Keypoints Units and Numbers

Definitions

Meter
Milliliter
Significant Figures
Units
Volume
Weight

Concepts

1. Be able to define mass
2. Be able to explain the difference between mass and weight, and give a concrete example of this difference.
3. Be able to correctly identify the number of significant figures in a number written in standard notation, including recognizing when the number of significant figures is not entirely clear.

Calculations

1. Be able to round numbers correctly.
2. Be able to multiply two numbers with known numbers of significant figures, and give your answer with the correct number of significant figures.
3. Be able to add two numbers known to different levels of exactness and give your answer with the correct number of significant figures.
4. Be able to subtract two numbers with known numbers of significant figures, and give your answer with the correct number of significant figures.
5. Be able to convert between units when given the conversion factor that relates these units to each other.

Keypoints Matter, Mixtures and Compounds

Compound
Element
Gas
Heterogeneous Mixture
Homogenous Mixture
Liquid
Matter
Mixture
Pure Substance
States of Matter
Solid

Concepts

1. Be able to describe the 3 common states of matter and properties of each of these states.
2. Be able to identify a substance as either a mixture or a pure substance, and explain your answer. If it is not possible to identify the substance as one or the other be able to explain why.
3. Be able to tell if a substance is heterogeneous mixture, homogeneous mixture, compound or element.
4. Be able to give a way to separate both homogeneous and heterogeneous mixtures.
5. Be able to explain the difference between an element and a compound.
6. Be able to explain how a compound differs from a homogeneous mixture.

Keypoints of Basic Atomic Structure

Definitions

You will not be asked to write a definition of any of these but I do expect you to recognized them when they are used in problems, etc..

Definitions

Atom
Atomic Radius
Electrons
Element
Isotope
Neutrons
Periodic Table
Protons

Concepts

1. Be able to list the charges on the particles that make up and atom, and give their relative sizes.
2. Explain whether the mass of the protons, neutrons, and/or electrons that are (is) principally responsible for the mass of an atom.
3. Be able to explain how different atoms of the same element are able to have significantly different masses.
4. Be able to explain how elements are ordered in the periodic table.

Keypoints Periodic Table Groups and Reactivities

Definitions

alkali metals/group 1 metals
alkaline metals/group 2 metals
halogens
metals
noble gasses
non-metals
transition metals

Concepts

1. Be able to order each of the following groups, alkali metals, alkaline metals, and halogens, in terms of reactivity in comparison with other members of their group.
2. Be able to explain why sodium metal is stored under oil, and why it is not found in its elemental form in nature.
3. Be able to find noble gasses on the periodic table, and comment on their reactivity.
4. Be able to state which of the halogens are extremely corrosive.
5. Be able to identify non-metals when given a periodic table.

No Calculations

Atomic Orbitals and Periodic Trends

Definitions

Atomic Orbitals
outer shell electrons/valence electrons

Concepts

1. Recognize that what we know of electron positions reflect the likelihood of finding an electron at a place, and be able to demonstrate that you know that we cannot truly know just where an electron is.
2. Recognize that the outer shell electrons, also called valence electrons, and that they are the electrons that determine the chemistry of an element.
3. Be able to define ionization energy and electron affinity and recognize how these to aspects of elements can explain relative reactivity of elements.

4. Be able to explain how the very low reactivity of Noble Gases relates to the stability of filled valence shells.
5. Be able to explain how what we know the stability of completely filled shells can explain the charges found on ions of the main group elements (excluding B).

Keypoints Noble Gas Configuration, Ions and Covalent Bonds

Definitions

Ionic Bond

Ions

Ionic Compounds

Outer shell electrons/Valence electrons

Concepts

1. Be able to predict what ion will likely be formed from Group 1 and 2 metals when you are able to consult a periodic table. (These are the two columns farthest to the left on the periodic table.),
2. Be able to predict the ion that will likely be formed by non-metals, when you are able to consult a periodic table.
3. Be able to describe the forces that hold ionic compounds together.
4. Be able to predict the formula of a salt created by the interaction alkali and alkaline metals with non-metals.
5. Be able to give the difference between covalent and ionic bonds.
6. Recognize that nonmetals form salts and covalent bonds in order to adopt the electron configuration of the Noble Gases.
7. Recognize that covalent bonds form so that the shared electrons provide the bonding atoms to each have a filled outer shell. (Another way to say this is that they have a noble gas configuration or a filled valence shell.)

