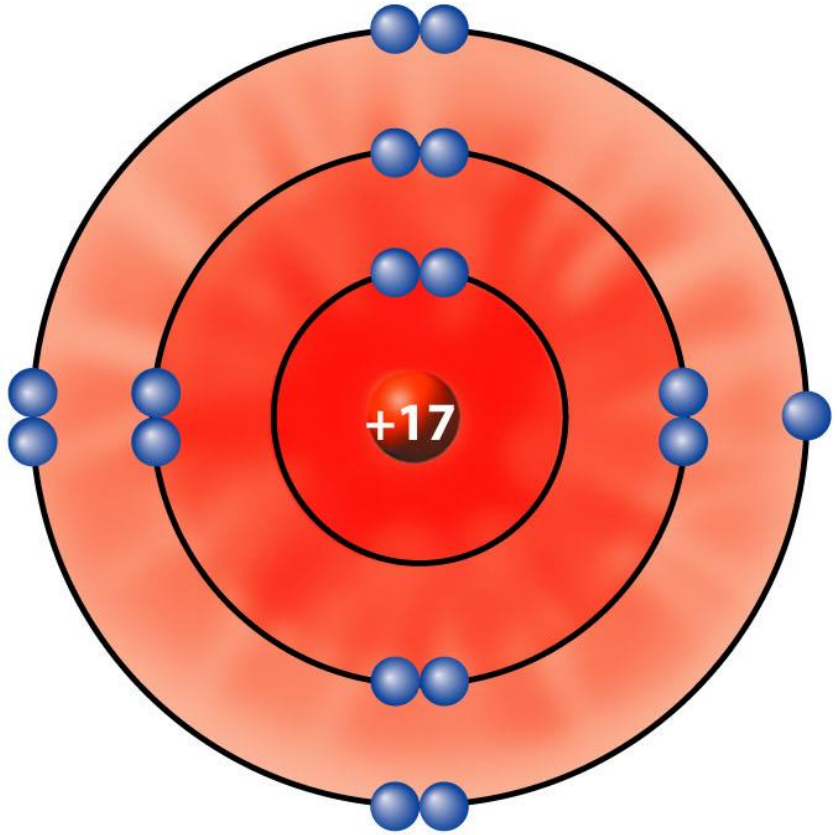
MODERN PERIODIC TABLE

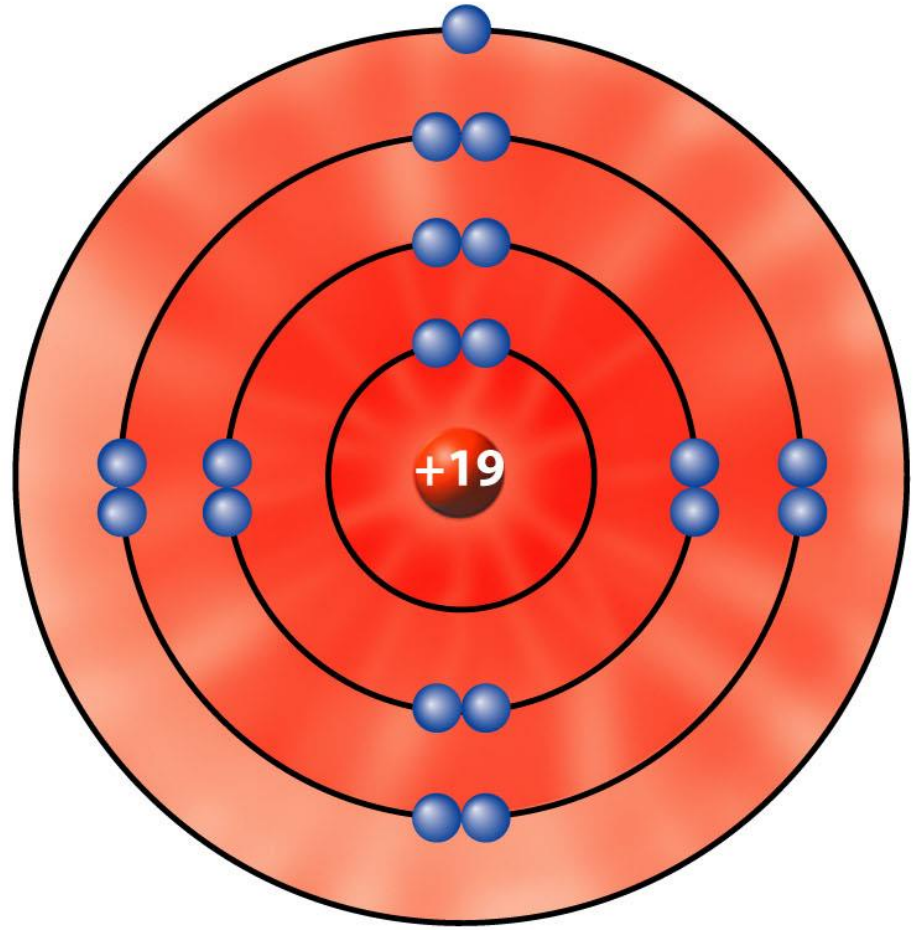
Lecture 7.



