Personalized Learning, The New Look of a Classroom in the Twenty-First Century

Nicole Lock
The College at Brockport, nscia101213@gmail.com

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Personalized Learning, The New Look of a Classroom in the Twenty-First Century

By: Nicole Lock

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Personalized Learning, The New Look of a Classroom in the Twenty-First Century

By Nicole Lock

APPROVED BY:

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Reader  Date

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Chair, Thesis Committee  Date
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Introduction

The “one size fits all” approach does not work for students in a typical classroom. Students come to class with a different amount of background knowledge and learn better from different learning styles. Therefore, students need information presented to them in different ways depending on what type of learner they are and how much background knowledge they have on a topic. Personalized learning offers the correct presentation of information to the correct learner. It is learner-centered and personalized learning environments offer experiences that are designed for student’s individual learning styles (Şahin & Kişla, 2016).

In order to make education more authentic for students and expose them to the nature of science the personalized learning approach is starting to be implemented more in classrooms. Şimşek and Çakır (2009) define personalization as embedding what students’ are interested in and their past experiences into classroom content. This technique helps students relate more to the content and helps them see the importance of the topic when they can compare it to the world that they live in. The personalization of word problems, for example, has had various positive effects on student learning (Şimşek, & Çakır, 2009). An argument against personalization is that the effect of it may be dependent on factors like the grade of the student, the type of problem, and students’ background knowledge. Research showed that there was no significant difference between students’ performance on math word problems that were personalized and those that were not. There was a meaningful correlation between attitudes toward personal learning environments and knowledge about personal learning environments. Students who knew about personalized learning environments scored higher than those that didn’t (Şahin & Kişla, 2016).
The personalized learning approach aims to represent material by the use of multiple modalities. This paper will focus on the modalities of technology, collaboration, and small group instruction. Technology was chosen as a focus because every day technology is improving and is present in students’ daily lives. Upon graduation students need to be able to look up, and evaluate information on the internet as well as know content knowledge. Students are presented with opportunities through technology that can make them more efficient with their time by using their smartphones (Ketheswaran & Mukunthan, 2016).

Collaboration is another piece to the personalized learning model presented in this paper. Collaboration for students allows them to learn from one another through discussing content and asking questions (Altun, 2015). For some students collaboration helps them understand content better because they are learning with their peers which makes the environment more student-centered. Other students benefit from peer instruction because it allows them to process the information given to them and reevaluate their thinking (Barth-Cohen et al., 2015).

The third modality present in this paper is small group instruction. Small group instruction has led to an increase in student engagement (Cavagnetto, Hand & Norton-Meier, 2010). It is less intimidating for students to ask questions when in front of a few peers compared to the whole class. When comparing small group and whole class instruction students reported that the small group proved them with greater variety of content. Whole class instruction leads to less discussion between students and is more teacher-centered (Cavagnetto et al., 2010).

When a teacher incorporates technology, small group instruction and collaboration into their classroom the role of the teacher changes. They are moving from a teacher centered to a
student centered environment. Teacher's role in a personalized learning classroom is that of facilitator. They are in charge of facilitating the learning that is going on.

Contemporary Science Education

Technology

With a change in technology comes a change in real world skills needed to be successful in this day and age. In order for today's students to be successful and competitive in the job market after graduation they need to be equipped with twenty first century skills. According to the faculty of education at the University of Malaysia, Husin, Arsad, Othman, Halim, Rasul, Osman and Iksan, the four main 21st century skills needed to prepare students to work in the digital world are digital age literacy, inventive thinking, effective communication and high productivity (Husin et al, 2016).

Digital literacy encompasses communication competency, analyses and interpretation of data, understanding models, task prioritization, and problem solving. Several of the aspects just listed coincide with the shifts in the Next Generation Science Standards. Inventive thinking is an activity that supports creative thinking related to problem solving. Effective communication encompasses information delivery, ability to collaborate, social responsibilities, and interpersonal skills. High productivity which is defined as the ability of a student to produce relevant high quality products (Husin et. al, 2016) is the fourth component of 21st century skills. In order to increase a student's 21st century skills the Project Oriented Problem Based Learning (POPBL) approach can be used. Husin et al (2016) noted that when the POPBL was used the largest categories of growth within the 21st century skills were in high productivity and digital age literacy.
Problem Based Learning

Another method to bridge the gap between what was taught in a traditional classroom and the 21st century skills needed for students is called problem based learning (Edmunds, Arshavsky, Glennie, Charles & Rice, 2016). Problem based learning can be used to increase the level of rigor in a classroom. This can be done by the use of projects. In one school 80% of students believed that their school had a high level of rigor and 63% said that they frequently participated in project based learning. One third of students reported that their school had both high rigor and a large amount of projects. When students reported a higher amount of projects they also reported a higher amount of rigor (Edmunds et al., 2016).

The research by Panjwani Micallef, Fenech, and Toyama (2009) had two goals. The first was to determine the effectiveness of the concept cartoons in problem-based learning and the second was to determine how concept cartoons affected the conceptual understanding of students and their problem-solving skill perception. The results from the conceptual understanding test showed that there was a significant difference between the problem based learning group which contained concept cartoons and the control group that did not (Balim, Çeliker, Türkoğuz, Evrekli & Ekici 2015). The incorporation of visual learning materials can help students observe situations and processes that without them would be difficult to do. By using pictures and videos in instruction can increase students’ level of attention as well as their ability to retain information (Panjwani et al., 2009).
**Classroom Environment**

Another impact on student learning is the classroom environment. The classroom environment includes the student’s attitude towards learning, norms of social interactions, acceptance of ideas and mistakes, and the learning structure that the teacher sets. Within the classroom environment there are three constituents that influence student’s engagement which are emotional support, classroom organization, and instructional support. Emotional support includes the ability of the teacher to foster students’ social and emotional functioning. Classroom organization refers to the classroom processes set in place by the teacher that manage students’ behavior and attention. Instructional support includes how the teacher implements activities as far as relating them to real-world issues (Spearman & Watt, 2013). Views on classroom environment can be directly related to student’s motivation, interest and success in a typical classroom. The expectancy-value model of motivation states that students’ expectations for success and the value that they attribute to a task will influence their performance and willingness to work on a task (Spearman & Watt, 2013). Based on results from an experiment performed by Spearman and Watt (2013) a girl's’ perception of structure in a classroom influenced their extrinsic utility value of science. If a student does not see a task as valuable to their learning then they are not going to put much effort into the task and therefore not perform very well on it.

**Why Personalized Learning? - The Nature of Science**

The nature of science is a component of science that has recently gained a lot of attention due to the Next Generation Science Standards. The nature of science refers to the way science works, the values regarding the development of scientific knowledge, and the way scientists
think to uncover new discoveries. There are several aspects of the nature of science that should be included into science curriculum which include that science: can be changed, is based on observations, is not completely objective, and it is influenced by society. Teaching the nature of science is crucial because it is a large part of scientific literacy. If we have scientifically literate citizens then they can justify knowledge based on evidence and therefore make decisions related to science in the everyday world (Wichaidit, 2015).

With the implementation of the Next Generation Science Standards a greater emphasis is being put on exposing students to the nature of science through inquiry. One way of doing this is through service learning which is a practice that integrates service and academic learning to promote understanding and help students develop various skills to deal with social issues (Bulunuz, Tapan, & Bulunuz, 2016). Other ways that the nature of science is incorporated in classrooms include having students discuss science with their peers and dividing students into small groups to work on science related questions. Small group work in science is seen as an authentic reflection of the nature of science (Woods-McConney, Wosnitza & Donetta, 2011).

Evidence has shown a decline in student interest in science. Students have reported having a negative view of scientists and believe science in school is irrelevant. To change this mindset schools are using inquiry to engage students in the nature of science (Wichaidit, 2015) and also are trying to get students more exposure with actual scientists (Chen & Cowie, 2013). When students work with scientists they have a better understanding of the nature of science, a stronger understanding of science content, and it helps teachers increase their content knowledge. Due to the difficulties involved in getting scientists to schools teachers have used online resources to bring scientists into the classroom (Chen & Cowie, 2013).
Chen and Cowie (2013) looked into how teachers were using videos containing scientists in classrooms and what students and teachers thought the impact was of these videos. Results from teacher interviews included the following; the belief that video clips expanded student understanding of scientists and inspire students future choice of career, learning about science on a local level engaged students more, made it easier to understand, and allowed them to connect to the material. Teachers also stated that these videos changed the classroom dynamic because it allowed the teacher to not be in front of the room lecturing the whole class. Students responses were similar to the teachers responses and included: an increased interest in the material because of the local connection, and an increase in focus because students were able to work together and a better understanding because students were able to visualize and listen to content. The three major benefits from bringing scientists into classrooms through the internet are the student’s ability to see themselves in a science field, the ability to learn through a multimodal approach, and scientists are an alternative authority in the classroom (Chen & Cowie, 2013).

Another part of the nature of science includes the ability to backup reasoning with facts. Students practice this skill everyday through argumentation. Argumentation plays a crucial role in student’s ability to process scientific reasoning and gain understanding in science. In order for argumentation to be successful a dialogue is needed which forces student to work collaboratively which is another component of the nature of science (Chin & Osborne, 2010).

**Multiple Modalities**

By using multimodal interactions students can engage with different modalities which can help their understanding and enrich their learning experience. Multiple modalities in a classroom offer a range of resources for individuals that can benefit from different learning
styles. Providing students with personal multimodal technologies can help them become engaged with a variety of science concepts (Anastopoulou, Sharples & Baber, 2011).

The Cognitive Load Theory by Sweller states that a person's working memory is limited. In order to reduce the amount of information in a person's working memory different types of media can be integrated into instruction. By incorporating different types of media into instruction a multimodal approach is implemented. Multimodal interactions include sensory and communication modalities. A sensory modality is the act of perceiving through the five senses while communicative modalities are the representation of meaning through a form such as verbal or visual (Anastopoulou et al., 2011). In science the world is represented through visual, verbal, and symbolic representation. As students get older these different types of representation get more complex. Words become detailed explanation, pictures become graphs and charts, and numbers are now inserted into algebraic expressions. To improve on a student's learning and problem-solving skills they need to experience these different types of representation and be able to manipulate them (Hill & Sharma, 2015). This is where being exposed to multiple modalities benefits the students.

One way of representing information to students is by using the flipped classroom. The flipped classroom model is becoming popular throughout high school and college classrooms because of its emphasis on student engagement. The flipped classroom model is composed of three different modalities including technology, collaboration, and instruction. The first part that students do on their own consists of online videos or articles to read in order to get the content. The second part of the flipped classroom model is the physical class where students collaborate and discuss the material that they read or watched. The third part is an interactive platform for
students to further their learning which could be something like an online discussion forum (Xuesong, Jibao, Hefu, Jyh-Chong, & Chin-Chung, 2017).

A method called the blended model is similar to the flipped classroom model (Jong, 2016). The blended learning model does not have a single definition which means it can be shaped to fit different contexts. One way the blended learning model is used includes students watching videos and getting the content both outside of class time and during class time and using class time as time to increase student engagement with the content (Baeple et al., 2014). Students have the ability to watch the videos as many times as they need to but it is in a more structured environment (Jong, 2016). Providing students with personal multimodal technologies can help them become engaged with a variety of science concepts (Anastopoulou et al., 2011). The blended model based instruction has been successful because it requires more scaffolding for students. The videos selected by the instructor are chosen in order to supplement students learning. In addition to the videos students are given the opportunity to work collaboratively with one another about the content and also are required to reflect on their learning through the blended model based instruction. Results have shown that a blended learning approach or incorporating multiple modalities into a class benefits student learning (Jong, 2016).

Sharples and Baber (2011) showed the impact of multiple modalities during their experiment where one group of students physically took part in a lab and the other group watched a lab take place. When looking at students test scores after the experiment was complete the results indicate that there was no difference in performance between the two group on questions about properties of motion but a statistically significant difference on questions relating to interpretation. It was concluded that students who also physically manipulation of the
data had a better understanding of the content compared to the ones who did not (Anastopoulou et al., 2011). This supports the theory that multiple modalities in a classroom whether they be kinesthetic or visual benefits learners.

**Modality One - Collaboration**

Group collaboration is considered one of the best learning strategies. Through collaboration students are able to discuss ideas with one another and make decisions on selecting the best answer. Because of the discussion piece of collaboration the common mind is better than the single best mind (Altun, 2015). Discussing science with peers is an effective strategy for students to learn about science. When students are divided into small groups in science is seen as an authentic reflection of the nature of science. Working in small groups has increased student motivation when placed in a cooperative learning setting (Woods-McConney, et al., 2011).

The nature of science includes the ability to backup reasoning with facts. Students practice this skill everyday through argumentation. Argumentation plays a crucial role in student’s ability to process scientific reasoning and gain understanding in science. In order for argumentation to be successful a dialogue is needed. Argumentation is a social activity and therefore involves group collaboration (Chin & Osborne, 2010). In order to construct a successful argument, group collaboration should include the asking of questions, coordination of evidence, and explanations. The types of questions that students ask each other impact their discussions and arguments. Critical discussions happen in four stages including focusing, exchanging, debating, and closing. The focusing, exchanging, and debating stages are impacted most by high quality peer questioning. Questioning is a process where students engage with their current understanding, discover different ways of explaining something, evaluate different
explanations, and ultimately come up with a conclusion. Chin and Osborne (2010) noticed that there was a positive correlation between the number of concepts addressed by the questions and the argument score. When questions that centered around scientific concepts were asked the argument received a higher score. These results indicated that it was the type of collaboration and the type of question that affected argument score more than the quantity of questions (Chin & Osborne, 2010).

