Unit 4

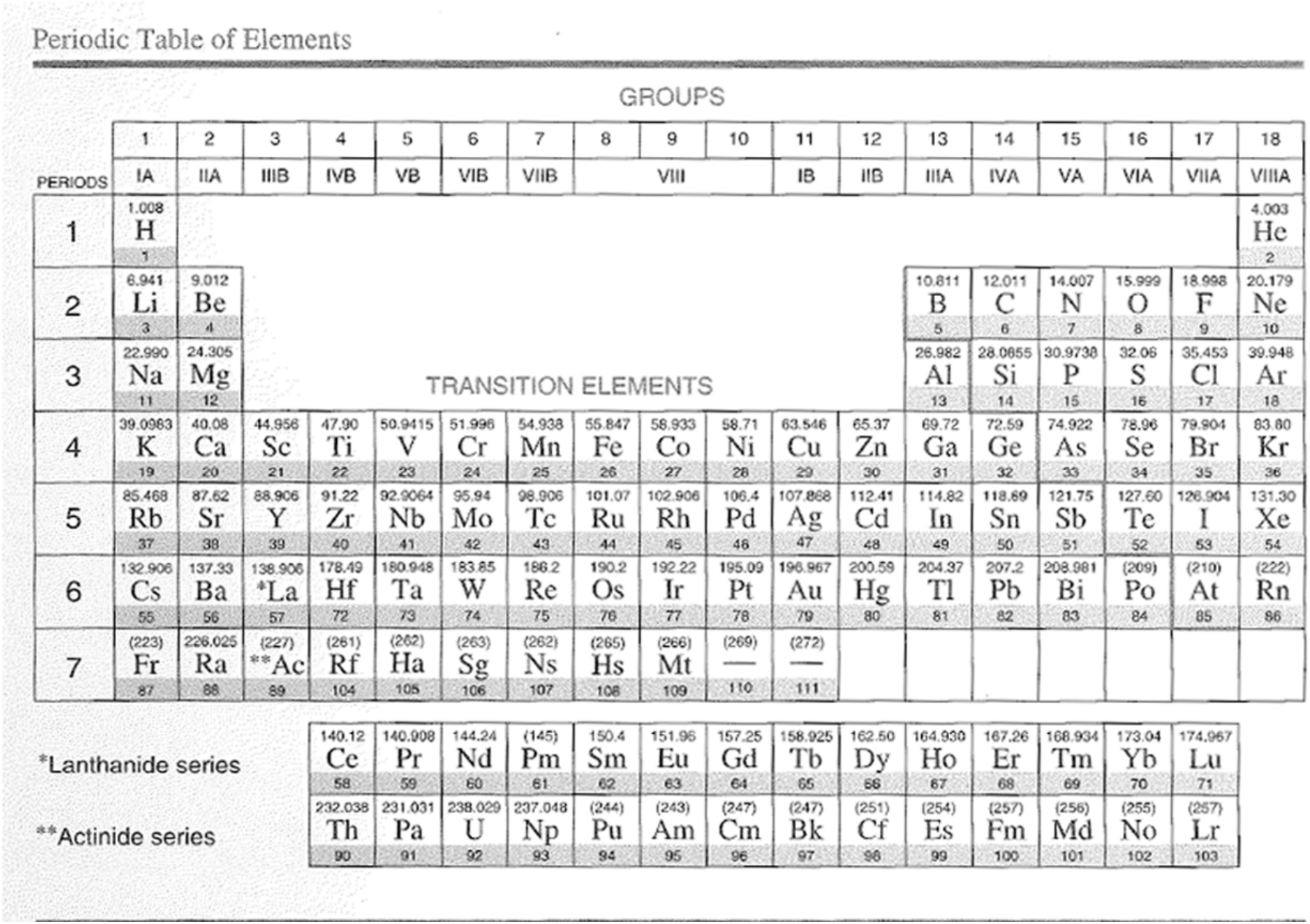
On completion of the unit you should be able to:

1. define valence electrons and atomic number.
2. define positive and negative ions.
3. identify the elements in the periodic which tend to form positive ions and those which tend to form negative ions.
4. write the name given the formula and vice versa for:

- binary compounds
- ternary compounds
- hydrates
- binary acids
- oxy acids

NAMING COMPOUNDS
4.1 Understanding the construction of a chemical formula • **Octet rule and valence electrons** • **Writing chemical formulae**
Reading: Hebden – page 70-71, 166
4.2 **Naming compounds**
4.3 **Greek prefix**
4.4 **Naming binary compounds**
4.5 **Naming ternary compounds**
4.6 **Naming hydrates**
4.7 **Naming binary acids**
4.8 **Naming oxy acids**
Reading: Hebden – page 65-69, 72-75
PROBLEMS: **Write chemical formulas** **Write chemical names**

Periodic Table of Elements



Periodic Table of Elements

GROUPS

PERIODS	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIII	9 VIII	10 VIII	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1.008 H 1																	4.003 He 2
2	6.941 Li 3	9.012 Be 4											10.811 B 5	12.011 C 6	14.007 N 7	15.999 O 8	18.998 F 9	20.179 Ne 10
3	22.990 Na 11	24.305 Mg 12											26.982 Al 13	28.0855 Si 14	30.9738 P 15	32.06 S 16	35.453 Cl 17	39.948 Ar 18
4	39.0983 K 19	40.08 Ca 20	44.956 Sc 21	47.90 Ti 22	50.9415 V 23	51.996 Cr 24	54.938 Mn 25	55.847 Fe 26	58.933 Co 27	58.71 Ni 28	63.546 Cu 29	65.37 Zn 30	69.72 Ga 31	72.59 Ge 32	74.922 As 33	78.96 Se 34	79.904 Br 35	83.80 Kr 36
5	85.468 Rb 37	87.62 Sr 38	88.906 Y 39	91.22 Zr 40	92.9064 Nb 41	95.94 Mo 42	98.906 Tc 43	101.07 Ru 44	102.906 Rh 45	106.4 Pd 46	107.868 Ag 47	112.41 Cd 48	114.82 In 49	118.69 Sn 50	121.75 Sb 51	127.60 Te 52	126.904 I 53	131.30 Xe 54
6	132.906 Cs 55	137.33 Ba 56	138.906 *La 57	178.49 Hf 72	180.948 Ta 73	183.85 W 74	186.2 Re 75	190.2 Os 76	192.22 Ir 77	195.09 Pt 78	196.967 Au 79	200.59 Hg 80	204.37 Tl 81	207.2 Pb 82	208.981 Bi 83	(209) Po 84	(210) At 85	(222) Rn 86
7	(223) Fr 87	226.025 Ra 88	(227) **Ac 89	(261) Rf 104	(262) Ha 105	(263) Sg 106	(262) Ns 107	(265) Hs 108	(266) Mt 109	(269) — 110	(272) — 111							

