NAME ANSWER KEY DECEMBER 2014

CHEMISTRY UNIT STUDY GUIDE

- **CHEMISTRY** is the study of matter and how it changes/interacts.
- **MATTER** is anything that has mass and volume.
  - **MASS** is the amount of "stuff" (matter/atoms) something is made of.
    - Measured in units called grams with an instrument called a triple beam balance
    - Weight is similar to mass, but depends on gravity. (w = m x g)
    - Mass a measure of/proportional to **INERTIA**, the tendency of an object to resist a change in its motion (Newton's 1st Law: *"An object in motion stays in motion; an object at rest stays at rest."*)
  - **VOLUME** is how much space an object takes up.
    - The volume of regular solids are measured in cubic centimeters (cm^3) using a ruler and the formula $V = L \times W \times H$.
    - The volume of irregular solids (or liquids) are measured in milliliters (mL) using the **water displacement method** and a graduated cylinder.
    - Graduated cylinders are read from the bottom of the **meniscus**, the curve in the surface level.

    $1\ cm^3 = 1\ mL$
  - **DENSITY** is a derived quantity, meaning it can't be measured but instead must be calculated.
    - The formula for density is $D = \frac{m}{V}$.
    - Substances with a density > 1.0 g/cm^3 will sink in water.
    - Substances with a density < 1.0 g/cm^3 will float in water.
    - Density is a **characteristic property**, meaning it's the same for all parts of a substance:

      Example 1: *20 oz. of Coke has less volume and mass than a 2 liter of Coke, but both have the same density.*

      Example 2: *Archimedes famously shouted "Eureka!" when he displaced water in his bathtub and had the idea to measure the volume and mass of a gold bar to find its density. Then he could compare it to the density of the king's crown, which he didn't believe was real gold. Even though the two didn't have the same shae, size, or weight, if they were both pure gold, then their densities should be equal.*

- Mass, Volume, & Density are all examples of physical properties, along with color, smell, texture, etc.
- Physical properties can be observed or measured **directly** without changing the chemical makeup of the substance. (Chemical properties can only be observed during a chemical change.)
  - **Malleability** is the ability to be bent, twisted, or shaped (like clay).
  - **Permeability** means water or other fluids can pass through it (like a sponge).
  - **Solubility** means is can dissolve in liquids (like sugar in water)
  - **Viscosity** is how thick a fluid is, or how slowly it pours.
    - Syrup or pudding have high viscosity, water has low (because it pours easily)
    - Heating a substance generally lowers viscosity.
  - **Luster** is the ability to reflect light, as in a metallic shine
  - **Sonorous** is the ability to vibrate with a ringing sound, as in a metal bell

- **Temperature** is a measure of the average kinetic (motion) energy of the particles in a substance.
  - According to the **Kinetic Theory of Matter**, everything is made of tiny particles (atoms) in constant motion. A substance's **State of Matter** (or "phase") – solid, liquid, gas (etc.) – is determined by how much kinetic energy/motion these particles have (**thermal energy**).
    - Heat is a measure of the transfer of thermal energy between substances.
    - Heat always travels from an area of high temp. to an area of low temp.
      - **Exothermic** describes heat leaving or exiting a substance.
      - **Endothermic** describes heat entering, or going into a substance.
  - Temp. is measured with a thermometer in metric units of degrees Celsius.
    - Temp. can also be expressed in **Centigrade** (same as Celsius),
    - **Fahrenheit** (British Imperial, not metric. Now used only in U.S.)
    - **Kelvin** (based on kinetic energy; zero particle motion = "**absolute zero**," theoretical lowest possible temperature = -273 degrees Celsius)
- **States of Matter** are Physical Properties determined by Temperature
  - Solid – particles are packed close together, connected; vibrating in place
    - Definite volume, definite shape
  - liquid – particles are close, but can slide around one another; more kinetic motion
    - Definite volume, indefinite shape (takes the shape of its container)
  - gas – particles have separated due to large kinetic motion, moving around in space
    - Indefinite volume, indefinite shape (expands to fill its container)
  - plasma – highly charged gas particles, emit electrical field; found in neon lights, lightning, stars; most common type of matter in the universe
  - Bose-Einstein condensate – exotic state of matter created under laboratory conditions near absolute zero Kelvin; all particle "condense" together to form one "super atom"
- **Phase Transitions**, or changes between States of Matter, are physical changes (because chemical identities don't change – ice water, liquid water, and water vapor are all still H_2O molecules.)
  - Solid → Liquid = melting
  - Liquid → Gas = boiling, evaporation
  - Solid → Gas = sublimation
  - [Gas → Plasma = ionization

  ENDOTHERMIC

  Liquid → Solid = freezing
  Gas → Liquid = condensation
  *Gas → Solid = deposition
  Plasma → Gas = deionization]

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- When graphing change in temperature over time, a stair-step pattern emerges with flat plateaus at the substance's Boiling/Condensation Point and Freezing/Melting Point. These are characteristic properties (like density) that can be used to identify a substance. (Water boils at 100 °C and freezes at 0 °C.)