Cooperative learning is a type of collaboration where students work together to reach a common goal. Working in small groups has increased student motivation when placed in a cooperative learning setting (Woods-McConney et al., 2011). Cooperative learning is a process that has to be taught through practice. There are certain requirement for the implementation of cooperative learning which are; positive interdependence, individual accountability, face to face interaction, social skills, and evaluation of the group processing. Cooperative learning has been proven to provide motivation to students, develop desirable attitudes of students, create good working habits, and improve favorable competition skills. When students shared a common purpose it helps to motivate weak students to participate and motivates strong students to help motivate the weaker students. Cooperative learning increases students’ sense of responsibility because it puts them in charge of their peers learning as well as their own (Altun, 2015).

Collaboration can also be in the form of peer instruction. Peer instruction is when students answer a question individually, then discuss it with a partner and answer the questions again. Peer instruction increases the amount of correct answers which could be due to the active engagement of students which increases understanding (Barth-Cohen et al., 2015).
Modality Two - Technology

During the time that students are in the school system they should be gaining both content knowledge and 21st century skills. For students to be successful after they have completed high school they need to be fluent in information literacy and have an abundance of critical thinking skills. Information literacy pertains to students being able to retrieve, select, and evaluate useful information (Kong, 2014). With the increase in technology information literacy is ever growing in importance.

Information literacy addresses four perspectives which are the cognitive perspective, the meta-cognitive perspective, the affective perspective, and the socio-cultural perspective. When discussing a student's critical thinking skills their capability to think reflectively and judge skillfully are what are being evaluated. Critical thinking skills have five major perspectives which include hypothesis identification, induction for reasoning, perspective of deduction, perspective of explanation, and perspective of evaluation (Kong, 2014).

One method used to increase a student's information literacy and critical thinking is by using digital classrooms. Digital classrooms are becoming more popular which are general classrooms where students are given the opportunities to use technology to further their learning. Digital classrooms have proven to be beneficial for students to learn both content knowledge and 21st century skills. Students are able to develop a deeper content knowledge by having access to multiple sources as well as develop their information literacy because they are required to evaluate and find information from different sources (Kong, 2014).

With the increase in smartphone sales and their low cost schools are finding that these devices can be used to help students with learning. Students can use their smartphone to look up
different texts, find video clips (Ketheswaran & Mukunthan, 2016). Mobile applications for cell phones allow students the opportunity to learn on the go and practice skills outside of the classroom setting. The possibilities that smartphones give students are endless. Smartphones provide students with a level of reach, and immediacy that is unattainable in a typical classroom environment. They are able to increase student enthusiasm as well as enhance learning outcomes. The use of smartphones for education can support collaborative learning and engagement between students which can improve student performance overall (Ketheswaran & Mukunthan, 2016).

One way that students can fit learning into their packed schedule is through smartphones. With more individuals owning smartphones than laptops there is a large market for mobile apps. Mobile apps for education are ways that students can learn or study material at any time because most of them will not leave their house without their phone. Steel (2012) asked students to list language specific reasons why they used the mobile apps that they had on their phone. The largest area of language learning that the apps helped students with was vocabulary. Most students reported having some type of dictionary app on their phone so they could look up words that they did not know. Another common app that helped students with vocabulary was an app that acted as flashcards so students could practice and study vocabulary terms and definitions. In addition to reporting on what apps they use students also reported on whether they liked using mobile apps for learning. Results showed that students valued the opportunities to work outside of the classroom that the apps gave them (Steel, 2012).

Another form of technology available to students is the internet. The internet allows professors that opportunity to record and post their lectures online. This new piece of technology
provides students with a decision to make which is whether to attend lecture, watch the lectures online, or both. In addition students also have the option about where they watch the videos. These questions were the backbone of a study done by Gorrisen, vanBruggen, and Jochems (2012). Results indicated that 27.1% of students watched the online lectures more than 10 times and 23% of students never watched them. When comparing the reasons that students watched the online lectures over 90% of students said that they watched it to make up for missing a lecture and over 85% of students said they watched them to prepare for an exam. The students who said that they did not watch the online lectures said that they did not because they went to class. These results indicate that having online instructional videos available to students can benefit students and are a good supplement to in class lecture (Gorissen et al., 2012). Teachers also can use the internet to show students videos of scientists in order to help students understand that nature of science teachers. By showing students videos of scientists it adds meaning to the science content. The videos allow the ability to be paused, rewound, and replayed for students if they need increased focus on a topic. Videos also include diagrams, animations, and pictures that help students visualize a topic which is difficult to do in science when discussing abstract concepts (Chen & Cowie, 2013).

**Modality Three - Small Group Instruction**

Small group instruction is more favorable for teachers compared to whole class instruction. Mayo, Sharma, and Muller (2009) explained that in whole class instruction there is a disjointed nature of discussion. Instead of holding a discussion with the class the teacher is forced to use a more interrogation approach because students are not offering information. A positive result of whole class instruction is that it exposes students to a greater variety of
questions. Teachers who preferred a whole class teaching approach said that classroom management needs led to their preferential (Cavagnetto et al., 2010).

During small group instruction students feel more comfortable voicing their questions as well as answering questions which creates a greater dialogue (Mayo et al., 2009). Small group implementation involves more student choice which can increase student engagement. Teachers that reportedly preferred the small group strategy indicated that it provided a greater variety for students (Cavagnetto et al., 2010).

**Discussion**

Due to the fact that all students do not learn the same way personalized learning is the way of the future for education. It incorporated multiple modalities such as small group instruction, technology, and student collaboration in order for students to learn. Through personalized learning the classroom is moving from a teacher centered to a student centered format. The teacher takes the role of facilitator instead of the ring leader.

With the availability of technology students’ needs are changing. They have to have a set of 21st century skills which include manipulating and evaluating technology. Being able to find information on their own and then use that information to answer questions and learn is a large component of personalized learning. Students are not waiting on the teacher to tell them the information they are finding it themselves using their resources.

The ability to work with peers is another 21st century skill that students need to have when they graduate high school. Through collaboration students can problem solve, evaluate facts, and discuss what is important about a particular topic. Collaboration helps both the strong and weak students. Strong students are helped because they are rewording their knowledge in a
way that their peers can understand. Weak students benefit from collaboration because they are hearing material explained to them in a different way.

Small group instruction benefits students because it allows them to feel more comfortable in the classroom setting. It is less intimidating to ask a question in from of 4 or 5 people compared to a class of 25. This comfort helps them become more engaged with the material. Teachers benefit from small group instruction because it allows them to monitor students learning on a more individual level.

Personally my thoughts on personalized learning are that it is a method that will be beneficial to our students in learning content and preparing for life outside of high school. The truth is that not all students will be going to college and it is just as important for use to teach them how to be successful in life and give them the 21st century skills that are required to do that. The fact is that education is changing with the increase in technology. With smartphones in everyone's pocket information is at our fingertips. The memorization of facts is not as important as it once was because of this magical tool called Google. Teaching students how to use technology effectively to find information they need and evaluate that information is just as valuable now as knowing who the 30th president of the United States was.

Teachers know that our classrooms are filled with students with varying learning styles and we have been told to differentiate our instruction. The issue is that we have not been told how or have been given a model on differentiating our instruction. Personalized learning and using the multimodal approach is that model that we have been asking for. The thought of coming up with virtually three different lessons for every topic is intimidating and a lot of
planning on the front end will be needed. However I believe that the reward will be worth the effort. After all we didn’t go into education so we could take the easy way out.

This literature review supports my final project because it has shown me the importance of collaboration, small group instruction, and technologies role in a classroom. Focusing on these three modalities has allowed me to see that personalized learning helps students participate in the nature of science as well as supports 21st century skills. Understanding the importance of collaboration, small group instruction, and technology in a classroom will allow me to create lesson plans that incorporate each the three modalities.

Some major implications that personalized learning has on science education include: the classroom environment, the role of the teacher in the classroom, and the incorporation of the nature of science. With the incorporation of personalized learning a science classroom will look different from the traditional classroom where the teacher is standing in front of the classroom and students are sitting in rows taking notes. Personalized learning will take a greater amount of classroom management because the teacher will only be working directly with a small group of students at a time and the rest of the class is expected to work at their designated station. The teacher will need to make sure that the technology and collaboration stations have enough content and structure to keep students working during the entire time frame selected. If students have down time at the stations that they are not directly working with the teacher then this will lead to students being off task, and classroom management issues. It is important to note that it is not the content that is changing but more so the role of the teacher in delivering that content to the student. The teacher will act more as a facilitator and will put more time into the planning of material so that students can find the information on their own instead of being the one telling
students the information. With the implementation of personalized learning it will help science classes actively participate in the nature of science. Students will be able to work together and discuss science topics, compare information that they find to decide if it is credible or not, and come up with conclusions given evidence. All of these aspects are should bring a greater meaning of science to students.

**Project Outline**

My final project will consist of lesson plans following the personalized learning model. This means that each lesson plan will consist of a collaborative, a technology, and a small group instruction portion. Each of the three modalities will all be on the same topic but represented in different ways to serve different learning styles. Students will still participate in all three modalities but they may not get to each set every class period. The aim of this project is to create a student-centered classroom that engages students and helps them understand and participate in the nature of science. Through personalized learning students are responsible for finding information, self-monitoring, and working collaboratively with their peers. When students feel that a topic is relevant to them they are more engaged and find more enjoyment in the content (Chen & Cowie, 2013). This project should be a reference for myself and other Chemistry teachers to use in hopes of bringing more meaning of chemistry to students and help them reach true understanding of material.
What is Personalized Learning

Personalized learning is the new way to ensure that all students needs are being met in a classroom. Research has shown that students learn in different ways. If teachers personalize a child’s learning then the child is getting curriculum in a way that is the most beneficial to them.

While there are many way to personalize a child’s learning I looked at two models published by the company Education Elements. The first model is called a three station rotation where each lesson is composed of three stations all relating to the same content but being expressed through different modalities. The three modalities include a small group instruction station where the teacher leads the group and can monitor the students more individually. The second modality is a collaboration station where students are working as a group to accomplish a task. The third modality incorporates technology and students use technology to complete an assignment. All of these stations are occurring simultaneously which will require a heightened level of classroom management.

The second model that I am incorporating is called the flex model. In the flex model students are given a list of assignments separated into categories and students have the choice on which assignments they complete from each category. This model takes a large amount of time up front planning as the teacher needs to have all of the assignment options ready day one of this lesson.
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| Summary                   | Technology Students will watch a video https://www.youtube.com/watch?v=V-m9UO-bdml with examples showing them how to calculate gram formula mass. They will copy these examples into their notebook. Small group instruction The teacher will have three types of gram formula mass problems (easy, moderate, and difficult) for students to solve. As students are working the teacher can monitor student progress and adjust what type of problems that the students are solving. Collaboration Students will work together to compose a list of steps to take in order to calculate gram formula mass. Rationale At the technology station students will benefit by following along with the video because they will have the opportunity to go back and
rewatch anything that was not clear to them. They also will benefit by both listening to the material and writing it down as they go. (Gorissen et al., 2012).

The small group instruction station really allows the teacher to differentiate instruction based on student needs. Students who are having a difficult time with the math will be able to practice the basics while those that would get bored with the basics have the opportunity to be challenged with the more difficult questions. (Mayo et al., 2009).

This collaboration activity is good for all learners because it forces students to try and put their thinking into words. Students are being asked to work together to develop a list of rules that anyone could follow step by step to solve gram formula mass problems. Putting one's thinking into words is a difficult task which can become easier through collaboration. (Altun, 2015)
Directions: At this station you will work together to compose a list of “rules” or “steps” that your peers can follow to solve any gram formula mass question. When you are done test your rules out with the following questions.

