



Pop Culture and Chemical Reactions

by Victoria Woods, 2017 CTI Fellow
Independence High School

This curriculum unit is recommended for:
High School Physical Science or Chemistry

Keywords: coefficient, subscript, conservation of matter, conservation of mass, binary compound, single replacement, double replacement, decomposition, synthesis, balanced equation, combustion, neutralization, hydrocarbon, chemical equation, chemical reaction, reactant, product, mass

Teaching Standards: See [Appendix 1](#) for teaching standards addressed in this unit.

Synopsis: This curriculum unit seeks to engage students in the exploration of chemical reactions by relating it to popular culture of their current interests. Students will explore through hands-on activities and interactive group games via the 5 E Teaching model. The Engagement will come from asking students probing questions to pique their interest. The Exploration part will come from students experiencing concepts by doing. The Explanation component will involve lectures and demonstrations. The Elaboration component will involve students comparing and contrasting relationships in popular culture to relationships in chemical reactions. The Evaluation portion of the lessons will involve students integrating their knowledge in the unit from learning and application to creating a brochure representation of their understanding of chemical reactions and a multiple-choice assessment.

I plan to teach this unit during the coming year to 62 students in High School Physical Science in grades 10-12.

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Pop Culture in Chemical Reactions

Victoria Woods

Introduction

As an educator, an important facet next to content and engagement is relevancy to the lives or interests of students. Making the topic interesting and relevant to students' lives is critical in helping them appreciate science. This is evident in their constant questions of "how is this going to help me outside of this class?" or "why do I need to know this?" No answer that I give will ever make them appreciate science more than relating it to something that they find interesting outside of class. This unit seeks to bridge that gap, the out of school world with the in school world. This unit will help students relate their research from social media to research from scientists in the laboratory.

I teach Physical Science and Earth/Environmental Science. Physical science is a high school course for students who have failed Earth/Environmental Science or Greenhouse Biology. The class is also for students who are not confident in the sciences. There is no Honors option for the course. It's a step in between those courses and Chemistry or Physics. With the district requiring 3 credits of science, physical science combines the less strenuous, introductory parts of the chemistry essential standards and the physics essential standards. In this course, students are expected to struggle with content, expected not to complete or turn in work, and are expected to have a high record of absence from school. I also have a high demographic of students who have just exited/graduated out of the ESL program in school so their English language proficiency may not be high.

I chose Physical Science, as opposed to Earth/Environmental Science because, from the data, my physical science students need more assistance and more thoughtful and intentional planning. Of course, my Earth kids need that as well, but I also have a lot more support and resources for that course, as there are 4 other teachers in the earth/environmental professional learning community. Currently I am the sole teacher for Physical Science in my school. I wanted to choose a unit that would be personally challenging but also largely beneficial to the kids that I'll be teaching. A lot of the students enrolled in the course are minorities. Past experience has taught me that these students spend a lot of time in suspension, outside and inside school. I don't want the course to be easy for them but I want it to be easily connected to past experiences and prior knowledge or interests that they have before they enter my classroom. I want the course to be one that makes them come to school, secondarily solving their issues with truancy. Making a classroom engaging and fun for students has a side effect of making them more likely to come to school in general.

I also chose Physical Science for this curriculum unit because of the challenge. My background in science is more familiar with the biological and earth sciences. Choosing to do a curriculum unit on Chemistry would sharpen my skills as a 9-12 Science educator and force me to learn more in depth content knowledge about a branch of science I'm not as comfortable with.

I figured I owed it to my students to try something challenging, an initiative that educators attempt to instill in their students every day.

The entire premise of the *Doing Science: Hands-On Learning in the Laboratory* seminar is to think of ways to integrate engaged, hands-on learning in science based classrooms at the K-12 level. Each Fellow in the *Doing Science* seminar brings a different perspective to the table because each of us deal with different demographics of students on a daily basis. Due to our wide ranging skill sets, the collaboration and ideas shared in the seminars were helpful. The scientific method is at the core of every learning opportunity in our world and it seems that the curiosity in students is lost through the years. A fun way of learning involves getting to touch things and experience phenomena through observation and laboratory exercise. Through this unit, students will get four hands-on, engaging lessons delivered in the 5 E model of teaching to help them understand the different types of chemical reactions and how to balance them.

