Chemistry, Part 1 – Live Labs

In Chemistry, students will develop an understanding of the key principles of matter, and the elements and the periodic table, with a focus on the trends and reactivity of the elements. Students will learn about chemical compounds and bonding, as well as the types of chemical reactions, and how they all adhere to the conservation of matter. Students will go on to be able to solve for chemical proportions in compounds, as well as quantities in chemical reactions, including finding the limiting reagent and percent yield. Students will then learn about solutions and solubility, and will move on to the nature and behavior of acids and bases. Students will study gases and will learn the gas laws, as well as be able to comprehend the concept of chemical equilibrium.

1. **Paper Chromatography**
   Students gain an understanding of chromatography. They observe the separation of metal ions, the components of ink, etc. Students will learn to separate components of a liquid solution by passing them through a porous paper, noting capillary action. Students will put three drops of copper nitrate and three drops of bromophenol blue into a well and will mix them with a pipet. They will then put a drop of this mixture on a predetermined mark on the paper and will then dip the paper in water. The distances of the components of the mixtures will be measured and recorded, after the paper has dried. The same process will be done with a dot from a black felt tip open, and with other dark water solutions, like food coloring, beet juice, etc. The students will report on their findings.

2. **Properties of a Group in the Periodic Table**
   Students are introduced to the concept of elements groups. They will show how elements in their groups are similar to one another and explain why. Students will note patterns in the periodic table and will verify them through experimentation. The room temperature resistance of C, Si, Ge and Sn will be measured using a multimeter on the resistance range in the 200 Ohm scale. The samples will then be cooled with ice water, and after drying, their resistances will be measured again. The students will repeat the same process again, after having heated the samples with hot water. The students will then attempt to scratch the samples with a knife, to determine if they are soft, brittle, or ductile. The results will be recorded in a table and interpreted, looking for how the elements from group IVB are similar, and different.

3. **Atomic Orbital Models**
   Students will become familiar with the geometry of some atomic orbitals. Students will make a physical representation of the atomic orbitals, based on the Heisenberg Uncertainty Principle, and the Schrodinger Wave Equation. They will make a 3d model of atomic orbitals, using pipe cleaners and foam balls, along the X,Y,Z axis. Students will build three 2P orbitals and will determine whether or not there is overlap between any orbitals, the size or each orbital, and how that represents the “likelihood” of an electron being in a specific location.

4. **Hybridization of Orbitals**
   Students will visualize hybridization. Students will build a model of methane, showing sp3 orbitals from paper clips, pipe cleaners, foam balls, and thumbtacks, noting hybridization that occurs as the orbitals compete for space. Students will be required to measure and build the bonds at specific angles (109.5 degrees) and will note the resulting shape of the hybridized molecule of methane.

5. **Electrical Conductivity**
   Students will get a better understanding of conductivity of liquids. Students will measure the difference in conductivity between salts, strong acids, strong bases, weak acids, and weak bases, as well as the conductivity of an organic solution and an organic liquid. Students will put samples in wells and will measure their electrical conductivity using a conductivity apparatus and a 9-volt battery. The results will be presented in a table, and will be interpreted by the student, looking for trends in conductivity.

6. **Decomposition**
   Students will observe the decomposition of H2Oand NaCl, noting the nature of stepwise reaction, and properties of hydrogen and oxygen. The students will use an electrolysis device, placing the electrodes in a beaker with the liquid being measured. As gas is produced, it will be measured by collecting it in test tubes, and the gas will be test for flammability. The student will be asked to interpret which gas is created at the positive and negative terminals of the electrolysis device, noting the stepwise reaction that is responsible for creating the gas. The process will be done for both water and sodium chloride

7. **Double Replacement Reaction**
   Students will gain a better understanding of double replacement reactions and learn that reactions go to completion when one of the products is removed. Students will experiment with the double replacement reaction involving Ca(NO3)2, Cu(NO3)2, Ni(NO3)2, and Zn(NO3)2, by placing the solutions in wells. Chemical reactions will be recognized by a change in color, as a precipitate is formed. The results will be organized into a table, and the students will write a balanced equation for all of the double replacement reactions that occurred.

8. **Oxidation - Reduction**
   Students become familiar with single replacement reactions. They gain a better understanding of oxidation, reduction and oxidation-reduction reactions; as well as the reactivity of some metals. They will perform a series of reactions to understand single replacement reactions and the ideas of oxidation, reduction, and oxidation-reduction reactions. Students will react Cu(NO3)2, Fe(NO3)2 and Zn(No3)2 with raw copper, iron, and zinc. Students will then look for and record which metals appeared to have been oxidized, and who the corresponding oxidizing agents were. The results will then be organized in a table and interpreted.

9. **Mole Ratios**
   Students will experimentally find moles ratios of simple reactions and will find excess and limiting reactants. The two reactions that the students will experiment with are between Copper Nitrate & Potassium Iodide, and Calcium Nitrate and Sodium Oxalate. Varying ratios of each will be placed in wells and each will be examined for the formation of precipitate. The results will be recorded in a table and interpreted, for mole ratios and the identification of limiting and excess reactants.

10. **Titration**
    Students will better understand molarity. They will perform a simple titration and use the experimental data to determine the molarity of vinegar and will go on to calculate the percent of acetic acid in the vinegar. Vinegar will be placed in a small beaker and diluted with water. Then, NaOH will be added to titrate the vinegar solution. Phenolphthalein indicator paper will be used to find the amount of NaOH required to bring the vinegar solution to a neutral pH of 7. The experiment will be repeated, and the outcomes averaged to reduce experimental error, and the results will be interpreted and used to find the molarity of vinegar as well as the percent of acetic acid in the vinegar.

11. **Molar Mass by Titration**
    Students will verify the molar mass of a compound by conducting a titration using KHP and KOH. The KHP will first be dissolved in water and the pH of the solution will be assessed using the phenolphthalein indicator paper. KOH will then be added incrementally, until the solution is measured as having a neutral pH. The process will be repeated five times, so that students can average their results, reducing error. Then, by knowing the amount of KOH added, they will be able to determine the molarity of the KHP, and its molar mass.