CHEM 12 STUDY NOTES

Unit I-1

Definition of REACTION KINETICS and REACTION RATE
Calculating reaction rate (units used and slope method); calculating rate of products produced based on rate of reactants used
Methods used to measure reaction rates
Relationship between rate and: temperature, concentration, pressure, presence of catalysts/inhibitors, surface area/phase
What "nature of reactants" means
Definition of HOMOGENEOUS REACTION, HETEROGENEOUS REACTION, CATALYST, INHIBITOR
Graphs of product and reactant concentrations vs time
Graphs of rate of using reactants and rate of producing products vs time
Tangent method of calculating reaction rate
Collision theory: effect of concentration, temperature, pressure
KE, PE and bond energy
Exothermic and endothermic reactions

Unit I-2

# of particles vs KE diagrams: how to draw them, what changes them
Effect of temperature changes on slow reactions (rule of thumb)
Definition of ACTIVATED COMPLEX, ACTIVATION ENERGY
Activation energy diagrams, how KE changes as PE changes, why activation energy exists in the first place
Conditions required for successful reaction
Relationship between E_a(f), E_a(r) and ?H
Reaction mechanisms: what are they
finding overall reaction
finding missing step
finding formula of activated complex
Rate determining step: what is it, identifying it, how concentrations are affected by slow and fast steps
PE diagrams of a reaction mechanism
Effect of catalyst on activation energy and number of "humps"
Identifying the catalyst and reaction intermediate in a reaction intermediate

Unit II-1

Definition of CLOSED SYSTEM, MACROSCOPIC, DYNAMIC EQUILIBRIUM
What is equilibrium and what must exist or be true at equilibrium; importance of closed system
What ratios must exist at equilibrium
Entropy, what is it, relative entropy of different phases
Predicting whether a reaction goes 100%, 0% or goes to equilibrium; predicting ?H given relative entropies and words to describe extent of reaction
Le Chatelier's Principle: definition, drawing graphs, identifying changes when given graphs
Conditions needed (temperature, pressure) to get high or low amounts of products

Unit II-2

Definition of EQUILIBRIUM EQUATION, EQUILIBRIUM EXPRESSION, EQUILIBRIUM CONSTANT
What to include and not include in K_{eq}, with examples
Effect on K_{eq} of reversing or doubling equilibrium equation
Tricky stuff: Adding/removing a solid or "only" liquid does not shift an equilibrium
Only temperature affects the value of K_{eq}
Effect of temperature on K_{eq}
Diagram: how to select the method to be used when solving a given type of equilibrium problem
Each type of equilibrium problem and how each step is taken in solving the problem

Unit III-1

Definition of ELECTROLYTE, NON-ELECTROLYTE, MOLECULAR SOLUTION, IONIC SOLUTION
Identifying ionic vs molecular compounds
Dissociation of ionic compounds in water; dissolving of molecular compounds in solution
Conditions of saturation; dissolving vs crystallization reactions
Using the mass of a substance and the volume it is dissolved in to calculate its molar concentration
Converting from g/L to mol/L and vice versa
Experimental determination of solubility by evaporating a saturated solution to dryness
Solubility diagrams: what it means to be below, on and above solubility line; effect of changing temperature; effect of evaporating solvent; lines for exo vs endothermic reactions
Calculating the concentration of dissolved ions when an ionic compound is dissolved
Dilution calculations and ion concentrations in diluted solutions
Predicting whether a compound is soluble vs low solubility (trick: Cu^{2+} vs Cu^{+}; alkali ions always soluble)
Na^{+} and "wanted" negative ion produce a soluble compound; NO_3^- and "wanted" positive ion produce a soluble compound
Writing a double replacement FORMULA equation (ion swap, assigning charges, predicting correct compound formulae, predicting which compound has low solubility)
Breaking the FORMULA equation down into a TOTAL IONIC equation (leave precipitate intact)
Identifying SPECTATOR IONS
Eliminating spectator ions from total ionic equation to make NET IONIC equation
How to set up a reaction table to decide which negative ions must be added to precipitate positive ions one at a time from solution.
How to set up a reaction table to decide which positive ions must be added to precipitate negative ions one at a time from solution.

Unit III-2

Definition of SOLUBILITY PRODUCT EXPRESSION, SOLUBILITY PRODUCT CONSTANT
Writing the solubility product expression; what it means if K_{sp} is large or small
Differentiating between SOLUBILITY and SOLUBILITY PRODUCT
Finding K_{sp}, given the solubility of a compound
Find the concentration of a dissolved compound, given the K_{sp} (trick: ion concentrations may be multiples of the concentration of the compound)
Predicting whether a precipitate will form when 2 solutions are mixed; how to interpret $Q < K_{sp}$, and $Q > K_{sp}$, and $Q = K_{sp}$
Calculating the minimum concentration of an ion required to start the precipitation of another ion from solution
How to perform chloride ion titrations; finding an unknown concentration or an unknown volume; using titration to help find K_{sp}; using titration to find percentage purity
Hardness in water: what causes hardness; temporary vs permanent hardness; eliminating temporary hardness; effect of hardness on soap; washing soda - what it is and how it works
What happens to a solubility equilibrium when the solubility of a salt increases and when the solubility of a salt decreases
Common ion effect; what is it and what effect it has on the solubility equilibrium. Which ions have to be added to cause the common ion effect
Which ions have to be added to increase the solubility of a salt