School Setting

My school on the southeast side of the city, on the border of Charlotte and Mint Hill, and is very diverse as one of the 30 Charlotte-Mecklenburg high schools. The total minority enrollment of the school is 66% of the 2,349 students who are enrolled. Of that total enrollment, 55% of students are economically disadvantaged. The school is 53% male, serving 9th-12th graders in the area. It's a large school with a large student body.

My course load consists of one Earth/Environmental course and two Physical Science courses. The North Carolina Department of Public Instruction requires students to pass 3 core science courses and both of the courses that I teach can satisfy that requirement. It isn't uncommon for me to teach the same student twice, in Earth/Environmental and then again in Physical Science. Students see me on a daily basis for an entire Semester (or two Quarters). There is no A Day/B Day format for either course.

Curriculum/Goals

Charlotte-Mecklenburg Schools follows the North Carolina Standard Course of Study in all core courses. Physical Science fits as a science requirement for students with less than 3 years of science or an elective for students with more than 3 years of science classroom and laboratory experience. The course has an NCFE (North Carolina Final Exam) that is state mandated and administered. The test assesses students on chemistry and physics concepts learned throughout the course in a 45 multiple-choice exam. Of those concepts, this curriculum unit will address one Physical Science standard that has two clarifying objectives, shown in Appendix 1.

The unit will explore relationships that students understand outside of school and relate them to the relationships of atoms in the Periodic Table with chemical reactions. Students will play interactive matching games, competitive group games, and complete engaging independent activities to gain relevance between science and the popular culture that they love so much. With the diversity of learners that teachers serve these days, I wanted this unit to cater to all kinds of learners. That way it will be more effective at educating my students.

Background

Popular culture encompasses the music, dancing, fashion do's and don'ts and celebrity happenings of the current day and age. It's also referred to as pop or pop culture. Given that pop culture has such a strong influence on teens, I felt it was imperative to somehow drive a connection between those influences and the influences of science.

This generation (and presumably generations to come) is heavily influenced by social media. Students are creating friendships, creating rivalries, determining what's cool and what's not, and sharing their ideas and beliefs at a rate unseen in previous generations. Social media is at the center of the life of most of today's youth. Tapping into this interest has the potential to have a grand impact on the way that students learn in the classroom. Science has a lot to do with relationships and pop culture is much in the same.

Chemistry Background

Atoms

Atoms are the building blocks of our universe. All matter is made out of atoms. All atoms are made of tiny subatomic particles called protons, neutrons, and electrons (see Figure 1). Electrons carry the negative charge of an atom. Protons carry the positive charge and neutrons carry no charge. Protons and neutrons are located in the nucleus of the atom. This gives the nucleus an overall positive charge. Outside of the nucleus is the electron cloud, where the negative electrons are moving in an orbit.¹

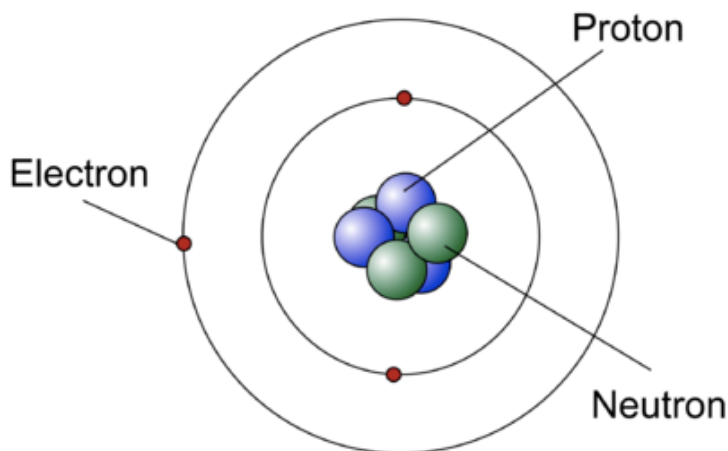


Figure 1. The structure of the atom.²

Ions

A key piece of chemistry is understanding that opposites attract. The opposites of chemistry reference include the positive or negative charges that ions have. Ions are created when atoms gain or lose electrons, the negatively charged subatomic particle of all atoms. Ions of positive