Chlorine

+17 Actual nuclear charge
−10 Inner shell electrons

+7 Effective nuclear charge



Potassium

+19 Actual nuclear charge
−18 Inner shell electrons

+1 Effective nuclear charge

TREND FOR EFFECTIVE NUCLEAR CHARGE

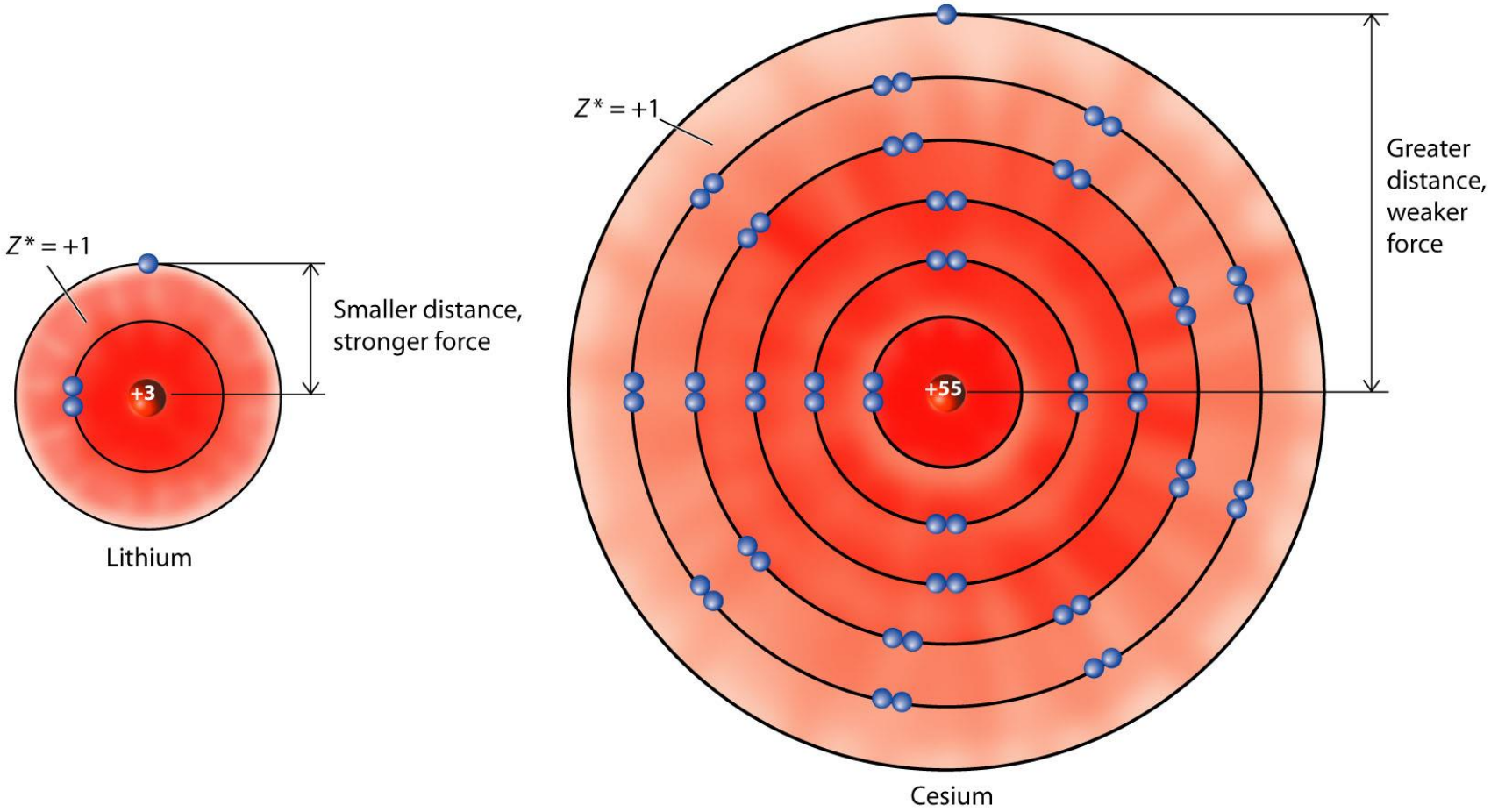
- Across a period, nuclear charge increases by +1, however the valence shell remains the same i.e. the incoming electron is accommodated to the same shell.
- Thus, the EFFECTIVE NUCLEAR CHARGE Z_{eff} increases across a period.

- Down the group, nuclear charge increases, however a new valence shell is added i.e. the incoming electron is accommodated in the next shell.
- Shielding effect exhibited by inner electrons increases as a result.
- Thus, the EFFECTIVE NUCLEAR CHARGE Z_{eff} decreases down the group.

