Last chapter

IOC Mega Revision

● Live at 8:00 PM

1st March - 13th March

150 min

8PM

10k – 40k (March)

90L

BIG SURPRISE

On 13 March 8 PM

Teaser

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Qs GOC
↓
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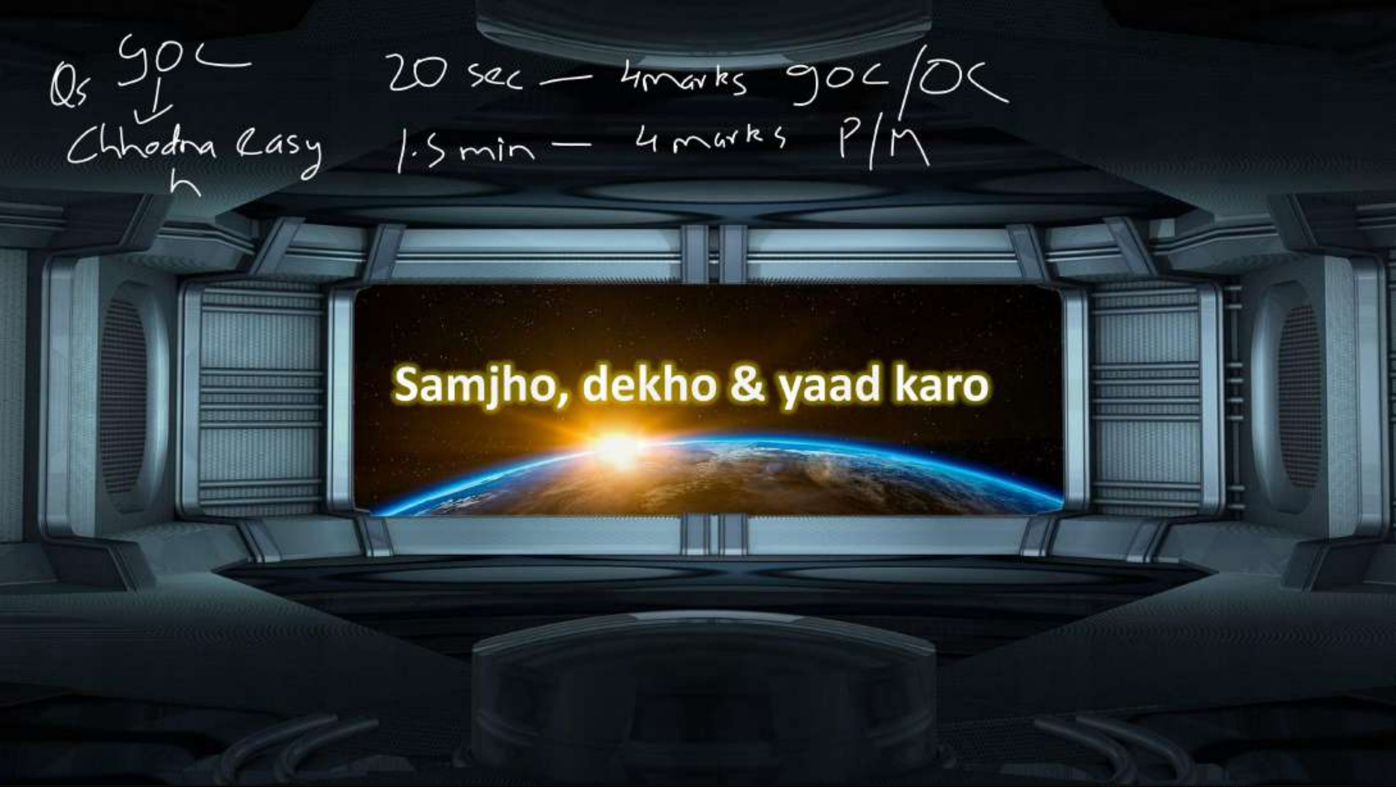
h

20 sec — 4marks GOC/OC

1.5 min — 4 marks P/M



Samjho, dekho & yaad karo

Complete Chemistry Mega Revision Timetable

1 March	Coordination Compounds
3,4 March	Chemical Bonding
5 March	p–block (Class 12)
6 March	p–block (class 11) + Periodic Table
8 March	Metallurgy
10 March	s-block + Hydrogen
12 March	d & f-block
13 March	🎁 **Surprise Gift** 🎁

