



Periodic Properties of Elements in the Periodic Table

Presented By
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Periodic Table (Modern Form)

											IA																0
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	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn									
7	Fr	Ra	+ Ac	Rf	Ha	106	107	108	109	110	111	112															

Periodic Table of the Elements

Naming conventions of new elements

* Lanthanide Series

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

+ Actinide Series

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



Periodic Law

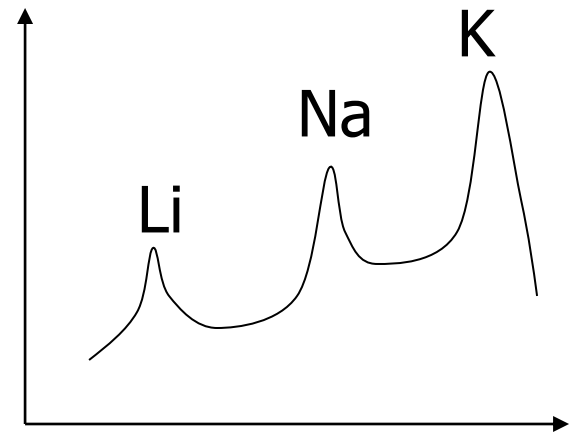
- The properties of elements are a **periodic function** of their **atomic number**

$$P = F(z)$$

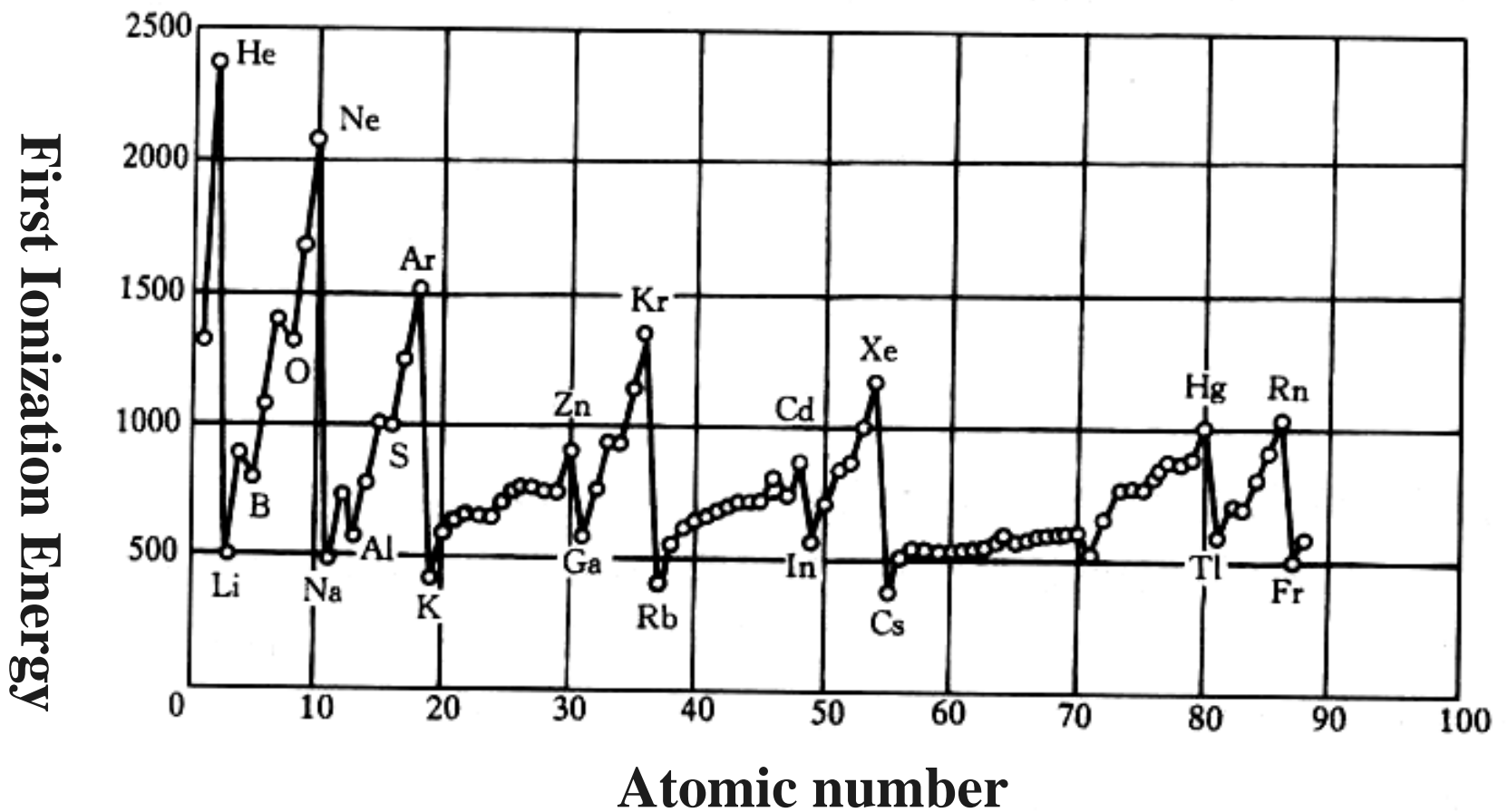
Periodic Law

- When elements are arranged in order of **atomic number**, **similar properties recur periodically**.

Atomic radii vs. Z



Periodic Law





Why Periodic Law?