charge, meaning that they have lost electrons, are called cations. Ions of negative charge, meaning that they gained electrons, are called anions. Understanding that opposites attract, anions and cations like to bond to each other. You wouldn't see a cation binding to a cation or an anion binding to an anion.

Compounds and Molecules

Bonds occur between molecules and compounds to form new ones. All compounds are molecules but not all molecules are compounds in that a molecule is made from 2+ atoms and a compound is made from 2+ elements.³ For example: water is made of hydrogen and oxygen. H₂O, the chemical formula for water, is a compound because it contains multiple elements. Those elements are hydrogen and oxygen. On the other hand, molecular hydrogen (H₂) and molecular oxygen (O₂) are diatomic. Diatomic means that the molecule is composed of two atoms. Because of this, molecular hydrogen and molecular oxygen are simply molecules but are not compounds.

Bonds

When compounds join together in a bond, that bond is characterized by the atoms that are involved. The Periodic Table of Elements is organized so that one can tell the type of element based on its location on the periodic table. The Periodic Table, generally, has the strongest metals on the left, least strong metals in the middle, elements that are semi-metals towards the right of those, and then complete nonmetals further to the right of those. The actual names of these groupings of elements are not relevant for this curriculum unit.

Ionic Bonds

When metals bind with metals, the bond is called metallic. When a metal and a nonmetal bind, the bond is called ionic. This is because the ionization energy of a metal and nonmetal are vastly different. Ionization energy is the energy or ability of an atom to lose its valence electron(s). Valence electrons are the electrons of an atom that can be used for bonding. Ionic bonds happen when metallic elements donate their valence electrons to nonmetallic elements. Elements on the left side of the periodic table (metals) are more likely to give away their valence electron and elements on the right side of the periodic table are more likely to accept the valence electron(s) from a metal. That loss and that acceptance of the electron(s) is what makes one of the compounds an anion and the other a cation. Don't forget that opposites attract. This means that anions won't bond with anions and cations won't bond with cations.

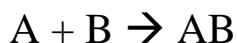
Covalent Bonds

When nonmetals bind with nonmetals, they are so alike in ionization energy that they share electrons, rather than transfer them to one another. Neither element will completely give an electron away so no ions are formed. Those bonds are called covalent.

Chemical Reactions

Recall that compounds bond to form new compounds. This is called a chemical reaction. For a reaction to happen, there has to be some sort of attraction between the molecules. Remember anions won't bond with anions and cations won't bond with cations because opposites attract. There are four types of reactions that occur between compounds that are relevant to this curriculum unit: Synthesis, Decomposition, Single Replacement, and Double Replacement.

Synthesis reactions, as implied by the term, relate the joining of compounds. A new compound is synthesized by the addition of two compounds into one. The generic example using letters that is commonly used in explanation is shown below.



In chemical reactions, equal signs are not used and are replaced with arrows in the direction of the reaction.

Decomposition reactions are the exact opposite, representing the breakdown of chemicals from one compound into two.



As you've probably noticed, decomposition and synthesis reactions are mere opposites of one another. Because of this, the single pointed arrow can be represented as double pointed to symbolize the fact that the reaction can occur either way.



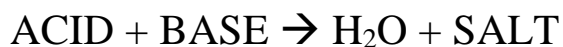
Another type of chemical reaction is called single replacement. These reactions involve the "switching" or, replacement (as the term implies), of one compound in the reaction. Maintaining the letter examples, a single replacement reaction would present as follows. Single replacement reactions are socially similar to switching places with the "third wheel" element.