Keypoints Lewis Dot Structures

Definitions

Covalent bond
Double bond
Electron pair
Lewis Dot Structure
Lone pair
Non-bonding electron
Single bond
Triple bond
Valence electrons

Concepts

1. Recognize whether or not a Lewis Dot Structure for a molecule is correct. (We will only consider molecules containing H, C, N, O, F, Cl, Br, and I.)
2. Predict the nature of the covalent bonds between 2 atoms by using Lewis Dot Structures. (Single Bond, Double Bond, Triple Bond)
3. Be able to recognize lone pairs of electrons on a Lewis Dot Structure.

Keypoints Stoichiometry

concentration by percent
isotope

molar mass

molarity (M)

moles

parts per billion (ppb)

parts per million(ppm)

Solution
solvent

solute

Concepts

1. Be able to explain why the molar mass of carbon is 12.011 g/mole, not 12.0000 grams/mole.

Calculations

1. Be able to calculate *the molar mass of a compound* when given the *formula of the compound* and a *periodic table* that gives the atomic, or molar, masses of the elements.

2. Be able to calculate *the number of moles* in a sample when given the *number of grams* in the sample, and be able to calculate the *number of grams* of a sample when given the *number of moles* in the sample.

3. Be able to calculate the *molarity* of a solution when given the *number of moles of the solute* and the *volume of the solution*.

4. Be able to calculate *the number of moles of a solute* in a solution when given *the volume* of the solution and its *molarity*.

5. Be able to calculate *concentration of a solution* made by *diluting a solution of known molarity*.

6. When given the *number of grams of a solute in a solution*, and the *mass of the solutuion* be able to calculate the *concentration of the solute in percents, ppb and ppm*.

7. Be able to calculate *the mass of a solute* in a solution when given the concentration of the solute in either *concentration by percent, ppb or ppm*.

8. When given a *chemical equation*, and *the number of moles of one of the reactants or products* be able to calculate *the number of moles of another one of the reactants or products*.

Acid Base Keypoints

Definitions

Acetic Acid/Acetate

Ammonia/Ammonium

Bronsted-Lowry Acid

Bronsted-Lowry Base

Hydoxide Ion

Hydrogen Ion/Proton

pH

Strong Acid

Strong Base

Titration

Weak Acid

Weak Base

Concepts

1. Be able to demostrate that you understand the Bronsted – Lowry Definition of Acids and Bases.
2. Know the neutralization reaction that occurs between OH^- and H^+.
3. Know that HCl is a strong base, and that NaOH is a strong base.
4. Know that strong acids dissociate completely in water. (For Example HCl --> $H^+ + Cl^-$)
5. Know that NaOH dissociates completely in water. (NaOH--> $Na^+ + OH^-$)
6. Recognize that when a strong acid dissociates the anion behaves just as it would if it were produced by a salt which contained it. (For example the Cl^- from HCl behaves just the same as Cl^- from NaCl).
7. Know that Acetic Acid (CH_3COOH) is a weak acid, and that NH_3 is a weak base.
8. Know that weak acids partially dissociate in water, when they dissociate a base is formed and a hydrogen ion is donated to water. (This is often just written as though a proton leaves the acid, because that the water accepts the hydrogen ion is assumed.) For Example: CH3COOH + H_2O --> CH_3COO^- + $H3O^+$ is or CH3COOH + H_2O --> CH_3COO^- + H^+ useful because it makes it clear that water is acting as the base.
9. Be able to write a chemical equation for the reaction of a weak acid and a weak base.
10. Be able to describe a titration, and understand the one that you did in lab.
11. Recognize that a basic solution has a pH > 7, an acidic solution has a pH<7, and a neutral solution has a pH of 7.
12. Recognize that a buffers keep the pH of a solution constant.

Calculations

1. Be able to calculate the molar concentration of H^+ in a solution made using a strong acid , when given the number of moles of the strong acid in the solution and the volume of the solution.
2. Be able to calculate the molar concentration OH^- of a solution made using a hydroxide when given the number of moles of the strong base in the solution and the volume of the solution.
3. Be able to estimate the pH of a solution when given [H+], and estimate [H+] when given pH.

