The Chemistry of NASCAR:
How Chemistry Principles Are Used in the Motorsports Industry

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Rationale

I teach science at an urban Title One middle school of about 1400 students. The demographic make-up is 90% African-American and 65% are male students. 80% of our students receive free or reduced lunch. Many of our students are considered homeless or in transitional (non-permanent) homes. This includes students living in shelters, extended stay hotels, or with extended family members. This causes our population to be very transient, with students changing schools often. The majority of our students (60%+) are below grade-level readers. This challenge requires more scaffolding and differentiation than many other classrooms to bring students up to grade level in reading, while still covering the Common Core Standards and New Science Essential Standards so that the students will be successful in their End of Grade (EOG) tests and be ready to move on to the next grade, as well as, to high school. Many of the focus areas of this unit were developed to serve the specific needs of these middle school below level readers especially those that may have stressful living environments. This being said, it is designed with rigorous activities and high order thinking activities. There are low reader differentiation strategies and scaffolding ideas included.

Background Information

While I teach grades six through eight, the focus of this unit will be 8th grade Science, with the emphasis on Chemistry and Physical Science. The purpose of this curriculum unit is to incorporate the sport of NASCAR into our chemistry concepts. Creating lessons around a theme helps students to make their own connections to the science content and have fun at the same time. One of our goals as science educators is to incorporate technology into our student's science experience. The concept of "21st Century Learners" is designed to increase our student's basic technology skills to enhance their ability to communicate in our ever changing, fast paced world. These skills are learned best through interdisciplinary, project-based activities/curriculum by utilizing the seven survival skills advocated by Tony Wagner in his book, *The Global Achievement Gap*:*why even our best schools don't teach the new survival skills our children need--and what we can do about it.Critical Thinking and Problem Solving.* These skills include:

- Collaboration across Networks and Leading by Influence
- Agility and Adaptability
- Initiative and Entrepreneurialism
- Effective Oral and Written Communication

- Accessing and Analyzing Information
- Curiosity and Imagination

Chemistry Background and Vocabulary

The 8th grade Essential Standards that need to be covered in this unit are included in detail in Appendix A. The big ideas include: 1) the concepts and properties of atoms and subatomic particles, 2) the differences between pure substances (elements/compounds) and mixtures, 3) the basics of the Periodic Table, including the different types of elements and their properties, 4) the difference between chemical and physical changes, and the indications that a chemical reaction has taken place, 5) the Law of Conservation of Mass and balancing chemical equations, and 6) the Law of Conservation of Energy and how it is related to the conservation of Mass. Eighth grade science students are not required to do in-depth mathematics or memorization of formulas, but they will need to be able to read data charts, do basic computations, and understand how to read and balance chemical equations and formulas.

Teachers need to provide a basic understanding of the Periodic Table of theElements and the following vocabulary: (this list is not all-inclusive)

Ductility: A solid material's ability to deform under tensile stress; this is often characterized by the material's ability to be stretched into a wire.

Malleability: A solid material's ability to deform under compressive stress; this is often characterized by the material's ability to form a thin sheet by hammering or rolling.

Plasticity: The extent to which a solid material can be plastically deformed without fracture. (Both Ductility and Malleability are related to a substance’s plasticity)

Conductivity: The intensive property of a material that indicates its ability to conduct heat (thermal) or electricity (electrical).

Density: The amount of matter in a given volume. Formula: D=m/v

Melting point: The temperature at which a solid changes state from solid to liquid.

Boiling point: The temperature at which a liquid begins to turn in to a gas (steam/vapor).

Reactivity: The rate at which a chemical substance tends to undergo a chemical reaction

Covalent bond: The chemical bond that involves the sharing of pairs of electrons between atoms.

Ionic bond:A type of chemical bond formed through an electrostatic attraction between two oppositely charged ions. Ionic bonds are formed between a Cation(+ charge), which is usually a metal, and an Anion (- charge), which is usually a nonmetal or Halogen.*Pure* ionic bonding cannot exist: all ionic compounds have some degree of covalent bonding.

