Dougherty Valley HS Chemistry
Some Review Topics from Honors Chemistry

S-3

This list is a general guideline to help you study. It is NOT a definitive list. There are potentially things on here that will not show up on the tests, and there are potentially things not on this list that will show up on the tests. Material that appeared anywhere during the Honors Chem course all have the potential to appear on the test. Pay attention to anything that indicates it was not taught during your school year, you will need to self-study those topics as part of your summer assignment. Remember everything is on the Honors tab of the class website! www.mychemistryclass.net

\+ denotes calculations

Chemistry Basics and Atomic Structure

- Chemistry Math
  - Know the equation for Density
  - Know how to solve for each variable in the Density equation
  - Know the common metric prefixes (KHDBdcm)
    + Be able to perform metric conversions using either "King Henry" or Dimensional Analysis
    + Know how to perform "single" and "double" unit dimensional analysis problems
  - Know how to count the number of significant figures in a given number
    + Know how to carry sig figs through a calculation to report the final answer with the correct number of sig figs

- Properties of Matter
  - Be able to tell the difference between a physical property and a chemical property
  - Be able to tell the difference between a physical change and a chemical change
  - Know examples for each type of property
  - Know examples for each type of change
  - Know each type of classification of matter (Pure Substance, Element, Compound, Mixture, Homogeneous, Heterogeneous)

- Atomic Structure
  - Know each type of subatomic particle (Proton, Neutron, Electron)
  - Know the difference between their charges, location, etc… for each type of subatomic particle
  - Be able to describe and explain the experiment that lead to the discovery of the electron
  - Be able to describe and explain the experiment that lead to the discovery of the nucleus
  - Know the different models of "atom" and be able to sketch or identify a simple version of each
    - Democritus
    - J. Dalton (billiard ball)
    - J.J. Thompson (plumb pudding)
    - N. Bohr (planetary model)
    - E. Rutherford (atomic nucleus)
    - J. Dalton
    - Quantum Model

- Atomic #'s
  - Know the difference between Atomic #, Atomic Mass, Mass Number, Isotope
    + Know how these terms relate to each other so you can calculate things such as the number of protons, neutrons, electrons, and mass of a given atom

+ Know how to calculate the average atomic mass when given the relative abundances of various isotopes

+ Know how to calculate the % relative abundance of two different isotopes when given the avg mass (only doing two isotopes)

Nuclear Chemistry

- Basics
  - Be able to describe the difference between Chemical Reactions and Nuclear Reactions
  - Be able to describe and identify nuclear fission, nuclear fusion, neutron bombardment
  - Be able to describe the different types of radioactive decay – charges, masses, symbols, penetration power, what stops them, what charge are they attracted to, where/how they originate (alpha, beta, gamma, positron) (α, β, γ)
  - Know some pros and cons about nuclear chemistry (medicine, power plants)

- Equations
  - Identify types of equations or particles when shown an equation
    - Alpha, beta, gamma, positron, fission, fusion, neutron bombardment
  + Be able to write nuclear equations involving α, β^+, β^-, γ, neutrons and protons
    - Find the missing part when given most of an equation
    - Write the equation when given it in words
  - Be able to write and graph a decay series

- Half-Life
  - Definition
  - Find the half-life when given a chart or a graph
  + Equations
    - Know the equation for half-life: $A_E = A_S \times 0.5^n$
    - Know how to calculate the number of half-lives: $n = \frac{t}{h}$
    - Know how to solve for A_E and A_S
    - Know how to calculate the % still radioactive: $\%_{still\ radioactive} = 0.5^n$
    - Know how to calculate the % decayed: $\%_{decayed} = 100\% - \%_{still\ radioactive}$
    - Know how to calculate the amount decayed into stable: $A_{decayed} = A_S - A_E$
    - Know how to use logarithms to solve for t or h (isolate the one you are looking for): $\log\left(\frac{A_E}{A_S}\right) = \frac{t}{h} \times \log(0.5)$

Electrons

- Orbitals
  - Know the definition of an orbital
  - Know how many shapes/types of orbitals there are
  - Know how many of each shape/type of orbital there are in a "set"
  - Know how many electrons can fit inside an individual orbital

- Orbital Diagrams
  - Know the rules for filling an Orbital Diagram and be able to apply them to filling out an orbital diagram
    - Hund's Rule
    - Pauli Exclusion Principle
    - Aufbau Principle

- Electron configuration
  - Be able to write the electron configuration for:
    - An atom using an orbital diagram
    - An atom using only the periodic table
    - An ion
    - Noble gas configuration