TREND FOR ATOMIC RADIUS:

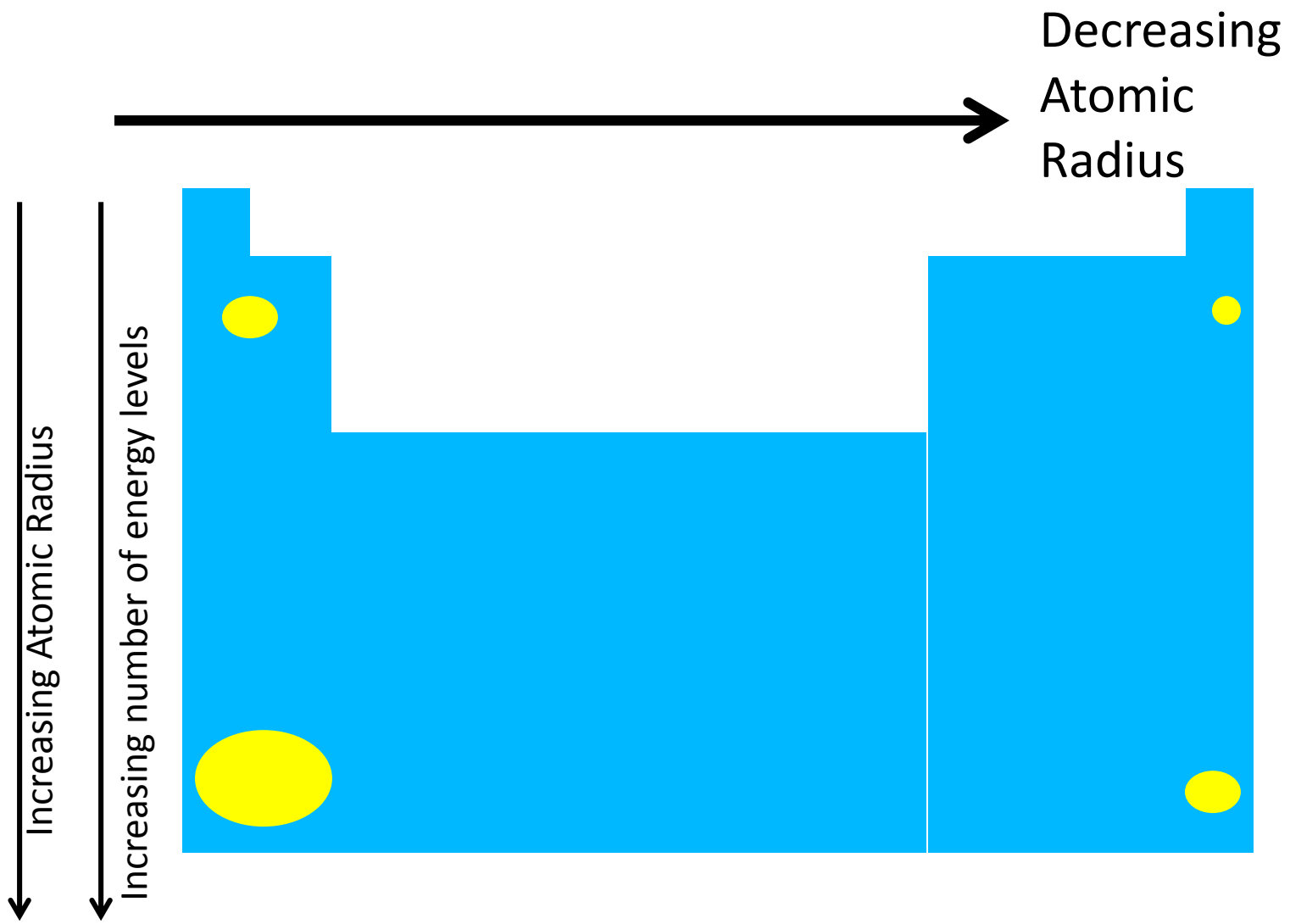
- Across a period, nuclear charge increases by +1, however the valence shell remains the same i.e. the incoming electron is accommodated in the same shell.
- Hence, the EFFECTIVE NUCLEAR CHARGE Z_{eff} increases across a period.
- Due to poor shielding of electrons, Atomic Radius across a period decreases.

- Down the group, nuclear charge increases, however a new valence shell is added i.e. the incoming electron is accommodated in the next shell.
- Hence, the EFFECTIVE NUCLEAR CHARGE Z_{eff} decreases down the group.
- Shielding effect of these inner electrons increases and so does the ATOMIC RADIUS down the group.



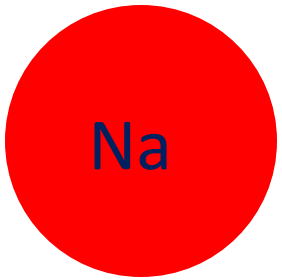
Li: Group 1 Period 2

Cs: Group 1 Period 6

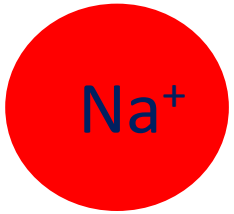

Decreasing
Atomic
Radius
Increasing Atomic Radius
Increasing number of energy levels

An ion is formed when an atom, or group of atoms, has a net positive or negative charge.

If a neutral atom **looses** one or more electrons it becomes a cation.