TRANSITION ELEMENTS

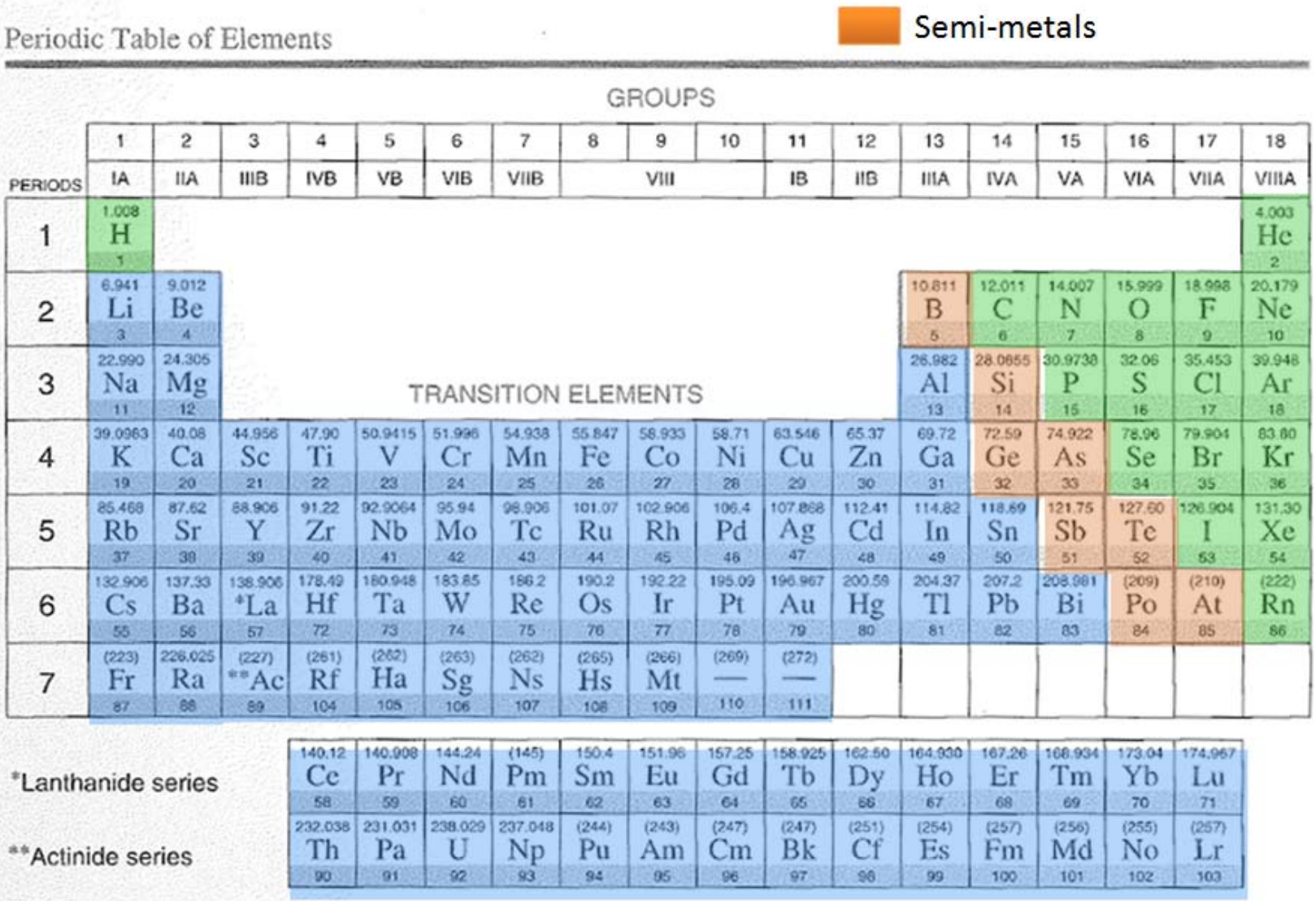
*Lanthanide series	140.12 Ce 58	140.908 Pr 59	144.24 Nd 60	(145) Pm 61	150.4 Sm 62	151.96 Eu 63	157.25 Gd 64	158.925 Tb 65	162.50 Dy 66	164.930 Ho 67	167.26 Er 68	168.934 Tm 69	173.04 Yb 70	174.967 Lu 71
**Actinide series	232.038 Th 90	231.031 Pa 91	238.029 U 92	237.048 Np 93	(244) Pu 94	(243) Am 95	(247) Cm 96	(247) Bk 97	(251) Cf 98	(254) Es 99	(257) Fm 100	(256) Md 101	(255) No 102	(257) Lr 103

Periodic Table of Elements

Metals

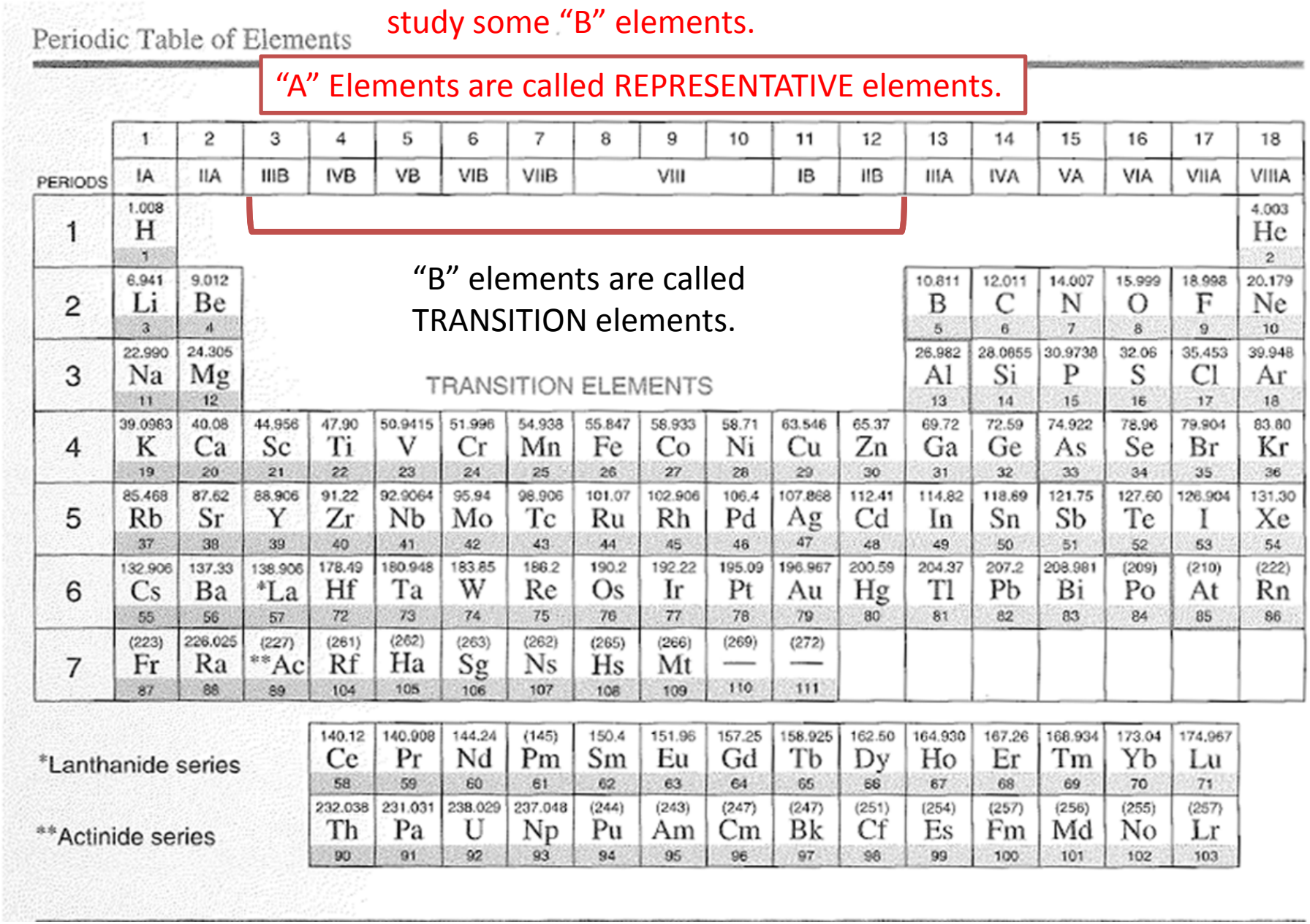
Non-metals

Semi-metals



Periodic Table of Elements

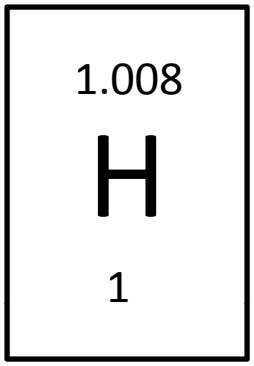
For this course, we will mainly focus on the "A" elements, and we will study some "B" elements.



Periodic Table of Elements

- All the elements on the Periodic Table of Elements are **NEUTRAL**.

The Hydrogen atom



Symbol for Hydrogen

Atomic Number

Atomic Number = # of protons

Hydrogen has **1 proton**!

Since a H atom is NEUTRAL, it must have **1 electron**.

Elements are atoms.
Atoms are made up of:

Proton
has +1 charge.

Neutron
has no charge.

Electron
has -1 charge.

Question: How many protons and electrons does carbon have?
Answer: 6 protons and 6 electrons

LEARN: the first 20 elements on the Periodic Table (Symbols and Names)

- All the elements on the Periodic Table of Elements can become charged. When they are charged, they are called ions.

Ions

When an atom loses electron(s), they form positive ions.
Positive ions are called CATIONS.

When an atom gains electron(s), they form negative ions.
Negative ions are called ANIONS.

Example:

H is a Hydrogen atom (neutral).
H^+ is a Hydrogen ion (+1 charge).

Example:

O is an Oxygen atom (neutral).
O^{2-} is an Oxygen ion (-2 charge).

How does one know what charge an ion has?

It has to do with
Valence Electrons & Octet Rule.

