Charlotte Teachers Institute
Collaborative Teacher Education

Curriculum Unit Title

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This curriculum unit is recommended for:
Fourth Grade, Science

Keywords: Chemistry, Energy, Chemical Magic
Teaching Standards: See Appendix for teaching standards addressed in this unit.

Synopsis: This unit is designed to fit a fourth grade science curriculum. One of the topics that seem to get "skipped over" or taught extremely quickly is Conservation and Transfer of Energy. The reason for this is because typically the topic is covered after the End of Grade (EOG) test when the students have "checked out", yet it is generally the most "fun" topic of the semester. Chemistry is in everything we do. It is what makes things happen. While it is important that my students know the basics of the "how" things work- we plug things in and they turn on, we eat food and then we feel full-I believe it is even more important for them to dig deeper and really understand how things happen. I want my students to be able to really experience science and feel successful when they have a high understanding of the topics and can explain how it is that a light turns on. In order for me to be successful in teaching this topic, I had to do much in-depth research, which is in the next couple of pages to follow. Hopefully you will see the method to my madness in the classroom.

I plan to teach this unit during the coming year in to 25 students in 4th grade Science

Chemistry Makes Things Happen!

Lyndsay Burns

Introduction

Chemistry is the world around us. We are chemistry. Our students are chemistry. Without knowing it, we depend on all sorts of chemistry. We depend on chemistry in our bodies, chemistry between people, chemistry in our food, etc. While we don't sit and think about chemistry and chemical reactions, it is clear that it is very important.

I am a fourth grade teacher in a large urban school in Charlotte North Carolina. I have a class size, year to year, between 20-25 students. I am also the Exceptional Children's (EC) Inclusion teacher. This means that out of a classroom of twenty students, 10-12 of them have an Individualized Education Plan (IEP). The students in my class are a range of students whom are learning disabled, educationally disadvantaged, and emotionally disturbed mixed with students who are either at or above grade level. Most students in my classroom are not on grade level and perform two are three grade levels below the expected fourth grade level. This presents many challenges in the classroom, as I tend to spend most of the day teaching basic reading and math skills so the students can be better prepared for future grades. The students in fourth grade learn science as an inquiry. Throughout the one hundred eighty days that school is in session, the students learn a variety of topics in science- Forces of Motion (students must explain how a variety of forces affect the motion of an object), Properties and Change of Matter (students must understand the composition and properties of matter before and after they undergo a change or interaction), Conservation and Transfer of Energy (students must recognize that energy takes various forms, that may be grouped based on their interaction with matter), Earth in the Universe (students must explain causes of night and day, and the phases of the moon), Earth History (students must understand the use of fossils and changes in the surface of the earth as evidence of the history of Earth and its changing life forms), Ecosystems (students must understand the effects of environmental changes, adaptations and behaviors that enables animals (including humans) to survive in changing habitats), and Molecular Biology (students must understand food and the benefits of vitamins, minerals, and exercise). The students study many areas of this Science but very broadly. There is so much information to cover and so little time, that they don't get much of a chance to "dig deep" into any one topic.

One of the topics that seem to get “skipped over” or taught extremely quickly is Conservation and Transfer of Energy. The reason for this is because typically the topic is covered after the End of Grade (EOG) test when the students have “checked out”, yet it is generally the most “fun” topic of the semester. The standards for this topic that the students are expected to master includes the following: recognize the basic forms of energy (light, sound, heat, electrical, and magnetic) as the ability to cause motion or create change, as well as recognize that light travels in a straight line until it strikes an object or travels from one medium to another, and that light can be reflected, refracted, and absorbed. The students in the past have had to create parallel and simple circuits with a guide that helps them to figure out how to light a miniature light bulb at the end of the circuit. While for many students this can be challenging, I want it to be more rigorous and get their brains really working. In this unit, the students will figure out how to create circuits with wires, but also create electricity and circuits using various chemical solutions. This will also tie into the previous standard that the students have studied which is for them to be able to understand the composition and properties of matter before and after they undergo a change or interaction. This topic involves the students needing to be able to compare the physical properties of samples of matter (strength, hardness, flexibility, ability to conduct heat, ability to conduct electricity, ability to be attracted to magnets, and reactions to water and fire). My goal in this unit is for the students to really understand the importance of chemistry in the world around them.

Rationale

As I mentioned before, chemistry is in everything we do. It is what makes things happen. While it is important that my students know the basics of the "how" things work- we plug things in and they turn on, we eat food and then we feel full-I believe it is even more important for them to dig deeper and really understand how things happen. I want my students to be able to really experience science and feel successful when they have a high understanding of the topics and can explain how it is that a light turns on. In order for me to be successful in teaching this topic, I had to do much in-depth research, which is in the next couple of pages to follow. Hopefully you will see the method to my madness in the classroom.

Background Knowledge

What is Light?