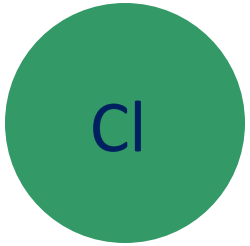


11 protons
11 electrons

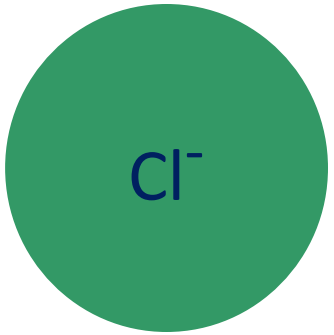


11 protons
10 electrons

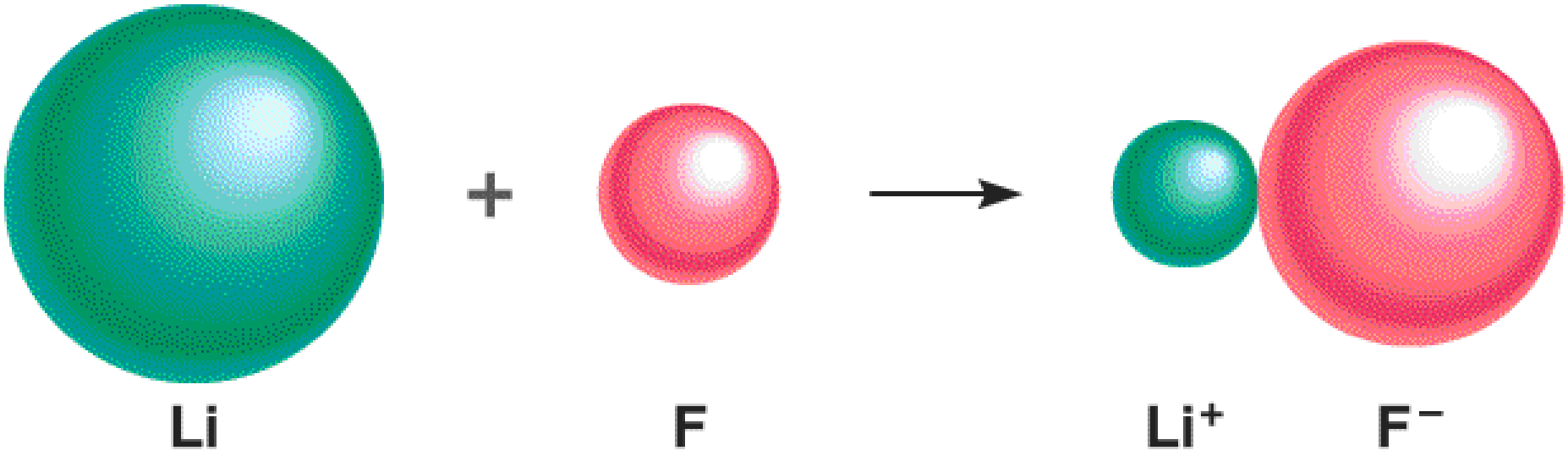
If a neutral atom **gains** one or more electrons it becomes an anion.



17 protons
17 electrons



17 protons
18 electrons

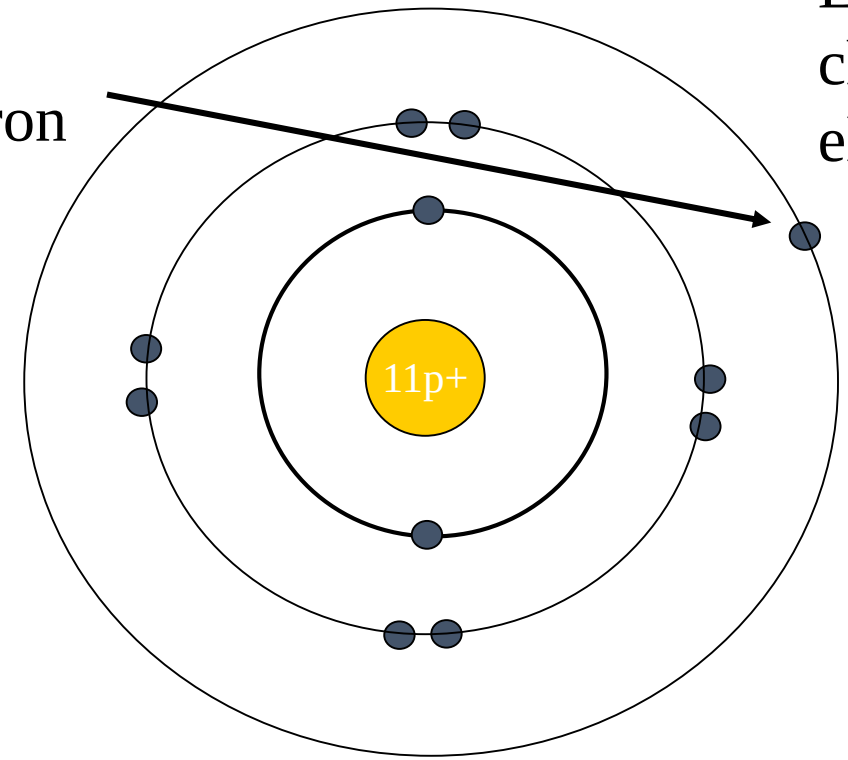


Cation is always **smaller** than atom from which it is formed. **Anion** is always **larger** than atom from which it is formed.

CATION FORMATION

Na atom

1 valence electron



Effective nuclear charge on remaining electrons increases.

