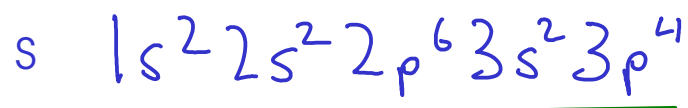
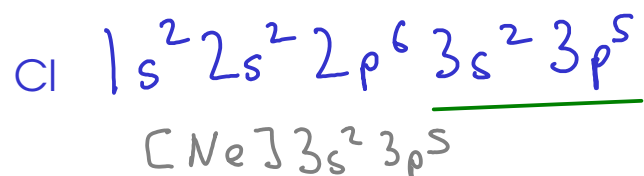


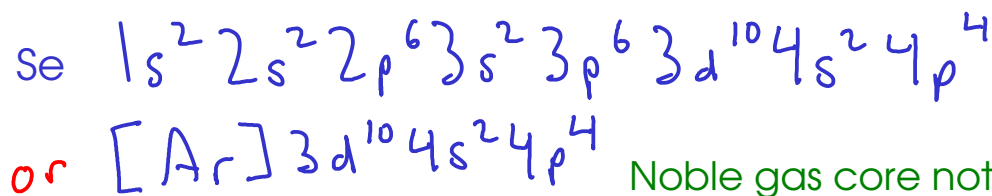
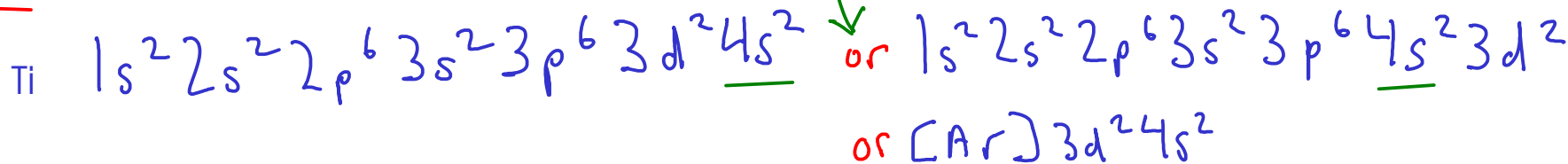
Remember - valence electrons are ALL of the electrons in the outermost SHELL! (may have more than one SUBSHELL)!



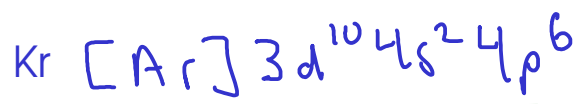
TITANIUM is a transition metal that commonly forms either +2 or +4 cations. The 4s electrons are lost when the +2 ion forms, while the 4s AND 3d electrons are lost to form the +4!



You can order the subshells in numeric order OR in filling order



Noble gas core notation. Use the previous noble gas on the table, then add the electrons that it doesn't have to the end.



You are responsible for writing electron configurations up to Z=18, Argon. These are here to illustrate other points!

PERIODIC TRENDS

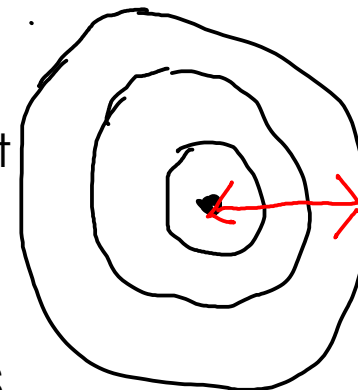
- Some properties of elements can be related to their positions on the periodic table.

ATOMIC RADIUS

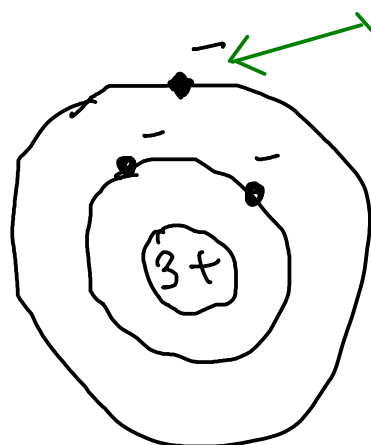
- The distance between the nucleus of the atoms and the outermost shell of the electron cloud.
- Relates to the size of the atom.
- As you go DOWN A GROUP (↓), the atomic radius INCREASES.