Calculate the gram formula mass of the following compounds
   \( \text{CO}_2, \text{H}_2\text{O}, \text{Na}_2\text{SO}_4 \)
Easy questions
NaCl
MgO
K$_2$S
MgF$_2$

Moderate questions
Fe$_2$O$_3$
Mg$_3$N$_2$
Mn$_2$O$_7$

Difficult questions
Mg$_3$(PO$_4$)$_2$
Be(NO$_3$)$_2$
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| **NYS Chemistry Standard** | M1.1 Measure and record experimental data and use data in calculations  
|                           | • show uncertainty in measurement by the use of significant figures                                                                                                                                                    |
| **Time**                  | 1 Day                                                                                                                                                                                                               |
| **Supplies**              | White boards, dry erase markers, chromebooks. Stations, quizizz website                                                                                                                                               |
| **Objective**             | Students will be able to determine how many significant figures are in a number as well as perform math problems and express their answer to the correct number of significant figures.                                       |
| **Key Questions**         | What are the rules for counting significant figures?                                                                                                                                                                  |
| **Summary**               | **Collaboration Station:**  
|                           | At this station students will choose one card to begin with. Answer the question written on the card. Locate the card that features that answer. Lay these cards down so that the question and answer are next to one another. Then, answer the question on the new card.  
|                           | Repeat this process until they run out of cards. The question on the last card should match up with the answer on the first card.  
|                           | **Small group instruction:**  
<p>|                           | The teacher will be monitoring this station and helping students as needed. Students will find 10 cards. Each card has an arithmetic problem on the front and the answer (with the correct number of significant figures) on the back. They will work through each card. |</p>
<table>
<thead>
<tr>
<th><strong>Rationale</strong></th>
<th><strong>Technology</strong></th>
<th>using the dry erase board and calculator. If their answer doesn’t match the back of the card the teacher will be there for support.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology</strong></td>
<td>Students will go to join.quizizz.com and type in the code provided by the teacher (624017). When all students are logged in the teacher will start the game. Quizizz is an interactive game that asks students questions and rewards them with points the faster they come to an answer.</td>
<td></td>
</tr>
<tr>
<td><strong>Rationale</strong></td>
<td>This technology component helps motivate students by bringing in a competitive aspect to their learning. They are competing against one another and by doing so they are motivated to win which involves doing the best they can. Answering questions in this format still gets the material across but students are much more engaged with the use of technology.</td>
<td></td>
</tr>
</tbody>
</table>
| **Collaboration** | This station really makes students work together because it is in a puzzle format. Students can work together to find the next clue and answer the following question. There will be debates on significant figure rules and methods of counting since the rules are different depending if a decimal is present or not.  
(Altun, 2015) |
| **Small group instruction** | At this station students will be working independently to solve math problems expressing their answer to the correct number of significant figures. The teacher will easily |
be able to monitor students progress and work one on one with individuals who they can see are not getting the correct answers. The immediate feedback component of this station is the most beneficial to students. (Cavagnetto et al., 2010).
Collaboration Station: Looping Cards

At this station, you will find a deck of 32 cards. Each card features a question and an answer to a different question.

With a partner choose one card to begin with. Answer the question written on the card. Locate the card that features that answer. Lay these cards down so that the question and answer are next to one another.

Now, answer the question on the new card. Repeat this process until you run out of cards. The question on the last card should match up with the answer on the first card.
Station One Cards

147000
Round 2347 to 3 significant figures.

2350
Round 1.269 to 2 significant figures.

1.3
Round 186 to 1 significant figure.

200
Round 2.0137 to 4 significant figures.

2.014
Round 368249 to 1 significant figure.

400000
Round 0.00245 to 1 significant figure.

0.002
Round 0.0000058763 to 2 significant figures.

0.0000059
Round 0.000030456 to 2 significant figures.
0.000030
Round 7.994 to 2 significant figures.

8.0
Round 10.356 to 3 significant figures.

10.4
Round 0.08907654 to 1 significant figure.

0.09
Round 89.98 to 3 significant figures.

90.0
Round 45678 to 1 significant figure.

50000
Round 136000 to 2 significant figures.

140000
Round 78.97654 to 4 significant figures.

78.98
How many significant figures does 0.0006 have?
Round 0.00097 to 1 significant figure.

0.001
Round 23.0687 to 3 significant figures.

23.1
How many significant figures does 45.0987 have?

6
How many significant figures does 0.00000102 have?

3
Round 0.000019 to 1 significant figure.

0.00002
Round 140189 to 4 significant figures.

140200
Round 1.092 to 2 significant figures.

1.1
Round 0.0186 to 2 significant figures.
Small group instruction station:  
**Arithmetic Task Cards**

At this station, you will find 10 cards. Each card has an arithmetic problem on the front and the answer (with the correct number of significant figures) on the back. Work through each card using the dry erase board and calculator. If your answer doesn’t match the back of the card, ask for help!
Question Cards

165 Cm + 8 Cm + 4.37 Cm

13.25 g + 1000 g + 9.5g

26 Cm X 378 Cm

0.036 m x 0.02m

35 cm/062 cm

0.075 g/0003cm

13.57 g - 6.3g

23.27 km - 12.058 km

(1.80 m)(3.4 m) + 32.00 m

(55.41 g - 54.79g)/55.32
Answer Cards

20 g/cm

7.3g

11.21 km

38.1 m.

0.011g

29 Cm

32.8g

9.8 cm

O.0007m

56 Cm
<table>
<thead>
<tr>
<th>Title</th>
<th>Compound, Element, Mixture</th>
</tr>
</thead>
</table>
| **NYS Chemistry Standard** | 3.1r A pure substance (element or compound) has a constant composition and constant properties throughout a given sample, and from sample to sample.  

3.1ccA compound is a substance composed of two or more different elements that are chemically combined in a fixed proportion. A chemical compound can be broken down by chemical means. A chemical compound can be represented by a specific chemical formula and assigned a name based on the IUPAC system.  

3.1dd Compounds can be differentiated by their physical and chemical properties.  

3.1s Mixtures are composed of two or more different substances that can be separated by physical means. When different substances are mixed together, a homogeneous or heterogeneous mixture is formed.  

3.1t The proportions of components in a mixture can be varied. Each component in a mixture retains its original properties.  

3.1u Elements are substances that are composed of atoms that have the same atomic number. Elements cannot be broken down by chemical change. |
| **Time** | 1 Day |
| **Supplies** | Homework [Worksheet](#) [Webquest](#) [Salt](#) [Salt water](#) [Copper](#) [Paperclips and erasers in a beaker](#) [Two truths and a lie](#) |
| **Objective** | Students will be able to compare and contrast compounds, elements, and mixtures |
Students will be able to identify which substances are compounds, element, or mixtures based on their properties.

| Key Questions | What type of substance cannot be broken down?  
What type of substance can be broken down and how?  
What is one difference between compounds and elements? |
|---------------|--------------------------------------------------|

| Summary | **Small group instruction**  
The teacher will sit down with different examples of elements (copper), compounds (sodium chloride), and mixtures (salt water, and paperclip & eraser) and ask students about what they see. During the questioning the teacher will discuss properties of each substance.  
**Technology**  
Students will complete a webquest that takes them to a site and they have to compare and contrast compounds, elements, and mixtures. In addition they are to go to a different site and take a quiz on the content they just wrote down.  
**Collaboration**  
During the collaborative section students can read over the given articles and from that write 2 truths and a lie about each of the three components (compounds, elements, and mixtures). Then they can ask each other the questions and correct one another if they get a guess incorrectly.  
**Homework**  
Students will complete the following [worksheet](#) to see what they took away from today's lesson. |

| Rationale | **Small group instruction**  
At this stations students will be able to see and have a hands on experience with the topic at hand. In addition to that the teacher is able to direct the flow of instruction in the way that fits the small group of students best. In different groups the conversations may go in different directions and having that flexibility with the teacher in charge is key for student success. ([Cavagnetto et al., 2010](#)).  
**Technology**  
Growing up in the twenty first century students are surrounded by technology. Being able to pull information from technology is a twenty first century skill that students are going to need in order to be successful after high school. This task will help |
them practice that skill or finding key information. (Husin et. al, 2016)

**Collaboration**

When students are asking each other their two truths and a lie they are really quizzing each other's knowledge. This activity will allow their peers to correct them on misconceptions that they might have. For example, if a student thinks that elements can be separated chemically, their peers can tell that it is compounds that are separated chemically, not elements. (Chin & Osborne, 2010).
Two Truths and a Lie
Directions:
At this station you are to read the following article about compounds, elements, and mixtures. When you are done and you feel like you have a good understanding of each you will write down two truths and one lie about each of the substances. When everyone is done you can ask each other your questions and have them guess which one is the lie. If they are incorrect make sure to correct them and tell them why.

Article:
https://www.myschoolpage.com/the-difference-between-atoms-elements-molecules-compounds-and-mixtures/

WHAT ARE ELEMENTS?

The element is the fundamental substance that consists of only one type of atom. Elements consist of smaller particles and can be man-made or synthetic. Their arrangement in the periodic table is based on the number of protons in an increasing order. The atomic number of an element is indicated by Z. When atoms are arranged differently in an element having the same number of protons, you get different forms of an element. For example, both graphite and diamond are elements of carbon but they look very different from each other.
WHAT IS COMPOUND?

The chemical formula of water is H2O. Observe that, water is made of two hydrogen atoms and one oxygen atom. Here, two different elements, hydrogen and oxygen combine, giving rise to a new substance called water. Such substances, which are made by the combination of two or more kinds of elements are called Compounds. The atoms in a compound are chemically bonded and hence cannot be separated easily. Similarly, the chemical formula of carbon dioxide is CO2 and it is made up of two elements, carbon and oxygen. Some other examples of compounds are table salt (NaCl), chalk (CaCO3) and water (H2O).

WHAT IS A MIXTURE?
Mixture is a substance made by the physical combination of two or more different elements or compounds. A mixture does not involve any chemical reaction. So, if you mix magnetized powder with sand, you get a mixture that can be separated physically by means of a magnet. It can be composed of solids, liquids or gases and can be classified into 6 different categories – homogenous, heterogeneous, solutions, alloys, suspensions, and colloids.

An evenly distributed mixture of water and ethanoic acid is called vinegar and can termed as a homogenous mixture. When two or more substances are not evenly distributed in a mixture, like a blend of oil and water, the mixture is called heterogeneous. When salt is dissolved in water, you get a solution and when you combine two heterogeneous fluids containing solid particles that settle at the bottom, you get suspensions. Colloids are formed when one substance in a heterogeneous mixture is evenly dispersed throughout the other substance, example milk. Alloys are mixtures of one or more metals in a solid solution. Bronze, steel and brass are common examples of alloys.

I hope this helps all our students to clear their doubts on the differences between atoms, elements, molecules and mixtures.
Name:  
Homework

Elements, Compounds & Mixtures Worksheet

Part 1: Read the following information on elements, compounds and mixtures. Fill in the blanks using the following word bank:

Atoms, heterogeneous, atom, cannot, cannot, elements, periodic table, chemically, compounds, homogeneous

Elements:
- A pure substance containing only one kind of ____________.
- An element is always uniform all the way through (homogeneous).
- An element _____________ be separated into simpler materials (except during nuclear reactions).
- Over 100 existing elements are listed and classified on the ____________________.

Compounds:
- A pure substance containing two or more kinds of ____________.
- The atoms are ________________ combined in some way. Often times (but not always) they come together to form groups of atoms called molecules.
- A compound is always homogeneous (uniform).
- Compounds ________________ be separated by physical means. Separating a compound requires a chemical reaction.
- The properties of a compound are usually different than the properties of the elements it contains.

Mixtures:
- Two or more ________________ or _________________ NOT chemically combined.
- No reaction between substances.
- Mixtures can be uniform (called ____________________) and are known as solutions.
- Mixtures can also be non-uniform (called ____________________).  
- Mixtures can be separated into their components by chemical or physical means.
- The properties of a mixture are similar to the properties of its components.

Part 2: Classify each of the following as elements (E), compounds (C) or Mixtures (M). Write the letter X if it is none of these.

___Diamond(C) ___Sugar (C₆H₁₂O₆) ___Water (H₂O)
___Milk ___Iron (Fe) ___Air
___Bismuth (Bi) ___Sulfuric Acid (H₂SO₄) ___Gasoline
___Electricity ___Ammonia (NH₃) ___Alcohol (CH₃OH)
___Krypton (K) ___Uranium (U) ___
Part 3: Match each diagram with its correct description. Diagrams will be used once.

A

B

C

D

E

___1. Pure Element – only one type of atom present.

___2. Mixture of two elements – two types of uncombined atoms present.

___3. Pure compound – only one type of compound present.

___4. Mixture of two compounds – two types of compounds present.

___5. Mixture of a compound and an element.

Part 4: Column A lists a substance. In Column B, list whether the substance is an element (E), a compound (C), a Heterogeneous Mixture (HM), or a Solution (S). (Remember a solution is a homogeneous mixture.) In Column C, list TWO physical properties of the substance.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
<th>Column C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Summer Sausage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Steam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Salt Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Pencil lead (Pb)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Dirt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Pepsi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Silver (Ag)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Toothpaste (Na₂HPO₄)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. A burrito</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Italian Dressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Title</td>
<td>Nuclear: Alpha, Beta, Gamma</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------</td>
<td></td>
</tr>
</tbody>
</table>
| **NYS Chemistry Standard** | 4.4c Nuclear reactions can be represented by equations that include symbols which represent atomic nuclei (with the mass number and atomic number), subatomic particles (with mass number and charge), and/or emissions such as gamma radiation.  
3.1p Spontaneous decay can involve the release of alpha particles, beta particles, positrons, and/or gamma radiation from the nucleus of an unstable isotope. These emissions differ in mass, charge, ionizing power, and penetrating power  
3.1ix Determine the decay mode and write nuclear equations showing alpha and beta decay |
| **Time** | 1 day |
| **Supplies** | White board, dry erase marker, computer, technology, worksheet, article |
| **Objective** | Students will be able to identify alpha, gamma, and beta particles if they are given the particles properties. |
| **Key Questions** | Can you name three differences between alpha, beta, and gamma particles?  
Can you write the products of an alpha, beta, or gamma decay? |
| **Summary** | **Small group instruction**  
At this station the teacher will have the following diagram drawn on a dry erase board and ask the students to copy it down in their notes. The teacher will then go through each box describing what need to be written in each.  
**Collaboration group**  
Each person is going to read the same article. Before reading students need to decide with their group which particle they are going to focus on. Groups will make sure at least one person is covering each particle. Then students will read the entire article but focus on their particle individually. Students may write on or highlight as they see fit. After about 7 or 8 |
minutes students will share with the group what you learned about their particle.