- Absorption and Emission
  - Know how absorption and emission work and be able to sketch a picture of each
  - Describe how Absorption and Emission Spectra can be used to identify elements present in a sample or in a star

Periodic Table

- Know the names of groups on the periodic table
  - Alkali metals, alkaline earth metals, transition metals, semi-metals(metalloids), other non-metals, halogens, noble gases, rare earth metals

- Know how to use the periodic table to find the number of valence electrons for s and p block

- Know how to use the periodic table to find the charge each element likes to make

- Define the following trends
  - Atomic radius
  - Electronegativity
  - Ionization energy
  - Electron affinity
  - Ionic radius
  - Reactivity

- Describe how the trends above change as you go up/down left/right on the periodic table

- Explain WHY the trends above change as you go up/down left/right on the periodic table
  - Make sure you are including terms such as greater effective nuclear charge, shielding, energy levels, etc – BUT make sure you are also explaining what those mean in terms of distance from nucleus and the attraction strength between nucleus and valence electrons
    - Make sure you are thinking about the difference between an ok answer, a better answer, and the BEST answer!

- Be able to rank elements from small to big, or big to small for the trends listed above.
  - Do not worry about exceptions for simple ranking

Bonding

- Types of bonds and properties of each type
  - Ionic transfers electrons, covalent shares, metallic delocalized free flowing sea of e^-
  - Draw and explain the "sea of electrons" model regarding metallic bonding.
  - Explain why these delocalized electrons allow for conductivity
  - Describe the difference between properties of ionic, covalent, metallic compounds
  - Identify ionic and covalent compounds based on what class of elements they are made of? Metal-metal, metal-nonmetal, nonmetal-nonmetal
  + Be able to tell if particular bonds between elements are ionic or covalent using electroneg. differences (numbers will be provided)

- Naming and Writing Formulas
  - Ionic – must be neutral, crossing over
  - Covalent – prefixes

- Lewis Structures
  - Know the octet rule. Be able to explain some of the exceptions to the rule. Which elements have an exception to the octet rule? Understand that anything can break the rule if it has to.
  - Draw Lewis Structures of single bonds, double bonds, triple bonds, ions
  - Draw Lewis Structures of "weird" molecules that break the "rules"

- VSEPR
  - Identify molecular geometry (memorized from chart)
  - Identify bond angles (memorized from chart)
  - Identify electron geometry and hybridization when provided with a VSPER chart

- Polarity
  - Identify if a bond or molecule is polar or nonpolar
  - What does it mean to be a polar bond?
  - Draw the polarity of a molecule using arrows or partial positive/negative symbols

Reactions

- Signs of a reaction

- Basic vocabulary
  - Reactant
  - Product
  - Word equations
  - Skeleton equations
  - Conservation of mass

- Balancing equations

- Identify the types of chemical reactions
  - Synthesis
  - Combustions
  - Decomposition
  - Single Replacement
  - Double Replacement

- Predict products
  - Use the identified type of reaction to follow the pattern and predict the products
    - DON'T STEAL SUBSCRIPTS!!!!
      - Make valid neutral formulas by crossing over FROM SCRATCH
      - Careful about diatomics!
      - Balance when done to fix any conservation of mass issues
  - Single replacement → use activity series to see if it actually happens
    - Do not need to memorize the activity series, just use it if given. If not given then you assume the reaction happens.
  - Double replacement → use solubility rules to determine phases
    - Do not need to memorize the solubility rules, just use if given.
    - Soluble = Aqueous → breaks apart into ions
    - Insoluble = Solid (a precipitate) → doesn't break apart into ions
    - Gases and liquid do not break apart into ions

- Net ionic equations
  - Be able to use solubility rules to break apart aqueous into ions
  - Identify and remove spectator ions
  - Be able to "put it all together"
    - Names of reactants → formulas → identify type of reaction → predict the products → balance → identify phases using solubility chart → write complete ionic equation showing the aqueous compounds broken apart → identify spectator ions → write net ionic equation with spectator ions gone

Stoichiometry

+ Calculate Molar mass

+ Molar Conversions
  - Grams A, moles A, molecules A
  - Extra conversions such as adding in a metric conversion, or a density, etc.

- Identify mole ratios

+ Stoichiometry problems when converting from molecule A to molecule B
  - All combos of mole highway pathways
  - Extra conversions such as adding in a metric conversion, or a density, etc.
  - Be able to show work using <u>dimensional analysis set up with all units shown!</u>
    - Getting the right numerical answer is not enough – we are assessing a skill!

