Exam 1 is live – Chapters 1 & 2

– Due date Thursday evening

Currently

Middle of Chapter 3 w/ electronic config.

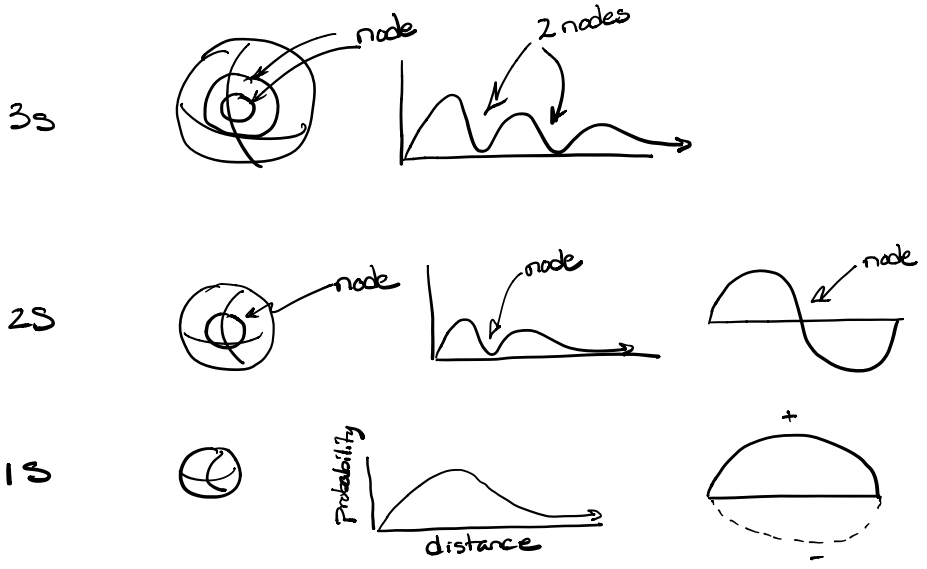
Today

Electronic Config of Ions

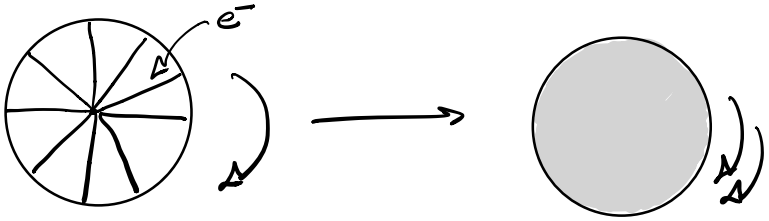
Nomenclature (System of naming)

Orbitals – Probability Density Maps

S-orbital – Spherical — one orbital



Wave like analogy



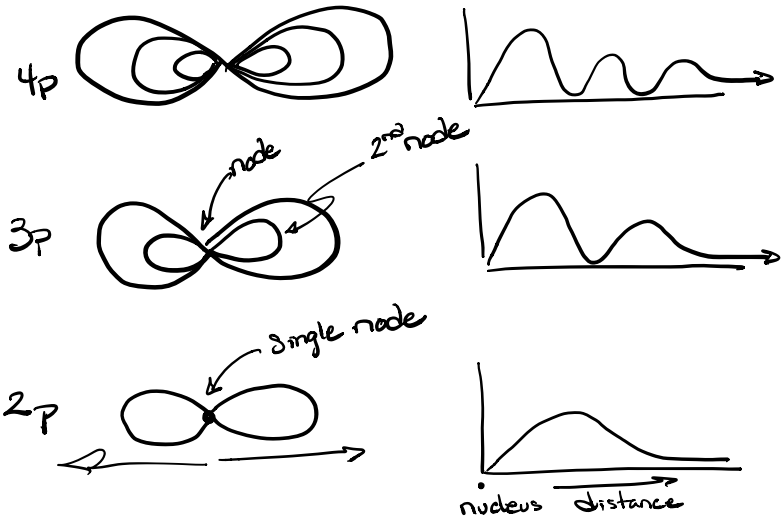
Bike Wheel
Stopped
e^- = particle
fixed position
&
known location