**Technology group**
Students will watch a *variety of videos* that lead them through alpha, beta, and gamma decay. As they are watching students should be writing what they see in their notes. In addition there is a link article to read that contains 5 multiple choice questions that directly follow it to check students understanding.

**Rationale**

**Technology**
By having students use technology and watch videos that explain a concept it allows students to monitor their own learning. If they don’t understand something the first time they are able to stop and rewind in order to rewatch it as many times as needed. This is something a is not able to be done in a traditional lecture.
(Gorissen et al., 2012).

**Collaboration**
By having students focus on different topics and then teaching their topic to their peers it allows motivates them to really understand the topic they have because their peers are depending on them. Likewise when a student is listening to what their peers have to say about a topic that they are not familiar with they are more likely to pay close attention and ask questions about what is unclear to them.
(Chin & Osborne, 2010). (Barth-Cohen et al., 2015).

**Small group instruction**
Small group instruction benefits the learners who need direct instruction. It helps students stay on task because they are in a more intimate setting with the teacher compared to a whole class lecture. Some students may find it intimidating to ask a question during a whole class lecture so small group instruction also makes that easier on the student. In addition it is beneficial to the teacher because they can monitor students progress more easily when they are only looking at 4 or 5 students at a time.
(Cavagnetto et al., 2010). (Mayo et al., 2009).
Name __________________________

Read the following web page and answer the “quiz” questions at the bottom of the page. Record your score here /5.
https://owlcation.com/stem/The-Three-Types-of-Radiation

Alpha Reactions
Follow along with the video and write the equations in your notebook. Then complete the sample questions below by typing the correct answer next to the question.
https://www.youtube.com/watch?v=JwrehvNOSz4
http://www.chemteam.info/Radioactivity/Writing-Alpha-Beta.html

\[ ^{184}_{74}W \rightarrow ^{4}_{2}He + \underline{} \quad ^{14}_{0}C \]

\[ \underline{} \rightarrow ^{4}_{2}He + ^{207}_{81}Tl \]

\[ ^{210}_{82}Pb \rightarrow \underline{} + ^{206}_{80}Hg \]

Beta Reactions
Follow along with the video and write the equations in your notebook. Then complete the sample questions below by typing the correct answer next to the question.
https://www.youtube.com/watch?v=Yln_pmy-mWk

\[ ^{14}_{6}C \rightarrow ^{0}_{-1}e + \underline{} \]

\[ ^{35}_{16}S \rightarrow \underline{} + ^{35}_{17}Cl \]

\[ \underline{} \rightarrow ^{0}_{-1}e + ^{60}_{28}Ni \]

Gamma Reactions
Follow along with the video and write the equations in your notebook.
https://www.youtube.com/watch?v=5U3YVW8Fk-M
Diagram

<table>
<thead>
<tr>
<th></th>
<th>What will stop it / Strength</th>
<th>Charge</th>
<th>Mass</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beta</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Directions: Before you read the article decide with your group if you are going to focus on the alpha, beta, or gamma particle. Make sure at least one person is covering each particle. Then read the entire article but focus on your particle individually. Feel free to write on or highlight as you see fit. After about 7 or 8 minutes share with the group what you learned about your particle.

Types of Radioactive Decay

There are three main types of radioactive decay: alpha, beta, and gamma. Let's pause here a minute to define "decay." When an element decays the parent element's nucleus changes - it will actually decay to turn into a different daughter element altogether! How is this possible? Because during radioactive decay the number of protons in the nucleus can change (I know, right?).

Alpha Radiation/Decay

During Alpha decay an atom spits out two protons and two neutrons from its nucleus. This little bundle is called an "alpha particle."

- Alpha decay usually happens in larger, heavier atoms.
- The symbol looks like Helium because Helium-4 has the same number of protons and neutrons as an alpha particle (no electrons, though).
- Since Alpha particles have two protons and no electrons, they have a net charge of 2+.
- During Alpha radiation an atom’s proton count drops by two, and we know what that means - a NEW element is formed!
- Alpha radiation can be stopped by PAPER.

Beta Radiation/Decay

Remember we said a neutron is a proton with an electron attached? In beta decay a neutron sends its electron packing, literally ejecting it from the nucleus at high speed. The result? That neutron turns into a proton!

- Beta decay increases an atom's electron count by 1 (notice the 1- in the symbol).
- During Beta radiation an atom's proton count grows by one. Once again, NEW element!
- Beta radiation can be stopped by WOOD.
**Gamma Radiation/Decay**

Gamma rays (remember that term from when we studied the EMS?) is electromagnetic radiation similar to light. Gamma decay does not change the mass or charge of the atom from which it originates. Gamma is often emitted along with alpha or beta particle ejecton.

- Gamma radiation can be stopped by LEAD.

**Comparison of Alpha, Beta and Gamma Radiation/Decay**

The diagram below shows the difference between alpha, beta and gamma particles.

The diagram below should make you think back to the cathode ray tube experiment - notice how the negatively charged beta particles are attracted to the (+) plate while the positively charged alpha particle is attracted to the (-) plate. Since gamma radiation has no charge its path does not bend.
The diagram below shows what materials can block each type of radiation. Notice it's easy to block alpha radiation (paper will do!) but tough to block gamma radiation (you'll need a lead vest).

These resources will help you understand the different types of radioactive decay:

- **Alpha vs. Beta vs. Gamma Radiation**

**How do you write equations for alpha decay?**

Fair warning - these reactions look more complicated than they are! If you can subtract 4, 2, 1 or 0 from whole numbers you can write basic nuclear equations.

Remember when an element spits out an alpha particle it loses two protons (changing the atomic number) and two neutrons (changing the isotope's mass number). Your job is to make sure all the mass numbers (top) and atomic numbers (bottom) add up.

Let's start with a non-chemistry example to prove this is a piece of cake (mmmm, cake!):

\[ 210 = 4 + ? \]

Not so bad, right? The \( ? = 206 \) In a nuclear equation for alpha decay you'd be half done! This is how you balance the top part of the equation. So let's finish...

\[ 84 = 2 + ? \]

Again, easy. The \( ? = 82 \). In solving a nuclear equation you're approaching the finish line! The 82 is the atomic number of the daughter element, so find element 82 in your trusty periodic table and you are done. This is how it looks as the full equation for the alpha decay of Polonium-210.

\[ _{84}^{210}\text{Po} \rightarrow _2^4\text{He} + _{82}^{206}\text{Pb} \]
How do you write equations for beta decay?

Same idea and even easier since the mass number doesn't even change during alpha decay. Remember when an element spits out a beta particle all it loses is one electron. It still changes the atomic number because what used to be a neutron is now an extra proton. Your job here is to make sure all the atomic numbers (bottom) add up.

Once again we'll start with a non-chemistry example to prove this is easy: \( 144 = 0 \ + \ ? \)

There's gotta be a catch, right? Too easy? Nope. The \( ? = 144 \). Remember the mass number doesn't change during beta decay.

\( 50 = -1 \ + \ ? \)

The only trick here is remembering you're working with negative numbers, so the daughter will have a HIGHER atomic number than the parent (extra proton, remember?). This is how it looks as the full equation for the beta decay of Cerium-144.

\[
\begin{align*}
\text{Ce}^{144}_{58} & \rightarrow _{-1}^0 \text{e} + \text{Pr}^{144}_{59} \\
\end{align*}
\]

Practice your equation writing skills here! (Answers provided so you can check your answers).

How much do you need to know about nuclear decay?

- Know the names and descriptions of the three main types of nuclear decay (alpha, beta, gamma).
- Know the symbols and charges for alpha and beta particles.
- Know how to write basic nuclear reactions for alpha and beta decay.

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<table>
<thead>
<tr>
<th>Title</th>
<th>Le Chatelier’s Principle</th>
</tr>
</thead>
</table>
| NYS Chemistry Standard | 3.4j LeChatelier's principle can be used to predict the effect of stress (change in pressure, volume, concentration, and temperature) on a system at equilibrium.  
3.4v qualitatively describe the effect of stress on equilibrium, using LeChatelier's principle |
| Time | 1 Day |
| Supplies | Computer  
Ball and ramp  
Worksheet  
Worksheet  
Station manipulatives |
| Objective | Students will be able to predict what will happen to any variable in a system at equilibrium when a change in temperature, pressure, or concentration occurs in that system. |
| Key Questions | When a system at equilibrium experiences an increase in pressure what direction will the equilibrium shift?  
When a system at equilibrium experiences an increase in concentration of the products what direction will the equilibrium shift?  
When a system at equilibrium experiences a decrease in the concentration of reactants what direction will the equilibrium shift? |
| Summary | Video Station  
Students will follow along with a video explaining Le Chatelier’s Principle and then fill in a chart that corresponds to the video.  
Small Group Instruction (ball and ramp) Station  
This station is small group instruction led by the teacher. The teacher will use the ball and ramp to show how a system in equilibrium shifts when a stress is applied to it. Then with the |
teacher, students will work on the worksheet entitled Le Chatelier’s Principle.

**Collaborative Station**
Students will work in groups and Pick one Equation from the equation pile and write it on their worksheet. Then pick 4 cards from the stress pile, record each stress and indicate which direction the shift will go.

<table>
<thead>
<tr>
<th>Rationale</th>
<th>Small group instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small group instruction benefits the learners who need direct instruction. It helps students stay on task because they are in a more intimate setting with the teacher compared to a whole class lecture. Some students may find it intimidating to ask a question during a whole class lecture so small group instruction also makes that easier on the student. In addition it is beneficial to the teacher because they can monitor students progress more easily when they are only looking at 4 or 5 students at a time. (Cavagnetto et al., 2010).</td>
<td></td>
</tr>
</tbody>
</table>

**Collaboration**
When students are able to collaborate with their peers it opens up a new window of learning. Students are able to work through discuss what they know or don’t know about a topic and help one another come to a conclusion. They all have the same goal which is to be successful so that allows them to explain to one another a concept that may be difficult to some yet easy for others. In addition some students find it less intimidating to be learning from a peer then their teacher. They feel more comfortable asking their peer to rephrase something or explain it gain than they do an adult. (Altun, 2015). (Barth-Cohen et al., 2015).

**Technology**
By having students use technology and watch videos that explain a concept it allows students to monitor their own learning. If they don’t understand something the first time they are able to stop and rewind in order to rewatch it as many times as needed. This is something a is not able to be done in a traditional lecture. (Gorissen et al., 2012).
Directions: The following link will take you to a video pertaining to the equation written below. Follow along with the video and fill in the chart below.

https://www.youtube.com/watch?v=BPDkl92NCUs&t=3s

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

What directions will the shift be when the following occurs?

<table>
<thead>
<tr>
<th>Stress</th>
<th>Shift (right, left, no shift)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add N₂</td>
<td></td>
</tr>
<tr>
<td>Add H₂</td>
<td></td>
</tr>
<tr>
<td>Add NH₃</td>
<td></td>
</tr>
<tr>
<td>Remove N₂</td>
<td></td>
</tr>
<tr>
<td>Remove NH₃</td>
<td></td>
</tr>
<tr>
<td>Increase Temp.</td>
<td></td>
</tr>
<tr>
<td>Decrease Temp.</td>
<td></td>
</tr>
<tr>
<td>Increase Vol.</td>
<td></td>
</tr>
<tr>
<td>Decrease Vol.</td>
<td></td>
</tr>
</tbody>
</table>
Group Station
Pick one Equation from the equation pile and write it below. Then pick 4 cards from the stress pile, record each stress and which direction the shift will go.

Pick one Equation from the equation pile and write it below. Then pick 4 cards from the stress pile, record each stress and which direction the shift will go.

Pick one Equation from the equation pile and write it below. Then pick 4 cards from the stress pile, record each stress and which direction the shift will go.
**Equation Pile**

\[ \text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_2(g) + 10 \text{ kcal} \]

\[ 5\text{kcal} + \text{H}_2(g) + \text{I}_2(g) \rightarrow 2\text{HI}(g) \]

\[ \text{NaOH}(s) \rightarrow \text{Na}^+(aq) + \text{OH}^-(aq) + 6\text{kcal} \]

**Stress Pile**

Increase concentration of products

Increase concentration of reactant

Increase Temperature

Increase Pressure

Decrease concentration of products

Decrease concentration of reactant

Decrease Temperature

Decrease Pressure
<table>
<thead>
<tr>
<th>Title</th>
<th>Voltaic Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NYS Chemistry Standard</strong></td>
<td>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. 3.2k A voltaic cell spontaneously converts chemical energy to electrical energy.</td>
</tr>
<tr>
<td><strong>Skills</strong></td>
<td>(3.2vii) identify and label the parts of a voltaic cell (cathode, anode, salt bridge) and direction of electron flow, given the reaction equation (3.2x) use an activity series to determine whether a redox reaction is spontaneous</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>3 Days</td>
</tr>
</tbody>
</table>
| **Supplies**              | Youtube Song: https://www.youtube.com/watch?v=bxJXt_69yM&t=2s  
Virtual Lab:  
POGIL: https://doc-14-8s-apps-viewer.googleusercontent.com/viewer/secure/pdf/n1u0duvjb8vuypr90ii0c65k7hsnk8mehgi08kiw6epqili5gv9ldqdc4kltdp/1498568775000/drive/0655246560798673917/ACFrOgDDHw73gkgJmJXz0ZdRQjakOC3j-m6-XXA_G_zxi-P5FjiFY0j33i_akgW_x_hlHZLQPVvhFhm-BYd_61If52NYKqvCWHh3_PRYT3XjX4VS4eooOftHFcU7d3IXQ=?print=true  
Worksheet: https://doc-04-8s-apps-viewer.googleusercontent.com/viewer/secure/pdf/n1u0duvjb8vuypr90ii0c65k7hsnk8op2bk9jpbgmsnc76i9jsbavlbpqk3/1498569000000/drive/0655246560798673917/ACFrOgDnPKBDYUN_slaefnb1zfMikiSPvyGRKXZMR053MzlhBLkHYOKfa1R1Tiv2AZXPt9aA-skR6GtyDHmS |
| **Objective** | Students will be able to create, label, and explain a model of an electrolytic cell on a molecular level. |
| **Key Questions** | How does an electrolytic cell work?  
What is occurring at the anode and why?  
What is occurring at the cathode and why? |
| **Summary** | **Day 1: Notes** - Students will have the choice to do notes with the class or work their way through the [Voltaic Cell Tutorial](#) by themself.  