Light is clearly a form of energy. Throughout history, light has become a very intense topic of science. Light is a name for a range of electromagnetic radiation that can be detected by the human eye. Over centuries, scientists’ views of light have changed. The first “real” theories of light came from Pythagoras in ancient Greece. He inquired that light was a ray, and that vision resulted from light rays emerging from a person’s eye and striking an object. Epicurus furthered Pythagoras' theory and said that objects produced light rays which traveled to the eye. To go along with these theories, Euclid and Ptolemy used ray diagrams to show how light bounced off a smooth surface (or bent) as it transferred to one medium or another.

Arab scholars also produced their own theories of light called geometrical optics. These scholars applied geometrical methods to the optics of lenses, mirrors, and prisms. Through this application, Ibn-al-Haytham identified the optical components of the human eye and described vision as a process involving light rays bouncing from an object to a person's eye. Through this research he also invented the pinhole camera, discovered laws of refraction, and studied rainbows and eclipses.[i]

Next in the research of light, Dutch mathematician and astronomer Christiaan Huygens discovered the "Treatise on Light" which speculated on existence of some invisible medium called ether that filled all empty spaced between objects. Through his research he found that light forms when a luminous body causes a serious of waves or vibrations in the ether. Waves would then advance forward until they encounter an object- if it is in the eye, it will stimulate vision. Isaac Newton did not embrace Huygens' theory. In 1704 he described light as particles. Newton claimed that light travelled in straight lines and bounced off "mirrors". No one saw these particles of light because they were moving too fast, they were too small, or our eyes could see right through them.[ii]

All these theories came to prove that light can be produced in many ways. The first is James Clerk Maxwell's idea of oscillating charge (electricity). Light follows complicated paths that don't need a medium to travel through. Thomas Young demonstrated the most famous experiments in the history of science- the "Double-Slit Experiment". He said that light waves obey the laws of reflection and refraction. The bending of light waves account for mirages (optical illusions caused when light waves more from the sky toward the ground and are bent by heated air). James Clerk Maxwell also formulated his own theory- electromagnetism. This theory stated that light is composed of electric and magnetic fields and can be produced by oscillating charge, such as a radio tower. These fields vibrate at right angles to the direction of the movement of the wave and right angles to each other. Also, light waves can be quantified in wavelengths. A wavelength is a distance between any two corresponding points of successive waves. Light can also be measured by its frequencies based on the number of waves that pass a point in space at any given time. Frequency is measured in cycles or the number of waves that pass a set point per second called Hertz. We can see visible light waves if they have wavelengths that range from 400-700 nanometers. Visible light is referred to as color. In frequency units this is measured from 430 trillion Hertz (which is the color red) to 750 trillion Hertz (which is violet). It is also true that high frequency light waves are of higher energy and low frequency light waves are low energy.

Light can also be produced by excited atoms and molecules. Max Planck claimed that light must carry energy is discrete quantities. Albert Einstein, in 1905, advanced his theory by explaining the photoelectric effect. Einstein said that if energy of light comes in bundles, then one can think of light as particles called photons (or "tiny lumps"). When these photons strike a metal surface, they transfer their energy to electrons which become "dislodged" from their "parent" atoms. Once the electrons are freed, they move along the metal or get ejected from the surface. Einstein also said that light is a continuous field of waves. This became what is called the Wave-Particle Duality. A collection of one or more photons propagating through spaced are electromagnetic waves. When they pass through slits they are divided into two wave fronts. These fronts overlap and approach a screen. At the moment of impact, the entire wave field disappears and a photon appears.

In 1913 Neils Bohr applied Planck's idea to refine the model of an atom. He said that electrons exist in discrete orbits based on their energy. When an electron jumps from one orbit to a lower orbit, it gives off energy in the form of a photon. This is the Quantum Theory of Light- that light exists as tiny particles called photons. A photon is produced when an electron in a higher than normal orbit falls back into its normal orbit. A photon has a frequency or color that matches the energy that the electron loses when the electron falls into the lower energy orbits.

A third way that light can be produced is chemiluminescence in living organisms. Traditional light is formed in incandescence where a filament in a bulb gets hot and emits light, but light can also be produced as a product in a chemical reaction, called chemiluminescence. Chemiluminescence in living organisms (such as bacteria, fireflies, squid, deep sea fish, etc.) is called bioluminescence. There are two important factors in bioluminescence- luciferin (the one producing the light) and luciferase (the enzyme that drives or catalyzes the reaction). Bioluminescence is a straightforward sequence reaction. The luciferase catalyzes oxidation of luciferin. Luciferin combines with oxygen to produce oxyluciferin. The reaction produces a blue, green, or blue-green light. Another way that bioluminescence reaction occurs is by a photoprotein. This is when luciferin binds with a catalyzing protein and oxygen. When an ion (which is typically calcium) is added to the photoprotein, it oxidizes the luciferin, resulting in light and inactive oxyluciferin. Marine organisms produce a blue light, which is helpful because the light transmits further in water. Luminescent animals have chemical compounds that mix together to produce a glow.