150

Complete Chemistry Mega Revision PYQs & Quiz Timetable

① Lack of Qs Practice 1) Mehul ② Chirag ③ Shubham

2 March

Coordination Compounds

PYQs

Quiz

4 March

Chemical Bonding

PYQs

Quiz

5 March

p–block (Class 12)

PYQs

Quiz

7 March

p–block (class 11) and Periodic Table

PYQs

Quiz

eSaral APP

✓

11 March

Metallurgy

PYQs

Quiz

12 March

s-block + Hydrogen

PYQs

Quiz

13 March

d & f-block

PYQs

Quiz

Transition Elements

metals
S ⟷ P
moderate
non-metals
d-block
f-block

They are often called 'transition elements' because their position in the periodic table is between s-block and p-block elements

Zn → transition metal

Typically, the transition elements having completely filled d-level, are not considered as transition elements but they are d-block elements.

General Characteristics

Metallic Character

They are all metals and good conductor of heat & electricity.

metallic bonds
↓
free e^-

Cu Au
Fe Ag

Electronic Configuration

3d

Trick

$(n-1)d^{1-10}ns^{1-23}$

बदनाम

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	
साइन्स	टीचर	very	cruel	मन	फे	को	नी	क्यू	जान	जलाती हो।

As usual	$4s^1$	$4s^1$
Others are	$3d^5$	$3d^{10}$

M.P.

d^5 (Max)
$4s^1$

Cr → Maximum

Cr
Mo
W

6 no. of unpaired e^-s are involved in metallic bonding

Zn
Cd
Hg

Lowest m.p.

Due to no unpaired e^-

For metallic bonding

d^{10}

Variation in Atomic Radius

4d ≈ 5d size
4d < 5d IE

$$\mathrm{Sc} \longrightarrow \mathrm{Mn}\ \underbrace{\mathrm{Fe\ Co\ Ni}}\ \mathrm{Cu\ Zn}$$

decreases — Remains same — Increases again

Ionisation Energy

1^{st}, 2^{nd}, 3^{rd} IE's are increasing from left to right for 1^{st} Transition series, but not regularly.

Density VV Imp

The atomic volume of the transition elements are low, compared with s-block, so their density is comparatively high (D = M/V).

Fe < Ni < Cu

Fe < Cu < Au

Fe < Hg < Au

In all the groups (except IIIB) there is normal increase in density from 3d to 4dseries, and from 4d to 5d, it increases just double.

Due to Lanthanide contraction
Ex. : Ti < Zr << Hf

Variable Oxidation States Possible

$IE_{1,2,3,4}$

The elements which give the greatest number of oxidation states occur in or near the middle of the series.

↗ vos → baap

Manganese, for example, exhibits all the oxidation states from +2 to +7.

d^4 to d^7

Variable valecy

The lesser number of oxidation states at the extreme ends stems from either too few electrons to lose or share (Sc, Ti) or too many d electrons (hence fewer orbitals available in which to share electrons with others) for higher valence (Cu, Zn).

At the other end, the only oxidation state of Zinc is +2 (no d electrons are involved).

↓ HOS ↑

In group 6, Mo(VI) and W(VI) are found to be more stable than Cr(VI).

$Cr^{+6} \rightarrow Cr^{+3}$

Thus Cr(VI) in the form of dichromate in acidic medium is a strong oxidising agent, whereas MoO_3 and WO_3 are not.

Low oxidation states are found when a complex compound has ligands capable of π-acceptor character in addition to the Sigma bonding.

Oxidation states of the Ist transition series most common ones are in bold types

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
			+ 1					+ 1	
	+ 2	+ 2	+ 2	+ 2	+ 2	+ 2	+ 2	+ 2	+ 2
+ 3	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3		
	+ 4	+ 4	+ 4	+ 4	+ 4	+ 4	+ 4		
		+ 5	+ 5	+ 5					
			+ 6	+ 6	+ 6				
				+ 7					

Learn

All Cu (II) halides are known except the Iodide.

