Test Information - AP Chemistry Test In

Materials

Textbook and ISBN number: Chemistry Matter and Change (2005 Copyright) by Glenco Science, ISBN: 0-07-866418-7

Note: Wayzata Public Schools and its employees are not responsible to provide students a textbook during the test in/out process.

- **Units/Chapters of emphasis:** 1-19

Test Format

Multiple Choice Portion: 65 questions worth 65 points - 90 minutes

Lab Portion: Two parts - 90 minutes
Multiple Choice: 11 points
Lab: 19 points

Course Learning Targets/Objectives

Outline

Unit 1 - Ch. 1-3	Matter, Measurement/data analysis
Unit 2 - Ch. 11-12	Moles & Stoichiometry
Unit 3 - Ch. 4-7	Atomic structure & Nuclear Chemistry & Periodic Table & The elements
Unit 4 - Ch. 8-10	Chemical reactions; ionic and molecular bonding
Unit 5 - Ch. 13-14	Gases and States of Matter
Unit 6 - Ch. 16	Energy and Chemical Change
Unit 7 - Ch. 15,17,18	Solution Chemistry; Reaction rates (collision theory) & Equilibrium
Unit 8 - Ch. 19	Acids and Bases

Problem Set 1
Ch. 2 – Measurement/Uncertainties/Intro to Significant Figures

1) Students will be able to read any instrument (ruler, balance, graduated cylinder, thermometer etc.) to the correct decimal place and with the proper uncertainty.
   a. Students will know all measurement have <u>one</u> guessed digit.
   b. Students will know that the uncertainty of a measurement is typically ½ the increment.
2) Students will know that when adding numbers with uncertainties the uncertainties add together and are then rounded to one non-zero digit. The number must that round to the same place as the non-zero digit in the uncertainty.
3) Students will be able to explain the role of significant figures in measurements. i.e. Significant figures include all certain digits plus one doubtful digit.

Problem Set 2
Ch. 2 – Significant Figures

1) Students will be able to count the number of significant figures in a number.
2) Students will be able to do addition/subtraction and round to the appropriate number of significant figures.

3) Students will be able to do multiplication/division and round to the appropriate number of significant figures.
4) Students will be able to recognize that a count is exact (has infiinite significant figures) and conversions within a system are exact (100 cm = 1m; 12 inches = 1 ft etc.)

Problem Set 3

Ch. 2 – Scientific Notation/Dimensional Analysis/ Metric System

1) Students will be able to identify the SI units for time (s), length (m), mass (kg), and temp (K). Student will also be able to recognize units for volume (cm^3 or mL or L), for density (g/mL or g/cm^3 or g/L etc.).
2) Students will know that 1 mL = 1 cm^3.
3) Students will be able to explain the difference between the terms heavy and dense.
4) Students will be able to convert between normal and scientific notation.
5) Students will be able to do addition/subtraction/multiplication/division with numbers in scientific notation without using a calculator.
6) Students will be able to use dimensional analysis to solve problems. (IMPORTANT!)

Problem Set 4

Ch. 1 –Observation/Interpretation

1) Students will be able to identify quantitative observations as those with a number or those that make a comparison to a known value.
2) Students will be able to make observation and identify them as qualitative/quantitative.
3) Students will be able to identify statements as observations or interpretations.
4) Students will be able to explain the difference between mass and weight.
5) Students will be able to explain why mass is loss after burning a match in terms of the gases (CO_2 and H_2O) that are lost.

Ch. 1 – Scientific Method/Safety

1) Students will be able to explain the steps of the scientific method including the following terms: hypothesis, theory, law, model, observation, experiment, control, dependent/independent variable.
2) Students will be able to identify safety rules important in lab.
3) Students will be able to describe the formation of ozone in words/a chemical equation/pictures.
4) Students will be able to describe the depletion of ozone in words including the role of CFCs in its depletion.

Essential Questions ch. 4-7:

- How have experiments led to the nuclear model of the atom?
- How can an atom be described by atomic number and mass number?
- How is the stability of a nucleus determined?
- How can an element's electronic configuration be used to predict properties of the element?
- The student will explain why elements in a group have similar properties.
- The student will relate the group and period trends seen in the periodic table to the electron configuration of atoms.
- The student will classify elements based on their electron configurations.
- The student will relate electron configurations to the properties of the elements.
- The student will identify the sources and uses of selected elements.