Combustion: The sequence of exothermic chemical reactions between a fuel and an oxidant accompanied by the production of heat and conversion of chemical species. The release of heat can result in the production of light in the form of either glowing or a flame. Fuels of interest often include organic compounds (especially hydrocarbons) in the gas, liquid or solid phase.

Combustion Reaction: A combustion reaction is when all substances in a compound are combined with oxygen, which then produces carbon dioxide and water.

Law of Conservation of Energy: Energy can be neither created nor destroyed; it only changes form (e.g.: chemical to thermal energy).

Law of Conservation of Mass: Mass (matter) can neither be created nor destroyed, although it may be rearranged. Balancing of chemical equations is a great way to reinforce this concept.

Alloy: A solid substance made by mixing a metal with another substance (usually another metal).

Element: A substance that is composed of one type of atom; an element cannot be chemically separated.

Metal: An element that is a good conductor of heat and electricity, and is usually shiny and hard at normal temperatures.

Steel: An alloy of iron and carbon that is hard, strong, and malleable.

NASCAR Science Background

The car, the fuel, the tires, the tracks, the driver's suits; nearly everything about a NASCAR® race relies on the most advanced materials possible to maximize speed, maneuverability, and safety. Chemistry is involved in every aspect of the industries related to motorsports. This is part of why NASCAR® makes a great topic to create a themed chemistry unit.

Charlotte, North Carolina is considered the “home” of NASCAR®. Most of the race teams have their main race shops in the area, there is a drag strip track, a superspeedway, the NASCAR®hall of fame. All of these attributes make NASCAR®a perfect theme with which to teach related topics.

How does NASCAR®relate to Chemistry and Physical Science?

Many of the materials used in NASCAR®have been designed and engineered to maximize the energy output of the engines, the car body to efficiently compete against as well as enhance the forces of gravity, the tires to help with the physics, especially friction, the tracks themselves, the fuel, and the safety of the drivers drive the technological advancements of all the industries related to NASCAR®. These materials and technologies can be used to teach our physical science objectives. Students can learn about chemical bonding, chemical reactions, and properties of elements by learning about the materials used to make the car, tires and fuel. They can learn about laws of conservation of energy and mass through exploring the concept of combustion, and the different ways that engineers must cool the engine and the driver during the race, due to the extreme levels of energy that need to be produced in order to get the amount of horsepower needed to race at such high speeds.

Many different metals, alloys, and other materials are used to create modern day NASCAR stock cars. The term “stock car” implies that the drivers race cars that are the same to the “Stock” of any car dealer, but that is no longer the case. The cars used in NASCAR today have been designed and redesigned to maximize speed, safety, and efficient use of energy.

Metal Fabrication

Metal fabrication is not a new process. Humans have been manipulating metals and making alloys of different metals for centuries, in the attempt to find the best formulations for different uses. One of the first widely used alloys was bronze (copper and tin); followed by brass (copper and zinc). The benefits of an alloy over a pure metal can include increase tensile strength, and shear strength. The increased strength of the alloys usually comes from the mixture of different size atoms from the original metals. The physical configuration of these different sized atoms creates internal compression on the smaller atoms by the larger atoms. This helps the new alloy not deform, or lose its shape, as easily. One example is related to the alloys used in jewelry. Pure gold is much too soft to use in rings and other types of jewelry, but when mixed with other metals to create gold alloys (24 KARAT gold, 14 KARAT gold, white gold, Black Hill’s gold), the new alloy holds its shape better, and has different colors and textures than pure gold.