In this case, Cu^{2+} Oxidises I^- to I_2

$$\underset{Cu^{2+}}{2Cu^{2+}} + \overset{oxidise}{4I^-} \longrightarrow \underset{Cu^{+1}}{\overset{reduce}{Cu_2I_2(s)}} + I_2$$

CuI ✗

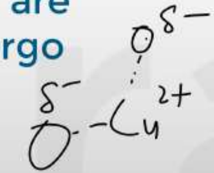
CuF$_2$ ✓

CuCl$_2$ ✓

CuI$_2$ ✗

CuBr$_2$ ✓

However, many Copper (I) compounds are unstable in aqueous solution and undergo disproportionation.



$$2Cu^+ \longrightarrow Cu^{2+} + Cu$$

HE

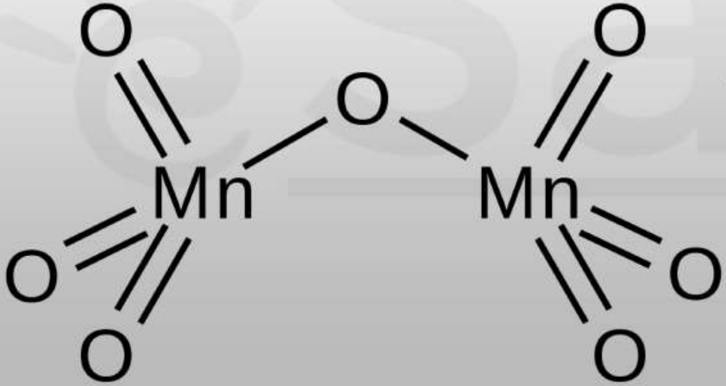
ϕ

The stability of Cu^{2+}(aq.) rather than Cu^+(aq) is due to the much more negative hydration enthalpy of Cu^{2+}(aq.) than Cu^+, which more than compensates for the second Ionisation Enthalpy of Cu.

The highest oxidation number in the oxides coincides with the group number and is attained in Sc_2O_3 to Mn_2O_7.

X-O-X

In the covalent oxide Mn_2O_7, each Mn is tetrahedrally surrounded by O's including a Mn–O–Mn bridge.



Learn

Cr^{2+} is reducing Mn^{3+} is oxidising ✓✓ Imp d^4

Reduction Potential for Cu^{2+}/Cu is positive $3d \rightarrow M^{2+}/M$
For rest of 3d series metals this value is negative RP(-ve)

Mn^{3+} & Co^{3+} are strongest ~~Oas~~ OA in aq soln. Cr^{2+}, Ti^{2+}, V^{2+} are strong RAs.

Learn the whole slide

Formation of Coloured Ion

Colour (aquated)

upe

→Ti^{4+} ⟶ Colourless

V^{4+} ⟶ Blue

V^{2+} ⟶ Violet

Cr^{3+} ⟶ Green

→Sc^{3+} ⟶ Colourless

Ti^{3+} ⟶ Purple

V^{3+} ⟶ Green

Cr^{2+} ⟶ Blue

Learn this

d-d transition

Mn^{2+} ⟶ Light pink

Fe^{3+} ⟶ Yellow

Ni^{2+} ⟶ Green

→Zn^{2+} ⟶ Colourless

Mn^{3+} ⟶ Violet

Fe^{2+} ⟶ Light green

Co^{2+} ⟶ Pink

Cu^{2+} ⟶ Blue

Catalytic Properties

→ Surface property

eSaral → Visualisation

The transition metals and their compounds are known for their catalytic activity.

This activity is ascribed to their ability to adopt multiple oxidation states and to form complexes.

V_2O_5

Vanadium(V)oxide (in Contact Process), finely divided Iron (in Haber's Process), and Nickel (in Catalytic Hydrogenation) are some of the examples.

Learn 2013, 14 2015, 16

For example, Iron(III) catalyses the reaction between Iodide and persulphate ions.

Fe^{3+}

$$2I^- + S_2O_8^{2-} \longrightarrow I_2 + 2SO_4^{2-}$$

Bhuaji/Mamiji
/Aunty

An explanation of this catalytic action can be given as

$$2Fe^{3+} + 2I^- \longrightarrow 2Fe^{2+} + I_2$$

$$2\,Fe^{2+} + S_2O_8^{2-} \longrightarrow 2Fe^{3+} + 2SO_4^{2-}$$

Catalyst **Used**

Learn

$TiCl_3$ ⟶ Used as the Ziegler-Natta catalyst in the production of polythene.

V_2O_5 ⟶ Convert SO_2 to SO_3 in the contact process for making H_2SO_4

$FeSO_4 + H_2O_2$ ⟶ Used as Fenton's reagent for oxidizing Alcohols to Aldehydes.

