Chemistry Around Us

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INTRODUCTION

There are many sayings about teaching as a profession. Some people believe teaching is an art form. Others believe that one has to love teaching in order to make it a lifelong commitment. The latter is true for me. I love to teach, and I want my lessons to be interesting and meaningful to my students. My experiences with different age groups have made this idea of a meaningful and interesting lesson a burning desire for me to accomplish within the confines of the curriculum.

I have taught for many years, in different countries, and at different grade levels. All through these years, the same questions keep coming to mind.

- How can I make my lessons interesting and meaningful to the students?
- What kinds of hands-on- materials would be most useful and effective for the learners to comprehend, considering the enormous amount of materials/activities available to both teachers and students today?
- Is it possible for my students to design experiments, write equations for the chemical reactions, and create molecular descriptions of a future event based on current evidence or past experience?

Based on these experiences, I decided to develop a curriculum that will enable my students to understand the periodic table, elements, and compounds. If everything we see around us is either an element or a compound, then in order to understand the world, as we know it, we have to somehow engender in the students a mode of thought that sees things at that level. When students drink a glass of water for example, do they have a blank spot in their minds when the materials they are devouring are slithering down their little throats or do they see little models of the water molecule, in constant motion of course, in fact in enough motion to be in the liquid phase? And do they see the molecular interactions between the water molecules, with the negative pole of one little molecule attracting the positive pole of another, so much so in some cases that water actually ionizes itself, constantly forming hydronium and hydroxide ions and then just as constantly forming water molecules again depending on the proximity of the molecules? In this curriculum unit, I want to explore how we can create scientifically literate thoughts in the minds of our students and how we can get them thinking at the atomic level.

Learning to see the nano-world, the world of the very small, has never been more necessary than at this particular historical conjunction. With Hollywood making movies about the nanobots, instilling fear of what might certainly prove to be the salvation of our planet, the study of the atom-to-atom interactions must at some point be understood and mastered if we are to have the means to control our destiny. It becomes all the more important for teachers to address this aspect of the human conversation, demystifying and demythologizing the study of the atoms and molecules that make up our material environment.

This year I have been a participant in the Houston Teacher's Institute (HTI) seminar "Chemistry through the Ages." In the seminar we have attempted to peer into the discussion of what the universe is made of, starting with the Greeks—Democritus and his teacher Leucippus, who first proposed in writing that has been preserved, the concept of the atom. It is startling to look back as these incredibly perceptive natural philosophers as they used human reason to try to explain the world they see around them. It is amazing to know that their thinking was not influenced by a science class in school in which the teachers tried to get them to believe in atoms. They just deduced, using logic and their own experience, that the world must be composed of tiny basic particles that cannot be further divided without losing something essential.

This notion was debated, ignored, pondered, and finally in the 1600's, experimented with when John Dalton finally said, "Darn. My laboratory experiments tell me that Democritus was right on the money." But again, Dalton was experimenting and thinking in a relative scientific void compared to the climate our students are privileged to be immersed in. Later in the early 1900s we find ourselves having to again make a radical leap in our understanding as J. J. Thomsen discovers a disturbingly negative little something (electron) that streams out of the little solid marble that Democritus and Dalton envisioned. Then Rutherford stuns the world when his alpha particles whiz right through the thin gold foil instead of being deflected like Thomsen's plum pudding would have done if it indeed were plum pudding. Shazzam, we undergo a paradigm shift in our thinking about the atom, as it suddenly becomes mostly empty space, a far cry from what Democritus, Dalton and Thomsen saw. After Bohr got through with that empty space it was divided into distinct energy levels and after de Broglie got through with the electron, it was never in any one spot but was instead a negative cloud with only probabilities to describe it. The atom that our students learn then, is the result of a long process of trial and error, a model that is still being revised and changed but which now explains more neatly the things we see happening in our laboratories. And, seeing things happen in the laboratory that can then be explained using the models is what this unit purports to do.

Students will learn the specific uses of the elements, the dates of their discovery, and the probable physical and chemical changes that may occur when these elements are placed in close proximity to one another. The lessons will be suitable for middle school students, especially the sixth graders. This is the age when children seem to develop a lack of interest in academics, and science in particular. Either that or they suddenly develop inordinate interest in the social aspects of being human so that all else is pushed aside. The objective of this unit is to present lessons on elements, compounds, and chemical reactions that show a relationship amongst these topics in a fun and interesting way. Experimentation with household items that will demonstrate the extent of chemical reactions around us will be explored at a greater length. Making chemical reactions real instead of an abstract concept will be a major focus of this curriculum unit.