Day 2 - Stations  
Students will have 22 minutes at each station to complete the task assigned. What they do not finish in that time is homework.  

**Station 1 - Virtual Lab**  
**Station 2 - Teacher led** Plickers and Practice Regents Questions Worksheet  

**Day 3 - POGIL** - Group Work |
| **Rationale** | **Technology**  
A virtual lab is great for students especially those that have attendance issues. Unlike a traditional lab, a virtual lab students are able to bring home and work on. This also benefits all learners because they are able to work at their own pace and i Do not have to be concerned if they will have the lab finished and picked up before the bell rings.  

**Collaboration**  
The Process Oriented Guided-Inquiry Learning (POGIL) assignment is designed in a way to foster student discussion. Because of the design of the assignment and the wording of the questions students are forced to work together to come to a final conclusion.  

**Small Group Instruction** |
<p>| |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>The teacher will be able to differentiate their instruction</td>
</tr>
<tr>
<td>more by having a small group instruction station. During this</td>
</tr>
<tr>
<td>lesson the teacher can move as slow or as fast as the students</td>
</tr>
<tr>
<td>need to. Flexibility is one of the largest benefits of small</td>
</tr>
<tr>
<td>group instruction which is always a crucial component of a</td>
</tr>
<tr>
<td>classroom. Cavagnetto et al., 2010).</td>
</tr>
</tbody>
</table>
Electrochemical Cells: Virtual Activity

Electrochemical cells involve the transfer of electrons from one species to another. In these chemical systems, the species that loses electrons is said to be “oxidized” and the species that gain electrons is said to be “reduced”. A species cannot gain electrons unless another has lost electrons and vice versa. Oxidation and reduction go hand in hand. There are two major types of electrochemical cells: voltaic (also called galvanic) and electrolytic. Voltaic cells produce electricity by harnessing the energy present in the flowing electrons. These reactions are spontaneous. Electrolytic cells use electrical energy to drive a redox reaction that normally would not occur because it is nonspontaneous.

Part I: Standard Cell Potentials (Voltaic Cells)


Make the following voltaic cells:

#1: Cu2+/Cu ↔ Ag+/Ag  #2: Zn/Zn2+ ↔ Ag+/Ag  #3: Zn/Zn2+ ↔ Cu2+/Cu

2. For each of the above, place the metal in a solution of its own ions. Make sure the cells are set up so that the cell potential is a positive value, indicating that the voltaic cell is set up correctly and the redox reaction is spontaneous. (Hint: In this simulation, the anode is black and the cathode is red.)

3. For each of the three voltaic cells, record the direction of electron flow, determine which electrode is the anode and which is the cathode, and record the cell voltage in the table on the next page.

4. For each electrode, determine whether oxidation or reduction is taking place. Record this in
the table.

5. For each electrode, determine whether the electrode is dissolving away (becoming an ion and going in to solution) OR gaining mass (ions in solution are becoming neutral atoms that are deposited on the electrode). Record this in the table.

6. You must click the “Off” switch to reset for the next voltaic cell.

<table>
<thead>
<tr>
<th>Voltaic Cell #</th>
<th>Electrodes</th>
<th>Direction of electron flow</th>
<th>Anode</th>
<th>Cathode</th>
<th>$E^\circ_{\text{cell}}$ (Volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cu and Ag</td>
<td>Oxidation or Reduction?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dissolving into solution or Gaining mass?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Zn and Ag</td>
<td>Oxidation or Reduction?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dissolving into solution or Gaining mass?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cu and Zn</td>
<td>Oxidation or Reduction?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dissolving into solution or Gaining mass?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analysis Questions: Part I (show setups for any calculations)

1. What is another name for a voltaic cell?

2. For the first cell, Cu-Ag:
   
   (a) Write the oxidation AND reduction half-reactions. Label each as “oxidation” or “reduction”.

   (b) Write the balanced, net ionic equation for the reaction.

3. For the second cell, Zn-Ag:
   
   (a) Write the oxidation AND reduction half-reactions. Label each as “oxidation” or “reduction”.

   (b) Write the balanced, net ionic equation for the reaction.
4. For the third cell, Zn-Cu:

(a) Write the oxidation AND reduction half-reactions. Label each as “oxidation” or “reduction”.

(b) Write the balanced, net ionic equation for the reaction.

Part II: Electroplating (Electrolytic Cells)


2. Construct a copper electroplating cell by placing a copper anode and iron cathode in a solution of Cu2+ ions. (anode is red and cathode is black)

3. Record the initial mass of the iron cathode in the data table. 4. Run the simulation at a current of 2.00 amperes at 2.00 V for 5:00 minutes. Record the final mass of the iron cathode. Record in the data table and calculate the mass of copper deposited on the iron.

<table>
<thead>
<tr>
<th>Initial mass of Fe (g)</th>
<th>Final mass of Fe (g)</th>
<th>Mass of Cu deposited on Fe (g)</th>
</tr>
</thead>
</table>

Analysis Questions: Part III (show setups for any calculations)

1. Is electroplating a spontaneous reaction, or does it require energy? (Look at the voltage)

2. What attracts the Cu onto the Fe electrode?

3. State the direction of electron flow through the circuit.

4. Calculate the moles of copper formed.

5. Write the Cu half reaction that takes place on the Fe electrode as Cu is deposited.

6. How many moles of electrons are transferred when one mole of Cu is formed?
7. Calculate the moles of electrons that ran through this circuit in order for the Cu to form. (Multiply the moles of Cu by the moles of electrons traveling).
POGIL Oxidation and Reduction What happens when electrons are transferred in a chemical reaction?

Why? Silver tarnishes when it comes in contact with sulfur compounds in the air. Copper gets coated in beautiful green patina as it ages. Metals rust or corrode in the presence of air and water. Minerals (ionic compounds) found in ore can be decomposed with the use of electricity to produce pure metals and nonmetals. All of these reactions are examples of oxidation and reduction, otherwise known as redox reactions. In this activity you will explore what is happening at the atomic level in redox reactions.

Model 1 – Redox Reactions

Redox Reactions

A. \( \text{Zn(s)} + \text{Cu}^{2+}(aq) \rightarrow \text{Zn}^{2+}(aq) + \text{Cu(s)} \)  
B. \( 2\text{I}^-(aq) + \text{S}_2\text{O}_8^{2-}(aq) \rightarrow \text{I}_2(s) + 2\text{SO}_4^{2-}(aq) \)

C. \( 4\text{Fe(s)} + 3\text{O}_2(g) \rightarrow 2\text{Fe}_2\text{O}_3(s) \)  
D. \( 4\text{H}^+(aq) + \text{MnO}_4^-(aq) + 3\text{Fe}^{2+}(aq) \rightarrow 3\text{Fe}^{3+}(aq) + \text{MnO}_2(aq) + 2\text{H}_2\text{O(l)} \)

Nonredox Reactions

E. \( \text{HCl(g)} + \text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{O}^+(aq) + \text{Cl}^-(aq) \)  
F. \( 2\text{NaOH(aq)} + \text{H}_2\text{SO}_4(aq) \rightarrow \text{Na}_2\text{SO}_4(aq) + 2\text{H}_2\text{O(l)} \)

G. \( \text{Ba}^{2+}(aq) + 2\text{OH}^-(aq) \rightarrow \text{Ba(OH)}_2(s) \)  
H. \( 2\text{AgNO}_3(aq) + \text{CaCl}_2(aq) \rightarrow \text{Ca(NO}_3)_2(aq) + 2\text{AgCl(s)} \)

1. What two types of reactions are shown in Model 1?

2. Examine the redox and nonredox reactions in Model 1. Is/are there any feature(s) in the redox reactions that would allow you to identify them as redox reactions? If yes, use specific examples from Model 1 to support your answer.
3. In the space under each reaction in Model 1, write the oxidation number for every atom. Divide the work among your group members. An example is shown here:

\[
4\text{Fe}(s) + 3\text{O}_2(g) \rightarrow 2\text{Fe}_2\text{O}_3(s)
\]

\[
\begin{array}{ccc}
0 & 0 & +3 \ -2 \\
0 & 0 & +3 \ -2 \\
\end{array}
\]

4. Identify any elements that changed oxidation number in the reactions in Model 1. Connect the starting and ending oxidation numbers with a line. An example is shown here:

\[
4\text{Fe}(s) + 3\text{O}_2(g) \rightarrow 2\text{Fe}_2\text{O}_3(s)
\]

\[
\begin{array}{ccc}
0 & 0 & +3 \ -2 \\
0 & 0 & +3 \ -2 \\
\end{array}
\]

5. Based on the oxidation number analysis you just performed for the reactions in Model 1, are there any features of the redox reactions that would allow you to identify them as redox reactions? If yes, use specific examples from Model 1 to support your answer.

6. Identify the following reactions as either redox or nonredox using oxidation numbers as evidence.
a. \( \text{Pb(NO}_3\text{)}_2(\text{aq}) + 2\text{NaI(aq)} \rightarrow \text{PbI}_2(\text{s}) + 2\text{NaNO}_3(\text{aq}) \)

b. \( 2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2 \)

c. \( \text{CH}_4 + 2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{CO}_2 \)

d. \( \text{HCl} + \text{NaOH} \rightarrow \text{H}_2\text{O} + \text{NaCl} \)

Read This! The process of oxidation and reduction can be thought of as a transfer of electrons from one atom to another. Thus, one atom gives up electrons and the other atom gains them. As a result of this process, the oxidation numbers of both atoms change. All redox reactions can be divided up into two reactions—an oxidation half-reaction and a reduction half-reaction. This allows for better understanding of the electron transfer process.

Model 2 – Half Reactions

A. \( \text{Zn(s)} + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Cu(s)} \)
\[ \text{ox: Zn} \rightarrow \text{Zn}^{2+} + 2e^- \]
\[ \text{red: Cu}^{2+} + 2e^- \rightarrow \text{Cu} \]

B. \( 2\text{I}^- (\text{aq}) + \text{S}_2\text{O}_8^{2-}(\text{aq}) \rightarrow \text{I}_2(s) + 2\text{SO}_4^{2-}(\text{aq}) \)
\[ \text{ox: } 2\text{I}^- \rightarrow \text{I}_2 + 2e^- \]
\[ \text{red: } \text{S}_2\text{O}_8^{2-} + 2e^- \rightarrow 2\text{SO}_4^{2-} \]

C. \( 4\text{Fe(s)} + 3\text{O}_2(g) \rightarrow 2\text{Fe}_2\text{O}_3(s) \)
\[ \text{ox: } \text{Fe} \rightarrow \text{Fe}^{3+} + 3e^- \]
\[ \text{red: } \text{O}_2 + 4e^- \rightarrow 2\text{O}^{2-} \]

D. \( 4\text{H}^+(\text{aq}) + \text{MnO}_4^{-}(\text{aq}) + 3\text{Fe}^{3+}(\text{aq}) \rightarrow 3\text{Fe}^{3+}(\text{aq}) + \text{MnO}_2(\text{aq}) + 2\text{H}_2\text{O(l)} \)
\[ \text{ox: } \text{Fe}^{3+} \rightarrow \text{Fe}^{3+} + e^- \]
\[ \text{red: } 4\text{H}^+ + \text{MnO}_4^{-} + 3e^- \rightarrow \text{MnO}_2 + 2\text{H}_2\text{O} \]
7. What does the “e−” symbol represent in the oxidation and reduction half-reactions shown in Model 2?

8. Look at the oxidation half-reactions in Model 2.
   a. Which of the following types of particles may undergo oxidation? (Circle all that apply.) Neutral atoms/molecules Cations Anions
   b. Are electrons lost or gained by an atom during the process of oxidation?
   c. Does the oxidation number of an atom involved in the process of oxidation increase or decrease?

9. Look at the examples of reduction in Model 2.
   a. Which of the following types of particles undergo reduction? (Circle all that apply.) Neutral atoms/molecules Cations Anions
   b. Are electrons lost or gained by an atom during the process of reduction?
   c. Does the oxidation number of an atom involved in the process of reduction increase or decrease?

10. Consider the word “reduction” as it is used in the English language. In reduction half-reactions, what is “reduced”? Use the examples in Model 1 to verify your answer.