Formation of Interstitial Compounds

d-block

Interstitial compounds are those which are formed when small atoms like H, C or N are trapped inside the crystal lattices of metals.

They have high melting points, higher than those of pure metals.

They are very hard, some borides approach diamond in hardness.

They retain metallic conductivity.

They are chemically inert.

Alloy Formation

Cooking → utencils → Alloy

Brass

Bronze

SS

An Alloy is a blend of metals prepared by mixing the components.

Fe → Construction

→ C, Cr

Alloys may be homogeneous solid solutions in which the atoms of one metal are distributed randomly among the atoms of the other.

Properties improve

Because of similar radii and other characteristics of transition metals, alloys are readily formed by these metals.

The alloys so formed are hard and have often high melting points.

The best known are ferrous alloys. Chromium, Vanadium, Tungsten, Molybdenum and Manganese are used for the production of a variety of steels and stainless steel.

Alloys of transition metals with non transition metals such as brass (Copper-Zinc) and bronze (Copper-Tin), are also of considerable industrial importance.

Utensils

Ferric comounds are easily hydrolysed as compared to ferrous compounds.

Chromate-Dichromate

2 9mp

ppt

Residue (Fe_2O_3)

Filtrate (Na_2CrO_4)

Dissolve in water and filter

$$\underset{\text{(Chromite Ore)}}{4FeCr_2O_4} + 8Na_2CO_3 + 7O_2 \xrightarrow[\text{Red hot in presence of air}]{1000° - 1300°C} 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2\uparrow$$

$$2Na_2CrO_4 + \underset{\text{conc.}}{H_2SO_4} \longrightarrow Na_2SO_4\downarrow + Na_2Cr_2O_7 + H_2O$$

It's solubility upto 32°C increases and then decreases } Hence, suitable temp. is to be employed to crystallise out Na_2SO_4 first.

Then $Na_2Cr_2O_7$ is crystallised out as $Na_2Cr_2O_7 \cdot 2H_2O$ on evaporation.

$$\underset{\text{Hot conc.}}{Na_2Cr_2O_7} + 2KCl \xrightarrow[\text{Decomposition}]{\text{Double}} \underline{K_2}\overset{+6}{Cr_2}O_7 + 2NaCl \qquad \overset{+6}{Cr}O_4^{2-}$$

NaCl crystallises out first and filtered off.

Then $K_2Cr_2O_7$ crystallised out on cooling

The Chromates and Dichromates are interconvertible in aqueous solution depending upon pH of the solution.

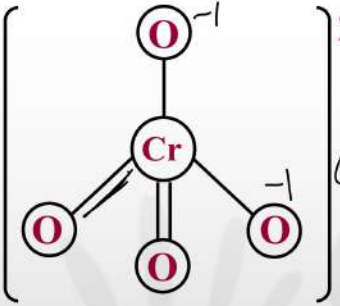
The oxidation state of Chromium in Chromate and Dichromate is the same.

Chromate

Dichromate

$$2CrO_4^{2-} + 2H^+ \longrightarrow Cr_2O_7^{2-} + H_2O$$

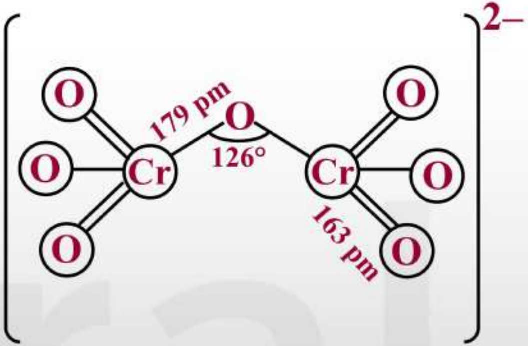
$$Cr_2O_7^{2-} + 2OH^- \longrightarrow 2CrO_4^{2-} + H_2O$$



Chromate ion

Cross check

Learn



Dichromate ion

Potassium dichromate is used as a primary standard in volumetric analysis.