UNIT BACKGROUND

Because of the work we did in the HTI seminar with Dr. Scott Perry (University of Houston chemistry professor) studying the developing understanding of chemistry through the ages, I am inspired to help my students investigate the nature of elements, their arrangement in the periodic table, the extent of their abundance, their difference from compounds and mixtures, and their role in chemical reactions.

The students will investigate the year elements were discovered, their uses, and how they are arranged in the periodic table. They will identify some familiar compounds and their constituent elements. This curriculum unit will help my sixth grade students understand the historical development of our knowledge of the elements, how we have learned to understand elements combining to form compounds, and how compounds and elements interact to create the phenomena we witness in our daily lives. The curriculum will also be an excellent tool for any middle school science teacher who is interested in a new and innovative method of teaching physical and chemical changes, chemical reactions, and the discovery of elements. The students will create a data table with the names of the elements, dates of discovery, uses of these elements, and plot a graphical representation of the period that the elements were discovered. The graph will be an additional tool to address different types of learners. Teachers who want to avail themselves of the books cited in the bibliography will find these sources rich in narratives that give life to what could otherwise be dry lists of facts. In the course of the HTI seminar we have read three books in particular which can help teachers develop a more narrative approach to the teaching of chemistry facts. (See bibliography)

One may want to know why it is important to know when these elements were discovered. Today's students want to accomplish tasks in a fast and easy manner. Anything that takes a while to accomplish is considered to be a waste of time. I see this behavior almost everyday in my laboratory. Students want to know why they should do three trials to obtain a valid result; why can't they do it once or twice; why do they need three trials per test, always why, why, why? Students need to know the many, many, many years of trials, accidents and lucky guesses that have preceded our current volume of knowledge about the make-up of the universe. The students need to know that some elements such as carbon and sulfur were known and used by ancient civilizations. The Iron Age and the Bronze Age are named for the elements and compounds that helped shaped the events we are taught as history.

In this unit, the students will also use analytical and qualitative skills, inferences and predictions, creativity, and problem-solving skills to investigate elements in each group of the periodic table. The students will work in groups of eight to investigate elements, when they were discovered, their physical and chemical properties, and some common reactions. They will also be able to identify constituent elements from the reactions.

Overview of Elements, the Periodic Table, Compounds, Mixtures, and Chemical Reactions

Elements are found almost everywhere, in the ocean, in the air, the earth, and the body. An element is a pure substance that is made of only one kind of atom. An atom is a tiny structure found in all matter. Matter is anything that has mass and occupies space. Most substances contain many different atoms. Elements contain only one kind of atom. The most abundant element in the air is nitrogen, in the earth is oxygen, and in the body is hydrogen. Elements found in the body are hydrogen, oxygen, carbon, nitrogen, and other trace elements. In the Periodic Table, elements are arranged in horizontal rows and vertical columns. The elements in the horizontal rows are known as periods while the elements in the vertical columns are known as groups or families. The horizontal rows represent electron energy levels, and the vertical columns represent the chemical properties of the elements. Elements are also grouped as metals, non-metals, and metalloids. Metals are elements that have the properties of luster, malleability, ductility, and conductivity. Nonmetals do not have the properties of luster, malleability, ductility, and conductivity. Metalloids are elements that have some properties of both metals and nonmetals. The type of information available from the periodic varies depending on the version; however, each table has the element name, symbol, the atomic number, and the atomic mass. A symbol identifies a single element, the atomic number equals the number of protons, and the mass number equals the number of protons plus neutrons. The number of electrons equals the number of protons. An atom is the smallest unit of an element. It consists of three particles, namely, protons, neutrons, and electrons. The nucleus of the atom is made of protons and neutrons while the electrons move around rapidly in the space outside the nucleus.

Chemists use the periodic table to determine which elements can combine and in what proportions. They also use the periodic table to determine which elements have similar properties. Chemists can use this information to help manufacturers determine how to improve their products and processes. For example, the use of helium instead of hydrogen in dirigibles provides safety.

Two or more elements combine chemically to form a compound. Molecules are two or more atoms joined together by chemical bonds. The atom can be the same element or different elements. If the molecule is a combination of different elements, it is a compound. Carbon dioxide (CO_2) and sodium chloride (NaCl) are compounds, while ozone (O_3) is not. It is a molecular form of the element oxygen.