In NASCAR, alloys of aluminum, steel, and other metals are used to create different parts of the vehicle. Certain areas, like the roll cage, need to be very strong and durable, but also need to be able to be formed into precise shapes. The body panels and the chassis have different functions, so the steel used in each are very different. Steel is an alloy of iron and carbon, mixed with other metals. The body panels have a lower carbon steel, which is lighter, while the chassis, which has to withstand great forces during the race and protect the driver, is made of higher carbon steel that is designed to hold its shape while withstanding the g-force pressures. This steel is created through a process called heat treatment. This is the process of heating a metal up to its melting temperature and then quickly quenching it to a low temperature. This modifies the crystal structure. The metal is then tempered back to an intermediate temperature to modify the ductility and strength. When this is done, new alloys can be created that match the needs of the engineer.

Materials Science

In order to evaluate the chemistry of materials, we will also review the materials often used in racing. To control costs, our materials samples will be only 3/8" diameter rods and a foot long. Despite the small size, this will allow a comparison between material bending strength and weight.

Our samples include the following:

Table 1. Material samples of NASCAR® used metals

Solid Bar	
Steel Cold Rolled Round Bar (1018)	∅3/8" × 12"
Stainless Steel Round Bar (304)	∅3/8" × 12"
Aluminum Round Bar (6061)	∅3/8" × 12"
Chrome Moly High Strength Steel (4130)	∅3/8" × 12"
Brass Round Bar (360)	∅3/8" × 12"
Super High Strength Tool Steel (S7)	∅3/8" × 7"
Tubular Steel	
Cold Drawn Seamless Tube (1018)	∅1-3/4" × 0.090"wall × 12"
DOM (Drawn over Mandrel) Steel Tube	∅1-3/4" × 0.090"wall × 12"

Welded (ERW) Steel Tube	∅1-3/4” × 0.095”wall × 12"

The result is that our students can hold and try to bend the samples. Some will seem very heavy and some will start to rust. The students must then answer some questions:

1. Which solid bar is the heaviest?
2. Which Tube is lightest?
3. Do any of these metals show signs of corrosion?
4. Can the student identify the weld line on the ERW steel tube?
5. Do any of the metals show a different color? After seeing these samples, could you identify a metal if you saw it on the street?

Chemistry of Combustion and Chemical Reactions

Eighth grade science is not concerned with students having a deep understanding of chemical equations and the different types of equations, but they need to be able to understand the concept of the Law of Conservation of Mass by practicing balancing chemical equations, students can gain the understanding that matter isn’t destroyed, but is rearranged. They also can learn the concept that a chemical reaction takes place anytime there is a chemical change, as well as the indicators that a chemical change has taken place through real-life examples of chemical reactions. The indicators of a chemical reaction include: 1) the production of light, 2) color change, 3) formation of a precipitate, 4) change in temperature (production of heat or cold), and 5) production of gas (bubbles, smoke, etc.)

Combustion is a great example of a chemical reaction.The standard formula we will use involves octane gas, which is a similar reaction to the gasoline that regular street cars use, is as follows:

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O + \text{Energy}$$

Students need to understand that this formula tells us that two molecules of Octane plustwenty five molecules of Oxygen react to form sixteen molecules of carbon dioxide + one molecule of water + a specific amount of energy (heat, etc.).

Teaching Strategy

Introduction of Content and Vocabulary

Students will interact with the basic vocabulary through different activities and mini-lessons. The activities will be presented in Station Lab format, but may be done individually, as well. Brief examples are given, and detailed handouts for this are in Appendix B: Unit Classroom Handouts and Resources.

Day one warm-up: List the different types of jobs related to a NASCAR race. Students will probably say: the driver, the pit crew, and may add crew chief, officials…. but help them to brainstorm further. We need the truck drivers to move all the vehicles and equipment, chefs to feed everyone, coordinators to plan the travel arrangements, mechanics, tire specialists, welders, engineers to make all the specialized parts and equipment…. not to mention all the jobs at the track on race day.

