Chemistry in Our World
Final Exam Topics

A handout was given out during the first week of class containing information on the scientific method and mathematical conversions between different units.

Scientific Method: We described this as a 4-step procedure (Question, hypothesis, experiment, observation), allowing the hypothesis to be turned into a theory and finally a law.

Matter: Mixtures (homogeneous or heterogeneous) and pure substances interconverted by a physical process. For compound and elements, a chemical reaction is required.

Conversions: *See handout given in lecture.* 'Given quantity' x $\frac{New\,units}{Old\,units}$

Atomic Theory: Mendeleev created first periodic table based on chemical properties and mass. Later, protons, neutrons, and electrons discovered that make up atoms. Molecular weights = sum of weights of individual atoms.

Balancing Equations: Number of atoms of each element in reactant must equal number in product. Balance equations by changing coefficients (not formulas).

Formulas and Structures: Classify compounds based on types (metal(s) and/or nonmetal(s)) of elements present.

Covalent Compounds: In covalent compounds, each atom has an 'ideal' number of bonds based on column of periodic table (C=4, N=3, S=2, F=1, H=1). Be able to convert Lewis and stick structures. If molecules contain 1 or more polar bonds, then molecules may be classified as polar. Sugar used as a representative example of a polar, water soluble molecule.

Ionic Compounds: Charges determined from position on periodic table. Salts contain cations (positively-charged ions) and anions (negative), with a total charge of zero. For transition metals, can only determine charge in compounds where charge of 'other' piece known. Salt (NaCl) discussed as a representative example.

Thermodynamics & Energy: ΔH = enthalpy (heat) of reaction. Negative values means heat given off by reaction. Breaking bonds always absorbs heat, while forming bonds always releases heat. Fuels react with oxygen to produce carbon dioxide (CO_2) and water (possibly other compounds depending on fuel). Fossil fuels include crude oil used to make gasoline (Middle East), coal (U.S. #1), and natural gas. $\approx \frac{1}{2}$ of U.S. electricity from burning coal.

Global Warming: Greenhouse gases trap heat, increasing earth's temperature which is essential for life. CO_2 is a greenhouse gas (produced by burning most fuels) whose concentration is increasing. Some are concerned this increase could lead to excess warming of our planet. Difficulties with measuring earth's temperature discussed.

Alternate Energy Sources: Renewable fuels will produce CO_2 when they burn (like fossil fuels), but take CO_2 out of the atmosphere when they are grown, so net change in CO_2 should be minimal. Still not practical. Potential sources include wind, solar energy, ethanol, hydrogen, and biomass produced from algae or various crops (corn, switchgrass, vegetable oils, ...).

Batteries and Fuel Cells: Batteries use redox reactions, in which one atom/compound is reduced (at cathode: charge becomes more negative, H gained and/or O lost) and another is oxidized (at anode: becomes more positive, O gained and/or H lost). Fuel cells being developed to use fuels (H_2, methanol, ...) instead of metals. Don't need to be 'recharged', but do require constant supply of fuel. Should be more efficient.

Ozone Layer: Ozone produced and destroyed in upper atmosphere (described by Chapman cycle), which protects us from high energy ultraviolet light. CFC (chlorofluorocarbons, with a 'unique' naming system) believed to destroy ozone layer, particularly near South Pole. Mechanism for this process discussed. Montreal Protocol approved to address this.

Acids and Bases: Vitamin C used to introduce acids. Acids taste sour, increase the amount of H^+ ions in solution, and lower pH. Acid rain produced by burning high-sulfur coal (SO_x) and combustion engines (NO_x). Regulations in U.S. have significantly reduced acid rain.

Foods and Metabolism

Carbohydrates: Sugars. Contain large # of OH groups. Starches and Glycogen. Polar.

Lipids: Fats, such as fatty acids, triglycerides, phospholipids, and cholesterol. Saturated vs. unsaturated (contain C=C). *cis* natural, *trans* causes health problems. Omega-3 and omega-6 are essential. Non-polar.

Amino Acids & Proteins: 20 amino acids, ≈9 essential.

Metabolism: Sugars (4 Cal/g, ≈1 day) and fats (9 Cal/g, ≈2-3 months) major fuel sources. Effects of starvation and diabetes discussed.

Diets: Government recommends a high-carb diet. Low carb (high-fat) diets appear to be better at lowering blood triglycerides.

Chocolate: Processing of chocolate from fruit to finished product discussed. Uniform fat content, and tempering required due to different crystalline forms. Major health benefit probably increase in antioxidants. Dark chocolate contains more 'chocolate liquor' and is higher in fat than sweet or milk chocolate.