- How does electronic structure of an atom dictate its chemical and physical properties?

Problem Set 4.1

Essential Questions:

- How have experiments led to the nuclear model of the atom?
- How can an atom be described by atomic number and mass number?

Specific Objectives:

- What's the difference between a theory and a law?
- Who was important in the development of our current model of the atom and how has our model evolved over time? i.e. What observations did scientists make and what conclusions did they draw from those observations? (specifically Dalton, Thomson, Milikan, Rutherford)
- Be able to describe how the following people contributed: Democritus, Aristotle, Proust, Lavosier, Chadwick
- Be able to describe our current model of the atom including locations of and details about protons, electrons, and neutrons.
- Be able to write nuclear symbols representing any isotope of a particular element.
- Be able to describe the differentiate between the terms: atom, ion, isotope.

Problem Set 4.2

Essential Questions:

- How can an unstable nucleus decay?

Specific Objectives:

- Be able to write equations representing alpha, beta, and gamma decay.

Problem Set 5.1

Essential Questions:

- How does electronic structure of an atom dictate its chemical and physical properties? (i.e. given the electron configuration of an element you should be able to predict chemical and physical properties or vice versa.)

Specific Objectives:

- Understand the Heisenberg Uncertainty Principle.
- Be able to distinguish between ground, excited, and ionized states. Understand how absorption and emission are related to transitions between these states.
- Be able to write the electron configuration or the orbital notation for any element. (Short or long-hand)
- Understand the rules and principle that govern electron configuration – Aufbau Principle, Pauli Exclusion Principle, Hund's Rule. (Understand what an orbital is, how many electrons it can hold, how electrons fill into orbitals and in what order).

Problem Set 6.1

Essential Questions:

- How does electronic structure of an atom dictate its chemical and physical properties? (i.e. given the electron configuration of an element you should be able to predict chemical and physical properties or vice versa.)

Problem Set 6.2

Essential Questions:

- How does electronic structure of an atom dictate its chemical and physical properties? (i.e. given the electron configuration of an element you should be able to predict chemical and physical properties or vice versa.)

Specific Objectives:

- Be able to explain Zeff and its trends across rows and columns. Be able to use Zeff to predict trends in atomic radius, ionization energy, electron affinity, and electronegativity.
- Be able to explain shielding and its trends across rows and columns. Be able to use Zeff to predict trends in atomic radius, ionization energy, electron affinity, and electronegativity.
- Be able to explain ionization energy. Be able to explain trends across rows and down columns for ionization energy (what happens to its magnitude and why). Be able to predict, given a series of ionization energies (IE1, IE2, IE3 etc) to what group an element belongs.
- Be able to explain how atomic radius is measured. Be able to explain trends across rows and down columns for atomic radius (what happens to an atoms size and why).
- Be able to explain electron affinity. Be able to explain trends across rows and down columns for electron affinity (what happens to its magnitude and why).
- Be able to electronegativity. Be able to explain trends across rows and down columns for electronegativity (what happens to its magnitude and why).
- Be able to explain ionic radii and its trends across rows and columns. Be able to compare the size of a cation to its neutral atom. Be able to compare an anions size to its neutral atom. Be able to compare the radii of a series of isoelectric ions.

Ch. 8-10 Objectives

Problem Set 8.1 – Ionic Compounds

1) Students will be able to predict charges for ions given their place on the periodic table.
2) Students will be able to predict the formula for an ionic compound given the elements/ions that comprise it.
3) Students will be able to write the Lewis dot structure for an ionic compound.
4) Students will be able to predict what elements will react to form ionic compounds.
5) Students will be able to name ionic compounds.
6) Students will be able to predict properties of ionic compounds and be able to explain how they relate to their intermolecular forces.

Problem Set 9.1 – Metals, Alloys (ch. 8) and Molecular Compounds

~~1) Students will be able to predict properties of metals and explain how a metal's structure and bonding lead to these properties.~~
~~2) Students will be able to explain what an alloy is and be able to differentiate between a substitutional and an interstitial alloy..~~
3) Students will be able to predict the formula for a molecular compound given the elements that comprise it.
4) Students will be able to predict what elements will react to form covalent compounds.
5) Students will be able to name molecular compounds.
6) Students will be able to predict properties of molecular compounds and be able to explain how they relate to their intermolecular forces.
7) Students will be able to differentiate between ionic and covalent bonding in terms of electron distribution, structure, and properties. (Students will be able to explain why ionic

bonding or covalent bonding would take place based on the electronegativity of the elements involved).