Read This! Oxidation occurs when atoms lose electrons. Reduction occurs when atoms gain electrons. These two processes always occur together. In other words, you can’t just let electrons loose into space—they must be grabbed by some other atom. Likewise, you can’t just grab electrons from space—they must be taken from some other atom. An easy way to remember these processes is to remember the phrase “LEO the lion goes GER.”

LEO = Loss of Electrons is Oxidation  
GER = Gain of Electrons is Reduction
11. Consider the incomplete half-reactions below.
   a. Use oxidation numbers to identify the reactions below as oxidation or reduction.
   b. Place the correct number of electrons on the appropriate side of the reaction to complete the Equation.

\[ \text{I}_2 \rightarrow 2\text{I}^- \quad \text{Cr}^{2+} \rightarrow \text{Cr}^{3+} \]

\[ \text{Sr} \rightarrow \text{Sr}^{2+} \quad \text{ClO}_2^- + \text{H}_2\text{O} \rightarrow \text{ClO}_3^- + 2\text{H}^+ \]

12. Consider Reaction A in Model 2. Show that the two half-reactions can be added together to give the overall redox reaction. Hint: Consider how you would add two equations together in algebra.

13. Show how the two half-reactions for Reaction B in Model 2 can be added together to give the overall redox reaction.

**Extension Questions**


16. When iron is exposed to oxygen, it forms rust as described by the following equation. In this reaction oxygen is acting as the oxidizing agent.

\[ 4\text{Fe}(s) + 3\text{O}_2(g) \rightarrow 2\text{Fe}_2\text{O}_3(s) \]

   a. What element was oxidized in the reaction above?

   b. Explain why oxygen is considered the oxidizing agent in this reaction? Hint: Consider the purpose of an “insurance agent” or a “real estate agent.”

   c. What is the reducing agent in the reaction above? Explain.
1. Write the appropriate half-reactions next to each half cell (beaker).
2. In which half-cell does oxidation take place?
3. In which cell does reduction take place?
4. What loses electrons?
5. What gains electrons?
6. Which electrode is the cathode?
7. Which electrode is the anode?
8. Which electrode will get larger as the reaction proceeds?
9. Which electrode will get smaller as the reaction proceeds?
10. In which direction will the electrons flow through the wire?
REGENTS QUESTIONS
Which conversion of energy always occurs in a voltaic cells
(1) light energy to chemical energy
(2) electrical energy to chemical energy
(3) chemical energy to light energy
(4) chemical energy to electrical energy

In a voltaic cell, chemical energy is converted to
(1) electrical energy, spontaneously
(2), electrical energy, non spontaneously
(3) nuclear energy, spontaneously
(4) nuclear energy, non spontaneously

14. Which statement is true about oxidation reduction in an electrochemical cell ?
(1) Both occur at the anode.
(2) Both occur at the cathode.
(3) Oxidation occurs at the anode and reduction occurs at the cathode.
(4) Oxidation occurs at the cathode and reduction occurs at the anode.
### The Atom

**NYS Chemistry Standard**

3.1b Each atom has a nucleus, with an overall positive charge, surrounded by negatively charged electrons.

3.1c Subatomic particles contained in the nucleus include protons and neutrons.

3.1d The proton is positively charged, and the neutron has no charge. The electron is negatively charged.

3.1e Protons and electrons have equal but opposite charges. The number of protons equals the number of electrons in an atom.

3.1f The mass of each proton and each neutron is approximately equal to one atomic mass unit. An electron is much less massive than a proton or a neutron.

### Time

1 day

### Supplies

- Worksheet
- chromebook

### Objective

Students will be able to compare the three subatomic particles based on size, charge, and location in an atom.

### Key Questions

Compare the three subatomic particles based on size, charge, and location in an atom.

### Summary

While students complete the 3 stations they will be filling out this worksheet.

**Technology station**

Students will use the links provided to answer questions about the structure of an atom.

**Small group instruction**

Students will draw and label a detailed model of the Bohr atom with the teacher.
| Collaborative Station | **Collaborative Station**
Students will work together to create five questions based on the material about the atom. |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| **Rationale**        | **Technology**
Growing up in the twenty first century students are surrounded by technology. Being able to pull information from technology is a twenty first century skill that students are going to need in order to be successful after high school. This task will help them practice that skill or finding key information. (Husin et. al, 2016). |
|                      | **Small group instruction**
Students will be able to ask the teacher specific questions about the bohr model that they wouldn’t be able to in a large group setting. When looking at models details are important so a small group setting will allow students to have the more accurate drawings and labels possible. (Cavagnetto et al., 2010). |
|                      | **Collaborative Station**
Students are asked to work with a partner to come up with quiz questions about the atom. By having students write questions they not only have to know the correct material but also list other options that may be tempting to select. Being able to discuss that with another peer will allow for a better quality of questions. (Altun, 2015). (Barth-Cohen et al., 2015). |
Technology station.

Go to: http://www.chemtutor.com/struct.htm and read the “And you thought you were strange” section to answer the following questions (put answers in the table).

1. What are the three subatomic particles that all atoms are made of?
2. Where are each of the three particles located within the atom?
3. What is the electrical charge of each particle?

<table>
<thead>
<tr>
<th>1. The 3 subatomic particles</th>
<th>2. Location within the Atom</th>
<th>3. Electrical Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Log on to the following website to complete the Web Quest.
http://www.qacps.k12.md.us/ghs/teachers/WeedonD/Atoms%20page%202.htm

1. The basic unit of all matter is the ____________________.
2. All atoms are made of three types of particles ________________, ________________, and ________________.
3. The __________ is used to identify an atom.
4. Protons are found in the _________________of atoms. They have a _______________charge.
5. The number of protons is called the _____________________________.
6. What happens when the number of protons in an atom changes?
7. How big are protons compared to electrons?
Click on learn about neutrons
8. Neutrons are found in the ______________________ of an atom?
9. How can you calculate the number of neutrons in an atom?

Click on Learn about electrons
10. What is the charge on an electron?______________________
11. How can you calculate the number of electrons in an atom?

12. Where are electrons found in an atom?

Teacher Station

Group Station
As a group create 5 questions about the atom that you think are fair for me to ask on a quiz.
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.

3.1tt On the pH scale, each decrease of one unit of pH represents a tenfold increase in hydronium ion concentration.

3.1uu Behavior of many acids and bases can be explained by the Arrhenius theory. Arrhenius acids and bases are electrolytes.

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 H3O+(aq), hydronium ion.

3.1ww Arrhenius bases yield OH-(aq), hydroxide ion as the only negative ion in an aqueous solution.

3.1xx In the process of neutralization, an Arrhenius acid and an Arrhenius base react to form a salt and water.

3.1yy There are alternate acid-base theories. One theory states that an acid is an H+ donor and a base is an H+ acceptor.

### Time

1 Day

### Supplies

- Worksheet
- Chromebook

### Objective

Students will be able to label a pH scale. Students will be able to solve mathematical questions pertaining to neutralization and molarity. Students will be able to predict the products of a neutralization reaction given the reactants.

### Key Questions

What is the definition of an acid and a base? Describe pH and what it measures. What are the products of all neutralization reactions?

### Summary

This is a review lesson to be done at the end of a unit.
<table>
<thead>
<tr>
<th><strong>Rationale</strong></th>
<th><strong>Technology</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology station</strong> - Students will watch and follow along with videos that take them step by step through solving titration and molarity formula questions.</td>
<td></td>
</tr>
<tr>
<td><strong>Teacher station</strong> - Students will write notes as the teacher talks about properties and definitions of acids and bases as well as pH.</td>
<td></td>
</tr>
<tr>
<td><strong>Collaboration station</strong> - Students will work together to complete the questions using their notes.</td>
<td></td>
</tr>
</tbody>
</table>

**Technology**
By having students use technology and watch videos that explain a concept it allows students to monitor their own learning. If they don’t understand something the first time they are able to stop and rewind in order to rewatch it as many times as needed. This is something a is not able to be done in a traditional lecture.
(Gorissen et al., 2012).

**Collaboration**
Some students learn best when they are teaching others while others learn better when they hear information coming from their peers. This is a huge benefit when having students collaborate. Those students who have a good understanding of a topic can solidify their knowledge by explaining it to their peers which also helps their peers learn in return.
(Woods-McConney, et al., 2011). (Barth-Cohen et al., 2015).

**Small group instruction**
Small group instruction benefits the learners who need direct instruction. It helps students stay on task because they are in a more intimate setting with the teacher compared to a whole class lecture. Some students may find it intimidating to ask a question during a whole class lecture so small group instruction also makes that easier on the student. In addition it is beneficial to the teacher because they can monitor students progress more easily when they are only looking at 4 or 5 students at a time.
(Cavagnetto et al., 2010).
Calculate the molarity of a solution prepared by dissolving 16.45g of NH₄NO₃ in water to make 250 mL of solution.

Then watch the video [https://www.youtube.com/watch?v=n7HdJiMdcGs](https://www.youtube.com/watch?v=n7HdJiMdcGs) and complete the following question with the video.

In a titration, a few drops of an indicator are added to a flask containing 35.0 mL of HNO₃ of an unknown concentration. After 30.0 mL of a 0.15M NaOH solution is slowly added to the flask, the indicator changes color, showing the acid is neutralized. Show a numerical setup for calculating the concentration of the HNO₃ solution.

After you have shown your work for the previous problem go to castle learning and complete the assignment.
**Group Station**

Define a neutralization reaction

With your group complete the following questions

<table>
<thead>
<tr>
<th>Question</th>
<th>The answer is correct because.....</th>
<th>The answer is incorrect because ......</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is produced when HCl and KOH react?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) H₂O and KCl</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2) H₂O and KOH</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) KCl and KOH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4) HCl and H₂O</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In a neutralization reaction, the two products are...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. salt and acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. base and acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. water and base</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. water and salt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In this box create your own question.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Title</td>
<td>Molecular Polarity</td>
<td></td>
</tr>
<tr>
<td>------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>NYS Chemistry Standard</td>
<td>5.21 Molecular polarity can be determined by the shape of the molecule and distribution of charge. Symmetrical (nonpolar) molecules include CO₂, CH₄, and diatomic elements. Asymmetrical (polar) molecules include HCl, NH₃, and H₂O.</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>2 Days</td>
<td></td>
</tr>
<tr>
<td>Supplies</td>
<td>Stations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PhET Simulation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mini Quiz</td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Students will be able to identify the polarity of molecules based on their shape.</td>
<td></td>
</tr>
<tr>
<td>Key Questions</td>
<td>What does polarity mean? How do you decide if a molecule is polar or nonpolar?</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td>This lesson would come after students took notes on polarity.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PhET Simulation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Students will complete the webquest during one 44 minute period using a PhET simulation to understand how molecular polarity works.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stations:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Students will complete two stations in 44 minutes. When they have completed both stations they will fill in the column that identifies if the molecule is polar or nonpolar.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Model Station - At this station student will use the model kits and build a model for each formula on the worksheet. They will do this using the key provided with the model kits. When they have completed each model they will sketch what it looks like on their worksheet.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lewis Structure Station - At this station students will draw proper lewis structures for each formula on the worksheet.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Homework:</td>
<td></td>
</tr>
</tbody>
</table>
For homework students need to complete the mini quiz

<table>
<thead>
<tr>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personalized learning allows students to obtain information in a way that is best for them. Some students learn best through one on one instruction, while others benefit from peer collaboration, and still some students learn best visually through the use of technology. This lesson plan incorporates all three of those modalities in order to serve students better.</td>
</tr>
</tbody>
</table>

The technology component in this lesson is a PhET simulation. This simulation will help visual learners understand what polarity might look like in a model. Since students are not able to see molecules in real life the use of technology will help them visualize the concept being discussed. In addition the homework assignment involves the students answering questions on a website. By doing this students get immediate feedback on their thinking since the website will inform students right away if a question is correct or incorrect. (Panjwani et al., 2009).

When students are able to discuss concepts and bounce ideas off one another they can build a greater understanding of the topic at hand. By physically building models in groups students are able to discuss with their peers what they see and through that discussion make connections to the concept of molecular polarity. (Woods-McConney, et al., 2011). (Altun, 2015).

Some students need small group instruction to really understand fundamental facts. During this lesson the teacher can show students individually how to draw lewis structures and correct any misconceptions they have about molecular polarity. When working in smaller groups it allows the teacher to evaluate each student's needs. (Cavagnetto et al., 2010).
**Directions**

**Models Station** - Use the ball and stick models to make models using the key provided with the kit for all of the formulas listed. After you make the model sketch what your model looks like in the space provided.

**Lewis Structure Station** - Draw a proper lewis structure for each formula in the space provided.

When you are done with both stations fill in the molecular polarity section with “polar” or “nonpolar”

<table>
<thead>
<tr>
<th>Formula</th>
<th>Sketch of Model</th>
<th>Lewis Structure</th>
<th>Molecular Polarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HBr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H₂O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PH₃</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH₄</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N₂</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO₂</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH₃Cl</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Molecule Polarity

In this activity you will use a PhET simulation to explore molecule polarity.

Part I: What factors affect molecule polarity?

1. Explore the Molecule Polarity simulation for a few minutes with a partner. In each of the three tabs, try to find all of the controls and figure out how they work.