- Why? As you go down a group (from one period to the next) , you are ADDING SHELLS!

- As you go ACROSS A PERIOD (→), the atomic radius DECREASES

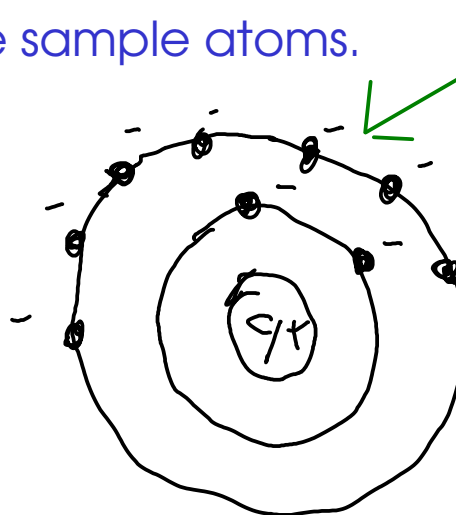


Why? Let's look at some sample atoms.



lithium

Outer electron sees an effective +1 charge (shielded from +3 nucleus by 2 electrons)



fluorine

Outer electrons see an effective +7 charge (shielded from +9 nucleus by 2 electrons)

... so fluorine's outer shell is pulled closer to the nucleus than lithium's!

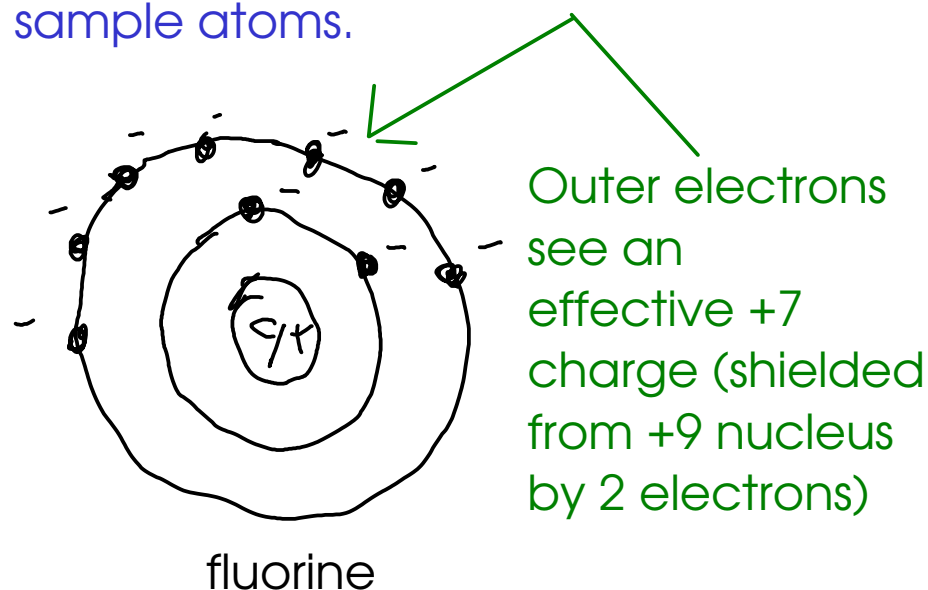
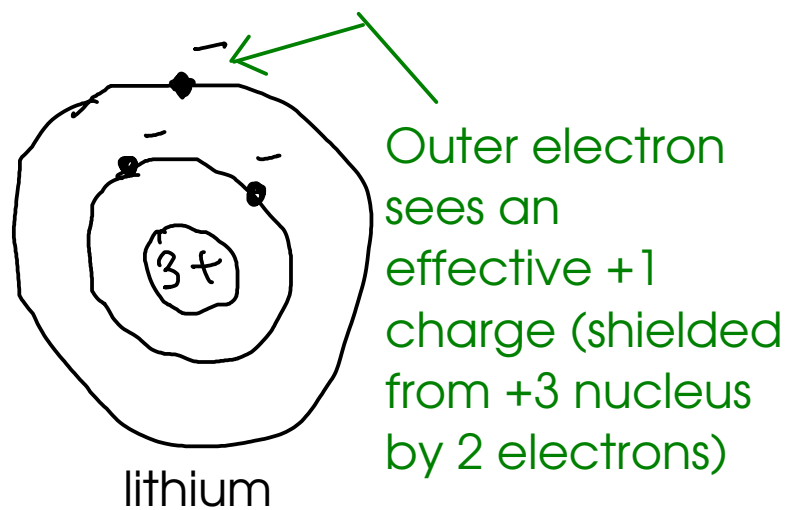
IONIZATION ENERGY (or FIRST IONIZATION ENERGY)

