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Why Do I Need to Know This? The Use of Authentic Text to Foster Student Engagement and Provide Relevance for the Major Understandings of Regents Chemistry

Nicole M. Calzi
The College at Brockport, nemiliano1@gmail.com

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by

Nicole Marie Calzi

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APPROVED BY:

Advisor ______________________________ Date ____________

Director, Graduate Programs ______________________________ Date ____________

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Chapter 1: Introduction

Problem Statement and Significance of the Problem

Science education today, ideally, should look very differently than it did twenty to thirty years ago. With our drastically and quickly changing society it has become extremely important for students of science to be trained as critical thinkers and creative problem-solvers. To foster this training science education needs to move beyond basic knowledge of science facts and concepts and shift to an understanding of what science is, what science is not, what science can and cannot do, and how science contributes to our culture (Schwartz et al., 2002). There needs to be a focus on science as a way of thinking, a process for figuring out how the world works. Students need a basic understanding of scientific inquiry or "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work" (Schwartz et al., 2002, p. 2). Explicitly teaching the process of scientific inquiry and the nature of the scientific enterprise will aid in creating scientifically literate students and in turn, a scientifically literate society.

Shifting from a traditional, teacher-centered science classroom that focuses purely on the acquisition of facts requires specific changes in teachers' perceptions of science education, restructuring of the classroom environment, adoption of new and innovative teaching methods, and buy-in from the students. Teaching science through inquiry begins with a constructivist approach (Schwartz et al., 2002). Teachers should begin with determining what students previously know about a particular concept and build their lessons upon this prior knowledge. Upon building on this prior knowledge students then participate in a discrepant experience where they truly engaged and able to generate authentic questions to further investigate. Students are motived to learn because they feel they have ownership and control over their learning (Wright & Wright, 1998).

Teachers often battle the “Why should I care?” questions from students. This is especially true in subjects with material that is not easily relatable to the lives of students. In chemistry, students may not find the mechanics behind writing chemical formulas too enticing. Challenge teachers continuously face is fostering student engagement when topics such as writing chemical formulas must be taught, reviewed, and assessed in great detail. One approach to this challenge is building connections between classroom topics and the “real world” (Hoban & Severson, 2011). The National Research Council (NRC, 1999) claims that high quality learning results when connections are made between the classroom and the lives of students outside of the school setting rather than learning without context or authentic purpose.

The following project provides specific methods to foster student engagement through making connections between classroom content and relevant aspects of students’ lives. The main avenue to for making connections is through the use of authentic text such as newspapers, magazine articles, Internet websites, books, etc. Careful attention is paid to text structure, as certain texts have been shown to be more beneficial for learning (Guzzetti, Synder, Glass, & Gamas, 1993; Sinatra, & Broughton, 2011). To fully support the use of text to foster engagement, the use of reading strategies and “writing-to-learn” strategies are included.

Purpose and Rationale

Recently in the United States, states like New York are embarking on a journey of educational reform after being given an incentive under the Obama Administration's Race to the Top (RTTT) program. Under RTTT states like New York are pushed to make significant educational policy changes that include opening more charter schools, revamping the teacher evaluation process, implementing assessment data-driven dialogue, and increase the extent to which reading is taught in all classrooms (McGuinn, 2012). At many schools teacher training surrounding data-driven dialogue has already begun through Student Based Inquiry Teams (SBIT). Teachers have also been addressed about the soon to be mandated Common Core ELA standards that will need to be taught in all content areas. The Common Core is a set of state standards, adopted by 48 states, that aims to increase the amount of reading, use of complex text, and use of argumentative writing in all subject areas.

Considering the complexity of text people are exposed to in their everyday lives has increased steadily over the last fifty years, the implementation of the Common Core strives to improve reading levels and text comprehension of students in the United States (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). The Common Core has already been implemented in New York but only in some content areas. Within the next two to three years New York State teachers, regardless of content area, will be required to increase the amount of text and the complexity of text used in their classrooms. To hold teachers and students accountable the state intends to change its high stakes assessments to reflect the necessary literacy and problem solving skills students will be expected to develop.

Considering the attitude surrounding reform is currently present, science teachers have an opportunity to rework their science teaching practices. Since changes in curriculum to incorporate the use of text, such as magazine and journal articles, textbooks, newspapers, and internet sites to name a few, are going to be necessary in the very near future, science teachers could couple increased use of text with increasing student engagement by using authentic text to make connections between curricula and the "real-world." In addition, the use of "writing-to-learn" as a means for improving student understanding, critical thinking skills, and a means for expressing their knowledge solidifies this framework for reform.

Definition of Terms

Critical Thinking: the process of thinking that questions assumptions.

Classroom environment: the academic, social, and physical conditions within a classroom that influence the learning situation.

Prior Knowledge: the knowledge that stems from previous experiences.

Constructivist approach: teaching based on the idea that students construct their own meaning after taking part in a learning activity.

Reading Strategy: a specific means for comprehending a text passage.

Writing-to-Learn: using writing activities to guide student learning and understanding.

Summary

The following project provides a review of the literature that supports instructional strategies for the use of relevant expository text in the science classroom to promote student motivation, reading comprehension, and writing-to-learn. Following the review of the literature thirty carefully selected text passages that encompass specific aspects of the Regents Chemistry curriculum and are relevant to students' lives are included. Each text passage is aligned with a reading and writing strategy to guide students in extracting information from the text. Further implications of this project, such as the effect using authentic text to provide relevance and foster student engagement, are discussed in the final section of the project.

Chapter 2: Literature Review

Introduction

The following literature review provides specific methods to foster student engagement through making connections between classroom content and relevant aspects of students' lives. This includes the use of authentic text such as newspapers, magazine articles, Internet websites, books, etc. and an investigation into the text structure (expository, persuasive, or refutation) that is most beneficial for learning. Finally, to fully support the use of text to foster engagement, the use of "writing-to-learn" in science is also reviewed.

Promoting Student Engagement and Interest

Student interest: Individual factors. A key aspect of fostering student learning is grabbing and holding student attention and interest (Bergin, 1999). Much of the literature regarding the promotion of student interest and motivation to improve learning lacks specific curriculum changes teachers can make to attract the interest of students in classroom activities. Bergin (1999) however outlines specific individual and situational factors that influence interest. The individual factors include belongingness, emotions, competence, utility-goal relevance, and background knowledge. The situational factors include hands-on, discrepancy, novelty, food, social interaction, modeling, games and puzzles, content, fantasy, humor, and narrative. He also comments on the degree to which teachers integrate these factors into their instruction and the likelihood of increased student interest and learning as a result.

Bergin (1999) discusses the social nature of the human race and how this promotes a need for students to develop a sense of belonging in the classroom. He highlights the three areas that target the creation of a sense of belonging to include cultural value, identification, and social support. In most cases people become interested in matters that are valued by their surrounding culture. High school students, for example, value certain types of music, sports, video-games, and technology to name a few. The degree to which a group of students share a common cultural value determines the frequency to which a teacher should touch on such cultural values. The more attached a group of students are to some cultural value, the more likely they are to become interested in subject matter that pertains to or is presented through such cultural values.

In addition, Bergin (1999) discusses how students identify themselves as members of specific groups within the overarching culture. Groups students identify with may include gender, ethnicity, religion, and geographic region. As people grow and material they develop an identity that corresponds to placing themselves into specific groups based on the above factors (Brophy, 1999). Once an identity has been created, the person is likely to develop a connection to matters that pertain to or align with their identity. For example, if a student identifies himself as a member of the white, male, middle-class, suburban athlete and he is exposed to matters pertaining to hunting, he is less likely to show interest in those matters because hunting does not connect with his identity. Careful investigation into the social interest of students by teachers is essential for creating interest based on specific identity groups. What the teacher finds interesting may be very different from what her students find interesting.

Emotions also have a strong influence on the development of interest (Bergin, 1999; Ekman, 1994; Ellsworth, 1994). People connect their emotions to subject matter when it (the subject matter) touches upon personal experiences that flare up emotions within that person. A student who has been notoriously criticized for her performance, or lack thereof, in science is likely to equate negative emotions with the subject and avoid it whenever possible. In contrast, a student may associate positive emotions with experiences that created happiness or euphoria for them in the past and, when these experiences or tasks like them are revisited, foster interest or happiness again. Emotions don't necessarily have to be positive to foster interest (Bergin, 1999). For example, if the Japanese nuclear crisis that emerged from the March 2011 tsunami was discussed along with the presentation of risks involved with nuclear power, students may experience emotional sadness that would intern promote interest in the subject matter. Student engagement and interest may also be fostered when students believe they will be competent with the task and/or if the topic is associated with students' prior knowledge. Students who feel that excel in mathematical subjects are likely to be more interested in topics in science that deal with mathematical problem solving. Or, if students have much interest or prior knowledge in the area of explosives, discussions in class regarding explosives are likely to promote the interest and engagement of those particular students (Bergin, 1999).

Student interest: Situational factors. The individual factors discussed in the previous section are dependent on student culture, identity, and previous interests and, although teachers can strive to uncover these individual factors, they cannot be initially controlled by the teacher. This next section discusses specific situational factors outlined by Bergin (1999) that can be controlled by the teacher on a daily basis. A few of these factors that especially pertain to the science classroom include learning through hands-on activities, novelty, content, and narrative.

Students seem to be interested in activities that are "hands-on" or that allow for students to create their own meaning through material manipulation and physical engagement. Students are also intrigued by activities that allow them to engage in learning while moving around the classroom, or participating in cooperative learning groups (Anderson, 2002). Discrepancy also plays a large role in promoting student interest. If teachers present students with evidence about material that students notoriously believe to be true and is in fact false (a misconception), students invest in resolving the discrepancy (Bergin 1999). Novelty has been shown to attract interest of students. In a science classroom this may be a discrepant event or flashy demonstration. Some content is notoriously more interesting to students than others. For example students are more likely to engage in material that is relevant to their lives and they see a direct connection between their life and the importance for knowing key concepts (Bergin, 1999). Narratives, or stories, also promote the gaining and holding of an audience's interest. It is been shown through a study by

Hidi and Anderson (1992) that narrative texts were rated more interesting than expository texts or mixed texts in a classroom environment.

The individual and situational factors discussed above should be considered by teachers when designing and planning instructional tasks (Bergin, 1999). The instruction should be as congruent as possible with existing individual student interests and the type of learning activities a given group of students tend to invest in while learning. Although these factors have been shown to promote interest they do not necessarily increase the level of student learning and understanding (Gamer et al., 1991; Garner et al., 1992; & Wade et al., 1995). Careful attention must be given to instructional planning to incorporate activities that not only promote interest but also increases student learning.

Student motivation, interest, and information transfer. A study conducted by Pugh and Bergin (2006) investigates the connection between student motivation and its influence on information transfer or the ability of students to apply their learning to new and novel contexts. Information transfer can be broken down more specifically into three categories. Transfer can be conceptualized as the successful application of skills, problem solving techniques, and content knowledge to a task that is related and very similar to the original learning context. Information transfer may also be applying knowledge and skills to more difficult and complex situations than the original learning context. Lastly information transfer may refer to the engagement or success in real-world tasks that require the knowledge and skills taught in the original learning context. It is argued by Pugh and Bergin (2006) that without transfer, the relevance and importance of formal schooling is limited and so any factors, such as motivation, that have been shown to further information transfer are worth investigating. The motivational aspects that were focused upon in this study included achievement goals, interest, self-efficacy, and intentional transfer. The aspects of achievement goals and interest are focused upon below.

Achievement goals refer to two different types of goals (Pugh & Bergin, 2006). The first type involves mastery, learning, and task involved goals that emphasize the development of skills and specific competencies. The second type involves performance-based and ego-involved goals that focus on appearing competent, especially through completing a task more successfully than an individual who did not undergo the specific learning. Although there is a distinction between types of achievement goals neither are mutually exclusive and are usually intertwined.

Considerable research has found that mastery goals significantly improve cognitive engagement. For example Wolters, (2004), found that junior high school math students who expressed goals in mastering material were more likely than other students to use cognitive and metacognitive strategies to learn material, put forth effort to complete their math assignments, and persist when getting frustrated. Although students with mastery goals tend to show improvement in metacognition there is little evidence that mastery goals actually predict achievement. Interestingly, however, performance-approach goals have been found to predict achievement. The simple fact-recall of mastery goals does not promote deep-level learning and understanding of concepts. If, however, students are going to be evaluated on a performance-based task they are more likely to engage in learning that promotes a deeper level of understanding (Wolters, 2004).

A study conducted by Lepper and Parker (1992) found that increasing student interest lead the greater learning and information transfer. Information transfer refers to student ability to apply their specific conceptual knowledge to different and new contexts. In their study students were learning the basics of a graphics programing through a program called Logo. In Logo, interest was included by adding fantasy context to the Logo activity for some of the students involved. Lepper and Parker claimed that by including fantasy items interest would be improved without obscuring the instructional foal of the activity. Results showed that students in the fantasy group had greater interest than those in the control section. Also, when measuring student performance on an exam that contained geometry concepts that related to those investigated in the Logo activity, students in the fantasy conditions showed significantly more learning than students in the control section.

Student motivation has been shown to influence information transfer in a positive manner (Pugh & Bergin, 2006). Motivation factors are seen to influence transfer because they also influence cognitive engagement such as use of learning strategies to promote connections between main ideas and engagement in metacognition. Some studies also show a positive correlation between interest in subject matter and information transfer (Prawat, 1989; Renkl et al.,1996). This area is under further investigation to examine the potential causal relationship between interest and transfer.

For a more focused and content specific approach Singh, Granville, and Dika (2002) conducted a study to examine the effects of motivation, attitude, and academic engagement on 8th grade students' achievements in math and science. These authors recognized that although the cognitive ability of students and their home lives are important predictors of achievement they desired investigating the prominent variables that have emerged in recent years as affecting student achievement in math and science.

In Singh, Granville, and Dika's study (2002) students from around the United States, in a variety of school settings (public, private, urban, suburban, rural) were randomly selected and completed a 45-minute questionnaire. There were items in the questionnaire that related to motivation. First the students were asked about how often they missed school, skipped classes, or were tardy. These questions were used to indicated the first latent construct of motivation. Second students were asked about how often they came to class without a pen/pencil, books, homework, and other necessary materials. These items were used to determine student participation and preparedness for classes, and formed the second latent construct of motivation. Thirdly, to investigate academic engagement, students were asked if they looked forward to math or science class, though math or science would be useful in the future, and if they were bored in school. Academic time was measured by asking students how much time they spent on math and science homework and how much time they spend watching TV on the weekdays. Standardized test scores in science and mathematical subjects measured the final variable, academic performance in math and science.

Singh, Granville, and Dika (2002) analyzed the results on math and science achievement separately. For the purpose of this paper, the results that correspond to science achievement will be discussed. The strongest effect on science learning was academic time. Students who spent more time on science homework had higher achievement in science. Attitude toward science was the next largest effect on science learning. The study showed that students who are motivated and have a more positive attitude for science are more likely to spend time on science homework and less likely to spend time watching TV on weekdays. The results of this study by Singh, Granville, and Dika (2002) are encouraging because the factors that were considered are possible to change or be encouraged strongly to change by teachers. These authors suggest creating a more positive school experience for students and improve teachers' instructional approaches. Also, they suggest increasing student motivation to learn science and math by creating a curriculum that focuses on creating meaning and relevance.

Use of Text to Provide Relevance and the Analysis of Text Structure Most Beneficial for Learning.

Considering the complexity of text people are exposed to in their everyday lives has increased steadily over the last fifty years, increasing the amount of reading in the science classroom is essential (National Governors Association Center for Best

Practices, Council of Chief State School Officers, 2010). Even so, use of text in the science classroom has declined since the 1980's when the push for inquiry-based learning and teaching of science immersed. Also, teachers have steered away from using science textbooks because of the sheer difficultly students have in interpreting the complex material (Sinatra & Broughton, 2011). Recently however, researchers have a renewed interest in the use of text in the science classroom as a tool to promote conceptual change and learning (Sinatra & Broughton, 2011). Also, when text is combined with interesting and stimulating tasks, there is an increase in student motivation for reading and reading comprehension (Guthrie et al., 2006).

Sinatra and Broughton (2011) investigate the connection between conceptual change, restructuring of preconceived notions students have of scientific concepts, and reading comprehension. Models of reading comprehension and the use of refutation text and their contributions to promoting learning and conceptual change in science are also investigated.

When students enter the science classroom they may have ideas about concepts, developed from their lives and daily experiences, that conflict with science concepts. Learning from text, according to Sinatra and Broughton (2011), can be related to changing students' conceptions of science topics. Changing student conceptions can be a very difficult process. Text comprehension relies on the process of making connections between background knowledge and the text content. Text that contradicts students' background knowledge, although it may be difficult to comprehend, may hold the ability to promote conceptual change. As students processes text information that is inconsistent with their background knowledge, they may recognize these inconsistencies and in turn increase the likelihood of conceptual change.

Research has shown that the structure of text used in the classroom contributes to the degree of conceptual change (Guzzetti, Synder, Glass, & Gamas, 1993; Sinatra, & Broughton, 2011). The structured that are examined include traditional expository text, persuasive text, and refutation text. Traditional expository text presents information in a list-like fashion and provides little support to help the reader make connections between the concepts that are being presented. Persuasive texts are designed to shift readers' attitudes and opinions about a particular topic or event. Refutation texts are persuasive in nature but are designed to change the readers' viewpoint about a particular scientific viewpoint. Refutation texts explicitly state a commonly held misconception and then immediately refute that misconception. For example "Some people think that seasons change because the Earth is closer to the sun in summer and farther away from the sun in the winter. However, this is not the case. Rather, it is the tilt of the Earth's axis that causes the seasons to change" (Sinatra & Broughton, 2011, p. 383). A study conducted by Guzzetti, Synder, Glass, and Gamas (1993) provided evidence suggesting that refutation texts were the most effective in promoting conceptual change.

In order for students to participate in reading activities, such as reading refutation text for the purposes described previously, students must be motivated take part in the reading experience. Guthrie et al. (2006) investigate the influences of stimulating tasks on student motivation to read and reading comprehension. Stimulating tasks include hands-on science experiences, participation in authentic tasks, and reading that satisfies curiosity.

Results from this study show that students who participated in a large number of stimulating tasks increased their reading comprehension in comparison to students who participated in a small number of stimulating tasks (Guthrie et al., 2006). The number of stimulating tasks, however, did not increase reading comprehension, as measured by a standardized test, when motivation was controlled. Stimulating tasks that included reading in turn increased situational interest and long term intrinsic motivation and reading comprehension.

Use of "Writing-to-Learn" Strategies in the Science Classroom

The Science Writing Heuristic (SWH). Over the last thirty years or so, science education researchers have argued for the implementation of "writing-to-learn" strategies in the science classroom to promote a deeper learning of scientific concepts, the skills necessary for scientific inquiry, and provide an effective avenue for assessing student thinking and conceptual knowledge (Yore, Bisanz, & Hand, 2003). "Writing-to-learn" in science provides a means for students to formulate and refine their new knowledge and to connect ideas by finding the most appropriate words and sentence structure to convey a clear textual meaning for others (Wallace et al., 2004). To support writing in a laboratory setting, researchers have been investigating a tool known as the "Science Writing Heuristic" (SWH) as an alternate format for conducting laboratory investigations and writing lab reports.