Chemical
and
Physical
properties

Type of
Bonding
and
structure

Atomic
properties

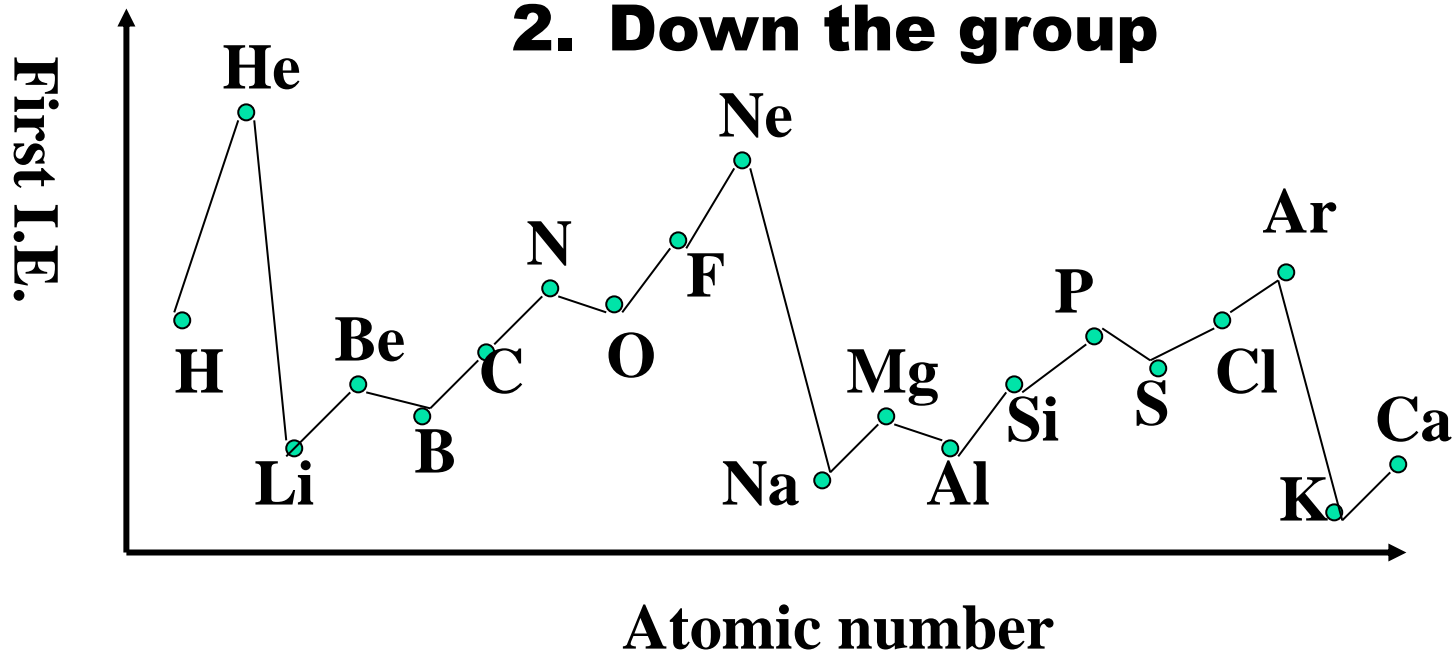
Atomic number



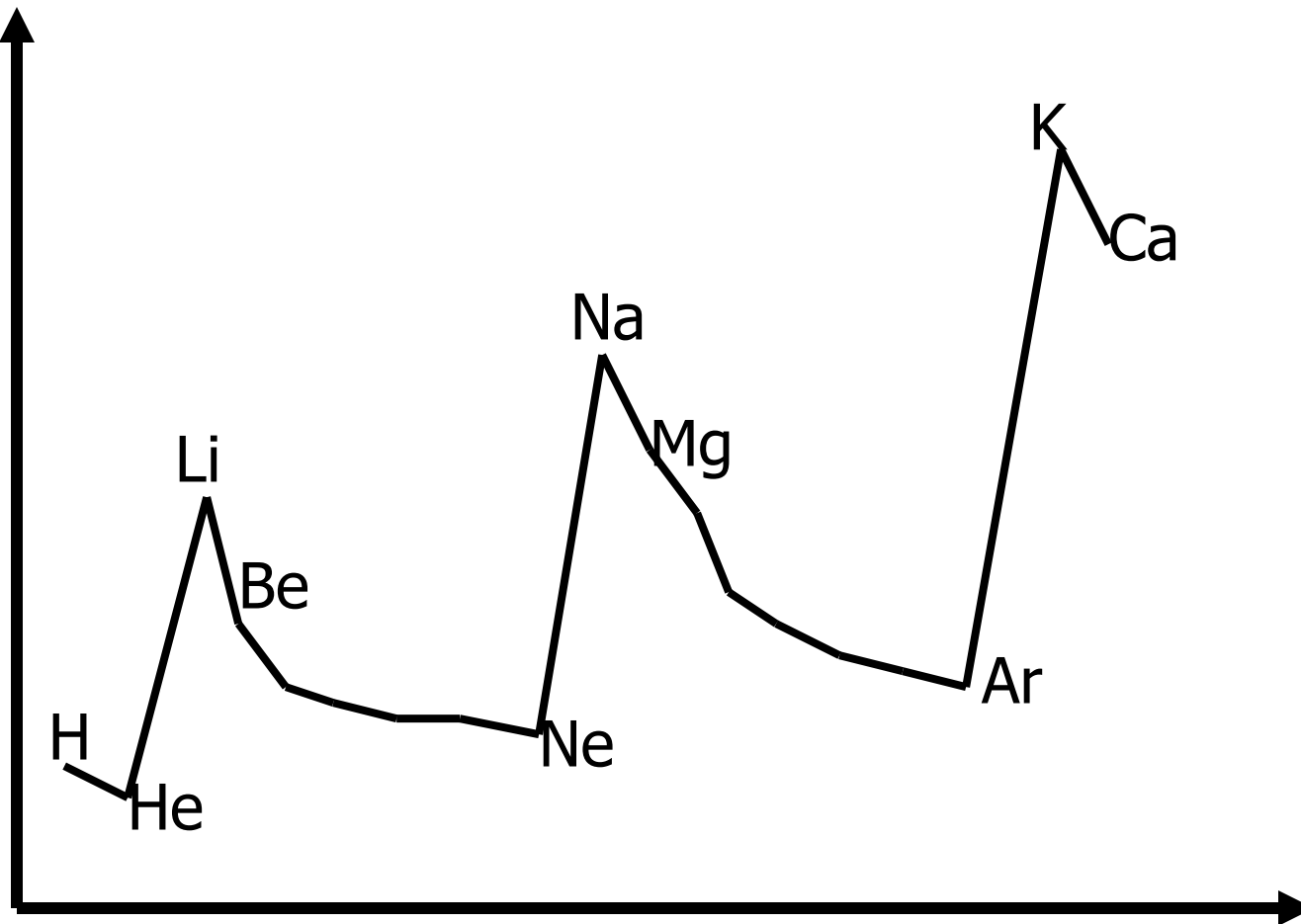
Ionization Energies

Variations:

