11/19/2018

Size of atom ~ valence (outer e⁻s)

ex: $_{11}Na$ $_{13}Al$ $_{18}Ar$

$11p^+$ $13p^+$ $18p^+$

$1s^2 2s^2 2p^6 3s^1$ $1s^2 2s^2 2p^6 3s^2 3p^1$ $1s^2 2s^2 2p^6 3s^2 3p^6$

But... valence e⁻s don't feel full nuclear charge, Z

... they experience an effective nuclear charge, Z_{eff}

where: $Z_{eff} = Z - S$

S = screening constant

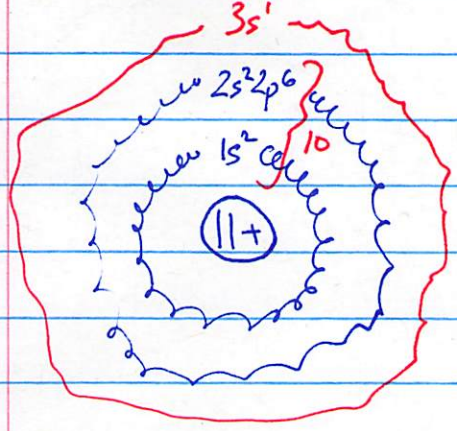
≈ #e⁻s in inner shells (core)

that block/screen full nuclear charge

Na

$1s^2 2s^2 2p^6 3s^1$

valence.



Na: valence e⁻.

$Z_{eff} = 11 - 10 = 1+$

(s)