Luminescence is more efficient than incandescence. Neither of these reactions requires nor generates much heat. This is considered "cold light". Animals, fungus, foxfire, and jack-o-lantern mushrooms emit this kind of light, as well as centipedes, millipedes, worms, fireflies, and glowworms. In the ocean depths of the disphotic (poorly lit) or more commonly known as the "twilight zone" (660- 3,300 meters deep) there are many animals that are known to have bioluminescence. Only a small amount of sunlight is found here. Seawater absorbs red, orange, and yellow sunlight but not blue and violet.

The only light that reaches this area of the ocean is blue-green because it has a shorter wavelength. At this level, the light making process requires a charged ion to activate the light reaction. This process also requires oxygen or adenosine triphosphate (ATP) which is a molecule that stores and transports energy into most living organisms. Many substances act like lucifernes and luciferases, depending on the species of the bioluminescent life form.

What is electricity?

Thales of Miletus was a Greek Philosopher. He was the first human to study electricity in 600 BC by rubbing amber with fur. He found that this attracted dust, feathers, etc. This was the first experiment with electrostatics. Electricity comes from the Greek word "elektron" which means amber![iii]

William Gilbert rubbed objects together and charged them with friction. He was the one to find magnetism and static electricity. He found when they attracted or repelled, he coined them as "electric" or "forces at work". He said these forces developed because of a rubbing action that removed a fluid from the objects leaving an atmosphere around it.

In 1729, Stephan Gray discovered that some materials didn't conduct electricity, specifically silk. He said that Gilbert's mysterious fluid could travel through objects or be hampered from traveling. This led to the Leyden Jar. The Leyden Jar was a glass jar containing water and a nail that could store an electrical charge.

Late in the 1700's Ben Franklin conducted his famous Kite Experiment. He proved that lightening was electric in nature. He discovered that electricity had positive and negative elements and the flow was from positive to negative. Charles Augustin de Coulumb piggy backed on this and created Coulumb's Law. This law claimed that like charges repel, and opposite charges attract Coulumb's Law made it possible to calculate the electrostatic force between any two charged objects.

It is known that electricity needs a conductor to move, as well as a generator (which is something to make electricity flow from one point to another). A generator is a device that moves magnets near a wire to create a steady flow of electricity by pushing a certain amount of electrons along and applies a certain amount of pressure to electrons.

Chemical electricity is formed when wires are connected into chemical solutions that form a reduction/oxidation reaction (reactions that have elements that change their oxidation state or charge during the reaction) and if the reactants are separated by distance and connected by a wire and salt bridge, the transfer of electrons between the reactants (through the wire) will produce an electrical charge. On example of a reaction that could be used as a battery is when copper is inserted into an electrolyte such as hydrochloric acid plus water. Copper loses electrons and hydrogen gains them. The end result is positive charged copper ions are produced and hydrogen gas. If we separated the two reactions, the copper metal to copper ion part and the hydronium (H+ ionsi n water from the acid) to hydrogen gas part they could produce a current if connected by a wire and some kind of salt bridge.

What is Heat?

The universe is made up of matter and energy. Matter is made from atoms and molecules. Energy uses these atoms and molecules to always be in constant motion with either each other- either bumping into each other or vibrating back and forth. The motions of atoms and molecules are called heat, or thermo-energy. Chemical energy is stored in bonds of chemical compounds. The energy stored is released as heat transfer when the bonds between atoms loosen or break and new compounds are created by the reforming of bonds. When bonds break and reform in many oxidation and combustion reactions, energy in the form of heat occurs instantly. An example is when energy is produced by digestion, keeping us warm, maintaining and repairing our bodies, and allowing us to move about. There are two types of heat processes: endothermic and exothermic. Exothermic is the process that releases energy in the form of heat. An example of this is freezing water, and solidifying solid salts. Some exothermic reactions are: combustion of hydrogen, dissolving lithium choloride in water, burning of propane, dehydration of sugar with sulfuric acid, thermite, decomposition of hydrogen peroxide, decomposition of ammonium dichromate, and halogenations of acetylene. Endothermic is the processes that absorbs energy in the form of heat. Some examples of endothermic processes are: melting ice cubes, evaporating liquid water, cooking an egg, and baking bread. Some examples of endothermic reactions are: dissolving ammonium chloride in water, mixing water and ammonium nitrate, mixing water with potassium chloride, and photosynthesis.

Thermal energy is another way to talk about energy that comes from heat transfer. When a substance is heated, its particles gain energy and vibrate vigorously. They bump into nearby particles and vibrate more. Thermal energy is passed through conduction. When particles in liquids and gasses get warm, they become less dense and they usually expand and rise to the top. The space they vacate is replaces by cooler particles that are less dense. Thermal energy transferred in this way called convection.