1. Across a period
2. Down the group



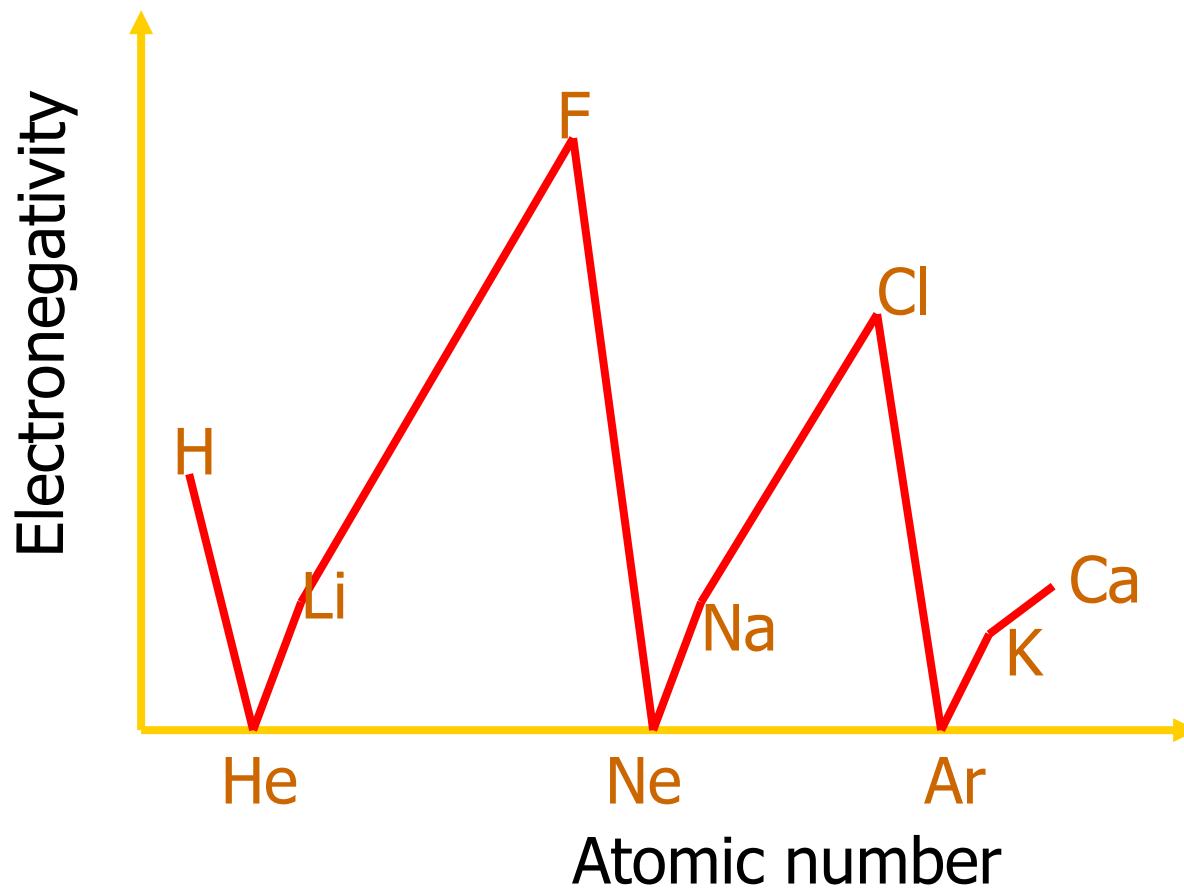
Atomic radius



Atomic Radius (pm) $1\text{pm}=1\times 10^{-12}\text{m}$

H 37																	He 54
Li 156	Be 105											B 91	C 77	N 71	O 60	F 67	Ne 80
Na 186	Mg 160											Al 143	Si 117	P 111	S 104	Cl 99	Ar 96
K 231	Ca 197	Sc 161	Ti 154	V 131	Cr 125	Mn 118	Fe 125	Co 125	Ni 124	Cu 128	Zn 133	Ga 123	Ge 122	As 116	Se 115	Br 114	Kr 99
Rb 243	Sr 215	Y 180	Zr 161	Nb 147	Mo 136	Tc 135	Ru 132	Rh 132	Pd 138	Ag 144	Cd 149	In 151	Sn 140	Sb 145	Te 139	I 138	Xe 109
Cs 265	Ba 210		Hf 154	Ta 143	W 137	Re 138	Os 134	Ir 136	Pt 139	Au 144	Hg 147	Tl 189	Pb 175	Bi 155	Po 167	At 145	Rn