+ Real life stoichiometry problems
  - Identify actual <u>question</u> is, your stoich is the justification to your answer to the real life Q.

+ Yields
  - Theoretical yield versus Actual yield
  - Percent Yield

Advanced Chemical Ratios

+ Limiting Reagent Stoichiometry
  - Be able to identify the limiting reagent and excess reagent in a problem
    - Must be able to justify your answer with actual work
  - Once you have identified the limiting reagent be able to perform various stoich problems using the limiting reagent amount as your starting value
  - Be able to determine how much of your excess reagent is left over after the reaction

+ Percent Composition

+ Empirical Formulas
  - Percent to mass, mass to mole, divide by small, multiply by whole!

+ Determining Molecular Formulas
  - Use empirical formula and molecular weight to find the multiplier for your coefficients

+ Combustion Analysis w/ things such as C, H, O, N
  - Just empirical formula calculations where your numbers are from lab data and you have to work to find which numbers to use!
  - Remember to find the mass of the obvious elements first, then subtract from total mass to find grams of the one you can't find easily (usually Oxygen).
  - Remember to be careful to use single atom masses and numbers, not diatomics!
  - Careful with elements found in separate experiments (usually Nitrogen)!

Gas Laws

- Conceptual items
  - Properties of Gases
  - KMT theory assumptions
  - Why we use kelvins
  - Pressure units and STP values
  - Kinetic Energy and Temperature relationship
  - How mass affects the speed of gases
  - Ideal versus Real Gases
  - Diffusion and Effusion

+ Basic Gas Law Equations
  - Know equations and be able to do calculations with them
    - Boyle's
    - Charles'
    - Gay-Lussac's
    - Avogadro's
    - Combined
  - Which equations are direct or indirect relationships
  - Identify graphs of each gas law equation

+ Ideal Gas Law Equation
  - Ideal Gas Constant
  - Calculating the molar mass by rearranging the Ideal Gas Law
  - Calculating density by rearranging the Ideal Gas Law

+ Dalton's Law of Partial Pressures
  - Regular Partial Pressure Problems
  - Problems using more than one equation
    - Using Boyle's Law calculations to find the Pressure values needed to do a Partial Pressure calculation
  - Collecting gas over water
    - Dry vs Wet Gas concept
    - Don't forget to subtract out the wet gas!

+ Gas Stoichiometry
  - Remember this is JUST stoichiometry! Sometimes you just need an equation instead of a conversion factor! Use your "Mole Highway" just like always!
  - Sometimes you can use Molar Volume as a shortcut if you are at STP

Thermochemistry

- Conceptual information
  - Definitions from chapter
  - Types of heat transfer
  - 1st Law of Thermodynamics
  - Endo vs. Exothermic including reaction diagrams
  - Meaning of all variables in the equations used this chapter

+ $Q=mC\Delta T$

+ Calorimetry
  - Q = -Q

+ Q=mL calculations
  - Understand *why* phase changes need a new equation
  - Remember L can be positive or negative

+ Heating/Cooling Curve calculations
  - Sketching a graph with start/end points can be very helpful!

~~+ *Mixed Phase Calorimetry*~~
  - ~~*Sketching a graph and labeling everything is very helpful!*~~
  - ~~*Can either do Q = -Q, or you can use the Q + Q = 0 trick to help eliminate double negatives if it helps your algebra (or sanity – ha!)*~~

~~- *Phase Diagrams*~~
  - ~~*Phase change lines*~~
  - ~~*Triple point*~~
  - ~~*Critical point*~~
  - ~~*Supercritical fluid*~~
  - ~~*Identifying information when given things like a specific temperature and/or pressure*~~

+ Molar Heat Calculations
  - Either converting moles to grams before doing a thermo calculation, or using C or L values that are in mol instead of grams

+ Heat of Reaction Calculations
  - Back to dimensional analysis again!
  - Sometimes you don't know what the heat of reaction is for a given equation. BUT if you know how much energy it takes to FORM each of the chemicals in the reaction, then you can figure out what the heat of reaction is for the equation you are interested in!
    - $\Delta H°rxn = \Delta H°formation\ Products - \Delta H°formation\ Reactants$
    - Don't forget you want to take into account the number of moles of each product and reactant in the balanced equation!