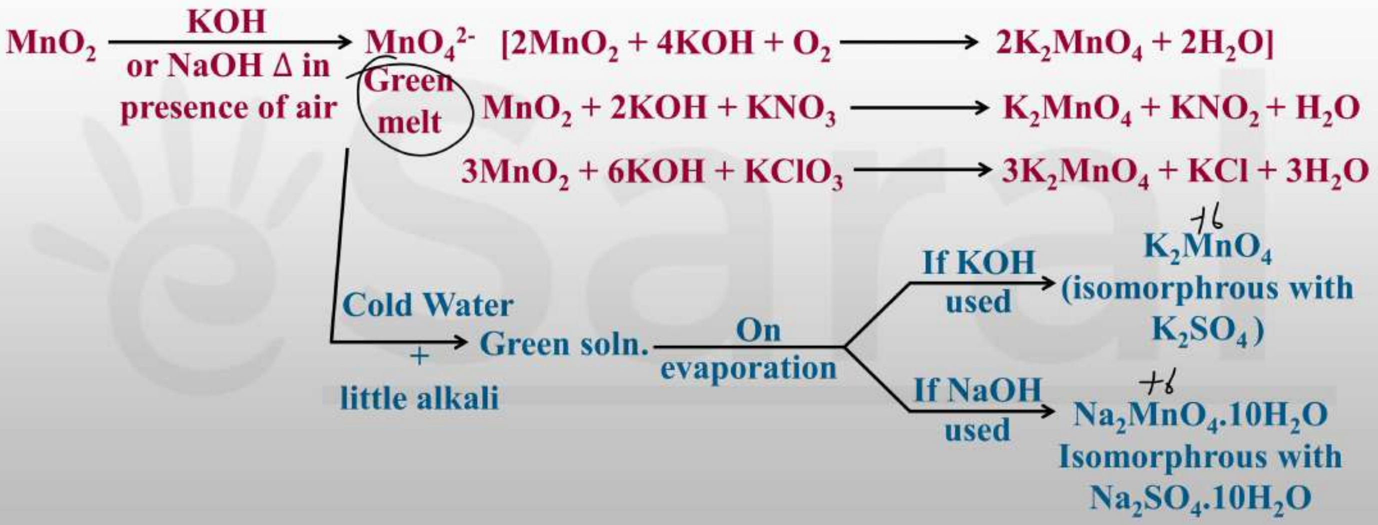
$$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O \quad (E^\ominus = 1.33V)$$

Potassium Dichromate when heated with concentrated sulphuric acid and a soluble chloride gives brown red vapours of CrO_2Cl_2

Learn

Chromyl

Manganate & Permanganate



$$\mathrm{MnO_2} \xrightarrow[\text{or NaOH } \Delta \text{ in presence of air}]{\text{KOH}} \mathrm{MnO_4^{2-}}$$

Green melt

$$[\mathrm{2MnO_2 + 4KOH + O_2 \longrightarrow 2K_2MnO_4 + 2H_2O}]$$

$$\mathrm{MnO_2 + 2KOH + KNO_3 \longrightarrow K_2MnO_4 + KNO_2 + H_2O}$$

$$\mathrm{3MnO_2 + 6KOH + KClO_3 \longrightarrow 3K_2MnO_4 + KCl + 3H_2O}$$

$$\text{Green melt} \xrightarrow[\text{little alkali}]{\text{Cold Water} + } \text{Green soln.} \xrightarrow[\text{evaporation}]{\text{On}}$$

- If KOH used → $\mathrm{K_2\overset{+6}{Mn}O_4}$ (isomorphrous with $\mathrm{K_2SO_4}$)
- If NaOH used → $\mathrm{Na_2\overset{+6}{Mn}O_4.10H_2O}$ Isomorphrous with $\mathrm{Na_2SO_4.10H_2O}$

In presence of $KClO_3$ & KNO_3 the above reaction is more faster because these two on decomposition provides O_2 easily.

Mangante +6

Per " +7

Manganate is also obtained when $KMnO_4$ is boiled with KOH.

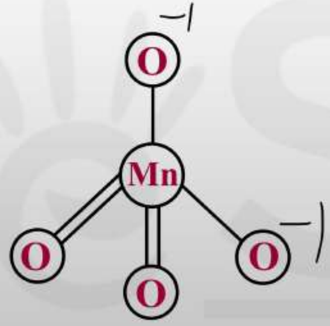
$$4KMnO_4 + 4KOH \xrightarrow{\text{Boiled}} 4K_2MnO_4 + 2H_2O + O_2$$

The green solution of manganate is quite stable in Alkali, but in pure water and in presence of acids, deposits MnO_2 and gives a purple solution of Permanganate.