La 187	Ce 183	Pr 182	Nd 181	Pm 181	Sm 180	Eu 199	Gd 179	Tb 176	Dy 175	Ho 174	Er 173	Tm 173	Yb 194	Lu 172			

Electronegativity



Electronegativity

Increase in electronegativity



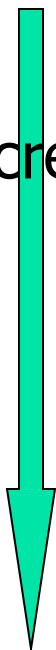
H
2.1

He
-

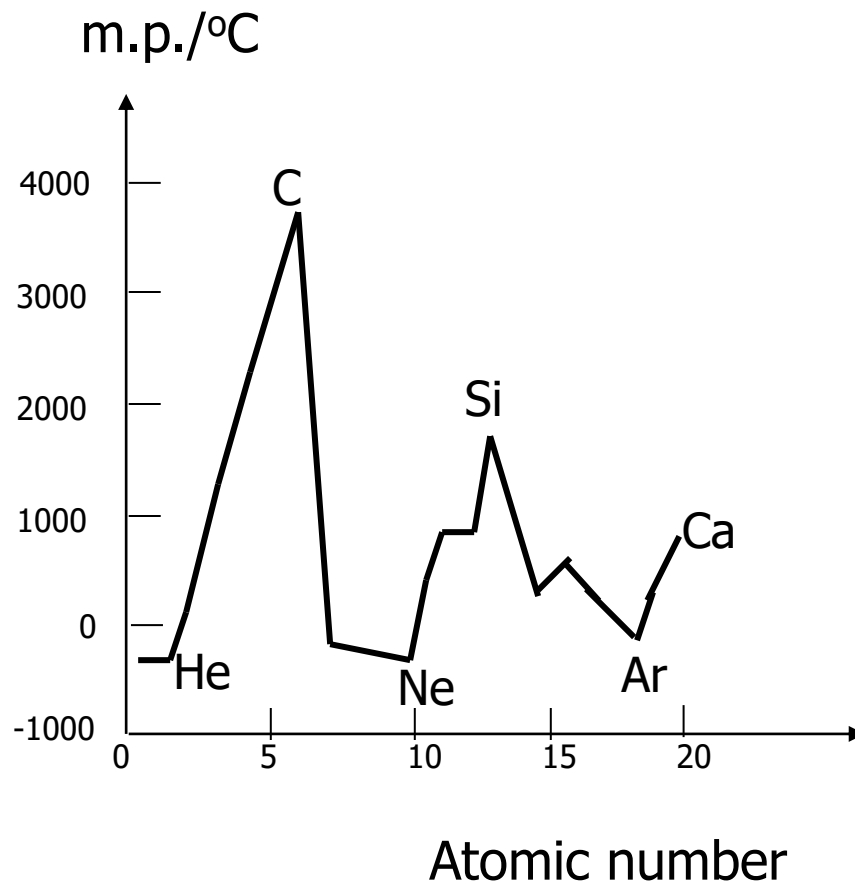
Li	Be
1.0	1.5
Na	Mg
0.9	1.2
K	Al
0.8	1.0

B	C	N	O	F	Ne
2.0	2.5	3.0	3.5	4.0	-
Al	Si	P	S	Cl	Ar
1.5	1.8	2.1	2.5	3.0	-

Decrease



Melting Points



Melting Points

Increase



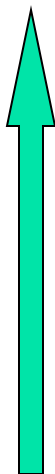
H
-259

He
-270

Li	Be
180	1280
Na	Mg
97.8	650
K	Ca
63.7	850

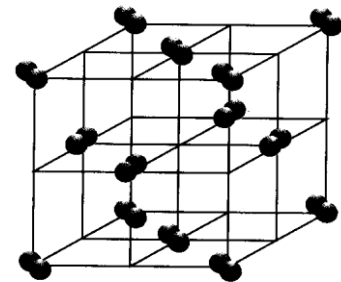
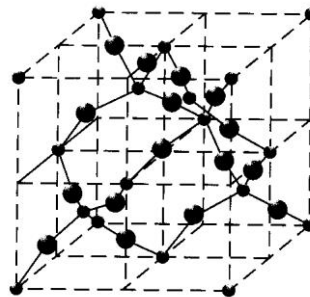
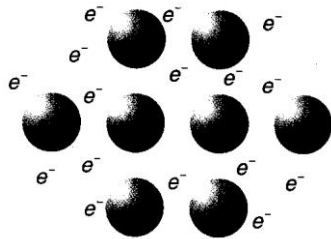
B	C	N	O	F	Ne
2300	3730	-210	-218	-220	-249
Al	Si	P	S	Cl	Ar
660	1410	44.2	119	-101	-189

