

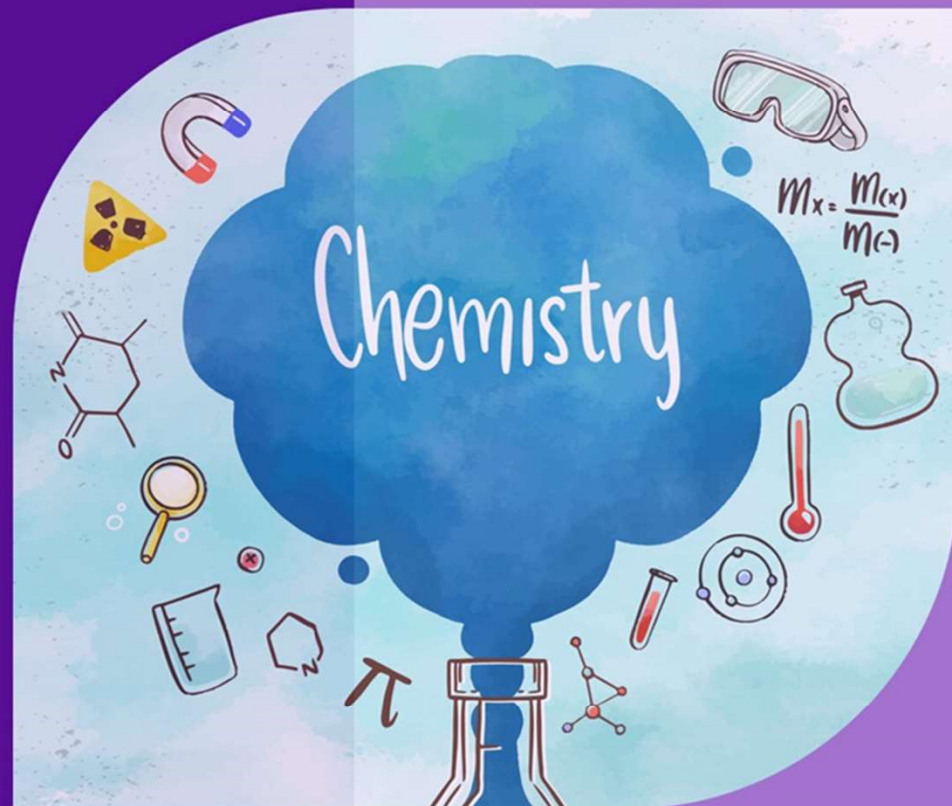


VARSIY 'Ka' ADMISSION PROGRAM 2020

CHEMISTRY

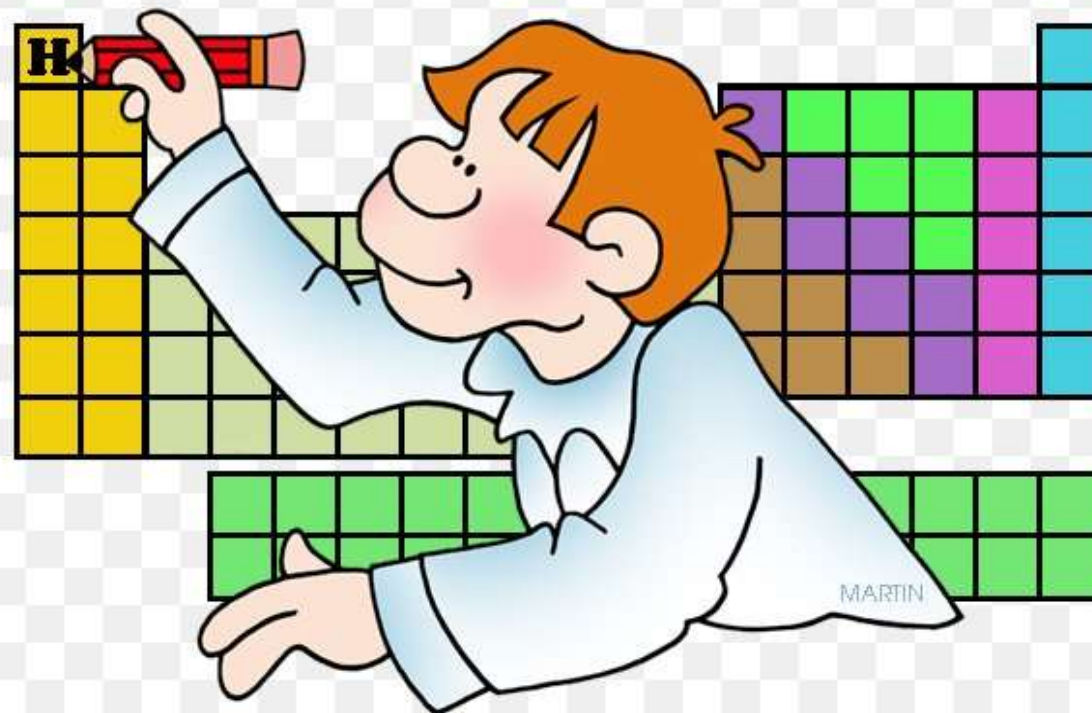
LECTURE : C-01

CHAPTER 3 : PERIODIC PROPERTIES OF ELEMENTS



WHITEBOARD

(Periodic properties)



WHITEBOARD

Aufbau
Rules
↓
last e
↓
orbital
↓
block element

18

S block-14 → G. configuration!
↳ block element

ms¹⁻²

1 H Hydrogen 1.008	2 He Helium 4.002602																
3 Li Lithium 6.94	4 Be Beryllium 9.0121831																
11 Na Sodium 22.98976928	12 Mg Magnesium 24.305	13 Al Aluminium 26.9815385	14 Si Silicon 28.085	15 P Phosphorus 30.973761998	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.948										
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955908	22 Ti Titanium 47.887	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938044	26 Fe Iron 55.845	27 Co Cobalt 58.933194	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.921595	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90584	40 Zr Zirconium 91.224	41 Nb Niobium 92.90637	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.293
55 Cs Caesium 132.90545196	56 Ba Barium 137.327	57-71 Lanthanoids	72 Hf Hafnium 178.49	73 Ta Tantalum 180.94788	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.222	78 Pt Platinum 195.084	79 Au Gold 196.966569	80 Hg Mercury 200.592	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98040	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89-103 Actinoids	104 Rf Rutherfordium (261)	105 Db Dubnium (268)	106 Sg Seaborgium (269)	107 Bh Bohrium (270)	108 Hs Hassium (277)	109 Mt Meitnerium (278)	110 Ds Darmstadtium (285)	111 Rg Roentgenium (282)	112 Cn Copernicium (285)	113 Nh Nihonium (284)	114 Fl Flerovium (289)	115 Mc Moscovium (288)	116 Lv Livermorium (293)	117 Ts Tennessine (294)	118 Og Oganesson (294)

57 La Lanthanum 138.90547	58 Ce Cerium 140.12	59 Pr Praseodymium 140.90768	60 Nd Neodymium 144.242	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92533	66 Dy Dysprosium 162.500	67 Ho Holmium 164.93032	68 Er Erbium 167.259	69 Tm Thulium 168.93402	70 Yb Ytterbium 173.054	71 Lu Lutetium 174.967
89 Ac Actinium (227)	90 Th Thorium 232.0377	91 Pa Protactinium 231.03688	92 U Uranium 238.02891	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (260)

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P block-36 → General confi. → $ns^2 np^{1-6}$
 ↳ p-orbital

1 IA H Hydrogen 1.008	2 IIA Be Beryllium 9.012182											18 VIIIA He Helium					
3 Li Lithium 6.94	4 Be Beryllium 9.012182											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.99840323	10 Ne Neon 20.1797
11 Na Sodium 22.98976928	12 Mg Magnesium 24.305	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIB	9 VIIB	10 VIIB	11 IB	12 IIB	13 IIIA Al Aluminium 26.9815385	14 IVA Si Silicon 28.085	15 VA P Phosphorus 30.973761998	16 VIA S Sulfur 32.06	17 VIIA Cl Chlorine 35.45	18 VIIIA Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955908	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938044	26 Fe Iron 55.845	27 Co Cobalt 58.933194	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.921595	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90584	40 Zr Zirconium 91.224	41 Nb Niobium 92.90637	42 Mo Molybdenum 95.95	43 Tc Technetium [98]	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.293
55 Cs Caesium 132.90545196	56 Ba Barium 137.327	57 - 71 Lanthanoids	72 Hf Hafnium 178.49	73 Ta Tantalum 180.94788	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.227	78 Pt Platinum 195.084	79 Au Gold 196.966569	80 Hg Mercury 200.592	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98040	84 Po Polonium [209]	85 At Astatine [210]	86 Rn Radon [222]
87 Fr Francium [223]	88 Ra Radium [226]	89 - 103 Actinoids	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [265]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [271]	111 Rg Roentgenium [272]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [290]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]

↳ ↓ → ↳

6 × 6 = 36

57 La Lanthanum 138.90547	58 Ce Cerium 140.116	59 Pr Praseodymium 140.90766	60 Nd Neodymium 144.242	61 Pm Promethium [145]	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92535	66 Dy Dysprosium 162.500	67 Ho Holmium 164.93033	68 Er Erbium 167.259	69 Tm Thulium 168.93422	70 Yb Ytterbium 173.045	71 Lu Lutetium 174.9668
89 Ac Actinium [227]	90 Th Thorium 232.0377	91 Pa Protactinium 231.03688	92 U Uranium 238.02891	93 Np Neptunium [237]	94 Pu Plutonium [244]	95 Am Americium [243]	96 Cm Curium [247]	97 Bk Berkelium [247]	98 Cf Californium [251]	99 Es Einsteinium [252]	100 Fm Fermium [257]	101 Md Mendelevium [258]	102 No Nobelium [259]	103 Lr Lawrencium [260]