Teaching Strategies

To being this unit, students must first learn the basics for what energy is and how energy is produced. The students must recognize the basic forms of energy (light, sound, heat, electrical and magnetic) as the ability to cause motion and create charge. We use our Science Textbooks a lot through our science units, as it is very kid friendly. The essential questions I will ask my students in these first lessons are: How can you tell an object is moving? What are some different forms of energy? The vocabulary that is introduced in these first lessons is: Motion, frame of reference, Speed, force, friction, inertia, work, energy. The students will discuss with a partner “How do you know I am moving?” Students will talk with their partner and come up with an explanation for the question. Now, students will read the appropriate pages in their Science text books and come up with a more complete answer to my question and record in their findings in their Daybook (note: a Daybook is a composition notebook the students use as a place to save all of the information they learn in a day).

Students will then answer: “How can we figure out the **speed** of something? When a car goes 65MPH, what does that mean? What are we measuring? Partners record answers in their Daybooks while other students find answers to their questions in their science text books.

A project that the students will complete during this time to exemplify how things move is the Marble in Motion project. Students are given the following items: marble stopwatch, string, and meter stick. The students will work in groups of three. Student one will tap the marble and record how long it moves, and measure how far it travels when it finally stops. Student two will do the same thing. Student three will measure the marble’s distance as well as follow the marbles path with the string. Students should repeat this several times while switching roles. At the end of their discovery, students will answer: Which time did the marble move fastest? How can you tell? The students should draw the conclusion that the fastest marble was the one that moved the greatest distance in the least amount of time.

To piggy back off this lab, and learning about speed is the Marble Motion Lab. Students will discover how fast a marble can move. Students will get the following materials: paper towel roll, marble, text books, ruler, tape, and stop watch. Students will create a tower by stacking books on top of each other and making a ramp with the paper towel roll. Students will roll the marble down the paper towel tube, and using the stop watch will calculate the time it takes to go down the tube. Students record their data on a table, and repeat the step ten times. Students can modify their ramp any way they can to produce more speed.

The first type of energy the students will work with is heat energy. Students will explore how fat keeps mammal warm. Students will need a plastic bag (with lard, or vegetable shortening), plastic gloves, bucket or pan with ice water, stop watch, and paper towels. Students make a prediction of whether or not they think an extra layer of fat can help keep their hand warm in a bucket of very cold water. Students will then put their hand in the bucket of water and time how long they can comfortably leave their hand in the water. Students will then coat their hand in the lard or vegetable shortening and place their hand back in the ice water. They will time how long they can comfortably keep their hand in the bucket. Students will be able to answer how long, on average, they were able to keep your hand in the ice water with and without the lard covering. Students will then infer that if lard represents a walrus's blubber, how might blubber help the walrus survive? Students will then research about what heat is (the flow of energy from one material to another) and how it is related to temperature. They will use their text books to discover this. Students will also learn about heat transfer (conduction, convection, and radiation). There are many labs that go with this in the classroom activities section of the paper. We also explore how heat affects size. Students complete a quick lab in which their use a string and rule to measure a blown up balloon. Students will heat up the balloon (putting it in front of a heater) and measure the distance around the balloon, then students will put it in a cold area (we use the refrigerator in the staff lounge) and measure the distance around the balloon. Students observe their measurements. How did heat affect your balloon? What do you think happens to the air particles in the balloon when the balloon is cooled and when the balloon is heated? We then compare what happened to the balloon to things we use every day (tires in our cars/bikes, etc.).

Next we explore light. To explore this, students complete a lab about what they see when they mix colors of light. Students need cardboard, a compass, scissors, markers, pencils and goggles. The students draw a circle on their piece of cardboard. The students must divide their circle into twelve equal sections. Each section should be a different color. They poke their pencil through the middle of the circle to create a spinner and spin it around. Students will observe what colors they see while their spinner is spinning. Students will make another spinner and their goal is to color it whatever colors they think will make it turn white when it spins. They keep playing with the colors on their spinners until they find the correct color combinations to spin white. After this lab is done, we discuss what light is (form of energy that gives off light). We use our science book to discuss low energy and high energy wavelengths and how that affects the energy in light. Students complete another quick lab to find out about absorption of light. Students wrap a thermometer in black paper, and another thermometer in white paper. Students put the two thermometers outside in the sun or another heat source. After ten minutes students record the temperature. Which thermometer heated up faster? Why do you think this happened? What do you think would happen if you tried different colors of paper? We then will introduce the chemical production of light with a glow sticks lab.

The next portion of the unit will be on electricity and magnetism. First we talk about static electricity, which is the most common and most familiar to the students. To do this, we inflate a balloon and tie them to string, then hang them from a table next to each other to see if any kind of action happens. We then perform a series of inquiries with the balloons. We rub one balloon with a piece of cloth and see if anything happens. Then we rub both balloons with the cloth to see if anything happens. Next we do the same thing with our hands. Students will find other ways to create this static electricity in the classroom (most students will rub the balloons on their heads to see what happens). We then discuss what an electrical charge is. It is important for students to know the basics of electricity, they do not need to know words such as “proton”, “electron”, and “neutron”, but they do need to know that atoms have positive and negative charges, and that the charges can either attract or repel each other. They need to know that opposite charges attract, positive charges attract negative charges, and charges that are similar repel each other. Students then create their own static electricity using a plastic comb. The students will comb their hair with a plastic comb and then bring the comb around their head without touching their hair. Students will do the same thing, but this time they will comb their hair around running water. Students discuss their observations.