Unit: °C



Periodic Variation of Physical Properties

- Structure & Bonding
 - Giant metallic → Giant covalent → Simple molecular

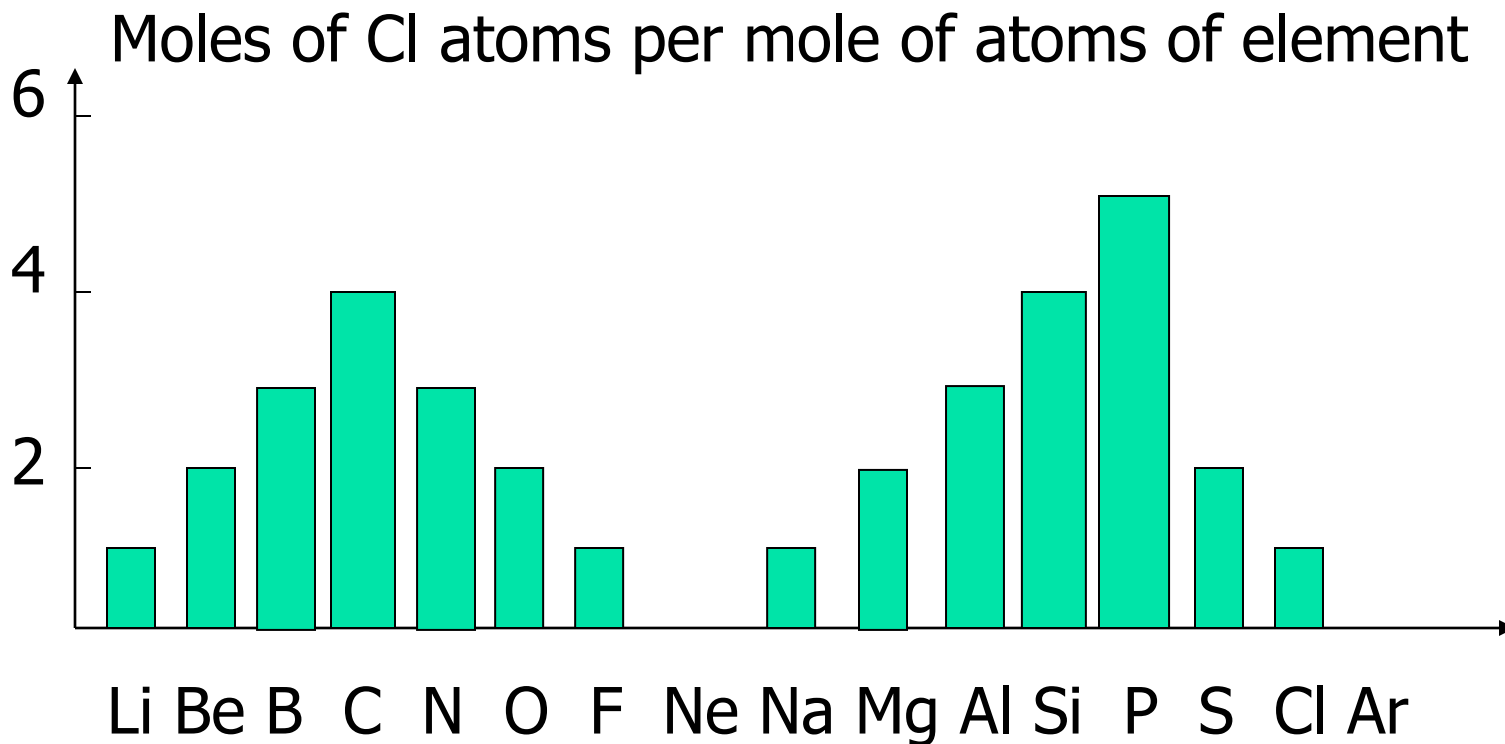




Periodic Variation of Chemical Properties

- Formulae of hydrides, oxides, chlorides
- Hydrolytic behaviours and explanations

Periodicity in formulae





Hydrides

Period 2	LiH	BeH ₂ B ₂ H ₆	CH ₄	NH ₃ H ₂ O HF
Period 3	NaH	MgH ₂ AlH ₃	SiH ₄ PH ₃	H ₂ S HCl
	Ionic	Covalent with some ionic character	Typically Covalent	Polar covalent



Hydrides

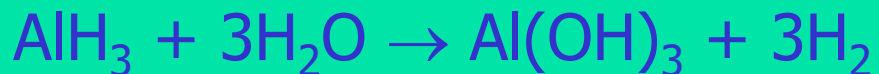
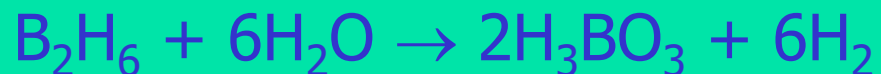
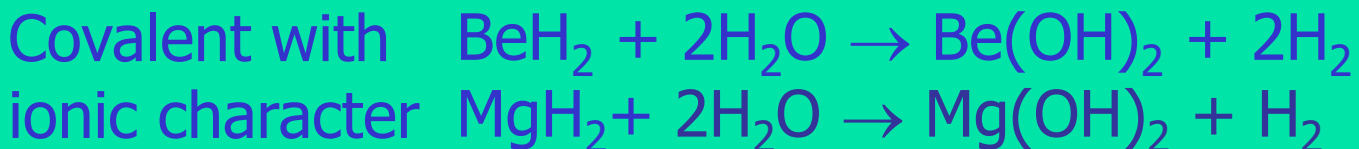
Bonding