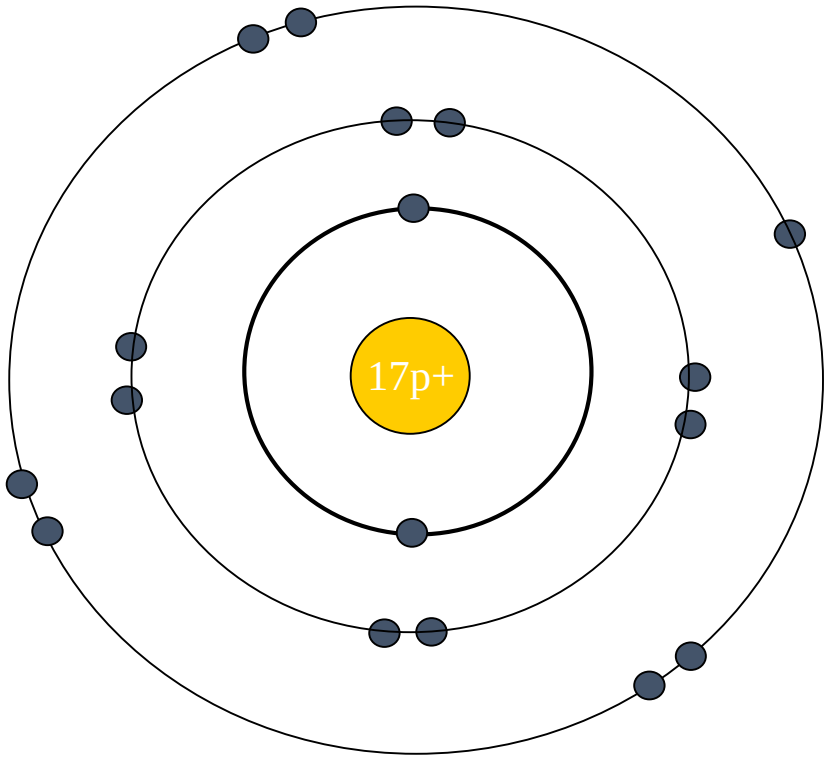
Remaining e- are pulled in closer to the nucleus. Ionic size decreases.

Valence e- lost in ion formation

Result: a smaller sodium cation, Na^+

ANION FORMATION

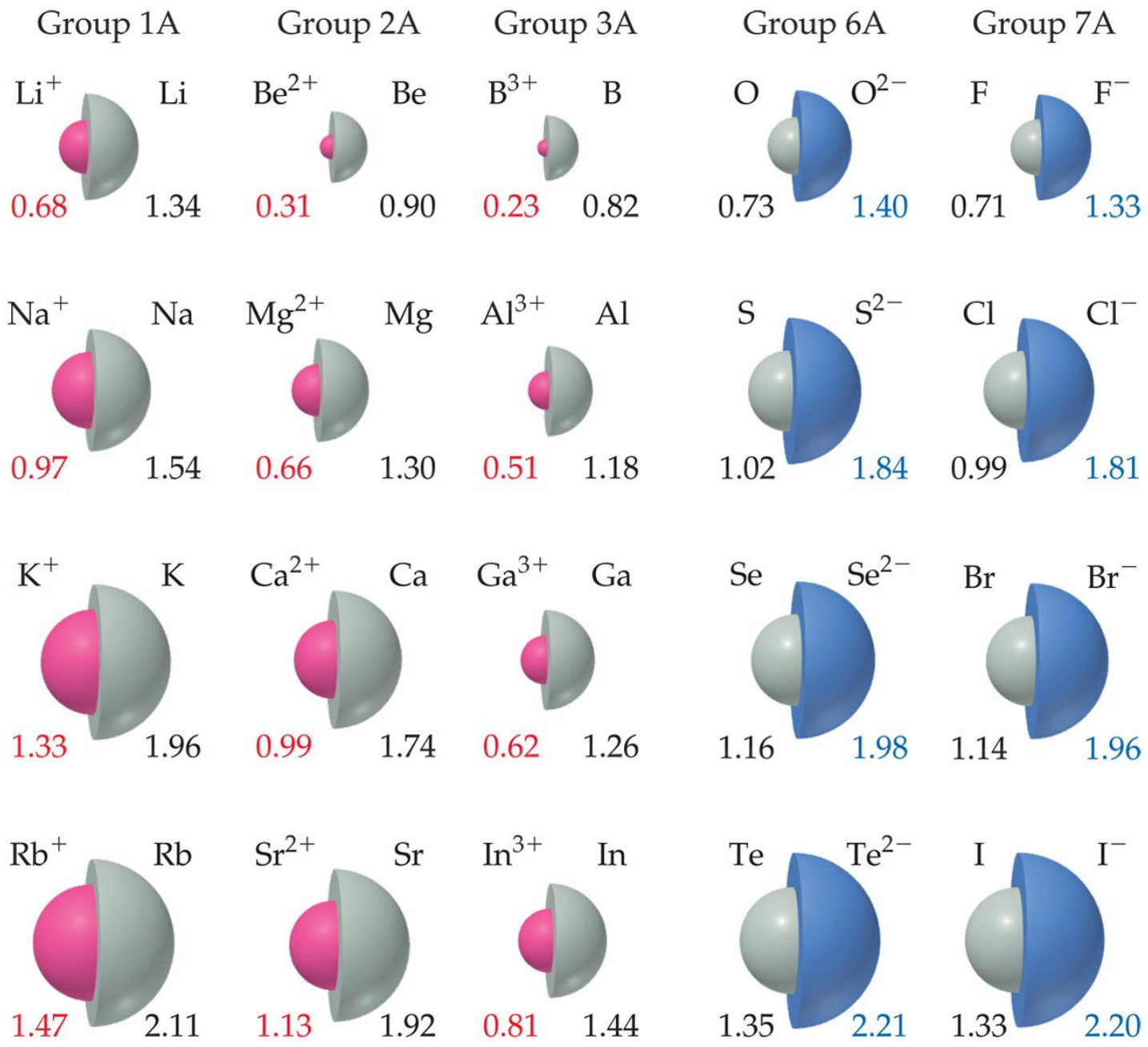
Chlorine atom with 7 valence e-



A chloride ion is produced. It is larger than the original atom.