Double replacement reactions, like single replacement, involve compounds switching places. Only this time, two compounds are doing the moving instead of just one. The two cations **or** two anions in the reaction will switch places. Note that both wouldn't switch because that would just be making the same substance.⁴ Remember opposites attract. The letter example follows.



In this example, letter B and letter C switched places with one another, creating two new molecules. This course also requires students to understand Neutralization reactions, a type of double replacement reaction shown below, in which an acid and a base produces water and salt.



Law of Conservation

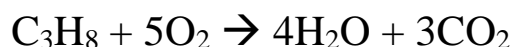
The end all be all in chemical reactions is the Law of Conservation of Matter or Law of Conservation of Mass. Both terms are essentially the same, stating that matter or mass cannot be created or destroyed, they're just changing state or form. In a chemical reaction, no matter or mass is lost, just transferred into something else. For example, if you have 5g of substance A and 5g of substance B, when combined, they should form 10g of substance AB. Did you guess what type of reaction I just described? It was a synthesis reaction in which two compounds came together to form one new compound. It is important to note that the Law of Conservation of Mass (or Law of Conservation of Matter) holds true to chemical reactions that produce a gas. The gas still has density. If the resulting gas were collected, it would hold whatever mass was presumably lost in the reaction.

Balancing Equations

The Law of Conservation of Mass applies to masses of compounds used and transferred in a reaction. The Law of Conservation of Matter applies to the balancing of these reactions. To balance an equation, you just have to make sure that you have the appropriate amount of "stuff" on each side. By stuff, I mean of each element. If you start of with 2 hydrogens, you shouldn't end up with 4. You should still only have two. This is where coefficients and subscripts come into play. Coefficients are the "big numbers" in front of compounds telling you how many of those compounds are in the reaction (on either side). Subscripts are the "little numbers" that tell the reader how many of each element is on either side. For example: In the water molecule below, you can note that the coefficient present is 3 and that the subscript present is 2. This means that there are 3 waters present and that each water has 2 hydrogens. This, in total, gives you 6 hydrogens and 3 oxygens. When trying to determine the amount of elements present, the easiest strategy I have is to multiply the coefficient by the subscript for the element it follows. Pretend there's an imaginary 1 subscript behind the oxygen (even though we don't write 1s in chemistry- it's assumed) and multiply it by the coefficient.



When balancing equations, you must have the same amount of material on both sides of the arrow, kind of like $2 + 2 = 4$. There is the same amount of material on both sides of the equals sign. Look at the example below to understand.



The equation above is a combustion equation, the only type of equation that Physical Science students do not need to know. This equation is the creation of fire. As you can see, on both sides of the equation there are 3 carbons, 8 hydrogens, and 10 oxygens. Make sure you note to students that you **cannot** change the subscripts of a chemical equation to satisfy equal amounts on both sides. Changing the subscripts changes the compound (because H_2 and H_3 are not the same thing). You can **only** change the coefficients to satisfy equality on both sides of the arrow. Remember that coefficients change the amount of molecules present, which is what you want to do to make it all balance out.

Teaching Strategies

Vocabulary Development

Vocabulary is the foundation for which knowledge in the unit is based on. The vocabulary terms for this unit will be entirely new for students. The course has several English Language Learners so vocabulary development will be done through personalized drawings that the students make.

Hands-On Learning

Students learn best when they get to experience course content for themselves. The main approach in this unit is to allow students to work with their hands, partners, and other classmates to understand chemical reactions.

Instructional Implementation

Lesson One: Chemical Reaction Types

This lesson will take one 90-minute class period, concluding with an informal assessment.

Engagement

Because this is the start of a new Essential Standard, students may or may not have any prior knowledge associated with classifying chemical reactions. Through use of the Quickwrite strategy, students will activate prior knowledge and then share their ideas with the class. The worksheet is in Appendix 3. To begin the strategy, ask students to brainstorm about “chemical reactions” and write their ideas in the first box. After a couple of minutes ask students to select and circle one of the ideas that they wrote and then quickwrite for another couple of minutes about that idea in the following box. Ask students to raise their hand to share the idea that they circled from the Brainstorm box and then an idea from their Quickwrite box. Use their ideas to gauge their prior knowledge about chemical reactions.