Research by Keys, Hand, Prain, and Collins (1999) argue for the use of the SWH in place of the traditional laboratory format. These researchers claim that when students conduct traditional laboratory experiments that use the traditional laboratory notebook format, students learn some laboratory techniques, but little else. Under these conditions, students also develop a poor attitude toward science and consider laboratory activities to be a waste of their time. Using the traditional format students will blindly follow directions and usually the data that is collected results in a large percent error. When little thinking is done by the student to plan and implement the investigation, that leads to large percent errors that are often equated to poor equipment, human error, or other various inappropriate sources of error. When students are asked to solve problems that require critical thinking on an exam or lab practical, student performance is generally poor. Incorporating guided-inquiry, learning cycles, group work, and the SWH in the laboratory setting is key for improving student conceptual understanding (Keys, Hand, Prain, & Collins, 1999).

The SWH is an alternate format for students to use for their lab reports and is a teaching technique for teachers to help format the activities that correspond with the laboratory experiment. Rather than using the traditional lab report format of purpose, methods, observations, results, and conclusions students respond to prompts that include questions, knowledge, claims, evidence, description of data and observations, methods, and reflect on changes in their own thinking as the experiment progresses. Teachers take an active role in pre-designing laboratory activities and guiding students through the laboratory experience.

According to Keys, Hand, Prain, and Collins (1999), the SWH has two distinct components: a teacher template and a student template. When planning laboratory activities, teacher are encouraged to use the template as a guide for involving students in meaningful thinking, writing, reading, and discussion. Teachers also use the template to fit the activities to their content, type of laboratory activity, personality of the students, and personal teaching style. The teacher template consists of eight components (Table 1).

Table 1 *Teacher template*
1. Exploration of pre-instruction understanding through individual or group concept mapping
2. Pre-laboratory activities, including informal writing, making observations, brainstorming, and posing questions
3. Participation in the laboratory activity
4. Negotiation phase I- writing personal meanings for the laboratory activity (For example, writing journals)
5. Negotiation phase II- sharing and comparing data interpretations in small groups (For example, making a group chart)
6. Negotiation phase III- comparing science ideas to textbooks or other printed resources (For example, writing group notes in response to focus questions)
7. Negotiation phase IV- individual reflection and writing (For example, creating a presentation such as a poster or report for a larger audience
8. Exploration of post instruction understanding through concept mapping

Students may repeat components three through six as necessary depending on the topic and nature of the investigation.

The student template is used by students, working individually or in small groups, as the laboratory investigation is conducted (Keys, Hand, Prain, & Collins, 1999). The student template consists of seven components (Table 2).

Table 2

Student template

1. Beginning Ideas- What are my questions?
2. Tests- What did I do?
3. Observations- What did I see?
4. Claims- What can I claim?
5. Evidence- How do I know? Why and I making these claims?
6. Reading- How do my ideas compare with other ideas?
7. Reflection- How have my ideas changed?

This template requires students to provide evidence for their claim and therefore encourages an understanding of the nature of science. Students also have the opportunity to compare their work with the work of other scientists through researching their claims in textbooks and other resources. Students then reflect on their conceptual ideas and how they have changed throughout the laboratory experience.

The SWH is an example of a type of writing activity that can be conducted in a classroom setting to support student metacognition and data reasoning. Students make meaning of the laboratory activities in multiple formats of discussion and writing. Also, the SWH provides teachers with a framework for implementing meaningful, authentic, and inquiry-based, laboratory investigations in their classrooms.

Use of the Science Writing Heuristic in the classroom. Research conducted by Rudd, Greenbowe, and Hand (2007) investigated the effect of using the Science Writing Heuristic on student understanding of general chemical equilibrium, a topic that is notoriously challenging for chemistry students both at the high school and college level. The research question in this study was "Do students who have an inquiry-oriented laboratory format exhibit better understanding of chemical equilibrium equations, concentrations, and concepts, as assessed by scores on a lecture exam question and a laboratory practical exam task, compared to students who have a standard laboratory format?" (Rudd, Greenbowe, & Hand, 2007, p. 2007). The study was conducted in the spring semester at a university located in Midwestern America and included 52 students where were enrolled in a second-semester general chemistry course for science and engineering majors. The 52 students were placed in two separate laboratory sections. One section conducted laboratory investigations using the traditional laboratory format, while the other section used the SWH format. All students had the same textbook, lecture professor, and class assignments.

Student understanding of chemical equilibrium was determined through the analysis of student responses on a lecture exam problem and a laboratory practical task. After analyzing all student responses, both descriptive and statistical evidence suggested that students taught using the SWH were more successful than students taught using traditional methods in identifying an equilibrium condition and explaining the equilibrium processes. Rudd, Greenbowe, and Hand (2007) were able to conclude that students who participate in a structured-inquiry laboratory experience are able to overcome difficulties in understanding chemical equilibrium, especially the common misconception that equilibrium is defined by equal concentrations of products and reactants. They also make a broader claim that students who participate in an inquiry lab have a greater opportunity to further their understanding of concepts being investigated in the laboratory experience.

Although "writing-to learn" in science has been shown to improve student conceptual understanding, studies in the last ten years have created various concerns among writing-to-learn science researchers. According to Rivard (1994), much of the past research was conducted on a small scale and failed to provide the evidence necessary to claim that actual learning benefits result from writing in science and across contexts. Rivard also expressed a necessity for more extensive research on the subject of writing-to-learn in science.

Since Rivard's article a variety of studies have been conducted to investigate the use of a range of writing support strategies (Yang, Hand, & Bruxvoort, 2002; Hand, Hohenshell, & Prain, 2007; Hand, Hohenshell, & Prain, 2004; Hohenshell, Hand, & Staker, 2004; Gunel, Omar, Grimberg, & Hand, 2002; Hand, Wallace, & Yang, 2004). These strategies include providing opportunities for students to brainstorm initial ideas on topics and confront with peers regarding initial and emerging understandings, a focus on writing for authentic audiences with the opportunity for feedback from these readers, drafting and redrafting writing tasks with feedback from peers and teachers, explicit teaching of format of science writing, a focus on big ideas to help students identify major concepts, use of assessment rubrics to guide student writing, and a variety of opportunities for research topics, plan, draft, edit, and proofread writing. Another focus in studying the use of "writing-to learn" was on the attainment of scientific literacy through dimensions that include understanding the nature of science and science inquiry, the role or reasoning and critical thinking, the influence of epistemological beliefs central to the construction and application of scientific knowledge (Gunel, Hand, & Prain, 2007).

Six studies, all focusing on the effect of "writing-to-learn" on student learning and understanding will now be described. Each of the six studies utilized a pre-test and post-test method of analysis to assess student learning after participating in a specific writing to learn strategy. The impact of each writing-to-learn strategy on student ability to answer expended response/short answer questions on an assessment was also investigated. The following criteria were held constant in each study: testing format, use of audiences other than teacher, use of a different writing to learn strategy for each group. (Gunel, Hand, & Prain, 2007).

The first study, conducted by Hand, Wallace, and Yang (2004) took place in a seventh grade biology classroom in a small city in a Midwestern America on the topic of cells. A small group of students were randomly selected for the treatment group and participated in a Science Writing Heuristic (SWH). The SWH required the teacher to participate in a variety of writing, reading, small and large group discussion to support students in meaningful thinking and problem solving. The SWH required students to generate their own questions and investigate those questions through scientific methods. Students are encouraged to report their findings in their own language. After conducting an investigation on cells, students in the treatment group were required to write a lab report in the format of a textbook passage for other seventh grade biology students. Students in the comparison group, those not selected for the treatment group, were required to write a chapter summary and answer questions from the end of a chapter in a textbook. Results from this study indicated that students who participated in the SWH performed better on the post-assessment than students who completed the more traditional writing task (Hand, Wallace, & Yang, 2004).

A second study conducted by Gunel, Omar, Grimberg, and Hand (2002) was very similar to the first study described previously. This study also was conducted in a seventh grade biology classroom where a group of students were selected randomly to be members of the treatment group. In this study, students in the treatment group were required to write a summary lab report in the form of a letter to other seventh grade students. Students in the comparison group wrote a summary of a chapter in a textbook and answer the questions at the end of the chapter. It was found, through analysis of student performance on a test, that the participation in letter writing (a form of a Science Writing Heuristic) was an effective strategy for learning the science content and facilitating the making of connections among procedures, data, evidence, and claims in a scientific setting (Gunel, Omar, Grimberg, & Hand, 2002).

A third study by Hand, Hohenshell, and Prain (2004) and a fourth study by Hohenshell, Hand, and Staker (2004) paralleled one another in that they both were conducted with tenth grade students and used the same experimental design. The only differences were that the Hand, Hohenshell, and Prain (2004) study was conducted in a public rural high school in Midwestern America, and the Hohenshell, Hand, and Staker (2004) study was conducted in private high school in an urban Midwestern American area. Also in the Hohenshell, Hand, and Staker (2004) study an assessment was given immediately following the implementation of the writing strategy. In both studies students were divided randomly into three treatment groups. The first treatment group, the traditional instruction group, wrote formal lab reports and a summary lab report to the teacher. The second treatment group participated in a SWH with modified lab reports and a summary lab report, again, written to the teacher. The third group participated in Calibrated Peer Review (CPR), and used a combination of the modified lab report and an Internet-based program that allowed their summary lab reports to be anonymously evaluated by three different peers. Results from the Hand, Hohenshell, and Prain (2004) study did not indicate any significant differences in performance between the three treatment groups. In the Hohenshell, Hand, and Staker (2004) study students were tested immediately following their participation in the SWH activities and summary report activities. Results from this study showed that students who participated in the nontraditional writing tasks performed better than those who wrote formal lab reports. This improvement in learning was demonstrated immediately following the participation in the writing activities.

A fifth study conducted by Hand, Hohenshell, and Prain (2007) was conducted in a tenth grade biology classroom in a rural Midwestern American high school. This study sought to investigate the effect of planning activities and writing-to-learn experiences on the topic of genetics and molecular biology. Also, this study investigated the learning outcomes of students who participated in two writing activities as opposed to one writing activity. Results from this study indicated that students who participated in the planning activities scored significantly better on conceptual test questions than those who had delayed planning experiences. Also, students who participated in two writing experiences scored better as a group as well.

A sixth study conducted by Yang, Hand, and Bruxvoort (2002) was conducted in an eleventh grade chemistry classroom in a Midwestern American high school and investigated the effect of using a writing-to-learn strategy versus answering end of chapter questions on student understanding of stoichiometry. This study incorporated both quantitative and qualitative methods of analysis. Quantitatively, student ability to answer conceptual questions about stoichiometry were analyzed. Qualitatively, students participated in end-of-unit interviews. Results showed that students who participated in the writing-to-learn strategy scored significantly better on the conceptual questions and could articulate their understanding on stoichiometry in a much more detailed and advanced manner than those who participated in the traditional instruction.

Given the results of these six studies researchers argue for the value of using writing-to-learn strategies in the science classroom (Gunel, Hand, & Prain 2007). "Writing-to-learn" required students to re-represent their knowledge in different forms and in their own language, and as a result greater learning opportunities exist.

With “writing-to-learn” strategies writing is a problem-solving tools that develops lifelong learning of science concepts. Traditional forms of writing on the other hand, such as answering end of chapter questions, rely on knowledge recall and replication rather than re-representation.

Conclusion. The teaching of science to support student attainment of scientific literacy is highly supported in the research and is the focus of the new National Science Education Standards (Wright & Wright, 1998). However, much of the research and the standards merely focus on the goals of science education and the definition of success rather than providing a solid framework, curriculum materials, or pedagogical instructions for the implementation of science inquiry in the classroom (Wright & Wright, 1998). With the emphasis of scientific inquiry in science curricula, teachers are challenged to come up with new approaches to teaching science courses that feature inquiry as essential for student learning (van Rens, Pilot, & van der Schee, 2010). This challenge is a barrier for many teachers of science. Many teachers themselves are not scientifically literate and have extreme difficulty creating and implementing lessons that model a scientific approach to solving problems (Wright & Wright, 1998). Today’s teachers also were once students who were taught in ways that did not incorporate scientific inquiry. Teachers lack training, confidence, materials, and time necessary for changing their curriculum and as a result it has been difficult for science education reform to take hold (Wright & Wright, 1998).

Considering the attitude surrounding reform is currently present, science teachers have an opportunity to rework their science teaching practices. Since changes in curriculum to incorporate the use of text, such as magazine and journal articles, textbooks, newspapers, and internet sites to name a few, are going to be necessary in the very near future, science teachers could couple increased use of text with increasing student engagement by using authentic text to make connections between curricula and the "real-world." In addition, the use of "writing-to-learn" as a means for improving student understanding, critical thinking skills, and a means for expressing their knowledge solidifies this framework for reform.

Chapter 3: Project Design

For each of the New York State Regents Chemistry Core Topics at least two samples of authentic text were selected to support content, provide relevance to students' lives, and generate student engagement. Authentic text samples are in the format of newspaper articles, magazine articles, carefully selected textbook passages, and Internet articles. The goal for using articles is to establish purpose for the curriculum and clearly exemplify why the chemistry curriculum is important for students to investigate.

Each text passage is supported by a specific reading strategy that will help students monitor their own comprehension, make connections, construct meaning, and synthesize important concepts. Each reading strategy also supports the Common Core Reading Standards for Literacy in Science and Technical Subjects. Each text passage will also be supported by a writing strategy to allow students to express their understanding in written format while practicing writing in the science context.

Reading Strategies

Think–Ink–Pair–Share (Billmeyer, 2003). According to the National Science Education Standards (1996) "student understanding is actively constructed through individual and social processes." The use of this strategy helps students develop skills that will help them feel more confident in sharing their ideas. Using this strategy requires students to read a passage and think about a question posed by the teacher. Students would then have time to respond to this question on their own. Once the student had an individual written response to the question, he would pair up with another student and share his response. See Figure 1 below for the Think–Ink–Pair–Share template.

Think	Why does the temperature of a boiling liquid remain constant? What happens to the energy?
Ink	
Pair	
Share	

Figure 1. Think–Ink–Pair–Share template
Used to promote idea sharing between students

Read, Write, and Talk (Harvey & Goudvis 2007). The read, write, talk strategy teaches readers to stop, think, and react to informational text. To use this strategy the instructor would model reading a piece of informational text and writing thoughts in the margins. Students would then use the strategy on their own by reading informational text and writing their thoughts in the margins. Stopping, thinking, and writing is stressed to students so that they can add to their store of knowledge, remember information, and better learn and understand the content in the passage. Once students have finished reading, they will discuss the passage in pairs or small groups. Students are encouraged to use their "notes" as a starting point for conversation.

The Frayer Model (Frayer, Frederick, & Klausmeier, 1969). The Frayer Model is a strategy that helps the reader activate prior knowledge, build vocabulary, and develop conceptual understanding by identifying characteristics, examples, and non-examples of specific terms. The Frayer Model may be provided to the student, with a specific vocabulary word in the center, prior to reading. Before reading a passage the student would have the opportunity to fill in the Frayer Model based on his prior knowledge and understanding. During and after reading, the student would revisit his initial responses and either adds to them, or make corrections. An example of a Frayer Model completed on Matter is show in Figure 2.

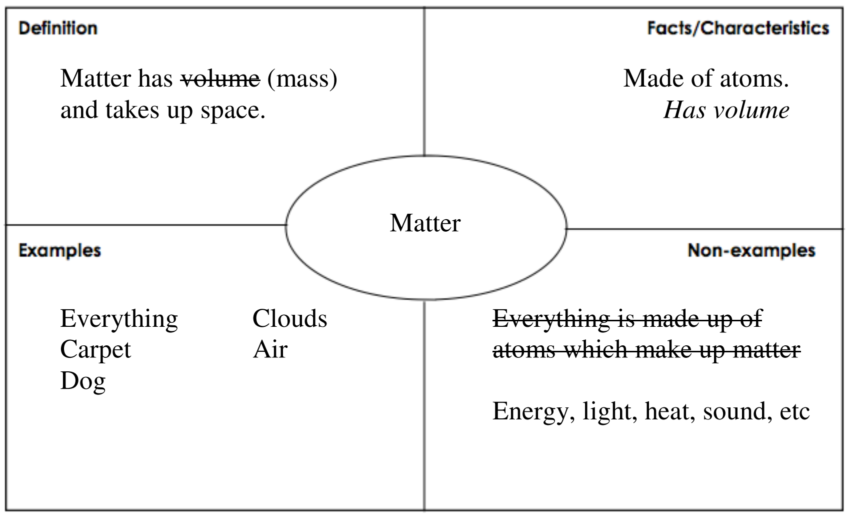


Figure 2. Frayer Model for vocabulary development

Concept Definition Mapping (Schwartz & Raphael, 1985). Concept definition mapping is a visual representation of the meaning of vocabulary terms. This strategy can be used to help students organize their thinking, make connections between concepts, and internalize the meaning of vocabulary terms. This strategy is very useful for complex concepts that include a variety of vocabulary terms.

Question-Answer Relationship (QAR) (Raphael, 1986). The QAR strategy supports reading comprehension by helping students make connections between their prior knowledge and the information presented in the text. It helps teachers and students alike refine their questioning skills. By engaging in a QAR while reading students are more apt to become strategic, careful readers. Four types of questions (as shown in Figure 3) are used as part of the QAR strategy: right there questions, think and search questions, author and you questions, and own my own questions.

Questions based on the article, *Mapping Scientific Frontiers*, www.sciencenews.org.

Right There Questions	• What is "normal" science according to Kuhn? • What do scientists do with the prevailing theory and novel findings during this time of "normal" science?
Think and Search Questions	• How is a paradigm shift - shift in understanding – represented in the visual representation? • How do the animated representation help communicate Chen's ideas?
Author and You Questions	• How does the information presented by the author, Ivars Peterson, compare to what you understand about the nature of science? • What questions would you ask of Dr. Chen?
On My Own Questions	• What can you do to deepen your understanding of the nature of science? • What is your prior experience with mathematical models and how they are used to make predictions or explain phenomena?

Figure 3. QAR template adapted from Rachel Billmeyer's *Strategies to engage the mind of the learner,* 2003.