We can now relate this to our science topics. A good attention grabbing question may be: "So what technologies can we discuss in relation to our chemistry goals?" Have students look at the list of careers they made in their warm-up, and make a list of the sciences that are needed to get a stock car made and to the race track today. This list includes: Chemistry, engineering, computer science, and on and on. Students should start to see that most areas of science can be explored through NASCAR

Station Lab: "Properties of Elements – How do we determine which materials are suitable for different industries?"

Level One -

At this point, students should know about the Periodic Table and the elements, as well as, basic related chemistry vocabulary. This two part lab activity will explore the different groups of elements of the Periodic Table (Earth Metals, Noble Gases, Alkaline Metals, Transitional Metals, etc.) and their properties. The first part will compare metals to nonmetals. They will look at the different Families of elements from the Periodic Table to determine the patterns of the properties. Students will use the attached "Properties of Elements Lab Sheet" to complete the activity.

Here is a sample of the data chart students need to complete as they work:

Sample Number	Color	Luster	Malleability	Conductivity	Reaction with Acid	Classification	Other Observations
1							
2							
3							
4							
5							
6							
7							

The second part of the lab activity will help students answer "Why do we use certain metals for jewelry and different metals for industrial applications?" (NASCAR® – copper? Why don't we all walk around with pure Copper necklaces?). Before doing the lab, a video or mini-lesson about the transition metals would refresh students on the basic properties and uses of common ones. The following website gives a great overview into the basics of stock car design: www.wheelsacademy.com/a1/racenascar/nascar.html. Students will explore the concepts of the Properties of Metals: Ductility, Malleability, Conductivity (heat and electric), Density, melting/boiling points, and Reactivity. Sample data tables for the NASCAR® related metals, as well as, other popular transitional metals can be found in the Appendix B: Unit Classroom Handouts and Resources.

Level Two -

This will discuss interactions between elements and bonding. It will cover items related to combustion engines, hydrocarbons, and energy levels. They will create models of ionic and covalent bonding and explore the concept of electroplating to reinforce the concept.

There are many ways to model chemical bonding, and I suggest that you do more than one of these three activities to help reinforce it.

Bond with a Friend

For this activity, your students will be acting as if they are positive or negative ions and forming bonds with their classmates. Have students create cards of various positive ions like a 1+ hydrogen or a 1- iodine. Give each student an ion card with two holes punched in it, a worksheet and a string of yarn to make a necklace out of it. Students will walk around the classroom to find ions that they can bond with. For example, a person with a hydrogen card (1+) could bond with an oxygen card (2-). If that bond were to occur, the students would write down H_2O and "water" down on their worksheet. Have the students find all the possible bonding combinations between one another. Make sure to use molecules the students are familiar with, and a few they are not. Sample data table for the worksheet:

Molecule	Name	Elements needed
H_2O	Water	H+ H+ O(2-)

Candy Compounds

This activity shows how different atoms bond using gumdrops and toothpicks. Create your own worksheet (similar to the table above). You need six different colors of gumdrops, toothpicks, plastic bags, a student worksheet and a candy key. In each bag you will place sets of gumdrops: four of one color, three of another, two sets of two different colors and two sets of one different color. The set of four is hydrogen, three is chlorine, the sets of two are oxygen and sodium and the sets of one are carbon and calcium. Have students create bonds using the toothpicks for various compounds like H_2, NaCl, H_20,

Na_2O, etc. The students should list if the bond is ionic or covalent and they should draw a picture of the model. The students can also show an electron dot model.

Couples Counseling

One entertaining way to refer to bonding is like a personal relationship. Create a poster, a PowerPoint or draw on the blackboard the four "couples" (types of bonds) that you will be counseling during the class. Four bonds you can look at are ionic, covalent, hydrogen and Van Der Waals forces. Talk about the four bonds as if they are couples, for example an ionic bond is a lasting bond formed by one member giving to another while a hydrogen bond stays together until heated, which you can say as they split when "things get hot". An entertaining extension is to show examples of celebrity couples that mimic the four types of bonds.

