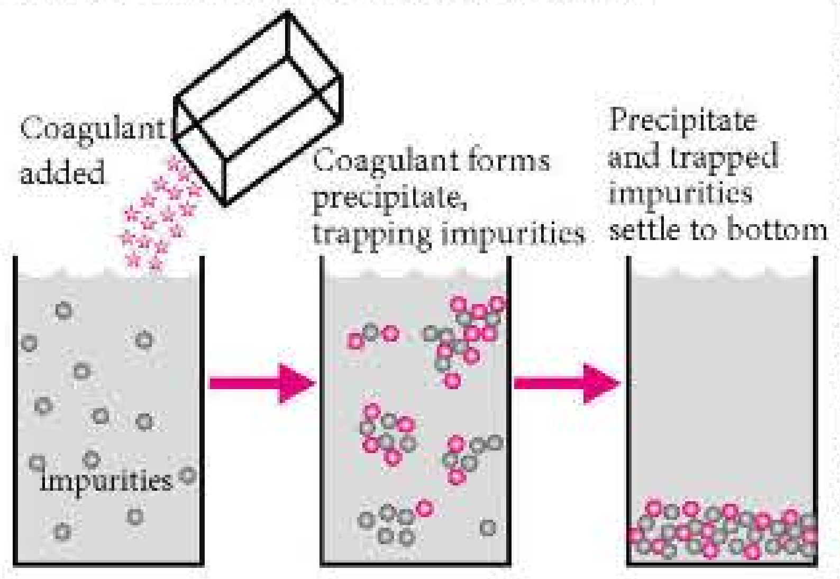
Smoke is a big problem for environment as it is the major cause of air pollution. Coagulation of the dispersed colloidal particles (smoke) occurs on metal plates before allowing them to pass through the chimney.



Cottrell Precipitator

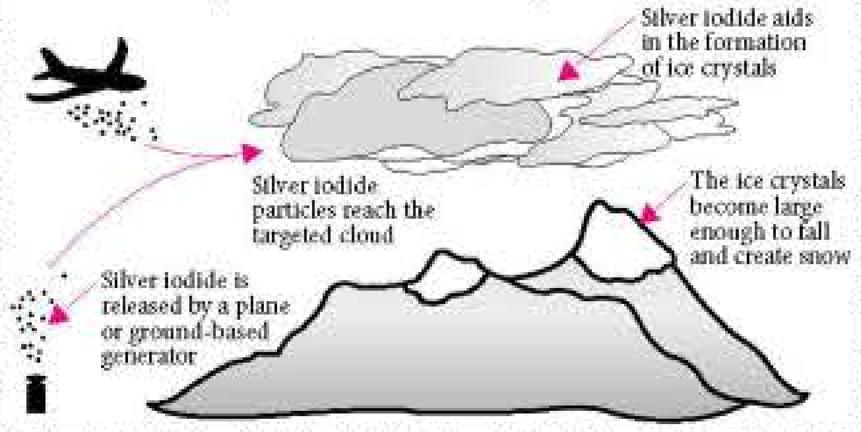
Purification of Drinking Water

Addition of the electrolyte (like alum) for water purification is based on the fact that impure water is a colloidal system.



Artificial Rain

Due to mixing of oppositely charged sand or common salt with the clouds to bring about coagulation of water particles.



Applications of Adsorption

Adsorption finds extensive applications in research laboratories and in industries. It can be used to remove certain classes of pollutants from air and industrial waste water.

In Gas Masks

Gas masks are used to adsorb poisonous gases (*e.g.*, Cl_2, CO, oxides of sulphur etc.) and thus purify the air for breathing. Activated charcoal is used for this purpose.

Removal of Colouring Matter from Solution

Many substances such as sugar, juice and vegetable oils (having coloured impurities) can be decolourised by using adsorbents like activated charcoal or fuller's earth, *e.g.*, animal charcoal is used as a decolouriser in the manufacture of cane sugar.

Heterogeneous Catalysis

Mostly heterogeneous catalytic reactions proceed through the adsorption of gaseous reactants on solid catalyst, *e.g.*,

- Finely powdered nickel is used for the hydrogenation of oils.
- Finely divided vanadium pentaoxide (V_2O_5) is used in the Contact process for the manufacture of sulphuric acid.

In Curing Disease

Some drugs can adsorb the germs and kill them hence, save us from diseases.

Separation of Inert Gases

Due to the difference in degree of adsorption of gases by charcoal, a mixture of inert gases can be separated by adsorption on coconut charcoal at different temperatures.

CHEMISTRY OF *f*-BLOCK ELEMENTS

The elements in which the last electron enters the anti-penultimate energy level, *i.e.*, $(n-2)$ *f*-orbitals, are called *f*-block or inner transition elements.

