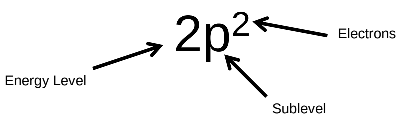
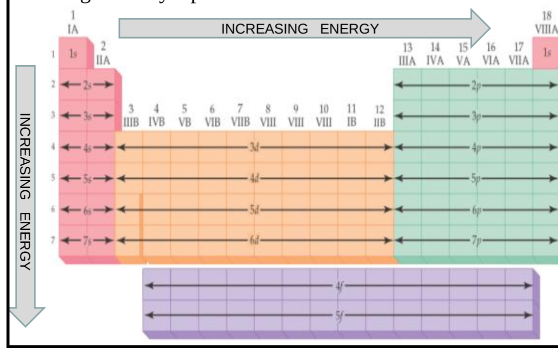
Electron Configurations

- The ***electron configuration*** of an atom is a shorthand method of writing the location of electrons by sublevel.
- The sublevel is written followed by a superscript with the number of electrons in the sublevel.
  – If the 2*p* sublevel contains 2 electrons, it is written $2p^2$



Sublevels and Energy Levels

- We can use the periodic table to predict which sublevel is being filled by a particular element.



Electrons and Sublevels

- The sublevels can only hold a maximum amount of electrons (relates to the number of elements the sublevel region is across in periodic table)

Sublevel	Number of Orbitals	Max Number of Electrons
s	1	2
p	3	6
d	5	10
f	7	14

Writing Electron Configurations

- First, arrange the energy sublevels according to increasing energy:

  S: 1*s* 2*s* 2*p* 3*s* 3*p* …

- Fill each sublevel with electrons, the only sublevel that may not be full is the last one:

  S: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

- The sum of the exponents should equal the atomic number of Sulfur (16)

Noble Gas Electron Configurations

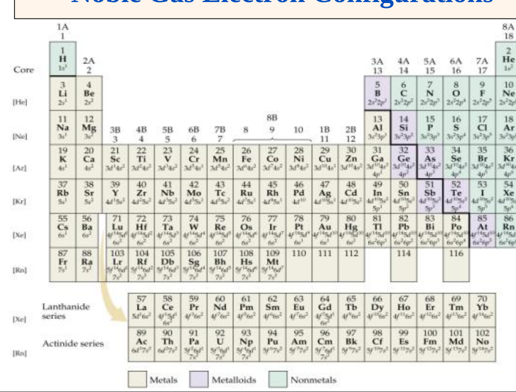
- Recall, the electron configuration for Na is:

  Na: $1s^2\ 2s^2\ 2p^6\ 3s^1$

- We can abbreviate the electron configuration by indicating the innermost electrons with the symbol of the preceding noble gas.
- The preceding noble gas with an atomic number less than sodium is neon, Ne. We rewrite the electron configuration:

  Na: [Ne] $3s^1$

Noble Gas Electron Configurations



Practicing electron configurations

- Na
- S
- He
- Ca

Valence Electrons

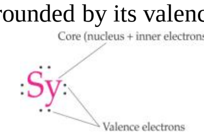
- When an atom undergoes a chemical reaction, only the outermost electrons are involved.
- These electrons are of the highest energy and are furthest away from the nucleus. These are the ***valence electrons***.
- The valence electrons are the *s* and *p* electrons beyond the noble gas core.

Predicting Valence Electrons

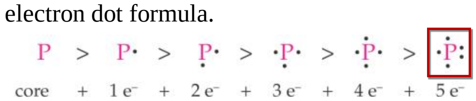
- The Roman numeral in the American convention indicates the number of valence electrons.
  - Group IA elements have 1 valence electron
  - Group VA elements have 5 valence electrons
- When using the IUPAC designations for group numbers, the last digit indicates the number of valence electrons.
  - Group 14 elements have 4 valence electrons
  - Group 2 elements have 2 valence electrons

Electron Dot Formulas

- An electron dot formula of an elements shows the symbol of the element surrounded by its valence electrons.
- We use one dot for each valence electron.



- Consider phosphorous, P, which has 5 valence electrons. Here is the method for writing the electron dot formula.



Practice Electron dot structures

- Li
- B
- O

Ionic Charge

- Recall, that atoms *lose or gain electrons* to form ions.
- The charge of an ion is related to the number of valence electrons on the atom.
- Group IA/1 metals lose their one valence electron to form 1+ ions.
  - $Na \rightarrow Na^{+} + e^{-}$
- Metals lose their valence electrons to form ions.

Predicting Ionic Charge

- Group IA/1 metals form 1+ ions, group IIA/2 metals form 2+ ions, group IIIA/13 metals form 3+ ions, and group IVA/14 metals from 4+ ions.
- By losing their valence electrons, they achieve a noble gas configuration.
- Similarly, nonmetals can gain electrons to achieve a noble gas configuration.
- Group VA/15 elements form -3 ions, group VIA/16 elements form -2 ions, and group VIIA/17 elements form -1 ions.

Ion Electron Configurations

- When we write the electron configuration of a positive ion, we remove one electron for each positive charge:

$$Na \rightarrow Na^{+}$$
$$1s^2\ 2s^2\ 2p^6\ 3s^1 \rightarrow 1s^2\ 2s^2\ 2p^6$$

- When we write the electron configuration of a negative ion, we add one electron for each negative charge:

$$O \rightarrow O^{2-}$$
$$1s^2\ 2s^2\ 2p^4 \rightarrow 1s^2\ 2s^2\ 2p^6$$

Practicing ionic electron configurations

- Na^{+1}
- Cl^{-1}
- P^{-3}