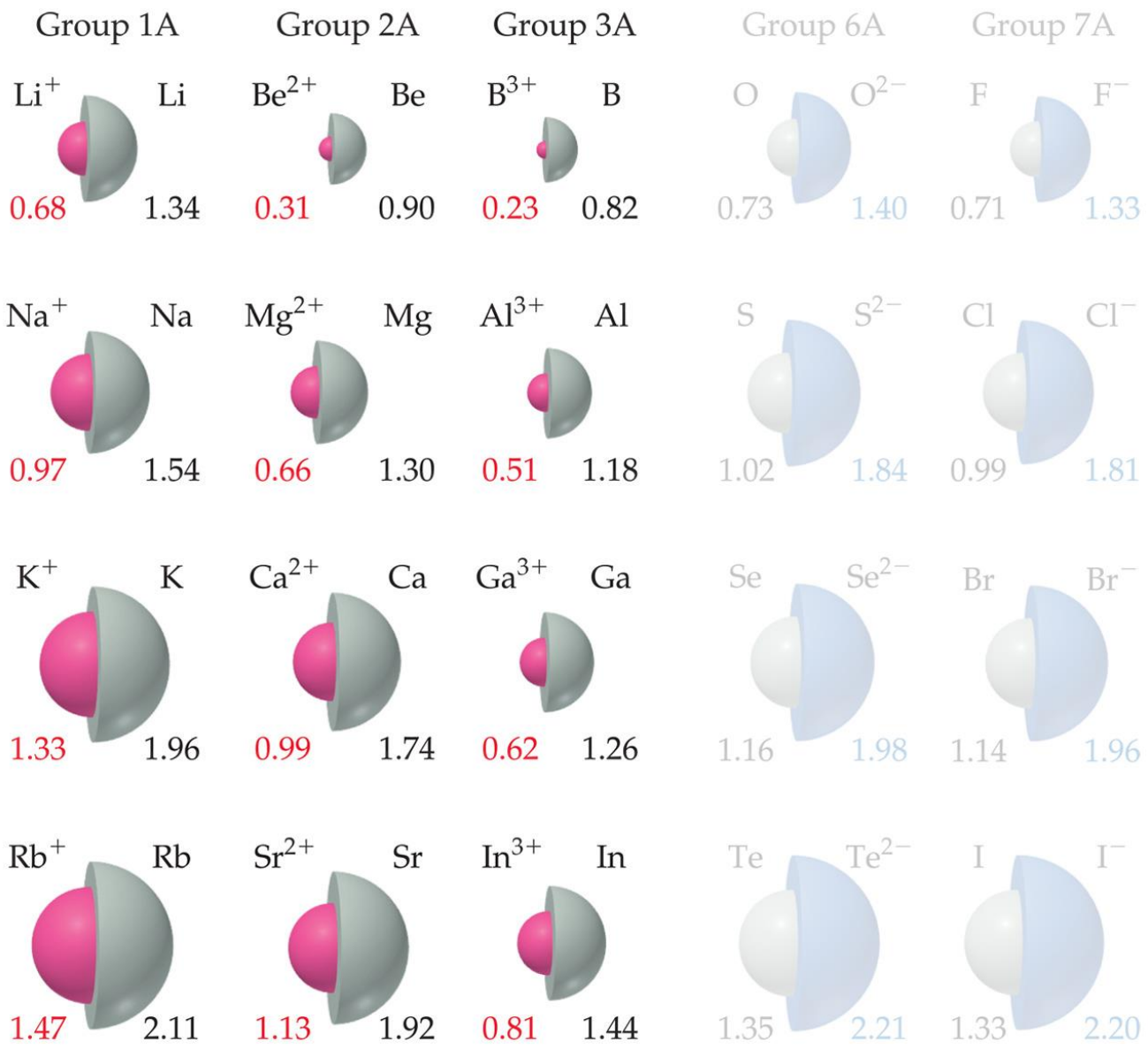
One e- is added to the outer shell.

Effective nuclear charge is reduced and the e- cloud expands.