General electronic configuration : $(n-2)f^{1-14}(n-1)d^{0-1}ns^2$

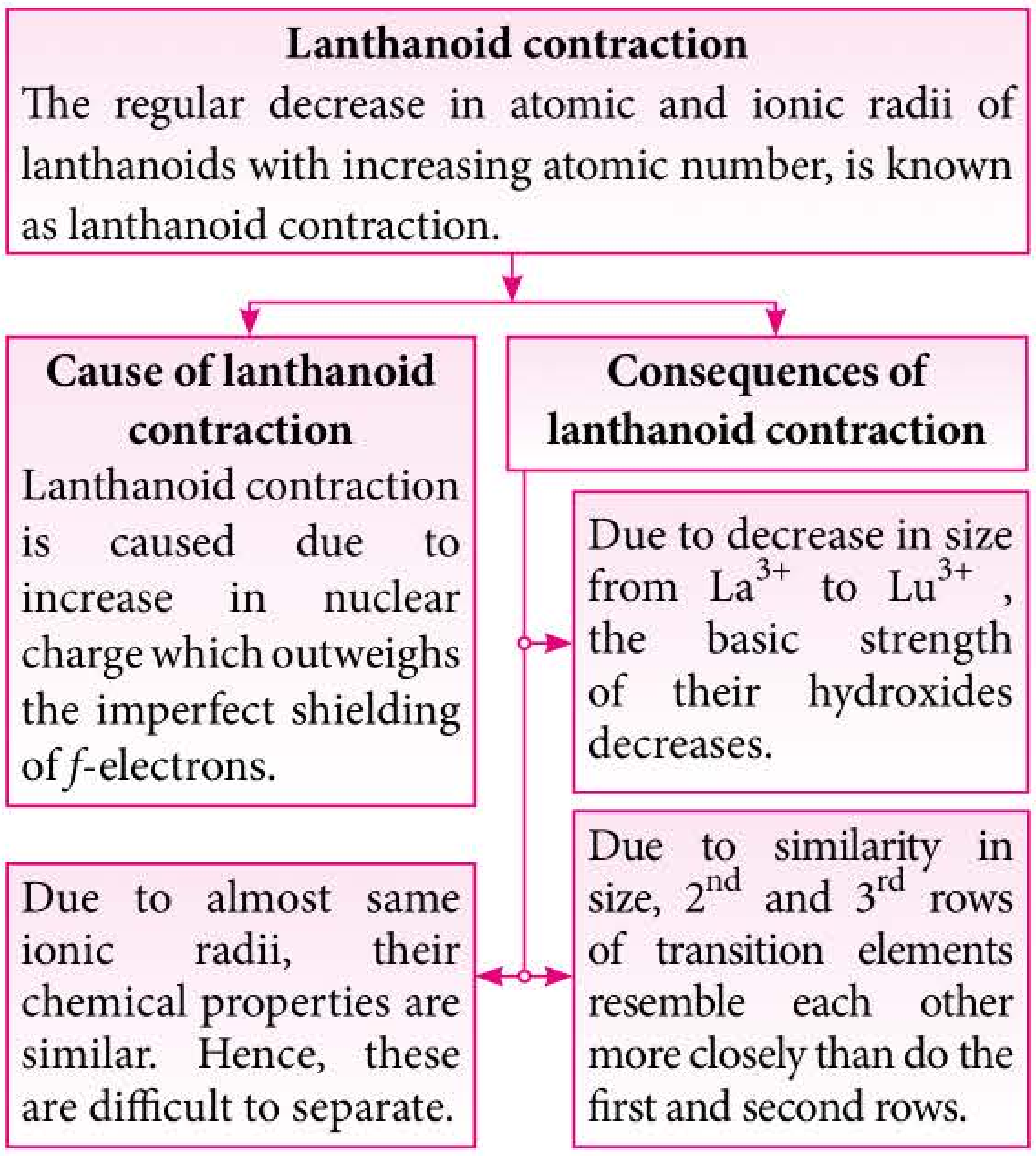
LANTHANOIDS

The elements in which the last electron enters one of the 4*f*-orbitals, are called lanthanides or lanthanons.

