

Chem E-1a
Friday Review Problems
Chapter 8: The Periodic Table

1. Provide the most stable electron configuration for each of the following ions. You may use the noble-gas abbreviations. How many unpaired electrons does each of these ions have in the ground state?

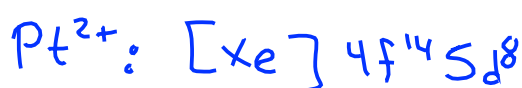
a) Se^{2-}



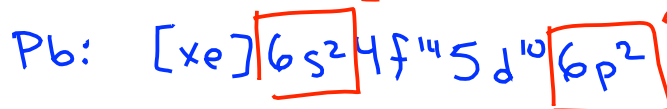
b) Pt^{2+}



REMOVE THESE e^- !
HIGHEST n



c) Pb^{4+}



REMOVE THESE SECOND!
REMOVE FIRST
(HIGHEST n
HIGHEST l)



d) V^{3+}



2. Explain the following observations.

- a) The first ionization energy of Al is less than the first ionization energy of Mg, but the second ionization energy of Al is greater than the second ionization energy of Mg, and, finally, the third ionization energy of Al is less than the third ionization energy of Mg.

1) $IE_1(Al) < IE_1(Mg)$ THIS IS AN EXCEPTION TO TREND!
WE MUST LOOK AT e^- CONFIGS.

Al: $[Ne] 3s^2 3p^1$ ← 3p e^- IS HIGHER IN ENERGY THAN 3s SO EASIER TO REMOVE. ALSO FORMS A FILLED 3s SUBSHELL
Mg: $[Ne] 3s^2$

2) $IE_2(Al) > IE_2(Mg)$

↑ IT IS HARDER TO REMOVE 2ND e^- / OR AN e^- FROM A $+1$ ION

THIS FOLLOWS TREND!

THIS EXPLANATION IS: OVERMOST e^- IN THEM HAVE SAME n , BUT Al^{2+} EXPERIENCES A GREATER Z_{eff} .

3) $IE_3(Al) < IE_3(Mg)$

DOES NOT FOLLOW TREND!

Al^{2+} : $[Ne] 3s^1$ ← MUCH EASIER TO REMOVE e^- TO FORM A NOBLE GAS CONFIG

Mg^{2+} : $[Ne]$

(UNLIKE WITH Mg^{2+} WHICH WOULD REQUIRE BREAKING UP A NOBLE GAS CONFIG.)

2. (cont.)

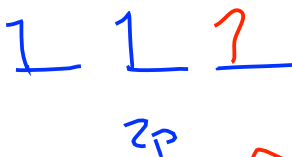
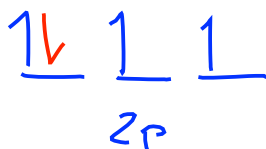
b) The electron affinity of N is very close to zero, but the electron affinity of its neighbor C is a large negative value (-122 kJ/mol).

NOT TOO EXOTHERMIC
SO NOT SO FAVORABLE

AN EXCEPTION TO TREND

EXOTHERMIC SO
FAVORABLE

LOOK AT e^- CONFIGS.



ADD AN e^-

BREAKING
UP THE
 $\frac{1}{2}$ -FILLED
SUBSHELL IS
UNFAVORABLE

FORMING A
 $\frac{1}{2}$ -FILLED SUBSHELL IS GREAT!

c) The first electron affinity of oxygen is negative, but the second electron affinity of oxygen is positive.

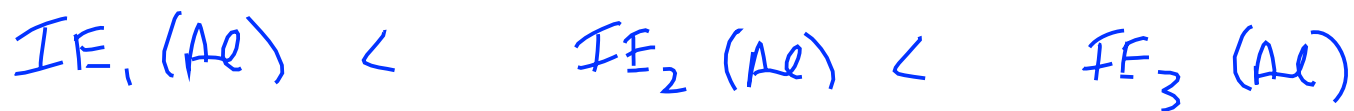
UNFAVORABLE
(ENDOTHERMIC)

FAVORABLE (EXOTHERMIC)

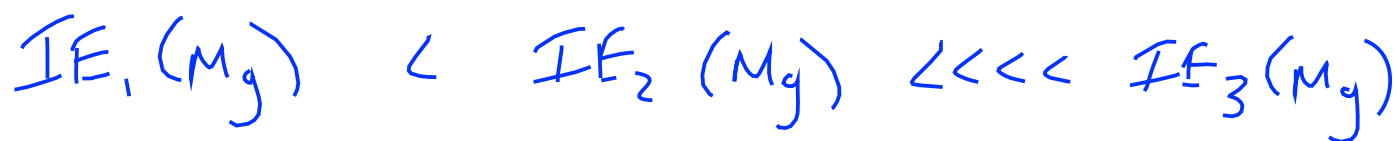


CHARGE REPULSIONS
MORE COSTLY

Also:



REASON: IT'S ALWAYS HARDER TO REMOVE e^- FROM $(+)$ IONS



↑
TRYING TO
BREAK UP
NOBLE GAS
CONFIGURATION

3. Compare the radius of the following pair of atoms or ions. Explain your answer.

a) Rb and Sr



SAME n , BUT Sr HAS LARGER Z_{eff}

b) Rb and Rb^+



BOTH HAVE
SAME NUCLEAR CHARGE
BUT Rb^+ HAS
FEWER e^-

c) Rb^+ and Kr

← ISOELECTRONIC SERIES
(SAME e^- CONFIG.)



Rb^+ HAS GREATER
NUCLEAR CHARGE
SO IT IS SMALLER

4. Choose the element or ion with the smallest radius and explain your answer.

a) Ga B O F Br

SMALLEST n
GREATEST Z_{eff}

b) O^{2-} F^{1-} Ne Na^+ Mg^{2+}

ISOELECTRONIC
~

5. Choose the element with the higher first ionization energy and explain your choice.

a) Na Mg

Mg HAS A HIGHER Z_{eff}
(SAME n)

b) P S

EXCEPTION TO TREND!
DUE TO $1/2$ -FILLED SUBSHELL