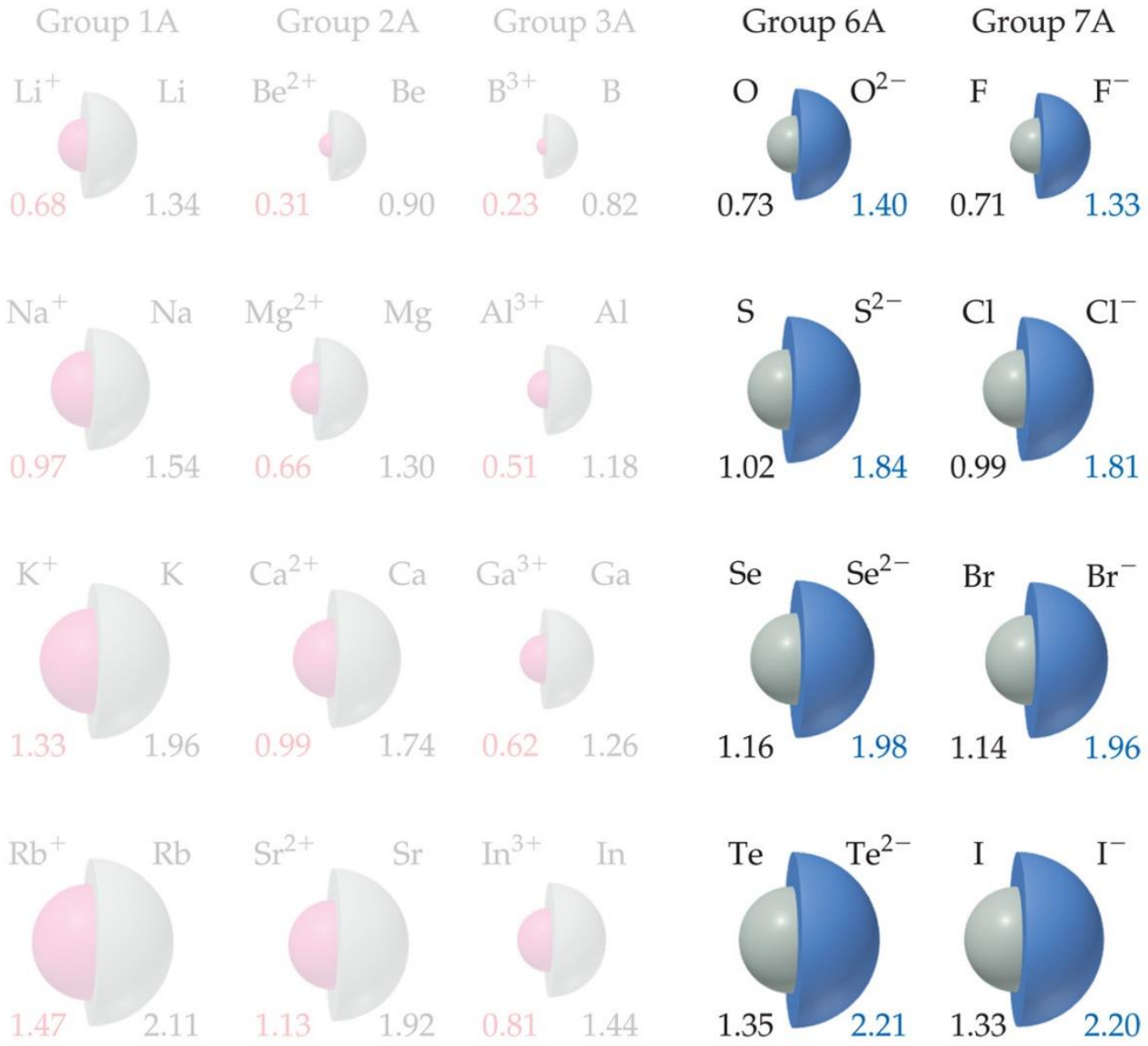
SIZE OF IONS

- Ionic size depends upon:
  - i. Nuclear charge.
  - ii. Number of electrons.
  - iii. Orbitals in which electrons reside.



SIZE OF IONS

- Cations are smaller than their parent atoms.
- The outermost electron is removed and repulsions are reduced.

