Ch. 3 NOTES ~ INTRODUCTION TO THE PERIODIC TABLE

NOTE: Vocabulary terms are in **<u>boldface and underlined</u>**. Supporting details are in *italics.*

3.1 Notes

I. Periodic Table Development

A. Johann Dobereiner, German chemist (1780-1849) and his triads
1) In 1817, he formed *triads (groups of threes) of similar elements* such as Ca, Sr, Ba
2) the middle element of the triad was an average of the other two atomic masses

B. John Newlands, English chemist (1837-1898) and the Law of Octaves
1) In 1863, he arranged elements according to increasing atomic masses
2) *Law of Octaves—properties of elements seemed to change every eighth element* (noble gases were not known yet)

C. Dmitri *Mendeleev—the father of the modern periodic table* (1834-1907)
1) *similar properties of elements were grouped in columns*
2) *he predicted properties of "missing" elements*
3) he arranged the elements by increasing atomic masses, not atomic numbers

D. Henry Moseley, British chemist (1887-1915)
1) In 1913, he found atomic numbers ("nuclear charges") of the elements by measuring the wavelength of x-rays given off by specific metals
2) he *ordered the elements by increasing atomic numbers*
3) he was killed in World War I, which was a great loss to science

II. The Modern Periodic Table

A. **<u>Periodic Law</u>**— *there is a periodic (repeating) pattern in chemical and physical properties of the elements when they are arranged by increasing atomic numbers*
This is **<u>Periodicity</u>**.

B. elements are arranged by increasing atomic numbers

C. *atomic masses are in amu (atomic mass units)*

D. electron "shell" capacities:

Shell #	**maximum number of electrons**
n = 1	**2**
n = 2	**8**
n = 3	**18**
n = 4	**32**
n = 5	**32**
n = 6	**18**
n = 7	**8**

E. element arrangements

<u>GROUP NUMBER</u>		**<u>SPECIAL NAME</u>**	**<u>CHARGE OF IONS</u>**
Group IA	**(1)**	**<u>alkali metals</u>**	**1+**
Group IIA	**(2)**	**<u>alkaline earth metals</u>**	**2+**
Group IIIA	**(13)**	**-----**	**some 3+**
Group IVA	**(14)**	**-----**	**varies**; metals 2+, 4+
Group VA	**(15)**	**-----**	**3-**
Group VIA	**(16)**	**<u>chalcogens</u>**	**2-**
Group VIIA	**(17)**	**<u>halogens</u>**	**1-**
Group VIIIA/0	**(18)**	**<u>Noble Gases</u> (inert)**	**0 (none)**
Group III B-XII B (3-12)		**<u>Transition Metals</u>**	**varies**
Inner Transition Metals; Lanthanide and Actinide Series; Rare Earth Metals			**varies**

1) **<u>representative elements</u>**: A groups (IA – VIIIA), or Groups 1, 2, 13, 14, 15, 16, 17, 18
2) *transition elements*: B groups (IIIB-XIIB), or Groups 3-12
3) **<u>groups</u>** = *vertical* columns
4) **<u>periods</u>** = *horizontal* lines

3.2 Notes

GROUP NUMBER	# VALENCE ELECTRONS	# ELECTRON DOTS	STATUS
Group IA	**1**	**1**	**(has 1 out of 8, missing 7 to be full)**
Group IIA	**2**	**2**	**(has 2 out of 8, missing 6 to be full)**
Group IIIA	**3**	**3**	**(has 3 out of 8, missing 5 to be full)**
Group IVA	**4**	**4**	**(has 4 out of 8, exactly half-full)**
Group VA	**5**	**5**	**(has 5 out of 8, needs 3 more to be full)**
Group VIA	**6**	**6**	**(has 6 out of 8, needs 2 more to be full)**
Group VIIA	**7**	**7**	**(has 7 out of 8, needs 1 more to be full)**
Group VIIIA	**8**	**8**	**(has 8 out of 8, completely full)**

III. Periodic Trends in Atomic Structure

A. Atomic structure of elements within a period: *as you move from left to right, the number of valence e- increases*

B. Atomic Structure of elements within a group: *valence number = group number*

1) Electron dot structures (**<u>Lewis dot diagrams</u>**)—diagrams of valence electrons as *dots around the symbol of the element*
    a) *only the valence electrons* are shown
    b) used to see the numbers of shared and unshared electron pairs around an atom
    c) number of unpaired electrons can show how many bonds can form
    d) procedure (NOTE: this is a different system from the book)
        a) write the symbol of the element
        b) imagine four rectangles framing the symbol
        c) place dots around the symbol according to the number of valence electrons

There are a few different methods of placing the dots, but we will use this way…

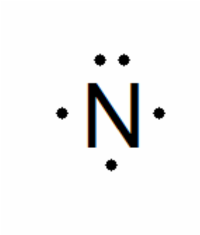
"right, left, up, down, top all the way around."