Bike Wheel
Spinning
e^- = wave
e^- occupy volume
no fixed position
no known location

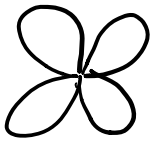
P-orbital

$\overline{p_x}$ $\overline{p_y}$ $\overline{p_z}$
3 orbitals

m_ℓ
-1 0 1
p_x p_y p_z



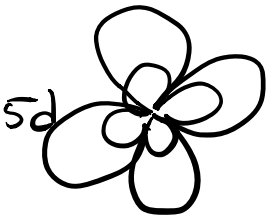
D - orbitals



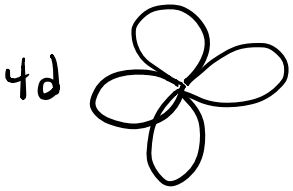
4 clover leafs

d_{z^2}
dumbel w/ ring

d_{xy}, d_{yz}, d_{xz}



5d



4d

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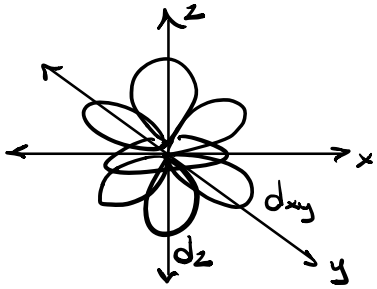
5 - Orbitals



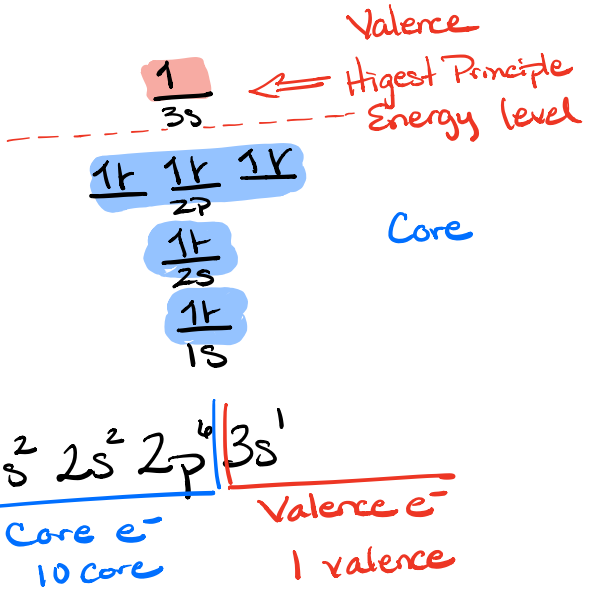
Valence electron - Highest principle energy level electrons

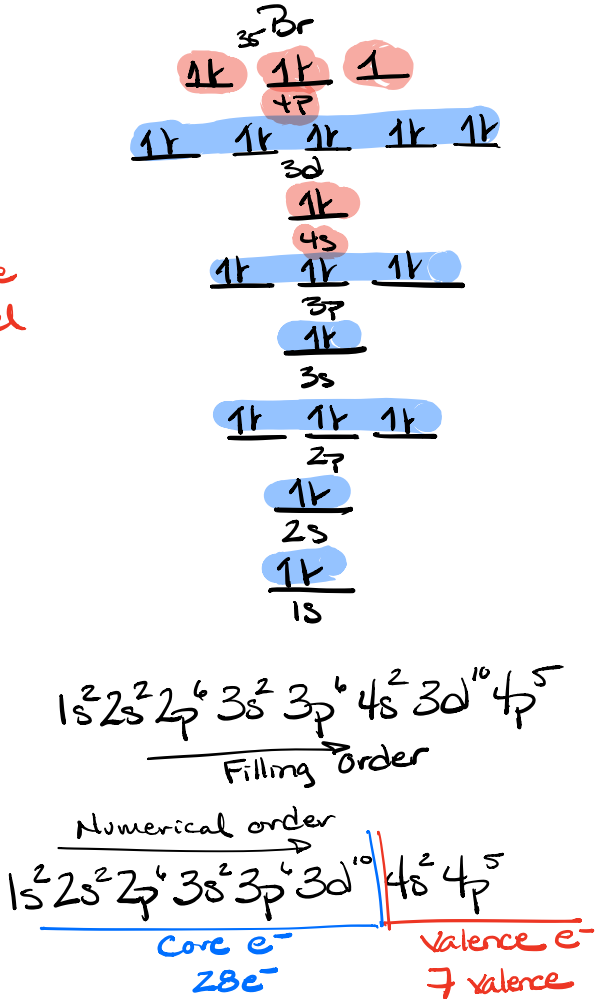
⇒ All electrons in the highest principle energy level

