Unit 4: The Periodic Table and Periodicity

The Elements

Element names come from a variety of sources.

elements known to the ancients… Au, Ag, S, Sn, C

place names… Fr, Po, Ge, Ga, In, Eu, Am, Cf, Sc

famous people… Es, Fm, Md, No, Gd, Rf, Bh

foreign languages… W, Fe, Au, Ag, Pb, Sn, K

mythology-related names… Th, Pm, Ce, Ta, Ti, Pd, Ir

names related to element properties… Xe

Background on the Periodic Table

Dmitri Mendeleev: given credit for Periodic Table (~1870)

-- organized Table by increasing atomic mass

-- left spaces and predicted properties of undiscovered elements

Henry Moseley: put elements in order of increasing atomic number

Describing the Periodic Table

periodic law: the properties of elements repeat every so often

- period: horizontal row; (7)
- group (family): vertical column; (18)

Regions of the Table

metals: left side of Table; form cations

properties: good conductors of heat and electricity, lustrous, malleable, ductile

nonmetals: right side of Table; form anions

properties: good insulators. gases or brittle solids

metalloids (semimetals): "stair" between metals and nonmetals

properties: in-between those of metals and nonmetals "semiconductors"

Si and Ge → computer chips

alkali metals: group 1 (except H); 1+ charge; very reactive

alkaline earth metals: group 2; 2+ charge; less reactive than alkalis

halogens: group 17; 1– charge; very reactive

noble gases: group 18; no charge; unreactive

lanthanides: elements 57–71
actinides: elements 89–103
} contain f orbitals

coinage metals: group 11

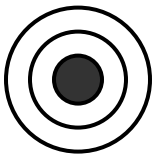
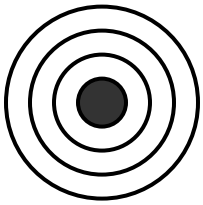
transition elements: groups 3–12; variable charges

main block (representative) elements: groups 1, 2, 13–18

Same number of valence e^- = similar properties

Li $1s^2 \underline{2s^1}$ Na $1s^2 2s^2 2p^6 \underline{3s^1}$

In any group, the element BELOW has one more occupied energy level than does the element ABOVE.

Li  Na 

The period that an element is in is the same as the energy level that its valence electrons are in.

Li → 2^{nd} E.L. / 2^{nd} period Na → 3^{rd} E.L. / 3^{rd} period

Periodicity → there are trends in properties of elements

-- left-right AND up-down trends

atomic radius: the size of a neutral atom

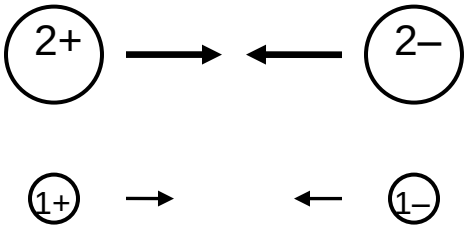
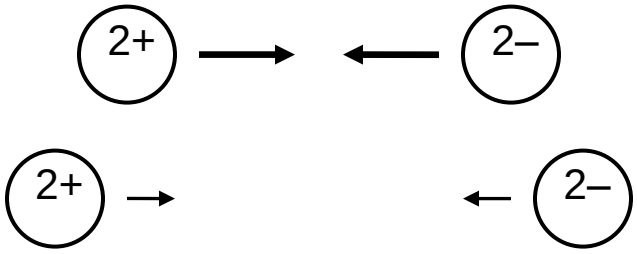
…increases as we go ↓

add a new energy level each time

…decreases as we go →

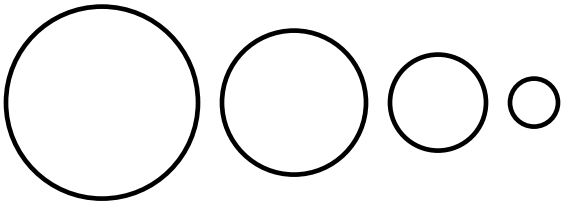
coulombic attraction: attraction between (+) and (–)

