I. Nature of Earth's surface
   A. Lithosphere broken into plates that move over weak asthenosphere
      1. movement due to convection of heat from inner Earth to surface
      2. plates composed of crust and some mantle
      3. most plates have continental and oceanic crust on them
      4. interaction of edges where relative movement is apparent
         a. divergent
            1) pressure release allows underlying asthenosphere to melt and fill in
            2) creates basaltic rock
         b. convergent
            1) oceanic crust can be forced down into mantle--subducted
            2) plates carrying continental crust too buoyant to subduct
         c. lateral ('transform') boundaries where plates slide past one another
   B. Features of ocean basins
      1. much is expansive flat areas—abyssal plains
      2. deep ocean trenches where sea floor is bent by subduction
         a. narrow zones bordered by young mountain ranges
         b. subduction creates uplift of these by generation of magma
      3. oceanic ridge system formed at divergent boundaries
         a. broad, gentle uplift may or may not be in center of basin
         b. interconnected to form largest volume of mountain range on Earth—70,000 km long
   C. Features of continents
      1. shoreline a coincidence of volume of ocean basin and amount of liquid water
         a. actual boundary between oceanic basin and continents due to type of crust upon lithosphere plate
         b. sea water laps up onto continental surfaces in zones of various widths
         c. 40% of Earth's surface is continental, although about ¼ of this is covered with sea water at present
      2. Mountain belts rise high above average elevation of continents
         a. Two major zones
            1) Circum-Pacific belt
            2) Alpine-Himalayan chain
         b. Both result of lithospheric plate convergence
      3. continental shield composed of remnants of ancient mountain belts
         a. folded crystalline rock
         b. stable, not near lithosphere plate boundaries
      4. stable platform
         a. has thin veneer of sedimentary rock deposited on them
         b. may be only fundamental difference to shield

II. Earth is a system, with the spheres continually interacting
    A. Parts are linked, and action in one changes another
    B. Cycles repeat motion over short or enormous lengths of time
    C. Energy for system
        1. External—provided by Sun
        2. Internal—original heat of gravitational contraction, and by radioactive decay

III. Matter is composed of atoms—smallest particle that retains properties
    A. Atoms—
        1. composed of ‘subatomic particles— three fundamental ones
            a. protons
                1) have mass ~ 1 atomic mass unit
                2) have positive electrical charge
            b. neutrons
                1) have mass ~ 1 atomic mass unit
                2) have no electrical charge
            c. electrons
                1) have mass of ~1/2000 atomic mass unit
                2) have negative electrical charge
        2. structure of atom
            a. nucleus contains protons and neutrons—subequal numbers
                1) number of protons determines the element
                2) number of neutrons may be different in different atoms of the same element—leading to different ‘isotopes
                    a) most isotopes are stable
                    b) unstable isotopes are ‘radioactive’, and disintegrate over time
                        i. in a certain length of time, one half of the atoms of an unstable isotope will decay into another substance
                        ii. this length of time is the ‘half-life; of the isotope
                            a. half-life is constant for an isotope
                            b. can be used to determine age of material, by measuring how much of the ‘daughter’ and ‘parent’
            b. electrons surrounding in cloud
                1) occur on average in more likely positions
                2) called ‘shells’, which have energy levels
                3) outermost shell are ‘valence electrons,
                    a) responsible for reactions with other atoms
                    b) full shells are not reactive
                        i. first shell can contain 2 electrons
                        ii. successive outer shells can contain 8 electrons
            c. atom is electrically neutral when it has the same number of electrons and protons

IV. Periodic table of elements
  A. Each atom is represented by a letter symbol—
    1. one or two letters
      a. capitalize the first letter,
      b. do NOT capitalize a second letter if present
    2. letters often initials in a foreign or even obsolete language, for the element or a major substance that contains the element
  B. Arranged in rows, or 'periods' according to atomic number, increasing mass in each succeeding row
  C. Columns are called 'groups'
    1. determined by number of valence electrons
      a. same number of valence electrons results in similar properties
      b. full shells of electrons are not reactive with other elements
      c. most atoms lose, gain or share electrons with other atoms in order to attain a 'full-shell' electron configuration
        1) elements gaining or losing electrons become 'ions'
          a) gaining electrons results in negative charge—'anion'
          b) losing electrons results in positive charge—'cation'
    2. groups—the columns
      a. far right—Noble Gases have full electron shells
      b. next to far right—Halogens: missing one electron of a full shell
      c. far left—Alkali Metals: single electron in outer shell
      d. next to far left—Alkaline Earth Metals: two electrons in outer shell
  D. Minerals are composed of bonded elements
    1. naturally occurring inorganic solid with atoms in orderly internal arrangement (crystalline structure) and a definite chemical composition (that can vary within limits)
    2. most minerals in Earth's crust are silicates—
      a. compounds containing oxygen and silicon
      b. building block is the 'silica tetrahedron'—one oxygen, four silicon
  E. Elemental structure can be shown with diagrams of electron shells
    1. 'Bohr diagrams' named after Niels Bohr, who presented the hypothesis of electrons filling shells
    2. Show element with its symbol, and arcs indicating the electron shells
      a. First shell filled with two electrons—e^{2-}
      b. Successive shells filled with eight electrons
      c. Number of arcs corresponds to the row number of element in the periodic table

F. Electron dot-diagrams are useful for predicting bonding of elements—dots surrounding the element represent its valence electrons
   1. Show how elements bond by filling or emptying dot shell
   2. become ions with dots, charges and electrons
      a. $Ca \rightarrow Ca^{2+} + 2e^-$
      b. $Br + e^- \rightarrow Br^-$
      c. Show ionic bonding reactions by transfer of electrons only
   3. Covalent bonds share electrons
      a. Show unfilled shells on left
      b. Show sharing of electrons on right
      c. $Cl+Cl \rightarrow Cl_2$
      d. Electrons shared equally by same type of atom—nonpolar
      e. Different types of atoms, resulting in a molecule that has 'polarity', or is 'polar' (like a magnet has poles)

V. Molecules
A. Electron dot-diagrams are useful for predicting bonding of elements—
   1. Show how elements bond by filling or emptying dot shell
   2. become ions with dots, charges and electrons
      a. $Ca \rightarrow Ca^{2+} + 2e^-$
      b. $Br + e^- \rightarrow Br^-$
      c. Show ionic bonding reactions by transfer of electrons only
B. Naming Compounds
   1. Cations take on their element name, plus 'ion'
   2. Anions names derive from their element name
      a. change ending to 'ide'
      b. plus 'ion'
   3. put two names together, cation first, anion after
C. formulas of ionic compounds
   1. find charges of ions from location in periodic table
   2. combine so charges cancel to zero—electrically neutral compound
   3. book states to crossover the charge amounts into subscripts—works