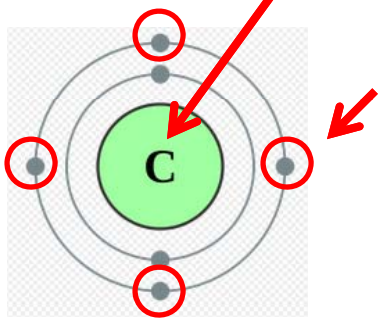
Valence Electrons & Octet Rule

Valence electrons are electrons that are in the *outer shells* of the atom. They are associated with an atom that can participate in the formation of a chemical bond.

12.011
C
6

6 protons

6 electrons



The protons are in the nucleus of the atom.

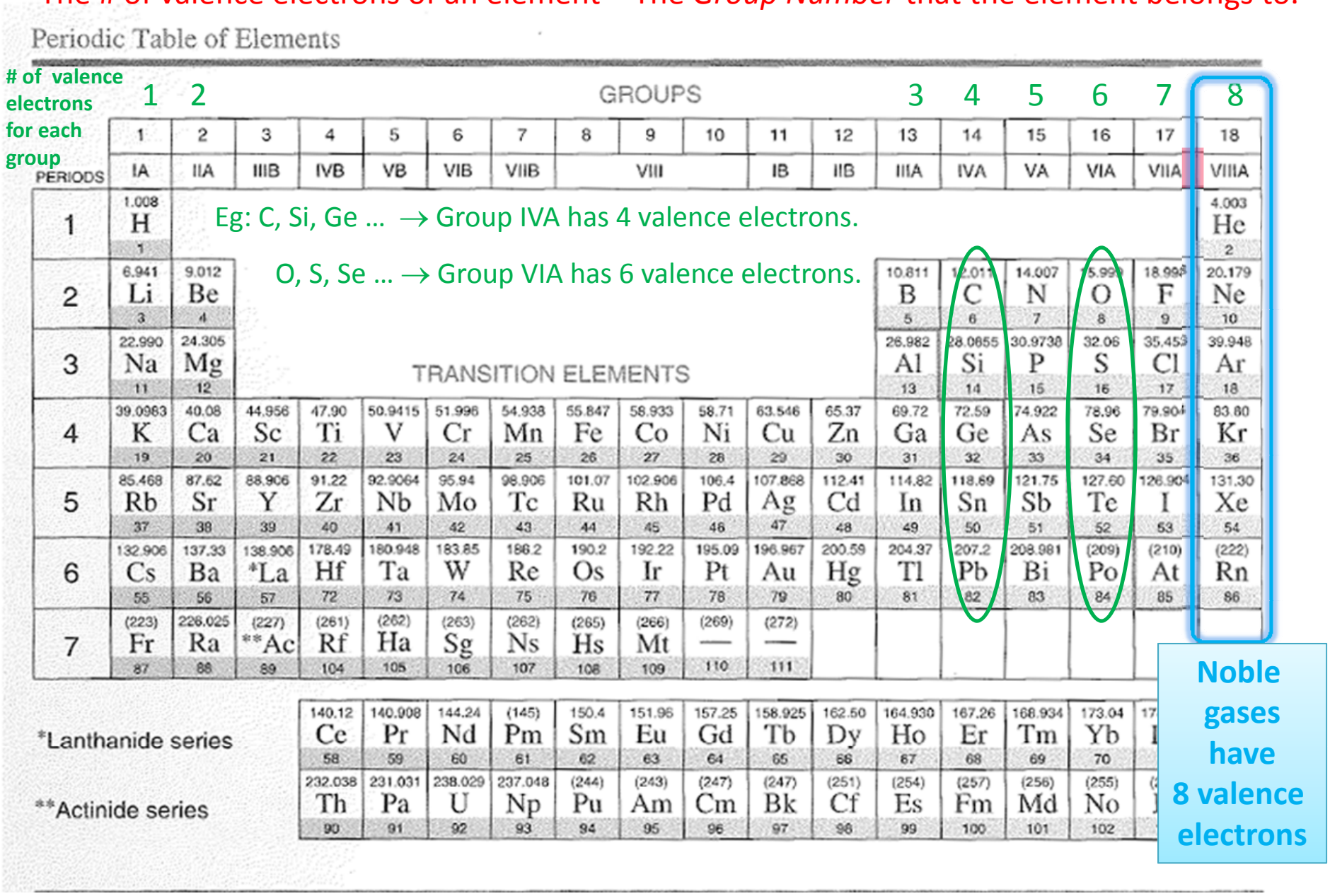
These are the valence electrons.
For carbon, there are FOUR.

The number of valence electrons that an element has depends on its location on the Periodic Table of Elements.

Let's take a look at the Periodic Table of Elements.

Periodic Table of Elements

The # of valence electrons of an element = The *Group Number* that the element belongs to.



Valence Electrons & Octet Rule

Atoms of Group A elements tend to combine in such a way that each atom has EIGHT electrons in its valence shell, giving it the same electronic arrangement as a noble gas.

Octet Rule or RULE of EIGHT - 8 electrons give a stable arrangement.

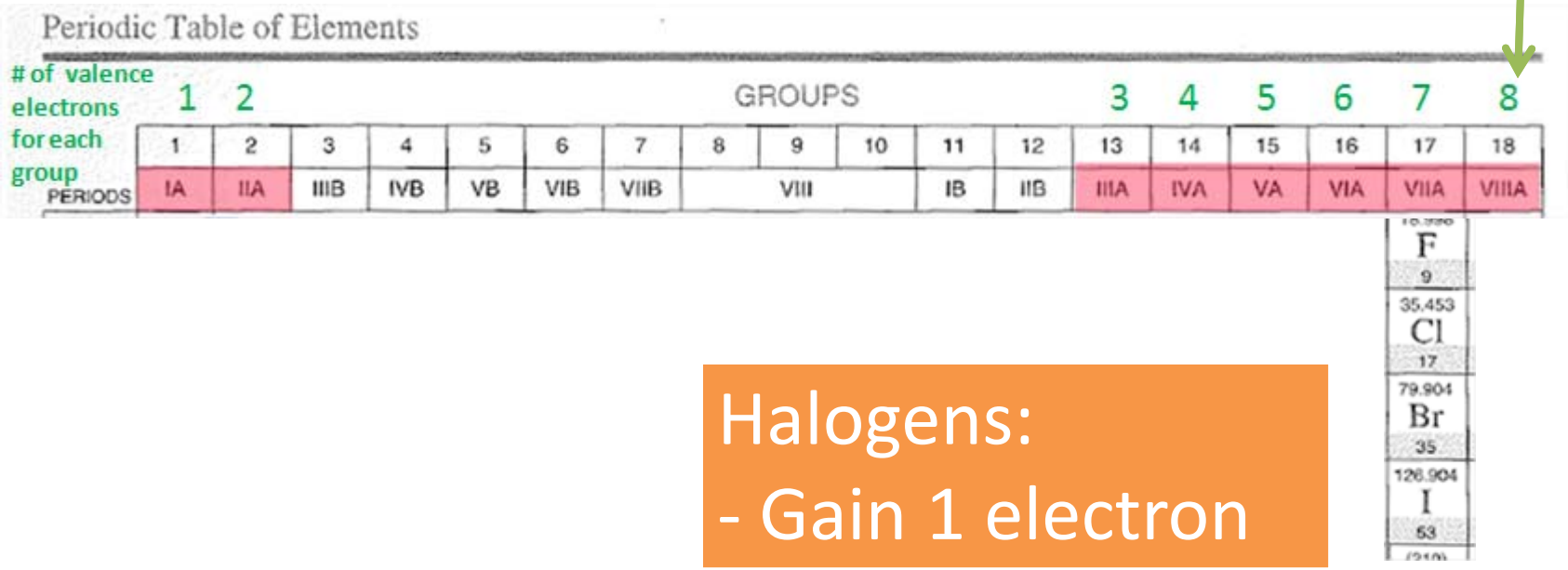
Formation of ions from atoms follow the octet rule because they always seek the most stable electron arrangement.

Let's take a look at how these simple ions (ions involving 1 element) are formed.

Octet Rule & Valence Electrons

Atoms of Group A elements tend to combine in such a way that each atom has EIGHT electrons in its valence shell, giving it the same electronic arrangement as a noble gas.