Two Atoms tab

2. Describe all of the ways you can change the polarity of the two-atom molecule.

3. Explain how the representations below help you understand molecule polarity.

   - Electrostatic Potential
   - Electron Density

Three Atoms tab

4. Describe any new ways you can change the polarity of the three-atom molecule.

5. Explain the relationship between the bond dipoles and the molecular dipole.
6. Can a non-polar molecule contain polar bonds? Explain your answer with an example.

Real Molecules tab

7. **Predict** the polarity of 6 real molecules. First, draw the molecules and any bond dipoles. Then draw any molecular dipoles. Explain your reasoning before you check your predictions with the simulation.
<table>
<thead>
<tr>
<th><strong>Title</strong></th>
<th>The Atom Flex Model</th>
</tr>
</thead>
</table>
| **NYS Chemistry Standard** | 3.1 Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them.  
i. use models to describe the structure of an atom  
ii. relate experimental evidence (given in the introduction of Key Idea 3) to models of the atom  
iii. determine the number of protons or electrons in an atom or ion when given one of these values  
iv. calculate the mass of an atom, the number of neutrons or the number of protons, given the other two values |
| **Time** | 4 Days |
| **Supplies** | Chromebooks, POGIL, Beans, Construction Paper, Regents Questions Worksheet, Castle Learning |
| **Objective** | Students will be able to determine the correct number of subatomic particles given an atom, ion, or isotope.  
Students will be able to create a bohr model of an atom.  
Students will be able to determine what atom, ion, or isotope they are looking at given the subatomic particles. |
| **Key Questions** | Can you correctly place the proper amount of subatomic particles in the correct locations on a Bohr model of an atom?  
Compare Ions, Isotopes, and Atoms.  
How is the mass of an atom calculated? |
| **Summary** | For this set of lessons students all students will complete a mandatory assignment and then be given the opportunity to choose between a list of assignments a total of 4 more to complete by the end of the timeline.  
**During all of the assignment the teacher will be pulling students aside based on their products to clear up any misconceptions.**  
Mandatory assignment - Students will be assigned a specific element and have to create a Bohr model of that element making sure to place the subatomic particles in the correct spots as well |
as have the correct number of each.

**Option 1** - Students create a self study using Castle Learning on the atom.

Or

**Option 2** - Students will complete a 30 question Castle Learning assignment on the atom.

**Option 3** - Students may work in group of 3 to complete the POGIL assignment on Ions

Or

Option 4 - Students will work independently on the Practice regents questions worksheet where an answer is given and students have to justify if the answer that is selected is correct or incorrect and why.

**Option 5** - Students may work with one partner to write 10 practice questions using their notes on a google form. I will then use these practice questions later in the unit.

Or

**Option 6** - Students can work with one person to create a mind map given a list of vocabulary terms

Option 7 - Students can do the “Bean Lab” where they count different beans that represent different subatomic particles to determine what atom, ion, or isotope they have.

Or

**Option 8** - Students work independently to complete a pHet simulation

<table>
<thead>
<tr>
<th>Rationale</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>The use of technology in chemistry is crucial for students especially those that have a hard time visualizing concepts. By using the pHet simulation students will be able to have a better visual representation of what an atom looks like. This is crucial</td>
<td></td>
</tr>
</tbody>
</table>
in a course like chemistry because the topics that are discussed are often things not seen with the naked eye. (Panjwani et al., 2009)

Collaboration
If students chose to partake in the mind map activity it will be interesting for them to see the differences in their thinking compared to their friends thinking.

Small group instruction
The small group instruction looks different in this lesson because it is on an “as needed basis” determined by the teacher. By allowing students choose what activities they would like to do the teacher is now available to monitor student progress more readily than they would if they were doing a whole class lecture. This style allows for a more personal relationship. (Cavagnetto et al., 2010).
You will have 4 class days to work through the following list of assignments. Under the "options" column you can see how many of the activities that you have to complete. You may work on these outside of class as well. All supplemental material is located in the back of the room. You do not need to work in any specific order.

<table>
<thead>
<tr>
<th>Options</th>
<th>Activities</th>
<th>Date Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandatory</td>
<td>You will be assigned a specific element and have to create a Bohr model of that element making sure to place the subatomic particles in the correct spots as well as have the correct number of each. See Directions sheet.</td>
<td></td>
</tr>
<tr>
<td>Pick 1</td>
<td>Option 1 - Create a self study using Castle Learning on the atom. Or Option 2 - Complete the 30 question Castle Learning assignment I created.</td>
<td></td>
</tr>
<tr>
<td>Pick 1</td>
<td>Option 3 - You may work in group of 3 to complete the POGIL assignment on Ions Or Option 4 - You will work independently on the Practice regents questions worksheet where an answer is given and students have to justify if the answer that is selected is correct or incorrect and why. See Worksheet for clarification.</td>
<td></td>
</tr>
<tr>
<td>Pick 1</td>
<td>Option 5 - You may work with one partner to write 10 practice questions using your notes on a google form and then share the form with me. I will then use these practice questions later. Or Option 6 - You can work with one person to create a mind</td>
<td></td>
</tr>
</tbody>
</table>
| Pick 1 | Option 7 - You can do the “Bean Lab” where you count different beans that represent different subatomic particles to determine what atom, ion, or isotope you have.  
See lab for clarification and directions.  
Or  
Option 8 - Students work independently to complete a pHet simulation |
Create an atom Project

· Make a poster for an atom and include
  · A visual representation of the atom using Bohr's model
  · Correct # of Protons
  · Correct # of Electrons
  · Correct # of Neutrons
  · Correct Atomic Number
  · Correct Atomic Weight
  · Correct Nucleus placement and make-up
  · Correct scale(size) of subatomic particles
1. Compared to the charge of a proton, the charge of an electron has
   1. a greater magnitude and the same sign  2. a greater magnitude and the opposite sign
   3. the same magnitude and the same sign  4. the same magnitude and the opposite sign

2. Which particle has no charge?
   1. electron    2. neutron    3. positron    4. proton

3. An electron in a sodium atom gains enough energy to move from the second shell to the third shell. The sodium atom becomes
   1. a positive ion  2. a negative ion
   3. an atom in an excited state  4. an atom in the ground state

4. Which particles have approximately the same mass?
   1. an electron and an alpha particle  2. an electron and a proton
   3. a neutron and an alpha particle    4. a neutron and a proton

5. According to the wave-mechanical model of the atom, an orbital is a region of the most probable location of
   1. an alpha particle  2. a gamma ray
   3. an electron      4. a proton

6. Which statement about one atom of an element identifies the element?
   1. The atom has 1 proton.
   2. The atom has 2 neutrons.
   3. The sum of the number of protons and neutrons in the atom is 3.
   4. The difference between the number of neutrons and protons in the atom is 1.
7. State one conclusion about the internal structure of the atom that resulted from the gold foil experiment.

8. Which electron configuration represents the electrons in an atom of Ga in an excited state?
   1. 2-8-17-3   2. 2-8-17-4
   3. 2-8-18-3   4. 2-8-18-4

9. When an excited electron in an atom moves to the ground state, the electron
   1. absorbs energy as it moves to a higher energy state
   2. absorbs energy as it moves to a lower energy state
   3. emits energy as it moves to a higher energy state
   4. emits energy as it moves to a lower energy state

10. In the wave-mechanical model of the atom, an orbital is defined as
    1. a region of the most probable proton location
    2. a region of the most probable electron location
    3. a circular path traveled by a proton around the nucleus
    4. a circular path traveled by an electron around the nucleus

**Figure 2**
Base your answer to the question on the information below and on your knowledge of chemistry.
When magnesium is ignited in air, the magnesium reacts with oxygen and nitrogen. The reaction between magnesium and nitrogen is represented by the unbalanced equation below.

\[ \text{Mg}(s) + \text{N}_2(g) \rightarrow \text{Mg}_3\text{N}_2(s) \]

11. [Refer to figure 2]
In the ground state, which noble gas has atoms with the same electron configuration as a
magnesium ion?

12. Which electron configuration represents the electrons of a sulfur atom in an excited state?
   1. 2-6-6       2. 2-7-7
   3. 2-8-4       4. 2-8-6

13. Compared to the energy and charge of the electrons in the first shell of a Be atom, the electrons in the second shell of this atom have
   1. less energy and the same charge       2. less energy and a different charge
   3. more energy and the same charge     4. more energy and a different charge

14. An atom of lithium-7 has an equal number of
   1. electrons and neutrons       2. electrons and protons
   3. positrons and neutrons      4. positrons and protons

15. An orbital is defined as a region of the most probable location of
   1. an electron       2. a neutron       3. a nucleus       4. a proton

16. Which phrase describes an atom?
   1. a negatively charged nucleus surrounded by positively charged protons
   2. a negatively charged nucleus surrounded by positively charged electrons
   3. a positively charged nucleus surrounded by negatively charged protons
   4. a positively charged nucleus surrounded by negatively charged electrons

17. Which particles have approximately the same mass?
   1. alpha particle and beta particle       2. alpha particle and proton
   3. neutron and positron                   4. neutron and proton

18. What is the charge of the nucleus of an oxygen atom?
   1. 0       2. −2       3. +8       4. +16
19. Which term identifies the most probable location of an electron in the wave-mechanical model of the atom?
1. anode  
2. orbital  
3. nucleus  
4. cathode

20. Which two notations represent isotopes of the same element?
1. $^{14}_7\text{N}$ $^{18}_7\text{N}$  
2. $^{20}_7\text{N}$ $^{20}_{10}\text{N}$  
3. $^{14}_7\text{N}$ $^{17}_{10}\text{Ne}$  
4. $^{19}_7\text{N}$ $^{16}_{10}\text{Ne}$

21. Which electron configuration represents an excited state for an atom of calcium?
1.2-8-7-1  
2.2-8-7-2  
3.2-8-7-3  
4.2-8-8-2

22. The stability of isotopes is related to the ratio of which particles in the atoms?
1. electrons and protons  
2. electrons and positrons  
3. neutrons and protons  
4. neutrons and positrons

23. The valence electrons in an atom of phosphorus in the ground state are all found in
1. the first shell  
2. the second shell  
3. the third shell  
4. the fourth shell

24. Which notations represent hydrogen isotopes?
1. $^1_1\text{H}$ $^2_1\text{H}$  
2. $^1_1\text{H}$ $^4_2\text{H}$  
3. $^2_2\text{H}$ $^3_1\text{H}$  
4. $^2_1\text{H}$ $^7_2\text{H}$

25. The nuclides I-131 and I-133 are classified as
1. isomers of the same element  
2. isomers of Xe-131 and Cs-133  
3. isotopes of the same element  
4. isotopes of Xe-131 and Cs-133
26. Which particle has two neutrons?
1. $^{1}_0n$  
2. $^{1}_1H$  
3. $^{2}_1H$  
4. $^{2}_2He$

27. Which conclusion was drawn from the results of the gold foil experiment?
1. An atom is electrically neutral.
2. An atom is mostly empty space.
3. The nucleus of an atom is negatively charged.
4. The electrons in an atom are located in specific shells.

28. Which subatomic particles are paired with their charges?
1. electron–positive, neutron–negative, proton– neutral
2. electron–negative, neutron–neutral, proton– positive
3. electron–negative, neutron–positive, proton– neutral
4. electron–neutral, neutron–positive, proton– negative

29. Which electron shell contains the valence electrons of a radium atom in the ground state?
1. the sixth shell  
2. the second shell
3. the seventh shell  
4. the eighteenth shell

30. All atoms of uranium have the same
1. mass number  
2. atomic number
3. number of neutrons plus protons  
4. number of neutrons plus electrons
Name ________________________________

**Ions How are ions made from neutral atoms?**

Why? You have learned that not all atoms of an element are the same. Variation in the number of neutrons results in different isotopes of the element. In this activity we will explore another variation that can take place—the loss and gain of electrons. The exchange of electrons between atoms is a very common way for chemical change to take place. We will see it many times throughout the year.

1. Use Model 1 to complete the following table.

<table>
<thead>
<tr>
<th>Metal or Nonmetal</th>
<th>Is the number of protons the same in the atom and the ion?</th>
<th>Is the number of neutrons the same in the atom and the ion?</th>
<th>Is the number of electrons the same in the atom and the ion?</th>
<th>Charge on the ion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium metal</td>
<td></td>
<td></td>
<td></td>
<td>1+</td>
</tr>
<tr>
<td>Magnesium</td>
<td></td>
<td></td>
<td></td>
<td>2+</td>
</tr>
<tr>
<td>Aluminum</td>
<td>yes</td>
<td></td>
<td></td>
<td>3+</td>
</tr>
<tr>
<td>Fluorine</td>
<td></td>
<td>no</td>
<td></td>
<td>1–</td>
</tr>
<tr>
<td>Oxygen nonmetal</td>
<td>yes</td>
<td>no</td>
<td></td>
<td>2–</td>
</tr>
<tr>
<td>Nitrogen</td>
<td></td>
<td></td>
<td></td>
<td>3–</td>
</tr>
</tbody>
</table>

2. Based on the table you completed in Question 1, what distinguishes a neutral atom from an ion?

3. Examine the isotope symbols in Model 1.
   a. Where is the ion charge located in the isotope symbol?
   
   b. Is a charge indicated on the neutral atoms? If yes, where is it located?
4. Which subatomic particle carries a positive charge?

5. Which subatomic particle carries a negative charge?

6. Propose a mathematical equation to calculate the charge on an ion from the number of protons and electrons in an ion. Confirm that your equation works using two positive ion examples and two negative ion examples from Model 1.
Read This! Chemists refer to positively charged ions as cations. Chemists refer to negatively charged ions as anions.