Unit IV-1

Definition of ACID, BASE and SALT (Arrhenius version)
Know the quick method for balancing an Arrhenius acid-base reaction
Know the descriptive properties of acid and of bases
Know some common properties of acids and bases
Know what the HYDRONIUM ION is and how to write the dissociation of an acid in water in terms of hydronium ions
Definition of ACID and BASE (Brønsted-Lowry); know how to identify a substance as a Brønsted-Lowry acid or base

Definition of MONOPROTIC, DIPROTIC, TRIPROTIC, POLYPROTIC and AMPHIPROTIC; know how to recognize an amphiprotic substance

Know that a Brønsted-Lowry acid-base reaction has an acid and a base on both sides of the equation

Definition of CONJUGATE PAIR, CONJUGATE ACID and CONJUGATE BASE; be able to identify a conjugate pair, the conjugate acid of a base and the conjugate base of an acid

Know that organic acids end in "COOH" and that organic bases end in "NH_2" or "NH"

Know that a Brønsted-Lowry acid-base reaction essentially involves the transfer of a single proton

Definition of STRONG ACID, STRONG BASE, WEAK ACID and WEAK BASE; know that "strong" and "weak" differ in meaning from "reactive", "dilute" and "concentrated"

Know that the amount of ionization of an acid/base can be determined by the conductivity of the solution containing the acid/base

Be able to identify the six strong acids and the two strong bases using the table "Relative Strengths of Acids"; know that H_2SO_4 is only strong for its first dissociation

Know that the conjugate acids of the strong acids are spectator ions (except for HSO_4^-) and the conjugate acids of the strong bases never act as acids

Know that the higher on the left side of the acids table, the stronger the acid; that the lower on the right side of the acids table, the stronger the base; that the stronger an acid the weaker its conjugate base and vice versa

Know that amphiprotic substances may be found on both the acid and base side of the acids table; that when comparing acid strengths look only on the right side of the acids table; that when comparing base strengths look only on the right side of the acids table

Know what the LEVELLING EFFECT is and the effect on the molarity of the hydronium ions in solution

Definition of ACIDIC, BASIC and NEUTRAL solutions

Know how to write the K_W expression for water and know the value of K_W

Know that $[H^+] = [OH^-] = 1.00 \times 10^{-7}$ M in a neutral solution; know that $[H^+]$ and $[OH^-]$ are changed by changing the temperature

Know how to calculate the $[H^+]$, given the $[OH^-]$, and vice versa

Unit IV-2

Definition of ACID IONIZATION, ACID IONIZATION CONSTANT, BASE IONIZATION and BASE IONIZATION CONSTANT; be able to write the K_a expression and K_b expression and understand that the greater the value of K_a (or K_b) the greater the $[H^+]$ (or $[OH^-]$) in solution

Know that $K_a \times K_b = K_w$ for a conjugate acid-base pair; be able to calculate Kb for the conjugate base of an acid having a known value of Ka

Know that the side of a Brønsted-Lowry equilibrium having the weaker acid will be favoured

Alternately, know that $K_{eq} = \frac{K_a(\text{reactant acid})}{K_a(\text{product acid})}$ and that $K_{eq} > 1$ implies products are favoured

Know that the stronger acid and stronger base are on the same side of the equation

Know that all salts are 100% dissociated in water

Definition of pH, pOH and pK_w

Know how to convert from $[H^+]$ to pH and vice versa

Be able to use pH + pOH = pK_w = 14.00 at 25°C to calculate pH given pOH and vice versa

Know that only the digits after the decimal of a pH are significant

Know that the pH and pOH of pure water both decrease (or both increase) when the temperature changes

Know that the lower the pH of a solution, the greater the conductivity

Be able to sketch the pH scale and relate pH to pOH, [H+] and [OH–], understanding that the lower the pH the greater the $[H^+]$

Understand that a solution having pH > 7 is basic and a solution having a pOH > 7 is acidic

Understand that a change in [H+] by one power of 10 changes the pH value by 1
Be able to calculate the pH of a solution made by mixing known volumes of a strong acid and a strong base, each of which has a known concentration.

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Be able to calculate the amount of a strong acid (say) that produces a specified pH in a known volume of a strong base having a known concentration
Know the definition of HYDROLYSIS
Be able to identify spectator ions in a solution
Know the procedure for determining the hydrolysis behaviour of a salt in water
Be able to predict whether an aqueous solution of a salt is**:** neutral, acidic or basic**;** whether a salt containing an amphiprotic ion is acidic or basic in solution**;** whether a salt produces an acidic or basic solution when both the anion and cation undergo hydrolysis**;** how to deal with aqueous metal ions such as $Fe(H_2O)_6^{3?}$
Know how to distinguish a reaction between two ions in solution versus a reaction between an ion and water
Understand that both the strength of an acid and its solubility have an effect on the number of ions produced in solution and the pH of the solution