core valence

$1s^2 2s^2 2p^6 3s^2 3p^6$

$_{18}Ar$: valence e⁻s

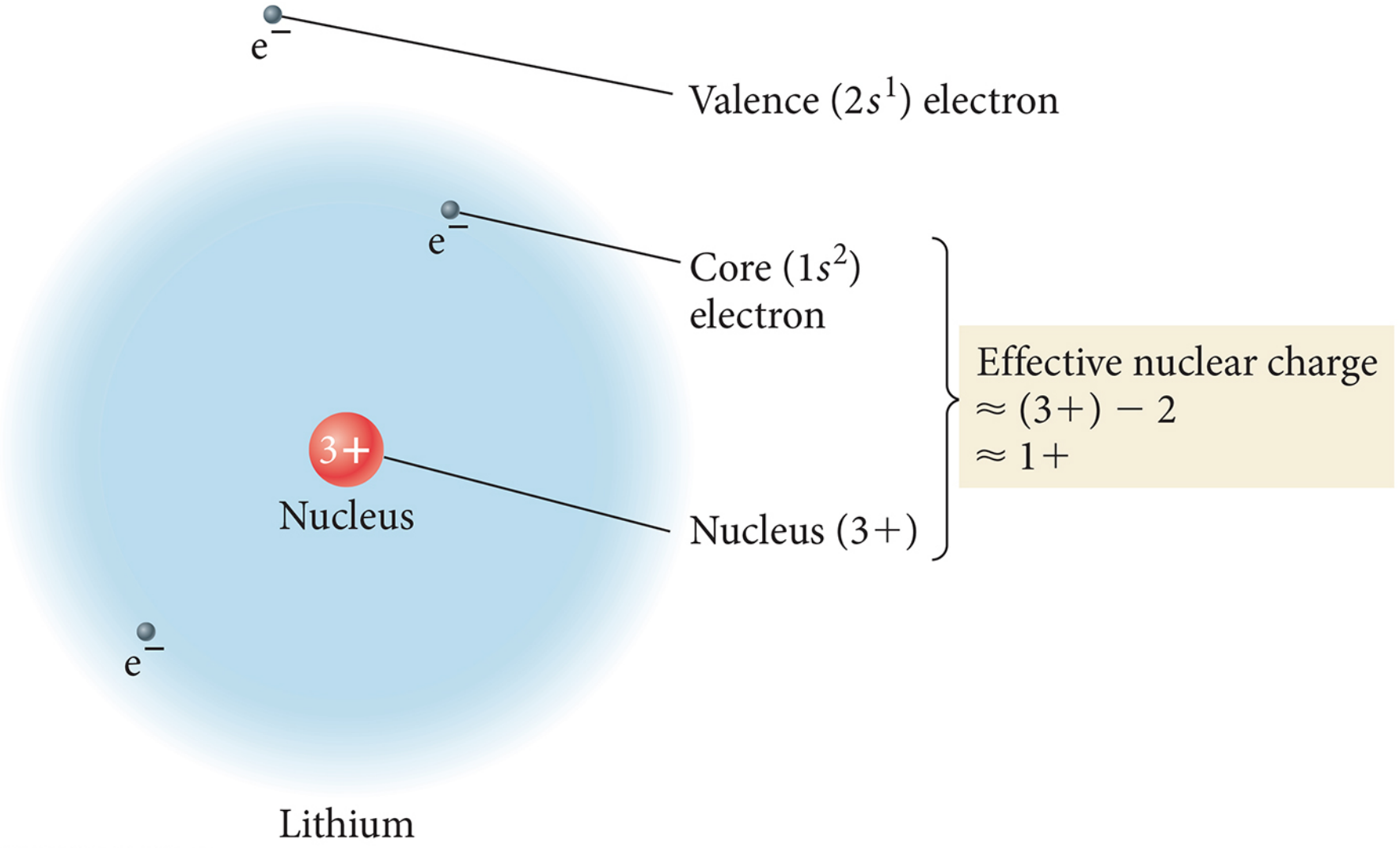
$Z_{eff} = 18 - 10 = 8+$

(s)

$_{13}Al$: valence e⁻s $1s^2 2s^2 2p^6 3s^2 3p^1$

$Z_{eff} = 13 - 10 = 3+$

Shielding and Effective Nuclear Charge



so outer e⁻s in Na feel 1+ effective nuclear charge
Al feel 3+
Ar feel 8+

going across 3rd period
- Z_{eff} ↑
- attraction between valence e⁻s + nucleus ↑
- radius ↓

What about K vs Na (same gp.)

Na: $Z_{eff} = (1+)$ $Z = 11$, $S = 10$ $(1s^2 2s^2 2p^6)$ } $Z_{eff} = 11 - 10 = 1+$

$_{19}K$ $Z = 19$, $S = 18$ } $Z_{eff} = 19 - 18 = 1+$

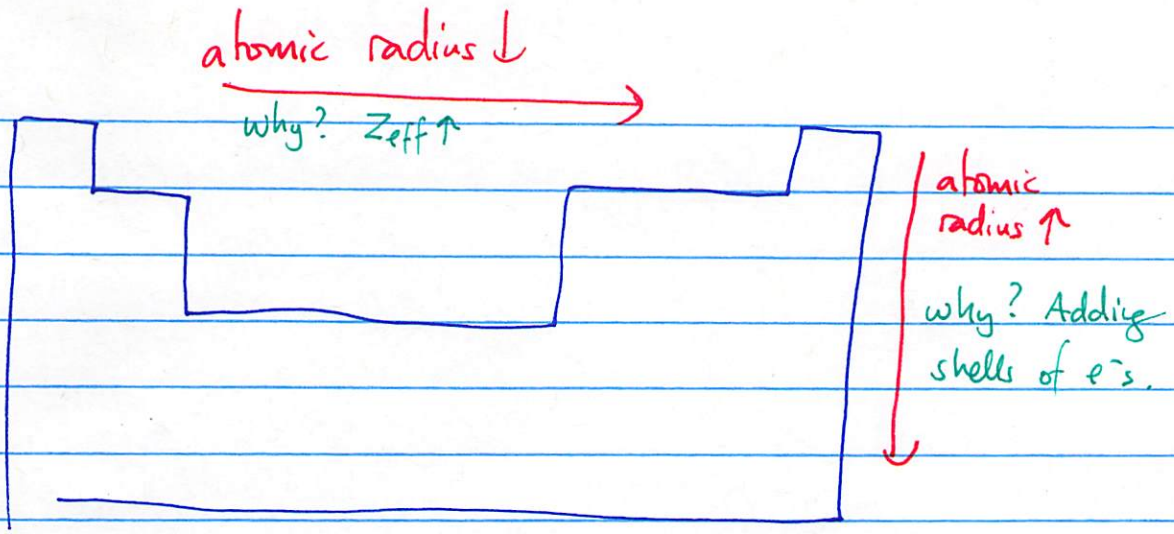
$1s^2 2s^2 2p^6 3s^2 3p^6$ (core) $4s^1$ (valence)

Both have same Z_{eff}!

But: K vs Na ← valence e⁻ is in 3rd shell.
↳ valence e⁻ is in 4th shell

⇒ K is larger, since it has extra shell!

