

Main-Group Elements
s Subshell fills

Main-Group Elements
p Subshell fills



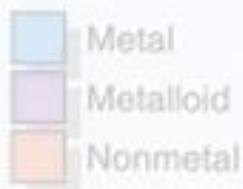
Study of Gp 13 and Gp 14 of p-block elements

1	1 IA H 1s ¹	2 IIA He 1s ²	Transition Metals d Subshell fills										13 IIIA B 2s ² 2p ¹	14 IVA C 2s ² 2p ²	15 VA N 2s ² 2p ³	16 VIA O 2s ² 2p ⁴	17 VIIA F 2s ² 2p ⁵	18 VIIIA Ne 2s ² 2p ⁶						
2	3 Li 2s ¹	4 Be 2s ²											5 B 2s ² 2p ¹	6 C 2s ² 2p ²	7 N 2s ² 2p ³	8 O 2s ² 2p ⁴	9 F 2s ² 2p ⁵	10 Ne 2s ² 2p ⁶						
3	11 Na 3s ¹	12 Mg 3s ²	13 Al 3s ² 3p ¹	14 Si 3s ² 3p ²	15 P 3s ² 3p ³	16 S 3s ² 3p ⁴	17 Cl 3s ² 3p ⁵	18 Ar 3s ² 3p ⁶											31 Ga 4s ² 4p ¹	32 Ge 4s ² 4p ²	33 As 4s ² 4p ³	34 Se 4s ² 4p ⁴	35 Br 4s ² 4p ⁵	36 Kr 4s ² 4p ⁶
4	19 K 4s ¹	20 Ca 4s ²	21 Sc 3d ¹ 4s ²	22 Ti 3d ² 4s ²	23 V 3d ³ 4s ²	24 Cr 3d ⁵ 4s ¹	25 Mn 3d ⁵ 4s ²	26 Fe 3d ⁶ 4s ²	27 Co 3d ⁷ 4s ²	28 Ni 3d ⁸ 4s ²	29 Cu 3d ¹⁰ 4s ¹	30 Zn 3d ¹⁰ 4s ²	31 Ga 4s ² 4p ¹	32 Ge 4s ² 4p ²	33 As 4s ² 4p ³	34 Se 4s ² 4p ⁴	35 Br 4s ² 4p ⁵	36 Kr 4s ² 4p ⁶						
5	37 Rb 5s ¹	38 Sr 5s ²	39 Y 4d ¹ 5s ²	40 Zr 4d ² 5s ²	41 Nb 4d ⁴ 5s ¹	42 Mo 4d ⁵ 5s ¹	43 Tc 4d ⁵ 5s ²	44 Ru 4d ⁷ 5s ¹	45 Rh 4d ⁸ 5s ¹	46 Pd 4d ¹⁰ 5s ⁰	47 Ag 4d ¹⁰ 5s ¹	48 Cd 4d ¹⁰ 5s ²	49 In 5s ² 5p ¹	50 Sn 5s ² 5p ²	51 Sb 5s ² 5p ³	52 Te 5s ² 5p ⁴	53 I 5s ² 5p ⁵	54 Xe 5s ² 5p ⁶						
6	55 Cs 6s ¹	56 Ba 6s ²	57 La* 5d ¹ 6s ²	58 Ce 4f ⁰ 5d ¹ 6s ²	59 Pr 4f ¹ 5d ⁰ 6s ²	60 Nd 4f ² 5d ⁰ 6s ²	61 Pm 4f ³ 5d ⁰ 6s ²	62 Sm 4f ⁶ 5d ⁰ 6s ²	63 Eu 4f ⁷ 5d ⁰ 6s ²	64 Gd 4f ⁷ 5d ¹ 6s ²	65 Tb 4f ⁹ 5d ⁰ 6s ²	66 Dy 4f ¹⁰ 5d ⁰ 6s ²	67 Ho 4f ¹¹ 5d ⁰ 6s ²	68 Er 4f ¹² 5d ⁰ 6s ²	69 Tm 4f ¹³ 5d ⁰ 6s ²	70 Yb 4f ¹⁴ 5d ⁰ 6s ²	71 Lu 4f ¹⁴ 5d ¹ 6s ²							
7	87 Fr 7s ¹	88 Ra 7s ²	89 Ac** 6d ¹ 7s ²	90 Th 6d ² 7s ²	91 Pa 5f ² 6d ¹ 7s ²	92 U 5f ³ 6d ¹ 7s ²	93 Np 5f ⁴ 6d ¹ 7s ²	94 Pu 5f ⁶ 6d ¹ 7s ²	95 Am 5f ⁷ 6d ¹ 7s ²	96 Cm 5f ⁷ 6d ² 7s ²	97 Bk 5f ⁹ 6d ¹ 7s ²	98 Cf 5f ¹⁰ 6d ¹ 7s ²	99 Es 5f ¹¹ 6d ¹ 7s ²	100 Fm 5f ¹² 6d ¹ 7s ²	101 Md 5f ¹³ 6d ¹ 7s ²	102 No 5f ¹⁴ 6d ¹ 7s ²	103 Lr 5f ¹⁴ 6d ² 7s ²							

Mrs. Asha Gupta

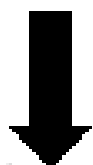
Associate Professor Chemistry

H.M.V Jalandhar



Position of p-block in periodic table

s - block



p - block



d - block



	1																		18	
1	H 1.008																			He 4.003
2	Li 6.941	Be 9.012												B 10.81	C 12.01	N 14.01	O 16.00	F 19.00	Ne 20.18	
3	Na 22.99	Mg 24.31												Al 26.98	Si 28.09	P 30.97	S 32.07	Cl 35.45	Ar 39.95	
4	K 39.10	Ca 40.08	Sc 44.96	Ti 47.88	V 50.94	Cr 52.00	Mn 54.94	Fe 55.85	Co 58.93	Ni 58.69	Cu 63.55	Zn 65.39		Ga 69.72	Ge 72.61	As 74.92	Se 78.96	Br 79.90	Kr 83.80	
5	Rb 85.47	Sr 87.62	Y 88.91	Zr 91.22	Nb 92.91	Mo 95.94	Tc 98.91	Ru 101.1	Rh 102.9	Pd 106.4	Ag 107.9	Cd 112.4		In 114.8	Sn 118.7	Sb 121.8	Te 127.6	I 126.9	Xe 131.3	
6	Cs 132.9	Ba 137.3	Lu 175.0	Hf 178.5	Ta 180.9	W 183.8	Re 186.2	Os 190.2	Ir 192.2	Pt 195.1	Au 197.0	Hg 200.6		Tl 204.4	Pb 207.2	Bi 209.0	Po 209.0	At 210.0	Rn 222.0	
7	Fr 223.0	Ra 226.0	Lr 262.1	Rf 261.1	Db 262.1	Sg 263.1	Bh 264.1	Hs 265.1	Mt 268	Uun 269	Uuu 272	Uub 277		Uut 289	Uuq 289	Uup 289	Uuh 289	Uus 289	Uuo 293	
6			La 138.9	Ce 140.1	Pr 140.9	Nd 144.2	Pm 146.9	Sm 150.4	Eu 152.0	Gd 157.3	Tb 158.9	Dy 162.5	Ho 164.9	Er 167.3	Tm 168.9	Yb 173.0				
7			Ac 227.0	Th 232.0	Pa 231.0	U 238.0	Np 237.0	Pu 244.1	Am 243.1	Cm 247.1	Bk 247.1	Cf 251.1	Es 252.0	Fm 257.1	Md 258.1	No 259.1				

Atomic number
Symbol
Atomic weight

Metal
Semimetal
Nonmetal

f - block

What are p-block elements?