Thermodynamics Keypoints

Definitions

Activation Barrier/E_a

Catalyst/Catalyzed

Enthalpy

Entropy

Equilibrium Reaction/Double Arrow Reaction
Free Energy
Reaction Coordinate
Reaction Rate/Speed of a Reaction
Spontaneous Reaction

Concepts

1. Be able to label ΔG of a reaction as well as the activation barrier, when given a reaction coordinate diagram for the reaction.
2. Be able to recognize a change that has a positive ΔS, is one in which the degree of disorder increases.
3. Understand that transitions that increase entropy are entropically favored. (The world tends toward disorder.)
4. Understand that some reactions give off heat ($\Delta H<0$) and some absorb heat ($\Delta H>0$), and that reactions that absorb heat are cooling reactions.
5. Whether or not a reaction occurs depends on the Free Energy associated with the reaction. (ΔG)
6. The free energy change associated with a reaction depends on the enthalpy and entropy changes associated with the reaction.
7. When the free energy change associated with a reaction is positive the reaction is not spontaneous. ($\Delta G>0$)
8. When the free energy change associated with a reaction is negative the reaction is spontaneous. ($\Delta G<0$)
9. The difference in the free energy of the reactants and products is not something that can be shifted. (The free energy of the reactants and of the products is set. It does not matter how they were made.)
10. Recognize that when ΔG is close to 0, the reaction is a equilibrium reaction (a double arrow reaction). Both the forward and reverse reactions are observed.
11. The rate, or speed, of a reaction is a measure of how quickly the reactants are converted to products.
12. Be able to identify what determines the rate of a reaction and the effect that temperature, concentration have on the rate of a reaction.
13. Be able to describe how the activation barrier associated with the reaction impacts the rate of a reaction.
14. Be able to describe what it means to catalyze a reaction, and how the reaction coordinate changes when this happens. (The activation barrier associated with a reaction can be changed. When this is done the reaction is said to be catalyzed.)

Keypoints Amino Acids and Proteins

Definitions

α-helix
Acidic Side Group
Amino Acid
Amino Acid R Group (or Amino Acid Side Group)
β-pleated Sheet
Basic Side Group
Denatured Protein
Disulfide Bond (or –S-S- bond)
Hydrogen Bonds
Hydrophillic Interactions
Hydrophobic Interaction
Nonpolar Side Group
Peptide
Polymer

Polar Side Group
Protein
Quaternary Protein Structure
Salt Bridge (Ionic Interaction)

Concepts

1. When given a line structure of an amino acid be able to categorize it as having a basic side group, an acidic side group, or a side group that is neither of these. (You should not memorize these. If there is a –COOH in the side group it is acidic. If there is a nitrogen atom in the side group it is basic, except for histidine.)
2. Recognize that proteins are polymers of amino acids.
3. Be able to predict what form of an amino acid will predominate a high, middle, and low pHs.
4. Be able to list the varied roles of proteins (enzymes, structural proteins, transport proteins, hormones, etc.)
5. Be able to describe how hydrogen bonding between C=O and N-H stabilize β-sheets and α-helixes.
6. Be able to explain how different types of intermolecular interactions stabilize the structure of proteins. (hydrogen bonding, ionic forces, hydrophobic interactions, S-S links)
7. Be able to explain what happens when a protein is denatured.
8. Be able to describe how heat, strong bases, and detergents can be used to denature proteins.
9. Be able to explain how a change in the overall fold of a protein can be changed by the environment of the protein, or by a change of 1 amino acid in the protein's amino acid chain.
10. Be able to predict whether or not you expect to find a type of amino acid side group on the inside or outside of a protein.

Keypoints Enzymes and Vitamins

Activation
Acivation Energy
Active Site
Catalyze/Catalyst
Coenzyme
Cofactor
Enzyme
Feedback Inhibition
Inhibition
Substrate
Vitamin

Concepts

1. Be able to identify different types of intermolecular interactions that can help to hold a substrate in an enzyme active site, or that might facilitate enzyme catalysis.
2. Recognize how enzyme catalyzed reaction are impacted by increasing the substrate concentration or the enzyme concentration. Be able to compare what is seen in these two cases.
3. Be able to describe how temperature can impact enzyme catalyzed reaction.
4. Be able to describe how vitamins are recognized. (What is observed in order to people to realize that a chemical is a vitamin.)
5. Be able to tell the difference between water soluble and fat soluble vitamins when given their chemical structures.
6. Be able to explain why water soluble vitamins are not as commonly associated with illnesses that result from over consuming these vitamins.