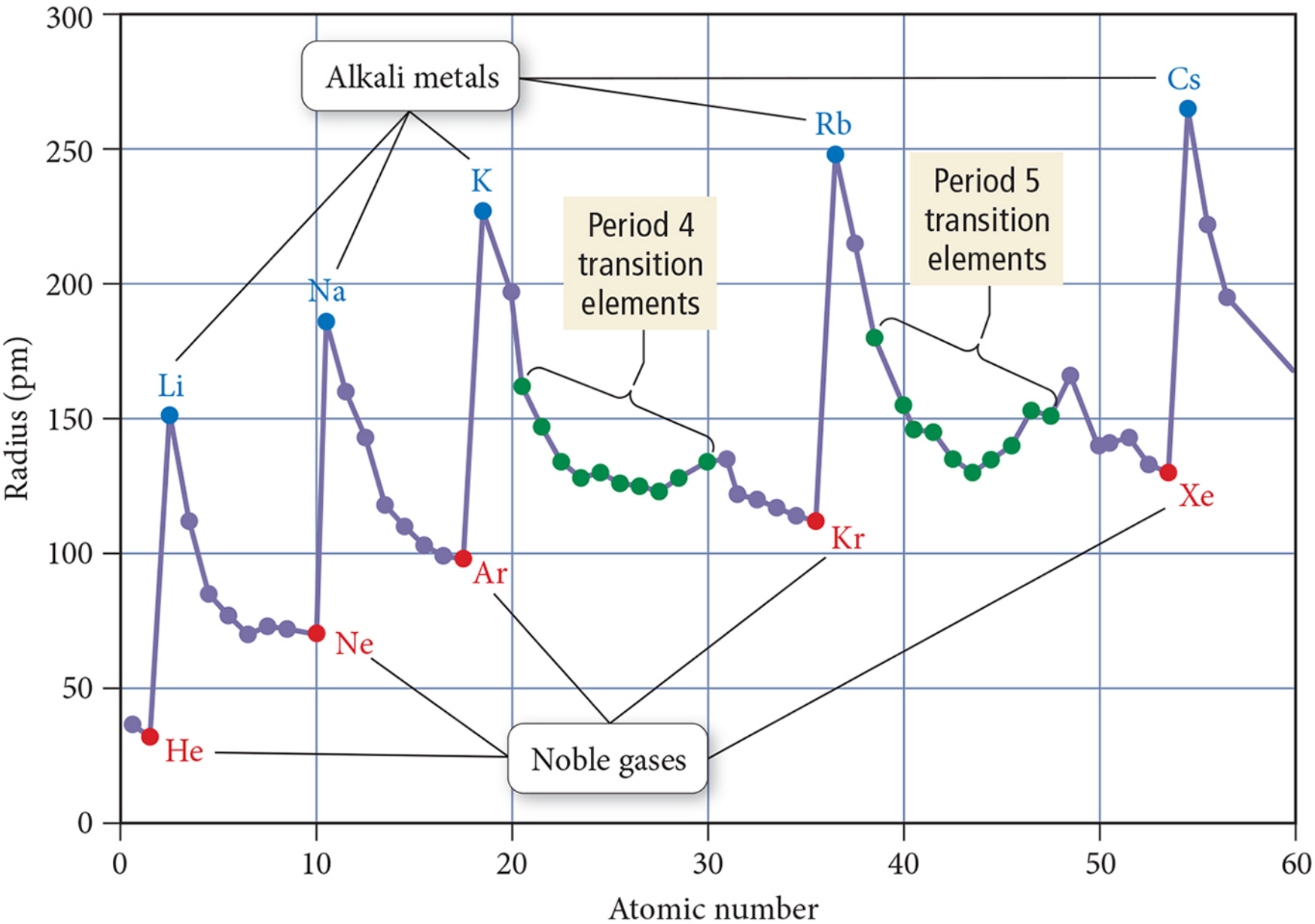
In general, more e⁻ shells going down PT groups
⇒ size ↑