Problem Set 10.1 –Reaction Types (Dissolving, single-replacement, and double-replacement reactions)

1) Students will be able to balance a chemical equation by changing the coefficients or reactants/products.
2) Students will know which elements exist as diatomic molecules in nature.
3) Students will be able to predict whether or not a single-replacement reaction will occur using the activity series and will be able to write a balanced equation, including writing proper subnotations (s, l, g, aq).
4) Students will be able to write a balanced equation for a double replacement reaction, including writing proper subnotations (s, l, g, aq).
5) Student will be able to use the solubility rules to predict the solubility of compounds and whether or not a precipitate is formed in a double replacement reaction.

Problem Set 10.3 –Reaction Types (Add total and net ionic equations for single and double replacement reactions)

1) Students will continue with all the objectives from problem sets 10.1.
2) Students will be able to write a balanced total and net ionic equations for single and double replacement reactions, including writing proper subnotations (s, l, g, aq).
3) Students will recognize that aqueous ionic compounds and strong acids are written as ions in total ionic equations.
4) Students will recognize that spectator ions are omitted in net ionic equations.
5) Students will recognize that solid ionic compounds are not written as ions, molecular compounds remain as molecules, and elements are not charged.

Problem Set 10.3 – Balancing and Reaction Types (Synthesis, decomposition, combustion)

1) Students will continue with all the objectives of problem set 10.1 and 10.2.
3) Students will be able to write a balanced equation for the synthesis of a compound from its elements, including writing proper subnotations (s, l, g, aq).
4) Students will be able to write a balanced equation for the decomposition of a compound into its elements, including writing proper subnotations (s, l, g, aq).
2) Students will be able to write a balanced equation for the complete combustion of a compound, including writing proper subnotations (s, l, g, aq).

Ch. 11-12 Essential Questions:

- How can the concept of a mole be explained?
- How can you convert between various units that express the amount of a substance?
- How can you determine a molecular formula from experimental data?
- How can you use mole ratios to determine amounts of reactants needed or products formed?

Ch. 11-12 Objectives

Problem Set 11.1

1) Students will understand that a mole is the SI unit for amount of substance, and will be able to explain how it is based on the number of particles in 12 grams of carbon-12.

2) Students will be able to calculate the molar mass of any element or compound.
3) Student will know that one mole of particles is equivalent to 6.02×10^{23} particles.
4) Students will know that one mole of any gas occupies 22.4 L at STP (standard temperature - 0°C, and pressure – 1 atm).
5) Students will be able to convert between various amounts of substances (mass, volume, # particles, and moles). i.e. Students will be able to calculate "mole wheel" problems.

Problem Set 11.2

1) Students will be able to determine the empirical formula of a compound if given % composition, mass composition, or mole composition of a compound.
2) Stdents will be able to determine the molecular formula for a compound if given the empirical formula and the molar mass.
3) Students will be able to use a balanced equation to relate moles of reactants and products. i.e. Students will be able to convert between moles of reactants and products in a chemical reaction.

Problem Set 12.1 and PS 12.2

1) Students will be able to complete "3-step mole method" problems.
   a. mass of reactant/product → mass of a different reactant/product
      # particles of a different reactant/product
      volume of a different reactant/product (if a gas)
   b. # particles of reactant/product → mass of a different reactant/product
      # particles of a different reactant/product
      volume of a different reactant/product (if a gas)
   c. volume of gaseous reactant/product → mass of a different reactant/product
      # particles of a different reactant/product
      volume of a different gaseous reactant/product
2) Students will be able to determine the formula for a hydrate if given the mass of a compound before and after it has been heated to dryness.

Expt. S-3 "Silver Tree Lab"

1) Students will be able to balance a chemical equation by using experimental data.
2) Students will understand that several small rinses better than one large rinse.
3) Students will understand the following terminology: Filtering, Filtrate, Test tube, beaker, graduated cylinder (use smallest one that can still contain all liquid needed).

Problem Set 12.3

1) Students will be able to calculate the limiting reactant in a chemical reaction when given amounts of reactants as well as determine the amount of product.
2) Students will be able to calculate the % yield and % error of product formed if given the actual yield. (Note: In order to do so, they will be expected to calculate the theoretical yield as done in problem sets 12.1 and 12.2.)