Unit IV-3

Be able to calculate the pH of a weak acid solution**,** given its K_a and concentration
Be able to calculate the concentration of a weak acid solution**,** given its K_a and pH
Be able to calculate the K_a of a weak acid**,** given its pH and concentration
Be able to make the approximation that the small amount dissociation of weak acid does not affect the concentration of the acid**,** to an approximation of 5% error
Be able to calculate the percentage dissociation of a weak acid
Know when NOT to assume the amount of acid dissociation is negligible
Understand that only the 1st ionization of a polyprotic weak acid affects the pK_a of a solution
Understand that "H_2CO_3" is treated as "$CO_2 + H_2O$" and "H_2SO_3" is treated as "$SO_2 + H_2O$"
Be able to calculate the pH of a weak base solution, given its concentration (and having to calculate K_b by looking up the K_a of the conjugate acid)
Be able to calculate the concentration of a weak base solution**,** given its pH (and having to calculate K_b by looking up the K_a of the conjugate acid)
Be able to calculate the K_b of a weak base**,** given its pH and concentration
Given the concentration and pH of a weak base solution**,** be able to calculate the K_a value of the conjugate acid
Given the concentration and pH of a weak acid solution**,** be able to calculate the K_b value of the conjugate base
Be able to use the pH of a saturated salt solution (and look up the K_a value or work out the K_b value) to calculate the K_{sp} of the salt
Be able to use the K_{sp} of a saturated salt (and look up the K_a value or work out the K_b value) to calculate the pH of the salt solution

Unit IV-4

Definition of TITRATION and EQUIVALENCE POINT (or STOICHIOMETRIC POINT)
Understand that significant digits are always important in titration calculations
Be able to use the known molarity of a base**,** the known volumes of the acid and base used in the titration**,** and the stoichiometric ratio to calculate the unknown molarity of the acid
Be able to use the known molarities of the acid and the base**,** the known volume of the acid used in the titration**,** and the stoichiometric ratio to calculate the unknown volume of the base
Be able to use "millimoles" in a titration calculation
Be able to write a partial neutralization equation for a polyprotic acid
Be able to use the known molarities of the acid and base**,** and the known volumes of the acid and base**,** to calculate the stoichiometric ratio of the reaction and the formula of the salt produced
Be able to use titration data to calculate the percentage purity of an acid or base

Be able to use titration data to calculate the molar mass of an unknown acid or base
Understand how to average titration volumes**,** including when to omit a piece of data
Understand that titrating equal volumes and concentrations of a weak monoprotic acid and a strong monoprotic acid requires the same amounts of base**,** and why this is so
Definition of an INDICATOR

Understand that an indicator is in its conjugate acid form in acidic solutions and in its conjugate base form in basic solutions**;** similarly**,** understand that when [conjugate acid] > [conjugate base] the solution is acidic
Understand that at the END POINT or TRANSITION POINT of an indicator**,** the [conjugate acid] = [conjugate base]
Understand that an indicator changes colour when the $[H^+]$ in a solution equals the K_a value of the indicator and that the pH of a solution equals the pK_a value of the indicator
Understand that an indicator usually changes colour over a range of about 2 pH units
Be able to use the pH at the transition point of an indicator to calculate the K_a value of the indicator
Given the K_a value of an indicator**,** and the colours of the conjugate acid and base**,** be able to predict the colour of the indicator in solutions having different pH values.
Understand how to create a UNIVERSAL INDICATOR
Understand that if an indicator changes colour more than once it has more than one removable proton (is polyprotic)
Be able to predict the colour of a mixture of two or more indicators at different pH values
Be able to determine the pH range of a solution**,** given the colour of the solution with various indicators
Definition of STANDARD SOLUTION and PRIMARY STANDARD
Know the properties of a primary standard
Understand the difference between a standard and a promary standard
Be able to write a procedure for standardizing a solution
Know how to draw the pH versus volume curve for the titration of a strong acid with a strong base
Know how to draw the pH versus volume curve for the addition of a strong base to a weak acid
Know how to draw the pH versus volume curve for the addition of a strong acid to a weak base
Understand that the pH changes extremely rapidly at the stoichiometric point of a strong acid-strong base titration**,** a strong base-weak acid titration and a strong acid-weak base titration
Understand that pH = 7 at the stoichiometric point of a strong acid-strong base titration
Understand that pH > 7 at the stoichiometric point of a weak acid-strong base titration
Understand that pH < 7 at the stoichiometric point of a strong acid-weak base titration
Be able to use the pH at the “half-volume” point to calculate the K_a of a weak acid or the K_b of a weak base
Be able to use the initial pH and the pH at the “half-volume” point to calculate the K_a of the weak acid or K_b of the weak base
Be able to choose a suitable indicator for a strong acid-strong base titration**,** a weak acid-strong base titration and a strong acid-weak base titration
Know that the salt of a STRONG ACID and a STRONG BASE is NEUTRAL**,** that the salt of a weak acid and a STRONG BASE is BASIC**,** and that the salt of a STRONG ACID and a weak base is ACIDIC
Know that the pH at the “half-volume” point does not change when the molarity of the weak acid or base is changed

Unit IV-5

Definition of a BUFFER
Know that a buffer is created when roughly equal concentrations of a weak acid and its conjugate weak base are mixed
Understand that simply having a weak acid in solution does NOT create a buffer, even though small amounts of the conjugate base are present in equilibrium

Know that diluting a buffer has no effect on its pH
Know that the purpose of using a buffer is to have a solution that can neutralize substantial amounts of either an acid or base without appreciably changing the pH of the solution
Know that adding an acid to a buffer produces a very small decrease in the buffer's pH and that adding a base to a buffer produces a very small increase in the buffer's pH
Be able to create an acidic or basic buffer that has its pH in a given range
Know that whenever a weak acid or base is titrated, a buffer solution is created in the "half-volume" region
Know how to experimentally determine whether a solution is or is not a buffer

