Dynamic Earth – Test One

Minerals

- Eight most abundant elements in the Earth's Crust:

	Most common Ionic Form	Most Common Coordination Numbers	Relative Ionic Size
Oxygen (O)	O^{-2}	- - -	1.40
Silicon (Si)	Si^{+4}	Si (4)	0.26
Aluminum (Al)	Al^{+3}	Al (4, or 6)	0.39
Iron (Fe)	Fe^{+2}	Fe (6)	0.63
Calcium (Ca)	Ca^{+2}	Ca (8)	1.00
Sodium (Na)	Na^{+1}	Na (8)	0.99
Potassium (K)	K^{+1}	K (8, 12)	1.37
Magnesium (Mg)	Mg^{+2}	- - -	0.72

- Pneumonic
  - On
  - Sunday
  - Assholes
  - In
  - Church
  - Sing
  - Pagan
  - Music
- The **coordination number** of a cation is the number of anions that are its closest neighbors, i.e. how many anions are surrounding the cation
  - Cation: Positive charge
  - Anion: Negative charge
- Oxygen and Silicon are most abundant on earth's crust. Their bond is the strongest in minerals
- Silicon Tetrahedron is the basic building block common to various groups or classes of silicate minerals
- Distinction between crystalline and non-crystalline solids
  - Crystalline – term refers to the ordered, symmetrical, arrangement of the atoms that make up the structure
    - Minerals are naturally occurring solid chemical compounds with crystalline structure
    - Exhibits cleavage

- Non-Crystalline – (Ex. Glass) Soften as the temperature increases and have no sharply defined melting point

- The Most common silicate minerals: Structure and Composition
  - Olivine - $(Mg, Fe)_2SiO_4$; Independent Tetrahedral
  - Pyroxenes – $(Mg, Fe)_2Si_2O_6$; Single Chain
    - Amphiboles – $(W,X, Al)_{7-8}(Z_4O_{11})_2(OH)_2$; double chains
      - W represents the large cations Ca, Na and K (That can substitute for one another)
      - X Represents the smaller Mg and Fe
      - Z Represents the cations in the tetrahedral sites, Si and Al
  - Biotite mica – $K(MgFe)_3(AlSi_3O_{10})(OH)_2$; Sheet silicates
  - Muscovite mica – $KAl_2(AlSi_3O_{10})(OH)_2$; Sheet Silicates
  - Plagioclase feldspar – $NaAlSi_3O_8$ --- $CaAl_2Si_2O_8$ (solid solution series) ; framework silicates
  - Alkali Feldspars – $KalSi_3O_8$ –$CaAl_2Si_2O_8$ (solid solution series); Framework silicates
  - Quartz – SiO_2 ; Framework Silicates
- Summary
  - Olivine - common independent tetrahedral silicates
  - Plagioclase - common framework silicates
  - Amphibole - common double chain silicates
  - Pyroxene - common single chain silicates
  - Biotite - common sheet silicate
  - Muscovite mica – sheet silicate
  - Alkali feldspar - common framework silicates
  - Quartz - common framework silicate
- Pairs of elements that commonly substitute for one another in Silicates:
  - Si and Al
  - Mg and Fe (and also Al)
  - Na and K
  - Na and Ca
    - Factors that control substitution:
      - The size of the ions and the size of the crystallographic sites into which they substitute
      - The charges on the ions that are substitution for one another – if charges are the same, then the crystal structure can remain electrically neutral; if charges not the same then other substitutions must take place to maintain charge balance
      - Temperature and pressure at which the substitution takes place. Greater amount of substitution takes place at higher temperatures. Pressure can change the size of

both the site and the ion resulting in different substitutions

- Relationship of Cleavage to Structure in Silicates:
  - Cleavage is the breaking along a planar surface of a silicate, and it forms along the planes of ionic bonds

- Definitions:
  - Mafic: silicate minerals, magmas and rocks which are relatively high in the heavier elements, and rich in magnesium and iron
  - Felsic: silicate minerals, magmas and rocks which have a lower percentage of the heavier elements and are correspondingly enriched in the lighter elements, such as silicon and oxygen, aluminum and potassium
- While silicate minerals constitute most of the outer part of the solid Earth, many other minerals are both geologically and economically important.
  - Native elements
    - Gold
    - Silver
    - Copper;
  - Oxides
    - Magnetite
    - Bauxite
    - Rutile
  - Sulfides
    - Pyrite
    - Galena
  - Sulfates
    - Gypsum
  - Carbonates
    - Calcite
    - Malachite

Earth's Heat

- How is heat transferred (Radiation, conduction, convection)
  - Radiation: heat moves as electromagnetic radiation, such as heat transferred from the Sun to the Earth
  - Conduction: enhanced vibrational motion of atoms in materials is induced in neighboring atoms and this motion diffuses through the material. (Like the wave at a game)
    - Thermal conduction is very slow.
  - Convection: Heat is carried by matter, which is flowing. Warmer and less dense matter rises, while cooler and more dense matter sinks
  - Silicates are great thermal insulators, not conductors.