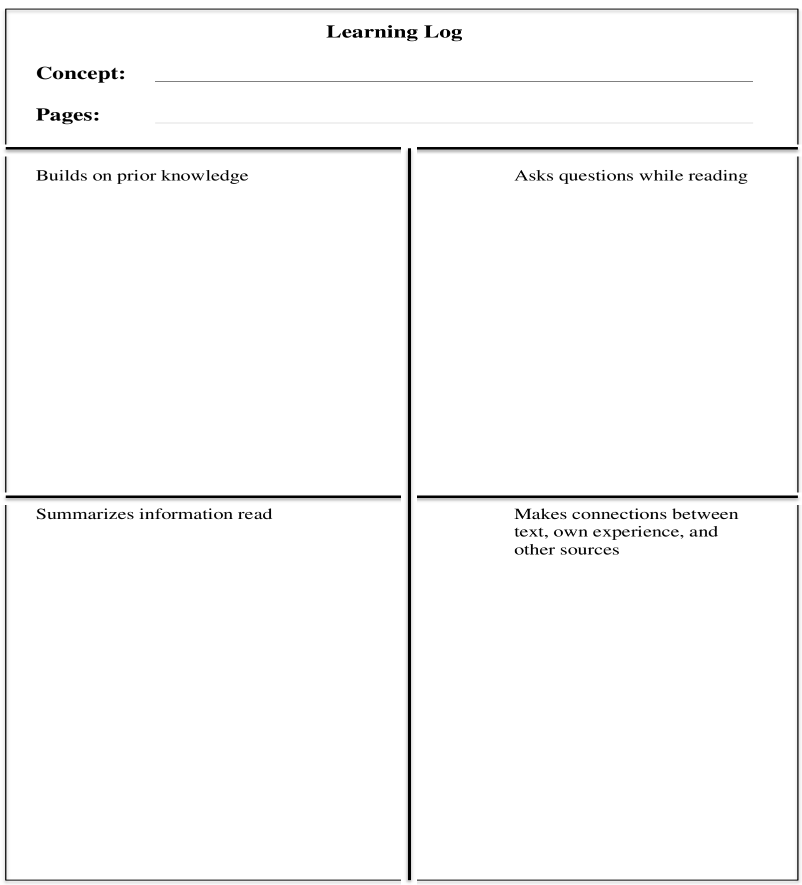
Visualizing in Nonfiction Text: Making Comparisons (Harvey & Goudvis, 2007). Much of nonfiction, expository text relies on concepts of size, weight, length, distance, and time to explain important information. Illustrations, graphs, charts, time lines, and diagrams provide visual support for students as they read and try to acquire information from expository text. Concepts that are often difficult to grasp can be learned through diagraming while reading. This is especially true in the field of chemistry where students must truly visualize in their minds to develop understanding. Teachers should encourage students to draw pictures in the margins as they read. The instructor may also prompt student drawings by giving students a list of prompts such as "As I read, I imagine, In my head I see, Based on the text I picture, and This reminds me of something I saw…"

Directed Reading/Thinking Activity (DRTA) (Moore, Readence, and Rickelman, 1982). This strategy can be used to help students approach a text that addresses common misconceptions in science. Prior to having students use this strategy, the instructor should probe students for preconceptions. Once the instructor knows student preconceptions, he may engage students in using this reading strategy. The DRTA strategy helps students learn to access their prior knowledge and approach text with purpose, questions, and the expectation that they will learn from what they're reading. When provided with a sample of text to read students will first answer a series of three questions: What I know I know, What I think I know, What I think I'll learn. After reading, the student will fill in their answer(s) to the final question: What I know I learned. See Figure 4 below for the DRTA template.

DRTA - Directed Reading / Thinking Activity
What I Know I Know -
What I Think I Know -
What I Think I'll Learn -
What I Know I Learned -

Figure 4. Directed Reading/Thinking Activity template for use in addressing student misconceptions while reading a text passage.

Learning Log (Billmeyer, 2003). This strategy causes the reader to monitor comprehension before, during, and after reading. Using a learning log when completing a reading passage allows students to be an active thinker and use necessary process skills to comprehend the passage (Billmeyer, 2004). As the students read they complete the Learning Log (Figure 5), which allows them to build upon their prior knowledge, ask questions while reading, summarize the information being read, and make connections between text, their own experience, and other sources.


Learning Log

Concept:

Pages:

Builds on prior knowledge

Asks questions while reading

Summarizes information read

Makes connections between text, own experience, and other sources

Figure 5. Learning Log Format, strategy utilized by students to improve reading comprehension.

Writing Strategies

Summary Wheel "Pizza (Piece of) Thinking"(Billmeyer, 2003). The summary wheel teaches students how to organize key ideas and terms, identify main ideas and supporting evidence, and organize their thoughts into meaningful, clear, and concise summaries. When using this strategy the instructor would first discuss the purpose and benefits of summarizing. The instructor would then have students read through a selected text passage for key terms or big ideas. Once the key terms were selected, the student would write each key term within the "crust" of the pizza (Figure 6). Students would then reread the passage and record details or supporting evidence for each key term. Instructors would also review with students the rules for summarizing: Include only important information, combine ideas, and add connective words for clarity and coherence. Also, the instructor would remind students that a summary should not include opinion, material directly copied, or quotes from the selection. Teachers instruct students to begin constructing their summary by first modeling how the information from one section of the "pizza" can be organized into a summary. The key term becomes the topic sentence and the details become the supporting evidence. Students then should construct their summary individually or in pairs.

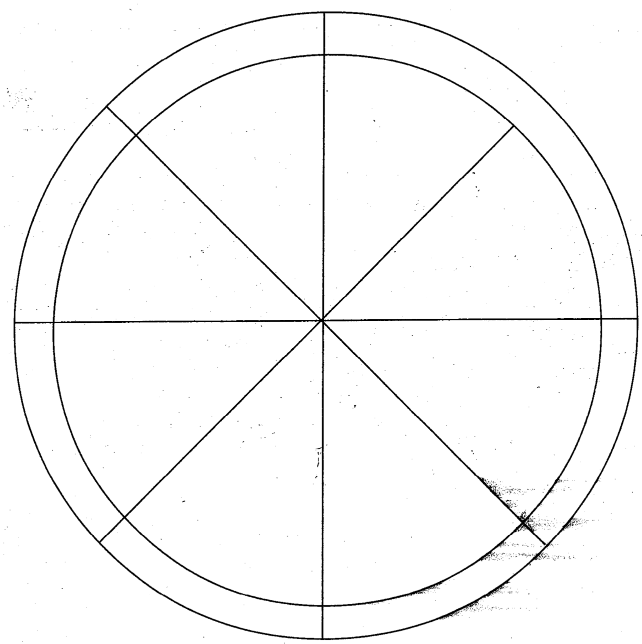


Figure 6. Summary Wheel. This figure represents an organizational tool used for constructing summaries of text passages.

The Science Writing Heuristic (SWH) (Keys, Hand, Prain, & Collins, 1999). The Science Writing Heuristic is an alternate format for laboratory investigations that promotes a deeper learning of scientific concepts, the skills necessary for scientific inquiry, and provides an effective avenue for assessing student thinking and conceptual knowledge (Yore, Bisanz, & Hand, 2003). Students use the SWH format for brainstorming ideas prior to conducting an investigation, determining a hypothesis, collecting and organizing data during lab, expressing their evidence-supported claims and conclusions, conducting further research, and reflecting upon how their ideas have changed as a result of completing the lab. Rather than using the traditional lab report format of purpose, methods, observations, results, and conclusions students respond to prompts that include questions, knowledge, claims, evidence, description of data and observations, methods, and reflect on changes in their own thinking as the experiment progresses (See Figure 7).

Science Writing Heuristic: *Student template*
1. Beginning Ideas- What are my questions?
2. Tests- What did I do?
3. Observations- What did I see?
4. Claims- What can I claim?
5. Evidence- How do I know? Why am I making these claims?
6. Reading- How do my ideas compare with other ideas?
7. Reflection- How have my ideas changed?

Figure 7. Science Writing Heuristic student template for use while conducting laboratory investigations. Template adapted from Keys, Hand, Prain, & Collins' *Using the Science Writing Heuristic as a Tool for Learning from Laboratory Investigations in Secondary Science*, 1999.

Double-Entry Journals (DEJ) (Herman & Wardrip, 2012). A double-entry journal is a two-column formatted chart for students to monitor and document their understanding of science texts. Completing a DEJ gives students an opportunity to actively read and reflect upon what has just been read. There are a variety of DEJ structures that would allow teachers to help students focus on an important idea or skill as they read. For example, a teacher may tailor the DEJ to focus on vocabulary development, determination of main ideas and supporting details, and accessing of prior knowledge. Completing a DEJ also helps students articulate their understanding of what they read in a variety of formats. For example, students may draw pictures and provide explanations for their pictorial representations of the text or apply their knowledge to practice problems while specifying where in the text the skills to complete the problems were mentioned. DEJs also provide teachers with insight on their students' thinking and understanding as they engage in a reading activity. According to Herman et al. (2008) and Herman et al. (2010), students who productively use the DEJ strategy demonstrate better understanding on related assessments. Figure 8 is an example of a TEJ or triple journal entry where three columns are used instead of two. Students pictorially represent three trials from an experiment and give written explanations of their representations.

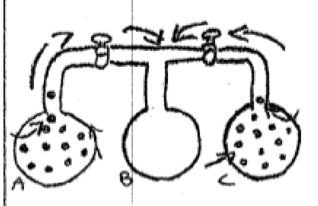
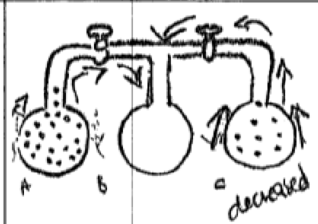
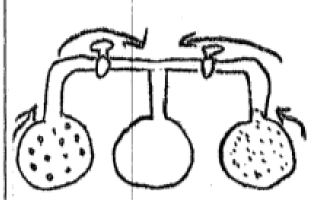
Trial	Diagram	Description
Trial 1		For trial one, A and C have the same initial concentration. When B is at 0 in the final results, the amount for A and B decreased, showing the equilibrium decreased, but all were equal.
Trial 2		The same effect took place. A had a higher concentration than C, but both decreased in the final concentration.
Trial 3		For trial 3, A had a lower concentration than C. Like the other trials, the final concentration had the same amount, showing that the equilibrium does in fact move.

Figure 8. Triple-entry Journal example. Students used pictorial representations of three trials of an experiment and gave written explanations for what was occurring during each trial.

Readable Writing Tasks (Silver, Dewing, & Perini, 2012). Readable writing tasks require students to clarify their thoughts and develop an organizational structure for their ideas. Readable writing is intended for an audience, usually the teacher, who can then assess students' depth of understanding and ability to construct appropriately reasoned responses. Students engage in readable writing tasks with the idea in mind that their writing should make sense and be easy to understand. Readable writing assignments have straightforward criteria for assessment and are great tools for developing students' skills in writing arguments, informative/explanatory texts, and narratives. Here are some sample writing prompts from Silver, Dewing, and Perini (2012) that align with these text types:

Argument. Based on the article we just read on the dangers of mobile phones, do you think there should be a minimum age for children to carry mobile phone? Use specific information from the article to defend your position.

Informative/explanatory text. Water freezes at 32^{o}F. Explain why it sometimes snows when the temperature is warmer than 32^{o}F.

Narrative. We have learned a lot about honeybees. Now it's your turn to image yourself as a honeybee. Give yourself a name, draw yourself, and describe three things you do during your day.

Comparison. Our textbook includes two primary accounts of the events at Wounded Knee: one from a member of the Lakota tribe and one from a U.S. soldier. Compare these eyewitness accounts. In your essay, make sure you address these two questions: What is the tone of each written account? What does the tone reveal about the author's perspective of the events?

Analysis (mathematical). Analyze the data charts showing the sales for best-selling fiction titles in hardcover, paperback, and e-book formats over the last 10 years. What conclusions can you draw? What do you anticipate the sales in each format to be 10 years from now? Explain your reasoning.

Description. After reading the first few vignettes in Sandra Cisneros's *The House on Mango Street,* briefly describe the character Esperanza and her Chicago neighborhood. (p. 55-56)

4-2-1 Free Write (Silver, Strong, & Perini, 2001). 4-2-1 Free Write is a dual-purpose strategy. First, it helps students focus their writing on the most important ideas through a process of collaborative summarization. Second, it prevents students from getting stuck when they write. According to Silver, Dewing, and Perini (2012) 4-2-1 Free Write is structured as follows:

1. After a reading, lecture or other learning experience, ask students to generate the four most important ideas.
2. Have students meeting in pairs to share their ideas and agree on two most important ideas from their lists.
3. Pair up the pairs into groups of four. Each group must agree on the single most important idea. Depending on students' facility with this process, you may choose to survey students' ideas, record them on the board, and then identify (or refine) the most important idea with the class.

4. Ask all students to free-write about the big idea for three to five minutes, explaining what they know well enough that someone who has never heard of the idea could understand it. Students may not stop writing at any point during the allotted time. If they get student, they should write about why they are stuck.
5. Students return to their groups, listen to one another's responses, and participate in a class discussion of the big idea. (p. 54-55)

Generalization/Principle Graphic Organizer (Baxendell, 2003). This graphic organizer is used to help students organize their thoughts regarding the main idea or ideas of a text passage. This graphic organizer helps students visualize how concepts are related to one another within a large text passage. By using such a graphic organizer students are better able to understand relationships between complex ideas or to arrange information to facilitate retention and recall. See Figure 9 for an example Generalization/Principle Graphic Organizer.

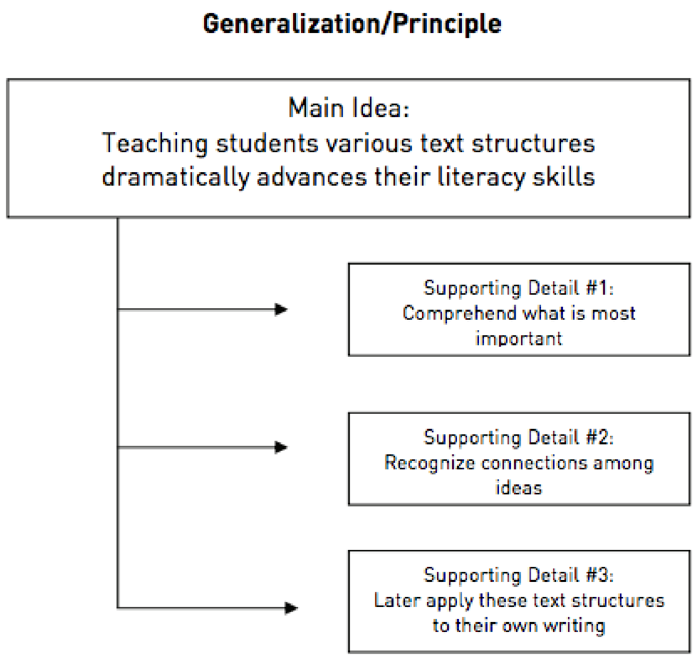


Figure 9. Generalization/Principle graphic organizer for student use in organizing main ideas and supporting details from a writing passage.

Articles

Atomic Concepts

Article Title	Fireworks!
Overview	This article provides students with an explanation of how fireworks work, how they burn into specific colors and patters, and stresses the importance of proper handling and safety. The article begins by discussing the internal structure and chemical make up of fireworks. A description of the physical and chemical processes invloved in creating the explosion to set off fireworks are given in detail. Specific attention is given to metal ions used in fireworks and how each ion produces a specific color after the explosion has taken place. The article clearly describes the process by which electrons enter the excited state and how light is given off at specific wavelengths upon the electron's return to the ground state. This article would serve as an excellent suppliment to the atomic concepts unit in Regents Chemistry as well as an application of the gas laws (specifically Charles' Law).
Source	(De Antonis, 2010)
Chemistry Core Topic	I. Atomic Concepts, V. Physical Behavior of Matter
Key Ideas from Regents Chemistry Core	Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	Performance Indicator 3.1: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. Major Understanding 3.1j: When an electron in an atom gains a specific amount of energy, the electron is at a higher energy state (excited state). Major Understanding 3.1k: When an electron returns from a higher energy state to a lower energy state, a specific amount of energy is emitted. This emitted energy can be used to identify an element. Performance Indicator 3.4: Use kinetic molecular theory

	(KMT) to explain rates of reactions and the relationships among temperature, pressure, and volume of a substance. Major Understanding 3.4c: Kinetic molecular theory describes the relationships of pressure, volume, temperature, velocity, and frequency and force of collisions among gas molecules.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
Reading Strategy	**Think-Ink-Pair-Share** **Rationale:** According to the National Science Education Standards (1996), "student understanding is actively constructed through individual and social processes." Through the use of the reading strategy, Think, Ink, Pair, Share, students develop important skills that help them feel more confident in taking the risk of sharing their ideas (Billmeyer, 2003). **Activity:** Think Questions: 1. What is Charles' Law? How does Charles' Law affect the loud sound produced by fireworks? 2. What causes fireworks to be different colors? Explain how different colors are produced in terms of electrons. How can fireworks be different colors? 3. What is a pyrotechnic chemist? How do you become a pyrotechnic chemist?
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 – 10.7): Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. Standard (WHST.9 – 10.9): Draw evidence from literary or informational texts to support analysis, reflection, and research.

Writing Strategy	Science Writing Heuristic **Rationale:** "Writing-to-learn" in science provides a means for students to formulate and refine their new knowledge and to connect ideas by finding the most appropriate words and sentence structure to convey a clear textual meaning for others (Wallace et al., 2004). To support writing in a laboratory setting, researchers have been investigating a tool known as the "Science Writing Heuristic" (SWH) as an alternate format for conducting laboratory investigations and writing lab reports. Rather than using the traditional lab report format of purpose, methods, observations, results, and conclusions students respond to prompts that include questions, knowledge, claims, evidence, description of data and observations, methods, and reflect on changes in their own thinking as the experiment progresses. Research by Keys, Hand, Prain, and Collins (1999) argue for the use of the SWH in place of the traditional laboratory format. These researchers claim that when students conduct traditional laboratory experiments that use the traditional laboratory notebook format, students learn some laboratory techniques, but little else. Incorporating guided-inquiry, learning cycles, group work, and the SWH in the laboratory setting is key for improving student conceptual understanding. The SWH is an example of a type of writing activity that can be conducted in a classroom setting to support student metacognition and data reasoning. Students make meaning of the laboratory activities in multiple formats of discussion and writing. Also, the SWH provides teachers with a framework for implementing meaningful, authentic, and inquiry-based, laboratory investigations in their classrooms. (Keys, Hand, Prain, & Collins, 1999). **Activity:** Use of the Science Writing Heuristic (SWH) format for laboratory investigation for a lab on atomic structure and flame testing. Students will be instructed that they must design and conduct an experiment to observe the characteristic colors produced by certain metallic ions when vaporized in a flame and then to identify an unknown metallic ion by means of its flame test.

	This laboratory investigation will be conducted after reading the article about Fireworks. Students will use this article as a source of reference for designing and conducting their experiment. They will also compare and contrast the results from their own experiment to those described in the article. Students will focus on comparing the theoretical colors of metallic ions to what they observed in lab. **SWH format for student written responses**: Beginning Ideas- What are my questions? Tests- What did I do? Observations- What did I see? Claims- What can I claim? Evidence- How do I know? Why and I making these claims? Reading- How do my ideas compare with other ideas? Reflection- How have my ideas changed?

Atomic Concepts

Article Title	Question From the Classroom. "Was it easy for people to accept the idea that matter is made of atoms when this idea was first introduced in the early 19th century? How did this idea appear anyway?"
Overview	This article focuses on the history behind the discovery of atoms, the role specific scientists played in the development of atomic theory, and how other scientists reacted to the new proposals regarding matter and its atomic structure. The article begins by discussing how the idea of matter consisting of a "smallest particle" that couldn't be further subdivided first appeared in Greece with 5th century B.C. Philosophers Leucippus and Democritus. It then goes into Dalton's theory and provides the specific components that were published by Dalton. There is also a description of Dalton's experiements and how he developed certain components of his theory as well as the reaction of some scientists to Dalton's publications. Specific attention is given to the law of conservation of mass and law of multiple proportions. In the Regents Chemistry curriculum this article could be used to suppliment the history of the atom and the progession of atomic models that lead to the current model of the atom.
Source	(Becker, 2010)
Chemistry Core Topic	I. Atomic Concepts
Key Ideas from Regents Chemistry Core	<u>Key Idea 3</u>: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	<u>Performance Indicator 3.2</u>: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. <u>Major Understanding 3.2a</u>: The modern model of the atom has evolved over a long period of time through the work of many scientists.