Know that the total moles of acid used in preparing a buffer sets a limit on the moles of base that the buffer can neutralize
Know that a METAL OXIDE produces a basic solution and be able to write an equation showing how the metal oxide reacts with water
Know that a NONMETAL OXIDE produces an acidic solution and be able to write an equation showing how the nonmetal oxide reacts with water
Understand that dissolved CO_2 causes even pure water to have a slightly acidic pH
Understand that ACID RAIN is rain that is more acidic than can be created by CO_2 alone
Know the reaction equations associated with the production of acid rain
Know that $CaCO_3$ (limestone) in a lake can neutralize some of the acid rain that falls into the lake
Know some of the problems associated with acid rain

Unit V-1

Definition of ELECTROCHEMISTRY, ELECTROCHEMICAL CELL, HALF-CELL, HALF-CELL REACTION, OXIDATION REACTION, REDUCTION REACTION, REDOX REACTION, REDUCING AGENT and OXIDIZING AGENT
Be able to decide whether a substance is being reduced or oxidized and know how to decide the number of electrons to be added and to which side of the half-cell reaction
Be able to break a redox reaction into two half-cell reactions and balance the half-cell reactions
Definition of OXIDATION NUMBER
Know that the oxidation number of an element is zero
Be able to assign oxidation numbers to all the elements in a compound or molecular ion
Be able to classify a reaction as a redox or non-redox reaction
Know that the number of attached oxygens increases during an oxidation reaction and decreases during a reduction reaction
Be able to predict the reaction that occurs when two half cells are combined
Know that the species being reduced is higher on the Table of Reduction Potentials than the species being oxidized and that a spontaneous reaction occurs only when the species being reduced is above and on the left side and the species being oxidized is below and to the right
Know that if a half-cell reaction involves H^+, there is no reaction unless an acid is present
Understand that some species (Fe^{2+}, Sn^{2+}, Cu^+, H_2O_2) are found on both the left and right sides of the Table
Know that the higher on the left side of the Table, the stronger the tendency to reduce; the lower on the right side of the Table, the greater the tendency to oxidize
Be able to order a set of reduction reactions from highest to lowest tendency to occur, given information on how certain species react with each other
Be able to balance a half-reaction by balancing the number of major atoms, adding H_2O to balance O's and adding H^+ to balance H's
Be able to balance a half-reaction in basic conditions
Know that if O_2, O_3, H_2 or H_2O_2 are involved in a half-reaction, no major species are present
Be able to assign a change in the oxidation number of an atom; know that the change in oxidation number of an atom is equal to the number of electrons gained or lost by the atom
Know that the oxidation number decreases during a reduction reaction and increases during an oxidation
Be able to balance a redox equation using the method of half-reactions

Definition of DISPROPORTIONATION
Be able to use a redox equation to solve single equation titration problems
Be able to use linked redox equations when solving titration problems
Know that redox titrations involving $KMnO_4$ are "self-indicating"
Definition of ELECTRODE, ANODE, CATHODE
Know that oxidation occurs at the anode, that reduction occurs at the cathode, that electrons flow from anode to cathode, that cations flow toward the cathode and anions flow toward the anode, and that electrons only flow in the external circuit and not through the solution

Unit V-2

Definition of VOLTAGE, STANDARD REDUCTION POTENTIAL, STANDARD STATE
Know that the voltage for the hydrogen half cell is assigned arbitrarily and that all other half–cell voltages are assigned relative to the hydrogen half cell
Know that standard reduction potentials only exist at standard state
Know that reversing a half-reaction changes the sign of its E^o value and that the E^o value is not changed if the half-reaction is multiplied by 2, 3, etc.
Know that the potential of a redox reaction is calculated from: $E^o_{CELL} = E^o_{RED} - E^o_{OX}$ and that the cell potential is the voltage gap between the reduction and oxidation half-cells
Know that a reaction is spontaneous if E^o_{CELL} is positive and non-spontaneous if E^o_{CELL} is negative
Know that even if the cell potential of a reaction is large and positive, the reaction is not guaranteed to occur because the activation energy for the reaction may be too high
Know that the surface area of an electrode has no effect on the cell potential
Know that Le Chatelier's Principle can be applied to half cells, so that (for example) increasing the concentration of a substance which reduces will increase its reduction potential
Know that as a cell continues to operate the reduction reaction has less tendency to occur and the oxidation reaction has less tendency to occur and therefore the cell voltage decreases and eventually becomes zero
Know that when more than one reduction reaction can occur, the reduction having the highest tendency to occur (highest on the Table) will occur preferentially.
Know that when more than one oxidation reaction can occur, the oxidation having the highest tendency to occur (lowest on the Table) will occur preferentially.
Understand that when given a list of ionic compounds that are involved in a spontaneous redox reaction, the compounds must first be broken into ions and then the ion(s) with the highest tendency to reduce will react preferentially and the ion(s) with the highest tendency to oxidize will react preferentially.
Know that the recharging reaction of a rechargeable battery is the opposite of the discharging reaction.
Know that fuel cells are reaction chambers that allow a continuous flow of reactants to come in and a continuous flow of products to flow in, while producing an electrical current as an electrochemical reaction occurs.
Know that fuel cells are pollution free and operate at very high efficiencies (80%).
Know that corrosion of metals is caused by the reduction of oxygen (in air) and water:

$$1/2\ O_2(g) + 2\ H^+(10^{-7}\ M) + 2\ e^- \rightleftharpoons H_2O(l);\ E^o = 0.82\ V$$

while the metal (such as iron) undergoes oxidation.
Know that metals can be protected from corrosion by:

- applying a protective layer (such as paint)
- coating the metal with a metal that does not corrode
- connecting the metal to be protected with another metal that has a greater tendency to oxidize (such as Mg or Zn). This process is called "cathodic protection".
- eliminating oxygen from the environment, preferentially in addition to making the environment very basic.