	3 5	
2	**SYMBOL**	**1**
6		**8**
	4 7	

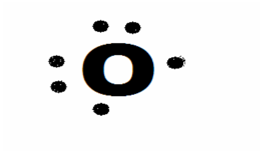
e) exception to the procedure is helium **He:**

B. review of examples

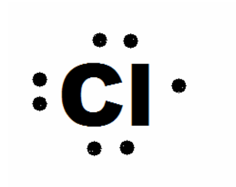
Group IA Group IIA Group IIIA Group IVA



Group VA



Group VIA



Group VIIA

Group VIIIA

IV. Physical States and Classes of the Elements

A. physical states of the elements

1) *most elements are solids* at room temperature
2) *bromine (Br) and mercury (Hg) are liquids at room temperature*
3) *gases at room temp.: H_2, N_2, O_2, F_2, Cl_2, He, Ne, Ar, Kr, Xe, Rn*

B. occurrence

1) most elements are naturally occurring
2) synthetic: Tc #43, Pm #61, all elements #93 and higher

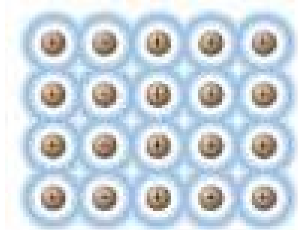
C. classification

1) **<u>metals</u>**—*ductile, malleable, shiny, lustrous, conductors*
2) **<u>nonmetals</u>**—*brittle solids, nonconductors*
   - *C,H,N,O,P,S,* **-** *important nonmetallic elements for living organisms*
3) **<u>metalloids</u>**—*semimetals or semiconductors; on the periodic table "staircase"*
   - B, Si, Ge, As, Sb, Te, Po, and At are the 8 metalloids

V. Semiconductors and Their Uses

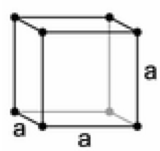
A. electrons and electricity: metallic bonds

1) **<u>metallic bonds</u>**—*sharing of delocalized electrons between metal cations (positive ions, allowing current to flow*
   b) **<u>delocalized electrons</u>** = *shared electrons* not in one place; mobile
   c) delocalized electrons are free to move throughout the piece of metal
   d) *conductivity*—electron flow

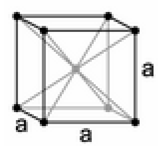


delocalized (shared) electrons

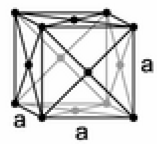
2) examples of crystal patterns in metals
   a) BCC: Li, Na, K, Rb, Cs, Ba, Ra, V, Cr, Mn, Fe, Nb, Mo, Ta, W, Pd, Pt, Eu
   b) FCC: Ca, Sr, Ni, Cu, Al, Au, Ag, Ge, Pb, Rn, Ir, Ce, Ac, Th, Yb
   c) HCP: Be, Mg, Sc, Ti, Y, Zr, Zn, Lu, Hf, Co, Tc, Ru, Re, Os, Cd, Tl, La, Pr, Nd, Gd, Tb, Dy, Er, Tm, Am, Cm



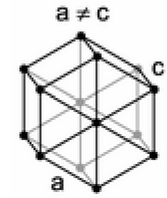
simple cubic



body-centered cubic (BCC)

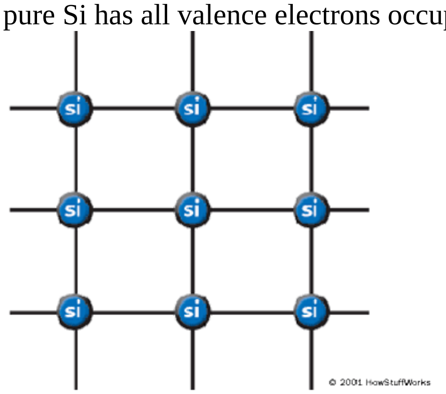


face-centered cubic (FCC)



hexagonal close-packed (HCP)

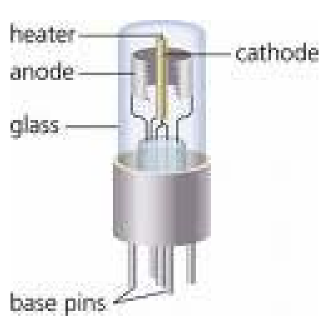
B. semiconductors
1) pure silicon (Si) allows very little electricity to flow through it (*insulator*)
2) pure Si has all valence electrons occupied in bonds – no delocalized e-



silicon crystal lattice from www.howstuffworks.com

2) **<u>doping</u>**—*adding small amounts of impurities ("dopants") into Si crystals to make Si into a semiconductor*
   a) *N-type*
      - *P (phosphorus) or As (arsenic) are used as dopants*
      - P and As have five valence electrons, so the fifth unpaired ones can move around as delocalized e-
      - named N for "negative"
   b) *P-type*
      - boron (B) or gallium (Ga) are used as dopants
      - B and Ga have three valence electrons, forming "holes" in the lattice
      - "holes" can conduct a current
      - named P for "positive"

C. *diodes—semiconductor devices allowing one-way electrical current flow*



DIODE from www.yourdictionary.com