Mixtures are made of two or more pure substances that are mixed together but not chemically combined. Examples of mixtures are Italian dressing, pizza, and fruit salads. In these examples, the ingredients are mixed together, but they still maintain their separate identity. Mixtures are classified into two groups namely heterogeneous and homogeneous. A heterogeneous mixture means that no two parts are identical, for example, pizza and salad. A homogeneous mixture occurs when different parts appear as one, but are not. Some examples of homogeneous mixtures are milk, stainless steel, and toothpaste. In homogeneous mixtures, particles are mixed together but are not dissolved completely; they are known as colloids. Colloids are larger than ordinary molecules but too small to be seen with ordinary eyes. Most colloids appear cloudy. The table below shows some examples of colloids:

Type of Colloid	Examples
Fog (Liquid in gas)	Clouds
Smoke (Solid in gas)	Smoke
Sol (Solid in a liquid)	Paint
Foam (Gas in a liquid)	Whipped cream
Emulsion (Liquid in a liquid)	Mayonnaise
Gel (Liquid in a solid)	Butter

Chemical reactions take place when bonds between atoms break and form one or more new substances. An equation describes a chemical reaction using symbols and formulas. The reactants are on the left of the equation while the product(s) are written on the right of the equation. Chemicals are reacting if there is evidence such as color change, production of a gas, and odor. New substances are created when chemicals react. A change in temperature indicates that energy is being released or used as new substances are formed. Reactants are chemicals that take part in chemical reactions, while products are the new substances that form as a result of the chemical reactions. An endothermic reaction is a reaction in which energy is absorbed. An endothermic reaction feels cool because heat energy from the hand is absorbed by the reaction. An exothermic reaction is a reaction in which heat energy is released.

A chemical equation may be a synthesis reaction, a decomposition reaction, or a replacement reaction. In a synthesis reaction, two or more substances combine to form a new substance. Synthesis reactions happen around us everyday. When fire burns, rust forms, and silver tarnishes, synthesis reactions have taken place. Burning of a wooden splint is a chemical reaction of a fuel and oxygen. Heat and light are always produced in this synthesis reaction. In decomposition reaction, a compound breaks down to form one or more simpler substances. This reaction occurs everyday, for example, when you take a cap off a bottle of sprite or any other soda, bubbles rise quickly to the top. Carbonic acid breaks down into carbon dioxide and water. Chemical bonds are the forces that hold the different substances of a compound together. These bonds are broken when the attracting forces are broken through the use of energy.

Replacement reactions may be a single replacement reaction or double replacement reaction. A single replacement reaction happens when one element replaces another in a compound while in a double replacement reaction two elements or compounds trade places and a precipitate, water or gas, forms. A precipitate is an insoluble solid formed in the solution.

A chemical reaction is also known as a chemical change. In a chemical change, a new substance is produced. Energy changes always accompany chemical changes. Some examples of chemical changes are:

- Hydrochloric acid reacts with sodium hydroxide to produce a salt, water, and heat.
- Potassium chlorate decomposes to potassium chloride and oxygen gas.
- Iron rusts.
- Milk sours.
- Wood rots.
- Acid on limestone produces carbon dioxide gas.

A physical change involves a change in form while the original substance still exists. Some examples of physical changes are:

- Sodium hydroxide dissolves in water.
- A pellet of sodium is cut in two.
- Liquid is heated and changed into vapor.
- Ice melts.

IMPLEMENTATION STRATEGIES

The students will work in groups to investigate the following:

> Elements and the year the elements were discovered, uses of these elements, and the arrangement of elements in the periodic table.

Each group will be given the following names: Group 1 - Alkalis (he Alkali Metal Family – Group 1 Elements), Group 2 – Earth Metals (The Alkaline Earth Metal Family – Group 2), Group 3 – Transitionals (The Transition Elements Family – Group 3- 12), Group 4- The BCNO (The Boron, Carbon, Nitrogen, Oxygen - Group 13- 16), Group 5- Halogens (The Halogen Family – Group 17), Group 6- Nobles (The Noble Gases – Group 18), Group 7 – Lanthanides, Group 8 - Actinides.

The students will make a list of elements and their discovery dates on a table similar to the table shown on Appendix A.

The data on the date of discovery of elements will be used to plot a bar graph that shows how many elements were discovered within a certain period. Is it important for the students to know when elements were discovered? I think it is important because students usually search for an easy route to solve problems; therefore, if they discover through their research that the discovery of elements were not made in a day, maybe they will be more patient during their lab investigations. Every teacher wants to cultivate the right attitude to their students, in this case, the scientific method of investigation and conducting experiments, so knowing when elements were discovered and their uses will add a wealth of knowledge to any middle school students, especially my six graders.