Unit V-3

Know that ELECTROLYSIS involves adding electrical energy to a mixture so as to make a non-spontaneous reaction occur.

Know that an ELECTROLYTIC cell is spontaneous, as opposed to an electrolysis cell.

Know that if platinum, gold or carbon electrodes are used in an electrolysis, these electrodes are INERT and only allow another reaction to occur.

Know that in an electrolysis reaction, the highest reduction reaction on the Table still goes preferentially and the lowest oxidation reaction on the Table still goes preferentially, BUT now the reduction reaction is BELOW the oxidation.

Know that the cell potential of an electrolysis reaction is NEGATIVE and that the voltage required to be applied is at least equal to the absolute value of the cell potential.

Know that when water is present in a reaction, one of the following reductions must be considered as possible reactions:

$2\ H^+ + 2\ e^- \ ?\ \ H_2(g)$ [if acid is present]

$2\ H_2O + 2\ e^- \ ?\ \ H_2(g) + 2\ OH^-(10^{-7}\ M)$ [if solution is neutral]

Know that when water is present in a reaction, one of the following oxidations must be considered as possible reactions:

$H_2O(l) \ ?\ \ 1/2\ O_2(g) + 2\ H^+ + 2\ e^-$ [if acid is present in the water]

$H_2O(l) \ ?\ \ 1/2\ O_2(g) + 2\ H^+(10^{-7}\ M) + 2\ e^-$ [if the water is neutral]

Know that if Cl^- or Br^- are present in an aqueous electrolysis solution, the Cl^- and Br^- will oxidize before the water will (this is an exception)

Know that when ELECTROPLATING with a metal, the following setup should be used:

- The metal to be plated out should be present as ions in solution
- The substance which is to be metal plated should become the CATHODE.
- The anode should be made out of the same metal to be plated out at the cathode.
- The electron flow must be from anode to cathode

Know that when ELECTROREFINING an impure metal, the following situation occurs:

- The anode must be the slab of impure metal
- The cathode must be made out of the pure metal which is be electrorefined (the metal which exists in the largest amount in the impure metal)
- At the anode, the metal to be refined will oxidize AND all metals present which have a greater tendency to oxidize will also oxidize.
- At the anode, NO metal above the metal to be refined will oxidize. Theses latter substances will simply fall off the electrode (“anode sludge”)
- At the cathode, only the metal to be refined will be reduced. All other ions in solution will remain behind, unreacted.

CHEM 11 STUDY NOTES

Unit I

Know all safety rules, location of safety and protective equipment and how to use equipment
Order of treating multiple emergencies, how to deal with controlled fires vs uncontrolled fires
Dealing with broken glass and excess chemicals

Unit II-1

How to set up a unit conversion problem, including multiple conversions
Memorize metric conversions, including: 1 mL = 1 cm^3 , 1 m^3 = 10^3 L , 1 t = 10^3 kg
How to set up and use metric conversions, including conversion of numerator and denominator
How to find derived quantities and derived units

Unit II-2

How to perform density calculations, memorize water's density, when an object sinks or floats
Significant figures: how to count, how to count when no decimal, certain vs uncertain digits, defined (counting) numbers, leading vs trailing zeroes
Accuracy vs precision
The rules for reading a scale: 1st digit(s), figuring out the next digit, guessing the last digit
Reading a scale when a pointer is exactly on a marked line
Experimental uncertainty: how to write, how to interpret, how to estimate
Rounding answers to the correct # of significant digits: adding/subtracting, multiplying/dividing

Unit III-1

Definitions (in own words, with examples when applicable)
Special comments on: hypotheses, theories and laws
properties of solids, liquids and gases
vapour versus gas
Relationships involving: viscosity, diffusion rate, vapour pressure, boiling temperature, gas compressibility
Diagram: classification of matter
Compare and contrast: compound vs mixture
element vs compound
mechanical mixture vs solution
Exception: water is always the solvent

Unit III-2

Definitions (in own words, with examples when applicable)
Types of physical separation methods, when each is used and how each is performed
Special things to know when using some separation methods (eg. can't filter solute from solution)
Use of %'s with solvent extraction
Chromatography theory
Summary of when to use each method of physical separation (what tells you to "use this method")
Comparison of heat involved in chemical vs physical changes
Diagram: phase changes and phases present; %'s of phases at a given point in a phase change
KE involved in phase changes and temperature changes
Drawings of KE motion in a molecule

Unit IV

Definitions (in own words, with examples when applicable)
Charges you are expected to memorize (by columns)
Stock naming system (Roman numerals)
Naming monatomic ions, including phosphide and nitride
Rules for writing the formula of ionic compounds; tricks (double word anion names, mercury(I) ion)
Rules for naming ionic compounds; finding the charge of ions so as to use the Stock system
Molecules to memorize: water and ammonia
Naming hydrates and writing their formulae
Rules for writing the formula of a binary covalent compound
Rules for naming a binary covalent compound; tricks ("mono" used with 2nd word, not 1st)
Common acids to be memorized
Colours of ions to be memorized
How to know when to name a compound as an ionic compound vs a binary covalent compound