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D block-41

↳ last shell e⁻ → d orbital

$sc(2d)$
 $[Ar]. 3d^1 4s^2$
 General configuration:
 $(n-1)d^{1-10} 4s^1-2$

1 IA H Hydrogen 1.008	2 IIA Be Beryllium 9.0121831											13 IIIA B Boron 10.81	14 IVA C Carbon 12.011	15 VA N Nitrogen 14.007	16 VIA O Oxygen 15.999	17 VIIA F Fluorine 18.99840323	18 VIIIA Ne Neon 20.1797
3 Li Lithium 6.94	4 Be Beryllium 9.0121831											5 Al Aluminum 26.9815385	6 Si Silicon 28.085	7 P Phosphorus 30.973761998	8 S Sulfur 32.06	9 Cl Chlorine 35.45	10 Ar Argon 39.948
11 Na Sodium 22.98976928	12 Mg Magnesium 24.305	3 Sc Scandium 44.955912	4 Ti Titanium 47.88	5 V Vanadium 50.9415	6 Cr Chromium 51.9961	7 Mn Manganese 54.938044	8 Fe Iron 55.845	9 Co Cobalt 58.933194	10 Ni Nickel 58.6934	11 Cu Copper 63.546	12 Zn Zinc 65.38	13 Ga Gallium 69.723	14 Ge Germanium 72.630	15 As Arsenic 74.921595	16 Se Selenium 78.971	17 Br Bromine 79.904	18 Kr Krypton 83.798
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955912	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938044	26 Fe Iron 55.845	27 Co Cobalt 58.933194	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.921595	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90584	40 Zr Zirconium 91.224	41 Nb Niobium 92.90637	42 Mo Molybdenum 95.94	43 Tc Technetium 98	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.293
55 Cs Caesium 132.90545196	56 Ba Barium 137.327	57-71 Lanthanoids	72 Hf Hafnium 178.49	73 Ta Tantalum 180.94788	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.222	78 Pt Platinum 195.084	79 Au Gold 196.966569	80 Hg Mercury 200.592	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98040	84 Po Polonium 209	85 At Astatine 210	86 Rn Radon 222
87 Fr Francium (223)	88 Ra Radium (226)	89-103 Actinoids	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (264)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 Ds Darmstadtium (267)	111 Rg Roentgenium (268)	112 Cn Copernicium (269)	113 Nh Nihonium (285)	114 Fl Flerovium (289)	115 Mc Moscovium (289)	116 Lv Livermorium (293)	117 Ts Tennessine (294)	118 Og Oganesson (294)

57 La Lanthanum 138.90547	58 Ce Cerium 140.12	59 Pr Praseodymium 140.90766	60 Nd Neodymium 144.242	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92535	66 Dy Dysprosium 162.500	67 Ho Holmium 164.93033	68 Er Erbium 167.258	69 Tm Thulium 168.93402	70 Yb Ytterbium 173.054	71 Lu Lutetium 174.967
89 Ac Actinium 227	90 Th Thorium 232.0377	91 Pa Protactinium 231.03688	92 U Uranium 238.02891	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (260)

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f block-27

G. Configuration:

 $(n-2)f^{1-14}$
 $(n-1)d^{1-10}$
 ns^2

1 IA										18 VIIIA									
1 H Hydrogen 1.008											2 He Helium 4.002602								
3 Li Lithium 6.94	4 Be Beryllium 9.012182											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.99840323	10 Ne Neon 20.1797		
11 Na Sodium 22.98976928	12 Mg Magnesium 24.305	3 IIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIB	9 VIIB	10 VIIB	11 IB	12 IIB	13 Al Aluminium 26.9815385	14 Si Silicon 28.0855	15 P Phosphorus 30.973761998	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.948		
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955908	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938044	26 Fe Iron 55.845	27 Co Cobalt 58.933194	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.921595	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798		
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90584	40 Zr Zirconium 91.224	41 Nb Niobium 92.90637	42 Mo Molybdenum 95.95	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.293		
55 Cs Caesium 132.90545196	56 Ba Barium 137.327	57 - 71 Lanthanoids	72 Hf Hafnium 178.49	73 Ta Tantalum 180.94788	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.222	78 Pt Platinum 195.084	79 Au Gold 196.966569	80 Hg Mercury 200.592	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98040	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)		
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14
13
27



WHITEBOARD

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Poll Question 01

In which block Thorium (Th) situated?

- (a) s block
- (b) p block
- (c) d block ←
- (d) f block ✗

Th \rightarrow $7s^2 6d^2$ d ব্লক



Determination of position of elements in periodic table

□ Determination of group of elements

(1-18)

- **s- block** Number of electrons in outer most shell [Subgroup A] ns^{1-2} ; 1 or 2
- **p- block** = Total number of electrons in outer most shell (sum of e^- in ns & np) + 10 $ns^2 np^{1-6}$
- **d- block** Total number of electrons in $(n-1)d + ns$ orbital [If the summation is 8, 9, 10 then the element is of Group VIII and if it is 11, 12 then of Group IB & Group IIB] [Subgroup B] $(n-1)d^{1-10} ns^{1-2} \rightarrow (d+s)$
- **f- block** = IIIB \rightarrow 3

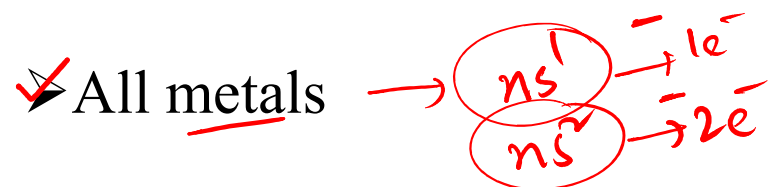
□ Determination of period of elements

The value of **principal quantum number (n)** is the period of that element.

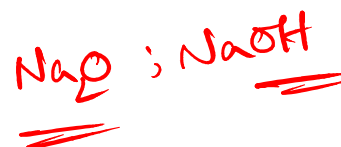
Shortcut:
 $s + p = 'A'$
 $d + f = 'B'$

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S-block



✓ Their oxide/ hydroxide is basic



✓ Lower ionization potential value

(I.E.) ↓↓

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P block (13)

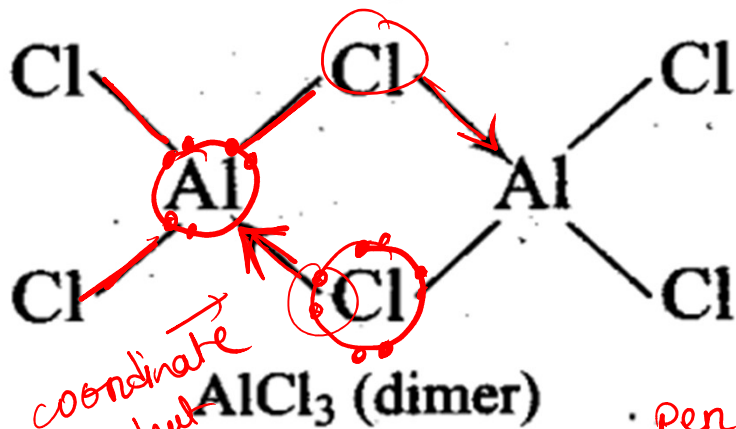
B, Al, Ga, In, Ti

✓ BF₃, AlCl₃ are lewis base

➤ In nature AlCl₃ exists as dimer (Al₂Cl₆).

Base
↳ e⁻ donate

Al → [Ne] 3s² 3p¹
(3v1)



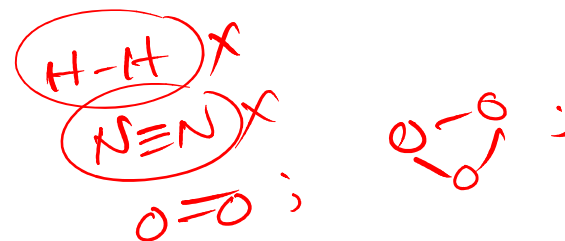
To: Octate ;

pen'cl' - 2 → (lone) 3 pair e⁻

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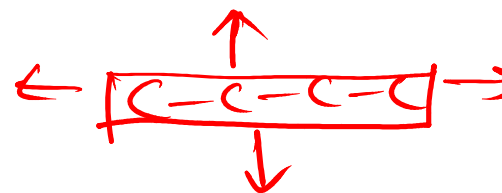
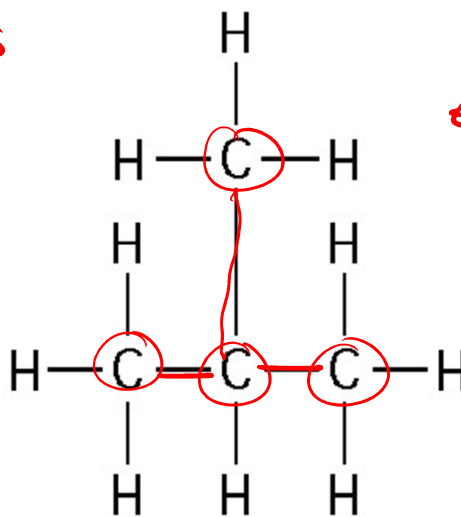
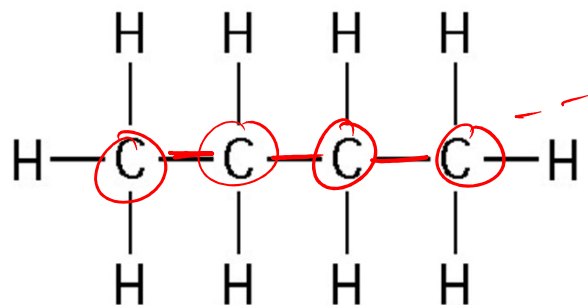
P block (14)

C, Si, Ge, Sn, Pb



★ Catenation property of carbon.