Noble Gases



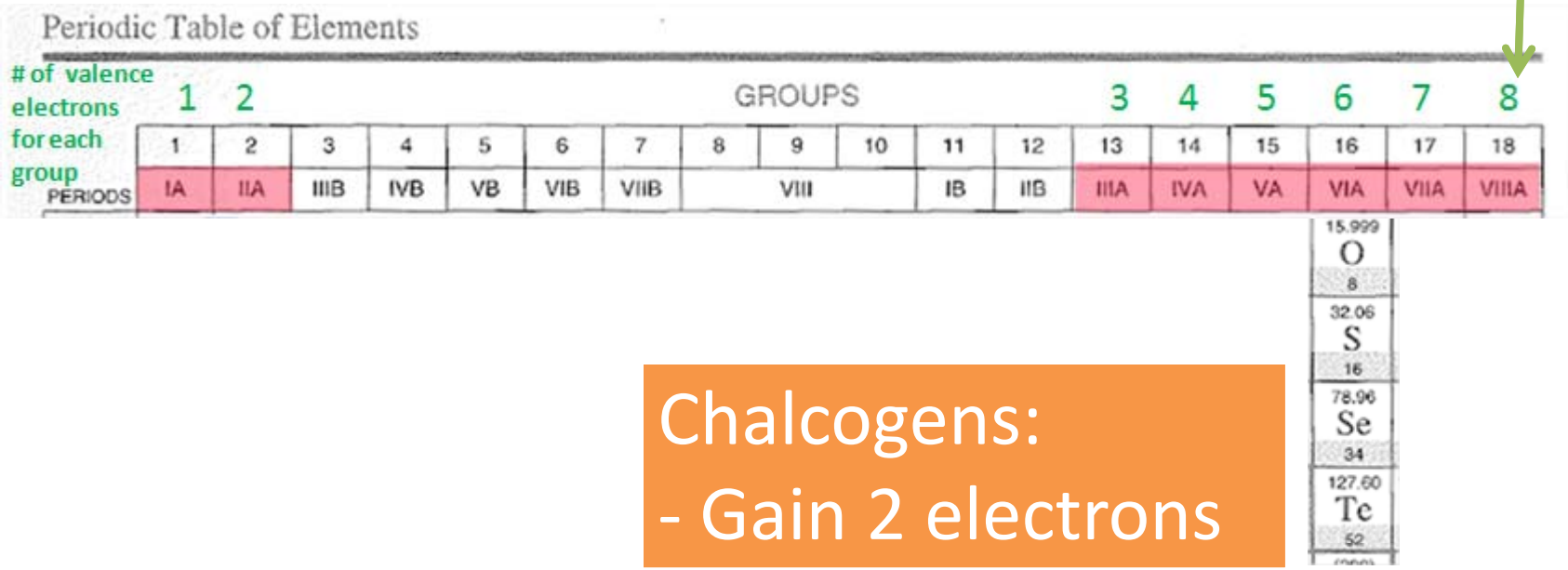
Halogens:
- Gain 1 electron

Form -1 Ions:
F^-, Cl^-, Br^-, I^-

Octet Rule & Valence Electrons

Atoms of Group A elements tend to combine in such a way that each atom has EIGHT electrons in its valence shell, giving it the same electronic arrangement as a noble gas.

Noble Gases



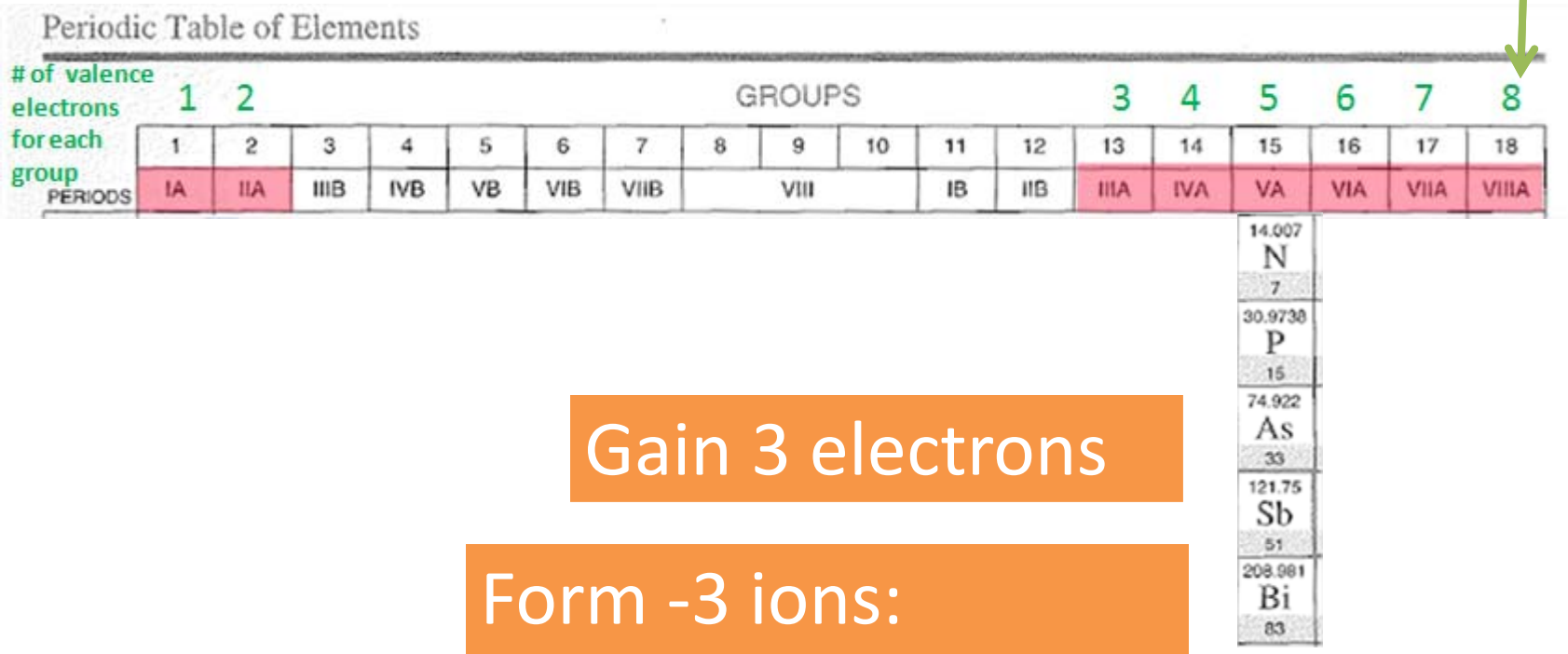
Chalcogens:
- Gain 2 electrons

Form -2 ions:
O^{2-}, S^{2-}, Se^{2-}, Te^{2-}

Octet Rule & Valence Electrons

Atoms of Group A elements tend to combine in such a way that each atom has EIGHT electrons in its valence shell, giving it the same electronic arrangement as a noble gas.

Noble Gases



Gain 3 electrons

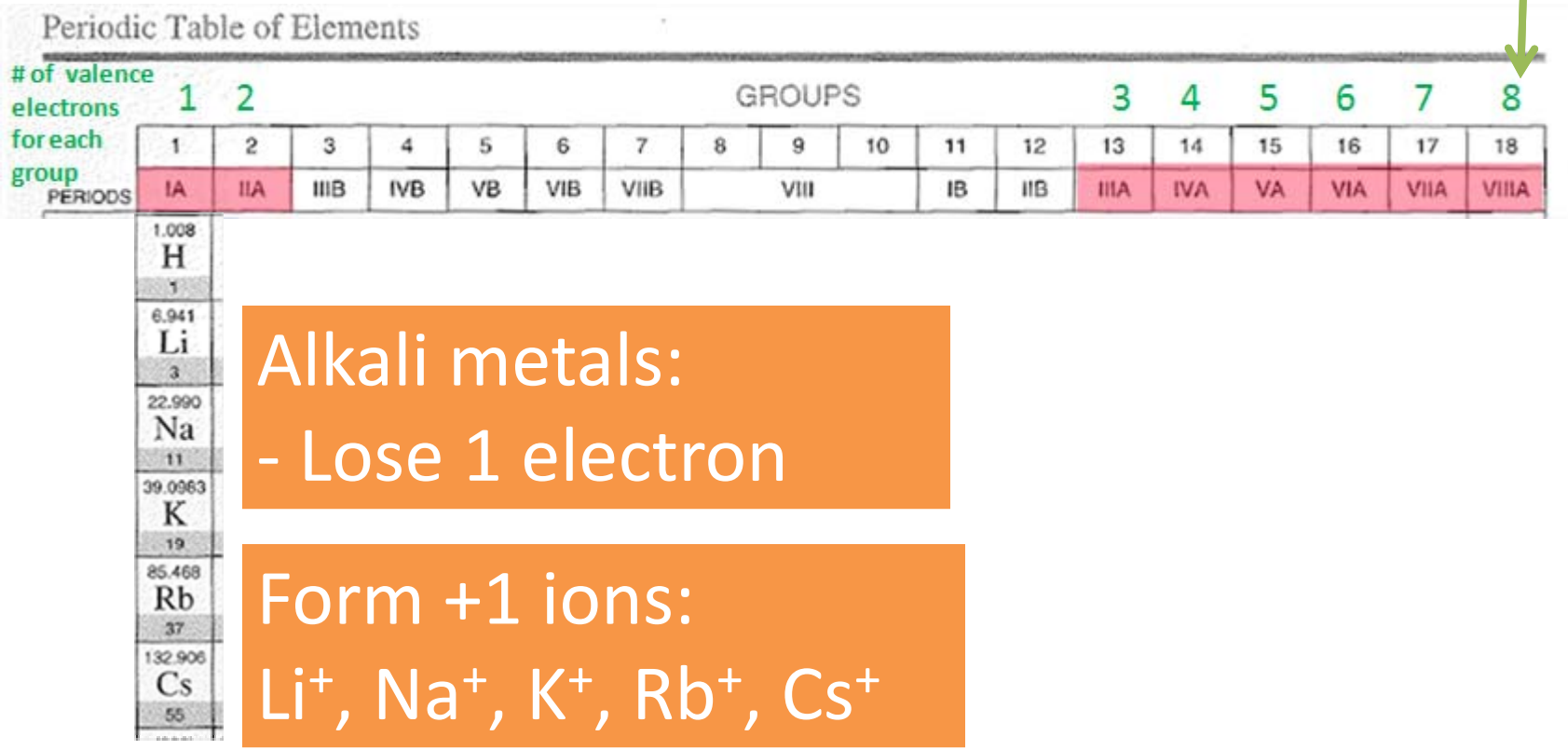
Form -3 ions:

N^{3-}, P^{3-}, As^{3-}, Sb^{3-}, Bi^{3-}

Octet Rule & Valence Electrons

Atoms of Group A elements tend to combine in such a way that each atom has EIGHT electrons in its valence shell, giving it the same electronic arrangement as a noble gas.

Noble Gases



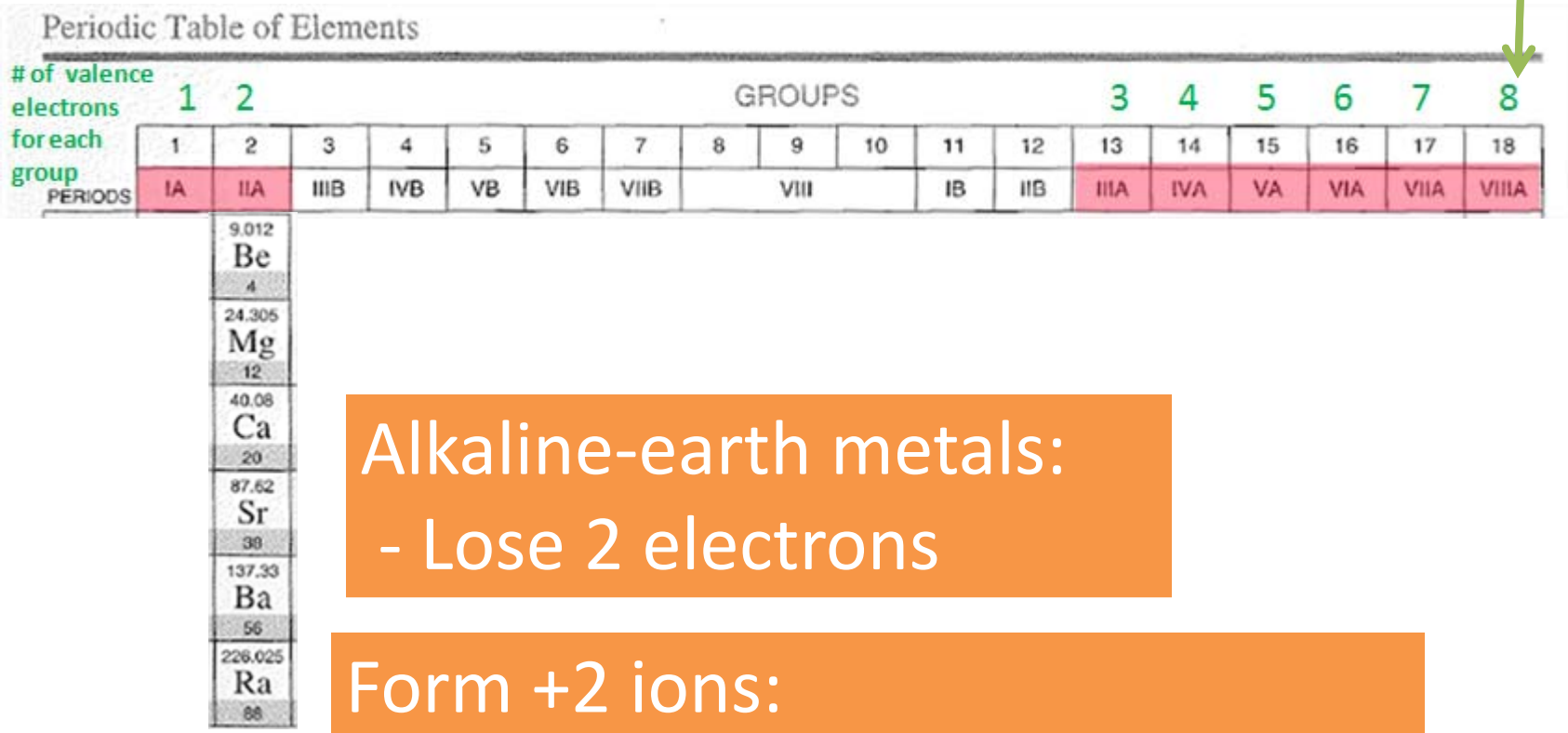
Alkali metals:
- Lose 1 electron

Form +1 ions:
Li^+, Na^+, K^+, Rb^+, Cs^+

Octet Rule & Valence Electrons

Atoms of Group A elements tend to combine in such a way that each atom has EIGHT electrons in its valence shell, giving it the same electronic arrangement as a noble gas.

Noble Gases



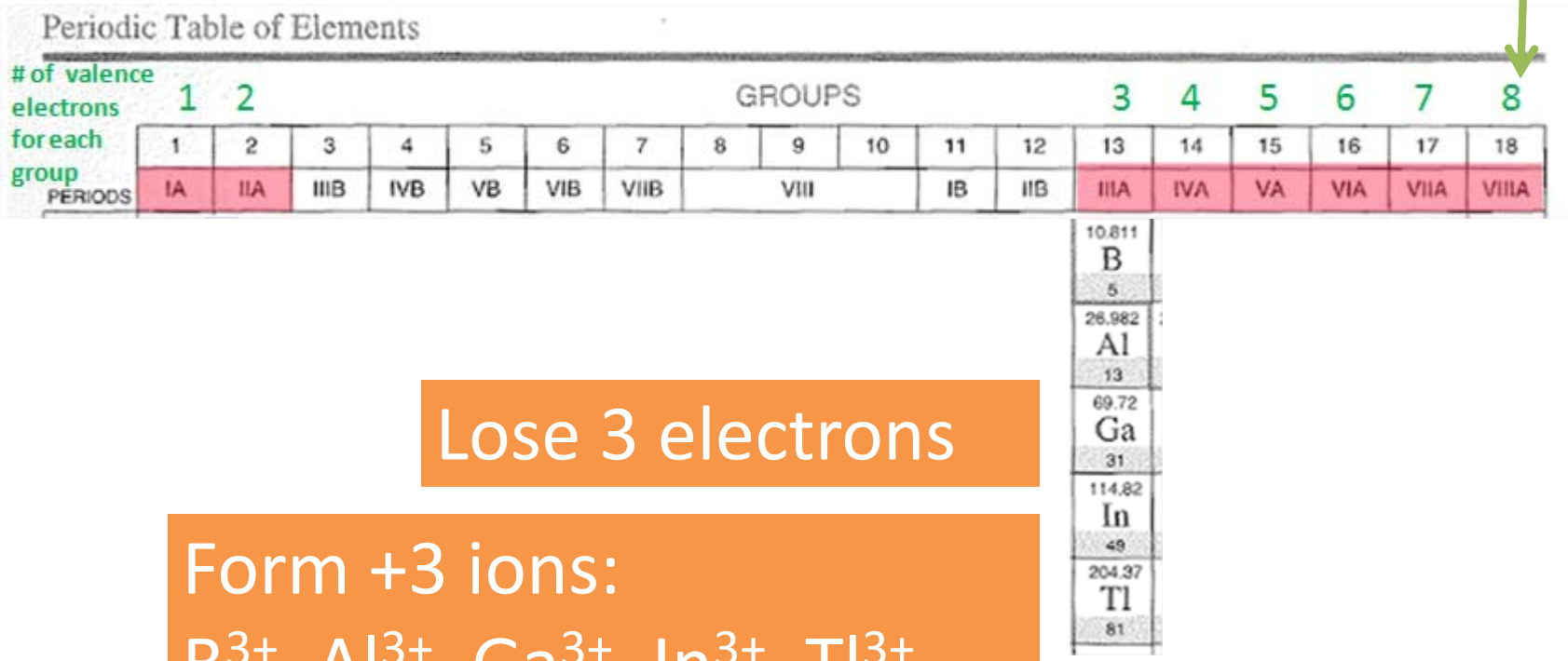
Alkaline-earth metals:
- Lose 2 electrons

Form +2 ions:
Be^{2+}, Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Ra^{2+}

Octet Rule & Valence Electrons

Atoms of Group A elements tend to combine in such a way that each atom has EIGHT electrons in its valence shell, giving it the same electronic arrangement as a noble gas.