Chem 11 Study Notes – 2

UNIT V-1

Memorize Avogadro's Hypothesis
Given the volumes of 2 gases that react, predict the molecular formula of the product (Exercise 2)
Definition of the MOLE and MOLAR MASS
How to calculate the molar mass, given the formula of a compound (Ex. 6)
How to calculate the molar mass of a hydrate, given its formula (Ex. 7)
How to convert from moles to mass (and vice versa), using the molar mass (Ex. 8,9)
Calculating the molar mass, given the mass and number of moles (answer is in g/mol) (Ex. 10)
What MOLAR VOLUME is; what STP is
How to convert from moles to gas volume at STP (and vice versa), use 1 mol = 22.4 L (Ex. 11,12)
What AVOGADRO'S NUMBER is (6.02×10^{23}). Know that Avogadro's Number is just a number (like a dozen) and doesn't have any special units
How to convert from moles to # of particles (and vice versa), use 1 mol = 6.02×10^{23} (Ex. 15-b,)
How to calculate the mass of 1 mol of a thing, given the mass (in grams) of ONE thing (Ex. 18-b)
How to convert from molecules to number of atoms in the molecule (Ex. 21)
How to know when to multiply a series of unit conversions by the number of atoms in a particle and when not to add the extra conversion
Memorize the diagram for converting between mass, gas volume at STP, moles and # of particles
How to set up a multiple conversion to convert, say, from mass to moles to number of particles
How to calculate the density of a gas at STP, given its chemical formula (Ex. 25)
How to calculate the volume of a solid or liquid, given the density and either the number of particles or the number of moles (Ex. 32)
How to calculate the number of particles or the number of moles of a solid or liquid, given the density and the volume (Ex. 27)
How to calculate the molar mass of a gas at STP, given the volume and the mass (Ex. 28)
How to calculate the molar volume of a solid/liquid, given its density and chemical formula (Ex. 33)
How to calculate the density of a solid or liquid, given its chemical formula, its volume and the number of moles of it (Ex. 34)
How to calculate the volume of a solid or liquid, given its chemical formula, its density and the number of moles of it (Ex. 41-f)

UNIT V-2

How to calculate the percentage composition of a compound, given its formula
How to calculate the percentage of water in a hydrate, given the chemical formula of the hydrate
What the EMPIRICAL FORMULA is
How to find the empirical formula, given the percentage composition of a compound
How to find the empirical formula, given the masses of each type of atom present
How to "clear fractions" when the mole ratio in an empirical formula ends in 0.20, 0.25, 0.33, 0.40, 0.50, 0.60, 0.67, 0.75, or 0.80
Summarize the methods use to calculate the molar mass
How to find the molecular formula, given the empirical formula and the molar mass

UNIT V-3

Definition of CONCENTRATION, CONCENTRATED and DILUTE
Definition of MOLAR CONCENTRATION and MOLARITY
What the units for molar concentration are, what "M" and "MOLAR" mean, what [NaCl] means
What is the special flask's name used to make up exact volumes, why the flask neck is narrow, what to do if too much liquid is added, why the liquid is added after the solid is in the flask
How to calculate the molarity, given the volume and the mass or moles of solid present (Ex. 59)
How to find the volume, given the molarity and the mass or moles of chemical dissolved (Ex. 62)
How to find either the mass or moles of solid dissolved, given the molarity and volume (Ex. 61)

How to write the experimental procedure to prepare a known volume and known molarity (Ex. 60)

How to calculate the density of a pure liquid or solid , given its molarity (Ex. 67)
How to calculate the molarity of a pure liquid or solid, given its density (Ex. 65)
How to calculate the molarity of a substance in solution, given the mass of a hydrate of the substance and the volume of the solution made (Ex. 59-e)
How to calculate the mass or moles of a hydrated substance, given the concentration of the "unhydrated" substance and the volume of the solution (Ex. 60-f)

How to calculate the diluted concentration of a solution, given the original concentration and the volumes of the solution used and the water added (Ex. 78)
How to calculate the diluted concentrations of two DIFFERENT chemicals when they are mixed together, given the original concentrations and volumes of the chemicals (Ex. 90)
How to calculate the combined concentration, given the concentrations and volumes of two different solutions containing the SAME chemical (Ex. 79)
How to calculate the volume of a concentrated chemical needed to make a given volume of a dilute chemical (Ex. 82)
How to calculate the molarity of a concentrated chemical used to make a given volume of a dilute chemical (Ex. 102-e)
How to calculate the molarity of a mixture, given the masses of two identical chemicals in two different volumes (Ex. 84)
How to calculate the molarity of a solution when the volume is "boiled down", given the original concentration and the original and final volumes (Ex. 85)