Ch. 13-14 Essential Questions

- How can you use kinetic molecular theory to distinguish between the properties of solids, liquids and gases?
- How can you use kinetic molecular theory to explain gas laws?
- How can you calculate pressure, volume, moles or temperature of a gas sample?

- How can you use pressure, volume, moles or temperature to determine the density or molar mass of a gas?
- How can you use mole ratios to determine amounts of gaseous reactants needed or gaseous products formed?
- How can you calculate the partial pressure of a gas in a mixture?

Chapter 13-14 Objectives

Problem Set 1

1) Students will be able to describe gases in terms of rapidly moving molecules.
2) Students will be able to explain why gases have the physical properties they do in terms of intermolecular forces and the kinetic molecular theory.
3) Students will be able to explain the five assumptions of the kinetic molecular theory.
4) Students will be able to describe the difference between inter- and intra-molecular forces.
5) Students will be able to describe how differences in intermolecular forces lead to different properties of solids, liquids, gases.
6) Students will be able to describe the difference between potential and kinetic energy changes.
7) Students will be able to describe the changes that take place in a phase change and whether these changes absorb or release energy and whether these changes are kinetic or potential energy changes.
8) Students will be able to describe why/when a substance will boil and what factors affect the temperature at which it boils (i.e. strength of intermolecular forces and value of air pressure).

Expt. #3- Warming/cooling behavior

1) Students will be able to describe the difference between inter- and intra-molecular forces.
2) Students will be able to describe the difference between potential and kinetic energy changes.
3) Students will be able to describe the changes that take place in a melting and freezing and whether these changes absorb or release energy and whether these changes are kinetic or potential energy changes.
4) Students will be able to describe how the shape of a warming/cooling curve would be affected by various factors (e.g. amount of substance, strength of intermolecular forces).

Boyle's Law Lab (Expt. #4)

1) Students will be able to explain qualitatively and quantitatively how the pressure and volume are related one another.
2) Students will be able to compare/contract the shapes of the following graphs – Pressure due to books vs. volume of gas sample; pressure due to books vs. the reciprocal of volume; total pressure vs. the reciprocal of volume.
3) Students will be able to use a graph of total pressure vs. the reciprocal of volume to determine the value of air pressure (in books).

Problem Set 2

1) Students will be able to read barometers and open/closed-end manometers.
2) Students will recognize various pressure units (mmHg, atm, torr, Pa, kPa, psi(lb/in^2) and be able to convert between them. (Students must know 1 atm = 760.0 mmHg but will be given other equivalents when needed.)

3) Students will understand what is meant by an absolute scale.
4) Students will be able to explain the significance of absolute zero.
5) Students will be able to convert between Celsius and Kelvin temperatures.
6) Students will know Boyle's Law and Charles' Law and be able to apply them to various initial/final gas problems.

Problem Set 3

1) Students will be able to explain qualitatively how the pressure, volume, temperature, and number of moles of a gas affect one another.
2) Students will be able to determine the dependent and independent variable when comparing any two of the following variables - P,V,T,n.
3) Students will understand what is meant by an absolute scale.
4) Students will be able to explain the significance of absolute zero.
5) Students will be able to convert between Celsius and Kelvin temperatures.
6) Students will know Boyle's Law, Charles' Law, Gay-Lussac's Law, and the combined gas law and be able to apply them to various initial/final gas problems.

Problem Set 4

1) Students will be able to calculate volumes of gas samples at STP or room conditions and know what is meant by these conditions.
2) Students will be able to calculate the molar mass or density of a gas at STP or "room" conditions.

Problem Set 5

1) Students will be able to explain why Dalton's Law of Partial Pressures is true in terms of the kinetic molecular theory.
2) Students will be able to calculate the partial pressure of gases in a mixture if given either the mass, number of moles, or % molecular composition of each gas.
3) Students will know that water vapor is also present when any gas is collected by water displacement.
4) Students will be able to calculate the partial pressure of a gas collected by water displacement if given a table with water vapor pressures at various temperatures.