Hydrolytic behaviour

Ionic



Covalent with
ionic character



Be(OH)_2 , Mg(OH)_2 , Al(OH)_3 are alkaline
 H_3BO_3 is acidic

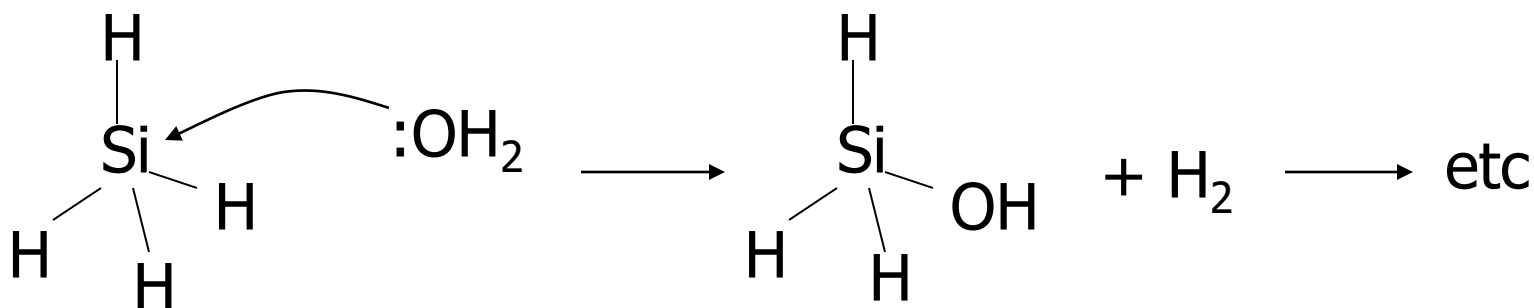
Hydrides

Typically
Covalent

CH_4 does not dissolve nor react

SiH_4 reacts to give $\text{SiO}_2 \cdot 2\text{H}_2\text{O} + \text{H}_2$

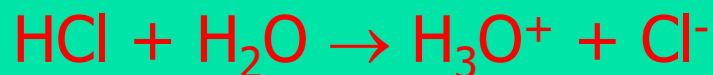
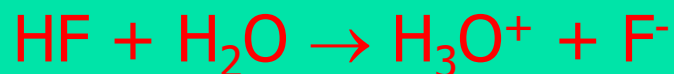
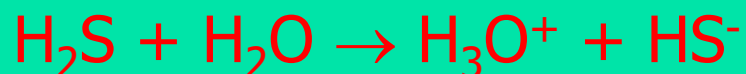
PH_3 very slight soluble





Hydrides

Polar covalent

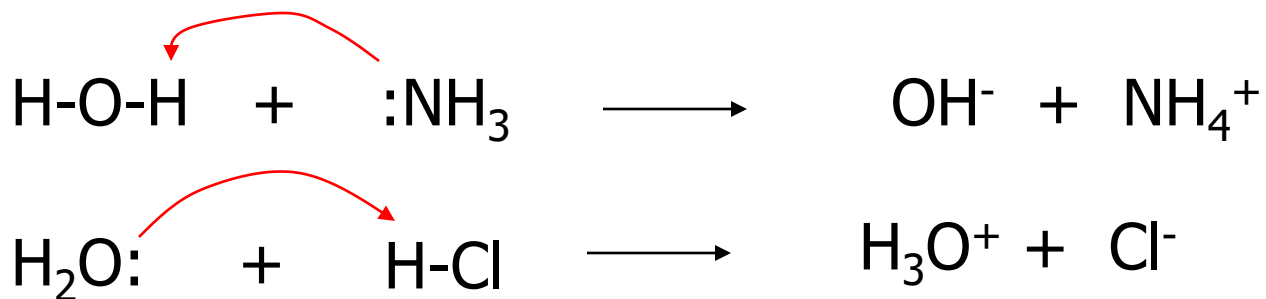


Note: From gp4 to gp7

Acidity increases because polarity of bond increase



Check point 38-3



N is more electronegative, hence more basic than Cl. It reacts with water by donating its lone pair electron.

CH_4 , due to its non-polar covalent bond, it does not dissolve nor react with water.

Oxides

Ionic



Ionic with
Covalent character



Covalent

Basic



Amphoteric



Acidic

Na_2O

Al_2O_3

CO_2

SO_2

NO_2



Ionic Oxides





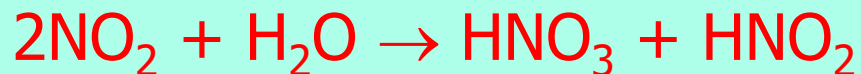
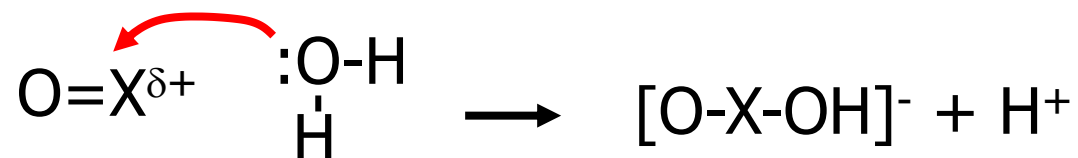
Amphoteric Oxides





Covalent Oxides

Mechanism of the Hydrolytic behaviour of covalent oxides:





Covalent Oxides

P_4O_6 and P_4O_{10} :