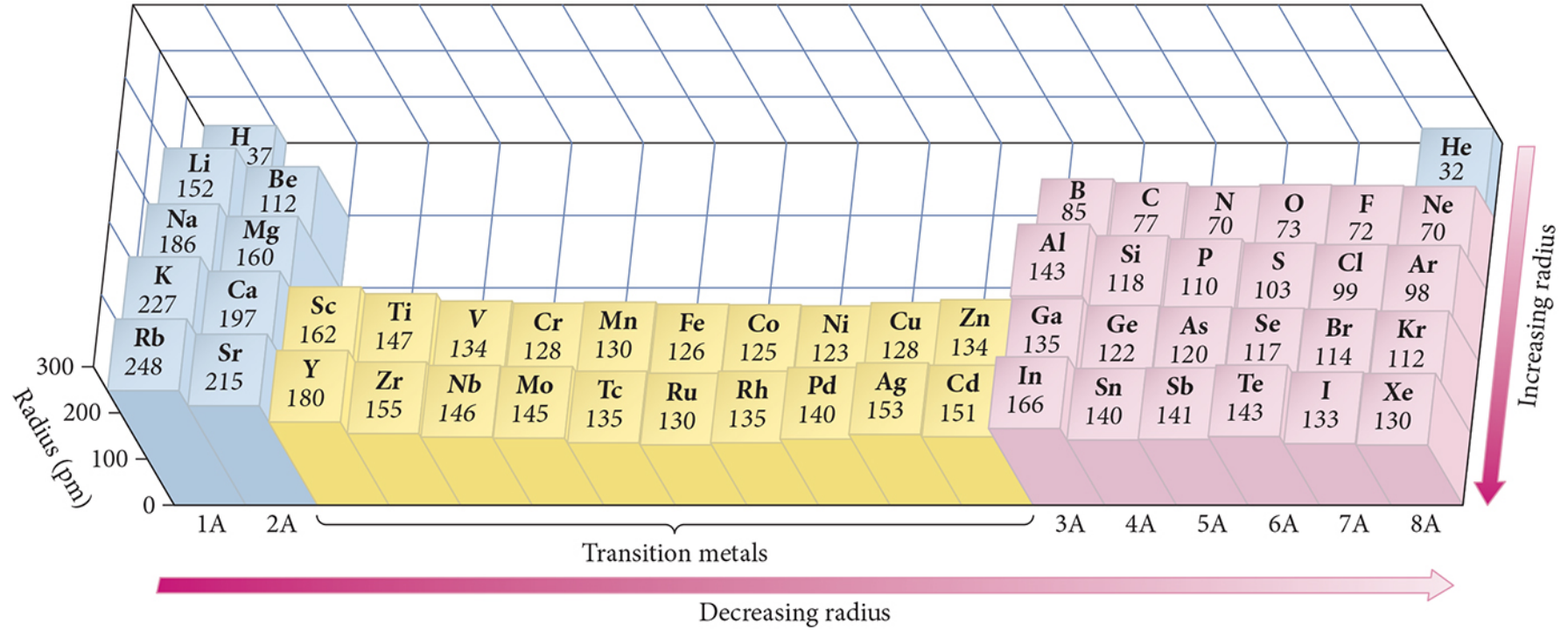
Q: Which atom will be bigger?

i) N vs F
ii) C vs Ge
iii) Al vs O
iv) Si vs As ?

Atomic Radii



Trends in Atomic Radius



e⁻ config of ions

Key concepts: add / remove e⁻s from VALENCE shell
(anions) (cations)
(largest n

isoelectronic w/ He [He]

ex: Li^+ $1s^2$ ← remove 1e⁻

$_3Li$ $1s^2 2s^1$

O^{2-} $1s^2 2s^2 2p^6$ ← isoelectronic as [Ne] (same e⁻ config)

$_8O$ $1s^2 2s^2 2p^4$

↑ add 2e⁻

Transition metals are interesting!

ex: V: [Ar] $4s^2 3d^3$

valence

V^{2+}: [Ar] $3d^3$

Q: What's e⁻ config for $_{30}Zn^{2+}$

orbital diagram too! (Use noble-gas core)

$_{30}Zn$: [Ar] $4s^2 3d^{10}$

$_{30}Zn^{2+}$: [Ar] $3d^{10}$

[Ar] ↑↓ ↑↓ ↑↓ ↑↓ ↑↓

3d

How do we know?

unpaired paired

- atoms w/ unpaired e's (↑ ↑ vs ↑ ↓)
  are attracted into a magnetic field,
  ... which is called: PARAMAGNETIC

- atoms w/ paired e's (↑↓) are slightly repelled by mag field: DIAMAGNETIC

Zn^{2+} = ~~diagma~~ diamagnetic!

Zn: [Ar] $4s^2$ $3d^{10}$

Zn^{2+} maybe it is: [Ar] $4s^2 3d^8$ paramagnetic

[Ar] [↑↓] [↑↓|↑↓|↑↓|↑|↑]
4s $3d^8$

What's e^- configs for Cr^{3+}?

-1 -2

Cr: [Ar] $4s^2 3d^4$ X [Ar] $4s^1 3d^5$
(4s: valence)

-remove $3e^-$ Cr^{3+}: [Ar] $3d^3$

diamagnetic/paramagnetic? ✓

[↑|↑|↑|_|_]