UNIT VI-1

Definition of CHEMICAL REACTION EQUATION, CHEMICAL WORD EQUATION, REACTANT, PRODUCT and COEFFICIENT
Definition of OPEN SYSTEM and CLOSED SYSTEM
Definition of CONSERVED and CONSERVATION LAW
Law of Conservation of Mass: what must be true if this law holds and what you see if the law is violated
Law of Conservation of Atoms: what must be true if this law holds and what you see if the law is Violated
Law of Conservation of Electrical Charge: what must be true if this law holds and what you see if the law is violated
Law of Conservation of Energy: what must be true if this law holds and what you see if the law is violated
How to identify a good atom to start with when balancing reaction equations
Procedure for balancing a chemical reaction equation
How to use fractions when balancing a reaction equation
How to balance whole groups when balancing a reaction equation
How to write the phases SOLID, LIQUID, GAS and AQUEOUS in a reaction equation
Which elements are diatomic
How to interpret CRYSTAL, POWDER and PRECIPITATE in a chemical word equation
How to translate a chemical word equation into chemical symbols, including phases

UNIT VI-2

Synthesis or Combination Reaction: what it is, how to recognize it, how to predict the products
Decomposition Reaction: what it is, how to recognize it, how to predict the products
Single Replacement Reaction: what it is, how to recognize it, how to predict the products
Double Replacement Reaction or Metathesis Reaction: what it is, how to recognize it, how to predict the products
Neutralization Reaction: what it is, how to recognize it, how to predict the products
Know that ACID + BASE produce SALT + WATER
Combustion Reaction: what it is, how to recognize it, how to predict the products
What a HYDROCARBON is
What special products are formed if the reactant in a combustion contains oxygen or sulphur

Bond breaking requires an input of energy; bond making gives off energy; energy is measured in KILOJOULES (kJ)
Definition of EXOTHERMIC REACTION and ENDOTHERMIC REACTION
Definition of ENTHALPY and ?H
Exothermic reactions are "losers": they give off heat, energy flows from reactants to surroundings, ?H is negative, heat is on product side, reactants have more energy than products, combustion is an example of an exothermic process
Endothermic reactions are opposite of exothermic reactions: they absorb heat, energy flows from surroundings to reactants, ?H is positive, heat is on the reactant side, reactants have less energy than products, the melting of ice is an example of an endothermic process

UNIT VII

Definition of STOICHIOMETRY
How to set up a conversion factor involving two chemicals, given their coefficients
How to calculate the mass, number of molecules or volume at STP of one substance, given the mass, number of molecules or volume at STP of another substance
How to calculate the combined volume of gases produced by reacting a substance
How to calculate the mass of a product, given the molarity and volume of a product
How to calculate the molarity of a reactant, given the volume of the reactant and the mass of the product
Definition of TITRATION, EQUIVALENCE POINT or STOICHIOMETRIC POINT
How to calculate the unknown concentration of an acid, given the concentration of the base it is titrated with and the volumes of both the acid and the base
How to calculate the unknown volume of an acid, given the volume and concentration of the base it is titrated with and the concentration of the acid
Definition of LIMITING REACTANT and EXCESS REACTANT
How to identify the limiting reactant and the excess reactant when two substances react
How to calculate the mass of product produced when two substances react, one of which is in excess
How to calculate the mass of excess reactant left over after a reaction

UNIT VIII-1

Know what the Rutherford model of the atom is
Know what the Bohr model of the atom is, and what the Rutherford–Bohr model is
Know the symbols, charges, masses and location of the atomic particles (electron, proton and neutron)
Definition of ATOMIC NUMBER and ATOMIC MASS
Know that atoms having the same atomic symbol have the same number of protons, and vice versa
Know that the atomic number equals the number of protons, and equals the charge on the nucleus and equals the number of electrons in a neutral atom
Know that the atomic mass equals the number of protons plus neutrons, and therefore the number of neutrons equals the atomic mass minus the atomic number
Know that adding electrons to a neutral atom creates a NEGATIVE ION having a charge equal to the number of electrons added
Know that removing electrons from a neutral atom creates a POSITIVE ION having a charge equal to the number of electrons removed
Definition of an ISOTOPE
Know that isotopes have the same atomic symbol and overall charge, only differing in mass
How to calculate the mass of an isotope, given the mass of two compounds that only differ in having different isotopes of one type of atom
Know that ^{2}H is DEUTERIUM and ^{3}H is TRITIUM
Know how to fill in a table such as that shown in Exercise 22
Know how to calculate the average molar mass of a mixture of isotopes, given the % of each isotope
Definition of ENERGY LEVEL, QUANTUM, ORBITAL, SHELL and SUBSHELL
Know that the "n" value describes the number of the shell and that the n-th shell has n types of orbitals possible

Know that the subshells are “s” (1 orbital), “p” (3 orbitals). “d” (5 orbitals) and “f” (7 orbitals)
Know how to draw the energy levels for hydrogen and for a polyelectronic atom
Know the rules which govern the placement of electrons in orbitals
Know how to write the electron configuration of a neutral atom
Definition of CLOSED SHELL
Know how to find the CORE set of electrons and how to write an electron configuration using CORE NOTATION
Know the electron configuration exceptions of Cr and Cu
Know how to write the electron configurations of positive and negative ions
Definition of VALENCE ELECTRONS and how to identify them in an atom or ion

