

# Ionization Energy

UNIT 3 PERIODIC TRENDS

# First Ionization Energy

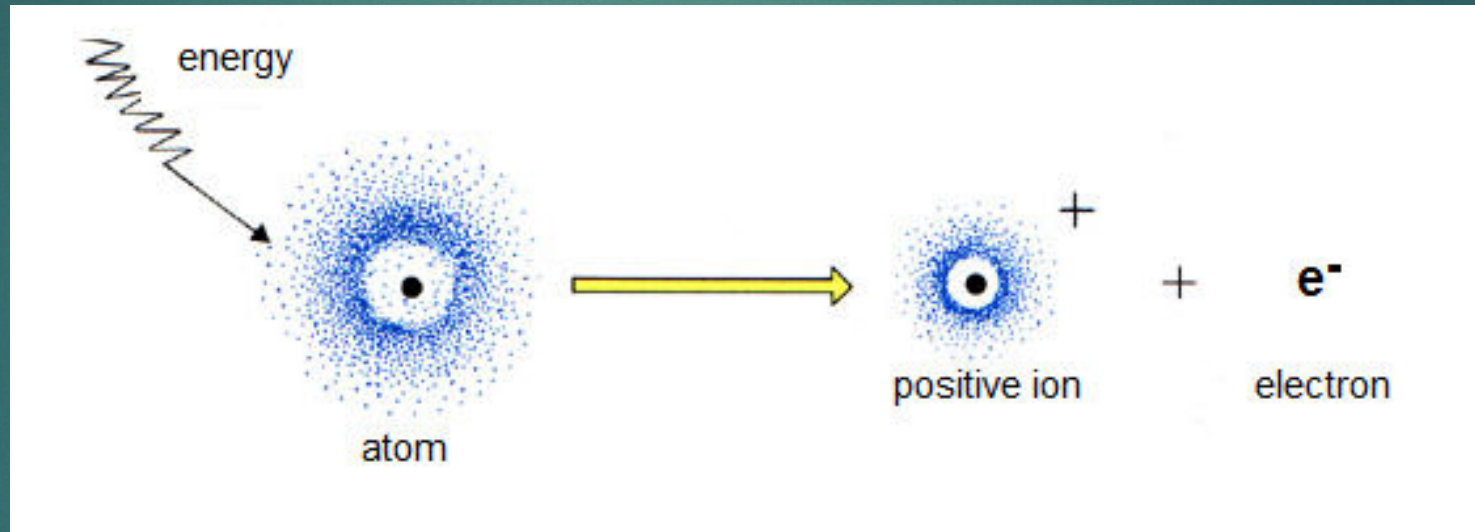
- **First Ionization Energy** is the amount of energy required to remove the *first* valence electron

			1s	2s	2p
Lithium	Li	$1s^2 2s^1$	$\uparrow\downarrow$	$\uparrow$	$\square\square\square$
Beryllium	Be	$1s^2 2s^2$	$\uparrow\downarrow$	$\uparrow\downarrow$	$\square\square\square$
Boron	B	$1s^2 2s^2 2p^1$	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\square\square$
Carbon	C	$1s^2 2s^2 2p^2$	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\uparrow\square$
Nitrogen	N	$1s^2 2s^2 2p^3$	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\uparrow\uparrow$
Oxygen	O	$1s^2 2s^2 2p^4$	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\downarrow\uparrow\uparrow$
Fluorine	F	$1s^2 2s^2 2p^5$	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\downarrow\uparrow\downarrow\uparrow$
Neon	Ne	$1s^2 2s^2 2p^6$	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\downarrow\uparrow\downarrow\uparrow\downarrow$

- If removing an electron completely empties an orbital, then the atom becomes more stable.
- This happens for Lithium and Boron.
- Oxygen also becomes more stable because each p orbital is only filled once.

# Metals vs Nonmetals

- ▶ Metals **lose electrons** easily so they require **less** ionization energy.
- ▶ Nonmetals want to **gain electrons** so losing them requires **more** energy.



- ▶ The process of removing an electron is always **endothermic**.

- **Noble gases** have the *highest* ionization energy because their **valence orbitals are full** and they do not want to lose electrons.

Helium	He	$1s^2$
Neon	Ne	$1s^2 2s^2 2p^6$
Argon	Ar	$1s^2 2s^2 2p^6 3s^2 3p^6$
Krypton	Kr	$[\text{Ar}] 4s^2 3d^{10} 4p^6$
Xeon	Xe	$[\text{Kr}] 5s^2 4d^{10} 5p^6$
Radon	Rn	$[\text{Xe}] 6s^2 5s^{10} 6p^6$