The next part of the unit, the students do a lot of “playing around” and “self-exploration.” To begin, we discuss how electricity flows. Electricity flows through circuits, and the flow of electricity through a circuit is also called a current. It is important for them to know the difference between a closed circuit and an open circuit. In a closed circuit, there are no breaks in the electricity’s path, thus making the path closed, allowing the electricity to flow. In an open circuit, there is a break in the path, thus making it incomplete; no current can flow in this circuit. We talk about switches, and that switches can turn on or off the current in a circuit. We then discuss the flow of electricity and what can affect it. Electricity flows best through conductors (this is a word that should already be familiar to them), and does not flow easily through resistors (a poor conductor of electricity). Resistors allow electrical energy to be changed into other forms of energy such as heat (used to heat coffee up) or light (a light bulb).Students need to know that current always follows the path of least resistance. We can make current through aelectrochemical cell which utilizes chemical energy to produce electrical energy. I tell the students that one way we will make electricity is through a battery cell. There are two types of cells-dry and wet. A dry cell has a center that is made of carbon rod, and around the carbon rod there is a chemical paste with a zinc container. Wires attach to the carbon core and the zinc part of the cell are the terminals on the battery. The carbon rod is attached to the positive side, and zinc container to the negative side. The carbon rod becomes more positively charged and current flows when a conductor is attached between the cells positive and negative sides. A wet cell contains two different metal bars that are put in a liquid. This liquid contains chemicals and an acid. Electrodes are the wired metal bars and current will flow between them and the solution. Tell students that this is how car batteries work. Students will not be doing much work with wet cells, so it isn’t too important to get into detail about how they work. Next we talk about types of circuits: series circuits (electricity can only flow one way), and parallel circuit (two paths in which electricity can flow).

All of this background knowledge is important for students to know, because they spend the rest of their time creating their own electrical circuits. In the first activity, students get a flashlight bulb, wire (with ends slightly stripped), 2 D-cell batteries, and a cell holder (which is optional). Students must try to get their light bulb to light. They record how they got it to light and create a drawing the best they can to explain what they did. In the next lab, students get various materials (nail, penny, button, pencil, yarn, washer, plastic cube), flashlight bulb, D-cell battery, and 3 wires (with ends already stripped). The goal is for the students to find out which materials are conductors. They will know they do when their light bulb lights up. This is a really fun lab for the students to do. If they get done early, I allow them to go around the classroom to see what other things are conductors. The next lab the students do is to create their own types of circuits. They will get 3 D-cell batteries, 3 flash light bulbs and as much wire as they need. They are to create circuits with and without a switch to see how they can light up a light bulb. They must be able to draw these circuits and explain how their circuits work. Again, in the classroom activities section of this lab there are other experiments that show conduction of electricity through chemicals

The last form of energy that we will discuss in this unit is magnetism. A magnet is a material or device that attracts items that contain the elements of iron, nickel, or cobalt. Magnets have two poles- north and south; like poles repel, and unlike poles attract. Magnets can be used to create an electric current, such as electrical generators, and current can be used to produce a magnet. When current flows around a piece of metal, it creates an electromagnet. Students will create their own electromagnets. Students will wind a wire twenty times around a nail near the head. Each end of the wire gets attached to a D-cell battery. Students predict how many paper clips their electromagnet can pick up and hold. The students will do the same thing again, only this time with two D-cell batteries. Students will record how many paper clips they pick up. An extension of this activity could be to let students can go around the classroom and school building to see what things they can pick up with their electromagnet.

The students will complete a test at the end of the unit. As I mentioned before, due to lack of time for the sciences in our curriculum, as well as the time of year this unit is taught, much of the student's background information comes from their science book, and there is a lot of inquiry in which the students are in charge of their learning. There are also not many worksheets that go with the labs because we do all of our responses in our daybooks.

Energy Unit Test

Name____Date_____________

1. If you are riding on a bus with your friends, could you look at them to tell that you are moving? _____ Where could you look to tell that you are moving? (2pts)

   ____
2. How would you calculate the speed of a moving object, like how fast you are riding a bike? (2pts)

   ____
3. Fat is an insulator. Tell how insulators keep an animal warm? (1pt)

____

4. Heat transfers from an object of high energy to an object of _ _ _ energy.

Put these vocabulary words in the correct places: conduction, radiation, convection.

5. Warm air forced into our classroom from the vent is______________________________.
6. Heat from the sun is transferred by ___________________________________.
7. Warm hands can touch and heat a cool face by __________________________________.

Put these vocabulary words in the correct places:
air reflection vibration refraction solids

8. Sound is made by the back and forth ________________ of something that was struck.
9. Sound travels fastest through ________________ and slowest through _____________.
10. When light bounces off water or a mirror, we call that _______________________.
11. Light bends when it passes from air into eye glasses or air into water. We call that ________________________.