Noble Gases



Lose 3 electrons

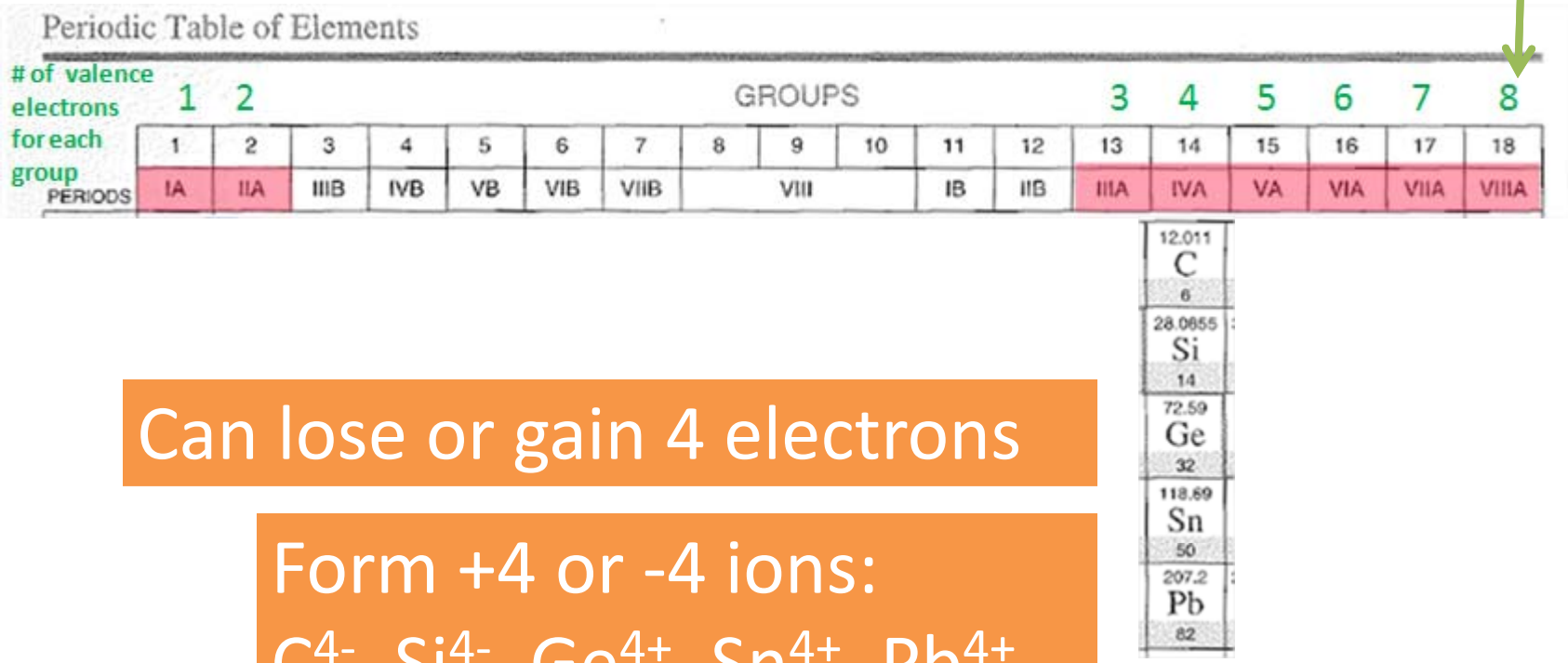
Form +3 ions:

B^{3+}, Al^{3+}, Ga^{3+}, In^{3+}, Tl^{3+}

Octet Rule & Valence Electrons

Atoms of Group A elements tend to combine in such a way that each atom has EIGHT electrons in its valence shell, giving it the same electronic arrangement as a noble gas.

Noble Gases

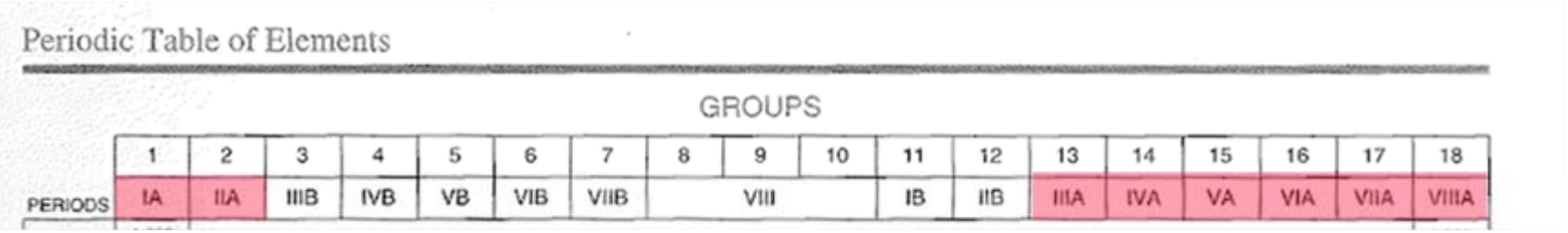


Can lose or gain 4 electrons

Form +4 or -4 ions:

C^{4-}, Si^{4-}, Ge^{4+}, Sn^{4+}, Pb^{4+}

Summary



# of valence electrons	1	2											3	4	5	6	7	8
Charge of Ions formed	+1	+2											+3	$^{+4}/_{-4}$	-3	-2	-1	0

Group Names to remember:

- Group I A elements: Alkali metals
- Group II A elements: Alkaline-earth metals
- Group VI A: Chalcogens
- Group VII A: Halogens
- Group VIII A: Noble Gases

Let's make some compounds!

Compounds

Periodic Table of Elements

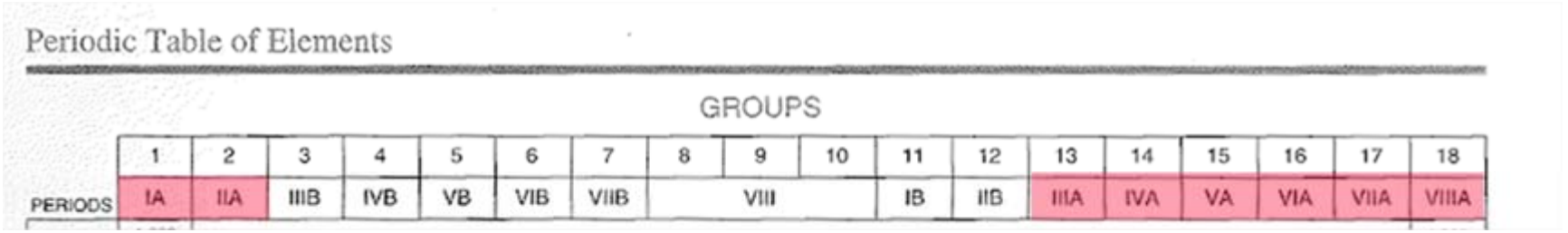
	GROUPS																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
PERIODS	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA

# of valence electrons	1	2				3	4	5	6	7	8
Charge of Ions formed	+1	+2				+3	$^{+4}/_{-4}$	-3	-2	-1	0

Compounds are neutral!

When ions come together to form a compound, they must combine to form a ***neutral*** compound.

Compounds involving simple ions



# of valence electrons	1	2					3	4	5	6	7	8
Charge of Ions formed	+1	+2					+3	$^{+4}/_{-4}$	-3	-2	-1	0

Let's make a compound with Hydrogen and Oxygen.