UNIT VIII-2

Know that the atoms in the periodic table are listed according to their atomic numbers; know the PERIODIC LAW
Definition of PERIOD, GROUP/FAMILY, REPRESENTATIVE ELEMENT, TRANSITION METAL, ALKALI METAL, ALKALINE EARTH METAL, HALOGEN, NOBLE GAS, LANTHANIDE and ACTINIDE. Be able to locate each group on the periodic table
Know the properties of the METALS, NONMETALS and SEMICONDUCTING NONMETALS and where each type of element is located on the periodic table
Know that elements become LESS metallic going from left to right across the periodic table and that elements become more metallic going down each column of the periodic table
Definition of ELECTROSTATIC FORCE, know that opposite charges attract, like charges repel, the closer two charges are the more they interact, and the greater the charges involved the greater the interaction between the charges
Know that the charge on the nucleus increases going from left to right across the periodic table and that all the electrons in a given shell are assumed to have the same average distance from the nucleus
Know that the size of atoms increases going down a column and the size of atoms decreases going from left to right across the periodic table, and why these trends occur
Definition of OPEN SHELL and CLOSED SHELL and how to identify atoms or ions having closed shells
Definition of VALENCE ELECTRONS and be able to count the number of valence electrons possessed by an atom or ion
Definition of VALENCE OF AN ATOM is and how to find the valence
Definition of IONIZATION ENERGY and how ionization energy changes going down a column and going from left to right across the periodic table
Understand why each point on the graph of Exercise 52 has a particular value relative to other points on the graph
Definition of IONIC BOND, how to predict when an ionic bond forms, understand that the smaller the ions involved the stronger the bond, and that the greater the charge on the ions the stronger the bond
Definition of ELECTRONEGATIVITY and how electronegativity changes going down a column and going from left to right across the periodic table
Understand the relationship between ionization energy and electronegativity
Know that ionic compounds have high melting temperatures
Know the probable charges formed by atoms when they become ions
Know that negative ions are larger than the corresponding neutral atom and why this occurs
Know that positive ions are smaller than the corresponding neutral atom and why this occurs
Definition of COVALENT BOND, how to predict when a covalent bond forms, understand that the smaller the atoms involved the stronger the bond, and that the more electrons involved in the bond the stronger the bond
Definition of OCTET RULE
Know that covalent bonds are very strong
Know the relationship between the number of shared electrons and bond length

Understand that whereas a molecule may be made from strong covalent bonds, the bonds holding one molecule next to another are much weaker, so that when the compound melts the covalent molecules separate from each other but the molecules stay intact
Know how to predict the formula of covalently-bonded binary compounds
Definition of INTRAMOLECULAR FORCE, INTERMOLECULAR FORCE, LONDON FORCE and DIPOLE–DIPOLE FORCE
Understand that London forces are extremely weak, that substances held together by London forces have very low melting temperatures and that the greater the total number of electrons possessed by a molecule the stronger the London force it creates
Know that London forces are only important with noble gases and adjacent molecules containing covalent bonding (that is, between species containing closed shells)
Know how to write the Lewis Structures of ions and ionic compounds
Know how to write the Lewis Structure of covalent compounds that obey the octet rule

Know how to write the Lewis Structures of covalent compounds that are electron deficient, have an expanded octet or have an odd number of electrons
Know the properties of the noble gases, including type of bonding in the solid state, relative melting temperatures, reactivity and ionization energy
Know the properties of the alkali metals, including relative melting temperature, reactivity, ions formed, ionization energy and electrical conductivity
Know the properties of the alkaline earth metals, including relative melting temperature, relative reactivity, ions formed and ionization energy
Know the properties of the halogens, including types of bonding in the solid state, relative melting temperatures, reactivity and ionization energy

UNIT IX

Definition of SOLUTION, SOLVENT, SOLUTE, SATURATED, UNSATURATED and SOLUBILITY
Know what information is required to specify a solubility
Know that a saturated solution of a solid must have some undissolved solid present and that the solubility of a solid usually increases with increased temperature
Know that a solution that is saturated with one substance can still dissolve a different substance
Know the following facts about conductivity in solutions: electrical conductivity requires the presence of ions; pure water contains a very small concentration of H^+ and OH^- ions; organic substances (covalent compounds) generally do not form conducting solutions; the greater the concentration of ions in solution the greater the electrical conductivity; acids, bases and salts (ionic compounds) form conducting solutions; solid ionic compounds do not conduct electricity but melted ionic compounds do;
Know how do decide whether a substance will be electrically conducting or nonconducting
Know that both metals and solutions of ions are electrical conductors
Definitions of DIPOLE-DIPOLE FORCES, POLAR and NONPOLAR
Be able to predict whether a covalent bond will be polar or nonpolar
Definition of an ASYMMETRICAL MOLECULE; be able to predict whether a molecule will be polar or nonpolar based on its symmetry
Know that dipole-dipole forces are weak, similar to London forces
Know what bonds must be present for a molecule to have HYDROGEN BONDS; be able to predict whether the bonding in a substance involves hydrogen bonds; know that hydrogen bonds are much stronger than London forces and dipole-dipole forces but much weaker than covalent and ionic bonds
Know what the statement “Like dissolves like” means with respect to polar versus nonpolar solvents dissolving polar versus nonpolar solutes; be able to explain the chemical reasoning behind the statement
Be able to identify the most important type of bonding between two particles
Definition of SOLVATION, IONIC SOLID, MOLECULAR SOLID, CRYSTAL LATTICE, DISSOCIATION REACTION and IONIZATION REACTION
Be able to write a dissociation or ionization reaction

Be able to calculate the individual concentrations of the ions that occur when a given molarity of an ionic compound dissolves in water

Be able to calculate the concentrations of the ions that occur when two ionic solutions are mixed