Core electrons - All the electrons that are below the highest Principle energy level

Ex

$_{11}Na$





1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H Hydrogen 1.008	2 2A																2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.30	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
4s¹ 19 K Potassium 39.10	4s² 20 Ca Calcium 40.08	3d¹ 21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.84	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.41	31 Ga Gallium 69.72	32 Ge Germanium 72.64	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
55 Cs Cesium 132.9	56 Ba Barium 137.3		72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)		104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (272)	112 Cn Copernicium (285)	113 Nh Nihonium (284)	114 Fl Flerovium (289)	115 Mc Moscovium (288)	116 Lv Livermorium (289)	117 Ts Tennessine	118 Og Oganesson

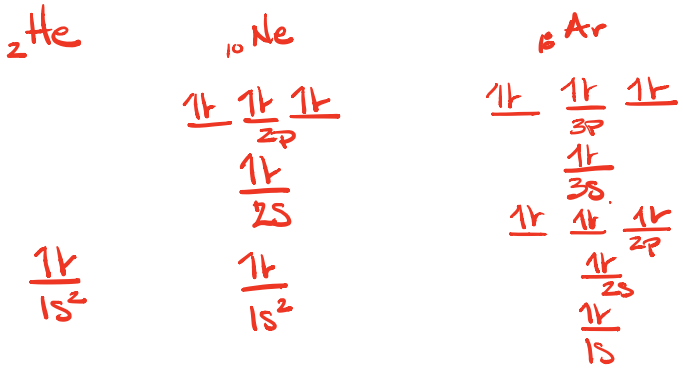
Lanthanides	57 La Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.2	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
Actinides	89 Ac Actinium (227)	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	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 (262)

Pure Appl.Chem., Vol.85, pp.1047–1078, 2013.
Values rounded to four significant figures

		# Valence e^-
Li:	$1s^2 \mid 2s^1$	1
Be	$1s^2 \mid 2s^2$	2
B	$1s^2 \mid 2s^2\ 2p^1$	3
C	$1s^2 \mid 2s^2\ 2p^2$	4
N	$1s^2 \mid 2s^2\ 2p^3$	5
O	$1s^2 \mid 2s^2\ 2p^4$	6
F	$1s^2 \mid 2s^2\ 2p^5$	7
Ne	$1s^2 \mid 2s^2\ 2p^6$	8

Valence e^- - Used in chemical reactions.

These are the e^- that are lost, gained, traded, shared that account for chemical reactivity, bonding, and ions.



All Nobel Gases have filled Energy levels

	He	Ne	Ar	Kr
Valence e^-	2	8	8	8

filled S & P orbitals
$2 + 6 = 8e^-$

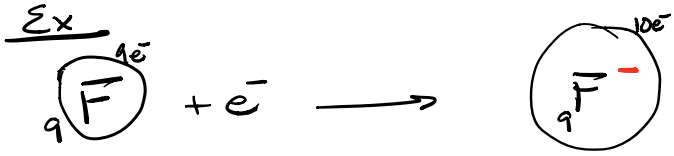
Very stable energetically to have S & P orbitals filled. ⇒ 8 valence e^-