Name of the elements	Symbol (Ln)	At. No. (*Z*)	Electronic configuration	Oxidation states
Lanthanum	La	57	$[Xe]\ 5d^16s^2$	+ $\underline{3}$
Cerium	Ce	58	$[Xe]4f^15d^16s^2$	+ $\underline{3}$, + 4
Praseodymium	Pr	59	$[Xe]4f^3\ 5d^06s^2$	+ $\underline{3}$, + 4
Neodymium	Nd	60	$[Xe]4f^45d^06s^2$	+ 2, + $\underline{3}$, + 4
Promethium	Pm	61	$[Xe]4f^55d^06s^2$	+ $\underline{3}$
Samarium	Sm	62	$[Xe]4f^65d^06s^2$	+ 2, + $\underline{3}$
Europium	Eu	63	$[Xe]4f^75d^06s^2$	+ 2, + $\underline{3}$
Gadolinium	Gd	64	$[Xe]4f^75d^16s^2$	+ $\underline{3}$
Terbium	Tb	65	$[Xe]4f^95d^06s^2$	+ $\underline{3}$, + 4
Dysprosium	Dy	66	$[Xe]4f^{10}5d^06s^2$	+ $\underline{3}$, + 4
Holmium	Ho	67	$[Xe]4f^{11}5d^06s^2$	+ $\underline{3}$
Erbium	Er	68	$[Xe]4f^{12}5d^06s^2$	+ $\underline{3}$
Thulium	Tm	69	$[Xe]4f^{13}5d^06s^2$	+ 2, + $\underline{3}$
Ytterbium	Yb	70	$[Xe]4f^{14}5d^06s^2$	+ 2, + $\underline{3}$
Lutetium	Lu	71	$[Xe]\ 4f^{14}5d^16s^2$	+ $\underline{3}$

*Underlined oxidation states are stable.

Lanthanoid Contraction



Lanthanoid contraction

The regular decrease in atomic and ionic radii of lanthanoids with increasing atomic number, is known as lanthanoid contraction.

Cause of lanthanoid contraction

Lanthanoid contraction is caused due to increase in nuclear charge which outweighs the imperfect shielding of *f*-electrons.

