The periodic trends in atomic radius are:

- **As you go left to right across a period:** $Z_{effective}$ increases moving to the right, since the number of protons is increasing. Electrons are also being added to the same shell so shielding does not increase much. Increasing $Z_{effective}$ attracts electrons closer, so atoms get smaller.
- **As you go down a group:** The size of atoms increase since electrons are being added to orbitals with **higher** $\boldsymbol{n}$.

Summary: left to right: atomic radius $\downarrow$
down a group: atomic radius $\uparrow$

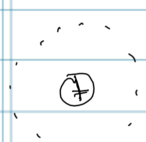
8-7 Electron configuration of Ions

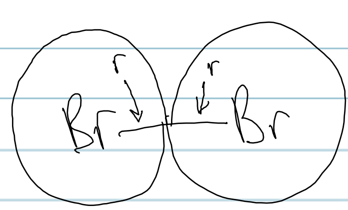
Na^+ ? $Na: 1s^2 2s^2 2p^6 \cancel{3s^1}$ $Na^+: 1s^2 2s^2 2p^6 = [Ne]$

- Na^+ and Ne are **isoelectronic** – they have the same number and configuration of electrons.

F^- ? $F: 1s^2 2s^2 2p^5$ $F^-: 1s^2 2s^2 2p^6 = [Ne]$

F^- is also isoelectronic with Ne.





Transition metal cations:

- Transition metals possess filled *ns* (n = 4, 5, 6) and partially filled $(n–1)d$ orbitals [configuration: $ns^2(n\text{-}1)d^x$]
- Transition metals lose electrons from the orbitals with the highest n first, so ns electrons are lost **before** $(n–1)d$.

Fe: [Ar] $4s^2 3d^6$ Fe^{3+}: ~~[Ar] $4s^2 3d^3$~~ [Ar] $3d^5$

Fe^{3+} $\boxed{\ }$ $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$ 5 unpaired electrons
4s 3d

<u>not</u> $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\ }\boxed{\ }$ 3 unpaired electrons
4s 3d

Ionic Radius

- When an atom loses an electron, the resulting cation is always smaller than the neutral atom (Figure 8.12).
- Anions are larger than the neutral atom (Figure 8.13).

$A > A^{+} > A^{2+} > A^{3+}$

Trends in ionic radius:

- As you go down a group, ionic radius gets larger, since atomic radius is increasing and charge is constant.
- As you go left to right across a period, change in size is less meaningful since charge is changing.
- Compare a set of ions that are all isoelectronic with Ar:

	S^{2-}	Cl^{-}	K^{+}	Ca^{2+}
Radius in pm:	184	181	133	99

1 pm $= 10^{-12}$ m

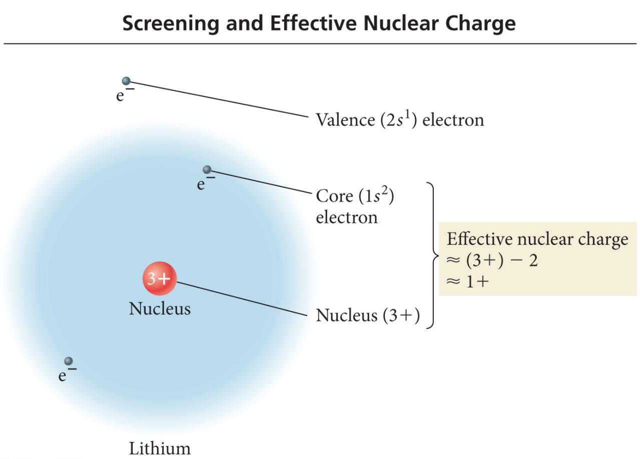
Size ↓ as the charge of ion becomes more positive
Size ↑ " " " " " " negative

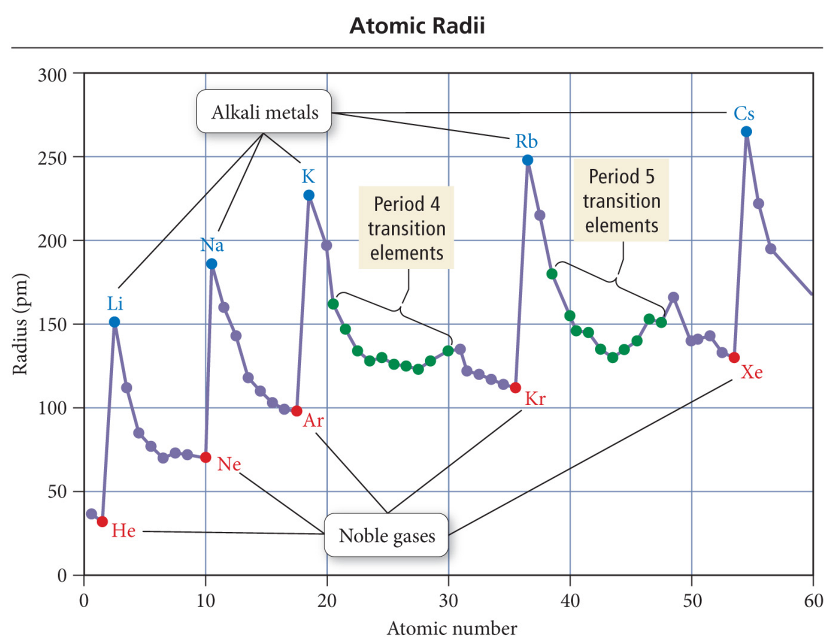
8.6 Periodic Trends in the Size of Atoms

- In general, properties of elements depend on the strength of the attraction between outer electrons and the nucleus.
- According to Coulomb's Law, the attraction is stronger as the **charge on the nucleus (Z) increases**, and as the electron gets **closer to the nucleus**.
- The charge of the nucleus increases as Z increases, but the electrons do not always "feel" all of the charge due to **shielding** by the inner electrons (Figure 8.11).
- The charge that an electron actually experiences is called the **effective nuclear charge, $Z_{\text{efffective}}$**.

$$Z_{\text{effective}} = Z - \text{shielding}$$

- Outer electrons are shielded by inner electrons. Electrons in the same shell do not shield very well.





- **Atomic radius** is a measure of the size of an atom. It can be defined as half of the distance between two atoms of the same element bonded together.