↳ to form a chain;



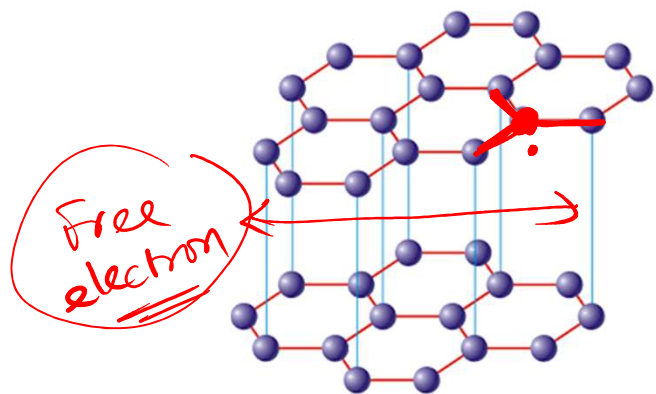
WHITEBOARD

P block (14)

C, Si, Ge, Sn, Pb

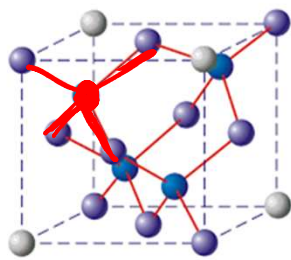


➤ Allotropic forms of carbon.



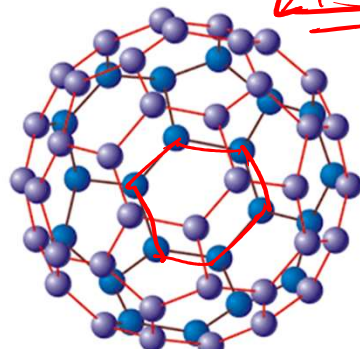
graphite

→ slippery
→ conduct electricity.



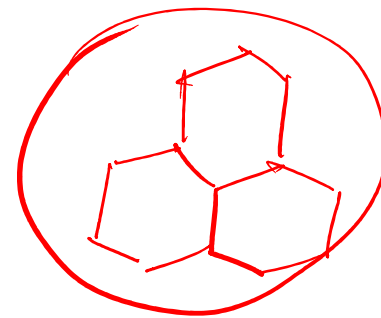
diamond

compact structure → solid
C₆₀ → Nanotechnology



fullerene

→ shape: football

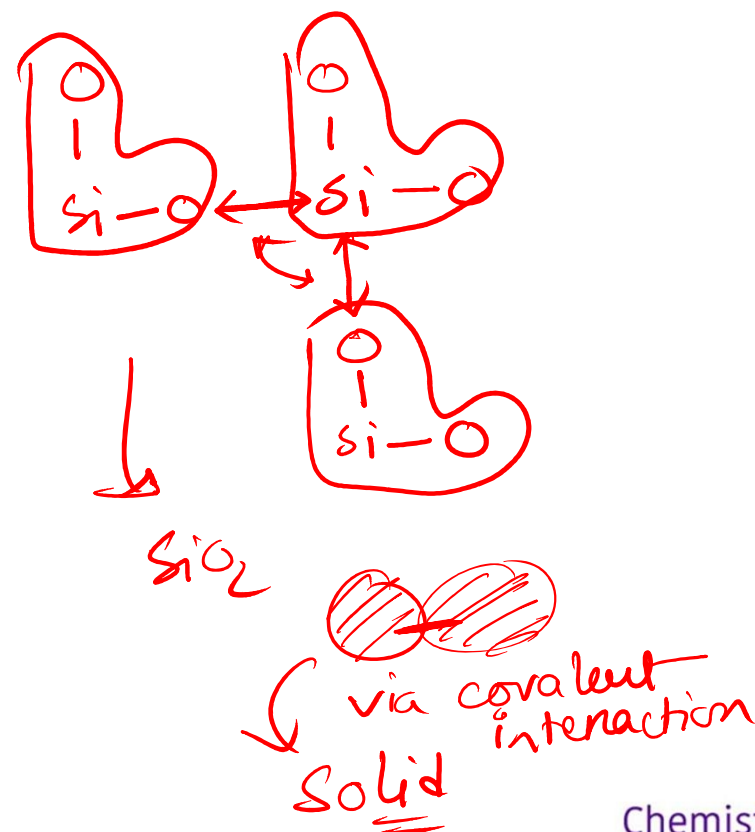
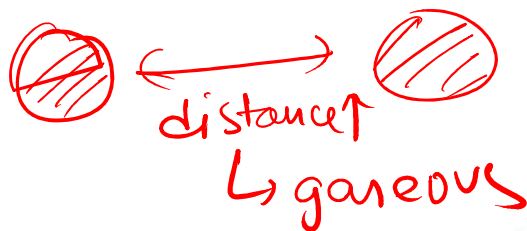


WHITEBOARD

P block (14)

C, Si, Ge, Sn, Pb

➤ CO₂ exists as gas but SiO₂ as solid, why?

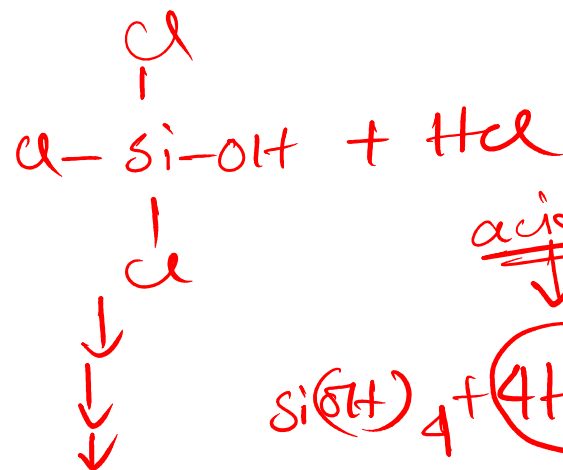
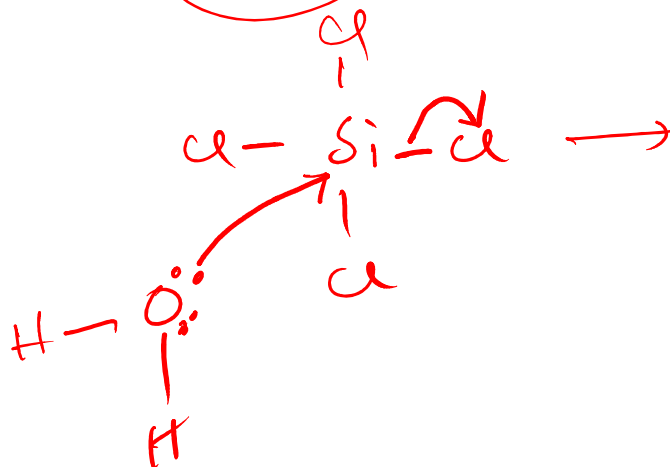
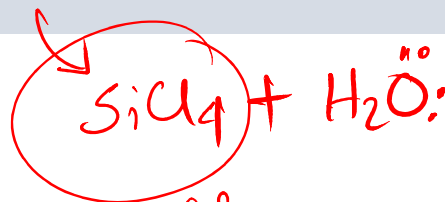


Poll Question 02

$SiCl_4$ is ?

- (a) ~~Basic~~
- (b) Acidic
- (c) ~~Amphoteric~~

(empty) $3d$ orbital

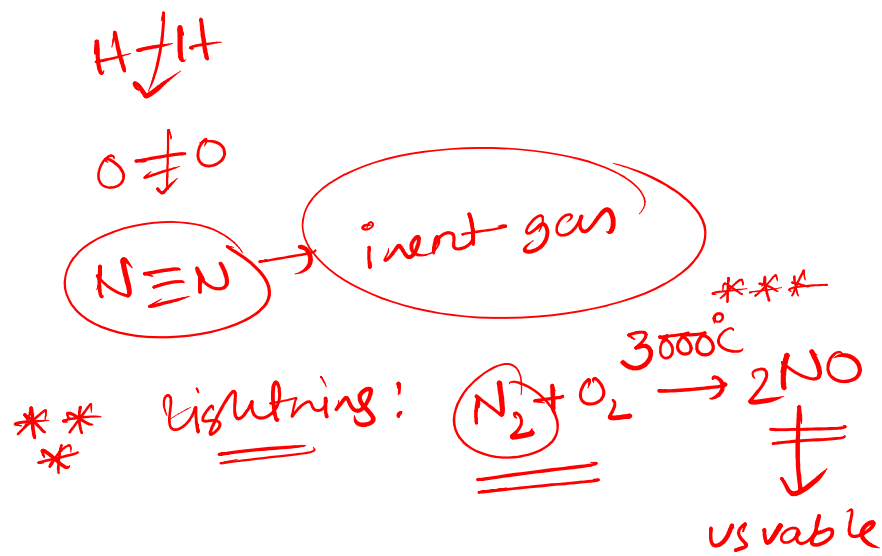
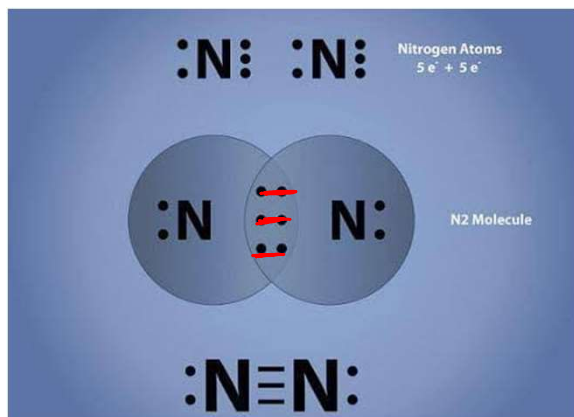


WHITEBOARD

P block (15)