- p-block elements are the elements in which the last electron enters '**np**' orbital which include six groups of elements i.e. group 13 to 18 boron family, carbon family, pnictogens, chalcogens, halogens and noble gases.

Main-Group Elements
s Subshell fills

Main-Group Elements
p Subshell fills



Transition Metals
d Subshell fills

Inner-Transition Metals
f Subshell fills

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

	Metal
	Metalloid
	Nonmetal

General electronic configuration & oxidation state

Group	13	14	15	16	17	18
G.E.C	ns^2np^1	ns^2np^2	ns^2np^3	ns^2np^4	ns^2np^5	ns^2np^6
First G. Element	B	C	N	O	F	He
G.O.S	+3	+4	+5	+6	+7	+8
Other	+1	+2	+3	+4	+5	+6
O.S		-4	-3	+2	+3	+4
			-2	+1	+2	-

- As metals, non-metals and metalloids exist only in p-block of periodic table.

- The heaviest element in each p-block group is mostly metallic in nature.

- Non-metallic character of the group decreases down.

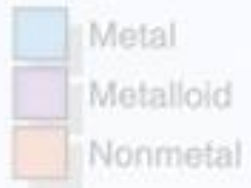


13 14 15 16 17
 IIIA IVA VA VIA VIIA

p - block



						18
						2
						He
						4.003
5	6	7	8	9	10	
B	C	N	O	F	Ne	
10.81	12.01	14.01	16.00	19.00	20.18	
13	14	15	16	17	18	
Al	Si	P	S	Cl	Ar	
26.98	28.09	30.97	32.07	35.45	39.95	
31	32	33	34	35	36	
Ga	Ge	As	Se	Br	Kr	
69.72	72.61	74.92	78.96	79.90	83.80	
49	50	51	52	53	54	
In	Sn	Sb	Te	I	Xe	
114.8	118.7	121.8	127.6	126.9	131.3	
81	82	83	84	85	86	
Tl	Pb	Bi	Po	At	Rn	
204.4	207.2	209.0	209.0	210.0	222.0	
113	114	115	116	117	118	
Uut	Uuq	Uup	Uuh	Uus	Uuo	
	289		289		293	



- Non metals have higher ionization enthalpy and electronegativity than the metals.

Hence metals form cations, and non metals form anions.

- Compounds formed between non metals are largely covalent in nature, while the compounds formed by highly reactive non-metal and metal have large difference in electronegativities.

The periodic table is color-coded as follows:

- Metal:** Blue background (Groups 1-10, 11-12, and most of the lower periods).
- Metalloid:** Purple background (Groups 13-16, elements like B, Si, Ge, As, Sb, Te, Po).
- Nonmetal:** Orange background (Groups 13-18, elements like C, N, O, F, Ne, P, S, Cl, Ar, Se, Br, Kr, I, Xe, At, Rn).

Key features of the table include:

- Group Labels:** IA, IIA, IIIA, IVA, VA, VIA, VIIA, VIIIA, VIII, IB, IIB.
- Subshell Fills:** s, p, d, f.
- Inner-Transition Metals:** Lanthanides (Ce-Lu) and Actinides (Th-Lr).
- Valence-shell configuration:** Indicated for each element (e.g., $1s^1$ for H, $1s^2$ for He).

p-block elements differ...



Symbol

Valence-shell configuration

- Size and all the properties of size

because of this the lightest p-block elements show the same

kind of differences as the lightest s-block element i.e. lithium and beryllium.

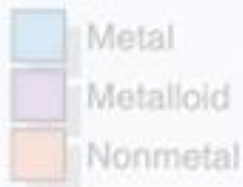
- Elements starting from boron are restricted to maximum covalence of four (using 2s and three 2p orbitals).

1	1 IA H 1s ¹	2 IIA He 1s ²	Transition Metals d Subshell fills										13 IIIA B 2s ² 2p ¹	14 IVA C 2s ² 2p ²	15 VA N 2s ² 2p ³	16 VIA O 2s ² 2p ⁴	17 VIIA F 2s ² 2p ⁵	18 VIIIA Ne 2s ² 2p ⁶								
2	3 Li 2s ²	4 Be 2s ²											5 Al 3s ² 3p ¹	6 Si 3s ² 3p ²	7 P 3s ² 3p ³	8 S 3s ² 3p ⁴	9 Cl 3s ² 3p ⁵	10 Ar 3s ² 3p ⁶								
3	11 Na 3s ¹	12 Mg 3s ²	13 Al 3s ² 3p ¹	14 Si 3s ² 3p ²	15 P 3s ² 3p ³	16 S 3s ² 3p ⁴	17 Cl 3s ² 3p ⁵	18 Ar 3s ² 3p ⁶	19 K 4s ¹	20 Ca 4s ²	21 Sc 3d ¹ 4s ²	22 Ti 3d ² 4s ²	23 V 3d ³ 4s ²	24 Cr 3d ⁵ 4s ¹	25 Mn 3d ⁵ 4s ²	26 Fe 3d ⁶ 4s ²	27 Co 3d ⁷ 4s ²	28 Ni 3d ⁸ 4s ²	29 Cu 3d ¹⁰ 4s ¹	30 Zn 3d ¹⁰ 4s ²	31 Ga 4s ² 4p ¹	32 Ge 4s ² 4p ²	33 As 4s ² 4p ³	34 Se 4s ² 4p ⁴	35 Br 4s ² 4p ⁵	36 Kr 4s ² 4p ⁶
4	37 Rb 5s ¹	38 Sr 5s ²	39 Y 4d ¹ 5s ²	40 Zr 4d ² 5s ²	41 Nb 4d ⁴ 5s ¹	42 Mo 4d ⁵ 5s ¹	43 Tc 4d ⁵ 5s ²	44 Ru 4d ⁷ 5s ¹	45 Rh 4d ⁸ 5s ¹	46 Pd 4d ¹⁰	47 Ag 4d ¹⁰ 5s ¹	48 Cd 4d ¹⁰ 5s ²	49 In 5s ² 5p ¹	50 Sn 5s ² 5p ²	51 Sb 5s ² 5p ³	52 Te 5s ² 5p ⁴	53 I 5s ² 5p ⁵	54 Xe 5s ² 5p ⁶								
5	55 Cs 6s ¹	56 Ba 6s ²	57 La 5d ¹ 6s ²	58 Ce 4f ¹ 5d ¹ 6s ²	59 Pr 4f ³ 6s ²	60 Nd 4f ⁴ 6s ²	61 Pm 4f ⁵ 6s ²	62 Sm 4f ⁶ 6s ²	63 Eu 4f ⁷ 6s ²	64 Gd 4f ⁷ 5d ¹ 6s ²	65 Tb 4f ⁹ 6s ²	66 Dy 4f ¹⁰ 6s ²	67 Ho 4f ¹¹ 6s ²	68 Er 4f ¹² 6s ²	69 Tm 4f ¹³ 6s ²	70 Yb 4f ¹⁴ 6s ²	71 Lu 4f ¹⁴ 5d ¹ 6s ²									
6	87 Fr 7s ¹	88 Ra 7s ²	89 Ac 6d ¹ 7s ²	90 Th 6d ² 7s ²	91 Pa 5f ² 6d ¹ 7s ²	92 U 5f ³ 6d ¹ 7s ²	93 Np 5f ⁴ 6d ¹ 7s ²	94 Pu 5f ⁶ 7s ²	95 Am 5f ⁷ 7s ²	96 Cm 5f ⁷ 6d ¹ 7s ²	97 Bk 5f ⁹ 7s ²	98 Cf 5f ¹⁰ 7s ²	99 Es 5f ¹¹ 7s ²	100 Fm 5f ¹² 7s ²	101 Md 5f ¹³ 7s ²	102 No 5f ¹⁴ 7s ²	103 Lr 5f ¹⁴ 6d ¹ 7s ²									