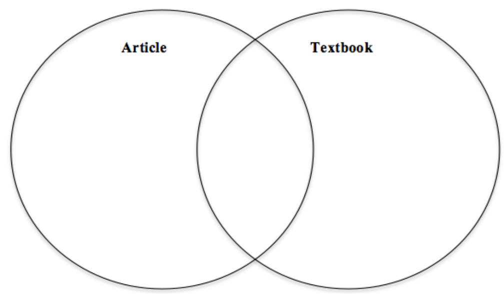
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.9): Compare and contract finding presented in a text to those from other sources (including their own experiments), noting when the finding support or contradict previous explanations or accounts.
Reading Strategy	**Learning Log** **Rationale:** This strategy causes the reader to monitor comprehension before, during, and after reading. Using a learning log when completing a reading passage allows students to be an active thinker and use necessary process skills to comprehend the passage (Billmeyer, 2004). Pressley (2006) observed, "In general, the conscious processing that is excellent reading begins before reading, continues during reading, and persists after reading is completed" (p. 57). Good readers are actively engaged not only during reading but also before reading and after reading. Being engaged before reading allows students to access what they already know about the topic and establish a purpose for reading. Being engaged after reading allows students to reflect on and seek to deepen their understanding of what was just read (Harvey & Goudvis 2007). **Activity:** Section 1: Access prior knowledge • What do you know about atoms and how atoms were first studied? Section 2: Ask questions when reading Section 3: Summarize information read Section 4: Make connections to own experience and other resources. • Find the definition of the Law of Conservation of Matter and the Law of Definite Proportions in your textbook. Compare and contrast this article's definition to what is stated in your textbook. Complete writing activity listed below.

Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 - 10.2): Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. Standard (WHST.9 – 10.5): Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach. Standard (WHST.9 – 10.8): Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.
Writing Strategy	**Compare and Contrast:** **Rationale:** Compare and contrast is a critical thinking strategy designed to build upon students' memories, eliminate confusion, and highlight crucial similarities and differences among concepts (Silver, Dewing, & Perini, 2012).

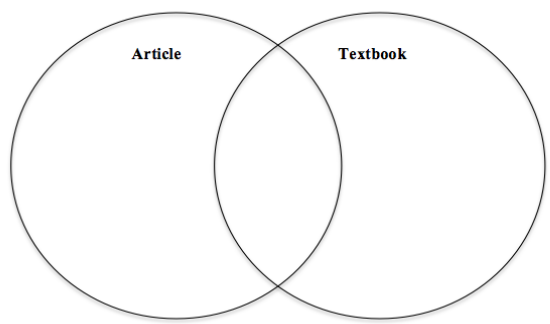
Activity:
Compare and Contrast**:** Law of Conservation of Matter and Law of Definite Proportions, Article vs. Textbook.

Step 1: After reading the article, find the description of the Law of Conservation of Matter and Law of Definite Proportions in your textbook. Use a Venn Diagram to compare and contrast how the article describes these laws, how your textbook describes these laws, and what is in common between the two sources.

Law of Conservation of Matter



Law of Multiple Proportions



Step 2: Write two paragraphs, using the Venn Diagram as an outline, to describe / summarize these Laws. The first paragraph should focus on the Law of Conservation of Matter and the second should focus on the Law of Definite proportions. Each paragraph should include specific information from both the article and the textbook in order to fully describe each of these laws.

Atomic Concepts

Article Title	"Follow the Carbon." Follow the What?
Overview	This article describes how scientists "follow carbon" or identify carbon-bearing compounds, their sources, and their process of transformation in order to evaluate the ability of the conditions on Mars to support life. The article goes into a discussion of how a rover on Mars is able to analyze surface samples collected (GC) and what information scientists would look for to determine if the conditions were able to support life. In addition, the author explains how the analysis of carbon isotopes is used to investigate whether or not life has existed on Mars in the past. This is done by analyzing the ration of carbon-12 to carbon-13 atoms and comparing that to those of life forms on earth.
Source	(Bleacher, 2008)
Chemistry Core Topic	I. Atomic Concepts
Key Ideas from Regents Chemistry Core	Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	Performance Indicator 3.1: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. Major Understanding 3.1g: The number of protons in an atom (atomic number) identifies the element. The sum of the protons and neutrons in an atom (mass number) identifies an isotope. Major Understanding 3.1u: Elements are substances that are composed of atoms that have the same atomic number. Elements cannot be broken down by chemical change.

Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.4): Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*.
Reading Strategy	**Read, Write, Think, Talk** **Rationale:** The Read, Write, Talk strategy is used when students read text that is dense in content causing students to lose focus as they read. This strategy allows the student to monitor his or her own comprehension when reading dense text passages. Students will stop, think, and react to the information as they read allowing them to monitor meaning, articulate their thinking, and become strategic readers who develop new insights (Harvey & Goudvis 2007). **Activity:** Students write ideas in the margins as they read. They are prompted with the following: As you read… 1. Circle, highlight, and underline things that surprise you. Write in the margins why you are surprised. 2. How come…? 3. I don't understand… 4. I wonder… 5. I have seen this before…(tell when you've seen it before) Once the reading has taken place, students will discuss the reading in pairs. They will begin their conversations with their responses to at least one of the "during-reading" prompts listed above.
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 – 10.1): Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence. Standard (WHST.9 – 10.9): Draw evidence from literary or informational texts to support analysis, reflection, and research.

Writing Strategy	Generalization/Principle Graphic Organizer
	Rationale: Visually displaying key content ideas can benefit learners who have difficulty organizing information (Fisher & Schumaker, 1995). Determining the main idea and supporting details of a topic is a difficult skill for many students (Baxendell, 2003). A Generalization/Principle graphic organizer is a tool students can use to establish the main idea of a text and separate important facts from extraneous ones. Also, once the main idea has been established, students can find and add supporting details to highlight the main idea's importance. **Activity:** After reading and discussing the article, students will construct a summary of how carbon isotopes are useful in detecting organic compounds on Mars. To plan for their summary, students will complete a generalization/principle graphic organizer. The main idea of "Carbon isotopes are useful in detecting organic compounds on Mars" will be provided for them. Student will decide if they agree or disagree with this statement and then provide at least three specific supporting details from the article to support their claim.

Periodic Table

Article Title	Where Do Chemical Elements Come From?
Overview	This article dicusses the origin of the elements found on Earth and hence the periodic table. The article begins by discussing how all elements originated from stars within our universe and ended up on earth after those stars underwent massive explosions. For stars that currently exist, like our sun, fusion of smaller elements like hydrogen and helium take place and form heavier elements. Also, it is discussed how fusion stops at the element iron and how stars cannot form elements heavier than iron unless unique conditions are in place. In order to form elements heavier than iron and element's nucleus must capture neutrons from other elements undergoing radioactive decay. This process is also responsible for the creation of isotopes of elements. In the last section of the article the author discusses how astronomers are able determine the composition of stars through spectroscopy. To conclude the article, the auther leaves the reader with the quote "we are all star stuff," solidifying the fact that everything we know to exist has originated in outer space.
Source	(Ruth, 2009)
Chemistry Core Topic	II. Periodic Table, X. Nuclear Chemistry
Key Ideas from Regents Chemistry Core	Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity Key Idea 5: Energy and matter interact through forces that result in changes in motion.
Performance Indicators, Major Understandings, Skills	Performance Indicator 3.1: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. Major Understanding 3.1b: Each atom has a nucleus, with an overall positive charge, surrounded by negatively charged electrons. Major Understanding 3.1c: Subatomic particles contained in the nucleus include protons and neutrons. Major Understanding 3.1m: Atoms of an element that contain

	the same number of protons but a different number of neutrons are called isotopes of that element. Major Understanding 3.1k: When an electron returns from a higher energy state to a lower energy state, a specific amount of energy is emitted. This emitted energy can be used to identify an element. Performance Indicator 5.3: Compare energy relationships within an atom's nucleus to those outside the nucleus. Major Understanding 5.3a: A change in the nucleus of an atom that converts it from one element to another is called transmutation. This can occur naturally or can be induced by the bombardment of the nucleus with high-energy particles. Major Understanding 5.3b: Energy released in a nuclear reaction (fission or fusion) comes from the fractional amount of mass that is converted into energy. Nuclear changes convert matter into energy. Major Understanding 5.3c: Energy released during nuclear reactions is much greater than the energy released during chemical reactions.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.9): Compare and contract finding presented in a text to those from other sources (including their own experiments), noting when the finding support or contradict previous explanations or accounts.
Reading Strategy	**Directed Reading / Thinking Activity** **Rationale:** A major issue when learning in science is detecting misconceptions or inconsistencies between student understanding and actual scientific principles. Student preconceptions may relate to a naïve understanding of a concept or may be a firmly held misconception. Activating prior knowledge in order to address student preconceptions helps students prepare to read and learn (Billmeyer, 2003). The DRTA strategy can be used to help students approach a text that addresses common misconceptions in science. The DRTA strategy helps students learn to access their prior knowledge and approach text with purpose, questions, and the expectation that they will learn from what they're reading (Moore, Readence, and Rickelman, 1982).

	Activity: Students respond to the following questions before reading: • What I Know I Know • What I Think I Know • What I Think I'll Learn Students respond to the following question after reading. Students should provide specific evidence and examples from the text to support their claim for what they learned. • What I Know I Learned
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 – 10.1): Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence Standard (WHST.9 - 10.2): Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. Standard (WHST.9 – 10.4): Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Standard (WHST.9 – 10.5): Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
Writing Strategy	**Summary Wheel** **Rationale:** One of the overarching themes of the Common Core State Standards is "Developing students' higher-order and critical thinking skills" (Silver, Dewing, & Perini, 2012). Writing "allows us to see conceptual relationships, to acquire insights, and to unravel the logic of what was previously murky or confusing" (Schmoker, 2011, p. 211). Use of the summary wheel strategy helps students summarize information during and after reading. When students summarize, they pull out the most important information and put it in their own words to remember it. This aids in the construction of meaning and allows thinking to evolve as information is added from the text passage (Harvey & Goudvis 2007). This approach helps students personalize learning so they better understand their coursework (Billmeyer, 2003). **Activity:** Students use the summary wheel format to plan for writing a summary of the article. A summary wheel with six pieces

	would be provided for the students. They would be required to identify at least four main ideas from the article and enter those ideas into the "crust" of the wheel. Once the four main ideas were identified students would then find specific evidence from the article that support their main ideas. Once the summary wheel was complete students construct a summary of the article writing at least two sentences per main idea identified. For struggling students main ideas may be provided. Examples include but are not limited to: • All elements come from outer space • The process of fusion fuels stars and is the process by which heavy elements are made • The capture of neutrons by nuclei are responsible for the creation of isotopes • Spectroscopy is the process used to determine the composition of stars

Periodic Table

Article Title	Is the Fluoride in Water Good for your Teeth?
Overview	This article discusses the controversial issue to adding fluoride to public drinking water. In the 1940's water treatment plants began adding fluorinated compounds to public drinking water. Fluoride has been found to help in the prevention of dental cavities by protecting and even rebuilding tooth enamal. The article provides sufficient evidence of the benefits of fluoride in drinking water including reduction of tooth decay and making some sort of dental care available to everyone regardless of socio-economic status. The article also provides evidence for the negative aspects of water fluoridation such as the public being exposed to too much fluoride considering fluoride is not only in water but in most oral care products (toothpaste, mouthwash, etc.). The article has an entire section dedicated to the controvsial aspects of water fluoridation which leaves the reader feeling as though they should consume only bottled water to avoid possible toxication from the fluoride in their tap water.
Source	(Ronca, 2011)
Chemistry Core Topic	I. Atomic Concepts, II. Periodic Table
Key Ideas from Regents Chemistry Core	<u>Key Idea 3</u>: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	<u>Performance Indicator 3.1</u>: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. <u>Major Understanding 3.1x</u>: Elements can also be differentiated by chemical properties. Chemical properties describe how an element behaves during a chemical reaction.

	<u>Major Understanding 3.1pp:</u> The concentration of a solution may be expressed in molarity (M), percent by volume, percent by mass, or parts per million (ppm).
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	<u>Standard (RST.9-10.1):</u> Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
Reading Strategy	**Think-Ink-Pair-Share** **Rationale:** According to the National Science Education Standards (1996), "student understanding is actively constructed through individual and social processes." Through the use of the reading strategy, Think, Ink, Pair, Share, students develop important skills that help them feel more confident in taking the risk of sharing their ideas (Billmeyer, 2003). **Activity:** Think Question: Is the fluoride in water good for your teeth? Why or why not? Students read the passage and "ink" their response with specific evidence from the passage. Students then pair with another student and share their response.
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	<u>Standard (WHST.9 – 10.1)</u>: Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence <u>Standard (WHST.9 – 10.4)</u>: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Writing Strategy	**Readable writing task: Argument** **Rationale:** Use of readable writing task prompts, relatively brief on-demand essays or responses, require students to clarify and organize their thinking after reading a text passage. Readable writing task prompts can drastically improve students' thinking and deepen their comprehension of

	content (Silver, Dewing, & Perini, 2012). A study at Vanderbilt University (Graham & Herbert, 2010) found that asking students to write regularly about the texts they read in science had a significantly positive influence on student comprehension. Since readable writing task prompts only require students to develop brief responses to text, teachers are more able to provide students with focused and formative feedback on their writing, a practice that improves students' writing and learning immensely (Graham, Harris, & Herbert, 2011). **Activity:** Based on the article we just read, do you believe fluoride should be added to drinking water? Use specific information from the article to defend your position. Use a **generalization/principle graphic organizer** to organize your thoughts. Enter your claim in the "Main Idea" section and fill in specific supporting details from the article to support your claim. Once your ideas are organized construct your argument in at least two well-written paragraphs.

Periodic Table

Article Title	Two Faces of Carbon
Overview	This article focuses on the element carbon and its allotropes: diamond and graphite. A discussion of the differences in physical properties based on differences in molecular structure is present as well as how the formation of allotropes from the same element is possible. In addition the author describes how diamonds could potentially be formed from sources of carbon including graphite and even the remains of deceased pets and family members.
Source	(Wood, 2004)
Chemistry Core Topic	II. Periodic Table
Key Ideas from Regents Chemistry Core	Key Idea 5: Energy and matter interact through forces that result in changes in motion.
Performance Indicators, Major Understandings, Skills	Performance Indicator 5.2: Explain chemical bonding in terms of the behavior of electrons. Major Understanding 5.2f: Some elements exist in two or more forms in the same phase. These forms differ in their molecular or crystal structure, and hence in their properties.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.4): – Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*. Standard (RST.9-10.5): – Analyze the structure of the relationships among concepts in a text, including relationships among key terms.
Reading Strategy	**Concept Definition Mapping** **Rationale:** Students in a typical science class are constantly exposed to many new words which makes vocabulary development a special concern in science (Billmeyer, 2003). Concept

	definition mapping (Schwartz & Raphael, 1985) is a visual representation of the meaning of vocabulary terms. This strategy can be used to help students organize their thinking, make connections between concepts, and internalize the meaning of vocabulary terms. This strategy is very useful for deconstructing complex texts that include a variety of vocabulary terms. **Activity:** 1. Create a concept map that links the following terms: Allotrope, carbon, diamond, and graphite. 2. Give a description of each term in the concept map. You may use words and/or pictures. Be as specific and clear and as possible. Include evidence from the reading to support your descriptions. 3. Research other examples of allotropes. Add them to your concept map.
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	<u>Standard (WHST.9 - 10.2)</u>: Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. <u>Standard (WHST.9 – 10.4)</u>: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Writing Strategy	**Readable writing task: Informative/explanatory text** **Rationale:** Use of readable writing task prompts, relatively brief on-demand essays or responses, require students to clarify and organize their thinking after reading a text passage. Readable writing task prompts can drastically improve students' thinking and deepen their comprehension of content (Silver, Dewing, & Perini, 2012). A study at Vanderbilt University (Graham & Herbert, 2010) found that asking students to write regularly about the texts they read in science had a significantly positive influence on student comprehension. Since readable writing task prompts only require students to develop brief responses to text, teachers are more able to provide students with focused and formative feedback on their writing, a practice that improves students' writing and learning immensely (Graham, Harris, & Herbert, 2011). **Activity:**

	Diamond and graphite have very different physical properties even though they are both composed of the same element (Carbon). Explain in detail how this is possible. Use specific information from the article to support your explanation.

Moles / Stoichiometry

Article Title	Recycling Aluminum: A Way of Life or a Lifestyle
Overview	This article focuses on the process by which aluminum metal is recycled and why recycling aluminum is a beneficial practice. The chemistry behind each step in the recycling process is discussed in detail through the use of chemical reactions, written descriptions, and diagrams. It is mentioned that recycling aluminum is not only beneficial for the environment but it also serves as a source of income for residences of Dharavi, India.
Source	(Husband, 2012)
Chemistry Core Topic	III. Moles / Stoichiometry, VIII. Oxidation – Reduction.
Key Ideas from Regents Chemistry Core	<u>Key Idea 3</u>: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	<u>Performance Indicator 3.2</u>: Use atomic and molecular models to explain common chemical reactions. <u>Major Understanding 3.2b</u>: Types of chemical reactions include synthesis, decomposition, single replacement, and double replacement. <u>Major Understanding 3.2j</u>: An electrochemical cell can be either voltaic or electrolytic. In an electrochemical cell, oxidation occurs at the anode and reduction at the cathode. <u>Major Understanding 3.2l</u>: An electrolytic cell requires electrical energy to produce a chemical change. This process is known as electrolysis.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	<u>Standard (RST.9-10.1)</u>: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. <u>Standard (RST.9-10.4)</u>: Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*.

<table>
<tr><td>Reading Strategy</td><td>Frayer Model

Rationale:
A major issue when learning in science is detecting misconceptions or inconsistencies between student understanding and actual scientific principles. Student preconceptions may relate to a naïve understanding of a concept or may be a firmly held misconception. Activating prior knowledge in order to address student preconceptions helps students prepare to read and learn (Billmeyer, 2003). The Frayer Model (Frayer, Frederick, & Klausmeier, 1969) is a strategy that helps the reader activate prior knowledge, build vocabulary, and develop conceptual understanding by identifying characteristics, examples, and non-examples of specific terms.

Activity:
Create two Frayer Model's. One Frayer Model will focus on physical changes; the other will focus on chemical changes.

