Essential Question

How do electrons change when atoms form ions?

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What Is an Ion?

- Ion: an atom that gained or lost e^-
- Cation: lost e^-, so it is (+)
- Anion: gained e^-, so it is (–)
- The protons never change

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Atoms Want a Noble Gas Configuration

- Main-group atoms gain or lose e^-
- Goal: full s and p, like a noble gas
- Groups 1, 2, 13 lose 1, 2, 3 e^-
- Groups 17, 16, 15 gain 1, 2, 3 e^-

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Configurations of Anions

- Add e^- to the open orbitals
- F: $1s^2\ 2s^2\ 2p^5$
- F^-: $1s^2\ 2s^2\ 2p^6$, the same as Ne

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Configurations of Cations

- Remove e^- from the highest n first
- Mg: [Ne] $3s^2$
- Mg^{2+}: [Ne], because both 3s electrons leave

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Isoelectronic Ions

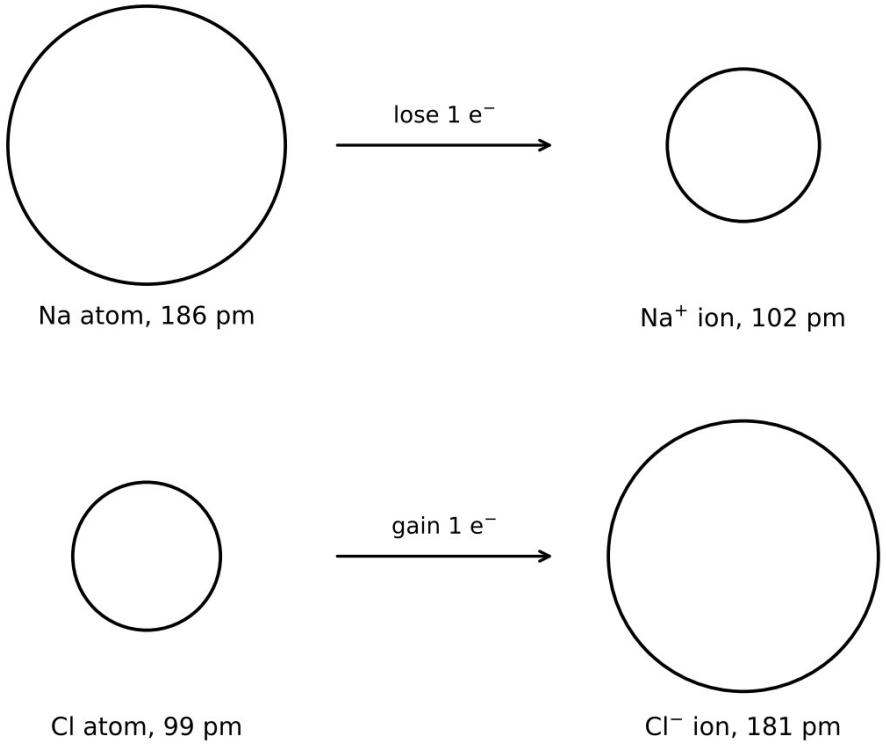
- Isoelectronic: same number of e^-
- Same e^- count = same configuration

Particle	Protons	Electrons
N^{3-}	7	10
O^{2-}	8	10
F^-	9	10
Ne	10	10
Na^+	11	10
Mg^{2+}	12	10

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Ion Size

- Cations are smaller than their atoms
- Anions are larger than their atoms
- Isoelectronic: more protons = smaller ion



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Transition Metal Ions

- Lose 4s e^- first (highest n), then 3d

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

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Exceptions: Chromium

- Half-filled 3d (5 e^-) is extra stable
- One 4s electron moves into 3d

Chromium	Configuration
Expected	[Ar] $4s^2$ $3d^4$
Actual	[Ar] $4s^1$ $3d^5$

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Exceptions: Copper

- Filled 3d (10 e^-) is extra stable
- One 4s electron moves into 3d

Copper	Configuration
Expected	[Ar] $4s^2$ $3d^9$
Actual	[Ar] $4s^1$ $3d^{10}$

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Example: Configuration of an Anion

Write the noble gas configuration of the sulfide ion, S^{2-}. Which noble gas has the same configuration?

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Example: Configuration of a Cation

Write the full and noble gas configurations of the aluminum ion, Al^{3+}.

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Example: Isoelectronic Ions

Which of these ions are isoelectronic with argon, Ar? Ca^{2+}, Na^{+}, Cl^{-}, P^{3-}, Br^{-}, K^{+}

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Example: Transition Metal Ion Boxes

Draw the orbital box diagram for Mn^{2+} using noble gas notation. How many unpaired electrons does it have?

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Ions and Exceptions

Big Ideas

- Ions form when atoms gain or lose e^-
- Main-group ions match a noble gas
- Cations lose e^- from the highest n (4s before 3d)
- Cations shrink and anions grow
- Cr and Cu: half-filled or filled 3d is extra stable

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