Molar Volume of H_2 Lab (Expt. #10)

1) Students will be able to determine the partial pressure of a gas collected over water.
2) Students will be able to use mole ratios to determine the moles of gas produced in a reaction if the moles of limiting reactant are known.
3) Students will be able to calculate the molar volume of a gas collected by water displacement given the mass of reactant, room temperature, room pressure, vapor pressure of water, volume of gas produced.
4) Students will be able to determine how various lab errors would affect their calculated results.
5) Students will be able to calculate % error.

Problem Set 6

1) Students will be able to use the ideal gas law to derive the other gas laws (Boyle's, Charles', Gay-Lussac's, and the combined gas law).
2) Students will be able to use the ideal gas law and known values of P,n,T, V of a gas at STP to calculate the value and units of the ideal gas constant, R.

3) Students will be able to use the ideal gas law to calculate the P,T,n, or V of a gas if given three of the variable.
4) Students will be able to calculate the molar mass or density of a gas at any conditions.
5) Students will be able to use the ideal gas law to complete stoichiometry problems that are not at STP or room conditions.

Ch. 16 Essential Questions

- How can you explain how energy is conserved in a chemical reaction?
- How can you experimental determine the amount of heat involved in a reaction?
- How can you calculate the theoretical heat involved in a reaction using heats of formation?
- How can you explain the spontaneity of a reaction in terms of enthalpy and entropy changes?

Chapter 16 Objectives

Problem Set 16.1

1. Students will be able to explain the law of conservation of energy and how that applies to PE changes in a chemical reaction.
2. Students will be able to explain exo/endothermic reactions in terms of heat gained/lost; PE, surrounding temp changes.
3. Students will be able to do stoichiometry using thermochemical equations.
4. Students will be able to differentiate between various enthalpy changes (heat of fusion, heat of vaporation, heat of combustion, heat of formation, heat of solution, etc.)

Problem Set 16.2

1. Students will be able to explain what is meant by the specific heat of a substance.
- Given the specific heat of various substances they will be able to predict which substance would have the largest temperature change if they all absorb the same amount of heat.
2. Students will be able to convert between joules, calories, kilojoules, and kilocalories.
3. Students will be able to distinguish between the terms energy, heat, and temperature.
4. Students will be able to apply the equation $q = mc\Delta T$ to various problems.

PhET Simulation

1. Students will be able to collect experimental data to calculate the ΔH of a reaction.
2. Students understand the terms specific heat and heat of solution. They will be able to compare/contrast the magnitudes and signs of these values as well as perform calculations involving these values.
3. Students will be able to explain the difference between q and ΔH and predict which is/are affected by changing the amount of reactants.
4. Students will be able to predict how errors made in lab would affect the results for their calculated value of heat of solidification.

Problem Set 16.3

1. Students will be able to apply the equation $q = mc\Delta T$ to various problems.
2. Students will be able to explain the difference between q and ΔH.
3. Students will be able to write thermochemical equations in two formats (heat term in the equation or in the ΔH format).
4. Students will be able to predict how ΔH would be affected if a chemical equation is a) multiplied by some factor, or b) reversed.

5. Students will be able to distinguish between the terms exothermic and endothermic in terms of what is happening to heat and what is happening to the temperature of the surroundings.
6. Students understand the terms molar heat of vaporization, condensation, fusion, and solidification. They will be able to compare/contrast the magnitudes and signs of these values as well as perform calculations involving these values.
7. Students will be able to explain the difference between and kinetic and potential energy change and be able to calculate energy involved in both kinds of changes.

Problem Set 16.4

1. Students will be able to write heats of formation equations for various compounds.
2. Students will be able to predict ΔH for reactions that are similar to a heat of formation equation (either multiplied by some factor, reversed, or both).
3. Students will be able to use Hess's law to calculate the heat of a reaction when given reactions that sum to give an overall reaction.

Problem Set 16.5

1. Students will be able to write heats of formation equations for various compounds.
2. Students will be able to predict ΔH for reactions that are similar to a heat of formation equation (either multiplied by some factor, reversed, or both).
3. Students will be able to use both the summation method as well as Hess's law to calculate the heat of a reaction when given reactions that sum to give an overall reaction.

Ch. 15 Objectives

Problem Set 15.1

1. Students will be able to explain solution terms – solution, solute, solvent, soluble, saturated, super saturated, polar, and nonpolar.
2. Students will be able to explain factors that affect rate of solvation – agitation, temperature, and surface area..
3. Students will be able to explain how a solute could absorb or release heat in the dissolving process.
4. Students will be able to describe factors that affect solubility – nature of solute/solvent, temperature, and pressure.
5. Students will be able to predict of substances are polar/nonpolar based 1) if they are ionic 2) if they have –OH groups 3) if they are hydrocarbons.