N, P, As, Sb, Bi

➤ Inertness of N_2

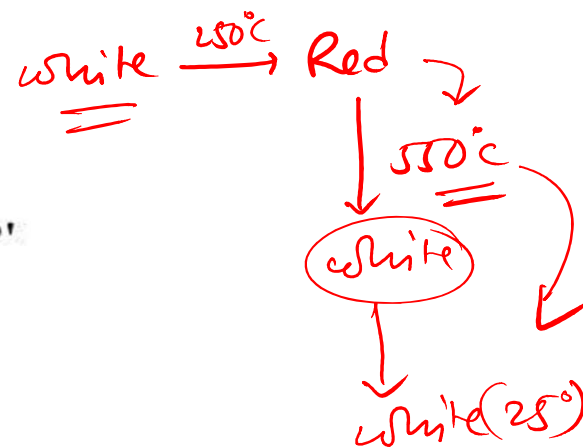
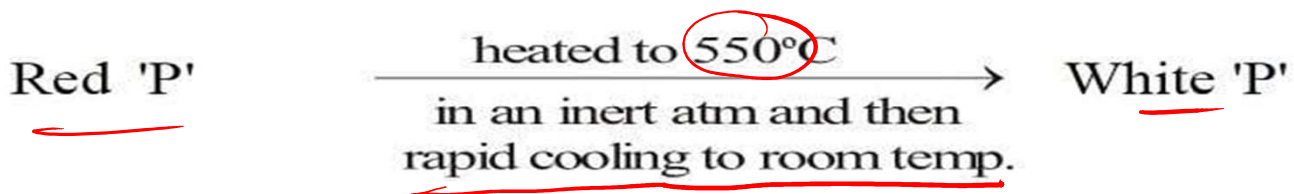
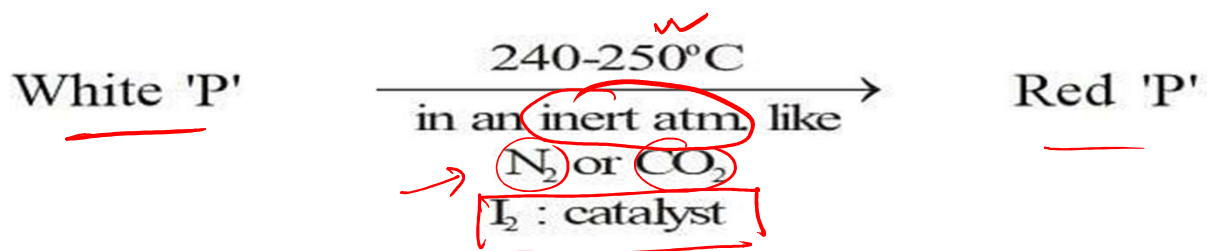


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P block (15)

N, P, As, Sb, Bi

➤ Allotropic forms of P.

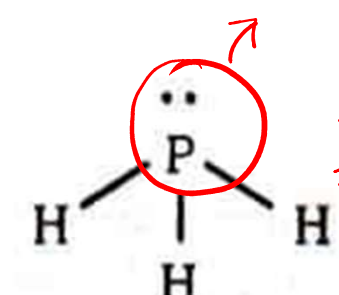


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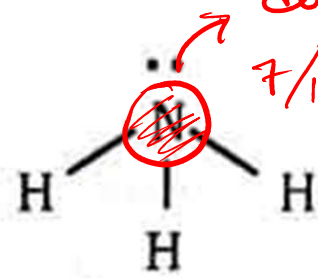
P block (15)

N, P, As, Sb, Bi

➤ Between NH_3 and PH_3 , which one is more basic?



PH₃ molecule



NH₃ molecule

(15 mp)

e^- donate

donation capability ↑↑

P \leftarrow N
 e^- density

7/10
No 2d orbitals

$\text{NH}_3 > \text{PH}_3$

P(15) \leftarrow 28
3d empty

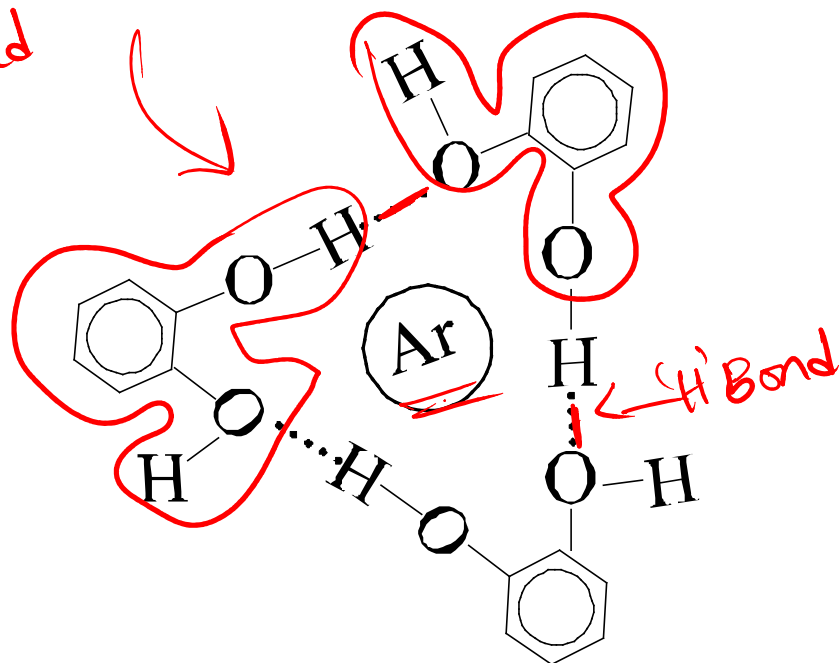
(28) 8

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Clathrate compound ;



Trapped



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d- block element

(21-30) ১৩

সিলভার-ভিউল ট্রানজিটরিক সিলভার গ্রুপের শেষে যা
 Sc Ti V Cr Mn Fe Co Ni Cu Zn

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	57-71	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	89-103	104 Rf	105 Db	106 Sg	107 Bh	108 Hs
109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Ts	118 Og

Lanthanide Series



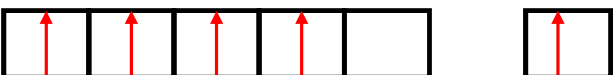

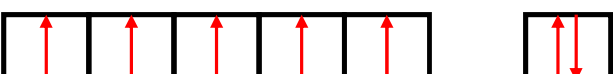
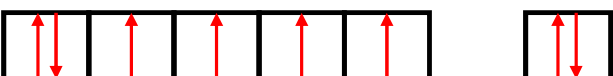
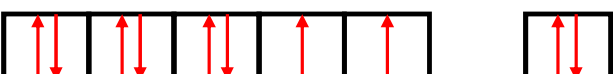

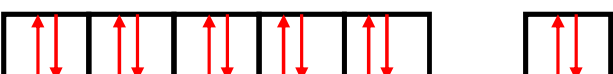

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Actinide Series

89 Ac	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
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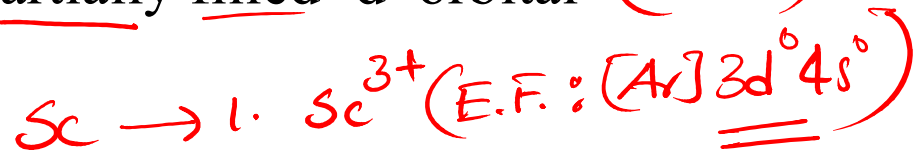
Sc (21) – [Ar] 3d ¹ 4s ²		
Ti (22) – [Ar] 3d ² 4s ²		
V (23) – [Ar] 3d ³ 4s ²		
✓ Cr (24) – [Ar] 3d ⁵ 4s ¹		
Mn (25) – [Ar] 3d ⁵ 4s ²		
Fe (26) – [Ar] 3d ⁶ 4s ²		
Co (27) – [Ar] 3d ⁷ 4s ²		
Ni (28) – [Ar] 3d ⁸ 4s ²		
✓ Cu (29) – [Ar] 3d ⁹ 4s ¹		
Zn (30) – [Ar] 3d ¹⁰ 4s ²		

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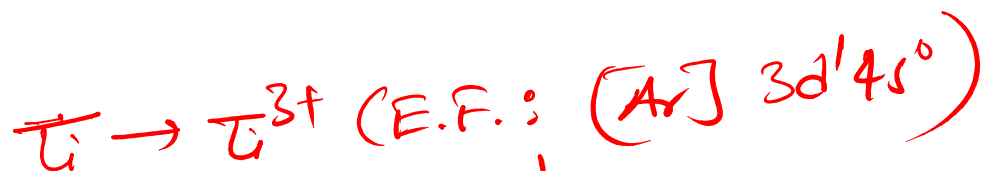
Transition metal

1. - Presence of Stable ion

2. - Partially filled 'd' orbital (d^{1-9})



2. 'Sc' is not a transition metal



Transition metal



* Inner Transition metal:
 \downarrow
f' block

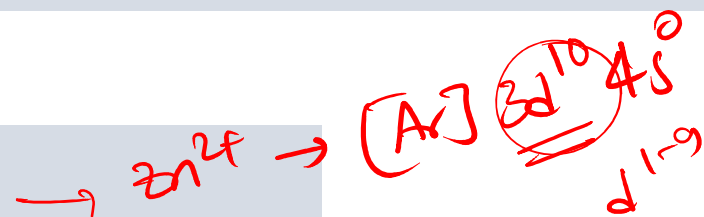
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✓ All transition elements are d- block, but all d- block elements are not transition elements

Poll Question 03

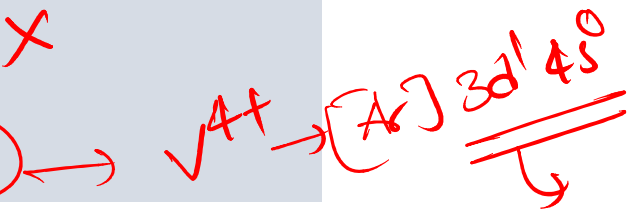
Which one is transition element?

(a) ~~Zn~~



(b) Sc ~~X~~

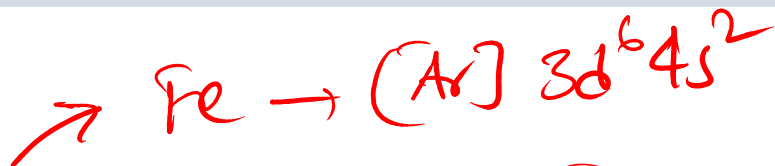
(c) V



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Poll Question 04

Which one is more stable ion ?