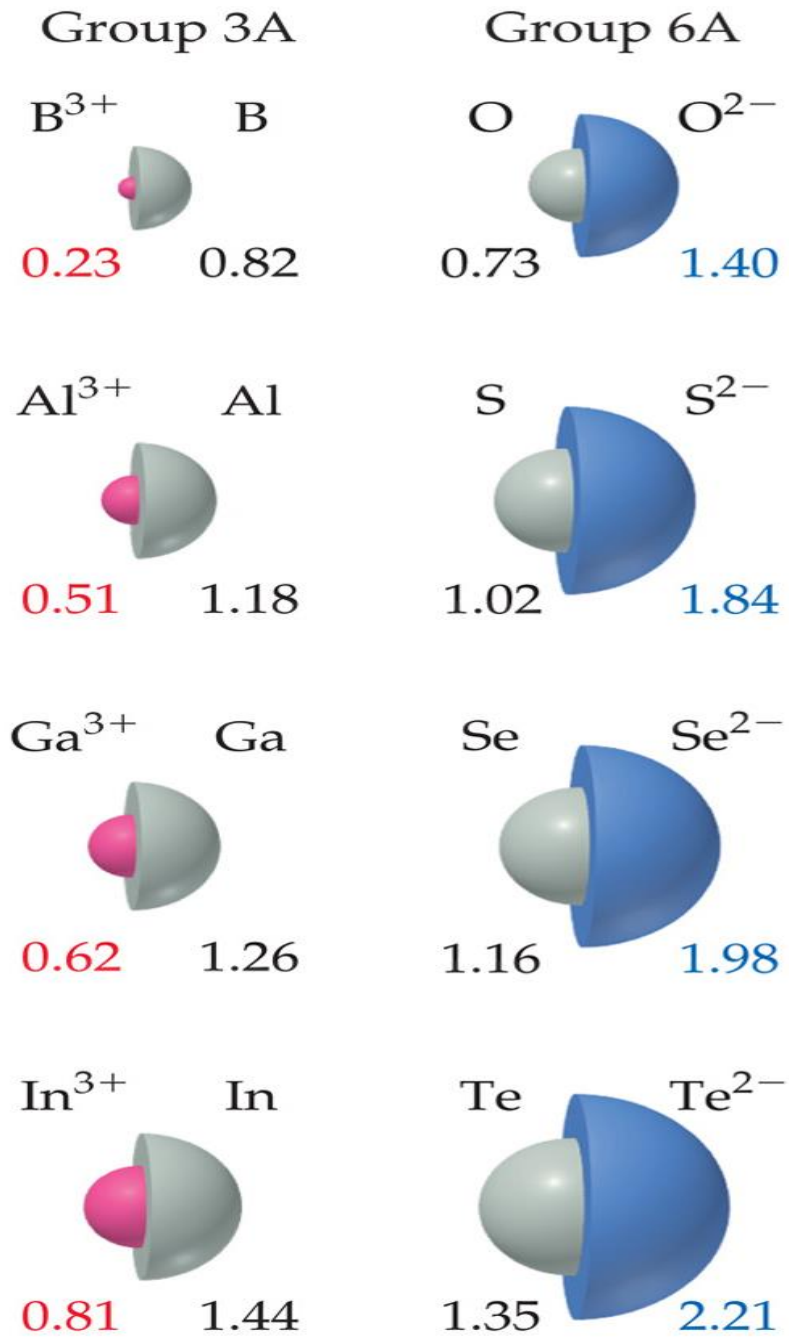


SIZE OF IONS

- Anions are larger than their parent atoms.
- Electrons are added and repulsions are increased.

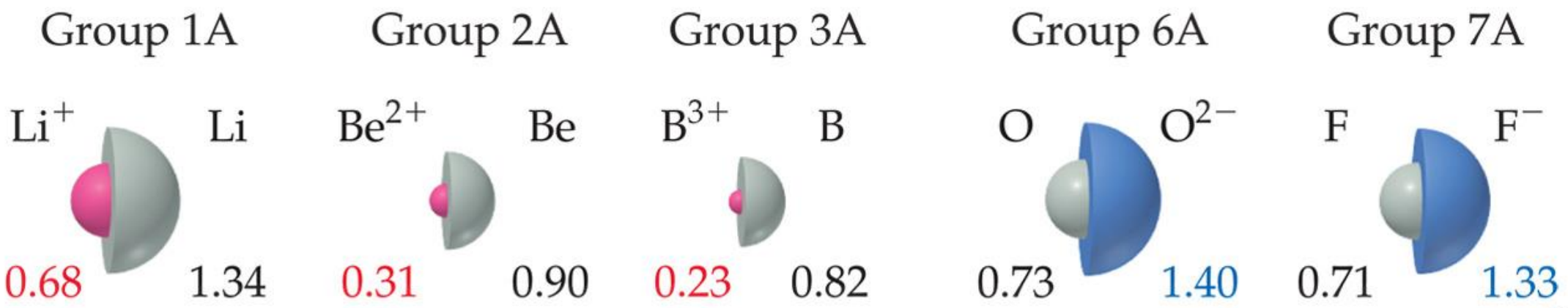
SIZE OF IONS

- Ions increase in size as you go down a column.
- Due to increasing value of *n*.



SIZE OF IONS

- In an isoelectronic series, ions have the same number of electrons.
- Ionic size decreases with an increasing nuclear charge.



REMEMBER!!

- Ionic Radius for:
  - i. Cations are always smaller than its atomic radius.
  - ii. Anions are always larger than its atomic radius.

IONISATION ENTHALPY

- If an electron is pulled toward another atom with enough energy to overcome the effective nuclear attraction of the parent atom holding the electron in the cloud, it can leave the atom completely.
- Once an electron has been removed from one atom and added to another, both atoms change into ions i.e. they have been “ionized”.
- The number of protons and electrons is no longer equal.
- The atom that lost an electron becomes POSITIVELY charged (more P+ than e-) while the atom that gained an electron becomes NEGATIVELY charged (more e- than P+).

IONISATION ENTHALPY

- Ionisation Enthalpy = Amount of energy required to remove a valence electron from an atom in gas phase.

- 1st Ionisation Enthalpy = Energy required to remove the most loosely held valence electron (e^- farthest from nucleus).
- So, 1st I.E. is the energy required to remove first valence electron.

$$Na \rightarrow Na^+ + e^-$$

- So, 2nd I.E. is the energy required to remove second valence electron.

$$Ca \rightarrow Ca^+ + e^-$$

$$Ca^+ \rightarrow Ca^{2+} + e^-$$

$$Ca \rightarrow Ca^{2+} + 2e^-$$

Any Question



“It is not the answer that enlightens, but the question.”

- Eugene Ionesco