Problem Set 15.2

1. Students will be able to explain how to prepare a solution by dissolving a solid.
2. Students will be able to explain how to prepare a solution by diluting a concentrated solution.
3. Students will be able to calculate the molarity of a solution.

Problem Set 15.3

1. Students will be able to calculate 3-step mole method problems involving molarity.
2. Students will be able to write total and net ionic reactions for reactions in solution (review from ch.

Ch. 17-18 Essential Questions:

- How can you describe the properties of a solution?
- In what ways can you change the solubility of a substance or the rate of dissolution?
- How can you express the concentration of a solution?
- How can you prepare a solution from a solid or a more concentrated solution?
- How can you describe the properties of a solution?
- In what ways can you change the solubility of a substance or the rate of dissolution?
- How can you express the concentration of a solution?
- How can you prepare a solution from a solid or a more concentrated solution?

Ch. (16),17,18 Objectives

Problem Set 16.X

1. Students will be able to predict which direction (forward or reverse) is favored by movement toward minimum energy or movement toward maximum randomness.
2. Students will be able to predict the driving force of a reaction (movement toward minimum energy or movement toward maximum randomness) given what is favored (reactants or products) at equilibrium.

Problem Set 17.1

1. Students will be able to explain what is required for a reaction to occur in terms of collision theory.
2. Students will be able to explain factors that affect reaction rate – nature of reactants, temperature, surface area, and presence of a catalyst.
3. Students will be able to explain a potential energy diagram including the terms: activation energy, activated complex, ΔH, endothermic, exothermic, reaction coordinate, and catalyst.
4. Students will be able to draw a potential energy diagram for a reaction given the ΔH and the E_a.

Problem Set 18.1

1. Students will be able to explain what it means to have a system at equilibrium.
2. Students will be able to provide multiple examples of systems at equilibrium.
3. Students will be able to distinguish between steady state and equilibrium systems.
4. Students will be able to write the equilibrium law expression (law of mass action) for any chemical reaction.
5. Students will be able to explain what happens to reaction rates throughout the course of a reaction and how equilibrium is achieved.
6. Students will be able to explain how a system at equilibrium can be recognized.
7. Students will be able to use the value of the equilibrium constant to predict what is favored at equilibrium – reactants or products.
8. Students will be able to calculate the value of the equilibrium constant given the concentrations of all reactants and products at equilibrium.

Problem Set 18.2a

1. Students will be able to apply LeChatelier's Principle to predict shifts in equilibrium as well as how that shift would affect concentrations of reactants and products as well as what affect, if any, it would have on the value of K.
2. Students will be able to apply LeChatelier's Principle to predict what conditions would favor the product of a specific substance in a reaction.
3. Students will be able to write the equilibrium constant expression and use equilibrium concentration of reactants and products to calculate its value.

4. Students will be able to use ICE charts to calculate equilibrium concentrations of substance and the value of K.

Experiment #21 & LeChatelier's Principle Demo

1. Students will be able to apply LeChatelier's Principle to predict shifts in equilibrium as well as how that shift would affect concentrations of reactants and products as well as what affect, if any, it would have on the value of K.

Problem Set 18.3

1. Students will be able to write the equilibrium constant expression and use equilibrium concentration of reactants and products to calculate its value.
2. Students will be able to use ICE charts to calculate equilibrium concentrations of substance and the value of K.
3. Students will be able to calculate the solubility product, Ksp, of an ionic compound given either the solubility of the compound or the concentration of its ions in a saturated solution.
4. Students will be able to calculate the solubility of an ionic compound given either the solubility product, Ksp, of the compound or the concentration of its ions in a saturated solution.
5. Students will be able to calculate the concentrations of ions in a saturated solution given either the solubility of the compound or the solubility product, Ksp
6. Students will be able to rank compounds' solubilities given their Ksp values.