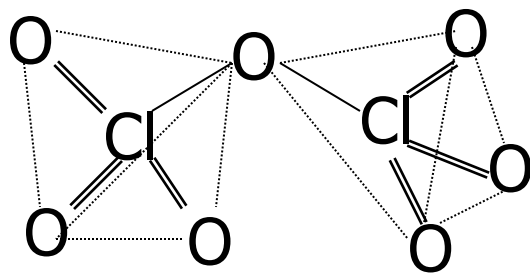
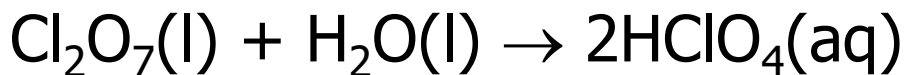
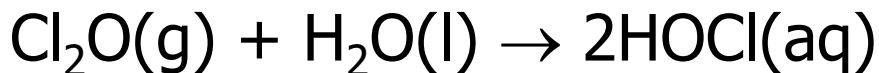
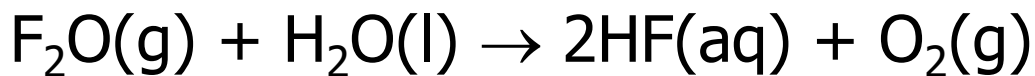
The actual reactions are complicated.

The products formed depend on the amount of water present and the conditions of reaction.

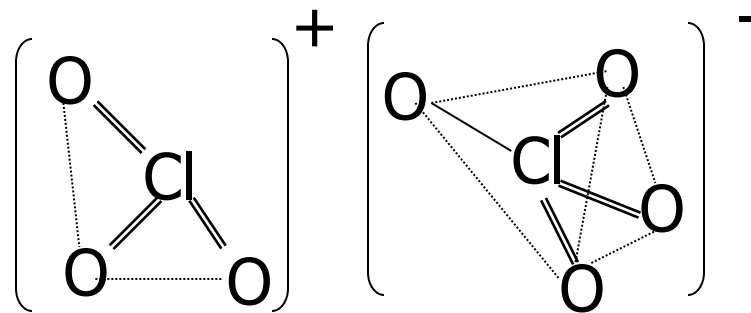


Covalent Oxides

Group VIIA: F_2O , Cl_2O and Cl_2O_7



$Cl_2O_7(g)/(l)$



$Cl_2O_7(s)$

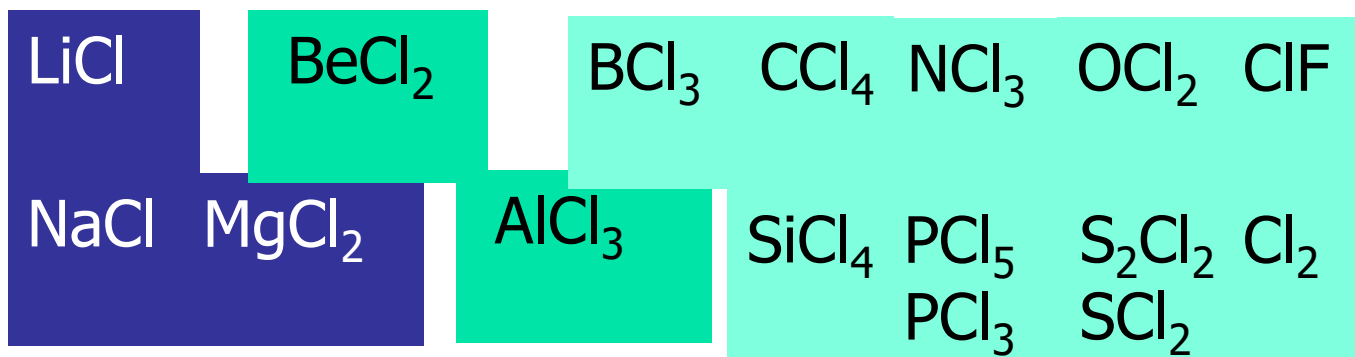


Check point 38-4

- a. SiO_2 does not react with water. The giant covalent structure has high lattice energy. It is not possible to break it down in aqueous solution.



Chlorides



Ionic

Intermediate
with covalent
character

Covalent



Ionic chlorides

- Group IA
 - LiCl, NaCl are not hydrolysed in aqueous solution, neutral solution formed when dissolved. $\text{NaCl (s)} \rightarrow \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$, $\text{LiCl (s)} \rightarrow \text{Li}^+(\text{aq}) + \text{Cl}^-(\text{aq})$
- Group IIA
 - MgCl_2 is not hydrolysed.
 - Hydrated crystals undergoes hydrolysis when heated. $\text{MgCl}_2 \cdot 6\text{H}_2\text{O} \rightarrow \text{MgCl(OH)} + 5\text{H}_2\text{O} + \text{HCl}$

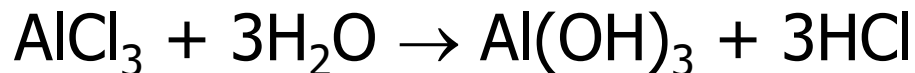
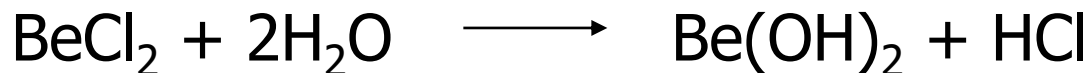
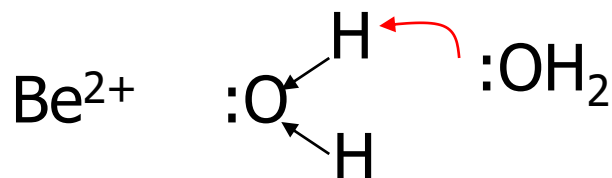


Intermediate chlorides

BeCl_2 and AlCl_3 :

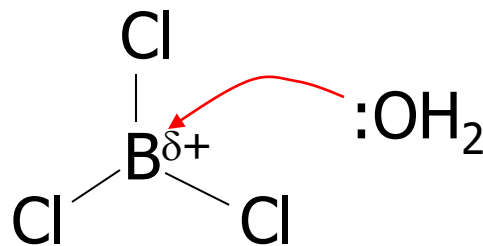
Be^{2+} and Al^{3+}

High charge/size ratio, strong polarizing power,
cation hydrolysis.