*Lanthanides

**Actinides

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr



Group 13 elements: The boron family

Elements At. No. Electronic conf.

B

5

$2s^2 2p^1$ (He)

Al

13

$3s^2 3p^1$ (Ne)

Ga

31

$3d^{10} 4s^2 4p^1$ (Ar)

In

49

$4d^{10} 5s^2 5p^1$ (Kr)

Tl

81

$4f^{14} 5d^{10} 6s^2 6p^1$ (Xe)

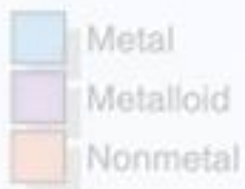
	Metal
	Metalloid
	Nonmetal

Atomic radii

- The atomic radii increases from boron to thallium.

Element	B	Al	Ga	In	Tl
At. radius	88	143	135	167	170

- The abrupt increase in atomic radius of Al is due to greater screening effect in Al than B.



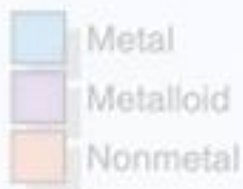
Ionization enthalpy

- Here the first ionization enthalpies of these elements are less than corresponding value of s-block element.

This is because p-electrons are less penetrating and more shielded than s-electrons.

B Al Ga In Tl

801 577 579 558 589

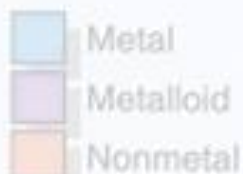


Electronegativity

- Down the group, electronegativity first decreases from B to Al and then increases till thallium.

This is because of the difference in atomic sizes of elements.

B
Al
Ga
In
Tl
2.0
1.5
1.6
1.7
1.8



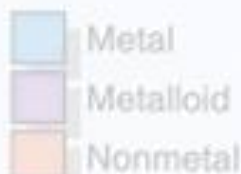
Physical properties

- Boron is extremely hard and black in colored solid which exists in many allotropic form.
- Density:- It increases from B to Tl due to increasing size of atom.

B Al Ga In Tl

Density 2.35 2.70 5.90 7.31 11.85

**Actinides



- **Metallic character:-**The elements of boron family are less metallic or electropositive as compared to group 2.

On moving down the group, the metallic character increases initially from B to Al but decreases from Al to Tl.

Periodic table showing elements color-coded by metallic character: Metal (blue), Metalloid (purple), and Nonmetal (orange). The boron family (Group 13) is highlighted in orange, showing a transition from nonmetal (B) to metal (Al, Ga, In, Tl).

*Lanthanides

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

**Actinides

90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

 Metal
 Metalloid
 Nonmetal

Main-Group Elements
s Subshell fills

Main-Group Elements
p Subshell fills

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



Atomic number
Symbol
Valence-shell configuration

Transition Metals
d Subshell fills

Inner-Transition Metals
f Subshell fills

*Lanthanides

**Actinides

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
$4f^1 5d^1 6s^2$	$4f^2 6s^2$	$4f^3 6s^2$	$4f^4 6s^2$	$4f^5 6s^2$	$4f^6 6s^2$	$4f^7 6s^2$	$4f^7 5d^1 6s^2$	$4f^9 6s^2$	$4f^10 6s^2$	$4f^11 6s^2$	$4f^12 6s^2$	$4f^13 6s^2$	$4f^14 6s^2$
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
$6d^2 7s^2$	$5f^2 6d^1 7s^2$	$5f^3 7s^2$	$5f^4 7s^2$	$5f^5 7s^2$	$5f^6 7s^2$	$5f^7 7s^2$	$5f^7 6d^1 7s^2$	$5f^9 7s^2$	$5f^10 7s^2$	$5f^11 7s^2$	$5f^12 7s^2$	$5f^13 7s^2$	$5f^14 7s^2$

- Metal
- Metalloid
- Nonmetal

Introduction

- 1) Group 13 elements and their uses
- 2) Boron – Electronic structure
Chemical properties
- 3) Aluminium- Structure and properties
- 4) Equations
- 5) Conclusion

Main-Group Elements
s Subshell fills

Main-Group Elements
p Subshell fills

1	1 IA H	2 IIA	Transition Metals										13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIII He														
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne														
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar														
4	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														
5	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														
6	55 Cs	56 Ba	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	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
7	87 Fr	88 Ra	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	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

Legend:

- Metal
- Metalloid
- Nonmetal



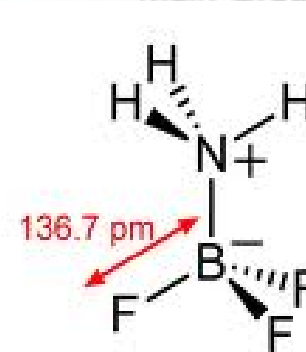
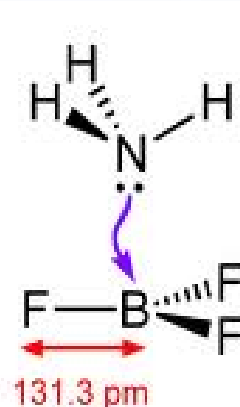
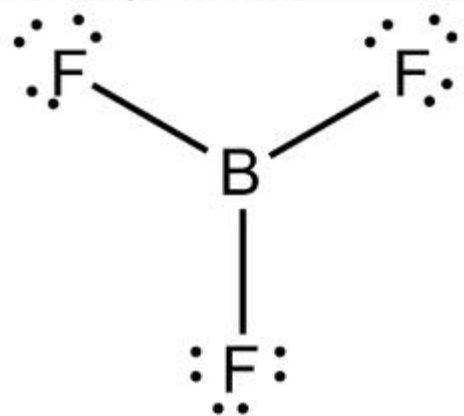
- Boron – glasses, ceramics and agriculture
- Aluminum – electrical devices and construction materials
- Gallium – amplifiers, solar cells and satellites
- Indium – coatings and alloys
- Thallium – photo electric cell, and toxics



Boron

- Electronic structure – $1s^2 2s^2 2p^1$ Atomic radius – 90 pm.
- Due to this relatively small size of boron, the sum of its first three ionization enthalpies is very high.
- This prevents it to form $3+$ ions and forces it to form only covalent compounds.
- In the trivalent state, boron can be called as electron deficient as it will have only 6 electrons in its outer most orbit. Thus, Boron has a tendency to accept a lone pair of electrons from another compound to become stable.
- This property also makes the compound a Lewis acid.





fills		18
		VIIIA
2	He	2
8	Ne	8
18	Ar	18
36	Kr	36
54	Xe	54
86	Rn	86

- It is unreactive in crystalline form
- However, amorphous boron on heating in air forms B_2O_3 . It reacts with di nitrogen at high temperatures to form nitrides.