Keypoints Chapter 21 Generation of Biochemical Energy

Definitions

ADP/ATP

Acetyl CoA/Ac-S-CoA

Coenzyme A

Coupled Reactions

Cell Membrane

Citric Acid Cycle

Electron Transport

$FAD/FADH_2$

Mitochondria/Mitochondrion

$NAD^+/NADH$

Oxidation/Reduction

Oxidized/Reduced

Oxidizing Agent/Reducing Agent

Redox Reaction

Concepts

1. Be able to why coupling biochemical reactions is important in using a storing biochemical energy.
2. Be able to identify the part of the cell where nearly all of the ATP production takes place.
3. Be able to describe the role of FAD and NAD+ have in the Citric Acid Cycle and in Electron Transport.
4. Be able to state what processes in the body produce the Acetyl-S-CoA used in the Citric Acid Cycle. (Ac-S-CoA can come from digestion of starches, proteins, or fats.)
5. Be able to explain how coenzymes are cycled in the Citric Acid Cycle and Electron Tranport. (FAD/FADH2, NAD+/NADH, ADP/ATP)
6. Be able to compare the Citric Acid Cycle and Electron Transport. (Where does the energy come from? Where is it stored in each? Which produces more ATP equivalents? Which produces products used in the other?
7. Be able to describe why an organism needs to release the energy from the oxidation of glucose in a series of steps rather than all at once.
8. Be able to give the role of ATP in organisms.

Carbohydrates Keypoints

Definitions

Carbohydrates
Cellulose
Disaccharide
Glucose
Glycogen
Disaccharide
Heparin
Lactose
Lactase
Monosaccharide
Polysaccharide
Starch

Stereoisomer
Sucrose

Concepts

- Be able to recognize whether or not a molecule belongs to the carbohydrate class of molecules.
- Recognize that several sugars can have the same formula, but still be very different because they are different stereoisomers.
- Be able to give the name of the type, or types, of sugar molecules found starch and glycogen.
- Be able to explain how some polysaccharides are able to act as lubricants and cushions in organisms.
- Be able to explain what feature of heparin's structure allows it to act as a anticoagulant.?
- Be able to compare and contrast the structures and functions of glycogen, starch and cellulose.
- Be able to give the intermolecular force that contributes significantly to the rigidity of cellulose.
- Recognize that maltose, glucose, glycogen, cellulose, and starch are all composed of glucose.

Chapter 23 Summary

<u>Things to know about digestion of starches</u>

- Digestion of starches and glycogen begins in the mouth where an enzyme, amylase, breaks them down into the disaccharide maltose.
- Amylase from the mouth continues to break down starches and glycogen in the stomach.
- A different type of amylase breaks down starch and glycogen in the small intestine.
- There are enzymes in the small intestine that break down disaccharides to form monosaccharides.
- Monosaccharides are taken up into the blood stream from the small intestine.
- Movement on monosaccharides into cells is regulated by the organism.

<u>Things to Know About Glycolysis</u>

- Glycolysis takes place in the cytosol (the region of the cell that is not inside its organelles),
- Glycolysis produces ATP and NADH from glucose.
- ATP and NAD^+ are required in order for glycolysis to take place.
- Glucose is broken into 2 three carbon molecules.
- The final product of glycolysis is pyruvate.
- 1 mole of glucose is converted into 2 moles of pyruvate.
- Pyruvate is used in the mitohondria to produce acetyl-S-CoA that will be used in the citric acid cyles.
- When oxygen is in short supply, pyruvate is reduced to lactate.