Ch. 19 Objectives

Conductivity Demo and Problem Set 19.1

1. Students will be able to write an equation for the self-ionization of water and explain why H+ and OH- ions must always be present.
2. Students will be able to write the equilibrium expression of water
3. Students will be able to differentiate between strong, weak, and non-electrolytes and provide examples of each.
4. Students will be able to explain the difference between dissociation and ionization. They should also be able to provide chemical equations that describe each process.
5. Students will be able to list all six strong acid names and their formulas.
6. Students will be able to explain the use of double and single arrows in the ionization of acids.
6. Students will be able to explain the relative conductivity of a solution based on the strength of the electrolyte and the concentration of the solution.
7. Students will be able to explain how a solution's ability to conduct is based on concentration of ions and be able to use the terms concentrated/dilute, strong/weak/non-electrolyte, and saturated/unsaturated in their explanation.

Problem Set 19.2 AND Titration Lab

1. Students will be able to write molecular, total, and net ionic equations for neutralization reactions (using either strong acids (ionize) or weak acids (write as molecules) reacting with strong bases.
2. Students will be able to explain why equal moles of H+ and OH- create a neutral solution.
3. Students will be able to calculate the moles of a given acid needed to completely neutralize the moles of a given base and vice versa.
4. Students will be able to calculate the molarity of a given acid solution if a specific volume was used to completely neutralize a specific amount (either moles or volume and molarity)

of a known base solution. OR Students will be able to calculate the molarity of a given base solution if a specific volume was used to completely neutralize a specific amount (either moles or volume and molarity) of a known acid solution.

5. Students will be able to determine the molar mass of a monoprotic acid if given the volume and molarity of based needed to completely neutralize it.
6. Students will be able to analyze errors made in lab to predict how the errors would affect their lab results for either the concentration of their base, the molar mass of their acid, and other similar analyses.

Problem Set 19.3

1. Students will be able to adeptly convert between the [H+], [OH-], pH, and pOH of any strong acid or strong base solution.
2. Students will be able to explain why a weak acid's pH cannot be directly calculated from the concentration of acid dissolved.
3. Students will understand the logarithmic nature of pH and how it relates to the acidity or alkalinity of a solution.

Problem Set 19.4

1. Students will be able to describe properties of acids and bases – including identification of a solution as acidic, basic or neutral based on its pH and identification of a solution as acidic or basic based on the color of either phenolphthalein or litmus.
2. Students will be able to define the definition of an Arrhenius acid and then be able to identify substances as acids or bases if given the formula.
3. Students will be able to explain why a weak acid's pH cannot be directly calculated from the concentration of acid dissolved.
4. Students will be able to name an acid if given its formula OR give an acids formula if given its name (both oxyacids and binary acids).
5. Students will be able to explain the difference between strong and weak acids in terms of ionization, strength of covalent bond to hydrogen, and $[H^+]$ in solution compared to concentration of acid dissolved.
6. Students will be able to identify species that are amphoteric and writing equations supporting their acidic and basic properties.
7. Students will be able identify metal hydroxide solutions, ammonia solutions, and solutions containing the carbonate ion as bases. They will also be able to show equations of these solutions acting as bases.
8. Students will be able to write the ionization of an acid and be able to describe the relative concentrations of species in solution (including the use the single or double arrows).
9. Students will be able to write the stepwise ionization of a polyprotic acid and be able to describe the relative concentrations of species in solution.

Problem Set 19.5

1. Students will be able to explain a Bronsted-Lowry acid and a Bronsted-Lowry base and provide example equations showing species acting as Bronted-Lowry acids and bases.

2. Students will be able to determine the formula of an acid's conjugate base and a base's conjugate acid.

3. Students will be able to describe the relationship between an acid's strength and its ability to ionize and produce H+ ions in solution. Students should be able to connect the concentration of H+ ions in solution with a pH value.

4. Students will be to explain the relationship of an acid's strength to the strength of its conjugate base, as well as the strength of a base to the strength of its conjugate acid.
5. Students will be to predict the relative extent to which a reaction will occur if given a Ka chart (i.e. predict whether reactions or products are favored OR predict which of a series of reactions would favor a particular side the most).

Problem Set 19.6.a

1. Students will be able to explain a Lewis acid and a Lewis base and provide example equations showing species acting as Lewis acids and bases..

Problem Set 19.6 b

1. Students will be able to calculate the [H+], [OH-], pH or pOH of a solution in which various amounts of acid and base have been mixed. (Students may be given amounts of acid/base in grams and volume, molarity and volume, or moles and volume.)