South Pasadena • AP Chemistry Name _____ Per ___

8 • Electron Configurations and Periodicity

STATION 1 – ORBITALS AND ELECTRONS

1. The number of **electrons** that can occupy a 3d ~~orbital~~ subshell is 10. NOTE: an orbital will hold 2 e-'s
2. The highest energy orbital in boron, B, is 2p.
3. The orbital **farthest** from the nucleus in Cr is 4s. NOTE: 3d is higher energy.
4. The number of **orbitals** when n=3 is 9. n^2 (3s 3p 3d 1+3+5=9)
5. The number of **electrons** that have n=2 is 8. $2 \cdot n^2$ (2 e- per orbital)
6. The orbital that fills **after** the 6s is 4f.
7. Circle the orbital representations that **could** exist: $4s^3$ $5g^{18}$ $3p^4$ $2p^8$ $6d^3$ $1s^1$ $7f^{15}$
8. When Zn becomes an ion, it loses its **electrons** from the 4s orbital.

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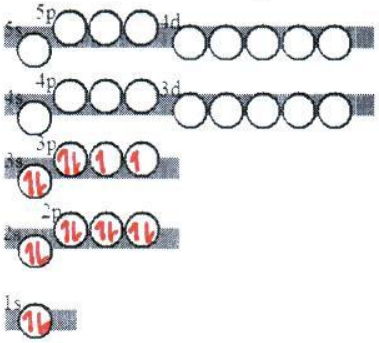
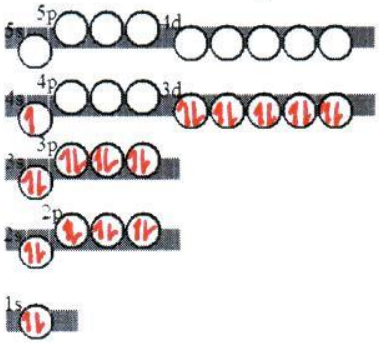
STATION 2 – ELECTRON CONFIGURATIONS

Fill in the orbital diagram for S. (16 e-)



Fill in the orbital diagram for Cu. (29 e-) exceptions ALSO Ag Au ! Cr ; Mo



Write the short form and long form **electron configurations** for **S** and **Cu**.

S	Cu
long: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$	long: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^{10}$
short: $[Ne]\ 3s^2\ 3p^4$	short: $[Ar]\ 4s^1\ 3d^{10}$ or $[Ar]\ 3d^{10}\ 4s^1$

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STATION 3 – THE PERIODIC TABLE

Write in the last orbital filled in each zone of the periodic table.

1																	18
1s	2											13	14	15	16	17	1s
2s												2p					
3s												3p					
4s	3d											4p					
5s	4d											5p					

Circle the following element(s) that would be **paramagnetic**: Zn Mg Mn^{2+} N O^{2-} Co^{2+}

DRAW OR VISUALIZE THE ORBITAL DIAGRAMS

5 3 3 half-filled orbitals

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STATION 4 – IONIZATION ENERGY

The Period 3 Elements are:

Na	Mg	Al	Si	P	S	Cl	Ar
1	2	3	4	5	6	7	8

← # of "easy-to-remove" electrons

Which Period 3 element has the following five ionization energies? Mg

IE_1	IE_2	IE_3	IE_4	IE_5
736 kJ	1445 kJ	7730 kJ	10,600 kJ	13,600 kJ

Which Period 3 element has the following five ionization energies? Si

IE_1	IE_2	IE_3	IE_4	IE_5
787 kJ	1575 kJ	3220 kJ	4350 kJ	16,100 kJ

Which period 3 element has the largest 3rd ionization energy? Mg

THIS MEANS THE 3RD e- COMES from a closer shell.
∴ 2 "easy-to-remove" electrons.

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STATION 5 – TRENDS IN IONIZATION ENERGY

For each pair of elements, circle the element with the **larger ionization energy**:

F & Cl	Na & Be	Mg & Al	N & O	C & O

↓ smaller ↓↔ smaller ↯ s vs p orb ↯ no e⁻-e⁻ repulsion ↔ smaller

Which element, Mg or Ca has the larger first ionization energy? Mg Explain.

Mg has fewer layers of electrons. The e⁻ removed from Mg is closer to the nucleus and feels a greater attraction.