12. What does a prism do to sunlight? (1 pt.)
____
____

13. Energy from the Sun reaches Earth by
    A. Friction
    B. Convection
    C. Reflection
    D. Radiation
14. Sound waves may travel through_________________.
    A. Solids
    B. Liquids
    C. Gases
    D. All of the above
15. The distance an object travels in a given time describes its _________________.
    A.Position
    A. Speed

B. Frame of reference
C. Energy

16. When matter is heated, like oatmeal in a microwave, it tends to ________________
    A. Expand
    B. Contract
    C. Conduct
    D. Insulate
17. Sound is produced by the ___________________ of moving particles.
    A. Amplitude
    B. Vibration
    C. Wave length
    D. Frequency
18. The ability to do work is called
    A. Frequency
    B. Friction
    C. Force
    D. Energy
19. The force you use to move something or do something is called
    A. Vibration
    B. Work
    C. Inertia
    D. Radiation

20. A rocket, headed for Mars, is getting ready to blast off from NASA space center in Florida. Describe 3 forms of energy that will be used or seen when that rocket takes off. Write a sentence for each. (3pts)

Classroom Strategies

1.Chemical Cold Pack- First Aid cold packs demonstrate spontaneous endothermic reactions.

Science Demonstrated: Endothermic reactions- chemical process that absorbs energy in the form of heat.

Vocabulary: endothermic reaction, temperature

Materials: Instant Cold Packs (for groups of 4)

Procedure: 1. Have a discussion with students about a time they needed an ice pack. Ask: What do ice packs do? How do ice packs work? Allow students to express their ideas and stories. 2. Explain to students that in an ice pack there is an outer pouch and an inner pouch. Inside the outer pouch there are chemicals. The chemicals are ammonia and nitrogen based substances in the form ofa molecule called ammonium nitrate (because they are only in fourth grade, I don't find it necessary to explain the complete chemical formula) which is one of the key ingredients in the reaction. Inside of the inner pouch, there is water with blue dye. 3. Have each member of the group squeeze the inner pouch to release the water and mix it with the ammonium nitrate. 4. Students write and discuss what they observe.

2.Chemical Hot Pack- first aid hot packs demonstrate spontaneous exothermic reactions.

Science demonstrated: chemical process that gives off energy in the form of heat.

Vocabulary: exothermic reactions

Materials: Instant hot packs

Procedure: 1. Have a discussion with students about a time they needed a heat pack. Ask: What do heat packs do? How do you think heat packs work? Allow students to discuss their ideas. 2. Explain to students that there is, again, an inner and outer pouch. Inside the outer pouch there are chemicals that contain the elementscalcium and chlorine mixed together to form a chemical called calcium chloride. Inside the inner pouch, there is water with red dye. In groups, allow the students to squeeze the inner pouch so the water mixes with the calcium chloride. 4. Students write and discuss what they observed.

This would be a good time to do a compare and contrast lesson about endothermic and exothermic reactions. The students could make a Venn Diagram to compare the two reactions.

3.**DEMONSTRATION**Oxidations of Luminol (how glow sticks work!)

Science demonstrated: chemical reaction to produce light.

Background Information: colorless liquid and a blue light are poured simultaneously into a large class funnel to emit a blue chemiluminescent glow for about 2 minutes.

Vocabulary: luminescent, chemiluminescent, oxidation

Materials: 4 g sodium carbonate, 3 L distilled water, 0.2 g luminol, 24 g sodium bicarbonate, 0.5 g ammonium carbonate, 0.4 g copper sulfate, 50 mL 3% hydrogen peroxide

Procedure: 1. Dissolve sodium carbonate into 500 mL of distilled water. 2. Add 0.2 g of luminol and stir to dissolve. 3. Ad 24 g of sodium bicarbonate, .5 g ammonium carbonate, and 0.4 g of copper sulfate and stir until it is all dissolved. 4. Dilute to a final volume of 1 liter with distilled water. 5. In another flask dilute 50mL of hydrogen peroxide to 1 liter of distilled water. 6. To perform demonstration, lights should be off. Pour the two liquids simultaneously into another clear jar. Watch it glow! 7. Hand out glow sticks to students. 8. Have the students "break" the glowsticks. Explain to students that the reaction they are seeing in the glow stick is the same type of reaction that you just showed them.

5. Magic Coin Heat Experiment:

Science demonstrated: endothermic and exothermic reactions to create energy.

Materials: A bowl of water, glass bottle with a small mouth opening, coin bigger than the mouth opening of the bottle

Procedure: 1.Fill the bowl with cold water. 2. Place the neck of the bottle and the coin in the water to get them nice and cold. You need to do this so that when you place the coin on top of the mouth of the bottle, it forms an airtight seal. 3. Set the coin on top of the mouth of the bottle and then wrap your warm hands around the bottle. 4. Wait for a few seconds and observe what's happening. 5. Then remove your hands and see what happens next.What happened? Did the coin jump? It should have. Can you figure out why? (When you wrap your hands around the bottle, the air inside the bottle heats up). The warm air inside the bottle pushes harder than the cool air outside the bottle which then causes the coin to jump. When the air inside the bottle cools, the coin will stop jumping.