Depends on…

amount of charge	distance between charges
	

H 

He 



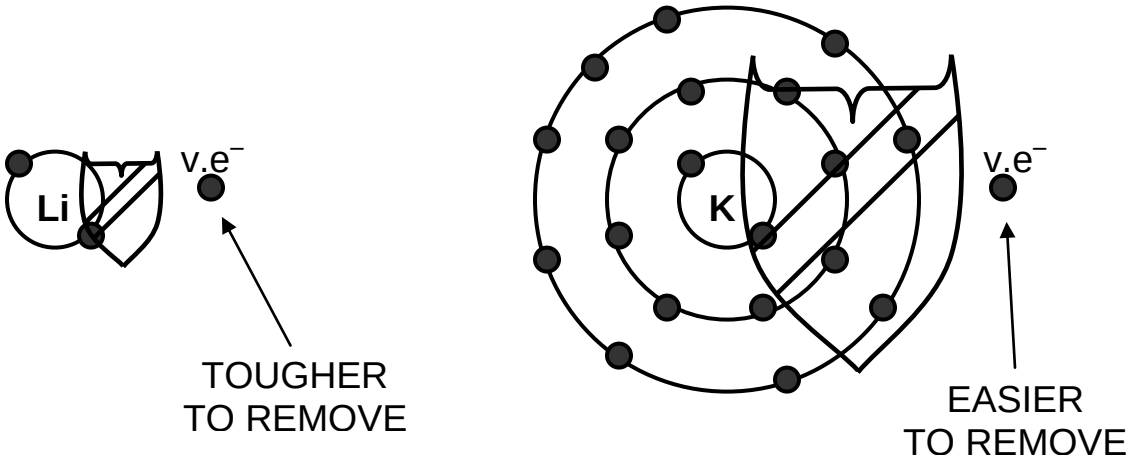
As we go → ,

more coulombic attraction, no new energy level, more pull,

<u>smaller size</u>

shielding effect: kernel e^- "shield" valence e^-

from attractive force of the nucleus



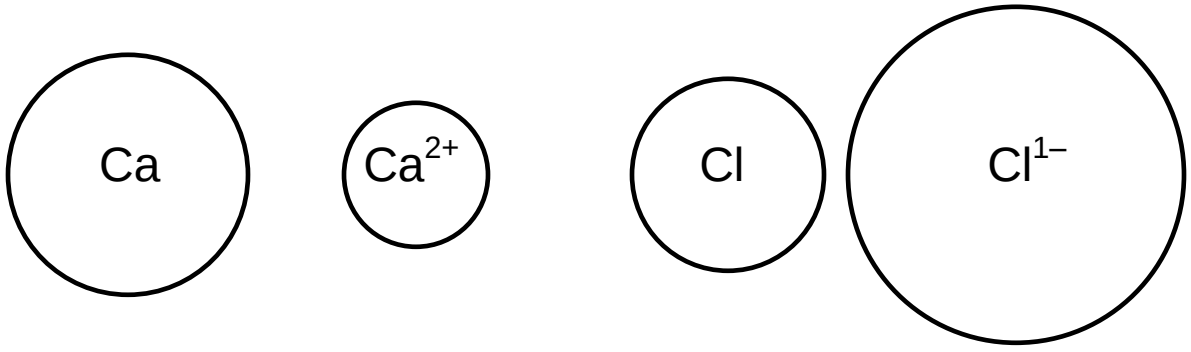
-- caused by kernel and valence e^- repelling each other

As we go ↓ , shielding effect increases.

↓

ionic radius: the size of an ion

cations		anions	
Ca atom	Ca^{2+} ion	Cl atom	Cl^{1-} ion
20 p^+	20 p^+	17 p^+	17 p^+
20 e^-	18 e^-	17 e^-	18 e^-



cations are smaller

anions are larger

ionization energy: the energy required to remove an e^- from an atom

$M + 1^{st}\ I.E. \rightarrow M^{1+} + e^-$ (removes $1^{st}\ e^-$)

$M^{1+} + 2^{nd}\ I.E. \rightarrow M^{2+} + e^-$

$M^{2+} + 3^{rd}\ I.E. \rightarrow M^{3+} + e^-$

Each successive ionization requires more energy than the previous one.

As we go ↓, 1^{st} I.E. decreases

As we go →, " " increases

electronegativity: the tendency for a bonded atom to attract e^- to itself

Linus Pauling quantified the electronegativity scale.

As we go ↓, electronegativity decreases

As we go →, " increases