- B_2O_3 is acidic and reacts with basic oxides forming metal borates

- It does not react with acids and alkanes.



Aluminum and other group 13 elements

- Sum of the first three ionization enthalpies is less, as compared to Boron. Thus, it is due to the easy tendency to lose electrons. It is able to form Al^{3+} .
- In the other elements, due to poor shielding effect of d and f orbitals, the nucleus holds the outer most s electrons tightly. Thus, only p bonding may be available for bonding.
- In all 3 elements, both +1 and +3 oxidation states are seen.
- The compounds in +1 state are more ionic than those in +3 state.



• Aluminum forms a very thin oxide layer.

With di nitrogen at high temperatures they form nitrides.

• It dissolves in mineral acids and aqueous alkalis and thus show amphoteric character.

• All the group 13 elements except thallium show reactivity towards halogens.

Periodic Table of Elements

Main-Group Elements s Subshell fills

Main-Group Elements p Subshell fills

Atomic number

Symbol

Group

Period

IA IIA IIIA IVA VA VIA VIIA VIIIA

1 H He

2 Li Be B C N O F Ne

3 Na Mg Al Si P S Cl Ar

4 K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr

5 Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe

6 Cs Ba La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu

7 Fr Ra Ac Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr

**Actinides

Metal

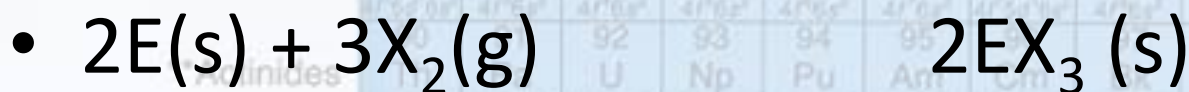
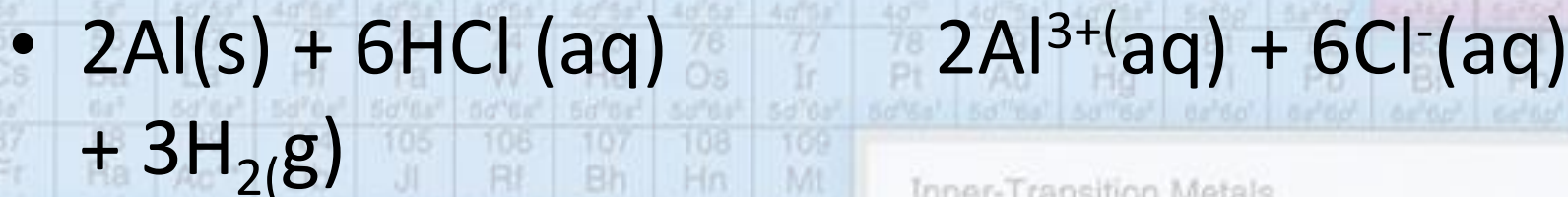
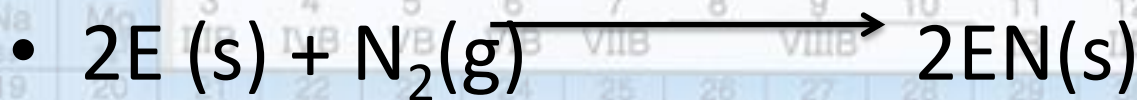
Metalloid

Nonmetal

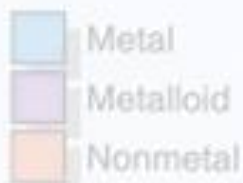
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Main-Group Elements
s Subshell fills

Main-Group Elements
p Subshell fills



[E = element]



Conclusion



Atomic number
Symbol
Valence-shell configuration

- We have learnt the far and wide reaching applications of all the group 13 elements.
- We learnt the chemical properties of boron, and aluminium in detail, how they form compounds with other elements their structures; and their reactivity with certain substances.

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
$4f^3 6s^2$	$4f^4 6s^2$	$4f^5 6s^2$	$4f^6 6s^2$	$4f^7 6s^2$	$4f^7 6s^2$	$4f^7 6s^2$	$4f^9 6s^2$	$4f^{10} 6s^2$	$4f^{11} 6s^2$	$4f^{12} 6s^2$	$4f^{13} 6s^2$	$4f^{14} 6s^2$	$4f^{14} 6s^2$
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
$6d^2 7s^2$	$5f^2 6d^1 7s^2$	$5f^3 7s^2$	$5f^4 7s^2$	$5f^6 7s^2$	$5f^7 7s^2$	$5f^7 7s^2$	$5f^7 7s^2$	$5f^7 7s^2$	$5f^7 7s^2$	$5f^7 7s^2$	$5f^7 7s^2$	$5f^7 7s^2$	$5f^7 7s^2$