- The amount of energy required to remove a single electron from the outer shell of an atom.
- Relates to reactivity for metals. The easier it is to remove an electron, the more reactive the metal.
- As you go DOWN A GROUP (\downarrow), the ionization energy DECREASES.

- Why? As you go down a period, you are ADDING SHELLS. Since the outer electrons are farther from the nucleus and charge attraction lessens with distance, this makes electrons easier to remove as the atoms get bigger!

- As you go ACROSS A PERIOD (\longrightarrow), the ionization energy INCREASES.

- Why? Let's look at some sample atoms.



... since fluorine's outer electrons are held on by a larger effective charge, they are more difficult to remove than lithium's.

PERIODIC TRENDS IN A NUTSHELL

LARGER
IONIZATION
ENERGY

SMALLER
RADIUS

| | | | | | | | | | | | | | | | | | | | | |
|----|-----|------|-----|----|-----|-------|--------|----|------------------------------------|-----|----|----|-------|-----|----|-----|------|--|-------|----|
| IA | | | | | | | | | | | | | | | | | | | VIIIA | |
| H | | | | | | | | | | | | | | | | | | | | He |
| Li | IIA | | | | | | | | | | | | III A | IVA | VA | VIA | VIIA | | | Ne |
| Na | Mg | IIIB | IVB | VB | VIB | VII B | VIII B | | IB | IIB | | Al | Si | P | S | Cl | Ar | | | Ar |
| K | Ca | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn | Ga | Ge | As | Se | Br | Kr | | | Kr |
| Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | Pd | Ag | Cd | In | Sn | Sb | Te | I | Xe | | | Xe |
| Cs | Ba | La* | Hf | Ta | W | Re | Os | Ir | Pt | Au | Hg | Tl | Pb | Bi | Po | At | Rn | | | Rn |
| Fr | Ra | Ac* | Rf | Db | Sg | Bh | Hs | Mt | *"inner" transition metals go here | | | | | | | | | | | |

LARGER
RADIUS

SMALLER
IONIZATION
ENERGY

"octet rule"

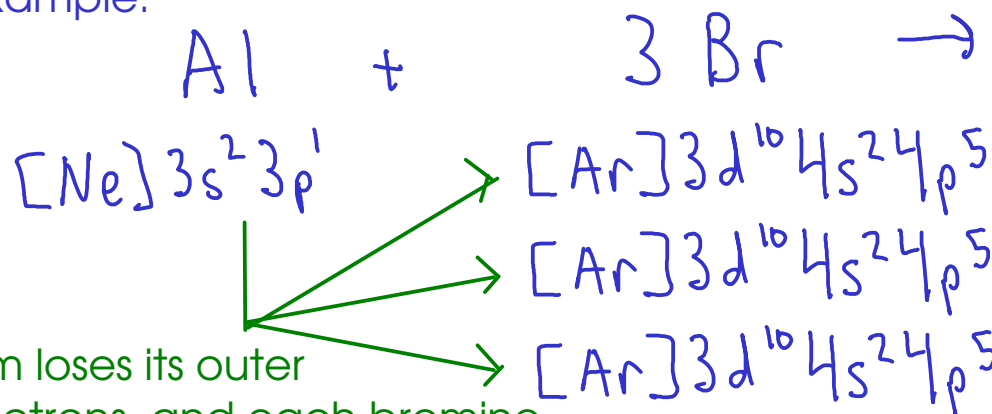
- a "rule of thumb" (NOT a scientific law) predicting how atoms will exchange or share electrons to form chemical compounds
- atoms will gain, lose, or share enough electrons so that they end up with full "s" and "p" subshells in their outermost shell.