During reading circle the steps of aluminum recycling that are physical changes and square those that are chemical changes. Add these examples to your Frayer Models. Classify the following steps as physical or chemical changes and add them to your Frayer Model (if they aren't there already)
Aluminum refining
Smelting
Ingot casting
Shredding and decoating</td></tr>
<tr><td>Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)</td><td><u>Standard (WHST.9 – 10.1)</u>: Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence
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<tr><td>Writing Strategy</td><td>Readable writing task: Argument

Rationale:
Use of readable writing task prompts, relatively brief on-demand essays or responses, require students to clarify and organize their thinking after reading a text passage.</td></tr>
</table>

	Readable writing task prompts can drastically improve students' thinking and deepen their comprehension of content (Silver, Dewing, & Perini, 2012). A study at Vanderbilt University (Graham & Herbert, 2010) found that asking students to write regularly about the texts they read in science had a significantly positive influence on student comprehension. Since readable writing task prompts only require students to develop brief responses to text, teachers are more able to provide students with focused and formative feedback on their writing, a practice that improves students' writing and learning immensely (Graham, Harris, & Herbert, 2011). **Activity:** Based on the article you just read discussing the benefits of recycling aluminum, do you believe our state should implement some sort of mandate for aluminum recycling? Why or why not? Use specific information from the article to defend your position.

Moles / Stoichiometry

Article Title	Nitrogen from Fertilizers: Too Much of a Good Thing
Overview	This article presents information about the risks and benefits associated with use of fertilizers in the agriculture industry. To illustrate the risks, the author highlights the use of nitrates in fertilizer and the negative impact these chemicals have on the environment. Possibilities for ways farmers may avoid use of fertilizers in the future are also discussed.
Source	(Nolte, 2010)
Chemistry Core Topic	III. Moles / Stoichiometry
Key Ideas from Regents Chemistry Core	Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	Performance Indicator 3.2: Use atomic and molecular models to explain common chemical reactions. Major Understanding 3.2b: Types of chemical reactions include synthesis, decomposition, single replacement, and double replacement.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Standard (RST.9-10.6): Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
Reading Strategy	**Question-Answer Relationship** **Rationale:** Pressley (2006) observed, "In general, the conscious processing that is excellent reading begins before reading, continues during reading, and persists after reading is completed" (p. 57). Good readers are actively engaged not only during reading but also before reading

	and after reading. Being engaged before reading allows students to access what they already know about the topic and establish a purpose for reading. Being engaged after reading allows students to reflect on and seek to deepen their understanding of what was just read (Harvey & Goudvis 2007). The Question-Answer Relationship (QAR) (Raphael, 1986) strategy supports reading comprehension by helping students make connections between their prior knowledge and the information presented in the text. It helps teachers and students alike refine their questioning skills. By engaging in a QAR while reading students are more apt to become strategic, careful readers. **Activity:** Right there Questions: • This article lists three chemicals needed for plant growth. Name them. • Most plants cannot use diatomic nitrogen to help them grow. Name three plants that <u>can</u> use N_2 and explain why they are able to use N_2. • In what form is nitrogen present in most fertilizers? • Nitrogen makes up what percent of the air? • How can changing annual crops (like wheat, corn, sorghum and sunflowers) to perennial crops reduce the need for fertilizer? Think and Search Questions: • In what ways can nitrogen harm the environments? Author and You questions: • Does the author of this article support the use of nitrogen fertilizers? Explain. On my own questions: • If your parents came to you and said they'd like to start a garden, would you recommend them using nitrogen fertilizers? Why or why not?
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	<u>Standard (WHST.9 – 10.1)</u>: Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence <u>Standard (WHST.9 – 10.4)</u>: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Writing Strategy	Readable writing task: Argument **Rationale:** Use of readable writing task prompts, relatively brief on-demand essays or responses, require students to clarify and organize their thinking after reading a text passage. Readable writing task prompts can drastically improve students' thinking and deepen their comprehension of content (Silver, Dewing, & Perini, 2012). A study at Vanderbilt University (Graham & Herbert, 2010) found that asking students to write regularly about the texts they read in science had a significantly positive influence on student comprehension. Since readable writing task prompts only require students to develop brief responses to text, teachers are more able to provide students with focused and formative feedback on their writing, a practice that improves students' writing and learning immensely (Graham, Harris, & Herbert, 2011). **Activity:** Extend the "On your own" question from the QAR you filled out as you read the article. If your parents came to you and said they'd like to start a garden, would you recommend them using nitrogen fertilizers? Why or why not? Use specific evidence from the article to defend your position.

Chemical Bonding

Article Title	Paintball: Chemistry Hits it's Mark
Overview	This article connects the sport of paintball to bonding and intermolecular forces by discussing the polarity of dyes and other chemicals used within paintballs. It also discusses Boyles' Law and its influence on the firing processes of paintball guns. This article would be an excellent supplement to bonding and intermolecular forces within the Regents Chemistry curriculum. It may also be used to represent an application of the gas laws (specifically Boyles' Law.)
Source	(Rohrig, 2007)
Chemistry Core Topic	IV. Chemical Bonding
Key Ideas from Regents Chemistry Core	Key Idea 5: Energy and matter interact through forces that result in changes in motion.
Performance Indicators, Major Understandings, Skills	Performance Indicator 5.2: Explain chemical bonding in terms of the behavior of electrons. Major Understanding 5.2l: Molecular polarity can be determined by the shape of the molecule and distribution of charge. Major Understanding 5.2m: Intermolecular forces created by the unequal distribution of charge result in varying degrees of attraction between molecules. Hydrogen bonding is an example of a strong intermolecular force. Major Understanding 5.2n: Physical properties of substances can be explained in terms of chemical bonds and intermolecular forces. These properties include conductivity, malleability, solubility, hardness, melting point, and boiling point.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.4): Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*. Standard (RST.9-10.7): Translate quantitative or technical information expressed in words in a text into visual form

	(e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equations) into words.
Reading Strategy	**Frayer Model** **Rationale:** A major issue when learning in science is detecting misconceptions or inconsistencies between student understanding and actual scientific principles. Student preconceptions may relate to a naïve understanding of a concept or may be a firmly held misconception. Activating prior knowledge in order to address student preconceptions helps students prepare to read and learn (Billmeyer, 2003). The Frayer Model (Frayer, Frederick, & Klausmeier, 1969) is a strategy that helps the reader activate prior knowledge, build vocabulary, and develop conceptual understanding by identifying characteristics, examples, and non-examples of specific terms. **Activity:** Create a Frayer Model for the following terms: Polar Molecule Nonpolar molecule Hydrogen Bonding Definition section must contain pictures and words. Examples and characteristics must come from the reading.
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 - 10.2): Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. Standard (WHST.9 – 10.4): Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Writing Strategy	**Readable Writing: Informative/explanatory text.** **Rationale:** Use of readable writing task prompts, relatively brief on-demand essays or responses, require students to clarify and organize their thinking after reading a text passage. Readable writing task prompts can drastically improve students' thinking and deepen their comprehension of content (Silver, Dewing, & Perini, 2012). A study at Vanderbilt University (Graham & Herbert, 2010) found that asking students to write regularly about the texts they read in science had a significantly positive influence on student comprehension. Since readable writing task prompts only require students to develop brief responses to text, teachers are more able to provide students with focused and formative feedback on their writing, a practice that improves students' writing and learning immensely (Graham, Harris, & Herbert, 2011). **Activity:** Students respond to the following prompt after reading the article. In the "Bonding with your paintballs" section of this article it is stated that the dyes within paintballs are water-soluble so that they may be washed out of clothes after a paintball match. Explain how these dyes are able to dissolve in water. Use the following terms in your explanation: polar molecule, nonpolar molecule, and hydrogen bonding. You may also include pictures to support your explanation.

Chemical Bonding

Article Title	How Do Home Water Purifiers Remove Ions from Tap Water?
Overview	This article discusses chemistry behind hard water. The presence of ions with a charge greater than +1 and especially those with a small radius interact with specific components of soap to create soap scum. This chemical process behind this interaction is given in detail. The article also describes how water purifiers are used to reduce the effects of hard ions by eliminating them with sulfate ions that act as ion exchangers.
Source	(Waldron, 2007)
Chemistry Core Topic	IV. Chemical Bonding
Key Ideas from Regents Chemistry Core	Key Idea 5: Energy and matter interact through forces that result in changes in motion.
Performance Indicators, Major Understandings, Skills	Performance Indicator 5.2: Explain chemical bonding in terms of the behavior of electrons. Major Understanding5.2h: Metals tend to react with nonmetals to form ionic compounds. Nonmetals tend to react with other nonmetals to form molecular (covalent) compounds. Ionic compounds containing polyatomic ions have both ionic and covalent bonding. Major Understanding 5.2n: Physical properties of substances can be explained in terms of chemical bonds and intermolecular forces. These properties include conductivity, malleability, solubility, hardness, melting point, and boiling point. Performance Indicator 3.1: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. Major Understanding 3.1nn: Differences in properties such as density, particle size, molecular polarity, boiling and freezing points, and solubility permit physical separation of the components of the mixture.

Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	<u>Standard (RST.9-10.4)</u>: Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*. <u>Standard (RST.9-10.9)</u>: Compare and contract finding presented in a text to those from other sources (including their own experiments), noting when the finding support or contradict previous explanations or accounts.
Reading Strategy	**Learning Log** **Rationale:** This strategy causes the reader to monitor comprehension before, during, and after reading. Using a learning log when completing a reading passage allows students to be an active thinker and use necessary process skills to comprehend the passage (Billmeyer, 2004). Pressley (2006) observed, "In general, the conscious processing that is excellent reading begins before reading, continues during reading, and persists after reading is completed" (p. 57). Good readers are actively engaged not only during reading but also before reading and after reading. Being engaged before reading allows students to access what they already know about the topic and establish a purpose for reading. Being engaged after reading allows students to reflect on and seek to deepen their understanding of what was just read (Harvey & Goudvis 2007). **Activity:** Section 1: Access prior knowledge • What do you know about water purifiers? • Based on what you know right now, how would you explain how a water purifier purifies water? Section 2: Ask questions when reading Section 3: Summarize information read • Which ions are most likely to cause water to be "hard?" Why is this? Section 4: Make connections to own experience and other resources. • Draw the Lewis Dot diagram for each of the ions given in the reading. • Describe your experience with hard water and/or soap scum. Research one method from removing

	soap scrum from your shower.
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 – 10.4): Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Standard (WHST.9 – 10.9): Draw evidence from literary or informational texts to support analysis, reflection, and research.
Writing Strategy	**Double-entry Journal** **Rationale:** Teachers need effective tools to help students learn more science and develop the critical reading-to-learn skills that literacy research identifies as essential for academic success (Biancarosa & Snow, 2006). Use of the Double-Entry Journal (DEJ) strategy provides a structure for students to monitor and document their understanding of science texts. This strategy also incorporates students creating pictorial representations of concepts. This strategy allows and encourages students to reflect on the meaning of what was just read and demonstrate their understanding through a variety of representations (Herman & Wardrip, 2012). According to Herman et al. (2008) and Herman et al. (2010), students who productively use the DEJ strategy demonstrate better understanding on related assessments. **Activity:** Create a double-entry journal that describes the process by which ion exchangers (sulfate ions) eliminate hard ions from water. Your journal should include two columns: (1) Pictorial representations of what is taking place during each step and (2) a description in words of what is taking place. Someone who is not familiar with the concept of ion exchangers should be able to read your double-entry journal and understand how ion exchangers are used to remove hard ions from water.

Physical Behavior of Matter

Article Title	Question from the Classroom. Why does a Helium Balloon Rise?
Overview	This article seeks to answer the question/statement "We learned in class that all objects have mass - even a helium balloon. So why then does a helium balloon rise?" To asnwer this question the author describes how the density of helium in relation to air combined with a buoyant force push helium balloons upwards and allow them to float. The article mentions properties of gas particles such as how collions of molecules with the sides of a container cause pressure. These properties and his explanation of density and buoyancy are used to support his explanation of how helium balloons are able to float even though they have mass.
Source	(Becker, 2006)
Chemistry Core Topic	V. Physical Behavior of Matter
Key Idea from Regents Chemistry Core	<u>Key Idea 3</u>: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	<u>Performance Indicator 3.1</u>: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. <u>Major Understanding 3.1w</u>: Elements can be differentiated by physical properties. Physical properties of substances, such as density, conductivity, malleability, solubility, and hardness, differ among elements. <u>Performance Indicator 3.4</u>: Use kinetic molecular theory (KMT) to explain rates of reactions and the relationships among temperature, pressure, and volume of a substance. <u>Major understanding 3.4c</u>: Kinetic molecular theory describes the relationships of pressure, volume, temperature, velocity, and frequency and force of collisions among gas molecules.

Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.7): Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equations) into words.
Reading Strategy	**Visualizing in Nonfiction Text** **Rationale:** Concepts that are often difficult to grasp can be learned through diagraming while reading. This is especially true in the field of chemistry where students must truly visualize in their minds to develop understanding. Teachers should encourage students to draw pictures in the margins as they read to keep students engaged during reading and allow them to make connections between what is being read and what is begin visualized in the mind (Harvey & Goudvis, 2007). **Activity:** As you read draw pictures in the margins to help you make sense of the article. Draw pictures to specifically define the following terms/concepts: buoyant force, exertion of gas pressure inside a balloon, decrease in atmospheric pressure higher in the atmosphere, the density of air vs. the density of helium.
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 - 10.2): Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. Standard (WHST.9 – 10.9): Draw evidence from literary or informational texts to support analysis, reflection, and research.
Writing Strategy	**Double-entry journal** **Rationale:** Teachers need effective tools to help students learn more science and develop the critical reading-to-learn skills that literacy research identifies as essential for academic success (Biancarosa & Snow, 2006). Use of the Double-Entry Journal (DEJ) strategy provides a structure for students to monitor and document their understanding of science texts. This strategy also incorporates students creating pictorial representations of concepts. This strategy allows and

	encourages students to reflect on the meaning of what was just read and demonstrate their understanding through a variety of representations (Herman & Wardrip, 2012). According to Herman et al. (2008) and Herman et al. (2010), students who productively use the DEJ strategy demonstrate better understanding on related assessments. **Activity:** Create a double-entry journal that describes the process by which helium balloons are able to float. Your journal should include two columns: (1) Pictorial representations of what is taking place and (2) a description in words of what is taking place. For this double-entry journal include pictures and descriptions for each of the following: • The impact of density on a helium balloon's ability to float • A description of buoyancy force and its impact on a helium balloon's ability to float • The cause pressure inside of a balloon and outside of a balloon Be sure to use specific examples from the text to support your explanations. Under your double-entry journal summarize, in your own words, the process by which helium balloons are able to float.

Physical Behavior of Matter

Article Title	Salting Roads: The Solution for Winter Driving
Overview	This article describes why salt is put on the roads during winter months to improve the safety of driving conditions. The chemistry behind the process is described through the concept of colligative properties and freezing point depression. The article briefly discusses other options for increasing traction on snow-covered roads, specifically in places like northern Canada and Alaska where it is too cold for salt to have an effect, such as adding sand or gravel. It also describes how compounds like calcium chloride or magnesium chloride have a better ability to melt snow and ice than salt because of the greater number of ions per formula unit of the crystal. In addition to explaining the chemistry behind the process, the history behind salting roads is also discussed.
Source	(Kimbrough, 2006)
Chemistry Core Topic	V. Physical Behavior of Matter
Key Ideas from Regents Chemistry Core	<u>Key Idea 3</u>: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	<u>Performance Indicator 3.1</u>: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. <u>Major Understanding 3.1qq</u>:The addition of a nonvolatile solute to a solvent causes the boiling point of the solvent to increase and the freezing point of the solvent to decrease. The greater the concentration of solute particles, the greater the effect.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Reading Strategy	**Directed Reading/Thinking Activity** **Rationale:** A major issue when learning in science is detecting misconceptions or inconsistencies between student understanding and actual scientific principles. Student preconceptions may relate to a naïve understanding of a concept or may be a firmly held misconception. Activating prior knowledge in order to address student preconceptions helps students prepare to read and learn (Billmeyer, 2003). The DRTA strategy can be used to help students approach a text that addresses common misconceptions in science. The DRTA strategy helps students learn to access their prior knowledge and approach text with purpose, questions, and the expectation that they will learn from what they're reading (Moore, Readence, and Rickelman, 1982). **Activity:** Students respond to the following questions before reading: • What I Know I Know • What I Think I Know • What I Think I'll Learn Students respond to the following question after reading. Students should provide specific evidence and examples from the text to support their claim for what they learned. • What I Know I Learned
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	<u>Standard (WHST.9 – 10.7)</u>: Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. <u>Standard (WHST.9 – 10.8)</u>: Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. <u>Standard (WHST.9 – 10.4)</u>: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. <u>Standard (WHST.9 - 10.2)</u>: Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

Writing Strategy	Science Writing Heuristic
	Rationale: "Writing-to-learn" in science provides a means for students to formulate and refine their new knowledge and to connect ideas by finding the most appropriate words and sentence structure to convey a clear textual meaning for others (Wallace et al., 2004). To support writing in a laboratory setting, researchers have been investigating a tool known as the "Science Writing Heuristic" (SWH) as an alternate format for conducting laboratory investigations and writing lab reports. Rather than using the traditional lab report format of purpose, methods, observations, results, and conclusions students respond to prompts that include questions, knowledge, claims, evidence, description of data and observations, methods, and reflect on changes in their own thinking as the experiment progresses. Research by Keys, Hand, Prain, and Collins (1999) argue for the use of the SWH in place of the traditional laboratory format. These researchers claim that when students conduct traditional laboratory experiments that use the traditional laboratory notebook format, students learn some laboratory techniques, but little else. Incorporating guided-inquiry, learning cycles, group work, and the SWH in the laboratory setting is key for improving student conceptual understanding. The SWH is an example of a type of writing activity that can be conducted in a classroom setting to support student metacognition and data reasoning. Students make meaning of the laboratory activities in multiple formats of discussion and writing. Also, the SWH provides teachers with a framework for implementing meaningful, authentic, and inquiry-based, laboratory investigations in their classrooms. (Keys, Hand, Prain, & Collins, 1999). **Activity:** Students investigate the concept of freezing point depression through a laboratory investigation for which they design the procedure. Students will use the Science Writing Heuristic lab write-up format as they plan, implement, and conclude their investigation. Students will provide evidence from the text that supports their initial question to investigate in lab. Some of the following ideas could be provided to students who were struggling with developing a question to test: • What is the effect of salt concentration on the

	freezing point of water (i.e. Does the amount of salt impact freezing point? • Does $CaCl_2$ really lower the freezing point of water more than NaCl? Students answer the following questions as they plan and implement their laboratory investigation. Formal answers to these questions would be provided for the final write-up of the investigation. 1. Beginning Ideas – What are my questions? 2. Tests – What did I do? 3. Observations – What did I see? 4. Claims – What can I claim? 5. Evidence – How do I know? Why am I making these claims? 6. Reading – How do my ideas compare with other ideas (specifically the salting roads article, our class textbook, and any other sources used by the students) 7. Reflection – How have my ideas changed? (Students compare what they know now about salting roads and freezing point depression to what they wrote in the "What I know I know," and "What I think I know" section of the Directed Reading/Thinking activity they completed when initially reading the article)

Physical Behavior of Matter

Article Title	Thermometers
Overview	This article serves to inform the reader about concepts involving heat and temperature. The article begins with a discussion about the difference between heat and temperature followed by a discussion on the development of the different temperature scales. In addition the author describes different types of thermometers and exactly how they work to measure temperature (or the average kinetic energy of the molecules in a sample).
Source	(Rohrig, 2006)
Chemistry Core Topic	V. Physical Behavior of Matter
Key Idea from Regents Chemistry Core	Key Idea 4: Energy exists in many forms, and when these forms change, energy is conserved.
Performance Indicators, Major Understandings, Skills	Performance Indicator 4.2: Explain heat in terms of kinetic molecular theory. Major Understanding 4.2a: Heat is a transfer of energy (usually thermal energy) from a body of higher temperature to a body of lower temperature. Thermal energy is the energy associated with the random motion of atoms and molecules. Major Understanding 4.2b: Temperature is a measurement of the average kinetic energy of the particles in a sample of material. Temperature is not a form of energy Skill 4.2i: Distinguish between heat energy and temperature in terms of molecular motion and amount of matter.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.2): Determine the central ideas or conclusions of a text; trace the text's explanation of depiction of complex process, phenomenon, or concept; provide an accurate summary of the text.