Write the equation for the first ionization of Mg: $Mg + energy \rightarrow Mg^+ + e^-$

Write the equation for the first ionization of Cl: $Cl + energy \rightarrow Cl^+ + e^-$

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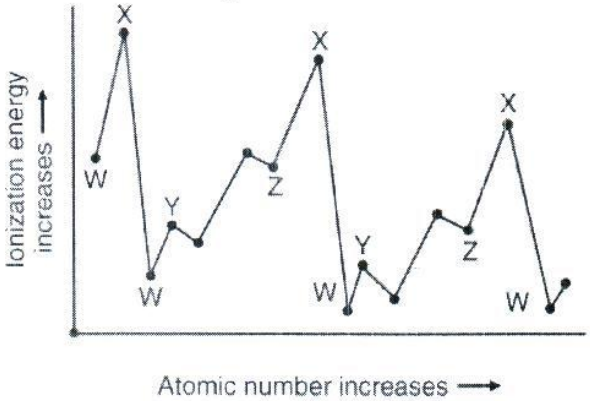
STATION 6 – GRAPHED IONIZATION ENERGIES

This is a graph of the ionization energies for the first 20 elements by atomic number.



W = easiest to remove = LARGEST ATOMS = LEFT OF PER. TABLE.

Determine which families are W, X, and Y:

W is the ALKALI METAL family and the HYDROGEN family.

X is the NOBLE GASES family.

Y is the ALKALINE EARTH family.

↑ ONE FAMILY AFTER ALKALI METALS

X = HIGHEST ENERGIES = SMALLEST ATOMS = RIGHT OF PER. TABLE.

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STATION 7 – ELEMENTS & ELECTRON CONFIGURATIONS

Identify the elements with the following electron configurations: ONE METHOD... COUNT THE ELECTRONS

Ca	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$
Fe	$[Ar]\ 4s^2\ 3d^6$
F	$1s^2\ 2s^2\ 2p^5$
Pm	$[Xe]\ 6s^2\ 4f^4$

Na	$[Ne]\ 3s^1$
Al	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$
Rh	$[Kr]\ 4d^7\ 5s^2$ ACTUALLY $[Kr]\ 4d^8\ 5s^1$
Cr	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$

Write the long form electron configuration for Fe^{3+}: DO Fe NEUTRAL & REMOVE 3 OUTER e⁻

Fe (Z=26) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6$ outer

Fe^{3+} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$

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STATION 8 – QUANTUM NUMBERS

Write the **quantum numbers** for each of the electrons in oxygen, O (Z = 8):

n	l	m_l	m_s

1	0	0	$+\frac{1}{2}$
1	0	0	$-\frac{1}{2}$

"1s"

2	0	0	$+\frac{1}{2}$
2	0	0	$-\frac{1}{2}$

"2s"

2	1	-1	$+\frac{1}{2}$
2	1	0	$+\frac{1}{2}$

* "2p"

2	1	+1	$+\frac{1}{2}$ *
2	1	+1	$-\frac{1}{2}$ *

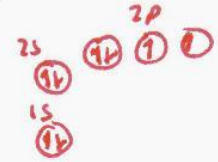
* some variability in answers

Write the **quantum numbers** for the outer electron of rubidium, Rb (Z=37):

5	0	0	$+\frac{1}{2}$ or $-\frac{1}{2}$

OUTER ORBITAL IS 5s

OXYGEN



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STATION 9 – TRENDS IN SIZE

For each pair of elements, circle the element with the **larger atomic radius**:

Mg & Ca	N & O	Sn & As	K & K^+	I and I^-
↕	↔	↕↔	+ ions shrink less e⁻-e⁻ repul.	− ions expand more e⁻-e⁻ repul.

As you move down a family (column) of elements, the atomic radius INCREASES (increases, decreases) because THERE ARE MORE LAYERS OF ELECTRONS.

As you move across a period (horizontal row) of elements, the atomic radius DECREASES (increases, decreases) because THE INCREASED NUMBER OF PROTONS PULLS IN THE SHELL.

Put these five elements in order from **smallest** atomic radius to **largest** atomic radius. F Br Ca K Cs

Smallest						Largest
	F	Br	Ca	K	Cs	