<u>Things to Know About Starvation</u>

- Glycogen is stored in the liver and in muscle cells.
- When glucose is not available from food the body breaks down glycogen in order to supply glucose to the body, then it uses amino acids that come from proteins to make glucose. In the cells with fat stores fatty acids are used to make Ac-S-Co
- It only takes about half of a fairly inactive day for a body to use up all of its stores of glycogen.
- The brain relies on blood glucose in order to function.
- Starvation has different stages.
    1. Initially glycogen stores are used up.
    2. Then blood glucose comes principally from breaking down proteins, and energy is provided to many cells in the body by using acetyl-S-CoA from fatty acids.
    3. After a few days the body switches over to a system in which energy can be obtained from ketone bodies. The brain is able to meet some of its energy needs by metabolizing ketone bodies.
- As long as enough water is available a person can usually survive a few months on just water.

What to Know About Blood Glucose Regulation

- Hypoglycemia is low blood sugar.
- Hyperglycemia is high blood sugar.
- That when blood sugar drops the body releases the hormone glucagon.
- Glucagon increases blood glucose level, one of the ways it does this is by causing glycogen to be broken down.
- When blood glucose increases the body releases insulin.
- Insulin decreases blood glucose level, one of the ways it does this is by storing glucose as glycogen.

Diabetes

- In individuals with diabetes blood glucose is poorly regulated.
- There are 2 types of diabetes; they have very similar symptoms but different causes.
- In diabetes insulin is unable to decrease the level of glucose in the blood.
- Diabetes results in high blood glucose levels that are maintained until the blood glucose is used up by normal metabolic processes.
- Diabetes can cause a body to waste away even though it has adequate caloric intake.
- Type I diabetes, juvenile diabetes, and insulin dependent diabetes are the same thing.
    - In these individuals, the pancreatic beta cells are nonfunctional and so insulin cannot be released into the blood stream.
    - Treatment for Type I diabetes includes insulin shots.
    - Type I diabetes can result in ketoacidosis when acidic ketone bodies build up in the blood. This occurs because of prolonged high levels of blood sugar.
    - Ketoacidosis makes breath smell like acetone. (Acetone is one of the ketone bodies. Breath often will smell more like alcohol than like acetone.)
    - Ketoacidosis results in a rapid respiration rate because removal on CO_2 can result in a decrease in the pH.
        - $H^+ + HCO_3^- \rightarrow H_2CO_3 \rightarrow H_2O + CO_2$
    - In individuals with Type I diabetes blood sugar can also reach dangerously low levels. This can occur because of an overdose of insulin, or a missed meal.
- Type II diabetes, adult onset diabetes, and insulin independent diabetes are the same thing.
    - Type II diabeties results when the body is no longer sensitive to insulin.
    - Type II diabetes seems to results when insulin receptors no longer recognize insulin.
    - Drugs that increase insulin, increase the number of insulin receptors, and careful diet are used to treat Type II diabetes.
    - Development of Type II diabetes seems to be diet dependent.

Things to Know About Gluconeogenisis.

- Gluconeogenisis is the creation of glucose from not carbohydrate molecules.
- Our bodies can sythesize glucose from amino acids, glycerol, and lactate.

What to Know, Chapter 24 Lipids

General Information

Waxes, triglycerols, steroids, prostoglandins have the general structures given on p. 746.

Fatty Acids

- Fatty acids are long unbranched carbon chains with a carboxyl group on one end.
- Fatty acids are frequently found joined to alcohols.
- Saturated fatty acids do not contain a carbon – carbon double bond in their tail.
- Unsaturated fatty acids contain at least 1 carbon-carbon double bond in their tail.

- Saturated fatty acids are solids at room temperature, unsaturated fatty acids are liquids at room temperature.
- Unsaturated fatty acid tails cannot line up next to each other.
- Hydrogenation of unsaturated fats converts them to saturated fats.
- All naturally occurring fatty acids are "cis" fatty acids not "trans" fatty acids.
- Partial hydrogenation can create "trans" fatty acids.

Naturally Occurring Fats

- Fats and oils that we encounter daily are usually combinations of several types of lipids.
- Lard and olive oil contain more than 5 types of fatty acids. The characteristics of lard and olive oil are determined by the relative amounts of these fatty acids.
  Proportionately lard contains more saturated fatty acids than olive oil,
- Lipids that are solid at room temperature generally contain more saturated fatty acids than lipids that are liquid at room temperature.

Waxes

- Waxes are lipids. Waxes occur naturally on fruits, vegetables, plant leaves, fur, and the feathers of water birds.
- Waxes are also put on fruits and vegetables in order to keep them fresh.
- Waxes dissolve in nonpolar solvents like gasoline.