Reading Strategy	Learning Log
	Rationale: This strategy causes the reader to monitor comprehension before, during, and after reading. Using a learning log when completing a reading passage allows students to be an active thinker and use necessary process skills to comprehend the passage (Billmeyer, 2004). Pressley (2006) observed, "In general, the conscious processing that is excellent reading begins before reading, continues during reading, and persists after reading is completed" (p. 57). Good readers are actively engaged not only during reading but also before reading and after reading. Being engaged before reading allows students to access what they already know about the topic and establish a purpose for reading. Being engaged after reading allows students to reflect on and seek to deepen their understanding of what was just read (Harvey & Goudvis 2007). **Activity:** Section 1: Access prior knowledge • What do you know about heat? What do you know about temperature? Are they the same thing? How is temperature measured? Section 2: Ask questions when reading Section 3: Summarize information read • In your summary address the following points: o Why would a person feel cold in the thermosphere? o What was the boiling point of water as measured using the Römer temperature scale? o What temperature did Fahrenheit use for body temperature? o On the initial scale that Celsius set up, what was the freezing point of water? o All bulb thermometers operate on what principle in science? o Why is the infrared thermometer unique? Section 4: Make connections to own experience and other resources. • Besides in science class, when have you used a thermometer?

Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 – 10.1): Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence. Standard (WHST.9 - 10.2): Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. Standard (WHST.9 – 10.4): Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Standard (WHST.9 – 10.5): Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
Writing Strategy	**4-2-1 Free Write** **Rationale:** The 4-2-1 strategy supports a type of writing-to-learn strategy known as provisional writing. Provisional writing activities are a form of quick writing, like brainstorming, that slows down and opens up the thinking process (Silver, Strong, & Perini, 2001). According to Reeves (2002) writing is "the skill most directly related to improved scores in reading, social studies, science, and even mathematics" (p. 5). Reeves also claims that writing brings "engagement, interest, and fun" (p. 5) to the classroom. **Activity:** After reading the thermometers article students are asked to generate the four most important ideas from the article (this would be done individually). Then students meet in pairs and narrow the main ideas down to the two most important. Each pair of students combines with another pair of students to create a group of four. Once in the group of four, students work together to select what they believe is the single most important idea from the article. Once the main idea is established students return to their seats for the free write activity. For the free write activity, students write what they know about the main idea for 3-5 minutes. They must write what they know about the idea well enough so that someone who has never heard of it could understand it. Students are not allowed to stop writing for the entire allotted time. If students do get stuck and can't continue to write, they should write about why they are stuck. Students then return to their group and share their responses with one another. After

	sharing the entire class has a discussion about the main idea of the article.

Physical Behavior of Matter

Article Title	Question from the Classroom: All Colored Gases are Poisonous. So is Water Steam Poisonous, too?
Overview	This article seeks to answer the question/statement "My chemistry teacher told our class that all colored gases are poisonous. He said that gases are generally invisible, so if you can see the gas, it is surely bad for you. But what about steam? That's a gas you can see but it is just made up of water in the gaseous state, so it can't be poisonous—right?" The author answers the question by stating that yes steam is not poisonous but highlights the fact that steam is not indeed water in the gas phase. He describes that as gaseous water is produced and hits the air it almost immediately condenses into liquid water which is the "steam" that is being observed. He states that pure gaseous water is indeed invisible and describes a demonstration he does in his classroom to demonstrate how gaseous water is invisible.
Source	(Becker, 2009)
Chemistry Core Topic	V. Physical Behavior of Matter
Key Ideas from Regents Chemistry Core	Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	Performance Indicator 3.1: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. Major Understanding 3.1kk: The three phases of matter (solids, liquids, and gases) have different properties. Major Understanding 3.1jj: The structure and arrangement of particles and their interactions determine the physical state of a substance at a given temperature and pressure.

	<u>Performance Indicator 3.2</u>: Use atomic and molecular models to explain common chemical reactions. <u>Major Understanding 3.2a</u>: A physical change results in the rearrangement of existing particles in a substance. A chemical change results in the formation of different substances with changed properties.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.7): Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equations) into words. Standard (RST.9-10.9): Compare and contract finding presented in a text to those from other sources (including their own experiments), noting when the finding support or contradict previous explanations or accounts.
Reading Strategy	**Learning Log** **Rationale:** This strategy causes the reader to monitor comprehension before, during, and after reading. Using a learning log when completing a reading passage allows students to be an active thinker and use necessary process skills to comprehend the passage (Billmeyer, 2004). Pressley (2006) observed, "In general, the conscious processing that is excellent reading begins before reading, continues during reading, and persists after reading is completed" (p. 57). Good readers are actively engaged not only during reading but also before reading and after reading. Being engaged before reading allows students to access what they already know about the topic and establish a purpose for reading. Being engaged after reading allows students to reflect on and seek to deepen their understanding of what was just read (Harvey & Goudvis 2007). **Activity:** Section 1: Access prior knowledge • What do you know about steam? What is steam made of? How is it created? Give at least 3 examples of when you've seen steam. Section 2: Asks questions when reading • Record any questions that come to mind when reading. Section 3: Summarize information read • In your summary address the following points:

	o What are you actually seeing when you observe steam? o Is it possible for pure gaseous water to exist? o Describe the process used by the author to light a fire with water. Section 4: Make connections to own experience and other resources. • Find a description of steam in your textbook. How does your textbook's description of steam compare with this article's description of steam? Draw a particle diagram to support your explanation.
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 - 10.2): Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. Standard (WHST.9 – 10.4): Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Standard (WHST.9 – 10.9): Draw evidence from literary or informational texts to support analysis, reflection, and research.
Writing Strategy	**Readable Writing Task: Informative/explanatory text** **Rationale:** Use of readable writing task prompts, relatively brief on-demand essays or responses, require students to clarify and organize their thinking after reading a text passage. Readable writing task prompts can drastically improve students' thinking and deepen their comprehension of content (Silver, Dewing, & Perini, 2012). A study at Vanderbilt University (Graham & Herbert, 2010) found that asking students to write regularly about the texts they read in science had a significantly positive influence on student comprehension. Since readable writing task prompts only require students to develop brief responses to text, teachers are more able to provide students with focused and formative feedback on their writing, a practice that improves students' writing and learning immensely (Graham, Harris, & Herbert, 2011). **Activity:** The article we just read claims steam is not actually water in the gas phase. If that is the case, then what is steam? Do we actually ever observe water in the gas phase? In a well-

	written paragraph, provide an explanation to these questions and use specific information from the article to support your explanation.

Kinetics / Equilibrium

Article Title	The Chemistry of Marathon Running
Overview	This article describes the chemistry (biochemistry) involved in running a marathon. The author touches upon how the body obtains the energy required to run 26.2 miles. This is done through a discussion of both anaerobic and aerobic processes. As the author describes these processes he give the chemical reactions behind them such as combustion of glucose and conversion of glucose to lactic acid and highlights how both of these processes are exothermic. A discussion of the importance of hydration and intake of carbohydrates is also discussed.
Source	(Rohrig, 2008)
Chemistry Core Topic	VI. Kinetics / Equilibrium
Key Ideas from Regents Chemistry Core	Key Idea 4: Energy exists in many forms, and when these forms change energy is conserved.
Performance Indicators, Major Understandings, Skills	Performance Indicator 4.1: Observe and describe transmission of various forms of energy. Major Understanding4.1b: Chemical and physical changes can be exothermic or endothermic. Major Understanding 4.1c: Energy released or absorbed during a chemical reaction can be represented by a potential energy diagram. Major Understanding 4.1d: Energy released or absorbed during a chemical reaction (heat of reaction) is equal to the difference between the potential energy of the products and potential energy of the reactants.

Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Standard (RST.9-10.4): Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*. Standard (RST.9-10.5): Analyze the structure of the relationships among concepts in a text, including relationships among key terms.
Reading Strategy	**Concept Mapping** **Rationale:** Students in a typical science class are constantly exposed to many new words, which make vocabulary development a special concern in science (Billmeyer, 2003). Concept definition mapping (Schwartz & Raphael, 1985) is a visual representation of the meaning of vocabulary terms. This strategy can be used to help students organize their thinking, make connections between concepts, and internalize the meaning of vocabulary terms. This strategy is very useful for deconstructing complex texts that include a variety of vocabulary terms. **Activity:** Read the article "The Chemistry of Marathon Running." Create a concept map that links together the following terms. • Energy • Calories • Combustion reaction • Glucose • Exothermic • Endothermic • Sweat • Glycogen • Aerobic • Anaerobic • Evaporation • Lactic acid • Water As you link each term together, provide an explanation for why you linked the terms the way you did. Include specific

	examples from the article in your explanation.
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 – 10.1): Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence Standard (WHST.9 - 10.2): Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. Standard (WHST.9 – 10.4): Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Standard (WHST.9 – 10.5): Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
Writing Strategy	**Summary Wheel** **Rationale:** One of the overarching themes of the Common Core State Standards is "Developing students' higher-order and critical thinking skills" (Silver, Dewing, & Perini, 2012). Writing "allows us to see conceptual relationships, to acquire insights, and to unravel the logic of what was previously murky or confusing" (Schmoker, 2011, p. 211). Use of the summary wheel strategy helps students summarize information during and after reading. When students summarize, they pull out the most important information and put it in their own words to remember it. This aids in the construction of meaning and allows thinking to evolve as information is added from the text passage (Harvey & Goudvis 2007). This approach helps students personalize learning so they better understand their coursework (Billmeyer, 2003). **Activity:** Students use the summary wheel format to plan for writing a summary of the article. A summary wheel with six pieces would be provided for the students. They would be required to identify at least four main ideas from the article and enter

	those ideas into the "crust" of the wheel. Once the four main ideas were identified students would then find specific evidence from the article that support their main ideas. Once the summary wheel was complete students construct a summary of the article writing at least two sentences per main idea identified. For struggling students main ideas may be provided. Examples include but are not limited to: • Energy can exist in many different forms. • The body receives energy to run a marathon through exothermic reactions that take place within the body. • Hydration is a very important aspect of running a marathon. • Consuming carbohydrates is important for successfully finishing a marathon.

Kinetics / Equilibrium

Article Title	Bite, Chew, and Swallow
Overview	This article discusses the process by which catalysts increase the rate of a chemical reaction. To explain this, the author uses the example of enzymes used by our bodies to aid in the digestion of the food that we eat. A potential energy diagram for an uncatalyzed and catalyzed reaction is also provided within the article.
Source	(Waldron, 2007)
Chemistry Core Topic	VI. Kinetics / Equilibrium
Key Ideas from Regents Chemistry Core	Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	Performance Indicator 3.4: Use kinetic molecular theory (KMT) to explain rates of reactions and the relationships among temperature, pressure, and volume of a substance. Major Understanding 3.4f: The rate of a chemical reaction depends on several factors: temperature, concentration, nature of the reactants, surface area, and the presence of a catalyst. Major Understanding 3.4g: A catalyst provides an alternate reaction pathway, which has a lower activation energy than an uncatalyzed reaction.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Standard (RST.9-10.4): Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*.

	Standard (RST.9-10.7): Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equations) into words.
Reading Strategy	**Think-Ink-Pair-Share** **Rationale:** According to the National Science Education Standards (1996), "student understanding is actively constructed through individual and social processes." Through the use of the reading strategy, Think, Ink, Pair, Share, students develop important skills that help them feel more confident in taking the risk of sharing their ideas (Billmeyer, 2003). **Activity:** Think Questions: What is a catalyst? What types of catalysts does your body use to break down food? Observe figure 12.23 "Climbing an energy hill." What is the figure showing? How and why does the figure change when a catalyst is added? Students read the passage and "ink" their response with specific evidence from the passage. Students then pair with another student and share their response. A class discussion of catalysts, potential energy diagrams, and chemical kinetics follows after this reading activity.
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 - 10.2): Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. Standard (WHST.9 – 10.4): Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Standard (WHST.9 – 10.5): Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
Writing Strategy	**Generalization/Principle Graphic Organizer** **Rationale:** Visually displaying key content ideas can benefit learners who have difficulty organizing information (Fisher & Schumaker, 1995). Determining the main idea and supporting details of a topic is a difficult skill for many

	students (Baxendell, 2003). A Generalization/Principle graphic organizer is a tool students can use to establish the main idea of a text and separate important facts from extraneous ones. Also, once the main idea has been established, students can find and add supporting details to highlight the main idea's importance. **Activity:** Students will identify the main idea of the article in pairs. Once the main idea has been established they will use a generalization/principle graphic organizer to find specific evidence from the article that supports the main idea. Once the graphic organizer is completed students will write a summary of the article independently. The summary must clearly convey the main idea of the article and give sufficient and specific details from the article to support the main idea.

Organic Chemistry

Article Title	Green Gasoline: Fuel From Plants
Overview	This article proposes a possible solution to the United States' dependence on oil for gasoline. This possible solution is known as "Green Gasoline" or gasoline that would be created from plants. The article highlights the advantages of green gasoline and the disadvantages of using gasoline derived from crude oil.
Source	(Schirber, 2012)
Chemistry Core Topic	VII. Organic Chemistry
Key Ideas from Regents Chemistry Core	Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity. Key Idea 4: Energy exists in many forms, and when these forms change energy is conserved.
Performance Indicators, Major Understandings, Skills	Performance Indicator 3.2: Use atomic and molecular models to explain common chemical reactions. Major Understanding 3.2c: Types of organic reactions include addition, substitution, polymerization, esterification, fermentation, saponification, and combustion. Performance Indicator 3.1: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. Major Understanding 3.1ff: Organic compounds contain carbon atoms, which bond to one another in chains, rings, and networks to form a variety of structures. Organic compounds can be named using the IUPAC system. Major Understanding 3.1hh: Organic acids, alcohols, esters, aldehydes, ketones, ethers, halides, amines, amides, and amino acids are categories of organic compounds that differ in their structures. Functional groups impart distinctive physical and chemical properties to organic compounds.

	Performance Indicator 4.1: Observe and describe transmission of various forms of energy. Major Understanding 4.1b: Chemical and physical changes can be exothermic or endothermic.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.4): Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*.
Reading Strategy	**Read, Write, Think, Talk** **Rationale:** The Read, Write, Talk strategy is used when students read text that is dense in content causing students to lose focus as they read. This strategy allows the student to monitor his or her own comprehension when reading dense text passages. Students will stop, think, and react to the information as they read allowing them to monitor meaning, articulate their thinking, and become strategic readers who develop new insights (Harvey & Goudvis 2007). **Activity:** Students write ideas in the margins as they read. They are prompted with the following: As you read… 1. Circle, highlight, and underline things that surprise you. Write in the margins why you are surprised. 2. How come…? 3. I don't understand… 4. I wonder… 5. I have seen this before…(tell when you've seen it before) Once the reading has taken place, students will discuss the reading in pairs. They will begin their conversations with their responses to at least one of the prompts.

Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 – 10.1): Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence Standard (WHST.9 – 10.4): Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Writing Strategy	**Readable Writing Task: Argument** **Rationale:** Use of readable writing task prompts, relatively brief on-demand essays or responses, require students to clarify and organize their thinking after reading a text passage. Readable writing task prompts can drastically improve students' thinking and deepen their comprehension of content (Silver, Dewing, & Perini, 2012). A study at Vanderbilt University (Graham & Herbert, 2010) found that asking students to write regularly about the texts they read in science had a significantly positive influence on student comprehension. Since readable writing task prompts only require students to develop brief responses to text, teachers are more able to provide students with focused and formative feedback on their writing, a practice that improves students' writing and learning immensely (Graham, Harris, & Herbert, 2011). **Activity:** Based on the article we just read about using gasoline made from plants rather than from crude oil, do you believe this is a practice that the United States should adopt? Use specific information from the article to defend your position.

Organic Chemistry

Article Title	Attack of the Gluten
Overview	This article focuses on the reasoning behind gluten sensitivity. It describes the origin of gluten in our food and its involvement in the rising of dough for use in breads and other foods. A description of the chemistry behind this process is given. The article also discusses gluten sensitivity in detail and provides an explanation of why certain people are unable to eat foods that contain gluten.
Source	(Hill, 2012)
Chemistry Core Topic	VII. Organic Chemistry
Key Ideas from Regents Chemistry Core	Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	Performance Indicator 3.2: Use atomic and molecular models to explain common chemical reactions. Major Understanding 3.2c: Types of organic reactions include addition, substitution, polymerization, esterification, fermentation, saponification, and combustion. Performance Indicator 3.1: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. Major Understanding 3.1ff: Organic compounds contain carbon atoms, which bond to one another in chains, rings, and networks to form a variety of structures. Organic compounds can be named using the IUPAC system. Major Understanding 3.1hh: Organic acids, alcohols, esters, aldehydes, ketones, ethers, halides, amines, amides, and amino acids are categories of organic compounds that differ in their structures. Functional groups impart distinctive physical and chemical properties to organic compounds.

Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
Reading Strategy	**Directed Reading/Thinking Activity** **Rationale:** A major issue when learning in science is detecting misconceptions or inconsistencies between student understanding and actual scientific principles. Student preconceptions may relate to a naïve understanding of a concept or may be a firmly held misconception. Activating prior knowledge in order to address student preconceptions helps students prepare to read and learn (Billmeyer, 2003). The DRTA strategy can be used to help students approach a text that addresses common misconceptions in science. The DRTA strategy helps students learn to access their prior knowledge and approach text with purpose, questions, and the expectation that they will learn from what they're reading (Moore, Readence, and Rickelman, 1982). **Activity:** Students respond to the following questions before reading: • What I Know I Know • What I Think I Know • What I Think I'll Learn Students respond to the following question after reading. Students should provide specific evidence and examples from the text to support their claim for what they learned. • What I Know I Learned

Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 - 10.2): Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. Standard (WHST.9 – 10.4): Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Writing Strategy	**Readable Writing Task: Informative/explanatory text.** **Rationale:** Use of readable writing task prompts, relatively brief on-demand essays or responses, require students to clarify and organize their thinking after reading a text passage. Readable writing task prompts can drastically improve students' thinking and deepen their comprehension of content (Silver, Dewing, & Perini, 2012). A study at Vanderbilt University (Graham & Herbert, 2010) found that asking students to write regularly about the texts they read in science had a significantly positive influence on student comprehension. Since readable writing task prompts only require students to develop brief responses to text, teachers are more able to provide students with focused and formative feedback on their writing, a practice that improves students' writing and learning immensely (Graham, Harris, & Herbert, 2011). **Activity:** Fermentation is a process by which sugar is converted to alcohol and carbon dioxide. Explain how the process of fermentation is involved in bread making. Does this reaction influence people's sensitivity to gluten? Use specific information from the article to support your response.