Exploration

Students will explore reaction types by modeling basic “reactions” that they know of already. Students will be given a “Hello My Name Is” name tag to wear on their backs. They cannot look at it. Students can see their peers name tag but not their own. Students will have to travel around

the room, conversing with each other, to match up and create a “reaction”. For example: Student A can be “milk”, Student B” can be “cereal”. This part of the lesson uses 21st Century skills, creating collaboration and communication. Names to use for the name tags are included in Appendix 3.

Explanation

Students should be briefed on the purpose of the Exploration activity and led into lecture on vocabulary and examples of the different reaction types. Essential vocabulary for this lesson includes: single replacement, double replacement, decomposition, synthesis, neutralization, chemical reaction, reactant, and product. The best method of presentation would be PowerPoint presentation with guided notes.

Elaboration

To help students understand reaction types, they will work in groups of 3 and will be given an envelope with celebrity photos. They will have to match the photos up by who’s dating who, who’s related to who, and so on. When they are finished, they should have created a celebrity relationship for each type of reaction and must tell the teacher the reaction for each celebrity relationship. Possible relationships to include (that are relevant to 2017) are in Appendix 3.

Evaluation

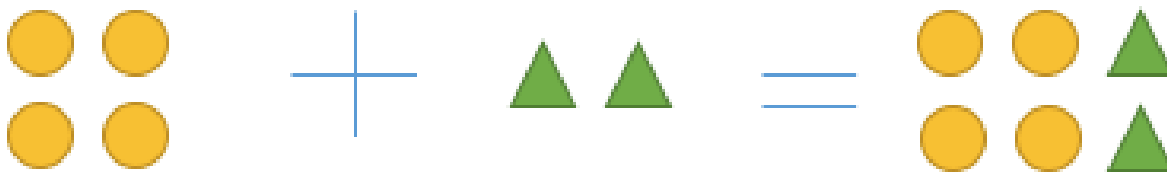
The last slide of the PowerPoint presentation should be an Exit Ticket. The slide should list 5-10 random reactions and students should take an index card, and classify the reactions to hand in on their way out of the door to their next class or to go home for the day. They shouldn’t focus on writing down the reactions presented, just the type. Teachers can use this to informally assess the varying degree of student understanding of the day’s content.

Lesson Two: Law of Conservation of Mass

This lesson will take one 90-minute class period, concluding with an informal assessment.

Engagement

Students will complete a warm up that will involve them using drawn shapes or figures to show balanced reactions. Ask students to select a different shape/figure for each element within balanced chemical reactions shown on the board. They are to, then, draw the shapes by the amount of atoms of each element. It would help to model the activity for students. For example, if $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ is the given chemical reaction, the student drawn answer should look something like the following:



Explanation

Students should be led into lecture on vocabulary and teacher should model how to balance a reaction. Essential vocabulary for this lesson includes: coefficient, subscript, conservation of matter, conservation of mass, binary compound, single replacement, double replacement, decomposition, synthesis, balanced equation, combustion, neutralization, hydrocarbon, chemical equation, chemical reaction, reactant, product, and mass.

Elaboration

Students should practice with real chemical reactions, as opposed to fictional ones. Post unbalanced reactions around the room and have students walk around, write the reactions, and then balance them. For large classes, it's best to have multiple sets of the gallery walk so students don't get congested into one area.

Evaluation

End the class with an index card exit ticket where students correct the mistake in an incorrectly balanced equation. They will note the error and then correct it. Present the incorrectly balanced equation of your choice on the board.

Lesson Three: Review and Product Production

This lesson will take approx. three 90-minute class periods, concluding with a formal assessment during the third class period.

Engagement/Explanation

Day 1: Teachers can create an anonymous online survey or poll for students to rate their comfort with the topics of the unit. Sites that provide real-time feedback to use are included in Appendix 2. Based on student responses, the teacher can spend time clearing up misconceptions that students have.