The students will also use a table to group substances into elements, compounds, and mixtures. The table should be similar to the one shown below:

Elements	**Compounds**	**Mixtures**
• Pure • One kind of atom • Can be separated in nuclear reactions • Examples: Gold (Jewelry) and Aluminum (soda can)	• Pure • Two or more kinds of atoms chemically combined • Can be separated by chemical reactions • Examples: beaker of water (Hydrogen and Oxygen) • Iodized salt (Sodium and Chlorine) • Carbon Dioxide (Carbon and Oxygen)	• Not pure • Two or more elements or compounds physically combined together • Can be separated in physical reactions • Examples: Italian Dressing and Dumpling Sauce

The table will also include equations for reactions and structural formulas. The students will use Styrofoam balls and other tools to make molecular structures.

The students will use many sources including books and the Internet to research their elements. Based on their investigations, the students will appreciate the role elements play in our daily lives.

Chemical reactions are the focal point of this unit; therefore, the students will conduct experiments that demonstrate different types of reactions, such as synthesis reactions, replacement reactions, and decomposition reactions, and write equations for the reactions. They should also be able to identify a reaction as exothermic or endothermic. In an endothermic reaction heat is released during the process while heat is absorbed in an endothermic reaction.

The project will end with a collage in which all the groups will work together to create a periodic table with information compiled by individual groups. The collage will be a replica of the periodic table, however, without element names, symbols or atomic numbers. The only data on the table will be the potential uses of the element in today's world. This will be the highlight of the project because it will involve all the scientists (my students) working together to create a periodic table that is unique, beneficial, and meaningful to them.

Finally, each student will either write a song, a poem, or create a puzzle about the periodic table using the ele ment symbol, picture and any new information that they have discovered during their investigation.

LESSON PLANS:

Lesson One: Discovery of Elements.

Objectives: The students will understand and appreciate the unique nature of elements, the historical development of elements, the arrangement of elements in the periodic table, and how elements play a role in our daily lives.

Materials

Computer
Paper
Pencil
Graph paper

Procedure

1. Provide background information on an element.
   Explain to the students that the periodic table is the most important tool available to scientists especially chemists, because it provides a wide range of information about natural and synthetic elements. At present, there are 92 naturally occurring elements and 23 synthetic elements. These elements are arranged in horizontal rows and vertical columns. The elements in the horizontal rows are called periods while the vertical columns elements are known as groups or families. The horizontal rows represent electron energy level, and the vertical columns represent the chemical properties of the elements. There are 7 periods and 18 groups or families, which are numbered from left to right of the periodic table.
2. Allow the students to draw a table with three columns in their laboratory book. The first column is titled "Element," the second column "Date of Discovery," and the third "Use." (See Appendix A.)
3. Take the students to the library where they can use computers, books and other resources to investigate elements. (See appendix for sample.)
4. After compiling the data, allow the students to plot a bar graph of the date that the elements were discovered.

By the end of lesson one, the students should be able to compile a table of elements, the date of discovery of these elements, uses of the elements, and plot a graph that will demonstrate how many elements were discovered within a given period.

Lesson Two: Chemical Reactions

***Objective*:** To understand chemical reactions using household materials and dilute acids.

In this lesson, chemical reactions will be explored with concrete examples using common substances such as baking soda, salt, baking powder, vinegar, laundry detergent, and chemicals, such as hydrochloric acid, sulfuric acid, and chlorine. The students will have opportunity to discuss, write equations, and make models.

Chemical reactions occur when bonds between atoms break and form one or more new substances. A chemical reaction is described by an equation using symbols and formulas. For example, calcium chloride reacts with sodium bicarbonate (baking soda) to produce calcium bicarbonate and sodium chloride. This is represented by the equation – $CaCl_2 + 2\ NaHCO_3 \rightarrow Ca(HCO_3)_2 + 2NaCl$.

A chemical reaction is also known as a chemical change. In a chemical change, a new substance is produced. Energy changes always accompany chemical changes. Some examples of chemical changes are as follows: iron rusts, milk sours, wood rots, potassium chlorate decomposes to potassium chloride and oxygen gas.

A physical change involves a change in form, or phase, the original substance still exists. Some examples of physical change are as follows: sodium hydroxide dissolves in water, heated liquid changes into steam, and ice melts into liquid.

Experiment 1

Question:
What species are involved in chemical reactions?

