

IV. Trends in Atomic Properties

A. Effective Nuclear Charge (Z_{eff})

1. Approximately constant down a group, and approximately equal to the number of valence electrons

eg Li vs. Na -- Na has 8 more protons, but also 8 more electrons ($2s^2 2p^6$) forming a shell of charge around the nucleus.

2. Increases from left to right across a period

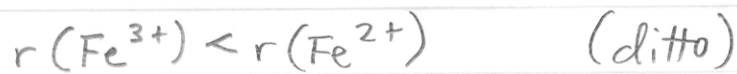
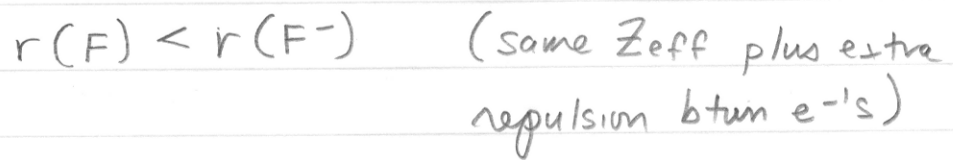
* Electrons do a poor job of shielding other electrons in the same shell

B. Atomic and Ionic Radii (average size)

$$r \sim \frac{n^2}{Z_{\text{eff}}}, \text{ where } n \text{ and } Z_{\text{eff}} \text{ refer to the valence (i.e. outermost) shell}$$

1. Across a period, r decreases. (Why?)
2. Down a group, r increases. (Why?)

3. Ionic Radii Examples



isoelectronic species: $r(\text{F}^-) > r(\text{Na}^+)$ (compare values of Z_{eff})

C. Ionization Energies (IE's)



$$\text{IE} \sim \frac{Z_{\text{eff}}^2}{n^2} \quad (\text{again, the } Z_{\text{eff}} \text{ and } n \text{ for the outermost electron(s)})$$

1. Across a period ...

a. IE usually increases ...

b. ...but pairing penalty destabilizes Group 6 (16)

c. Also remember the unexpectedly high stability of filled and half-filled subshells

(Trends p. 3)
(Atkins)

2. Down a group, IE decreases

D. Electron Affinities (EA's)



$$EA \equiv -\Delta E_{rxn}$$

(Atkins' convention)

* very rough trends *

1. Down a group, EA decreases (since r increases)

2. Highest for Group 7/17 (give me a full shell!!)

3. Second-highest for Group 6/16 (ditto!)

4. Negative EA's for Group 2 and Group 8/18