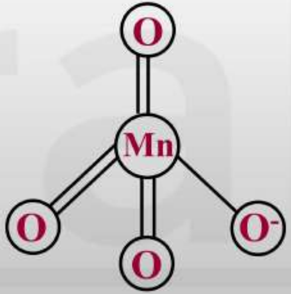
Rxn

$$3K_2MnO_4 + 2H_2O \longrightarrow \underset{\text{Purple}}{2KMnO_4} + \underset{\text{Dark Brown}}{MnO_2}\downarrow + 4KOH$$

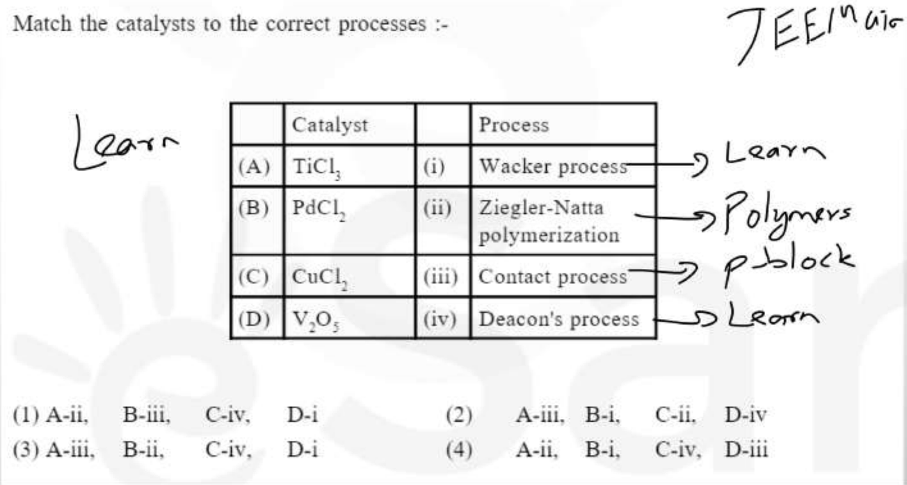
Permanganate is diamagnetic whereas manganate is paramagnetic.



Tetrahedral Manganate (green) ion



Tetrahedral PerManganate (Purple) ion



Match the catalysts to the correct processes :-

JEE Main

Learn

	Catalyst		Process	
(A)	$TiCl_3$	(i)	Wacker process	→ Learn
(B)	$PdCl_2$	(ii)	Ziegler-Natta polymerization	→ Polymers
(C)	$CuCl_2$	(iii)	Contact process	→ p-block
(D)	V_2O_5	(iv)	Deacon's process	→ Learn

(1) A-ii, B-iii, C-iv, D-i
(2) A-iii, B-i, C-ii, D-iv
(3) A-iii, B-ii, C-iv, D-i
(4) A-ii, B-i, C-iv, D-iii

Ans 4

Copper becomes green when exposed to moist air for a long period. This is due to :-

(1) the formation of a layer of cupric oxide on the surface of copper.
(2) the formation of basic copper sulphate layer on the surface of the metal
(3) the formation of a layer of cupric hydroxide on the surface of copper.
(4) the formation of a layer of basic carbonate of copper on the surface of copper.