(a) Fe (2+)



(b) Fe (3+)



\uparrow stable

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✓ Properties of transition elements

✓ Variable oxidation state

✓ Catalytic property

✓ Complex ion formation

✓ Colorful compound formation

✓ Magnetic property

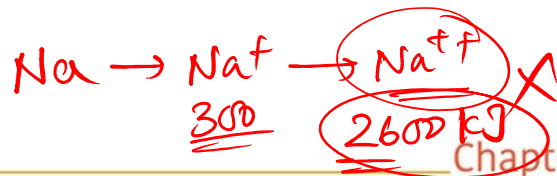
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Variable oxidation state

$x^+ \rightarrow x + e^-$

Element	Electron config.	Oxidation state
Sc	$3d^1 4s^2$	+3
Ti	$3d^2 4s^2$	+3, +4
V	$3d^3 4s^2$	+3, +5, +4
Cr	$3d^5 4s^1$	+2, +3, +6
Mn	$3d^5 4s^2$	+2, +3, +4, +6, +7
Fe	$3d^6 4s^2$	+2, +3
Co	$3d^7 4s^2$	+2, +3,
Ni	$3d^8 4s^2$	+2, +4
Cu	$3d^{10} 4s^1$	+1, +2
Zn	$3d^{10} 4s^2$	+2

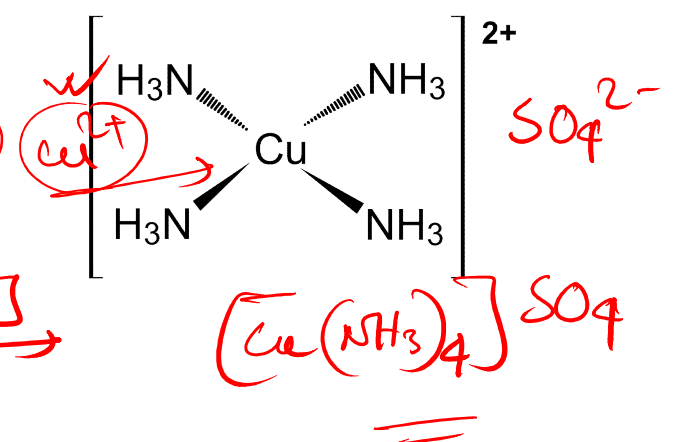
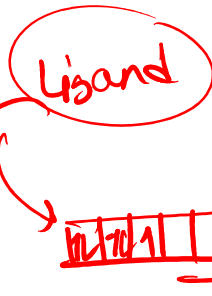
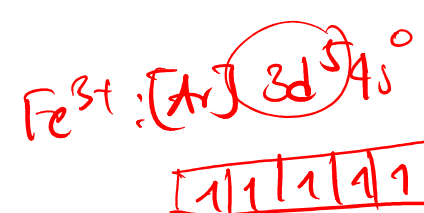
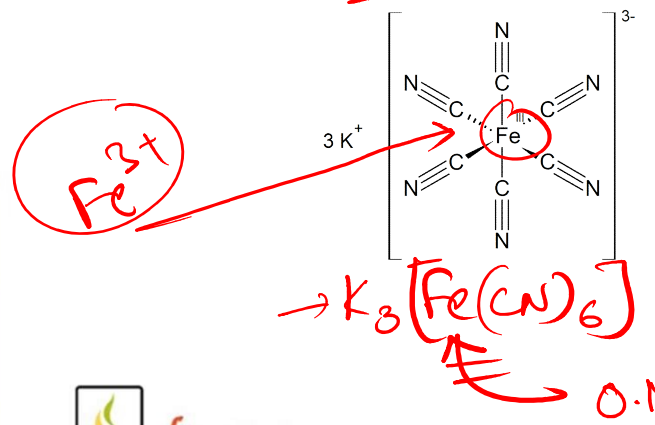
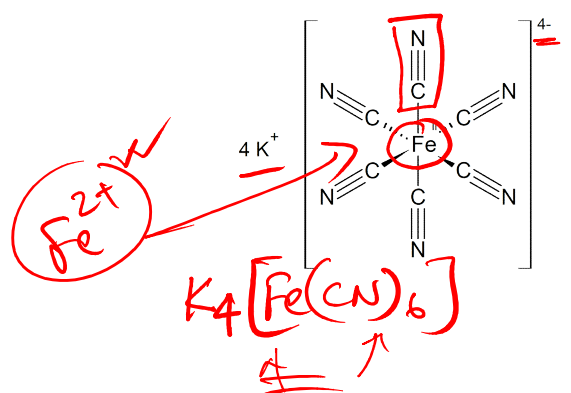
$3d, 4s$



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Formation of Complex compound: \rightarrow Anion/cation central atom (transition metal)
 \rightarrow Ligand (lone pair e⁻ donate)

Reason
 \downarrow
 "empty d orbital"



$\rightarrow (+) \times 3 + x + (-1) \times 6 = 0$
 $3 + x - 6 = 0$
 $x = 6 - 3 = +3$
 $\text{O.N} = ?$ CN^-

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Nomenclature of Complex Compounds

✓
Ligand name & number + Name of central transition element + O. N. of central transition metal

1. Positive Complex Ion:

Ligand name & number + central transition element (O.N.) ^{attached} - Anion



2. Negative Complex Ion:

^{attached}
Cation + Ligand name & number + central transition element (ate) (O, N.)



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Nomenclature of Complex Compounds

Ligand name & number

A prefix indicating the number must be added behind every ligand

Ligand	Name	Number of Ligands	Prefix
<u>OH⁻</u>	<u>hydroxo</u>	<u>1</u>	—
<u>NH₃</u>	** <u>Ammine</u>	2	di
<u>H₂O</u>	<u>Aqua</u>	3	tri
<u>Cl⁻</u>	<u>Chloro</u> (halo)	4	tetra
<u>CN⁻</u>	* <u>Cyano</u>		
<u>CNS⁻</u>	thiocyanato		
<u>NO/NO⁺</u>	* <u>Nitroso</u>		
<u>O²⁻</u>	oxo		
<u>CO</u>	* <u>Carbonyl</u>		

CO > CN > NO₂ > NH₃ > SCN > H₂O
 OH⁻ > F⁻ > Cl > Br > I

↑ weak ligand
 ↑ Moderate Ligand

← strong ligand

easily donate

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Magnetic properties (V.B.T)

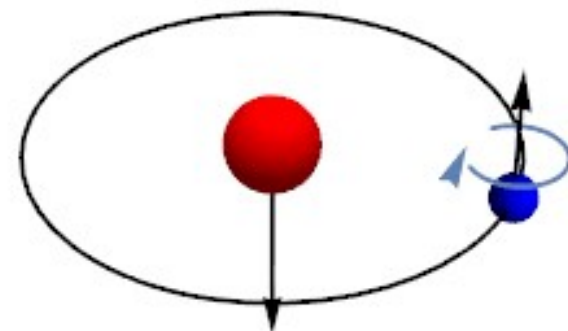
1✓

□ Ferromagnetic substance → (Fe, Co, Ni)

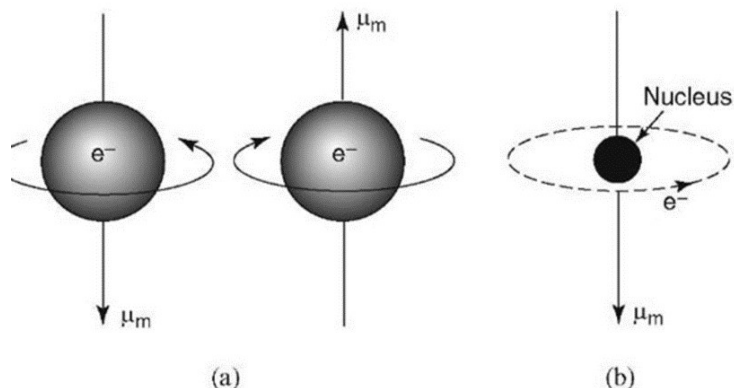
□ Paramagnetic substance → presence of unpaired e^-

□ Dia magnetic substance → absence of unpaired e^-

as a metal

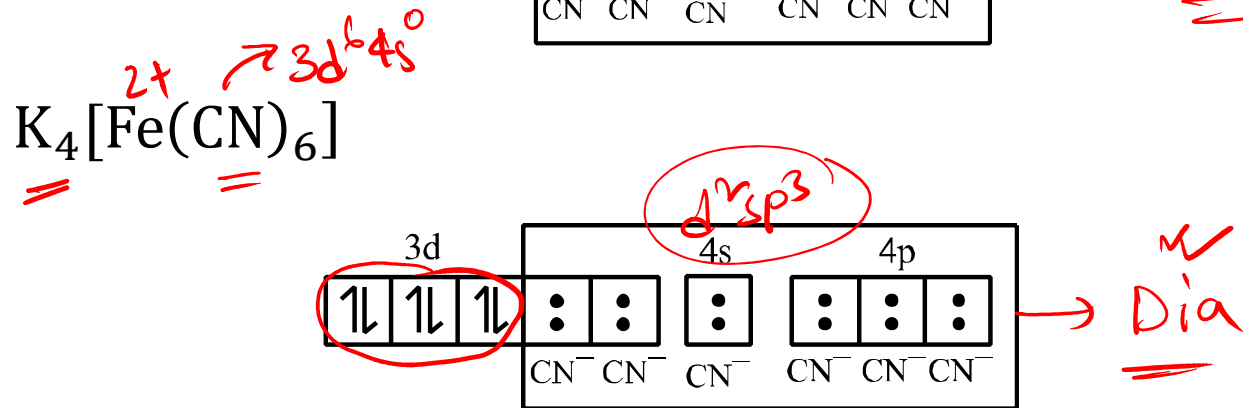
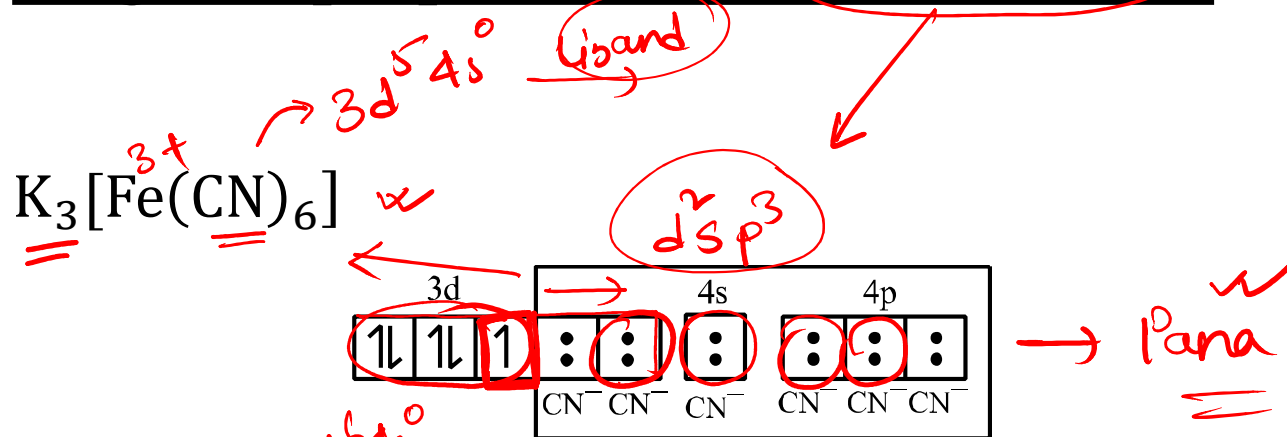