Day 2: To review the concepts of the unit, students will practice being a teacher! They will be given a copy of a fictional completed quiz, included in Appendix 4, of a fictional student who took a quiz on the topics covered in the unit. They will have to grade the student's quiz, marking the errors and writing what the correct answer should have been. The fictional quiz should also be posted on the overhead or Smart Board/Promethean so that a few students can get out of their seats and take turns grading the quiz for the class when they're done.

Exploration

Day 1: Students will be given an envelope with various true and false statements about concepts expressed in the unit. They will have to partner up and sort the statements into a true category and a false category. Statement handouts are included in Appendix 4.

Elaboration

Day 1-3: To cater to all learners, students will have different requirements that they can choose to independently present their learning. There will be six choices. Out of the six choices, students will have to choose three to represent personalized mastery of the unit. The requirements for each choice are independent assignments, that come together to create a portfolio style assignment of mastery. Portfolio handouts are included in Appendix 4.

Evaluation

Students will take an assessment on the second day that covers concepts from the unit. Assessment questions are included in Appendix 4.

Appendix 1: Implementing Teaching Standards for North Carolina Standard Course of Study

Essential Standard PSc 2.2: Understand chemical bonding and chemical interactions.

Clarifying Objectives:

PSc 2.2.4. Exemplify the law of conservation of mass by balancing chemical equations.

- Use coefficients to balance simple chemical equations involving elements and/or binary compounds
- Conclude that chemical equations must be balanced because of the law of conservation of matter

PSc 2.2.5. Classify types of reactions such as synthesis, decomposition, single replacement, or double replacement.

- Classify chemical reactions as one of four types: single replacement, double replacement, decomposition and synthesis. (Neutralization reaction is a type of double replacement reaction.)
- Summarize reactions involving combustion of hydrocarbons as not fitting into one of these four types. Hydrocarbon + oxygen \rightarrow carbon dioxide + water

Appendix 2: Teacher Resources

Websites:

www.polleverywhere.com is a good site to use that relays instant feedback. When rating student comfort with a topic, instant feedback provides information necessary to elaborate and explain specific content further.

www.mentimeter.com is another survey site that makes presentations interactive and provides instant feedback that can be used to gauge student success with a specific topic before an exam.

Appendix 3: Classroom Materials

Basic Materials Needed for Activities

“Hello My Name Is” nametag stickers

Envelopes

Index cards

Computer with internet access and printer capabilities

“Hello My Name Is..” Nametag Matches to be made by teacher

Name	Name Pair
Milk	Cereal
Paint	Paintbrush
Keychain	Keys
Shoes	Socks
Spaghetti	Meatballs
Nails	Nail polish
Hands	Gloves
Pen	Paper
Teeth	Toothpaste
Washer	Dryer
Salt	Pepper
Mail	Mailbox
Shampoo	Conditioner
Remote Control	Television
Umbrella	Rain
Spoon	Fork
Peanut	Jelly
Macaroni	Cheese
Shirt	Pants

Celebrity Relationships Relevant to 2017

1. Amber Rose + Wiz Khalifa → Sebastian Taylor Thomas
2. Blac Chyna/Tyga + Kylie Jenner/RobKardashian → Blac Chyna/Rob Kardashian + Tyga/Kylie Jenner
3. Chrissy Teigen + John Legend → Luna
4. Mariah Carey → Monroe + Moroccan
5. Selena Gomez/The Weeknd + Justin Beiber → Selena Gomez/Justin Beiber + The Weeknd