6. Fruit Battery Experiment-

Science demonstrated: how to use chemical reactions to create a battery.

Materials: citrus fruits (lemons, limes, oranges), copper and galvanized nails (recommended size in length is 2 inches or longer), small light bulb (preferable colored or opaque with a 2-inch lead with enough wire to connect it to the nails)

Procedure: 1. take your citrus fruit of choice in hand, and squeeze it on all sides with your hands without breaking the skin. Your aim is to soften the citrus fruit enough to extract its juices. 2. The next step is to puncture the citrus fruit with the nails. 3. Insert the nails into the fruit about 2 inches away from each other, in such a way that the two nails stop at the center of the fruit without touching. Be careful inserting each nail. Go slowly, being sure not to go through the fruit completely. 4.With the nails inserted into the citrus fruit, it is time to prepare your bulb. Take your bulb and peel off its plastic insulation, expose the wire underneath. Wrap the exposed wires around the head of the 2 nails. Use the electrical tape to secure each end of the wire on the nails. 5.With the bulb's wires attached securely to both the copper nail and the galvanized nail, your colored bulb will light!

7. Human Battery Power Source-

Materials: copper plate, aluminum plate, micro ammeter, 2 alligator / crocodile clips, lead wire, 2 blocks of wood, human volunteer

Procedure: 1. Mount the copper plate and the aluminum plate to separate blocks of wood. 2. Connect one of the Micro Ammeter's terminals to the copper plate and attach with a Crocodile clip.3. Connect the other Micro Ammeter's terminal to the aluminum plate and attach with a Crocodile clip.4. Have the human volunteer stand between the two plates and hold each one in their hands. SECOND VERSION 5. Follow steps 1-4 6. Place both hands in water. 7. Once again, have a human volunteer (with wet hands) stand between the plates and hold each one. Students will be able to see if electricity flows if the light on the ammeter lights up.

Safety Precautions

Chemistry laboratory can be a place of discovery and learning. However, by the very nature of laboratory work, it can be a place of danger if proper common-sense precautions aren't taken. All students must adhere to all safety procedures. Because the students are young in age, they won’t be working with any chemicals that will be explosive, but some (like glow sticks, heat and cold packs) could be poisonous if not handled properly. All students will wear safety goggles **must be worn at all times** when appropriate. All students with long hair will have to tie their hair back. We have a school rule that there is no food allowed out of the cafeteria so this rule will always be in place in the classroom, no students will be permitted to eat or drink anything during science lab. Students are not allowed to conduct their own experiments. If students are curious about trying a procedure not covered in the experimental procedure, they must have teacher permission. Students will never taste anything nor directly smell the source of any vapor or gas. They will waft a small sample to your nose. Do not inhale these vapors but take in only enough to detect an odor if one exists. All materials, with the exception of notebooks and pencils will have to be put away in desks and closets. Students are required to always wash their hands when done with the lab. If there are any accidents, students should report it to the teacher immediately. Students should consider **all** chemicals to be hazardous unless you are instructed otherwise. Make sure that as the teacher you kno what chemicals you are using, as well as what your students will be used. Carefully read the label *twice* before taking anything from a bottle. Again, because we are doing these labs with fourth graders, they will be using many every day things. These can be discarded into the trash can or down the sink. If chemicals come into contact with your skin or eyes, **flush immediately** with a lot of water. Call school nurse if needed. Students should never leave their work station unattended; they should raise their hand if they need assistance.

Conclusion

Chemistry is in everything we do. The point of this curriculum unit is to get students to understand that there is a lot more science behind turning on and off a light switch, or turning on and off a video game. Students in this unit will get the chance to explore two kinds of sciences; energy produced by heat, sound, electricity, light and magnets, as well as how utilizing chemical reactions and processes to create these forms of energy. Students will be able to compare and contrast their experiences when they produce their own energy in these fun activities.

Appendix: Implementing District Standards

4.P.3.1 Recognize the basic forms of energy (light, sound, heat, electrical and magnetic) as the ability to cause motion/create charge.

4.P.1.2 Explain how electrically charged objects push or pull on other electrically charged objects-electrically charges can result in attraction, repulsion and electrical discharge.

4.P.3.2 Recognize that light travels in a straight line until it strikes an object or travels from one medium to another, and that light can be reflected, refracted, and absorbed.