Artistic Interpretation

It isn't often that the creative students in your class get achance to be truly creative in science class. This activity is designed for students to plan at school and finish at home.Allow students to draw, sculpt or build their interpretation of a particular molecule. You might want to give students examples of particular molecules if you wish. The important part for the project is for them to show the bond in an artistic way. The students may draw an ionic bond as boyfriend and girlfriend holding hands while they may sculpt a hydrogen bond as two catty gal pals ready to split off looking for a boyfriend. Give credit to the most creative and entertaining designs.

Electroplating can be dangerous to do in class, so videos may be the best way to show the idea to students. Here are two great short and easy to understand videos:

1) How electroplating is done: http://www.youtube.com/watch?v=z7f7dQF2KLA

2) Simple electroplating (you may want to DEMO this for the class): http://www.youtube.com/watch?v=Q8Xo43sfLgY

The Law of Conservation of Mass and Combustion

Have students write the combustion reaction on their paper. Then, have them write it in a "math sentence".Students need to understand that this formula tells us that two molecules of Octane plus twenty five molecules of Oxygen react to form sixteen molecules of carbon dioxide + one molecule of water + a specific amount of energy (heat, etc.).

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O + \text{Energy}$$

Now ask students if they remember the Law of Conservation of Energy. Explain that The Law of Conservation of Mass is very similar, but deals with atoms and how they rearrange to form new substances. Give or have students create the following chart on their paper: (The Answer key and a blank version are in Appendix B)

Reactants		Reaction	Products		
$2C_8H_{18}$	$25O_2$	→	$16CO_2$	$18H_2O$	Energy
C =	O=		C =	H =	
H =			O =	O =	
Total Atoms =				Total Atoms =	

Now, give students a worksheet with similar charts for other reactions. For these equations, leave the coefficient (Number before each molecule) blank. Have students work in pairs to problem solve to figure out what the coefficient needs to be to create a balanced equation. A sample chart using the above equation is as follows:

Reactants		Reaction	Products		
__C_8H_{18}	__O_2	→	__CO_2	__H_2O	Energy
C =	O=		C =	H =	
H =			O =	O =	
	Total Atoms =			Total Atoms =	

"Is NASCAR® Harmful to the Environment?" Argumentative Essay

Students will create a five paragraph argumentative essay debating whether or not the industries surrounding NASCAR® are pro-environment, or not. They will use a rubric and essay template to create their argument. They will have access to different resources and may choose a more specific topic. Examples include: "Combustion Engine: Environment Friend or Foe?", "Are NASCAR®'s *Goodyear* tires killing the ozone layer?"

Here is an interactive persuasive essay map for students to use. It may be printed out and given to students, but students enjoy using the technology: http://www.readwritethink.org/files/resources/interactives/persuasion_map/. Students should include valid counterarguments and cite sources throughout their paper.

Experimental Design Culminating Project – "How energy efficient are the technologies used in NASCAR®?

Students must take the ideas of Force and Motion that they have already learned with me in 7th grade and add to them the knowledge of the Industrial Application of Elements to create a new technology. Students may want to design a racecar, or explore a specific industry (track models, tire types, fuel), as long as it will relate to NASCAR® technologies. Students will use information gathered during the other parts of the unit including the welding of metals and about the other materials used in the different parts of the racecars as well as the track surfaces, tires, and fuels. A link to the track template is included in the Teacher Resources section of the Bibliography if you would like to fabricate one for your students to test their designs. Use your students as a guide in designing this project. Some students may want to do a research based project, but others will want to build or design something.

Annotated Bibliography

Student/Teacher Resources

1. www.ptable.com – Interactive Periodic Table of the elements

2. http://www.21stcenturyschools.com/what_is_21st_century_education.htm - What is a 21st Century Learner?

3. http://portal.acs.org/preview/fileFetch/C/CTP_005376/pdf/CTP_005376.pdf - Great article about Chemistry and NASCAR®. May want to use as a reading for class.