Increasing Ionization Energy

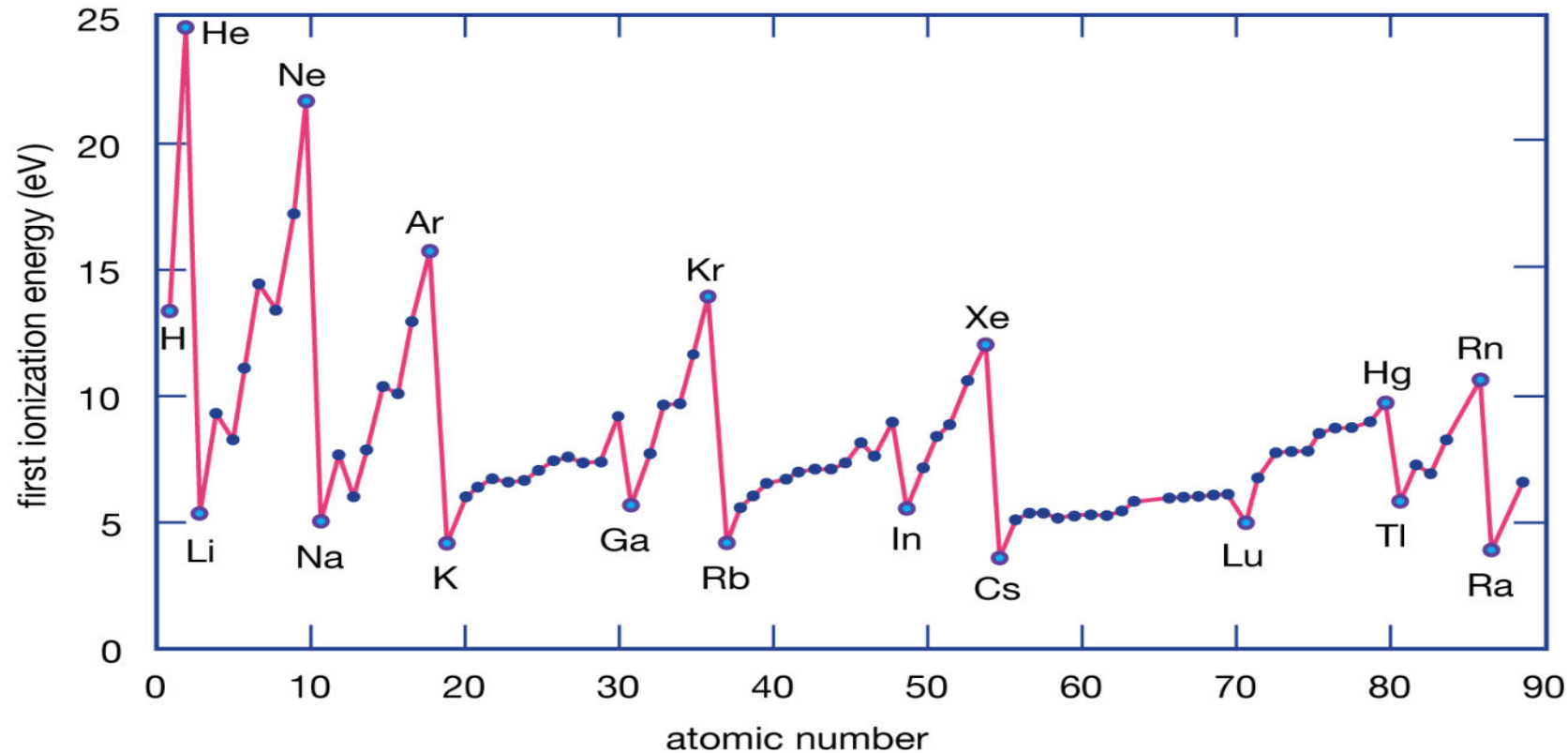
High Energy

Increasing Ionization Energy

Low Energy

1	IA H	IIA He																	IIIA B	IVA C	VA N	VIA O	VIIA F	VIIIA Ne
2	Li	Be																	Al	Si	P	S	Cl	Ar
3	Na	Mg	IIIB	IVB	VB	VIB	VIIA	VIII			IB	IIB	Ga	Ge	As	Se	Br	Kr						
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr						
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe						
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn						
7	Fr	Rd	Ac																					

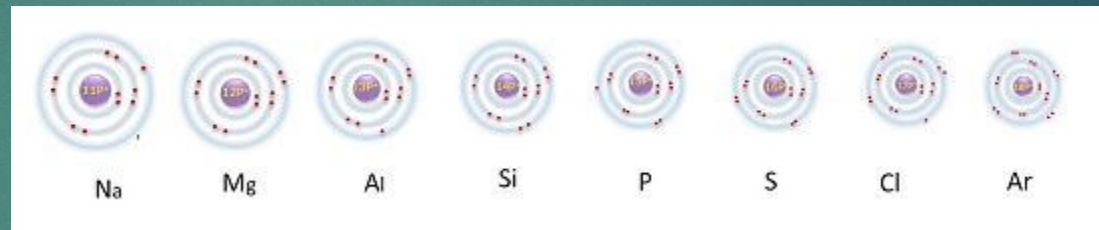
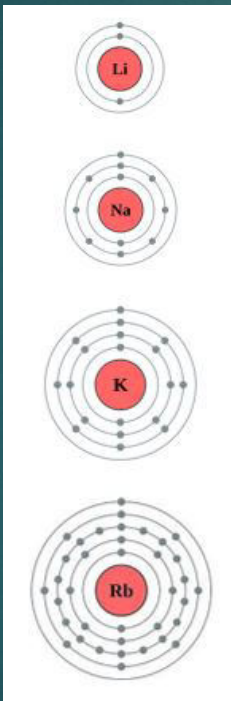
# Ionization Energy and Atomic #



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# Ionization and Atomic Radius

- ▶ The **smaller** the atom, the **harder** it is to remove an electron because the valence orbital is closer to the nucleus.



- ▶ Ionization energy **decreases as atoms get larger** because according to Coulomb's law the valence orbital is **less attracted** to the nucleus.