Net magnetic moment
↓
shows magnetic property



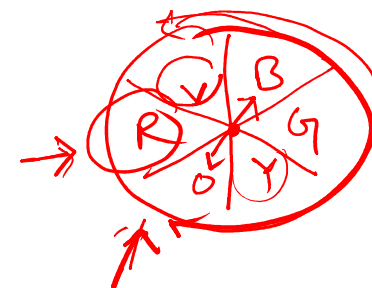
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Magnetic properties and Hybridization:



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Formation of colorful compound (C.F.T)

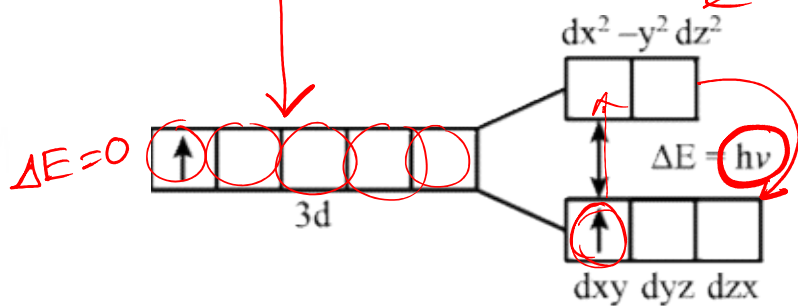
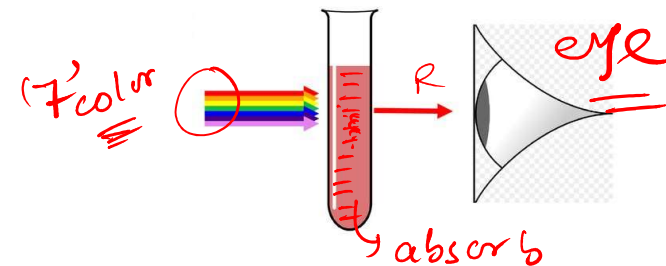


Degenerate condition

Effect of ligand

Increase of average stable energy

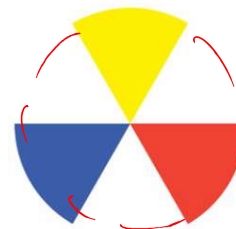
Non-degenerate condition



Color Wheel



Primary Colors



Secondary Colors

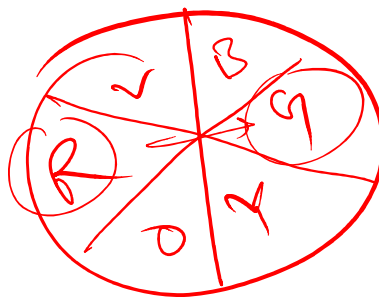


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Poll Question 05

Which one is the complementary color of red?

- (a) Blue
- (b) Green
- (c) Yellow



↳ absorb

emit → green

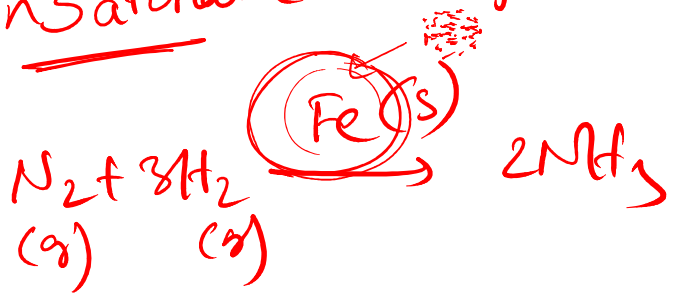
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Catalytic property → empty d orbital

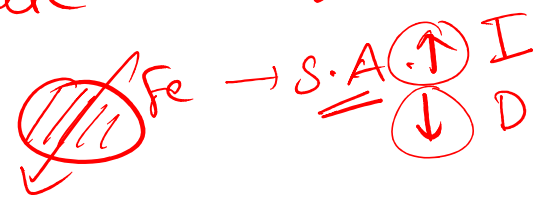
~~adsorption~~
absorption

Adsorption Theory

Unsaturated catalysis

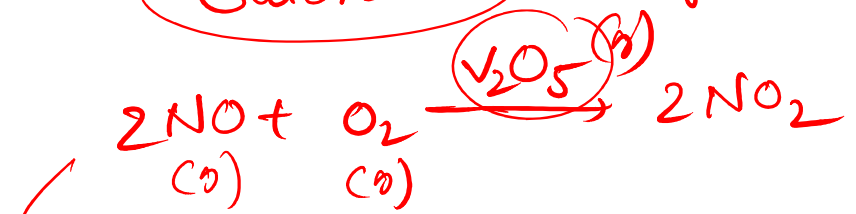


Reactant's state ≠ Catalyst's state

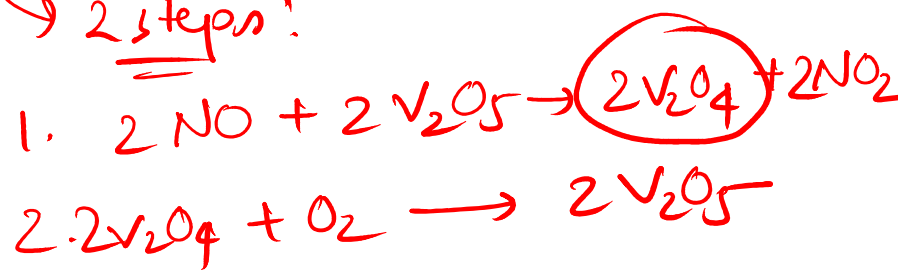


Intermediate compound Formation

Saturated catalysis

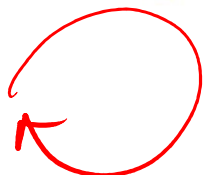


2 steps:

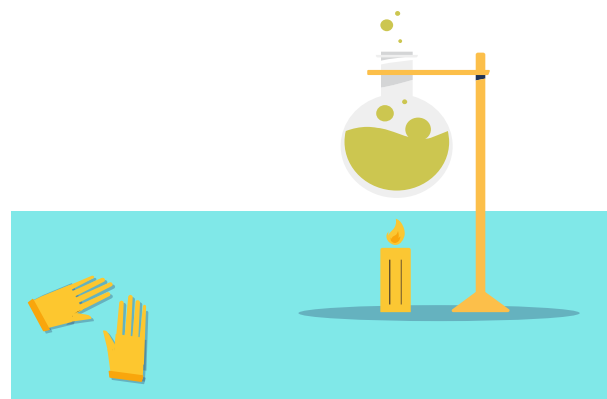


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Periodic properties

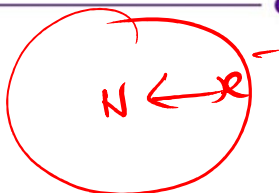


- Atomic & ionic radius
- Ionization energy
- Electron affinity
- Electronegativity
- Valency
- Physical characteristics (Melting point, density, conductivity etc.)



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Ionic Radius



$r =$ (distance between N. and last shell)

In any ion the distance up to which their nuclear attraction force is felt is called ionic radius.

Ions of third period	Na ⁺ → 11P	Mg ²⁺ → 12P	Al ³⁺ → 13P
electron number	10	10	10
ionic radius(nm)	0.095	0.065	0.050
size			

Decrease
Increase

Group	ion	ionic radius (nm)	size of ion	Group	ion	ionic radius (nm)	size of ion
IA	Li ⁺	0.060		VIIA	F ⁻	0.136	
	Na ⁺	0.095			C ⁻	0.181	
	K ⁺	0.133			Br ⁻	0.195	
	Rb ⁺	0.148			I ⁻	0.216	
	Cs ⁺	0.162					

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Poll Question 06

Which one is the largest ?

- (a) F^- $\frac{10}{9} = 1.1\text{---}$
- (b) F $\frac{9}{9} = 1$
- (c) F^+ $\frac{8}{9} = 0.9\text{---}$

Shortcut!