Organic Chemistry

Article Title	The Captivating Chemistry of Candles
Overview	This article summarizes the chemistry behind how candles work. There is a discussion of paraffin wax being used as fuel, and how as the wax liquefies it is able to travel up the wick through capillary action and provide the fuel for the flame. The process by which the wax is vaporized to undergo combustion within the flame is also described. There is also a break down of the flame to describe the different parts of the flame such as the blue inner portion versus the yellowish portion on the outside.
Source	(Rohrig, 2007)
Chemistry Core Topic	VII. Organic Chemistry
Key Ideas from Regents Chemistry Core	<u>Key Idea 3</u>: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity. <u>Key Idea 4</u>: Energy exists in many forms, and when these forms change energy is conserved.
Performance Indicators, Major Understandings, Skills	<u>Performance Indicator 3.2</u>: Use atomic and molecular models to explain common chemical reactions. <u>Major Understanding 3.2c</u>: Types of organic reactions include addition, substitution, polymerization, esterification, fermentation, saponification, and combustion. <u>Performance Indicator 3.1</u>: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. <u>Major Understanding 3.1gg</u>: Hydrocarbons are compounds that contain only carbon and hydrogen. Saturated hydrocarbons contain only single carbon-carbon bonds. Unsaturated hydrocarbons contain at least one multiple carbon-carbon bond.

	Performance Indicator 4.1: Observe and describe transmission of various forms of energy. Major Understanding 4.1b: Chemical and physical changes can be exothermic or endothermic.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Standard (RST.9-10.6): Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
Reading Strategy	**Question-Answer Relationship** **Rationale:** Pressley (2006) observed, "In general, the conscious processing that is excellent reading begins before reading, continues during reading, and persists after reading is completed" (p. 57). Good readers are actively engaged not only during reading but also before reading and after reading. Being engaged before reading allows students to access what they already know about the topic and establish a purpose for reading. Being engaged after reading allows students to reflect on and seek to deepen their understanding of what was just read (Harvey & Goudvis 2007). The Question-Answer Relationship (QAR) (Raphael, 1986) strategy supports reading comprehension by helping students make connections between their prior knowledge and the information presented in the text. It helps teachers and students alike refine their questioning skills. By engaging in a QAR while reading students are more apt to become strategic, careful readers. **Activity:** Right there Questions: • What is the source of paraffin wax? Is paraffin a pure substance? • What is the general formula for alkanes? • What role does the wick play in the burning of the candle? • What is capillary action? • What makes a candle flame luminous?

	• What is the secret ingredient in those trick candles that don't stay extinguished, and how does it work its magic? Think and Search Questions: • On the basis of what you read in the article, comment on the following statement: "All candle flames are conical in shape." Author and You questions: • What do you find most interesting about candles after reading this article? Do you think the author would agree with you? Why or why not. On my own questions: • What do you use candles for in your home? How does this compare with how candles were used in the 18th and 19th century?
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 - 10.2): Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. Standard (WHST.9 – 10.4): Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Standard (WHST.9 – 10.9): Draw evidence from literary or informational texts to support analysis, reflection, and research.
Writing Strategy	**Readable Writing Tasks: Informative/explanatory text:** **Rationale:** Use of readable writing task prompts, relatively brief on-demand essays or responses, require students to clarify and organize their thinking after reading a text passage. Readable writing task prompts can drastically improve students' thinking and deepen their comprehension of content (Silver, Dewing, & Perini, 2012). A study at Vanderbilt University (Graham & Herbert, 2010) found that asking students to write regularly about the texts they read in science had a significantly positive influence on student comprehension. Since readable writing task prompts only require students to develop brief responses to text, teachers are more able to provide students with focused and formative feedback on their writing, a practice that improves students' writing and learning immensely (Graham, Harris, & Herbert,

	2011). **Activity:** In class today, we discussed five types of chemical reactions. One of these types is combustion where a hydrocarbon combines with oxygen to form carbon dioxide and water. Explain how this type of chemical reaction contributes to the functioning of candles. Use specific information from the article to support your explanation.

Oxidation – Reduction

Article Title	Flaking Away
Overview	This article seeks to answer two questions regarding automobiles and rusting: (1) why are cars in snowy states more likely to rust? And (2) how is it possible to keep your car from rusting even if you live in a state where snow is prominent? To answer these questions, the author begins by discussing the process by which rusting takes place, oxidation-reduction reactions. She discusses how iron is a relative active metal, meaning that it is able to donate electrons relatively easily. It is this process of oxidation that the iron on cars rusts. The author also describes how salty and moist environments speed up this rusting process. Once the process by which iron rusts is established the author also discusses methods for preventing and slowing the rusting process, such as high tech paints and frequent car washes in winter months.
Source	(Brownlee, 2006)
Chemistry Core Topic	VIII. Oxidation-Reduction
Key Ideas from Regents Chemistry Core	<u>Key Idea 3</u>: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	<u>Performance Indicator 3.2</u>: Use atomic and molecular models to explain common chemical reactions. <u>Major Understanding 3.2a</u>: A physical change results in the rearrangement of existing particles in a substance. A chemical change results in the formation of different substances with changed properties. <u>Major Understanding 3.2d</u>: An oxidation-reduction (redox) reaction involves the transfer of electrons.

	Major Understanding 3.2e: Reduction is the gain of electrons. Major Understanding 3.2g: Oxidation is the loss of electrons. Major Understanding 3.2j: An electrochemical cell can be either voltaic or electrolytic. In an electrochemical cell, oxidation occurs at the anode and reduction at the cathode.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Standard (RST.9-10.4): Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*. Standard (RST.9-10.5): Analyze the structure of the relationships among concepts in a text, including relationships among key terms.
Reading Strategy	**Concept Mapping** **Rationale:** Students in a typical science class are constantly exposed to many new words, which make vocabulary development a special concern in science (Billmeyer, 2003). Concept definition mapping (Schwartz & Raphael, 1985) is a visual representation of the meaning of vocabulary terms. This strategy can be used to help students organize their thinking, make connections between concepts, and internalize the meaning of vocabulary terms. This strategy is very useful for deconstructing complex texts that include a variety of vocabulary terms. **Activity:** Read the article "Flaking Away." Create a concept map that links together the following terms and describes the process by which cars rust. Your concept map should be clear and specific so that someone without a background in chemistry could understand the process of rusting. • Oxidation • Reduction • Anode • Cathode • Corrosion • Water • Salt

	• Rust • Ions • Electrons • Iron oxide As you link each term together, provide an explanation for why you linked the terms the way you did. Include specific examples from the article in your explanation.
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 – 10.1): Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence Standard (WHST.9 - 10.2): Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. Standard (WHST.9 – 10.4): Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Standard (WHST.9 – 10.5): Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
Writing Strategy	**Summary Wheel** **Rationale:** One of the overarching themes of the Common Core State Standards is "Developing students' higher-order and critical thinking skills" (Silver, Dewing, & Perini, 2012). Writing "allows us to see conceptual relationships, to acquire insights, and to unravel the logic of what was previously murky or confusing" (Schmoker, 2011, p. 211). Use of the summary wheel strategy helps students summarize information during and after reading. When students summarize, they pull out the most important information and put it in their own words to remember it. This aids in the construction of meaning and allows thinking to evolve as information is added from the text passage (Harvey & Goudvis 2007). This approach helps students personalize learning so they better understand their coursework (Billmeyer, 2003). **Activity:** Students use the summary wheel format to plan for writing a summary of the article. A summary wheel with six pieces would be provided for the students. They would be required

	to identify at least four main ideas from the article and enter those ideas into the “crust” of the wheel. Once the four main ideas were identified students would then find specific evidence from the article that support their main ideas. Once the summary wheel was complete students construct a summary of the article writing at least two sentences per main idea identified. For struggling students main ideas may be provided. Examples include but are not limited to: • Iron rusts by a process known as oxidation-reduction. • Cars in snowy states are more likely to rust. • It is very costly to fix cars that are already rusted. • There are ways to prevent cars from rusting in the first place.

Oxidation – Reduction

Article Title	Open for Discussion: Lithium-Ion Batteries: A Clean Source of Energy?
Overview	This article presents a dialogue between the authors regarding lithium-ion batteries and whether or not they are a clean source of energy. Properties of lithium, such as its low density, that contribute to its use in batteries are discussed. In addition the authors provide information about how lithium is extracted, the form in which it is used in batteries (ionized form, not pure form), how lithium batteries are able to produce more power than AA or AAA batteries, and how lithium batteries are able to be recharged. All information provided allows the reader to develop an informed opinion of whether or not lithium batteries are a clean source of energy.
Source	(Sitzman & Goode, 2011)
Chemistry Core Topic	VIII. Oxidation-Reduction
Key Ideas from Regents Chemistry Core	Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	Performance Indicator 3.2: Use atomic and molecular models to explain common chemical reactions. Major Understanding 3.2d: An oxidation-reduction (redox) reaction involves the transfer of electrons. Major Understanding 3.2j: An electrochemical cell can be either voltaic or electrolytic. In an electrochemical cell, oxidation occurs at the anode and reduction at the cathode. Major Understanding 3.2j: A voltaic cell spontaneously converts chemical energy to electrical energy

Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Standard (RST.9-10.6): Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
Reading Strategy	**Question-Answer Relationship** **Rationale:** Pressley (2006) observed, "In general, the conscious processing that is excellent reading begins before reading, continues during reading, and persists after reading is completed" (p. 57). Good readers are actively engaged not only during reading but also before reading and after reading. Being engaged before reading allows students to access what they already know about the topic and establish a purpose for reading. Being engaged after reading allows students to reflect on and seek to deepen their understanding of what was just read (Harvey & Goudvis 2007). The Question-Answer Relationship (QAR) (Raphael, 1986) strategy supports reading comprehension by helping students make connections between their prior knowledge and the information presented in the text. It helps teachers and students alike refine their questioning skills. By engaging in a QAR while reading students are more apt to become strategic, careful readers. **Activity:** Right there Questions: • Is lithium found in its elemental form in nature? Why or why not? • How is lithium extracted? What form is the lithium in after it's been extracted? • What process allows us to extract pure lithium? • Summarize the process by which lithium ion batteries work. Think and Search Questions: • What are the benefits of lithium ion batteries? What are the drawbacks of using lithium ion batteries? Author and You questions: • Does the author believe that lithium ion batteries are a clean source of energy? Why or why not? Do you

	agree with the author? Why or why not? On my own questions: • Do you believe the benefits of lithium ion batteries outweigh the drawbacks? Why or why not? Support your answer with specific evidence from the article.
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	<u>Standard (WHST.9 – 10.1)</u>: Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence <u>Standard (WHST.9 – 10.4)</u>: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Writing Strategy	**Readable Writing Task: Argument.** **Rationale:** Use of readable writing task prompts, relatively brief on-demand essays or responses, require students to clarify and organize their thinking after reading a text passage. Readable writing task prompts can drastically improve students' thinking and deepen their comprehension of content (Silver, Dewing, & Perini, 2012). A study at Vanderbilt University (Graham & Herbert, 2010) found that asking students to write regularly about the texts they read in science had a significantly positive influence on student comprehension. Since readable writing task prompts only require students to develop brief responses to text, teachers are more able to provide students with focused and formative feedback on their writing, a practice that improves students' writing and learning immensely (Graham, Harris, & Herbert, 2011). **Activity:** See "On my own" question from the QAR completed as the student read the article.

Oxidation - Reduction

Article Title	Fuel Cells
Overview	This article was published by the United States Department of Energy to provide information about fuel cells, a device that can efficiently use hydrogen to create power and energy. The article discusses the process by which fuel cells create energy from hydrogen, where fuel cells can be used, and the benefits of using fuel cells as a source of energy. There is also a discussion about the challenges that exist with uses fuel cells. A highly informative chart is included at the end of the article that compares different fuel cell technologies in terms of their efficiency, applications, advantages, and challenges.
Source	(U.S. Department of Energy, 2010)
Chemistry Core Topic	VIII. Oxidation - Reduction
Key Ideas from Regents Chemistry Core	Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	Performance Indicator 3.2: Use atomic and molecular models to explain common chemical reactions. Major Understanding 3.2d: 3.2d An oxidation-reduction (redox) reaction involves the transfer of electrons. Major Understanding 3.2j: An electrochemical cell can be either voltaic or electrolytic. In an electrochemical cell, oxidation occurs at the anode and reduction at the cathode. Major Understanding 3.2k: A voltaic cell spontaneously converts chemical energy to electrical energy.

Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.4): Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*. Standard (RST.9-10.5): Analyze the structure of the relationships among concepts in a text, including relationships among key terms. Standard (RST.9-10.7): Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equations) into words.
Reading Strategy	**Visualizing in Nonfiction Text** **Rationale:** Concepts that are often difficult to grasp can be learned through diagraming while reading. This is especially true in the field of chemistry where students must truly visualize in their minds to develop understanding. Teachers should encourage students to draw pictures in the margins as they read to keep students engaged during reading and allow them to make connections between what is being read and what is begin visualized in the mind (Harvey & Goudvis, 2007). **Activity:** As you read draw pictures in the margins to help you make sense of the article. For this article in particular, focus on the section "How do fuel cells work?" Use a separate sheet of paper and construct your own diagram and description of a fuel cell. Your diagram and description must clearly explain the process by which a fuel cell produces electricity. In your diagram and description include the following terms: • Anode • Cathode • Hydrogen gas • Catalyst • Protons and electrons • Membrane • Electricity • Air and oxygen • Water • Exothermic

	• Voltage
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 – 10.1): Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence Standard (WHST.9 – 10.4): Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Writing Strategy	**Readable Writing Task: Argument.** **Rationale:** Use of readable writing task prompts, relatively brief on-demand essays or responses, require students to clarify and organize their thinking after reading a text passage. Readable writing task prompts can drastically improve students' thinking and deepen their comprehension of content (Silver, Dewing, & Perini, 2012). A study at Vanderbilt University (Graham & Herbert, 2010) found that asking students to write regularly about the texts they read in science had a significantly positive influence on student comprehension. Since readable writing task prompts only require students to develop brief responses to text, teachers are more able to provide students with focused and formative feedback on their writing, a practice that improves students' writing and learning immensely (Graham, Harris, & Herbert, 2011). **Activity:** Based on the article we just read on fuel cells, do you believe the United States should adopt fuel cell technology as the main source of energy? Why or Why not? Use specific information from the article to defend your position.

Acids, Bases, and Salts

Article Title	How Swimming Pools Work
Overview	This article provides sufficient information on the chemistry behind swimming pools. The article begins with a discussion of pool chemicals, such as chlorine versus bromine, why specific chemicals must be used in pools, and why pools need to be "shocked." Next the author discusses pH and the importance of keeping pool water at an appropriate pH.
Source	(Harris, 2002)
Chemistry Core Topic	IX. Acids, Bases, and Salts
Key Ideas from Regents Chemistry Core	Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	Performance Indicator 3.1: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. Major Understanding 3.1ss: The acidity or alkalinity of an aqueous solution can be measured by its pH value. The relative level of acidity or alkalinity of these solutions can be shown by using indicators. Major Understanding 3.1vv: Arrhenius acids yield H^+ (aq), hydrogen ion as the only positive ion in an aqueous solution. The hydrogen ion may also be written as H_3O^+ (aq), hydronium ion. Major Understanding 3.1ww: Arrhenius bases yield OH- (aq), hydroxide ion as the only negative ion in an aqueous solution. Major Understanding 3.1xx: In the process of neutralization, an Arrhenius acid and an Arrhenius base react to form a salt and water.

Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Standard (RST.9-10.2): Determine the central ideas or conclusions of a text; trace the text's explanation of depiction of complex process, phenomenon, or concept; provide an accurate summary of the text. Standard (RST.9-10.4): Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*. Standard (RST.9-10.9): Compare and contract finding presented in a text to those from other sources (including their own experiments), noting when the finding support or contradict previous explanations or accounts.
Reading Strategy	**Learning Log (Scaffolded)** **Rationale:** This strategy causes the reader to monitor comprehension before, during, and after reading. Using a learning log when completing a reading passage allows students to be an active thinker and use necessary process skills to comprehend the passage (Billmeyer, 2004). Pressley (2006) observed, "In general, the conscious processing that is excellent reading begins before reading, continues during reading, and persists after reading is completed" (p. 57). Good readers are actively engaged not only during reading but also before reading and after reading. Being engaged before reading allows students to access what they already know about the topic and establish a purpose for reading. Being engaged after reading allows students to reflect on and seek to deepen their understanding of what was just read (Harvey & Goudvis 2007). **Activity:** Section 1: Access prior knowledge • What do you know about pool chemicals? • Why do pools need chemicals? • In addition to adding chemicals, what else needs to be done to maintain a healthy pool? Section 2: Ask questions when reading. • What do you wonder about as you read? Section 3: Summarize information read.

	• What form is chlorine in when added to a pool? Is it pure chlorine? • How does chlorine kill bacteria? • What is an alternative sanitizing agent that can be added to a pool, other than chlorine? • Why is a stabilizing agent needed? • Why do you have to occasionally "shock" your pool? • What is pH? • What happens if pool water is too acidic? Too basic? • On the pH scale, what range corresponds to an acidic pH? A basic pH? A neutral pH? • What is the ideal pH of a pool? • What is done to adjust the pH of a pool? Section 4: Make connections to own experience and other resources. • Pick two of the questions you answered in Section 3 of the learning log. Describe a personal experience you've had that relates to the questions you chose. • Pick one of the questions you wrote in Section 2 of the learning log. Research the answer and record it here in 3-5 complete sentences.
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	<u>Standard (WHST.9 - 10.2)</u>: Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. <u>Standard (WHST.9 – 10.6)</u>: Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others. <u>Standard (WHST.9 – 10.7)</u>: Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. <u>Standard (WHST.9 – 10.8)</u>: Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. <u>Standard (WHST.9 – 10.9)</u>: Draw evidence from literary or informational texts to support analysis, reflection, and research.

Writing Strategy	See Section 4 of the Learning Log Reading Strategy above.

Acids, Bases, and Salts

Article Title	Sports Drinks and Electrolytes
Overview	This article discusses sports drinks, such as Gatorade, and their use by athletes to provide electrolytes to the body. The article begins with a discussion of what exactly electrolytes are, how the body uses them, and why they are important. The specific ions provided by sports drinks are also discussed. The article also provides a dialogue about the advantages and disadvantages of consuming sports drinks.
Source	(Hunter, 1996)
Chemistry Core Topic	IX. Acids, Bases, and Salts
Key Ideas from Regents Chemistry Core	Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	Performance Indicator 3.1: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. Major Understanding 3.1rr: An electrolyte is a substance which, when dissolved in water, forms a solution capable of conducting an electric current. The ability of a solution to conduct an electric current depends on the concentration of ions.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Standard (RST.9-10.4): Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*.

	Standard (RST.9-10.5): Analyze the structure of the relationships among concepts in a text, including relationships among key terms.
Reading Strategy	**Think-Ink-Pair-Share (Scaffolded)** **Rationale:** According to the National Science Education Standards (1996), "student understanding is actively constructed through individual and social processes." Through the use of the reading strategy, Think, Ink, Pair, Share, students develop important skills that help them feel more confident in taking the risk of sharing their ideas (Billmeyer, 2003). **Activity:** Think Questions: Answer these questions to the best of your ability prior to reading the article on electrolytes and sports drinks. • Why do athletes drink sports drinks (such as Gatorade, Powerade, etc.)? • What is an electrolyte? Why are electrolytes important to the body? • What are the major cation and anion electrolytes? • For each of the following electrolytes: Potassium, Magnesium, Sodium, Calcium, and Chloride, describe the purpose they serve in our bodies. What happens if we consume too much of these electrolytes? What happens if we do not consume enough? • What can be done by athletes as an alternative to drinking sports drinks? Ink: Students read the passage and "ink" their response with specific evidence from the passage. Pair/Share: Students then pair with another student and share their responses. A class discussion of electrolytes, ionic compounds, and electrical conductivity follows after this reading activity.

Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	Standard (WHST.9 – 10.7): Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. Standard (WHST.9 – 10.9): Draw evidence from literary or informational texts to support analysis, reflection, and research.
Writing Strategy	**Science Writing Heuristic** **Rationale:** "Writing-to-learn" in science provides a means for students to formulate and refine their new knowledge and to connect ideas by finding the most appropriate words and sentence structure to convey a clear textual meaning for others (Wallace et al., 2004). To support writing in a laboratory setting, researchers have been investigating a tool known as the "Science Writing Heuristic" (SWH) as an alternate format for conducting laboratory investigations and writing lab reports. Rather than using the traditional lab report format of purpose, methods, observations, results, and conclusions students respond to prompts that include questions, knowledge, claims, evidence, description of data and observations, methods, and reflect on changes in their own thinking as the experiment progresses. Research by Keys, Hand, Prain, and Collins (1999) argue for the use of the SWH in place of the traditional laboratory format. These researchers claim that when students conduct traditional laboratory experiments that use the traditional laboratory notebook format, students learn some laboratory techniques, but little else. Incorporating guided-inquiry, learning cycles, group work, and the SWH in the laboratory setting is key for improving student conceptual understanding. The SWH is an example of a type of writing activity that can be conducted in a classroom setting to support student metacognition and data reasoning. Students make meaning of the laboratory activities in multiple formats of discussion and writing. Also, the SWH provides teachers with a framework for implementing meaningful, authentic, and inquiry-based, laboratory investigations in their classrooms. (Keys, Hand, Prain, & Collins, 1999). **Activity:** Use of the Science Writing Heuristic (SWH) format for laboratory investigation for a lab on electrolytes. Students

	will be instructed to test the effect on the concentration of ions in solution and conductivity. Students will then use their knowledge of ion concentration in solution and conductivity to determine which brand of sports drink Gatorade or Powerade has the greatest degree of conductivity and hence is the "best" electrolyte. Students will be instructed that they must design and conduct an experiment to observe the relationship between ion concentration in solution and conductivity. Students must then use their acquired knowledge to determine which brand of sports drink is the "best" electrolyte. This laboratory investigation will be conducted after reading the article about electrolytes in sports drinks. Students will use this article as a source of reference for designing and conducting their experiment. They will also compare and contrast the results from their own experiment to those described in the article. **SWH format for student written responses**: Beginning Ideas- What are my questions? Tests- What did I do? Observations- What did I see? Claims- What can I claim? Evidence- How do I know? Why and I making these claims? Reading- How do my ideas compare with other ideas? Reflection- How have my ideas changed?

Acids, Bases, and Salts

Article Title	British Scientists Say Carbon Dioxide Is Turning the Oceans Acidic
Overview	This article, from the New York Times, discusses how carbon dioxide is turning the Earth's oceans acidic. Because of this acidification many species of coral reefs and other marine life are in danger of harm. The article mentions how species that specifically have shells made of calcium carbonate (a basic substance) will be greatly affected by this acidification. The article discusses the sources of carbon dioxide, such as the burning of fossil fuels, and specifically how acidic the oceans are becoming in terms of the pH scale. The article also describes specific research projects that are taking place to investigate the effects of acidified oceans on marine life.
Source	(Chang, 2005)
Chemistry Core Topic	IX. Acids, Bases, and Salts
Key Ideas from Regents Chemistry Core	<u>Key Idea 3</u>: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
Performance Indicators, Major Understandings, Skills	<u>Performance Indicator 3.1</u>: Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. <u>Major Understanding 3.1uu</u>: 3.1uuBehavior of many acids and bases can be explained by the Arrhenius theory. Arrhenius acids and bases are electrolytes. <u>Major Understanding 3.1ss</u>: 3.1ss The acidity or alkalinity of an aqueous solution can be measured by its pH value. The

	relative level of acidity or alkalinity of these solutions can be shown by using indicators.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Standard (RST.9-10.6): Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address. Standard (RST.9-10.7): Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equations) into words.
Reading Strategy	**Question-Answer Relationship** **Rationale:** Pressley (2006) observed, "In general, the conscious processing that is excellent reading begins before reading, continues during reading, and persists after reading is completed" (p. 57). Good readers are actively engaged not only during reading but also before reading and after reading. Being engaged before reading allows students to access what they already know about the topic and establish a purpose for reading. Being engaged after reading allows students to reflect on and seek to deepen their understanding of what was just read (Harvey & Goudvis 2007). The Question-Answer Relationship (QAR) (Raphael, 1986) strategy supports reading comprehension by helping students make connections between their prior knowledge and the information presented in the text. It helps teachers and students alike refine their questioning skills. By engaging in a QAR while reading students are more apt to become strategic, careful readers. **Activity:** Right there Questions: • Where does the CO_2 that's being absorbed by the oceans come from? • Why is ocean absorption of CO_2 an issue? What are the negative consequences?

	Think and Search Questions: • How much of the 25 billion metric tons of CO_2 is absorbed by the oceans? How much would that be in metric tons? (Do the math!!) • For every change in one unit on the pH scale, the acidity or alkalinity of the water changes by a factor of what? So, if the ocean pH changed from 7.9 to 7.7 that mean it because how many times more acidic? (Do the math!) • Dr. Patrick J Michaels claimed that CO_2 levels in the atmosphere have been this high (or higher) for a good majority of Earth's history. Why then is the amount of CO_2 currently a problem? Author and You questions: • Does the author of this article believe climate change is an issue that is affecting our planet in a negative manner? Why or why not? Give specific examples from the article to support your explanation. On my own questions: • Why do you believe a newspaper would publish an article such as this? Explain in 3-5 complete sentences. • Do you believe the government, in the UK and in the United States, should be placing regulations on the amount of CO_2 emissions from automobiles and factories? Why or why not?
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	<u>Standard (WHST.9 – 10.1)</u>: Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence <u>Standard (WHST.9 – 10.9)</u>: Draw evidence from literary or informational texts to support analysis, reflection, and research.
Writing Strategy	"On my own questions" from the QAR reading strategy above. Require students to use specific information from the article to support their opinion.

Nuclear Chemistry

Article Title	The Sun: Fusion at Work
Overview	This article describes nuclear fusion as the source of fuel that powers the sun. A description of the process of nuclear fusion and its emission of large quantities of energy are described. The article discusses the specific elements that are involved in nuclear fusion and the types of elements that are created through nuclear fusion. The different component of the sun, such as the core, radiative zone, convective zone, photosphere, chromosphere, and corona are described. In addition the author provides the reader with information about how energy from the sun can be used to produce electricity here on earth.
Source	(Wood, 2007)
Chemistry Core Topic	X. Nuclear Chemistry
Key Idea from Regents Chemistry Core	Key Idea 4: Energy exists in many forms, and when these forms change, energy is conserved. Key Idea 5: Energy and matter interact through forces that result in changes in motion.
Performance Indicators, Major Understandings, Skills	Performance Indicator 4.4: Explain the benefits and risks of radioactivity. Major Understanding 4.4b: Nuclear reactions include natural and artificial transmutation, fission, and fusion. Major Understanding 4.4f: There are benefits and risks associated with fission and fusion reactions. Performance Indicator 5.3: Compare energy relationships within an atom's nucleus to those outside the nucleus. Major Understanding 5.3a: A change in the nucleus of an atom that converts it from one element to another is called

	transmutation. This can occur naturally or can be induced by the bombardment of the nucleus with high-energy particles. Major Understanding 5.3b: Energy released in a nuclear reaction (fission or fusion) comes from the fractional amount of mass that is converted into energy. Nuclear changes convert matter into energy. Major Understanding 5.3c: Energy released during nuclear reactions is much greater than the energy released during chemical reactions.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Standard (RST.9-10.4): Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*. Standard (RST.9-10.5): Analyze the structure of the relationships among concepts in a text, including relationships among key terms. Standard (RST.9-10.7): Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equations) into words.
Reading Strategy	**Concept Mapping** **Rationale:** Students in a typical science class are constantly exposed to many new words, which make vocabulary development a special concern in science (Billmeyer, 2003). Concept definition mapping (Schwartz & Raphael, 1985) is a visual representation of the meaning of vocabulary terms. This strategy can be used to help students organize their thinking, make connections between concepts, and internalize the meaning of vocabulary terms. This strategy is very useful for deconstructing complex texts that include a variety of vocabulary terms. **Activity:** Read the article "The Sun. Fusion at Work." Create a concept map to describe the process of Nuclear Fusion as it takes place in stars like the sun. Your concept map description of nuclear fusion must link together the following terms:

	• Nuclear Fusion • Energy • Gamma ray • Helium nucleus • Hydrogen-3 • Hydrogen nuclei • Neutron • Positron • Neutrino • Electron • Deuterium As you link each term together, provide an explanation for why you linked the terms the way you did. Include specific examples from the article in your explanation.
Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	<u>Standard (WHST.9 - 10.2)</u>: Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. <u>Standard (WHST.9 – 10.4)</u>: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. <u>Standard (WHST.9 – 10.9)</u>: Draw evidence from literary or informational texts to support analysis, reflection, and research.
Writing Strategy	**Readable Writing Task: Description**. **Rationale:** Use of readable writing task prompts, relatively brief on-demand essays or responses, require students to clarify and organize their thinking after reading a text passage. Readable writing task prompts can drastically improve students' thinking and deepen their comprehension of content (Silver, Dewing, & Perini, 2012). A study at Vanderbilt University (Graham & Herbert, 2010) found that asking students to write regularly about the texts they read in science had a significantly positive influence on student comprehension. Since readable writing task prompts only require students to develop brief responses to text, teachers are more able to provide students with focused and formative feedback on their writing, a practice that improves students' writing and learning immensely (Graham, Harris, & Herbert, 2011).

	Activity: After reading the article *The Sun; Fusion at Work* briefly describe the process of nuclear fusion and how it relates to the energy given off by the sun. Use specific details from the article in your description.

Nuclear Chemistry

Article Title	Open for Discussion: Nuclear Energy: When Will the Lights Go Out?
Overview	This article presents a dialogue between the two authors as they discuss the benefits and risks associated with the production of energy from nuclear power plants. The article discusses how nuclear fission of uranium-235 is used to create enormous amounts of heat energy that is then converted to electrical energy. The fact that this process does not release greenhouse gases into the environment is one of the benefits of nuclear power. One drawback that is mentioned is the storage of spent nuclear fuel rods. The article ends with questioning the reader about their opinion of nuclear power.
Source	(Sitzman & Goode, 2011)
Chemistry Core Topic	X. Nuclear Chemistry
Key Ideas from Regents Chemistry Core	Key Idea 4: Energy exists in many forms, and when these forms change energy is conserved. Key Idea 5: Energy and matter interact through forces that result in changes in motion.
Performance Indicators, Major Understandings, Skills	Performance Indicator 4.4: Explain the benefits and risks of radioactivity. Major Understanding 4.4e: There are inherent risks associated with radioactivity and the use of radioactive isotopes. Risks can include biological exposure, long-term storage and disposal, and nuclear accidents. Major Understanding 4.4f: There are benefits and risks associated with fission and fusion reactions. Performance Indicator 5.3b: Compare energy relationships within an atom's nucleus to those outside the nucleus. Major Understanding 5.3b: Energy released in a nuclear

	reaction (fission or fusion) comes from the fractional amount of mass that is converted into energy. Nuclear changes convert matter into energy.
Common Core Reading Standard for Literacy in Science and Technical Subjects (RST)	Standard (RST.9-10.1): Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Standard (RST.9-10.9): Compare and contract finding presented in a text to those from other sources (including their own experiments), noting when the finding support or contradict previous explanations or accounts.
Reading Strategy	**Directed Reading / Thinking Activity** **Rationale:** A major issue when learning in science is detecting misconceptions or inconsistencies between student understanding and actual scientific principles. Student preconceptions may relate to a naïve understanding of a concept or may be a firmly held misconception. Activating prior knowledge in order to address student preconceptions helps students prepare to read and learn (Billmeyer, 2003). The DRTA strategy can be used to help students approach a text that addresses common misconceptions in science. The DRTA strategy helps students learn to access their prior knowledge and approach text with purpose, questions, and the expectation that they will learn from what they're reading (Moore, Readence, and Rickelman, 1982). **Activity:** Students respond to the following questions before reading: • What I Know I Know • What I Think I Know • What I Think I'll Learn Students respond to the following question after reading. Students should provide specific evidence and examples from the text to support their claim for what they learned. • What I Know I Learned

Common Core Writing Standard for Literacy in History/Social Studies, Science and Technical Subjects (WHST)	<u>Standard (WHST.9 – 10.1)</u>: Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence <u>Standard (WHST.9 – 10.4)</u>: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Writing Strategy	**Readable Writing Task: Argument** **Rationale:** Use of readable writing task prompts, relatively brief on-demand essays or responses, require students to clarify and organize their thinking after reading a text passage. Readable writing task prompts can drastically improve students' thinking and deepen their comprehension of content (Silver, Dewing, & Perini, 2012). A study at Vanderbilt University (Graham & Herbert, 2010) found that asking students to write regularly about the texts they read in science had a significantly positive influence on student comprehension. Since readable writing task prompts only require students to develop brief responses to text, teachers are more able to provide students with focused and formative feedback on their writing, a practice that improves students' writing and learning immensely (Graham, Harris, & Herbert, 2011). **Activity**: Based on the article we just read on nuclear power, do you believe nuclear can keep us out of the dark until we develop new technology to provide enough energy to meet our needs? Use specific information from the article to defend your position.

Chapter 4: Summary

A crucial aspect of college and career readiness is being able to extract information from expository text (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). With that said, the use of text in the science classroom has declined since the 1980's when the push for inquiry-based learning and teaching of science was initiated (Sinatra & Broughton, 2011). With the implementation of the Common Core State Standards in New York State ELA, mathematics, social studies, and science teachers alike must incorporate the text into their curriculums. Text must be incorporated not only so that students may achieve the standards outlined by New York State but also to improve their reading and writing skills considering that the text complexity people are exposed to in their everyday lives has steadily increased over the last 50 years (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). The text passages included in this project were carefully selected to encompass topics outlined in the Regents Chemistry Core Curriculum while creating meaning and relevance to promote student interest and motivation. Reading and writing strategies were aligned to each passage to guide students in extracting information and actually learning the content.

Fostering student engagement in learning science begins with grabbing and holding students' attention and interest in the subject matter (Bergin, 1999). When selecting activities for students to complete in the science classroom teachers should be aware of certain individual and situational factors that influence student motivation. A few of these factors outlined by Bergin (1999) include feelings of belongingness to the content through activation of prior knowledge and situational circumstances such as hands-on, discrepancy, novelty, food, social interactions, games and puzzles, humor, and narrative. As text passages were selected for use in the Regents Chemistry classroom, usually comprised of junior and senior high school students, careful attention was given to selecting passages that related to the lives of 15-16 year old student and would indeed spark their interest.

Bergin (1999) discusses the importance of students having a feeling of belonging in the classroom. This can be developed through selecting activities that connect the content to matters that are valued by the surrounding culture. For high school students this would include matters such as sports, popular music, video games, and technology. This project addresses these matters by using text passages that focus on these cultural values or norms of high-school age children. For example, high school students usually have prior knowledge on the issues associated with the development of new sources of energy. Three articles included in this project directly address this issue. These articles include Green Gasoline: Fuel From Plants (Schirber, 2012), Fuel Cells (U.S. Department of Energy, 2010), and Nuclear Energy: When Will the Lights Go Out? (Sitzman & Goode, 2011). In addition there are articles that highlight popular sports such as paintball and marathon running.

According to Pugh and Bergin (2006) there is a connection between student motivation and its influence on the ability of students to apply their learning to new contexts. Such contexts would include successful application of skills, problem solving techniques, and content knowledge to a task that is related and very similar to the original learning context, more difficult than and complex than the original learning, or that is a real-world task. Investigation of this connection between motivation and information transfer is beyond the scope of this project. This would be an interesting connection to further investigate. In the Regents Chemistry course the connection to be investigated would be student ability to transfer newly acquired knowledge to successful completion of Regents Chemistry test questions.

Research has shown that the structure of text used in the classroom contributes to the degree of learning that will take place on a given topic (Guzzetti, Synder, Glass, & Gamas, 1993; Sinatra, & Broughton, 2011). Students enter the science classroom with preconceived notions about scientific concepts developed from their lives and daily experiences. Many times these ideas conflict with the actual science concepts. According to Guzzetti et al. (1993) persuasive and refutation texts are most effective in promoting conceptual change of preconceived misconceptions. Persuasive texts are designed to shift the reader's ideas and opinions about a particular topic or event. Refutation texts are also designed to change the reader's viewpoint but do so by explicitly stating a commonly help misconception and then immediately refutes that misconception. The idea that persuasive and refutation text promotes the greatest degree of conceptual change was taken into consideration when selecting passages for this project. For example, an article that discusses the use of lithium ion batteries (Sitzman & Goode, 2011) begins with the question "Are lithium ion batteries a clean source of energy?" Prior to reading this article students may hold a specific viewpoint regarding lithium ion batteries being “clean” that may be changed or adjusted after reading this article.

In addition to promoting reading comprehension, this project seeks to address the value to writing-to-learn in the science classroom. Writing-to-learn requires students to re-represent their knowledge in different formats and in their own language. According to Yore, Bisanz, and Hand (2003) writing-to-learn promotes a deeper understanding of science concepts and develops the skills necessary for scientific inquiry. They also claim that engaging students in writing-to-learn activities provides the teacher with an effective avenue for assessing student thinking and conceptual knowledge. Each of the text passages included in this project was aligned with a writing strategy to help students polish their ability to write summaries, arguments, and expository text. Conley (2007) stated “If we could institute only one change to make students more college ready, it should be to increase the amount and quality of writing students are expected to produce (p. 27-28). A variety of writing-to-learn strategies were aligned to the articles to ensure diversity of writing tasks. For example: the Summary Wheel (Billmeyer, 2003) strategy promotes the development of summary writing, the Science Writing Heuristic (Keys, Hand, Prain, & Collins, 1999) promotes writing in a laboratory setting, and Readable Writing Tasks (Silver, Dewing, & Perini, 2012) promote the development of brief essay responses where students clarify and organize their thinking after reading a text passage.

The National Science Education Standards and the Common Core Standards in Science and Technical Subjects support the attainment of science literacy through increased use of text in the science classroom (National Research Council, 1996; National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). These standards however focus on the goals of science education and definition of success and do not provide a solid framework, curriculum materials, or pedagogical methods for the implementation of these standards (Wright & Wright, 1998). This project seeks to address this issue by providing thirty relevant text passages, each aligned with a reading and writing strategy, to promote the goals of the National Science Education Standards and Common Core State Standards in the Regents Chemistry classroom.

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