Materials:

Distilled white vinegar (5% aqueous solution of acetic acid - $HC_2H_3O_2$)
Sanded magnesium ribbon (Mg)
Beaker
Graduated cylinder
Stirring rod
Triple beam balance (If using magnesium from a chemical supply store)
Science journal

Procedure:

1. Divide the class into 4 groups.
2. Give each group the above materials.
3. Measure 10mL of vinegar and pour it in a beaker.
4. Drop a piece of freshly sanded magnesium ribbon in the beaker of white vinegar and stir with a stirring rod. (If magnesium from a chemical supply lab is available, use a triple beam balance to measure 5g of magnesium.)
5. Record observation in your science journal. Draw and label the beaker of vinegar and magnesium.
6. Write a chemical equation for this reaction. Label the reactants and the products.

Safety Precaution:

1. Wear safety goggles
2. Do not taste or smell any substance.
3. Wipe spills as they happen.
4. Wash hands at the end of the activity.

Experiment 2

Question:

Is mass created or destroyed in a chemical reaction?

Hypothesis: (Allow students to state the hypothesis)

Example - If a chemical reaction has occurred, then there should be no change in mass after the reaction has taken place because atoms are only rearranged.

Materials:

Large test tube with rubber stopper
Small test tube that can fit in the large test tube
Triple beam balance
100-mL beaker
Lead nitrate solution $\{Pb(NO_3)_2\}$
Potassium Iodide solution (2KI)
Graduated Cylinder
Safety goggles

Procedure:

1. Measure 5 mL of lead nitrate solution in the graduated cylinder and pour it into the small test tube.
2. Use another graduated cylinder and measure 10 mL of potassium iodide solution, and pour it into the large test tube.
3. Carefully slide the small test tube into the large test tube without spilling. Place the stopper on the large test tube.
4. Put the test tube in a beaker in an upright position.
5. Place the beaker and test tubes on the triple beam balance, and record the mass in your laboratory notebook.
6. Turn the test tube upside down carefully to mix the contents.
7. Measure and record the exact mass again in your laboratory notebook.

Safety Precautions:

1. Wear safety goggles
2. Do not touch the chemicals.
3. Used materials should be disposed of properly.

Results:

Answer the following questions in your laboratory book.

1. What was the mass of the beaker and test tube in step 5?
2. What happened when you turned the test tube upside down?
3. What was the mass after step 7?
4. What were the reactants? What were the products?
5. Write an equation for this chemical reaction.

Conclusion:

Answer the questions below in your laboratory book.

1. Did you make any new substances? If so, what were they?
2. Was there any change in mass of the reactants and products? Explain.
3. Was your hypothesis correct or incorrect? Why?

Mind on Science Challenge:

Allow the students to set up an experiment to test this question: Is mass created or destroyed when a solution of Epsom salt ($MgSO_4$) is combined with a solution of washing soda ($NaCO_3$)?

Lesson Three: Types of Chemical Reactions

Objective: The students will explore different types of chemical reactions through experimentation.

In this section, the teacher will give the students background information on different types of chemical reactions. The students will be expected to perform simple experiments that demonstrate each type of reaction in this lesson and subsequent lessons.

Different Kinds of Chemical Reactions*:*

- **Synthesis Reaction -** Two or more substances combine to form a new substance. Synthesis reactions happen around us everyday. When rust forms or silver tarnishes, synthesis reactions have taken place.

- **Decomposition Reactions -** A compound breaks down to form one or more simpler substances. This reaction occurs everyday, for example, when a cap is taken off a bottle of sprite or any other soda, bubbles rise quickly to the top. Carbonic acid breaks down into carbon dioxide and water.

Carbonic acid	→	Carbon dioxide	and	water
(H_2CO_3) -	→	CO_2	+	H_2O

- **Replacement Reactions** – It may be a single replacement reaction or double replacement reaction. A single replacement reaction occurs when one ele ment replaces another in a compound, while in a double replacement reaction, two elements or compounds trade places and a precipitate forms. The precipitate may be water or gas.

Experiment One: Synthesis Reactions

Question: What will happen to a silver spoon if submerged in an egg yolk?

Hypothesis: (Allow the students to write their hypothesis.)

***Sample hypothesis* –** If there is a chemical reaction between the silver spoon and egg yolk, then a new substance should form.

Materials:

Egg
Silver spoon
Stop-watch
Beaker
Water
Laboratory notebook

Safety Precautions*:*

Wear goggles
Do not play with the egg.