4. http://www.readwritethink.org/files/resources/interactives/persuasion_map/ - An interactive persuasive essay map for students to use. It may also be printed out and given to students.

5. http://phet.colorado.edu/en/simulation/states-of-matter-basics - This site has many wonderful physical science simulations. The given examples show the basic difference between the states of matter. The site also has bonding simulations and more.

6. http://www.wheelsacademy.com/a1/racenascar/nascar.html - Great site with the basics of stock car design and the types of metals used.

7. http://www.youtube.com/watch?v=z7f7dQF2KLA - How electroplating is done demonstration with nickel and copper

8. http://www.youtube.com/watch?v=Q8Xo43sfLgY2) - Simple electroplating that you could demonstrate yourself or use the video to show to students.

Teacher Specific Resource

1. http://staceyhartberger.cmswiki.wikispaces.net/PD+Resources – My classroom wiki, with the race track diagrams and other related resources.

2. https://mospace.umsystem.edu/xmlui/handle/10355/7178 - Video of college seminar on the Chemistry of NASCAR by Steven W. Keller, associate professor of Chemistry at the University of Missouri-Columbia.

3. http://www.chemheritage.org/discover/media/periodic-tabloid/2011-09-23-get-the-lead-out.aspx - Chemistry article on high-octane fuel.

4. Wagner, Tony. *The Global Achievement Gap*: *why even our best schools don't teach the new survival skills our children need--and what we can do about it.* New York: Basic Books, 2008.Examines problems of the American educational system and offers solutions for preparing students to compete and work in a global economy.

Appendix A. Implementing Common Core Standards

This unit covers Students are not required to do in-depth mathematics and formulas but they will need to be able to read data charts, do basic computations, and understand how to read chemical equations and formulas. The 8^{th} grade Essential Standards that need to be covered in this unit include:

- 8.P.1 Understand the properties of matter and changes that occur when matter interacts in an open and closed container.
    - 8.P.1.1 Classify matter as elements, compounds, or mixtures based on how the atoms are packed together in arrangements.
    - 8.P.1.2 Explain how the physical properties of elements and their reactivity have been used to produce the current model of the Periodic Table of elements.
    - 8.P.1.3 Compare physical changes such as size, shape and state to chemical changes that are the result of a chemical reaction to include changes in temperature, color, formation of a gas or precipitate.
    - 8.P.1.4 Explain how the idea of atoms and a balanced chemical equation support the law of conservation of mass.
- 8.P.2 Explain the environmental implications associated with the various methods of obtaining, managing and using energy resources.
    - 8.P.2.1 Explain the environmental consequences of the various methods of obtaining, transforming, and distributing energy.
    - 8.P.2.2 Explain the implications of the depletion of renewable and nonrenewable energy resources and the importance of conservation.

Appendix B: Unit Classroom Handouts and Resources

Properties of Elements Lab Sheet

Materials

Each group should have the following materials:

1. Seven capped “mystery” vials, numbered 1-7:
    a. Iron filings (or bee bees)
    b. Sulfur rolls
    c. Mossy Zinc
    d. Graphite (lead from lead pencils)
    e. Silicon
    f. Mossy Tin
    g. Carbon (charcoal)
2. One dropper bottle with 6M HCL acid
3. One small hammer
4. Conductivity apparatus: (ex: 9V battery, wires and a small light bulb)
5. Eight pieces of 3.5x5 inch paper
6. Seven (labeled 1-7) test tubes and a test tube holder
7. Set of Goggles for entire group
8. This lab sheet

Procedures

- Review as a class the basic definitions of each property that is being testing during this activity.

- Groups should be 2-3 students maximum. Students will alternate doing each part of the procedure

- Each student should have on safety goggles and know basic lab safety guidelines

1. Student will take a piece of white paper, fold it in half, open it, and place it on the lab top. Another member of the group should then open vial 1 and shake about a pea-sized portion of the sample onto the white paper. Each student should observe the appearance of the sample and record his or her observations in the "color" and "luster" columns of the data sheet.