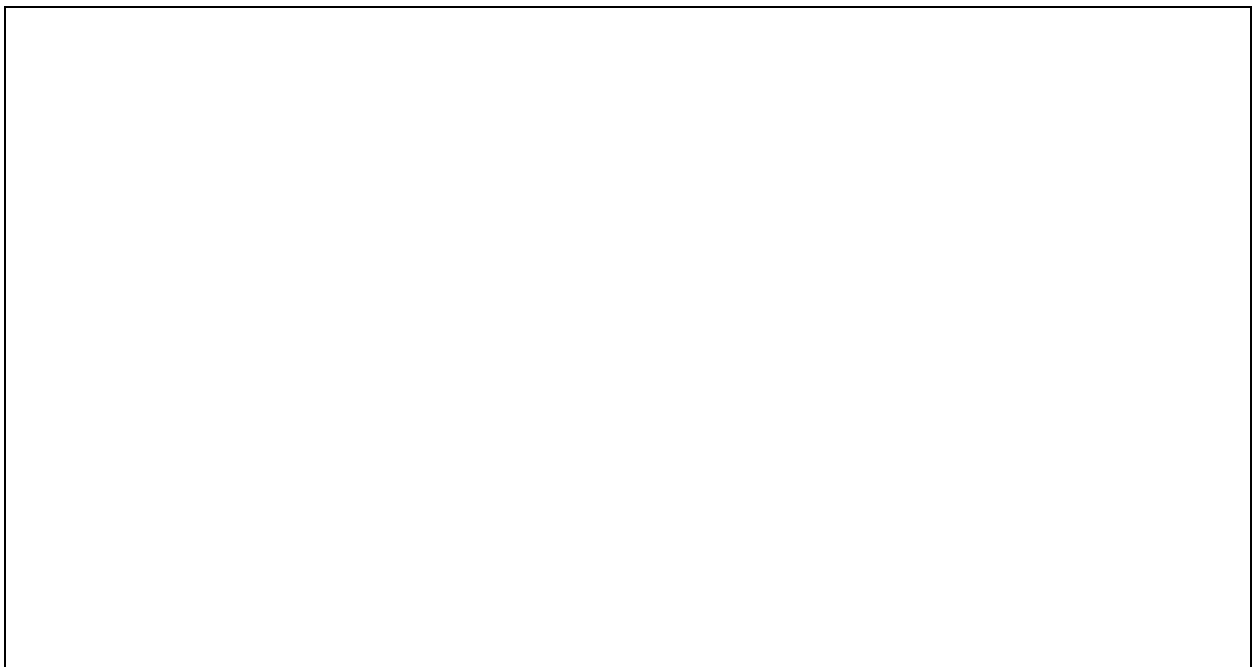
Appendix 4: Student Handouts and Worksheets

Quickwrite Strategy

Brainstorm

A large, empty rectangular box with a thin black border, intended for a brainstorming activity.

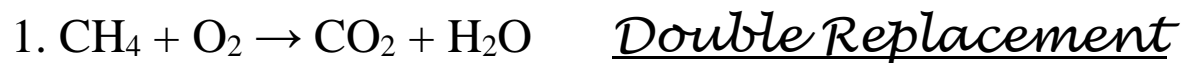
Quickwrite

A large, empty rectangular box with a thin black border, intended for a quickwriting activity.

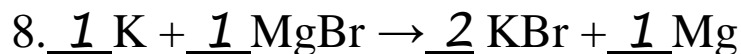
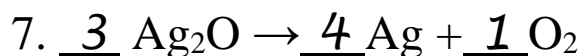
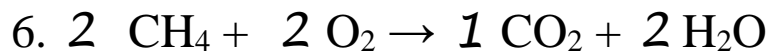
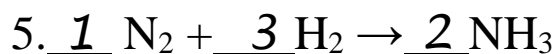
Chemical Reactions Quiz

Name Casey R. Jones

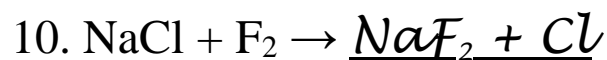
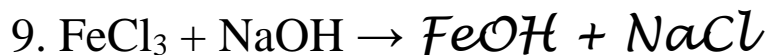
For questions 1-4, name the reaction type.



For questions 5-8, balance the reactions.



For questions 9-10, finish the reaction with the formed products.



Portfolio Choices

Chemical Reactions Project

To demonstrate mastery of the unit, you will choose three (3) out of the five (5) options given for the portfolio project.

Option One: Create a How To poster, worthy of classroom presentation, describing how to differentiate between the four types of chemical reactions.