**Actinides

	Metal
	Metalloid
	Nonmetal

Main-Group Elements
s Subshell fills

Main-Group Elements
p Subshell fills


 Atomic number
 Symbol
 Valence-shell configuration




BORON AND ITS COMPOUNDS

1	1 IA H 1s ¹	2 IIA Be 2s ²	Transition Metals d Subshell fills										13 IIIA B 2s ² 2p ¹	14 IVA C 2s ² 2p ²	15 VA N 2s ² 2p ³	16 VIA O 2s ² 2p ⁴	17 VIIA F 2s ² 2p ⁵	18 VIIIA He 1s ²
2	3 Li 2s ¹	4 Be 2s ²											5 B 2s ² 2p ¹	6 C 2s ² 2p ²	7 N 2s ² 2p ³	8 O 2s ² 2p ⁴	9 F 2s ² 2p ⁵	10 Ne 2s ² 2p ⁶
3	11 Na 3s ¹	12 Mg 3s ²	13 Al 3s ² 3p ¹	14 Si 3s ² 3p ²	15 P 3s ² 3p ³	16 S 3s ² 3p ⁴	17 Cl 3s ² 3p ⁵	18 Ar 3s ² 3p ⁶										
4	19 K 4s ¹	20 Ca 4s ²	21 Sc 3d ¹ 4s ²	22 Ti 3d ² 4s ²	23 V 3d ³ 4s ²	24 Cr 3d ⁵ 4s ¹	25 Mn 3d ⁵ 4s ²	26 Fe 3d ⁶ 4s ²	27 Co 3d ⁷ 4s ²	28 Ni 3d ⁸ 4s ²	29 Cu 3d ¹⁰ 4s ¹	30 Zn 3d ¹⁰ 4s ²	31 Ga 4s ² 4p ¹	32 Ge 4s ² 4p ²	33 As 4s ² 4p ³	34 Se 4s ² 4p ⁴	35 Br 4s ² 4p ⁵	36 Kr 4s ² 4p ⁶
5	37 Rb 5s ¹	38 Sr 5s ²	39 Y 4d ¹ 5s ²	40 Zr 4d ² 5s ²	41 Nb 4d ⁴ 5s ¹	42 Mo 4d ⁵ 5s ¹	43 Tc 4d ⁵ 5s ²	44 Ru 4d ⁷ 5s ¹	45 Rh 4d ⁸ 5s ¹	46 Pd 4d ¹⁰	47 Ag 4d ¹⁰ 5s ¹	48 Cd 4d ¹⁰ 5s ²	49 In 5s ² 5p ¹	50 Sn 5s ² 5p ²	51 Sb 5s ² 5p ³	52 Te 5s ² 5p ⁴	53 I 5s ² 5p ⁵	54 Xe 5s ² 5p ⁶
6	55 Cs 6s ¹	56 Ba 6s ²	57 La* 5d ¹ 6s ²	58 Ce 5d ¹ 6s ²	59 Pr 5d ¹ 6s ²	60 Nd 5d ⁰ 6s ²	61 Pm 5d ⁰ 6s ²	62 Sm 5d ⁰ 6s ²	63 Eu 5d ⁰ 6s ²	64 Gd 5d ¹ 6s ²	65 Tb 5d ¹ 6s ²	66 Dy 5d ⁰ 6s ²	67 Ho 5d ⁰ 6s ²	68 Er 5d ⁰ 6s ²	69 Tm 5d ⁰ 6s ²	70 Yb 5d ⁰ 6s ²	71 Lu 5d ¹ 6s ²	
7	87 Fr 7s ¹	88 Ra 7s ²	89 Ac** 6d ¹ 7s ²	104 Db 6d ¹ 7s ²	105 Jl 6d ¹ 7s ²	106 Rf 6d ² 7s ²	107 Bh 6d ³ 7s ²	108 Hn 6d ⁴ 7s ²	109 Mt 6d ⁵ 7s ²	Inner-Transition Metals f Subshell fills								

*Lanthanides

**Actinides

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

 Metal
 Metalloid
 Nonmetal

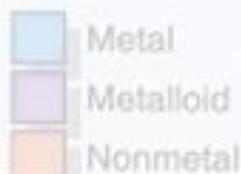
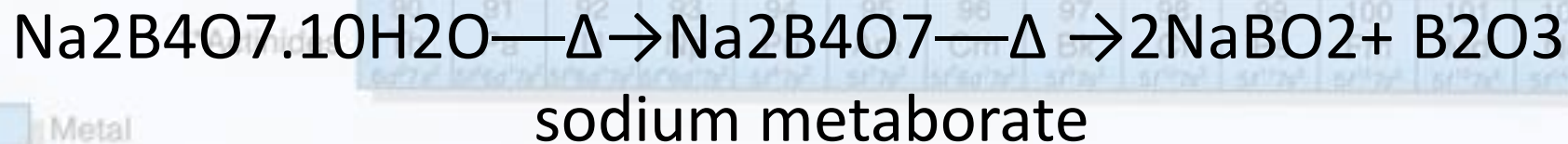
1. Borax

It is the most important compound of boron. It is a white crystalline solid of formula $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$. Borax dissolves in water to give an alkaline solution.



Orthoboric acid

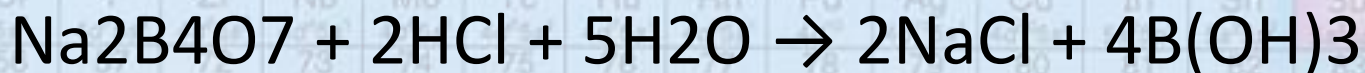
On heating, borax first loses water molecules and swells up. On further heating it turns into a transparent liquid, which solidifies into glass like material known as borax bead.



2.Orthoboric acid

Orthoboric acid, H_3BO_3 is a white crystalline solid, with soapy touch. It is sparingly soluble in water but highly soluble in hot water.

It can be prepared by acidifying an aqueous solution of borax.



It has a layer structure in which planar BO_3 units are joined by hydrogen bonds .

Boric acid is a weak monobasic acid. It is not a protonic acid but acts as a Lewis acid by accepting electrons from a hydroxyl ion:



On heating, orthoboric acid above 370K forms metaboric acid, HBO_2 which on further heating yields boric oxide, B_2O_3 .



3. Diborane, B_2H_6

The simplest boron hydride known, is diborane. It is prepared by treating boron trifluoride with LiAlH_4 in diethyl ether.



A convenient laboratory method for the preparation of diborane involves the oxidation of sodium boron hydride with iodine



Diborane is produced on an industrial scale by the reaction of BF_3 with sodium hydride.



PROPERTIES OF DIBORANE.

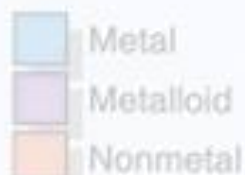
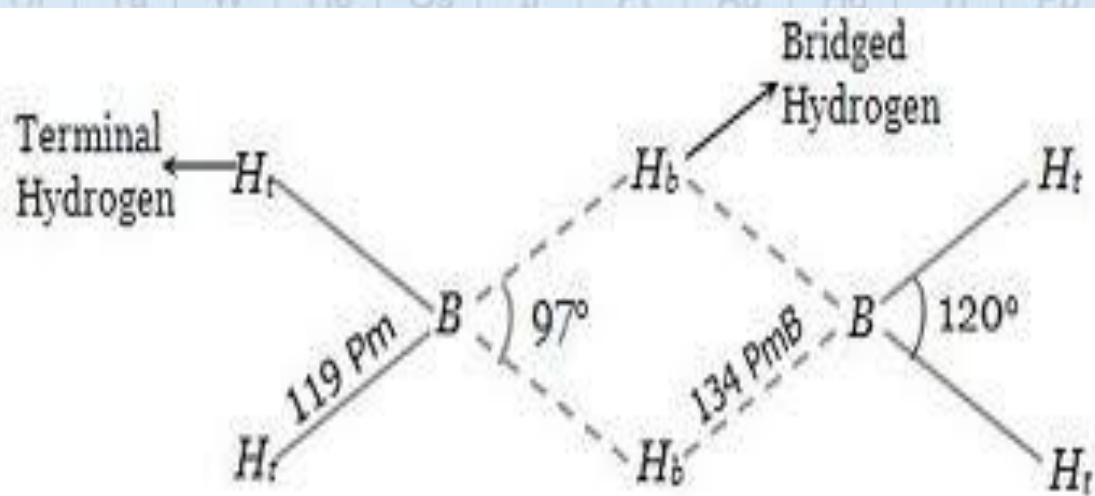
1. Diborane is a colourless, highly toxic gas with a b.p. of 180 K.

2. Diborane catches fire spontaneously upon exposure to air. It burns in oxygen releasing an enormous amount of energy.

3. Reaction of ammonia with diborane gives initially $B_2H_6 \cdot 2NH_3$, further heating gives borazine, $B_3N_3H_6$ known as “inorganic benzene”.