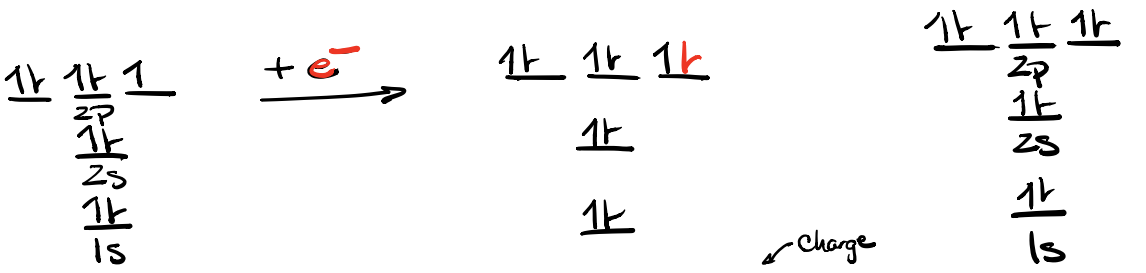
Isoelectronic – Two atoms or ions having the same electronic Configuration

Ion formation - The gain or loss of e^- resulting in a formal charge, either positive or negative, is governed by the octet rule.

octet rule - Atoms attempt to gain 8 valence e^- either by gaining e^-, losing e^-, or Sharing e^- (later)