2. Student will place a second piece of paper over the top of the sample and crush the sample with the hammer. The student should then remove the top piece of paper and each student in the group should observe the sample and record his or her observations in the "malleability" column of the data sheet.

3. Student will test the conductivity of the sample with the conductivity apparatus by placing the ends of the wires not attached to the power source or light bulb into the sample vial. DO NOT LET THE WIRES TOUCH EACH OTHER. Each student should observe the light bulb and record his or her observations in the "conductivity" column of the data sheet.

4. Student will pour sample 1 from the paper into the test tube and add 10 to 20 drops of 6M hydrochloric acid. Each student should then wait at least three minutes before observing and then record his or her observations in the "reaction with acid" column of the data sheet.

5. Groups will repeat steps 1-4 for samples 2-7

6. When students have cleaned up and returned all of their materials, they will then classify each of the samples as a metal, nonmetal, or semimetal. He or she should record the answer in the "classification" column of the data sheet. Each student should then submit his or her data sheet. M stands for Metal, NM stands for Non-Metal, and MO stands for Metalloid.

Data Sheet

Sample Number	Color	Luster	Malleability	Conductivity	Reaction with Acid	Classification (M – NM – MO)	Other Observations
1							
2							
3							
4							
5							
6							
7							

Notes on Alloys and Transitional Metals

Name of alloy	Composition (elements)	Special Properties	Common uses
brass			
bronze			
14-karat gold			
pewter			
solder			
stainless steel			
sterling silver			

Properties of NASCAR Metals Data Table

Solid Bar	**Mass (weight)**	**Density**	**Conductivity**
Steel Cold Rolled Round Bar (1018)			
Stainless Steel Round Bar (304)			
Aluminum Round Bar (6061)			
Chrome Moly High Strength Steel (4130)			
Brass Round Bar (360)			
Super High Strength Tool Steel (S7)			
Tubular Steel			
Cold Drawn Seamless Tube (1018)			
DOM (Drawn over Mandrel) Steel Tube			
Welded (ERW) Steel Tube			

The result is that our students can hold and try to bend the samples. Some will seem very heavy and some will start to rust. The students must then answer some questions:

6. Which solid bar is the heaviest?
7. Which Tube is lightest?
8. Do any of these metals show signs of corrosion?
9. Can the student identify the weld line on the ERW steel tube?
10. Do any of the metals show a different color? After seeing these samples, could you identify a metal if you saw it on the street?

Chemical Bonding “Bond with a Friend”

Molecule	Name	Elements needed
H_2O	Water	H+ H+ O2-

Balancing Equations – Law of Conservation of Mass Concept Example

Reactants		Reaction	Products		
$2C_8H_{18}$	$25O_2$	→	$16CO_2$	$18H_2O$	Energy
C =	O=		C =	H =	
H =			O =	O =	
Total Atoms =				Total Atoms =	

Balancing Equations Template

Reactants		Reaction	Products		
		→			
=	=		=	=	
=			=	=	
Total Atoms =				Total Atoms =	

Balancing Equations Concept- Answer Key

Reactants		Reaction	Products		
$2C_8H_{18}$	$25O_2$	→	$16CO_2$	$18H_2O$	Energy
C = **16**	O= **2x25=50**		C = **16**	H = **2x18=36**	
H = **2x18=36**			O = **2x16=32**	O = **1x18=18**	
	Total Atoms = **16+36+50=102**			Total Atoms = **16+32+36+18= 102** **so _____ atoms are**	

Balancing Equations – Find the Coefficient

Reactants		Reaction	Products		
__C_8H_{18}	__O_2	→	__CO_2	__H_2O	Energy
C =	O=		C =	H =	
H =			O =	O =	
Total Atoms =				Total Atoms =	