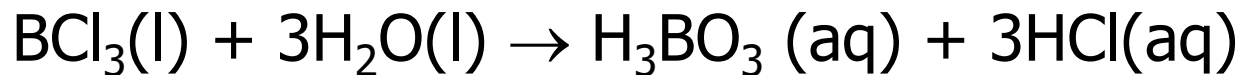
Covalent chlorides

Group IIIA BCl_3



Due to presence of vacant orbital and the polar B-Cl bond.

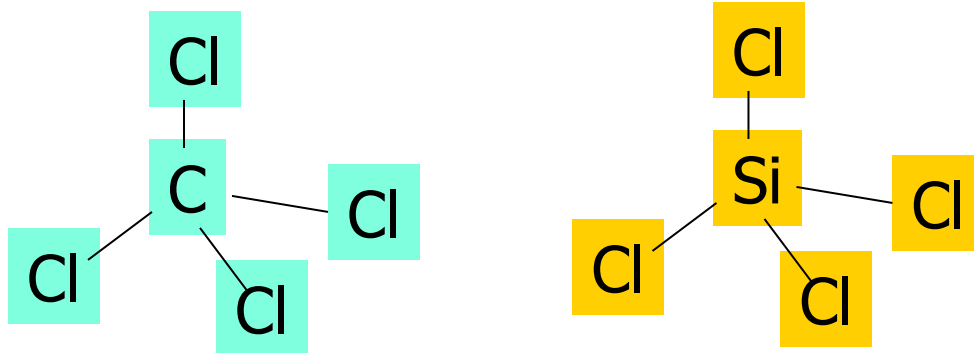
BCl_3 reacts vigorously with water to give boric acid, H_3BO_3 and HCl .





Covalent chlorides

Group 4A : CCl_4 and SiCl_4



CCl_4 does not hydrolyzed by water

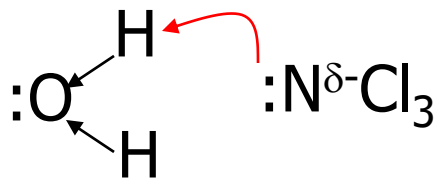
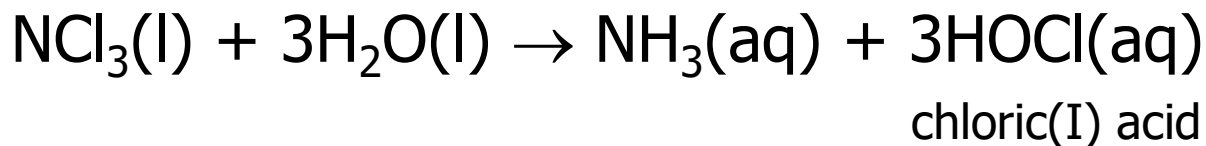
SiCl_4 hydrolyzes.





Covalent chlorides

Group VA: NCl_3

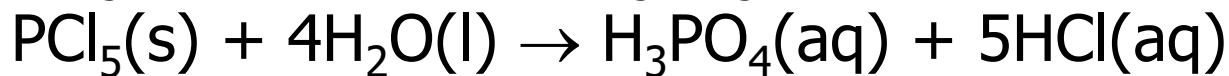
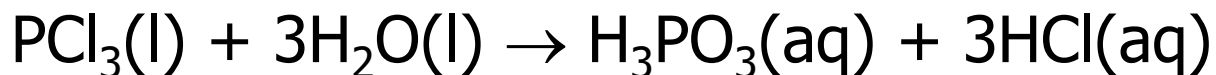


N does not have low-lying vacant orbital, it hydrolyses through the donation of lone pair electron of N atom to the H atom of water molecule.



Covalent chlorides

Group VA: PCl_3 and PCl_5



P is less electronegative than Cl.

PCl_3 and PCl_5 hydrolyze by **accepting the electron pair** from water molecule.

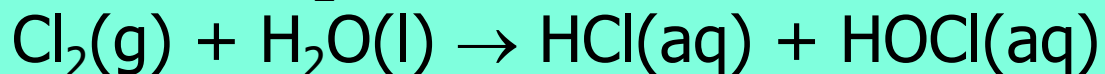
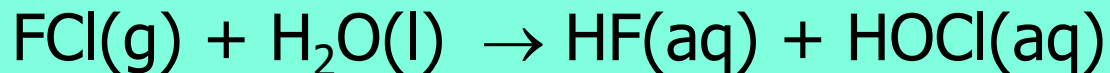


Covalent chlorides

Group VI: SCl_2 , S_2Cl_2



Group VII: FCl , Cl_2





Check point 38-5

Give the equation for the reaction between the following compounds with water:

- a. AlCl_3
- b. Cl_2O_6



Past paper questions

Periodicity

1999 IIA 3c

2001 IIA 3c