In this curriculum unit, the students will begin by learning and experimenting with the basic forms of energy based on what the standards and CMS says we have to teach. They will complete simple labs that lead them to the basic knowledge of sound, light, heat, electricity, and magnetism. I want my students to dig deeper into these meanings. The students will then expand their knowledge of these forms of energy through chemical experiments. They will learn about endothermic and exothermic reactions which will further their knowledge of heat. They will create light through experiments that show how glow sticks work, which will further their knowledge of light beyond flipping on and off a light switch. The students will conduct acid experiments using fruit to conduct electricity and using their own bodies to also conduct electricity. These meaningful educational experiments will “stick” with them and hopefully will enhance their basic understanding of these topics.

Annotated Resources

1."Electrochemistry." Electrochemical Reactions. http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch20/electro.php (accessed November 21, 2013). This website was useful in that it helped me to understand more about oxidation-reduction reactions.

2. "Endothermic and Exothermic Processes." Endothermic and Exothermic Processes. http://www.kentchemistry.com/links/Matter/EndoExo.htm (accessed November 21, 2013).

This website was great for teaching (adults) the difference between exothermic and endothermic processes and reactions. It also gave wonderful examples of each and videos to match.

3."How Bioluminescence Works." HowStuffWorks. http://science.howstuffworks.com/zoology/all-about-animals/bioluminescence5.htm (accessed November 23, 2013).

This website gives a great detailed description of bioluminescence.

4."How Light Works." HowStuffWorks. http://www.howstuffworks.com/light.htm (accessed November 21, 2013).

Great resource explaining the history of light and how it works.

5."Learning objects help people succeed." Methods of Producing Electricity. http://www.wisc-online.com/Objects/ViewObject.aspx?ID=DCE702 (accessed November 23, 2013).

This website was a great resource in providing different types of methods to produce electricity for demonstrations.

6. Shakhashiri, BassamZ..*Chemical demonstrations*. Madison, Wis.: Univ. of Wisconsin Pr., 1983.

Very useful resource for providing demonstrations for a chemistry class before they did their own experiments.

7. Shakhashiri, BassamZ..*Chemical demonstrations: a handbook for teachers of chemistry*. Madison, Wis.: University of Wisconsin Press, 19832011.

Very useful resource for providing demonstrations for a chemistry class before they did their own experiments.

8."What is Heat?." Cool Cosmos. http://coolcosmos.ipac.caltech.edu/cosmic_classroom/light_lessons/thermal/heat.htmlFind a website by URL or keyword... (accessed October 29, 2013).

Provides good explanation of heat, as well as demonstrations for creating heat.

9."What is chemical energy?." What is chemical energy?. http://www.eschooltoday.com/energy/kinds-of-energy/what-is-chemical-energy.html (accessed November 21, 2013).

Provides great experiments for kids.

10. "What is heat and thermal energy?." What is heat and thermal energy?. http://www.eschooltoday.com/energy/kinds-of-energy/what-is-thermal-energy.html (accessed November 23, 2013).Provides great experiments for kids.

11. Daniel, Lucy H. “Physical Science.” In *Macmillan/McGraw-Hill science.*New York: Macmillan/McGraw-Hill School Pub. Co., 2005.F1-F98.

This is from the textbook we use for our curriculum in our school district.

Works Cited

"Electrochemistry."Electrochemical Reactions. http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch20/electro.php (accessed November 21, 2013).

"Endothermic and Exothermic Processes."Endothermic and Exothermic Processes. http://www.kentchemistry.com/links/Matter/EndoExo.htm (accessed November 21, 2013).

"How Bioluminescence Works." HowStuffWorks. http://science.howstuffworks.com/zoology/all-about-animals/bioluminescence5.htm (accessed November 23, 2013).

"How Light Works." HowStuffWorks. http://www.howstuffworks.com/light.htm (accessed November 21, 2013).

"Learning objects help people succeed." Methods of Producing Electricity. http://www.wisc-online.com/Objects/ViewObject.aspx?ID=DCE702 (accessed November 23, 2013).

Shakhashiri, BassamZ..*Chemical demonstrations*. Madison, Wis.: Univ. of Wisconsin Pr., 1983.

Shakhashiri, BassamZ..*Chemical demonstrations: a handbook for teachers of chemistry*. Madison, Wis.: University of Wisconsin Press, 19832011.

"What is Heat?." Cool Cosmos. http://coolcosmos.ipac.caltech.edu/cosmic_classroom/light_lessons/thermal/heat.htmlFind a website by URL or keyword... (accessed October 29, 2013).

"What is chemical energy?." What is chemical energy?. http://www.eschooltoday.com/energy/kinds-of-energy/what-is-chemical-energy.html (accessed November 21, 2013).

"What is heat and thermal energy?." What is heat and thermal energy?. http://www.eschooltoday.com/energy/kinds-of-energy/what-is-thermal-energy.html (accessed November 23, 2013).

Daniel, Lucy H. “Physical Science.” In *Macmillan/McGraw-Hill science.*New York: Macmillan/McGraw-Hill School Pub. Co., 2005.F1-F98.

Endnotes

[i] http://www.howstuffworks.com/light.htm
[ii] http://www.howstuffworks.com/light.htm
[iii] http://www.howstuffworks.com/light.htm