- Physical Changes, like Phase Transitions, can generally be reversed.
- **Chemical Changes** cannot always be easily reversed (because atoms get rearranged – NOT created or destroyed)
    - **The Law of Conservation of Mass** says atoms cannot be created or destroyed, only rearranged; the number of atoms (and thus the mass) of the **reactants** will always be equal to the **products**
    - Examples of **Chemical Properties** (which are only evident during **Chemical Changes**) include...
        - **Reactivity** – how easily or quickly the the substance will react, and with what other chemicals
            - Has to do with valence electrons. (Alkali Metals & Halogens most reactive. Fr & Fl)
        - **pH** – how strong or weak an acid or base
            - Scale from 0 to 14; 0 = strong acid, 7 = neutral (water), 14 = strong base
            - Acids have H^+ cations, meaning they are electron recievers/proton donors
            - Bases have HO^- anions, meaning they are electron donors/proton recievers
            - Base in solution is called alkali, yeild water and a salt in neutralization reaction
        - Flammability – the ability to burn (means the same as "inflammability")
        - **Combustibility** – ability to combust (burn at a rapid rate, i.e., explode)
            - Combustion (burning) requires (1) ignition source, (2) fuel, (3) oxygen
        - **Toxicity**
        - Ability to Decompose or Decay (stable vs. unstable)
- The speed of a Chemical Reactions/Chemical Change is known as the **Rate of Reaction**
    - Factors that affect Rate of Reaction:
        - **Temperature:** higher temp. = more kinetic motion of particles = speedier R.o.R.
        - **Surface Area:** higher surface area (meaning pulverized/ground up more finely) = more particles exposed at once= faster Rate of Reaction
        - **Agitation** (stirring/mixing): artificially generates more kinetic energy, causes particles to interact more quickly = faster R.o.R.
        - **Concentration:** higher concentration (more solute dissolved into the solvent) means more particles to interact with = faster R.o.R.
        - **Pressure:** low pressure means gas particles spread out, interact less frequently; high pressure squeezes them close together, causing them to collide more often = faster R.o.R
        - **Catalyst:** a chemical substance that causes a reaction to speed up, acts as the "middle-man" go-between to help two reactants get what they need from each other
    - In a Chemical Reaction, the chemicals reacting with one another are called the reactants, and the chemicals produced are called the products. (They must equal one another.)
    - In a Chemical Equation, the sign "→" means yields, and shows the direction of the reaction.

- Matter is composed of **elements**, **compounds**, and **mixtures**.
  - Elements are the basic units of matter, the smallest particles of which are called **atoms**. There are 118 different types, each with unique physical and chemical properties.
  - Atoms combine together (chemically "bond") to form molecules.
    - **Diatomic** molecules are made of two atoms of the same element (e.g., O_2, H_2, Cl_2)
  - Atoms of different elements combine chemically ("bond") to form Compounds.
    - Compounds have different chemical & physical properties than the elements that compose them (e.g., Sodium is soft, silver-colored metal that reacts strongly with water and Chlorine is a yellow, poisonous gas. But the compound Sodium Chloride is a brittle white solid that dissolves in water and that is necessary in our diet.)
  - Mixtures do not combine together different substances chemically, but only mix them together in the same physical space. Therefore, they can be physically separated. Methods to separate mixtures take advantage of differences in physical properties, like magnetism, solubility, and different boiling points.
    - **Filtration** can separate solids that are insoluble from a liquid.
    - **Sieving** can separate solids of different particle sizes.
    - **Evaporation** and **Condensation** can separate dissolved solids from a liquid.
    - **Chromotography** can be used to separate different color dyes.
    - **Distillation** can be used to separate substances based on boiling and condensation points.
  - If the different substances are not uniformly distributed, meaning they can be easily distinguished from one another, then we describe that mixture as heterogeneous. ("hetero-" = different)
  - If the substances are evenly distributed, meaning they are so well mixed we can't tell them apart or see the difference, we describe them as homogeneous. ("homo-" = same)
  - Solutions are a common type of homogeneous mixture in liquid (e.g., salt water)
    - The substance dissolved in the liquid is called the solute.
    - The liquid doing the dissolving is the solvent.
    - Water is known as "the universal solvent."
  - Suspensions are a heterogeneous mixture in a liquid, in which the particles do not dissolve and will eventually settle out due to gravity. (e.g., snow globe, muddy water, orange juice)
  - Colloid are a solution of particles in water that will not settle out, but are nonetheless much larger than the particles of the solvent. Therefore, when you shine a light through the solution, the larger particles refract the light. (e.g., fog, milk, jello)
  - Emulsions are heterogeneous mixtures of oils and water (e.g. salad dressing)
  - Alloys are homogeneous mixtures of metals (e.g., brass, bronze, pewter)
  - Amalgams are homogenous mixtures involving mercury (e.g. dental fillings)