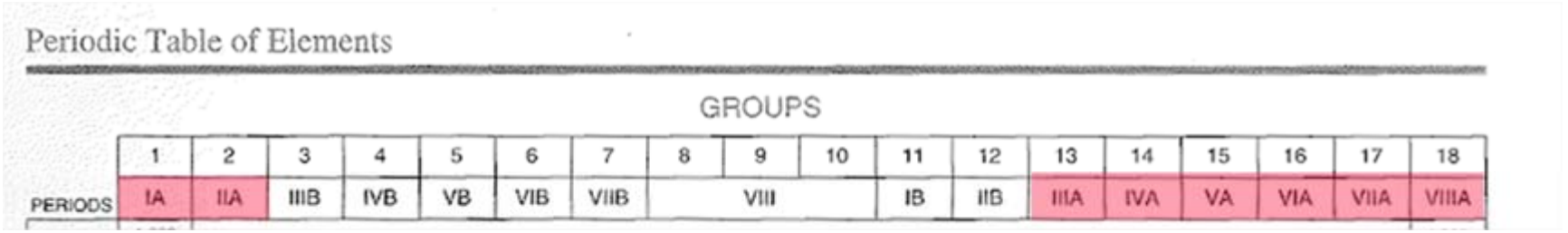
Group: IA VIA

Charge of ions: +1 -2

To form a neutral compound: H^+ H^+ O^{-2}

Write the chemical formula: H_2O (Water)

Compounds involving simple ions



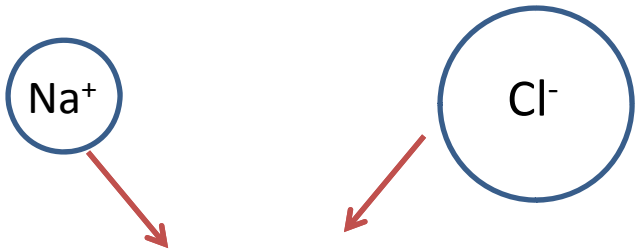
# of valence electrons	1	2					3	4	5	6	7	8
Charge of Ions formed	+1	+2					+3	$^{+4}/_{-4}$	-3	-2	-1	0

Let's make a compound with Sodium and Chlorine.

Group: IA VIIA

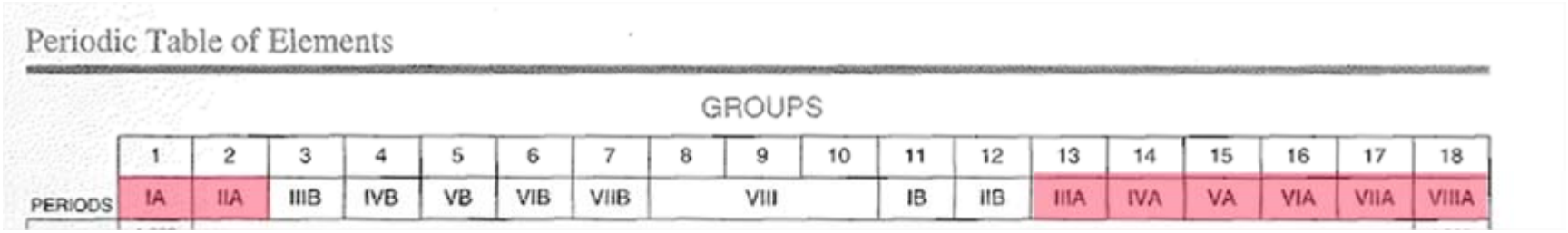
Charge of ions: +1 -1

To form a neutral compound:



Write the chemical formula: NaCl (Tablesalt)

Compounds involving simple ions



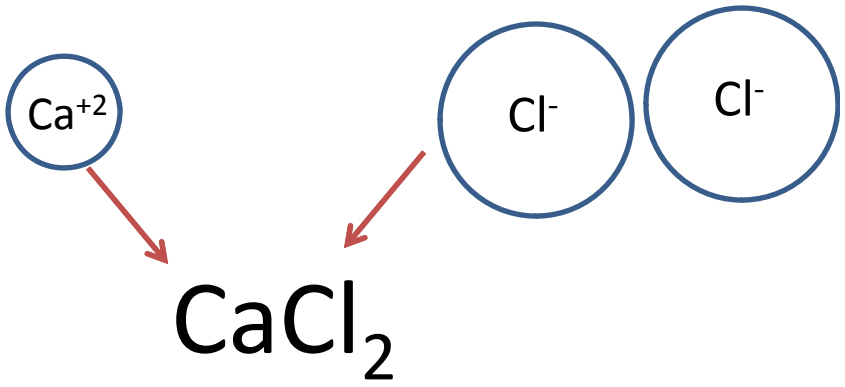
# of valence electrons	1	2					3	4	5	6	7	8
Charge of Ions formed	+1	+2					+3	$^{+4}/_{-4}$	-3	-2	-1	0

Let's make a compound with Calcium and Chlorine.

Group: IIA VIIA

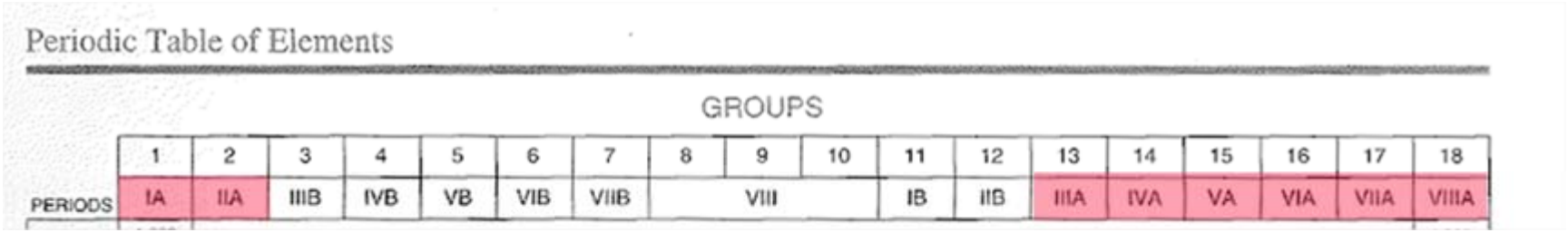
Charge of ions: +2 -1

To form a neutral compound:



Write the chemical formula: $CaCl_2$

Compounds involving simple ions



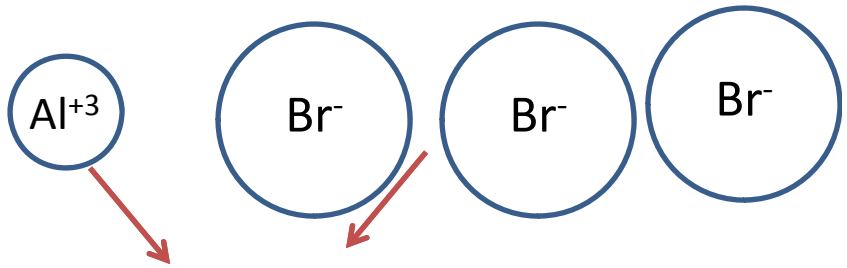
# of valence electrons	1	2											3	4	5	6	7	8
Charge of Ions formed	+1	+2											+3	$^{+4}/_{-4}$	-3	-2	-1	0

Let's make a compound with Aluminum and Bromine.

Group: IIIA VIIA

Charge of ions: +3 -1

To form a neutral compound:



Write the chemical formula: $AlBr_3$

12 polyatomic ions to learn!