Learn

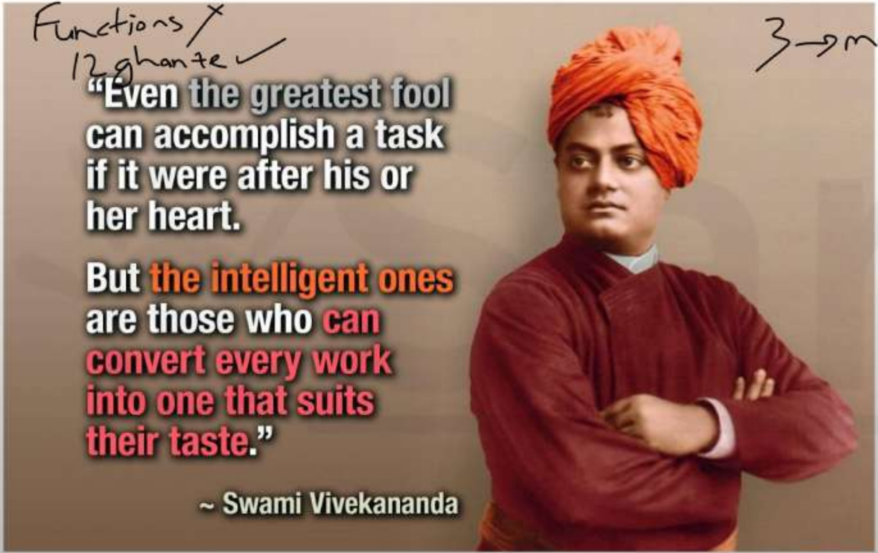
Ans 4

Sweat
\+
Copper → Ideal

Social ✗ Goal → NEET
Friends Limited JEE
Top 50, Goal — 10
↳ 6, 7 mann
3 → mann ✗

Functions ✗
12 ghante ✓

Chem ✓
Math ✓
Phy ✓
Bio

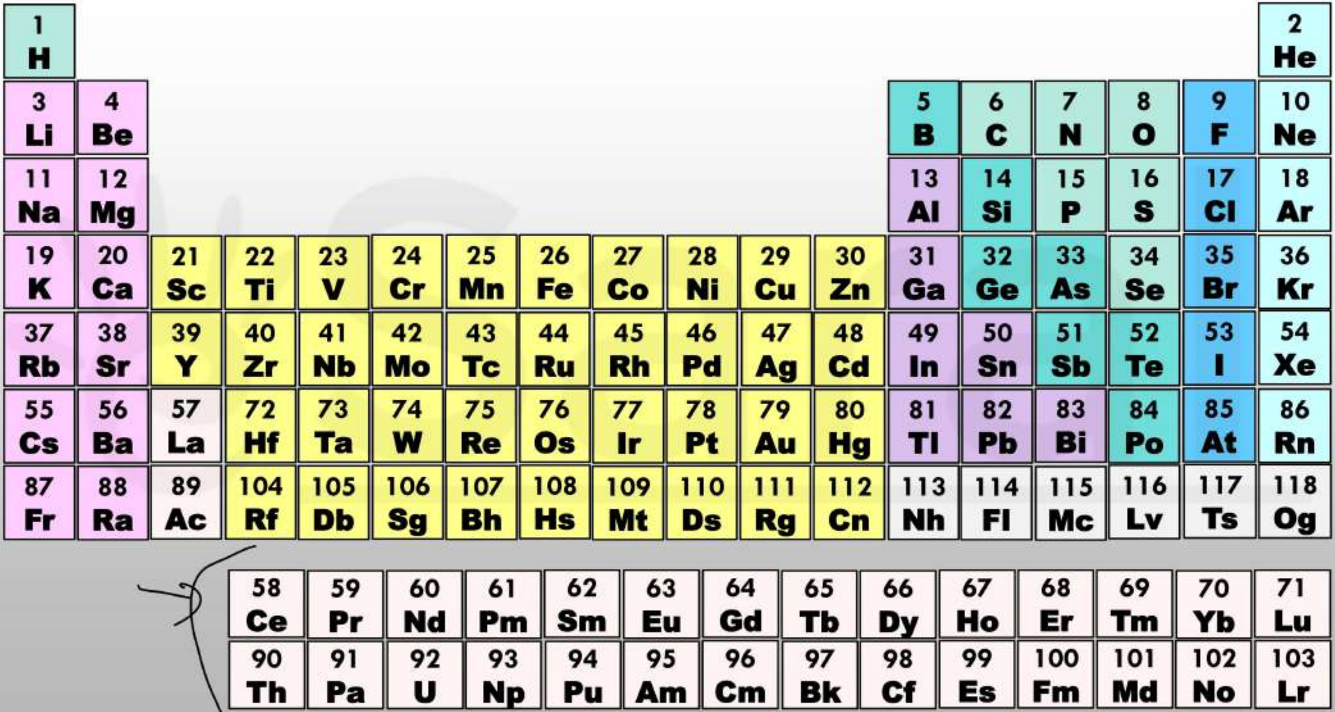


"Even the greatest fool can accomplish a task if it were after his or her heart.

But the intelligent ones are those who can convert every work into one that suits their taste."

~ Swami Vivekananda

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



1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

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

Lanthanides (Rare Earths or Lanthanones)

Lanthanides are reactive elements so are not found in free state in nature.