The structure of diborane is shown below. The four terminal hydrogen atoms and the two boron atoms lie in one plane. Above and below this plane, there are two bridging hydrogen atoms. The four terminal B-H bonds are regular two centre-two electron bonds while the two bridge (B-H-B) bonds are different and can be described in terms of three centre two Electron bond.



USES OF BORON AND ALUMINIUM AND THEIR COMPOUNDS

BORON

Boron has low density and very low electrical conductivity, finds many applications.

1. Boron fibres are used in making bullet-proof vest and light material for aircraft .
2. The boron-10 isotope has high ability to absorb neutrons and there f metal borides are used in nuclear industry as protective shields and control rods.
3. The main industrial application of borax and boric acid is in the manufacture of heat resistant glasses like glass-wool and fibreglass.
4. Borax is used as a constituent of medicinal soaps. An aqueous solution of orthoboric acid is generally used as a mild antiseptic.

ALUMINIUM

1. Aluminium is a bright silvery-white metal. It has a high electrical and thermal conductivity.
2. It forms alloys with Cu, Mn, Mg, Si and Zn. Aluminium and its alloys can be given shapes of pipe, tubes, rods, wires, plates or foils and, therefore, find uses in packing, utensil making, construction, aeroplane and transportation industry.
3. The use of aluminium and its compounds for domestic purposes is now reduced considerably because of their toxic nature.

Metalloid
Nonmetal

Main-Group Elements
s Subshell fills

Main-Group Elements
p Subshell fills

GROUP 14 ELEMENTS

1	1 IA H 1s ¹	2 IIA He 1s ²	Transition Metals d Subshell fills										13 IIIA B 2s ² 2p ¹	14 IVA C 2s ² 2p ²	15 VA N 2s ² 2p ³	16 VIA O 2s ² 2p ⁴	17 VIIA F 2s ² 2p ⁵	18 VIIIA Ne 2s ² 2p ⁶
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3	11 Na 3s ¹	12 Mg 3s ²	3 IIIB Sc 3d ¹ 4s ²	4 IVB Ti 3d ² 4s ²	5 VB V 3d ³ 4s ²	6 VIB Cr 3d ⁴ 4s ¹	7 VIIB Mn 3d ⁵ 4s ²	8 VIII B Fe 3d ⁶ 4s ²	9 VIII B Co 3d ⁷ 4s ²	10 VIII B Ni 3d ⁸ 4s ²	11 IB Cu 3d ¹⁰ 4s ¹	12 IIB Zn 3d ¹⁰ 4s ²	13 Al 3s ² 3p ¹	14 Si 3s ² 3p ²	15 P 3s ² 3p ³	16 S 3s ² 3p ⁴	17 Cl 3s ² 3p ⁵	18 Ar 3s ² 3p ⁶
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6	55 Cs 6s ¹	56 Ba 6s ²	57 La* 5d ¹ 6s ²	72 Hf 5d ² 6s ²	73 Ta 5d ³ 6s ²	74 W 5d ⁴ 6s ²	75 Re 5d ⁵ 6s ²	76 Os 5d ⁶ 6s ²	77 Ir 5d ⁷ 6s ²	78 Pt 5d ⁹ 6s ¹	79 Au 5d ¹⁰ 6s ¹	80 Hg 5d ¹⁰ 6s ²	81 Tl 6s ² 6p ¹	82 Pb 6s ² 6p ²	83 Bi 6s ² 6p ³	84 Po 6s ² 6p ⁴	85 At 6s ² 6p ⁵	86 Rn 6s ² 6p ⁶
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*Lanthanides

**Actinides

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce 4f ¹ 5d ¹ 6s ²	Pr 4f ³ 6s ²	Nd 4f ⁴ 6s ²	Pm 4f ⁵ 6s ²	Sm 4f ⁶ 6s ²	Eu 4f ⁷ 6s ²	Gd 4f ⁷ 5d ¹ 6s ²	Tb 4f ⁹ 6s ²	Dy 4f ¹⁰ 6s ²	Ho 4f ¹¹ 6s ²	Er 4f ¹² 6s ²	Tm 4f ¹³ 6s ²	Yb 4f ¹⁴ 6s ²	Lu 4f ¹⁴ 5d ¹ 6s ²
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th 6d ² 7s ²	Pa 5f ² 6d ¹ 7s ²	U 5f ³ 6d ¹ 7s ²	Np 5f ⁴ 6d ¹ 7s ²	Pu 5f ⁶ 7s ²	Am 5f ⁷ 7s ²	Cm 5f ⁷ 6d ¹ 7s ²	Bk 5f ⁹ 7s ²	Cf 5f ¹⁰ 7s ²	Es 5f ¹¹ 7s ²	Fm 5f ¹² 7s ²	Md 5f ¹³ 7s ²	No 5f ¹⁴ 7s ²	Lr 5f ¹⁴ 6d ¹ 7s ²

- Metal
- Metalloid
- Nonmetal

PRESENTATION OVERVIEW

- ❖ MODERN PERIODIC TABLE
- ❖ GROUP 14 ELEMENTS: THE CARBON FAMILY
- ❖ CARBON & ITS USES
- ❖ SILICON & ITS USES
- ❖ GERMANIUM & USES
- ❖ TIN & ITS USES
- ❖ LEAD & ITS USES
- ❖ ATOMIC AND PHYSICAL PROPERTIES
- ❖ CHEMICAL PROPERTIES

Main-Group Elements s Subshell fills

1 IA 2 IIA 3 IIIA 4 IVA 5 VA 6 VIA 7 VIIA 8 VIIIA 9 VIIIA 10 VIIIA 11 VIIIA 12 VIIIA 13 IIIA 14 IVA 15 VA 16 VIA 17 VIIA 18 VIIIA

1 H He

2 Li Be B C N O F Ne

3 Na Mg Al Si P S Cl Ar

4 K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga Ge As Se Br Kr

5 Rb Sr Y Zr Nb Mo Tc Ru Rh Pd Ag Cd In Sn Sb Te I Xe

6 Cs Ba La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu

7 Fr Ra Ac** Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr

Transition Metals

Inner-Transition Metals / Subshell fills

*Lanthanides

**Actinides

Metals

Metalloid

Nonmetals

chemistry.com

Main-Group Elements
s Subshell fills

Main-Group Elements
p Subshell fills

GROUP 14 ELEMENTS: THE CARBON FAMILY

Period	1 IA	2 IIA	Transition Metals d Subshell fills										13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIII	
Element			symbol										electron configuration						
1	H																	He	
2	Li	Be											B	C	N	O	F	Ne	
3																		Ar	
4	Carbon		Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
5	Silicon		Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
6	Germanium		Lanthanides	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
7	Tin		Actinides	Rf	Db	Sg	Bh	Hn	Mt	Inert Gas									
	Lead																		
			Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu			
			Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr			

- Metal
- Metalloid
- Nonmetal

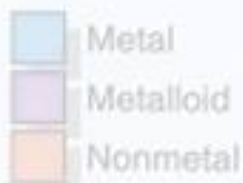
Atomic and physical properties: group 14 elements