Procedure:

1. Separate a yolk from an egg white and placed the yolk in a 100-mL beaker.
2. Place a clean silver spoon in the egg yolk and stir.
3. Allow the spoon to sit in the container for 30 minutes.
4. Remove the spoon in egg yolk, rinse with water, and observe what happened to the spoon.
5. Record observations in your laboratory note book.

Conclusions: Answer the questions in your laboratory notebook.

1. What happened to the spoon in the egg yolk?
2. Was there a chemical reaction? If there was, what caused the chemical reaction?
3. Is it possible to reverse the change? How?
4. Why does silver tarnish if left sitting for a long period of time? Is there sulfur in the air?
5. Write an equation for this reaction.

Experiment Two: Decomposition Reaction

Objective: The students will understand that decomposition reactions involve the breaking down of a compound to form one or more simpler substances.

Background Information:

Give the students an overview of the sugar molecule. Most students might not know that sugar is composed of three different elements with 45 atoms in one simple molecule. (Sugar molecule – $C_{12}H_{22}O_{11}$) Sugar can be decomposed by heating it.

Question: Does Sugar Break Down into it Constituents Elements When Heated?

***Hypothesis:* (**Allow the students to state the hypothesis)

Materials:

Sugar
Test tube
Metal tong
Hot plate or Bunsen burner
Triple beam balance

***Safety Precautions**:*

1. Do not eat the sugar
2. Use precaution when working with hot plate or Bunsen burner.

Procedure:

1. Measure 5g of sugar and place each 5g of sugar in two identical test tubes.
2. Place test tube A on the test tube rack.
3. Hold test tube B with a metal tong and heat the test tube carefully until the sugar is completely black.
4. Observe test tubes A and B and record your observation.
5. Using a wooden splint, taste the burnt sugar. (Do not shallow it)

Conclusion:

1. Did the change in chemical composition affect the appearance or odor? Is it still sugar?
2. Write a chemical equation for this reaction.

Experiment 3: Single Displacement Reactions

***Objective*:** The students will perform simple experiments that explain the process of replacement reactions.

Background Information:

Remind the students that replacement reactions may be a single replacement reaction or double replacement reaction. A single replacement reaction occurs when one element replaces another in a compound, while a double replacement reaction occurs when two elements or compounds trade places and a precipitate is formed. The precipitate might be water or gas. A precipitate is a solid in the solution that is not dissolved.

Materials:

3 Molar HCl (Hydrochloric acid) 20% solution
Copper (penny)
Zinc (galvanized nails are coated with zinc)
Magnesium (from a chemical supply store)
3 Test tubes (for each group)
Test tube rack (one for each group)
Goggles

Safety Precautions:

1. Wear goggles.
2. Do not touch the acid.
3. Report any spills to the teacher. Do not attempt to clean the spill!

Procedure:

1. Divide the class into 4 groups.
2. Label the test tubes, A, B, and C. A – Copper, B –zinc, C- magnesium.
3. Measure 10mL of hydrochloric acid into the three test tubes.
4. Drop each metal into their respective test tube and observe.

Conclusion:

1. Did you observe any bubbles in the test tube?
2. Which test tube had more bubbles? Why?
3. In which test tube did you feel a slight warming of the test tube?
4. Write a singe replacement reaction equation for the 3 test tubes.

Experiment 4: Double Replacement Reaction

Background:

This is a demonstration lab where the teacher will do the experiment and the students will only observe and record their observation in their science journal. In this experiment, the students will observe an orange precipitate form in the beaker and then disappear right before their eyes.

Materials:

0.1 M mercuric chloride
0.2 M potassium iodide solution
Glass beakers
Stirring rod
Goggles

Safety Precautions:

1. Wear goggles.
2. Wear plastic gloves – chemicals are toxic.
3. Do not inhale the chemicals.
4. Students should not be too close to the work area.
5. Follow safety procedures.

***Procedure*:**

1. Label 2 beakers A and B (Beaker A – Mercuric chloride; Beaker B –Potassium chloride)
2. Pour 10 mL of 0.1 M mercuric chloride into beaker A and 0.1 M potassium iodide solution into beaker B.
3. Slowly pour potassium iodide into the mercuric chloride a few drops at a time until a bright, orange solid appears.
4. Stir the solution gently until the orange disappears.

6. Continue pouring the remainder of the potassium iodide into the mercuric chloride until the solid remains as a precipitate.
7. Record observation in your laboratory notebook.