- Why "octet"? An "s" subshell can hold two electrons, while a "p" subshell can hold six. $2+6 = 8$

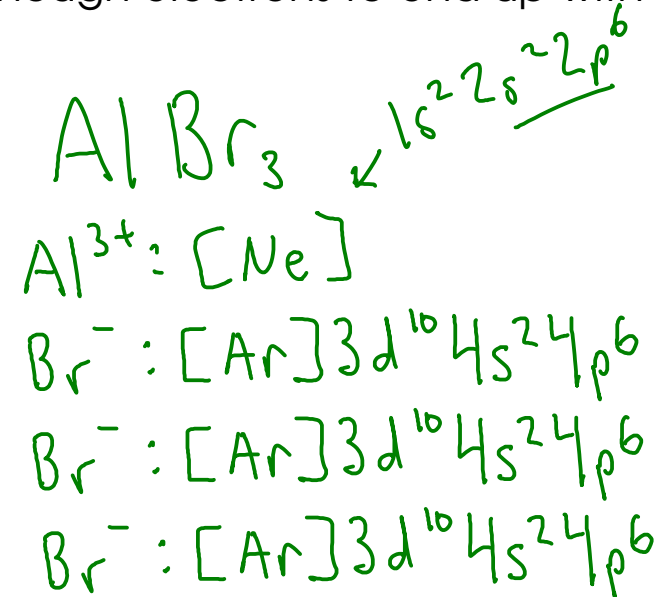
IONIC COMPOUNDS

- When atoms react to form IONS, they GAIN or LOSE enough electrons to end up with full "s" and "p" subshells.

example:



Aluminum loses its outer three electrons, and each bromine gains one!



↑ To save space, these electron configurations have been written with the "noble gas core" shortcut. Bromine's electron configuration is exactly like argon's - with the addition of some 3d, 4s, and 4p electrons!

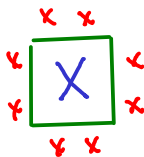
... but using electron configurations to describe how aluminum bromide forms is a bit cumbersome! Can we simplify the picture a bit?

LEWIS NOTATION / ELECTRON-DOT NOTATION

- Lewis notation represents each VALENCE electron with a DOT drawn around the atomic symbol. Since the valence shell of an atom contains only "s" and "p" electrons, the maximum number of dots drawn will be EIGHT.

- To use electron-dot notation, put a dot for each valence electron around the atomic symbol. Put one dot on each "side" of the symbol (4 sides), then pair the dots for atoms that have more than four valence electrons.

examples:



Which "side" you draw the dots on isn't important, as long as you have the right number of electrons and the right number of "pairs"