Property	Elements				
	Carbon	Silicon	Germanium	Tin	Lead
Atomic number	6	14	32	50	82
Atomic mass(g/mol)	12.01	28.09	72.60	118.71	207.2
Electronic configuration	[He]2s ² 2p ²	[Ne]3s ² 3p ²	[Ar]3d ¹⁰ 4s ² 4p ²	[Kr]4d ¹⁰ 5s ² 5p ²	[Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ²
Covalent radius/pm	77	118	122	140	146
Ionic radius M ⁴⁺ /pm	–	40	53	69	78
Ionic radius M ²⁺ /pm	–	–	73	118	119
Ionization enthalpy/Kjmol ⁻¹ (Δ _i H)	1086	786	761	708	715
Electronegativity	2.5	1.8	1.8	1.8	1.9
Density/g cm ⁻³	3.51	2.34	5.32	7.26	11.34
Melting point/K	4373	1693	1218	505	600
Boiling point/K	–	3550	3123	2896	2024
Electrical resistivity/ohm cm	10 ¹⁴ -10 ¹⁶	50	50	10 ⁻⁵	2 X 10 ⁻⁵

Chemical properties

Oxidation state:-

- Carbon and silicon have +4 oxidation state.
- C & Si have very rare +2 compounds.
- Ge, Sn & Pb show both +2 and +4 oxidation states.
- The +2 state is more stable than +4 state as we go down the group.
- Fajan's rule:- "smaller is the cation, the greater is the covalent character in its compounds". Eg Sn^{4+} compounds are covalent and Sn^{2+} compounds are ionic in nature.



Chemical properties (CONT-----)

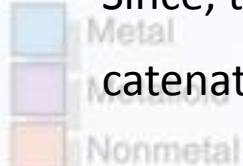
Catenation:-

- The property of self linkage leading to the formation of long chains and rings is termed catenation.
- Carbon has a greater tendency of self linking than other elements.
- Catenation tendency follows follows the order,



Bond	C–C	Si–Si	Ge–Ge	Sn–Sn
Bond enthalpy (Kjmol ⁻¹)	348	222	167	155

- Since, the M–M bond enthalpy decreases steadily from C to Sn. Therefore, the catenation tendency also decreases down the group.



Chemical properties (CONT--)

Formation of multiple bonds :- pi bonding

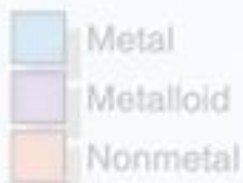
- Carbon forms stable multiple bonds with itself and with other elements.
- $>C=C<$ $-C\equiv C-$ $>C=O$ $>C=N$ $-C\equiv N$ $>C=S$
- Other elements of this group show no tendency to form pi bonds.
- However a few compounds containing multiple bonds have been isolated.
- Effect of pi bonding on the structure may be seen in graphite.

	Metal
	Metalloid
	Nonmetal

Chemical properties (CONT---)

Hydride formation:-

- Covalent hydrides of the type MH_4 are known for all group 14 elements except lead.
- Tendency of hydride formation decreases in going from C to Pb.
- Carbon forms a large number of cyclic and acyclic hydrides known as hydrocarbons.
- Silicon and germanium form fewer hydrides of the general formula Si_nH_{2n+2} & Ge_nH_{2n+2} known as silanes and germanes respectively..



Chemical properties (CONT---

Oxide formation:-

Group 14 elements form three types of oxides:-

MO(monoxide) **MO₂(Dioxide)** **M₂O₃(MO+MO₂)(Mixed oxide)**

All elements of group 14 except silicon form monoxides of the formula MO.

While CO is neutral, all other oxides are basic in character.

Carbon monoxide(CO) is the most important monoxide.

All group 14 elements form dioxides having the formula MO₂.

These oxides differ in their properties and structures.

	Metal
	Metalloid
	Nonmetal

Chemical properties (CONT--)

Halide formation:-

- Elements of group 14 form the following types of halides,

MX_4 type eg., CCl_4 (carbon tetrachloride)

MHX_3 type eg., $CHCl_3$ (Chloroform)

MX_2 type eg., $SiCl_2$ (Silicon dichloride)

- Dihalides of Ge, Sn & Pb are more ionic in nature.
- The stability of dihalides increases in going down the group
- Tetrahalides of the type MX_4 are known for all the elements of group 14.
- Tetrahalides are tetrahedral and covalent.
- The tetrahalides of all elements except of carbon undergo hydrolysis.

CARBON



Atomic Number
Symbol
Valence-shell configuration

Introduction

- **Symbol :-C.**
- **Latin word:- "carbo" meaning "charcoal"**
- **Atomic Number = 6, Atomic Mass = 12.01**
- **Most common element:** graphite, diamonds and coal.
- **Most common compounds:-** Hydrocarbons and Carbon dioxide.

Physical Properties

- Carbon is a soft, dull gray or black non-metal that can be scratched with a fingernail.
- The density of carbon as graphite is 2.267 g/mL, which means it will sink in water.



Main-Group Elements
s Subshell fills

Main-Group Elements
p Subshell fills

CARBON-Uses

Diamond

- Jewellery
- Manufacturing tools
- In making dies

Graphite

- Lubricant at high temperature
- Manufacturing lead pencils

Coal

- Fuel
- Manufacturing coal tar, coke and coal gas
- Manufacturing synthetic petrol



SILICON

Introduction

- **Symbol :-Si.**
- **Latin word:-“Silicium”**
- **Atomic Number = 14, Atomic Mass = 28.09**
- **Most common compounds:-Silicon dioxide (SiO_2), Silicon carbide (SiC), Sodium silicate (Na_2SiO_3) and Silicon tetrachloride (SiCl_4)**

Physical Properties

- Crystalline silicon has a metallic grayish color
- Silicon is relatively inert, but it is attacked by dilute alkali and by halogens
- Silicon transmits over 95% of all infrared wavelengths (1.3-6.7 mm)

Main-Group Elements
s Subshell fills

Main-Group Elements
p Subshell fills

SILICON-Uses

- Electronic devices such as transistors, diodes and chips
- For producing ferrosilicon
- As a deoxidiser in steel industry
- Important to plant and animal life



Atomic number
Symbol
Valence-shell configuration

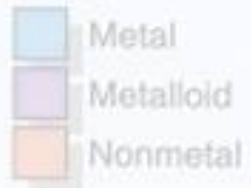
Transition Metals
d Subshell fills

Inner-Transition Metals
f Subshell fills

*Lanthanides

**Actinides

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr



GERMANIUM

Introduction

- **Symbol :-**Ge
- **Latin word:-** “Germania”
- **Atomic Number = 32, Atomic Mass = 72.60**
- **Most common compounds:-** Oxide(s): GeO, GeO₂ Chloride(s): GeCl₂, GeCl₄, Hydride(s): GeH₄, Ge₂H₆

Physical Properties

- Germanium is a lustrous, hard, gray-white semi-metallic element
- Germanium expands as it freezes
- It is a semiconductor
- Germanium and the oxide are transparent to infrared radiation

GERMANIUM-Uses

- Semiconductor devices
- Making prisms, lenses and windows in instruments based on IR
- As catalyst

Main-Group Elements s Subshell fills

Main-Group Elements p Subshell fills

Transition Metals d Subshell fills

Inner-Transition Metals / Subshell fills

*Lanthanides

**Actinides

Legend: Metal (Blue), Metalloid (Purple), Nonmetal (Orange)