Ex





$1s^2 2s^2 2p^5$

Fluorine

neutral element

$[1s^2 2s^2 2p^6]^-$

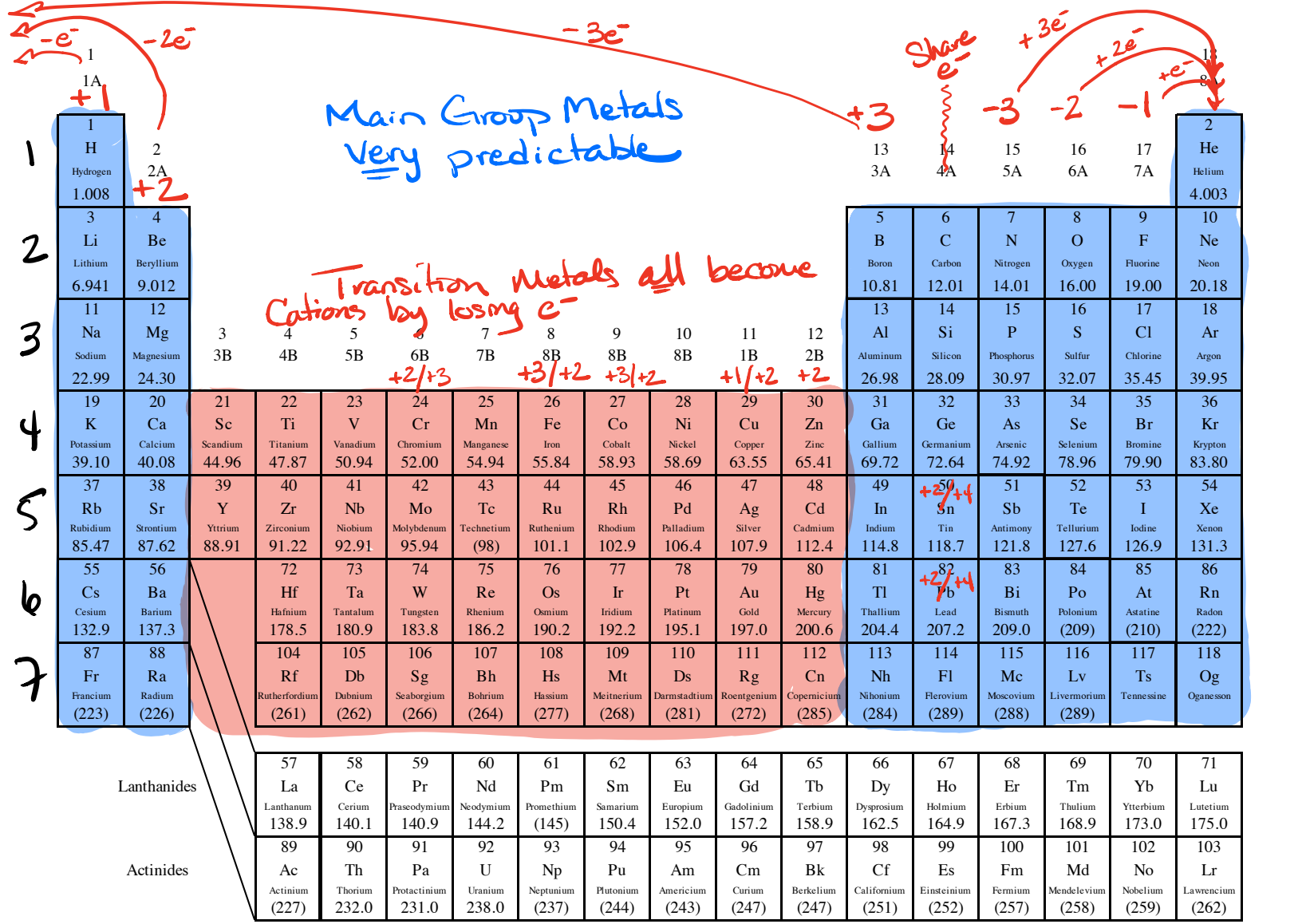
F^-, Fluoride

-ide atomic anion

$1s^2 2s^2 2p^6$

Fluoride ion, F^- & Neon, Ne

are isoelectronic ⟹ they have the same electronic configuration



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Ion Formation — octet rule

Anions

$F + e^- \longrightarrow F^-$

$1s^2|2s^2 2p^5$ — 7 valence — Flourine

$[1s^2|2s^2 2p^6]^-$ — 8 valence — Fluoride — -ide = atomic anion

$N + 3e^- \longrightarrow N^{3-}$

$1s^2|2s^2 2p^3$ — 5 valence — Nitrogen

$[1s^2|2s^2 2p^6]^{3-}$ — 8 valence — Nitride

Cations

$Li \longrightarrow Li^+ + e^-$

$1s^2|2s^1$ — 1 valence — Lithium

$[|1s^2]^+$ — 2 valence — Lithium ion — isoelectronic w/ He

$Na \longrightarrow Na^+ + e^-$

$1s^2 2s^2 2p^6|3s^1$ — 1 valence — Sodium

$[1s^2|2s^2 2p^6 3s^0]^+$ — 8 valence — Sodium ion

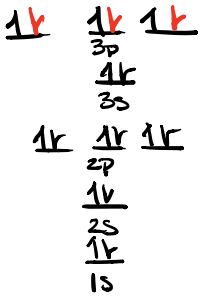
Transition Metal Ions - Fe

Fe	Fe^{2+}	Fe^{3+}
$\uparrow\downarrow\ \uparrow\ \uparrow\ \uparrow\ \uparrow$ (3d)	$\uparrow\ \uparrow\ \uparrow\ \uparrow\ \uparrow$ (3d)	$\uparrow\ \uparrow\ \uparrow\ \uparrow\ \uparrow$ (3d)
$\uparrow\downarrow$ (4s)	$\uparrow$ (4s)	$-$ (4s)
$[Ar]$	$[Ar]$	$[Ar]$
$[Ar]3d^6 \mid 4s^2$	$[[Ar]3d^5 4s^1]^{2+}$	$[[Ar]3d^5 4s^0]^{3+}$
2 valence	isoelectronic w/ Cr	$3s^2 3p^6 3d^5$ 13 valence$^-$
Iron	Iron(II) ion	Iron(III) ion
old system	Ferrous ion	Ferric ion
	-ous	-ic
	low Charge State	High Charge State

Ex what is the electronic Configuration of phosphide ion?

atomic anion = P^{3-}

P^{3-}



$$\left[1s^2 2s^2 2p^6 3s^2 3p^6\right]^{3-}$$

- What ion has the electronic Configuration of

$$\left[[Kr]\, 5s^2 4d^{10} 5p^0\right]^{2+}$$

2+ ← Mission Critical ⇒ lost $2e^-$

$$\downarrow +2e^-$$

$[Kr]\, 5s^2 4d^{10} 5p^2$ neutral element