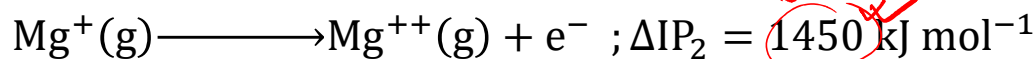
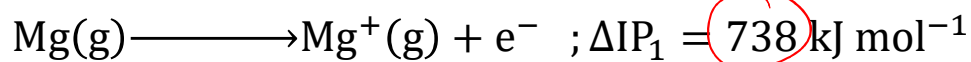
↑ size / radius = $\frac{e^-}{p}$ ↑
↓ " " " ↓

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Ionization energy



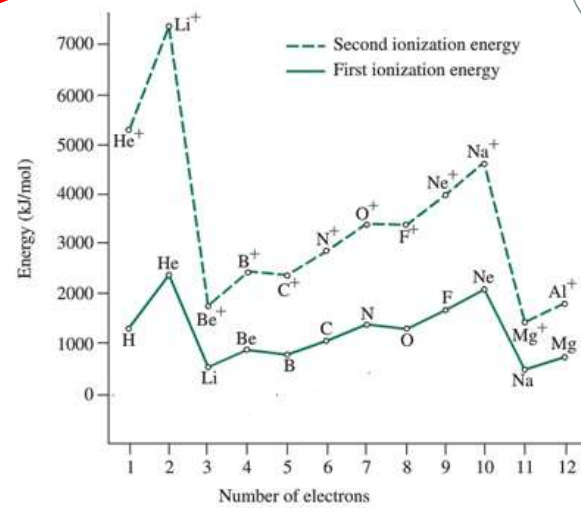
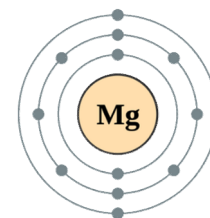
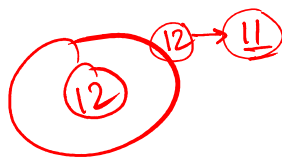
The **ionization energy** or **ionization potential** of an element means the amount of **energy needed** to turn **1 mole** of **gaseous** atoms to **1 mole** of positive ion by removing **1 mole electron** from each atom.



$\Delta IP_2 > \Delta IP_1$

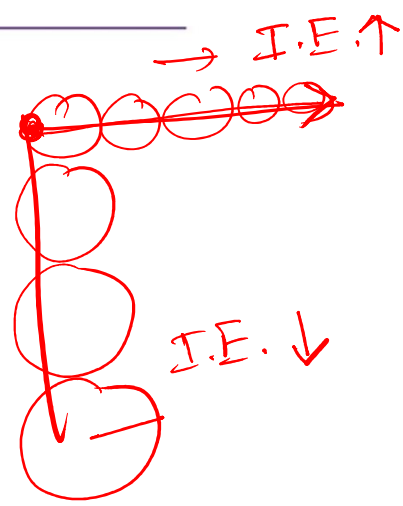
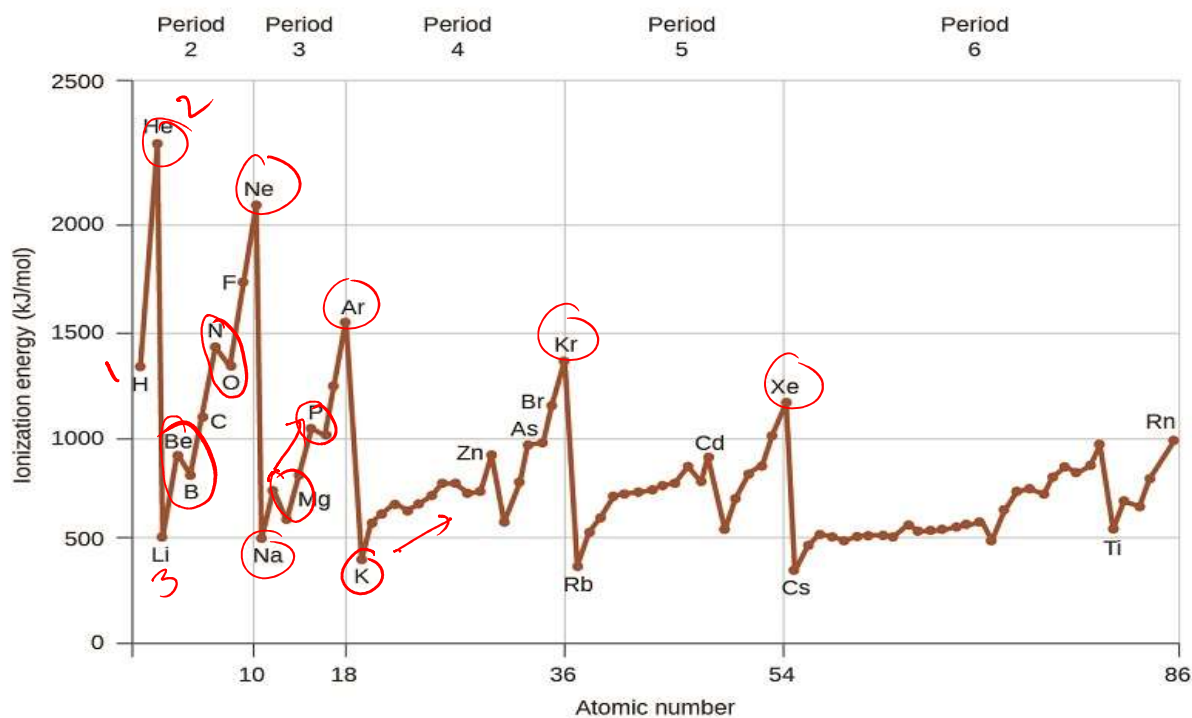
Octate
↓
stability
↘
I.P. ↑

Why the value of ΔIP_2 is always greater than the value of ΔIP_1 ?



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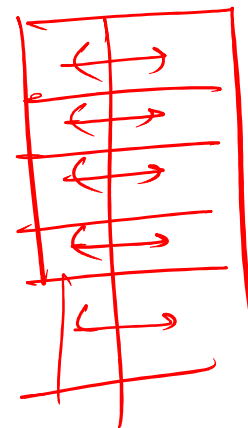
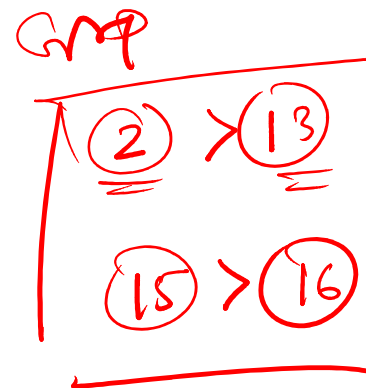
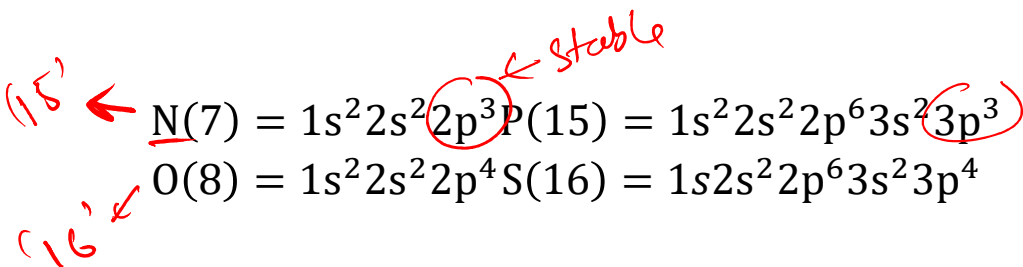
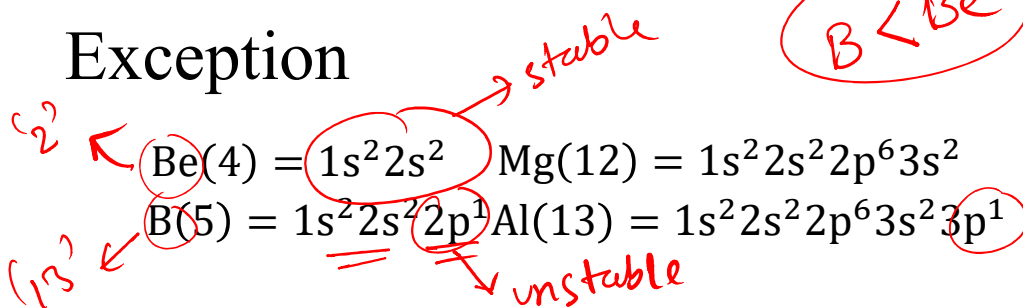
Ionization energy



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Ionization energy

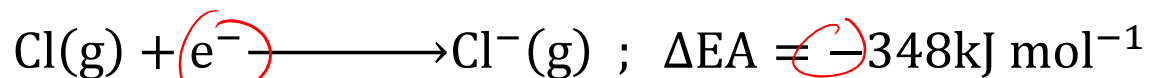
Exception



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Electron Affinity

The amount of energy changed to turn **1 mole** neutral **gaseous** atoms to **1 mole** negatively charged atoms by accepting **1 mole** electrons is called **electron affinity**.