+ Bond Energy
  - It ALWAYS takes energy to break a bond. = endothermic = $-\Delta H$
  - It ALWAYS releases energy to make a bond = exothermic = $+\Delta H$
  - Use a chart of bond energies to calculate the heat of reaction.
    - (Bonds Broken, + values) + (Bonds Formed, - values)
    - Remember – you can draw lewis structures to help you determine which bonds are broken/formed

+ Hess's Law
  - Calculate the energy of a reaction by adding together the energy of individual steps with known energy values
  - If reversing a reaction, reverse the algebraic sign on the ΔH for that step
  - If multiplying the coefficients in a reaction, multiply the ΔH by the same value

Solutions

+ Definitions
  - Homogeneous solution
  - Solute versus Solvent
  - Solubility
  - Saturated vs. Unsaturated vs. Supersaturated
  - Colloids
  - Dissolving vs. Dissociating
  - Electrolytes vs. Non-electrolytes

+ Solubility
  - How does solubility change based on their phase?
  - Using solubility curves
    - Identify based on the curve if it is saturated, unsaturated or super saturated

- "Like Dissolves Like"
  - Identify what an appropriate solvent/solute combo would be based on polar/non-polar

+ Various ways of calculating the [ ] of solutions
  - Mass Percent/Percent composition
  - Parts per million
  - Grams per liter
  - Mole fraction
  - Molarity
  - Making Dilutions

Kinetics

- What is a rate?

- Positive versus negative rates

- Rate affecting factors
  - Temperature
  - Concentration
  - Surface Area
  - Catalysts

- Collision Theory
  - What is it?
  - How do the rate affecting factors relate to it?

- Activation Energy
  - What is the energy used for?
  - How is it affected by catalysts

- Reaction Mechanism
  - Difference between it and the overall reaction
  - Rate determining step – also known as Slow step
    - Significance of it?

- Using a graph of appearance/disappearance
  - Identifying which line(s) reactant(s)
  - Identifying which line(s) products(s)

+ Average Rate and Rate Expressions
  - Calculating average rate over a period of time when given data
  - Positive for products
  - Negative for reactants
  - Writing rate expressions
    - Taking into account the stoichiometry
    - Solving for average rate of one chemical when given data on another by using rate expressions

+ Instantaneous Rates
  - Calculate based on drawing a tangent line

+ Rate Laws
  - Write rate laws based on a single step reaction
    - Coefficients are exponents
  - Use data charts to find orders for rate law when it isn't a single step
    - Look for trials to keep all but one substance constant and see how the change to concentration changes the rate and determine order from that
  - Find the overall order of a reaction
  - Use data and rate law to find the rate constant
  - Understand what rate constant is, what changes it, etc.

Equilibrium

- What is equilibrium?
  - When rate forward equals rate backwards
  - Rates are the same, not concentrations!
  - Dynamic microscopically, static macroscopically

- Factors that affect equilibrium
  - Concentration
  - Heat
  - Pressure (if gases)
  - Solids, liquids do not affect equilibrium

- Le Chatelier's Principle
  - What is it?
  - Predict shifts due to a stressor
  - Predict increase, decrease, no change, slight increase or slight decrease after the shift

+ Writing Equilibrium Expressions
  - Remember solids and liquids are not included!
  - Equilibrium Constant
    - What is it
    - Factors that affect it
    - How to calculate it

+ K versus Q
  - Which direction will the rxn shift to reach equilibrium

+ Kc, Kp, Ksp
  - What are the differences?

+ ICE Tables to find equilibrium concentrations
  - Without 5% rule
    - Solve for x with algebra, potentially quadratic formula
  - With 5% rule
    - Only if K <1, and K 1000x smaller than initial concentrations better guideline
    - Must always show that 5% rule was a valid assumption when finished!

Acid Base

- Properties of Acids and Bases

- Types of Acids/Bases
  - Arrhenius
    - Acids make H+ ions in water, Bases make OH- ions in water
  - Bronsted-Lowry
    - Acids donates protons, Bases accept protons
  - Lewis
    - Acids accept electron pairs, Bases donate electron pairs

- Conjugate Acids/Bases

- pH scale

- pH calculations
  - pH = -log [H+]
  - pOH = -log [OH-]
  - $[H+] = 10^{pH}$
  - $[OH-] = 10^{pOH}$
  - pH + pOH = 14
  - $[H+][OH-] = 1 \times 10^{-14}$

- Naming Acids and Bases

- Strong versus Weak

- Self-Ionization of Water

- Kw calculations

- pH calculations for weak acids/bases with ICE Tables

- Neutralization reactions

- Hydrolysis reactions

- Salts
  - Identifying if a salt is acidic/basic/neutral
  - Calculating the pH of a salt solution

- Titration
  - Vocabulary
  - Set up and procedure

- Titration calculations
  - Concentrations
  - Molar masses
  - Moles or Grams