Triacylglycerols

1. Triglyceride and Triacylglycerol are different names for the same thing.
2. Triacylglycerols are nonpolar, and uncharged.
3. Triacylglycerols contain 3 fatty acids linked to a glycerol.
4. The lipids in fat cells are triacylglycerols.

Hydrolysis of Fats

1. Lipids are traditionally used to make soaps, this process is called saponification.
2. Hydrolysis of a lipid occurs when it is heated in the presence of a strong base.
3. In the presence of a strong base fatty acid esters break down to give an alcohol and a fatty acid. (See the top of page 756)
4. The carboxylic portion of the fatty acid is polar.
5. Micelles have the structure shown on p. 756 of the text. This arrangement creates a nonpolar region in the middle of the micelle.
6. In soap molecules, the fatty acids arrange them selves in micelles.
7. The micelles allow nonpolar molecules to dissolve in a water solution, and this is why soap can clean oil off surfaces.

Cell Membrane Structure

- Cell membranes are composed of a phospholipid bilayer as shown on p. 763 and p. 764.
  - Phospholipids have a small polar region and a 2 long nonpolar chain.
- The polar heads of the lipids that make up the membrane are oriented toward the water and the nonpolar tails are oriented inward.
- The phospholipids can very from one another. The phosphate group usually has another group attached to it.

Glycolipids in cell membranes

- Glycolipids are lipids with a carbohydrate group attached.
- Glycolipids are frequently found in cell membranes. The lipids resemble other memebrane lipids, carbohydrate portion of these lipids extends into the polar surrounding solvent.
- Glycolipids frequently function as receptors, and as transmitters.
- Ganglioside is a particular glycolipid.
- Tay Sachs is a terminal genetically determined illness that results from an overabundance of a glycolipid, ganglioside, in neural tissues.

- Like Sickle Cell Anemia both parents must be carriers in order for the disease to be seen.

Cholesterol
- Cholesterol is a steroid, but it is not a hormone. (Like testosterone etc..)
- Cholesterol is flat, rigid, and nonpolar.
- It is found in the hydrophobic region of cell membranes.
- Cholesterol increases the rigidity of cell membranes, probably because it is rigid.

Prostaglandins
- Prostaglandins seem to have a role in controlling and stimulating many biological processes.
- Prostaglandins are quickly metabolized by our bodies, so they act locally.
- Prostaglandins, and their derivatives, are important medically.

Chapter 25: What to Know

General Information

Lipids do not easily travel in the blood stream. They need to be grouped with other lipids in lipoproteins.

Lipoproteins are a combination of phospholipids, proteins, cholesterol, and cholesterol derivatives.

Digestion Pre Intestine
- Fats are not broken down by enzymes in the mouth.
- The stomach churns the fats into very small droplets.
- This process takes time, so a person feels "full" for a longer time.
- Stomach acids do **not** break the fats down.

Intestines
- Enzymes are used to break the triacylglycerols into fatty acids, glycerol, monoacylglycerols, and diacylglycerols. In general the triacylglycerols are only partially broken down by the enzymes.
- The enzymes are lipases and they originate in the pancreas.
- Bile is needed in order for fats to be digested. Bile comes from the gall bladder,.
- The larger insoluble products of this digestion are carried through the blood in lipoproteins.

Lipoproteins
- Lipoproteins are grouped by composition,density and function.
- 4 classes of lipoproteins are involved in transporting lipids to, or away from the liver.
    - Very-low-density lipoproteins (VLDL) – take triacylglycerols from the the liver to other parts of the body. (Very bad)
    - Low-density lipoproteins (LDL)- transportation of cholesterol from the liver to other parts of the body. (Bad)
    - Intermediate-density lipoproteins (IDL)- carry pieces of very low density lipoproteins back to the liver.
    - High-density lipoproteins (HDL)- transport cholesterol from dead or dying cells back to the liver. (Good)
- HDL is generally called "good cholesterol". LDL is generally called "bad cholesterol".
- HDL and LDL both contain cholesterol. The cholesterol in these is the same. What is different is the lipoprotein that they are held in.
- High LDL is associated with heart disease, while high HDL is associated with lower risk of heart disease.