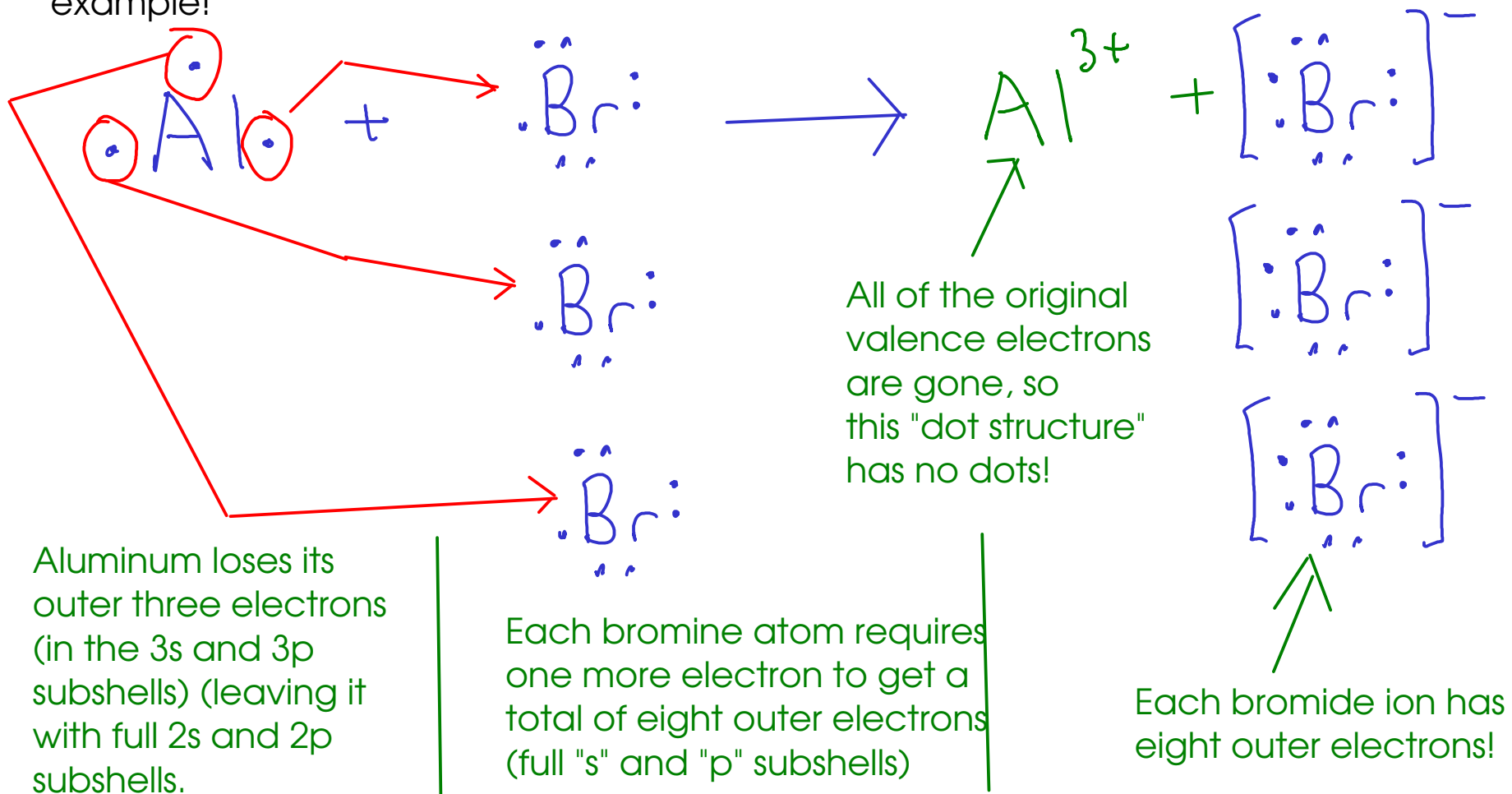
To draw a dot structure for an atom, you need to know HOW MANY valence electrons it has! You can determine this simply from the periodic table, WITHOUT writing the whole electron configuration!

The number of valence electrons equals the group number in the A/B group numbering system

| | | | | | | | | | | | | | | | | | | | |
|---|----|----|-----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--|----|
| 1 | H | | | | | | | | | | | | | | | | | | He |
| 2 | Li | Be | | | | | | | | | | B | C | N | O | F | | | Ne |
| 3 | Na | Mg | | | | | | | | | | Al | Si | P | S | Cl | | | Ar |
| 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 | Ra | Ac* | Rf | Db | Sg | Bh | Hs | Mt | | | | | | | | | | |

1 valence electron (Group IA)
 2 valence electrons (Group IIA)
 3 valence electrons (Group IIIA)
 4 valence electrons (Group IVA)
 5 valence electrons (Group VA)
 6 valence electrons (Group VIA)
 7 valence electrons (Group VIIA)
 8 valence electrons (except helium!) (Group VIIIA)

... but how do we use this to describe a reaction that produces ions? Let's look at our previous example!



... this is a bit easier to follow than looking at all those letters and numbers in the electron configurations for these elements!

This is an OXIDATION-REDUCTION (electron transfer) reaction. Dot notation makes the transfer of electrons very obvious.