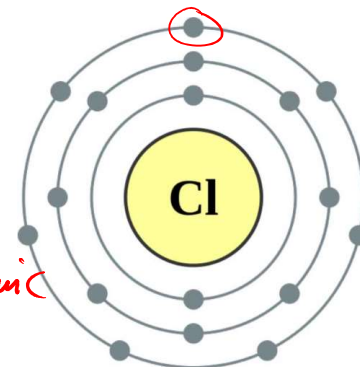


exothermic

whereas →

E.E. →

endothermic

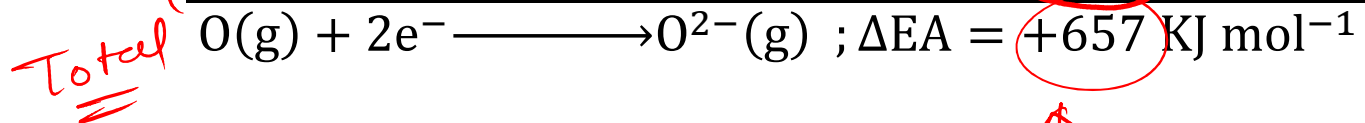
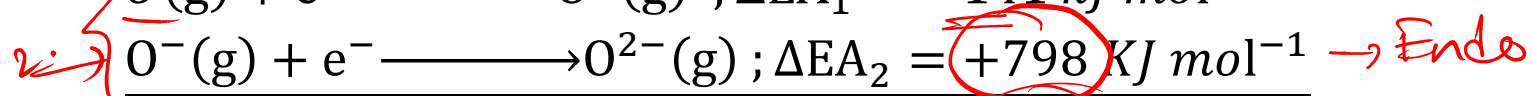
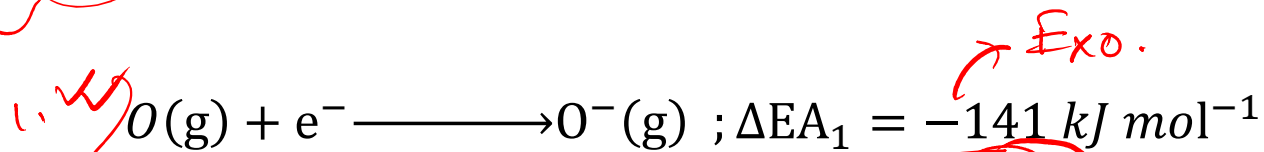
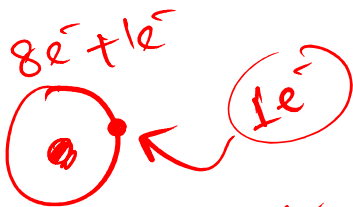


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Poll Question 07

$O^- + 2e^- = O_2^{2-}$, the reaction is?

- (a) Exothermic
- (b) Endothermic



↑ Endo

2nd E.A $\rightarrow \Delta H$
 \downarrow
 (+)ve

Exception in case of Electron Affinity

Poll Question 08

Electron affinity of A is -300 kJ/mol, electron affinity of B is -400 kJ/mol; which one has lower ionization potential ?

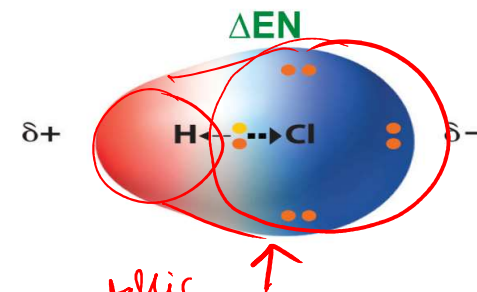
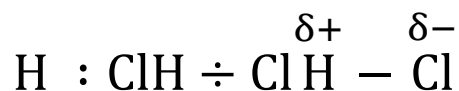
(a) B

(b) A

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Electronegativity

In a covalent compound molecule formed by different elements, the tendency of an atom to **attract the bond pair electron** towards itself is called **electronegativity**.



Period	Group						
	I	II	III	IV	V	VI	VII
2	Li 1.0	Be 1.5	B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
3	Na 0.9	Mg 1.2	Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0
4	K 0.8	Ca 1.0	Ga 1.3	Ge 1.75	As 2.0	Se 2.4	Br 2.8

Handwritten notes:
 - A red arrow points from the 'metallic' label to groups I and II.
 - A red arrow points from the 'non-metallic' label to groups VI and VII.
 - The value 4.0 for Fluorine is circled in red.
 - A red circle around H and Cl in the diagram above is labeled 'H e receive'.

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Oxide properties of elements (acid-base properties)

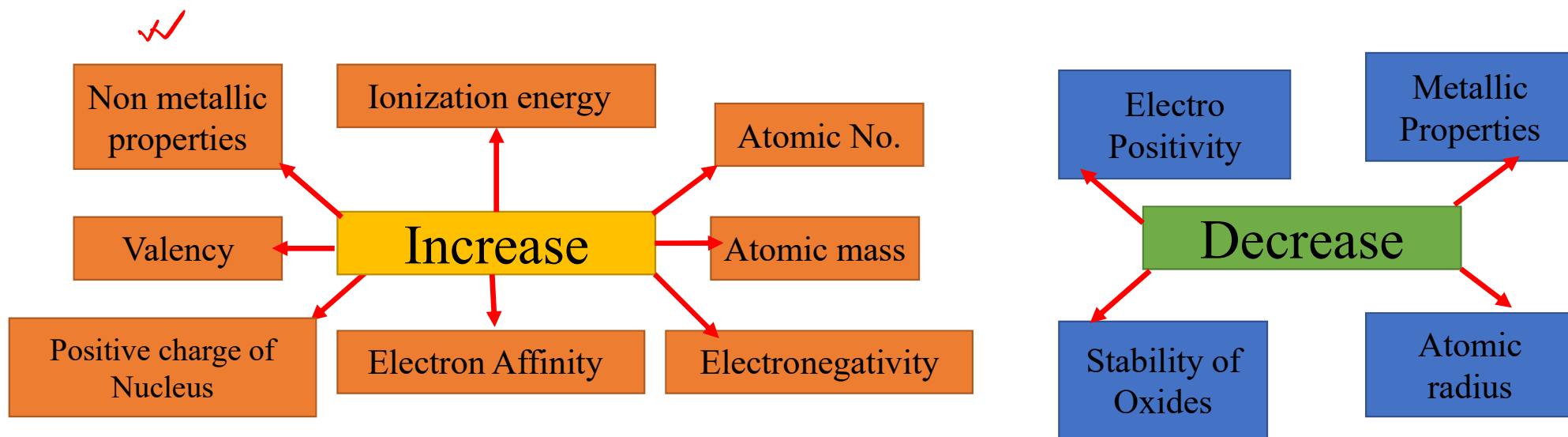
✓
 period (3)
 * * *
 metal → Basic
 non-m → Acidic

Basic ↓
 left → right

• Na_2O	Basic	$\text{Na}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{NaOH}$	strong base
• MgO	Basic	$\text{MgO} + \text{H}_2\text{O} \rightarrow \text{Mg(OH)}_2$	moderate
• Al_2O_3	Aluminium Oxide is amphoteric		
•	As a base:	$\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 2\text{H}_2\text{O}$	
•	As an acid:	$\text{Al}_2\text{O}_3 + 6\text{NaOH} + 3\text{H}_2\text{O} \rightarrow 2\text{Na}_3\text{Al(OH)}_6$	
• SiO_2	Acidic	$\text{SiO}_2 + 2\text{NaOH} \rightarrow 2\text{Na}_2\text{SiO}_3 + \text{H}_2\text{O}$	→ weak acid
• P_4O_{10}	Acidic	$\text{P}_4\text{O}_{10} + 6\text{H}_2\text{O} \rightarrow 4\text{H}_3\text{PO}_4$	→ acid
• SO_2	Acidic	$\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3$	} strong acid
• SO_3	Acidic	$\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$	
		→ HClO_4	→ strongest acid

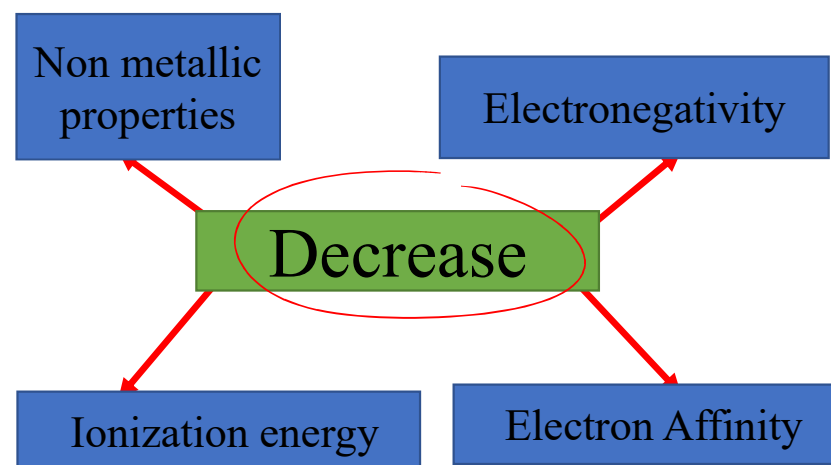
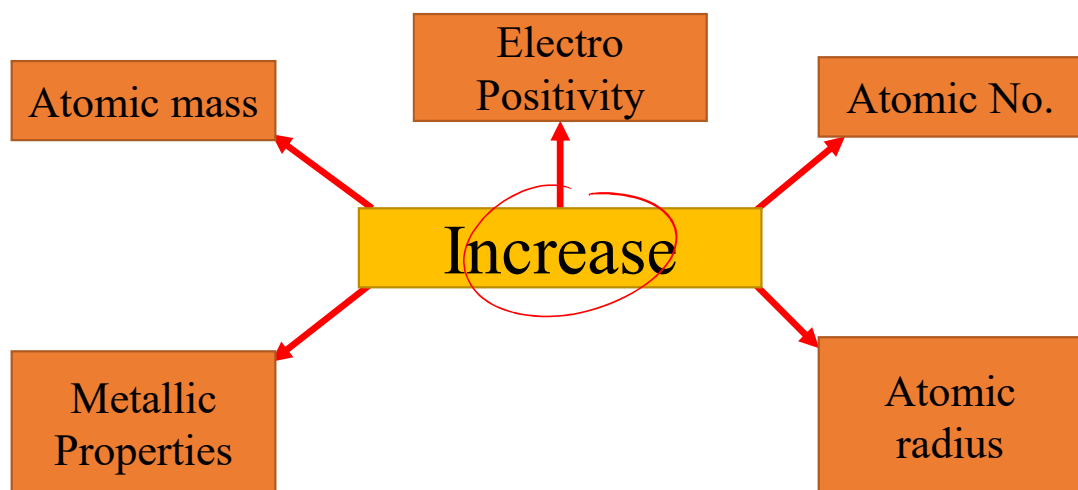
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Variation of properties in a period from left to right



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Variation of properties in a group from top to bottom



লেগে থাকো সৎ ভাবে,
স্বপ্ন জয় তোমারই হবে।