Conclusion:

- Why did the orange precipitate disappear? (The orange precipitate disappears because it can only stay as a precipitant in a supersaturated solution.)
- Describe what you observe in this demonstration experiment.
- What was the orange precipitate? (Mercuric iodide)
- Write equation for the double replacement reaction. (Mercuric chloride reacts with potassium iodide to form Mercuric iodide and potassium chloride.
  Equation for the reaction – $HgCl_2$ + KI --→ HgI_2 + KCl)

Lesson Four: Get To Know Your Elements (Gifted &Talented/Pre-Advanced Placement Students)

***Objective*:** The students will work independently to write a detail description of five elements and how they are used today.

This section will be devoted to the detailed discussion of the uses of elements. The students are to use the resources in the library to investigate the uses of their assigned elements. This is mainly for the Gifted and Talented /Pre- Advanced Placement students.

Each student should give a detailed description of at least 10 elements and how they are used today. For example: Helium is used by astronomers to eliminate space noise on their detectors. The students should describe how it works. For example, how do astronomers use helium to eliminate space noise? Helium was used to make the first gas lasers. Today gas lasers are used in bar code scanners. Scuba divers use a mixture of oxygen and helium to breathe. These are some of the uses for helium.

Procedure:

Following a class discussion of the uses of the different elements, the class will construct a periodic table of the elements in which each element is represented by a picture of its use. Chemical symbols will be added to the picture for identification purposes.

APPENDIX A

Element	Date of Discovery	Use
Phosphorus	1669	-It is used to make produce light, in glow in the dark clocks, watches, and toys. -It is used in television to make the image. -It is used in laundry soaps and other detergents.
Platinum	1700	-It is used to make jewelry. -It is used in refining oil, dental instruments, ceramics, electrical and the electronic industries.
Nickel	1751	-It is used to make coins and nickels. -It is used in magnets, heating elements in toasters and electric ovens. -It is used in rechargeable batteries for calculators, computers, and electric shavers.
Hydrogen	1766	-It is used to make ammonia, fertilizer, margarine and rocket fuel.
Oxygen	1774	-It is used as liquid rocket fuel, makes ozone that protects us from ultraviolet rays from the sun.
Potassium	1807	-It is used in explosives and gunpowder, to make batteries, and liquid soap.
Iodine	1811	-It is used to make photo film, kill germs in small wounds. -Iodine tablets are used to purify water.
Aluminum	1825	-It is used to make doors, screens, and window frames. -It is used to make drink cans, pots, and pans. -Aluminum is used in wires, reflectors, resistors, antennas, and solar mirrors.
Indium	1863	-It is used in transistors and photocells.
Argon	1894	-Argon is used in fluorescent light bulbs.

APPENDIX B

Definition of Terms

Atom: The smallest unit of an element.

Atomic mass: Equals the number of protons plus neutrons.

Atomic number: Equals the number of protons.

Chemical bonds: Forces that hold atom together in molecules and keep ions in place in solid ionic compounds.

Chemical equation: Is a statement that uses chemical formulas to express the identities and quantities of the substances involved in a chemical or physical change.

Chemical reaction (chemical change): A chemical reaction occurs when bonds between atoms break and form one or more new substances.

Chemical formula: Scientific short way of describing the chemical content of a substance. Number and letters stand for how many and what kinds of atoms are in one molecule of the chemical. For example: In CO_2, the C stands for carbon and the O stands for Oxygen. There are two atoms of oxygen and one atom of hydrogen.

Compound: Two or more elements combined chemically.

Constant: Conditions that an experimenter tries to keep from varying. (The same)

Control: In a simple experiment, there is only one subject or group that gets the experimental treatment. To better judge the results, the experimenter may use a control group or subject. This group does not get the experimental treatment but it is treated in every other way like the experimental subject or group.

Colloids: Homogeneous mixture in which particles are mixed together but are not dissolved.

Decomposition reaction: A compound breaks down to form one or more simpler substances.

Dependent/Responding variable: When the experimenter changes something to observe what happens in an experiment. What he or she changes may cause something else to happen. Therefore, what happens as a result of the change is known as the dependent or responding variable.

Electron: An electron carries a negative charge. Electrons move around rapidly in the space outside the nucleus.

Element: An element is a pure substance that is made of only one kind of atom.

Endothermic reaction: A reaction in which heat energy is absorbed.

Exothermic reaction: A reaction in which energy is released.

Experiment: An investigation made by changing or manipulating things. An experiment is usually planned to answer a specific question, to solve a problem, or to test a statement or hypothesis.

Heterogeneous mixtures: A mixture that has one or more visible boundaries among its components.

Homogeneous mixtures (solution): A mixture that has no visible boundaries among its components.

Hypothesis: A statement that explains what is to be tested, the purpose of an investigation, and what the experimenter intends to prove or disprove.

