

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. **Scientific Method**

This lab introduces the scientific method to the student. It explains the importance of experimentation and illustrates how experiments are conducted. It sets the pattern and investigation for doing all the labs.

2. **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 pen, and with other dark water solutions, like food coloring, beet juice, etc. The students will report on their findings.

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 of 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 sp^3 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 H_2O and $NaCl$, 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 tested 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 $Ca(NO_3)_2$, $Cu(NO_3)_2$, $Ni(NO_3)_2$, and $Zn(NO_3)_2$, 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. **Analysis of Hydrates**

Students will find the water of hydrations of several salts by first measuring the mass of the salts, on a digital balance, before water is added. The salts will then be heated up, and water will be added. The masses of the solutions with water and salt will then be weighed and recorded in a table. Students will use these values to calculate the theoretical ratios of salt to water for each of the salts and measure those ratios against known values.

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.