1	1	2	Transition Metals										13	14	15	16	17	18
IA	IIA	d Subshell fills										IIIA	IVA	VA	VIA	VIIA	VIIIA	
1	H	He											B	C	N	O	F	Ne
2	Li	Be											B	C	N	O	F	Ne
3	Na	Mg	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6	Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7	Fr	Ra	Ac**	Rf	Bh	Hn	Mt	Inner-Transition Metals / Subshell fills										
			58	59	60	61	62	63	64	65	66	67	68	69	70	71		
			Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
			90	91	92	93	94	95	96	97	98	99	100	101	102	103		
			Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		

TIN

50	Sn	$5s^2 5p^2$
----	----	-------------

Atomic number
Symbol
Valence-shell configuration

Introduction

- **Symbol :-Sn**
- **Latin word:- “Stannum”**
- **Atomic Number = 50, Atomic Mass = 118.69**
- **Most common compounds:-SnF₄, SnCl₄, SnBr₄ and SnCl₂**

Physical Properties

- Tin is a malleable silvery-white metal which takes a high polish
- It possesses a highly crystalline structure and is moderately ductile.
- When a bar of tin is bent, the crystals break, producing a characteristic 'tin cry'.
- Tin has a cubic structure.
- Upon warming, at 13.2°C gray tin changes to white

Metal

Metalloid

Nonmetal

Main-Group Elements
s Subshell fills

Main-Group Elements
p Subshell fills

TIN-Uses



- For tinning of copper and brass utensils
- For making tin foils for wrapping cigarettes
- For making alloy:- solder, bronze and gun metal
- SnO_2 coated glass is scratch resistant i.e. aircraft windows
- Used in agriculture to control fungi such as potato blight

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

	Metal
	Metalloid
	Nonmetal

LEAD

Introduction

- Symbol :-Pb
- Latin word:- “plumbum”
- Atomic Number = 82, Atomic Mass = 207.19
- Most common compounds:- PbCl_2 , PbO_2 , $\text{Pb}(\text{NO}_2)_2$, Pb_3O_4 , $\text{Pb}(\text{CH}_3)_4$

Physical Properties

- Lead is a soft, malleable and poor metal
- It is also counted as one of the heavy metals
- Metallic lead has a bluish-white color after being freshly cut, but it soon tarnishes to a dull grayish color when exposed to air
- Lead has a shiny chrome-silver luster when it is melted into a liquid



Atomic number
Symbol
Valence-shell configuration

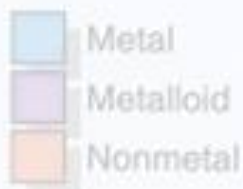


Main-Group Elements
s Subshell fills

Main-Group Elements
p Subshell fills

LEAD-Uses

- For making water pipes
- Lead storage battery
- For making bullets, shots, etc
- Alloys:- solder
- Used for preparing high refractive index glasses



Main-Group Elements
s Subshell fills

Main-Group Elements
p Subshell fills

1 IA		Transition Metals d Subshell fills															18 VIII		
2 IIA												13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	2 He		
1	1 H $1s^1$																$1s^2$		
2	3 Li $2s^1$	4 Be $2s^2$											5 B $2s^2 2p^1$	6 C $2s^2 2p^2$	7 N $2s^2 2p^3$	8 O $2s^2 2p^4$	9 F $2s^2 2p^5$	10 Ne $2s^2 2p^6$	
3	11 Na $3s^1$	12 Mg $3s^2$	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIII B		9	10	11 IB	12 IIB	13 Al $3s^2 3p^1$	14 Si $3s^2 3p^2$	15 P $3s^2 3p^3$	16 S $3s^2 3p^4$	17 Cl $3s^2 3p^5$	18 Ar $3s^2 3p^6$
4	19 K $4s^1$	20 Ca $4s^2$	21 Sc $3d^1 4s^2$	22 Ti $3d^2 4s^2$	23 V $3d^3 4s^2$	24 Cr $3d^5 4s^1$	25 Mn $3d^5 4s^2$	26 Fe $3d^6 4s^2$	27 Co $3d^7 4s^2$	28 Ni $3d^8 4s^2$	29 Cu $3d^10 4s^1$	30 Zn $3d^10 4s^2$	31 Ga $4s^2 4p^1$	32 Ge $4s^2 4p^2$	33 As $4s^2 4p^3$	34 Se $4s^2 4p^4$	35 Br $4s^2 4p^5$	36 Kr $4s^2 4p^6$	
5	37 Rb $5s^1$	38 Sr $5s^2$	39 Y $4d^1 5s^2$	40 Zr $4d^2 5s^2$	41 Nb $4d^4 5s^1$	42 Mo $4d^5 5s^1$	43 Tc $4d^5 5s^2$	44 Ru $4d^7 5s^1$	45 Rh $4d^8 5s^1$	46 Pd $4d^10 5s^0$	47 Ag $4d^10 5s^1$	48 Cd $4d^10 5s^2$	49 In $5s^2 5p^1$	50 Sn $5s^2 5p^2$	51 Sb $5s^2 5p^3$	52 Te $5s^2 5p^4$	53 I $5s^2 5p^5$	54 Xe $5s^2 5p^6$	
6	55 Cs $6s^1$	56 Ba $6s^2$	57 La* $5d^1 6s^2$	72 Hf $5d^2 6s^2$	73 Ta $5d^3 6s^2$	74 W $5d^4 6s^2$	75 Re $5d^5 6s^2$	76 Os $5d^6 6s^2$	77 Ir $5d^7 6s^2$	78 Pt $5d^9 6s^1$	79 Au $5d^10 6s^1$	80 Hg $5d^10 6s^2$	81 Tl $6s^2 6p^1$	82 Pb $6s^2 6p^2$	83 Bi $6s^2 6p^3$	84 Po $6s^2 6p^4$	85 At $6s^2 6p^5$	86 Rn $6s^2 6p^6$	
7	87 Fr $7s^1$	88 Ra $7s^2$	89 Ac** $6d^1 7s^2$	104 Db $6d^3 7s^2$	105 Jl $6d^4 7s^2$	106 Rf $6d^5 7s^2$	107 Bh $6d^6 7s^2$	108 Hn $6d^7 7s^2$	109 Mt $6d^8 7s^2$	Inner-Transition Metals f Subshell fills									

THANK YOU

*Lanthanides

**Actinides

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
$4f^1 5d^1 6s^2$	$4f^3 6s^2$	$4f^4 6s^2$	$4f^6 6s^2$	$4f^7 6s^2$	$4f^7 6s^2$	$4f^9 6s^2$	$4f^9 6s^2$	$4f^10 6s^2$	$4f^10 6s^2$	$4f^11 6s^2$	$4f^11 6s^2$	$4f^14 6s^2$	$4f^14 6s^2$
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
$6d^2 7s^2$	$5f^2 6d^1 7s^2$	$5f^3 7s^2$	$5f^4 7s^2$	$5f^6 7s^2$	$5f^7 7s^2$	$5f^7 7s^2$	$5f^9 7s^2$	$5f^9 7s^2$	$5f^10 7s^2$	$5f^10 7s^2$	$5f^11 7s^2$	$5f^14 7s^2$	$5f^14 7s^2$

- Metal
- Metalloid
- Nonmetal