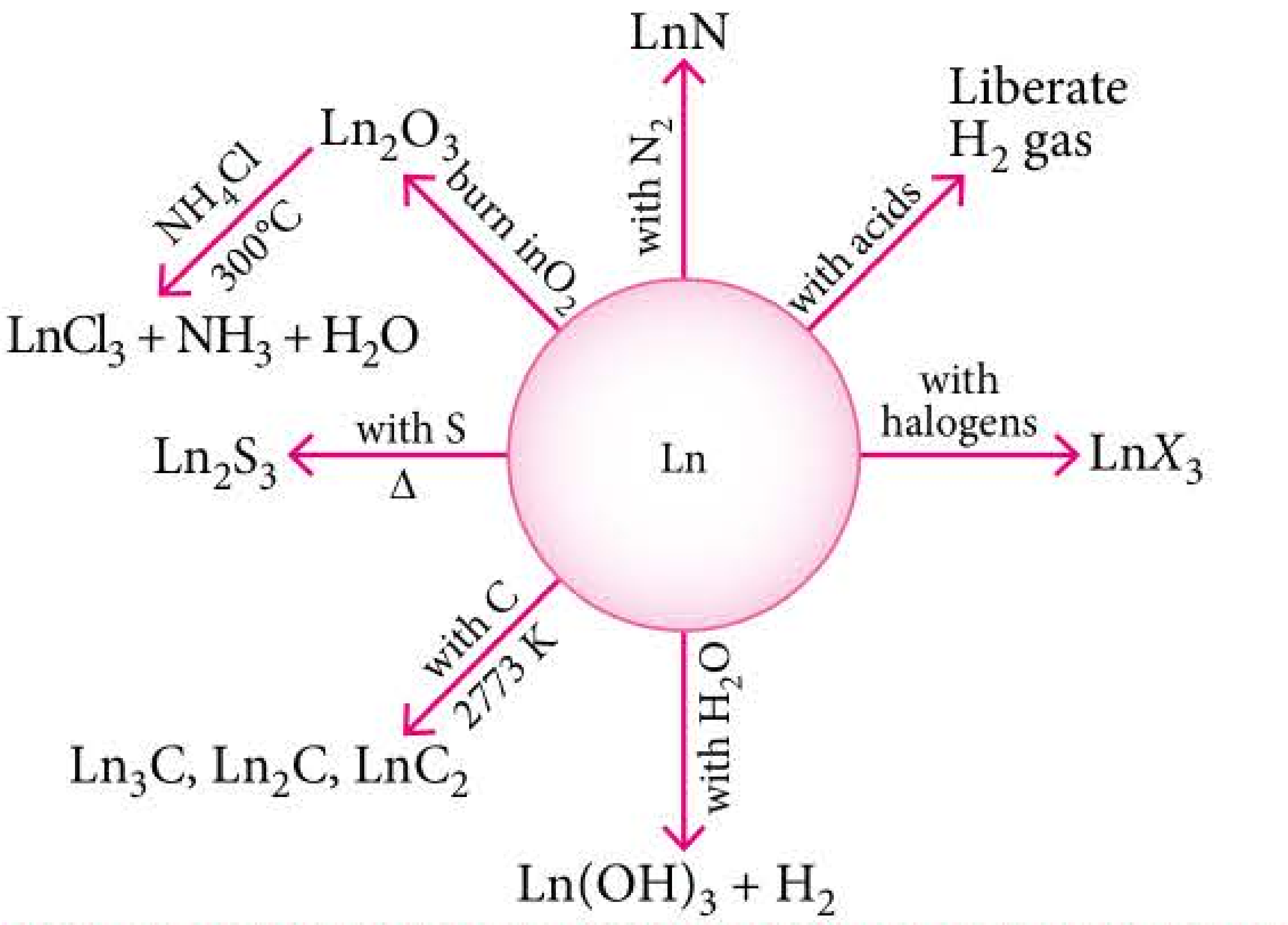
Consequences of lanthanoid contraction

Due to decrease in size from La^{3+} to Lu^{3+}, the basic strength of their hydroxides decreases.

Due to similarity in size, 2nd and 3rd rows of transition elements resemble each other more closely than do the first and second rows.

Due to almost same ionic radii, their chemical properties are similar. Hence, these are difficult to separate.

Chemical Properties of Lanthanoids



ACTINOIDS

Name of the elements	Symbol	At. No. (Z)	Electronic configuration	Oxidation states
Actinium	Ac	89	$[Rn]6d^1, 7s^2$	$+\underline{3}$
Thorium	Th	90	$[Rn]6d^2, 7s^2$	$+3, +\underline{4}$
Protactinium	Pa	91	$[Rn]5f^2, 6d^1, 7s^2$	$+3, +4, +\underline{5}$
Uranium	U	92	$[Rn]5f^3, 6d^1, 7s^2$	$+3, +4, +5, +\underline{6}$
Neptunium	Np	93	$[Rn]5f^4, 6d^1, 7s^2$	$+3, +4, +\underline{5}, +6, +7$
Plutonium	Pu	94	$[Rn]5f^6, 6d^0, 7s^2$	$+3, +\underline{4}, +5, +6, +7$
Americium	Am	95	$[Rn]5f^7, 6d^0, 7s^2$	$+\underline{3}, +4, +5, +6$
Curium	Cm	96	$[Rn]5f^7, 6d^1, 7s^2$	$+\underline{3}, +4$
Berkelium	Bk	97	$[Rn]5f^9, 6d^0, 7s^2$	$+\underline{3}, +4$
Californium	Cf	98	$[Rn]5f^{10}, 6d^0, 7s^2$	$+2, +\underline{3}$
Einsteinium	Es	99	$[Rn]5f^{11}, 6d^0, 7s^2$	$+2, +\underline{3}$
Fermium	Fm	100	$[Rn]5f^{12}, 6d^0, 7s^2$	$+2, +\underline{3}$
Mendelevium	Md	101	$[Rn]5f^{13}, 6d^0, 7s^2$	$+2, +\underline{3}$
Nobelium	No	102	$[Rn]5f^{14}, 6d^0, 7s^2$	$+2, +3$
Lawrencium	Lr	103	$[Rn]5f^{14}, 6d^1, 7s^2$	$+\underline{3}$

*Underlined oxidation states are stable.

COMPARISON OF LANTHANOIDS AND ACTINOIDS

Similarities

- The elements of both the series show mainly +3 oxidation state.
- The elements of both the series are electropositive in nature. They are reactive metals and act as strong reducing agents.
- Actinoids exhibit actinoid contraction like lanthanoid contraction. These contractions are due to the poor shielding effect of electrons residing in $(n-2)$ f-orbitals.
- Cations with unpaired electrons in both the series are paramagnetic.

INFO SHOTS

Transition Metal Silicides !

Transition metal silicides, a distinct class of semiconducting materials that contain silicon, demonstrate superior oxidation resistance, high temperature stability and low corrosion rates, which make them promising for a variety of future developments in electronic devices.

Dissimilarities

S.N.	Lanthanoids	Actinoids
1.	Except promethium, all the remaining lanthanides are non-radioactive.	All the actinides are radioactive.
2.	Besides +3 oxidation state, lanthanides in some cases show +2 and +4 oxidation states.	Besides +3 oxidation state, actinides show a variety of oxidation states like +2, +4, +5, +6 and +7.
3.	Oxides and hydroxides of lanthanides are less basic.	Oxides and hydroxides of actinides are more basic.
4.	Most of the tripositive ions are colourless.	Most of the tripositive and tetrapositive ions are coloured.