ANNOUNCEMENTS | CHEMIST'S TOOLS | LABS | LECTURES | SCANNED LECTURE NOTES

« Chemist's Tools: Activity Series for the Halogens

CHEM 0011 »

Chemist's Tools: Ions to learn

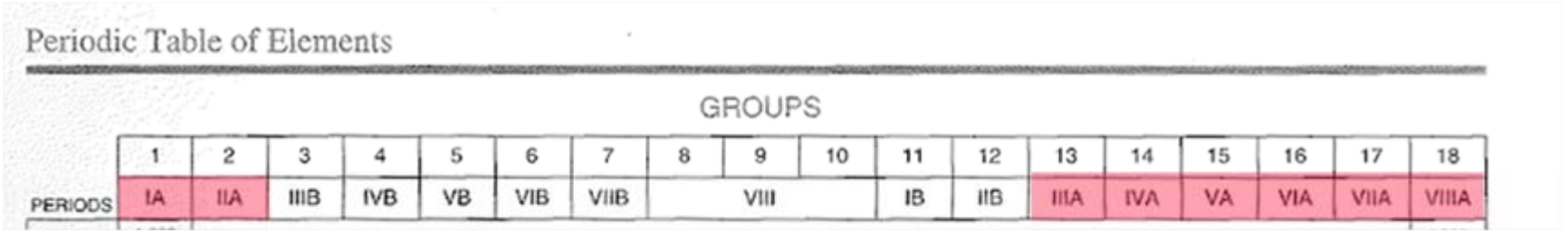
Names of Polyatomic ions and their Charges

In this course, you will need to learn some polyatomic ions. **Be sure to learn their names, formulas and their charges.**

Cation:	ammonium, NH_4^+
Anions:	nitrate, NO_3^-
	acetate, $C_2H_3O_2^-$
	sulfate, SO_4^{2-}
	hydroxide, OH^-
	phosphate, PO_4^{3-}
	carbonate, CO_3^{2-}
	cyanide, CN^-
	chlorate, ClO_3^-
	permanganate, MnO_4^-
	chromate, CrO_4^{2-}
	dichromate, $Cr_2O_7^{2-}$

Hint: Make flash cards for learning the ions
– on one side, write the formula,
– on the other side, write the name.

Compounds involving polyatomic ions



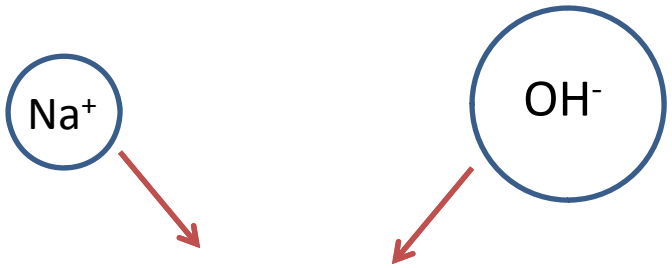
# of valence electrons	1	2											3	4	5	6	7	8
Charge of Ions formed	+1	+2											+3	$^{+4}/_{-4}$	-3	-2	-1	0

Let's make a compound with Sodium and Hydroxide ion.

Group: IA OH^-

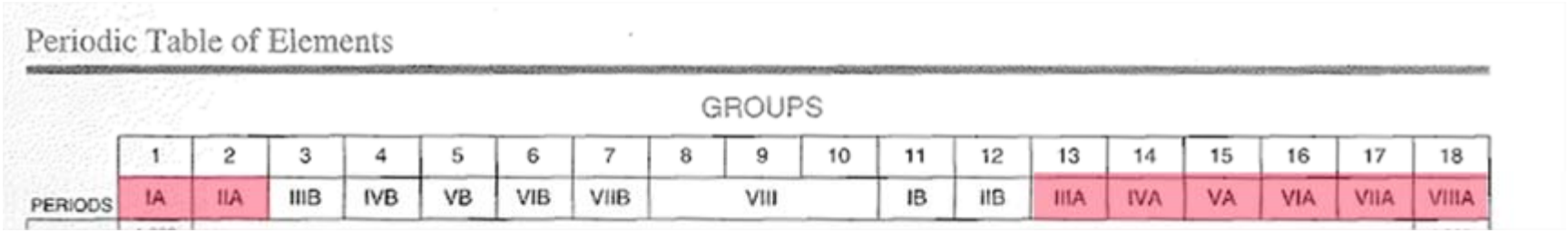
Charge of ions: +1 -1

To form a neutral compound:



Write the chemical formula: NaOH

Compounds involving polyatomic ions



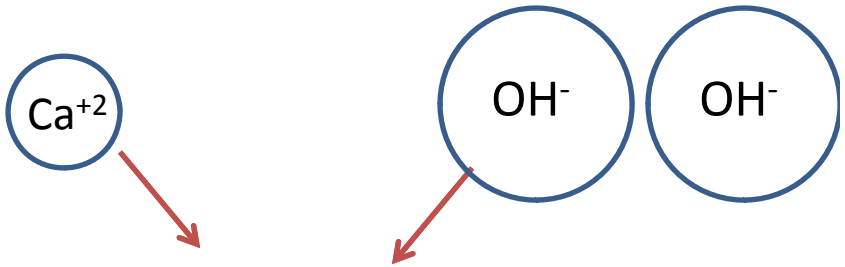
# of valence electrons	1	2											3	4	5	6	7	8
Charge of Ions formed	+1	+2											+3	$^{+4}/_{-4}$	-3	-2	-1	0

Let's make a compound with Calcium and Hydroxide ion.

Group: IIA OH^-

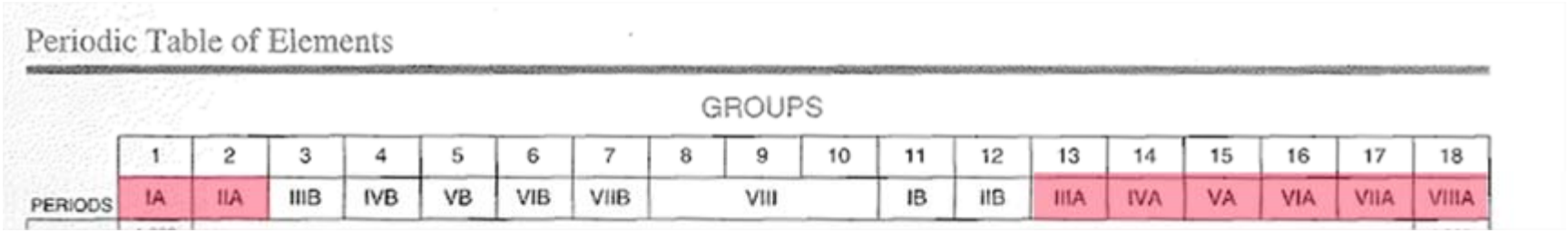
Charge of ions: +2 -1

To form a neutral compound:



Write the chemical formula: $Ca(OH)_2$

Compounds involving polyatomic ions



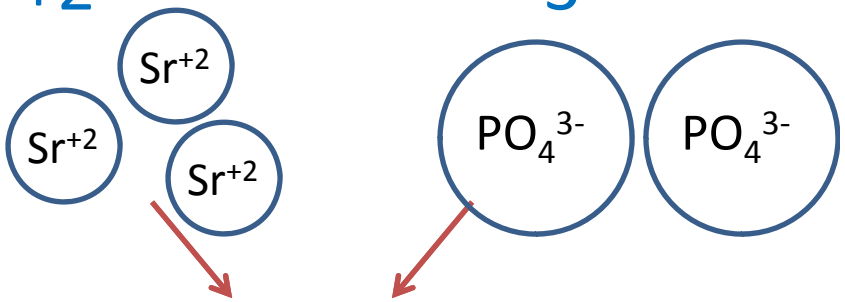
# of valence electrons	1	2	3	4	5	6	7	8
Charge of Ions formed	+1	+2	+3	$^{+4}/_{-4}$	-3	-2	-1	0

Let's make a compound with Strontium and Phosphate ion.

Group: IIA PO_4^{3-}

Charge of ions: +2 -3

To form a neutral compound:



Write the chemical formula: $Sr_3(PO_4)_2$

Compounds involving polyatomic ions

Periodic Table of Elements

	GROUPS																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
PERIODS	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA

# of valence electrons	1	2				3	4	5	6	7	8
Charge of Ions formed	+1	+2				+3	$^{+4}/_{-4}$	-3	-2	-1	0

Let's make a compound with Strontium and Phosphate ion.

Group: IIA PO_4^{3-}

Charge of ions: +2 -3

Criss-cross the charges

Write the chemical formula: $Sr_3(PO_4)_2$

Try worksheet

Scanned Lecture Notes

Road Maps:

- Mole – Mass – Volume – Particles conversion
- From Percent Composition to Empirical Formula to Chemical Formula

Worksheets:

- Lab Report Write up Instructions
- Unit 2 – Density Questions Worksheet
- Unit 3 – Name to Chemical Formula and Chemical Formula to Name Worksheet
- Unit 5 – Mole Concept Worksheet
- Unit 5 – Salt & Sugar Worksheet

Try Part B of the Naming worksheet

Part B:

Write the correct chemical formulae for the following compounds.

Pay attention to using:

- Correct symbols (case-sensitive)
- Subscripts when necessary
- Bracket only when necessary

11. ammonium nitrate = _____

12. calcium chlorate = _____

13. potassium dichromate = _____

14. plumbic carbonate = _____

15. silver acetate = _____

16. cuprous hydroxide = _____

17. potassium permanganate = _____

18. sulfuric acid = _____

19. stannous hydroxide = _____

20. potassium cyanide = _____