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	$4f^{1}\ 5d^{1}6s^{2}$	$4f^{1}$
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	$4f^{6}\ 6s^{2}$	$4f^{5}$

Atomic Number	Element	Symbol	Outer electronic configuration	
			Atomic	+3 ion
63	Europium	Eu	$4f^7 6s^2$	$4f^6$
64	Gadolinium	Gd	$4f^7 5d^1 6s^2$	$4f^7$
65	Terbium	Tb	$4f^9 6s^2$	$4f^8$
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	$4f^{14} 6s^2$	$4f^{13}$
71	Lutetium	Lu	$4f^{14} 5d^1 6s^2$	$4f^{14}$

→ 5,4

For Lanthanides, the +3 Oxidation is common.

All the Lanthanides attain +3 oxidation state and only Cerium, Praseodymium, and Terbium exhibit higher oxidation state (+4).

Learn

Eu and Yb exhibit +2 oxidation state.

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.

Colour

The Lanthanide ions have unpaired electrons in their 4f orbitals.

Thus these ions absorb visible region of light and undergo f–f transition and hence exhibit colour.

Ionisation Energies

Lanthanides have fairly low Ionisation Energies comparable to alkaline earth metals.

Complex formation

Lu^{+3} is smallest in size and can form complexes.

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.

Lanthanide Contraction

4f e^-
↳ poor shielding
↳ size contract

In the Lanthanide series with increasing atomic number, there is a progressive decrease in the size from Lanthanum to Lutecium or from La^{+3} to Lu^{+3}.

This contraction in size is known as Lanthanide Contraction.

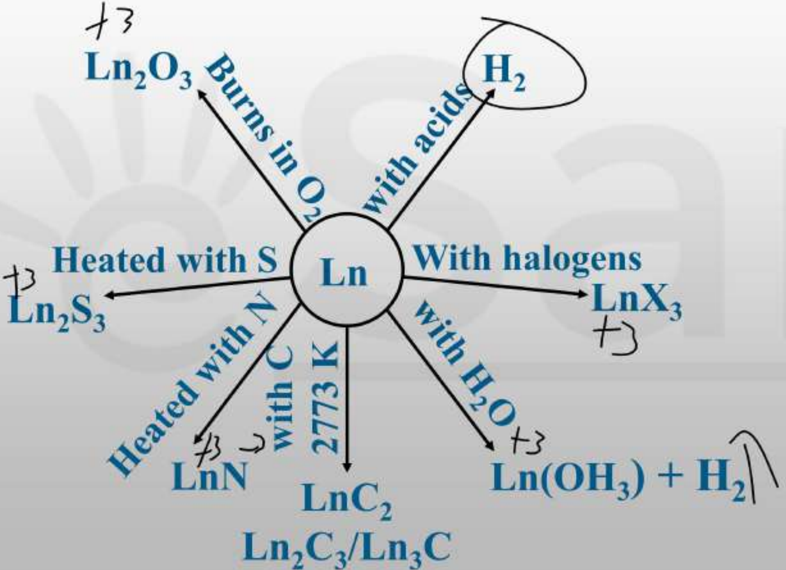
Ionisation Potential and Electronegativity

↓IG EN↓

4d–5d EN

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.

Chemical Reactions of The Lanthanoids



Ln

Burns in O_2 → +3 Ln_2O_3

with acids → H_2

With halogens → LnX_3 +3

with H_2O → +3 $Ln(OH_3) + H_2$

with C 2773 K → LnC_2 Ln_2C_3/Ln_3C

Heated with N → +3 LnN

Heated with S → +3 Ln_2S_3

Actinoids → Lanthanides

$f^1 \to f^7$

$f^8 \to f^{14}$

OS ↓

Actinoids are radioactive and highly reactive metals.

Irregularities in configuration similar to lanthanoids.

Actinoid Contraction happens similar to lanthanoids.

In general they show +3 oxidation state. First half of the series show higher oxidation states though. Pa, U and Np have +5, +6 & +7 oxidation state. Decreases in successive elements.

Uses of d&f block elements

goc
poori
revise
Kar
li

Group 11 metals are called coinage metals.

UK copper coins are copper-coated steel.
Silver UK coins are Cu/Ni alloy.

Learn

AgBr is used in photography industry.

Surprise→Aag

Gunmetal is an alloy of copper, tin, zinc and lead.