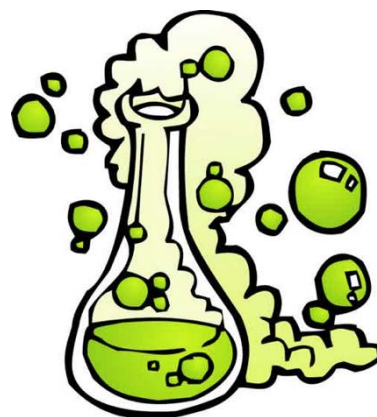
Option Two: Create an exam and answer key, complete with 20 questions in the form of true/false, multiple choice, matching, and short answer.

Option Three: Pretend to be an author and write a section in a textbook teaching students how to differentiate between the four types of chemical reactions and how to balance them. Include examples and highlight key terms.

Option Four: Create a song, rap, or catchy chant that your classmates can use to help them remember how to differentiate between the four types of reactions. This option must be performed for the class prior to the exam.

Option Five: Create a competitive group game to help students review for the exam. Be sure to include gaming instructions, gaming pieces (if any), and all other materials that go along with the game.

Option Six: Design a custom tshirt that creatively conveys a topic from the unit. T-shirt must be worn on exam day.



True/False Statements

True	False
Synthesis reactions are the opposite of decomposition reactions.	Cations are negative ions.
Cations only bond with anions.	All chemical reactions are irreversible.
Chemical reactions create new substances.	Polyatomic ions always break apart in chemical reactions.
Matter cannot be created nor destroyed.	Compound and molecule are interchangeable terms.
Subscripts are the little numbers after elements in a compound or molecule.	Materials on the left side of the reaction are products.
All compounds are molecules.	All molecules are compounds.

Appendix 5: Assessment Questions

1. To balance a chemical equation, it is only necessary to adjust the _____.
2. An insoluble solid produced by a chemical reaction in a solution is called a _____.
3. In what kind of reaction do two or more substances combine to form a new compound?

4. The equation $A + X \rightarrow AX$ is the general equation for a ____ reaction.
5. In what kind of reaction does a single compound produce two or more simpler substances?
6. In what kind of reaction does one element replace a similar element in a compound?
7. In the following chemical reaction, what product is represented by **X**?

$$AlCl_3 + NaOH \rightarrow X + NaCl$$
8. In the following reaction, what would be the second product formed?

$$Na + LiCl_2 \rightarrow Li + \underline{\hspace{2cm}}$$
9. The chemical equation, $KClO_3 \rightarrow KCl + O_2$, is an example of what type of reaction?
10. A reaction where an acid reacts completely with a base to produce water and a salt is called what?
11. A precipitate is a ____.
12. Complete the following chemical reaction: methane + oxygen \rightarrow carbon dioxide + ____.
13. What is the name of the chemicals that react in a reaction?
14. What type of chemical reaction is represented by the following:

$$KOH + HBr \rightarrow KBr + H_2O$$
15. What type of chemical reaction is represented by the following:

$$C_{10}H_{22} + O_2 \rightarrow CO_2 + H_2O$$
16. What is the Law of Conservation of Mass?
17. Balance the following reaction:

$$\underline{\hspace{1cm}} Na + \underline{\hspace{1cm}} Cl_2 \rightarrow \underline{\hspace{1cm}} NaCl$$
18. Balance the following reaction:

$$\underline{\hspace{1cm}} Al_2S_3 \rightarrow \underline{\hspace{1cm}} Al + \underline{\hspace{1cm}} S$$
19. The compound, sodium sulfate, contains how many elements?
20. The compound, sodium sulfate, contains how many atoms?

¹ (Chem4kids.com 2017)

² (Google sites 2009)

³ (Education.jlab.org 2017)

⁴ (KhanAcademy 2017)

Annotated Bibliography

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Center for Science, Mathematics, and Engineering Education. (2000). *Inquiry and the National Science Education Standards: A guide for teaching and learning*. Washington, D.C: National Academy Press.

A guide to teaching science through inquiry-based learning.

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Provides student work samples and strategies to teach science creatively to students.

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