Independent/Manipulated variable: An experimenter changes something in the experiment to observe what will happen. The something that is changed is the independent or manipulated variable.

Matter: Anything that has mass and occupies space.

Mixtures: Two or more substances that are mixed together but not chemically combined.

Neutron: Protons and neutrons make up the nucleus of an atom. It carries no charge, therefore, is neutral.

Precipitate: An un-dissolved solid in a solution.

Product: A new substance formed in a chemical reaction, the right side of the yield sign in a chemical reaction.

Proton: Protons and neutrons make up the center or nucleus of an atom. The proton carries a positive charge.

Reactants: The materials that react in a chemical equation, substances to the left of the yield sign.

Solutions: Mixtures in which molecules are dissolved and uniformly dissolved into one another.

Symbol: A symbol identifies a single element.

Variables: In a thing or pattern of things being observed, a change in a dimension or a characteristic, a change in value or quantity.

APPENDIX C - ANSWER KEY

Lesson Two: Chemical Reactions

Experiment One: Observations

When magnesium is placed in vinegar (vinegar contains 5% aqueous solution of acetic acid – $HC_2H_3O_2$), a chemical reaction occurs. Bubbles of hydrogen gas are released and the strip of metal forms a new substance called magnesium acetate.

Magnesium and acetic acid are the reactants, while magnesium acetate and hydrogen gas are the products.

Mg	+	$2C_2H_4O_2$	$\longrightarrow$	$Mg(C_2H_3O_2)$	+	H_2
Magnesium		Acetic		Magnesium acetate		hydrogen (gas)

Lesson Two: Chemical Reactions

Experiment Two**:** Is Mass Created or Destroyed in a Chemical Reaction?

Results**:**

1. Answer will vary depending on the size of the beaker.
2. The reaction of lead nitrate and potassium iodide yields a yellow solid of lead Iodide (PbI_2), and a clear liquid of Potassium nitrate (KNO_3) The Lead Iodide is known as a precipitate.
3. Answer will vary. Depends on the size of beaker.
4. Reactants are lead Nitrate $Pb(NO_3)_2$ and potassium iodide (KI)
5. Products are Lead iodide PbI_2 and potassium nitrate KNO_3.

Conclusion

1. Yes, lead iodide and potassium nitrate.
2. No, there is no change in mass after the reaction because matter is neither created nor destroyed, only the atoms are rearranged.
3. Answer will vary.

Lesson Three:

Experiment One: Synthesis Reaction

Conclusion

1. The spoon turned dark (tarnished).
2. Yes, the silver spoon reacts with the egg yolk that contain trace amount of sulfur. This reaction produced the dark color.
3. Yes, an acid will react with sliver sulfide to reverse the dark color.
4. There are some traces of sulfur in the air because of pollution- this trace element is responsible for the tarnishing of silver wares if left outside for a longtime. Yes, there are traces of sulfur in the air because of pollution.
5. Ag + S $\longrightarrow$ Ag_2S

   Silver Sulfur Silver sulfide

Experiment Two: Decomposition Reaction

Conclusion

1. Yes, the white powdered sugar turned black. This indicates that the sugar broke down into carbon (the black material in the test tube) and water. The water droplets are on the side of the test tube.
2. No, because the sugar has broken down into its constituent elements and compound which is carbon and water.
3. $C_{12}H_{22}O_{11}$ + heat → 12C + $11H_2O$
   Sugar (glucose) → Carbon + Water

Experiment Three: Single Replacement Reactions

1. Yes
2. No bubbles form in the Beaker A (copper). A reasonable amount of gas is produced in Beak B (Zinc) and while Beaker C (magnesium) produced bubbles of gas. Beaker C feels warm because the reaction of magnesium and hydrochloric acid is an exothermic reaction.
   1. Cu + HCl → $CuCl_2$ + H
   2. Zn + HCl → $ZnCl_2$ + H
   3. Mg + HCl → $MgCl_2$ + H

Experiment Four: Double Replacement Reaction

1. The orange precipitate disappears because it can only stay as a precipitant in a super saturated solution.
2. The mercury atom from mercuric chloride reacts with iodine atom from the potassium iodide. The orange precipitate was mercuric iodide. The orange precipitate appears for a while and disappears because it can only stay as a precipitate in a supersaturated solution.
3. Mercuric iodide
4. $HgCl_2$ + KI → HgI_2 + KCL
   Mercuric Iodide + Potassium Iodide → Mercuric Iodide + Potassium Chloride

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