7. Fill in the following table.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Atomic Number</th>
<th>Mass Number</th>
<th>Number of protons</th>
<th>Number of electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>31</td>
<td>28</td>
</tr>
</tbody>
</table>

8. Could a +3 ion of aluminum be made by adding three protons to an aluminum atom? Explain.

9. One of your classmates is having trouble understanding ions. He explains the formation of a cation like this:
   “When you add an electron, you get a positive charge because adding is positive in math.”
   a. As a group, explain in a grammatically correct sentence why this student is incorrect.

   b. Provide a better description of how math relates to electrons and ion formation.
10. Draw a stair-step line in Model 2 to separate the metals and nonmetals.

11. Consider the ions listed in Model 2.
   a. In general, do nonmetals form anions or cations?
   b. In general, do metals form anions or cations?
   c. Which nonmetal appears to be an exception to these guidelines?

**Extension Questions**

12. Name the family of elements that make 1– anions as shown in Model 2.

13. Name the family of elements that make 2+ cations as shown in Model 2.

14. For the main group elements (excluding the transition elements), is it necessary to memorize the type of ion each element makes or could you predict the ion charge using a periodic table? Explain.

15. In Model 2 there are several elements whose atoms make more than one type of ion. Where in the periodic table are these elements usually found?
**Directions:** There are 13 questions on the following pages. For each question, an answer has been selected for you. Review the *underlined* answer and determine if you agree. If you agree and think the answer is correct, explain how you know it’s correct in the second column. If you disagree and think that the answer is incorrect, explain why it is incorrect in the third column. The fourth column is asking for your comfort level with the concept the question is assessing. For each item circle the phrase that best describes how familiar you are with the skill on a scale of 1 to 4.

<table>
<thead>
<tr>
<th>Question</th>
<th>I think this is the correct answer and here’s why:</th>
<th>I think this is NOT the correct answer and here’s why:</th>
<th>Circle the statement that best describes how familiar you are with the skill or content of the question</th>
</tr>
</thead>
</table>
| A proton has approximately the same mass as                                |                                                     |                                                       | 1. This is unfamiliar to me  
2. I sort of remember learning this  
3. I remember learning about this, but not confident I could explain it to a friend  
4. I know and understand this |
| 1. a neutron                                                             |                                                     |                                                       |                                                                                               |
| 1. an alpha particle                                                     |                                                     |                                                       |                                                                                               |
| 2. a beta particle                                                       |                                                     |                                                       |                                                                                               |
| 3. an electron                                                          |                                                     |                                                       |                                                                                               |
| Which symbols represent atoms that are isotopes?                         |                                                     |                                                       | 1. This is unfamiliar to me  
2. I sort of remember learning this  
3. I remember learning about this, but not confident I could explain it to a friend  
4. I know and understand this |
| 1. C-14 and N-14                                                         |                                                     |                                                       |                                                                                               |
| 2. O-16 and O-18                                                         |                                                     |                                                       |                                                                                               |
| 3. I-131 and O-131                                                      |                                                     |                                                       |                                                                                               |
| 4. Rn-222 and Ra-222                                                    |                                                     |                                                       |                                                                                               |
| An ion with 5 protons, 6 neutrons, and a charge of 3+ has an atomic number of |                                                     |                                                       | 1. This is unfamiliar to me  
2. I sort of remember learning this  
3. I remember learning about this, but not confident I could explain it to a friend  
4. I know and understand this |
| 1. 5                                                                    |                                                     |                                                       |                                                                                               |
| 2. 6                                                                    |                                                     |                                                       |                                                                                               |
| 3. 8                                                                    |                                                     |                                                       |                                                                                               |
| 4. **11**                                                               |                                                     |                                                       |                                                                                               |
Atoms of O-16, O-17, and O-18 have the same number of neutrons but a different number of protons.

1. neutrons but a different number of protons
2. **protons but a different number of neutrons**
3. protons but a different number of electrons
4. electrons but a different number of protons

When an atom turns into an ion, it has a different number of protons.

1. **protons**
2. neutrons
3. electrons
4. positron

What is the number of electrons in an Al\(^{3+}\) ion?

1. 10
2. 3
3. 13
4. 16

All phosphorus atoms have the same:

1. atomic number
2. mass number
3. number of neutrons plus the number of electrons
4. **number of neutrons plus the number of protons**

What is the number of electrons in a S\(^{2-}\) ion?

1. 18
2. 3
### The total number of protons and neutrons in the nuclide $^{35}_{17}Cl$ is

1. 17  
2. **35**  
3. 16  
4. 18

### Neutral atoms must contain equal numbers of

1. protons and electrons  
2. protons and neutrons  
3. protons, neutrons, and electrons  
4. **neutrons and electrons**

### The total number of electrons in a neutral atom of any element is always equal to the atom’s

1. mass number  
2. number of neutrons  
3. **number of protons**  
4. number of nucleons

### Which of the following particles has the smallest mass?

1. neutron  
2. electron  
3. **proton**  
4. hydrogen atom

### An atom of Cl-35 contains

1. is unfamiliar to me  
2. I sort of remember learning this
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>17 protons, 17 neutrons, and 18 electrons</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>17 protons, 18 neutrons, and 17 electrons</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>18 protons, 17 neutrons, and 17 electrons</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td><strong>18 protons, 18 neutrons, and 18 electrons</strong></td>
<td>learning this</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. I remember learning about this, but not confident I could explain it to a friend</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. I know and understand this</td>
</tr>
</tbody>
</table>
Directions: You will create a mind map on construction paper using the following words. Remember that your mind map might not look the same as your partners but as long as you can justify why you connected certain vocabulary terms that is what matters. You must include all of the terms below.

Subatomic particle
Nucleus
Atomic number
Atom
Isotope
Ion
Proton
Neutron
Electron
Atomic mass
Orbital
Bohr model
Absorption
Emission
Gold Foil Experiment
Rutherford
Valence Electron
Wave Mechanical Model
Positive charge
Negative charge
Neutral charge
Name:

Bean Lab Three - Unit 3.2 Atomic Structure - A Journey into the Atom

Introduction:
Atoms are composed of subatomic particles, such as the protons and the neutrons, which make up the nucleus of the atom and are similar in mass, and electrons, which are found orbiting the nucleus in an electron, cloud and have a negligible mass. All atoms contain the same kinds of particles but may differ in the number of each particle. This accounts for the presence of isotopes and ions for the different elements.

This activity will allow you to use what you know about the composition of the atom, as well as isotopes and ions, to describe sixteen atoms. The atoms are contained in Ziploc bags and the subatomic particles are coded as follows.

Protons - pinto beans (brown with black spots)
Neutrons - white beans
Electrons - kidney beans (red, kidney shaped)

Purpose: Students will collect data and relate number of subatomic particles to atomic number, mass number, electrical charge, atomic symbol, and name of element.

Equipment: Materials:
Ziploc bags representing atoms

Procedure:
Analyze each Ziploc bag (atom) and record its vital statistics in the data table provided.

Data Analysis:
1. List all sets of isotopes. How do you know they are isotopes?
2. List all sets of ions. How do you know they are ions?

Conclusions:
A nuclear reactor generates a very large amount of energy by splitting a uranium 235 atom to produce Barium-139 and Krypton-94. How would each of these atoms be represented using the coding system used for atoms #1 - 16?
### Atomic Structure - A Journey into the Atom

<table>
<thead>
<tr>
<th>Bag #</th>
<th># of protons</th>
<th># of neutrons</th>
<th># of electrons</th>
<th>Atomic number</th>
<th>Atomic mass</th>
<th>Electrical charge</th>
<th>Electrical email</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td></td>
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<td>16</td>
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<td></td>
</tr>
</tbody>
</table>
Name ________________________________

PHET Simulation BUILD AN ATOM

PART I: ATOM SCREEN Build an Atom simulation
(http://phet.colorado.edu/en/simulation/build-an-atom)

1. Explore the Build an Atom simulation with your group. As you explore, talk about what you find.

2. a) List two things your group observed in the simulation.

b) What particle(s) are found in the center of the atom?

3. Play until you discover which particle(s) determine(s) the name of the element you build. What did you discover?

4. What is the name of the following atoms?
   a) An atom with 3 protons and 4 neutrons: ___________
   b) An atom with 2 protons and 4 neutrons: ___________
   c) An atom with 4 protons and 4 neutrons: ___________

5. Play with the simulation to discover which particles affect the charge of an atom or ion.
   a) Fill in the blanks below to show your results:
      Neutral atoms have the same number of protons and electrons.
      Positive ions have __________________ protons than electrons.
      Negative ions have __________________ protons than electrons.

   b) Develop a relationship (in the form of a single sentence or equation) that can predict the charge based on the number and types of particle.
6. Play with the simulation to discover what affects the mass number of your atom or ion.
   a) What is a rule for determining the mass number of an atom or ion?

7. Practice applying your understanding by playing 1st and 2nd levels on the game screen.

PART II: SYMBOL SCREEN

8. Using the Symbol readout box, figure out which particles affect each component of the atomic symbol. a) In the atomic symbol below, label each letter (a, b, c, and d) with:
   - the particle(s) used to determine the letter, and
   - how the value of each letter is determined.

\[
\begin{array}{c}
d \\
c \\
b \\
a \\
\end{array}
\]

9. Create a definition (using a complete sentence) for each of these items based on your labels from the atomic symbol above.
   a) Element Symbol
   b) Charge
   c) Atomic Number
   d) Mass Number

10. Practice applying your understanding by playing the 3rd and 4th game levels. Play until you can get all the questions correct on the 4th level.

11. In addition to atomic symbol, we can represent atoms by name and mass number.
a) Complete the table below:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{12}_{6}$ C$^{+1}$</td>
<td>Carbon-12</td>
</tr>
<tr>
<td>$^{18}_{9}$ F</td>
<td></td>
</tr>
<tr>
<td>$^{11}_{5}$ B</td>
<td></td>
</tr>
</tbody>
</table>

b) Each representation (Symbol and Name) in the table above provides information about the atom. Describe the similarities and differences between the Symbol and Name representations.

PART III: ISOTOPES

12. Play with the simulation to determine:
   a) Which particles affect the stability of the atom? ____________________
   b) Which particles do not affect the stability of the atom? _______________

13. What are the names of the stable forms of oxygen?
   a) Oxygen-16
   b) Oxygen-____
   c) Oxygen-____
   d) List all of the things that are the same about these atoms (ignore the electrons).
   e) List all of the things that are different about these atoms (ignore the electrons).

14. The atoms in the previous question are isotopes of each other. Based on this information, list the requirements for two atoms to be isotopes of each other.
15. The periodic table has a great deal of information about every atom. Using your periodic table, answer the following questions:

a) What is the atomic number of chlorine (Cl)? _____
b) What is the atomic number of tungsten (W)? _____
c) How many protons are there in any Cl atom? _____
d) How many protons are there in any Te atom? _____
e) Can you tell from the periodic table exactly how many neutrons are in an atom?
<table>
<thead>
<tr>
<th>Title</th>
<th>Periodic Table</th>
</tr>
</thead>
</table>
| **NYS Chemistry Standard** | 3.1v Elements can be classified by their properties and located on the Periodic Table as metals, nonmetals, metalloids (B, Si, Ge, As, Sb, Te), and noble gases.  

3.1y The placement or location of an element on the Periodic Table gives an indication of the physical and chemical properties of that element. The elements on the Periodic Table are arranged in order of increasing atomic number.  

3.1z For Groups 1, 2, and 13-18 on the Periodic Table, elements within the same group have the same number of valence electrons (helium is an exception) and therefore similar chemical properties.  

3.1aa The succession of elements within the same group demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties.  

3.1bb The succession of elements across the same period demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties. |

<table>
<thead>
<tr>
<th>Time</th>
<th>3 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supplies</strong></td>
<td>Chromebooks, Color Coding the Periodic Table Worksheet, Martian Periodic Table Worksheet, Periodic Trends Google Form, Castle Learning (30 Questions), Practice Questions on Paper (30 Questions)</td>
</tr>
</tbody>
</table>

| Objective | Students will be able to place a mystery element in the correct spot on the periodic table given the element's properties.  

Students will be able to label alkali, alkali earth, halogens, and noble gasses on the periodic table.  

Students will be able to use the periodic table to identify the trends that are present in the composition of the periodic table. |
<table>
<thead>
<tr>
<th>Key Questions</th>
<th>Why does the periodic table look the way that it does?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>What trends are present in the periodic table?</td>
</tr>
<tr>
<td></td>
<td>Which elements have the most similar chemical properties?</td>
</tr>
</tbody>
</table>

| Summary | Students will have three days to work through a list of assignments. On the list some of the assignments are listed as mandatory while in other groups they have to chose between two assignments. Students have to pick one technology assignment, one collaborative assignment, as well as two mandatory assignments that are done individually. |

**Mandatory assignments**

**Color Coding the Periodic Table**
Students can work with a partner and will need to following along with the worksheet to color in and label specific groups and elements on a blank periodic table.

Or

**Watch Video and Answer Question on Google Classroom**
Students will watch a short video clip and then respond to the question that appears on google classroom.

**Collaborative Option 1 - Martian Periodic Table**
Students may work in groups of 3 or 4 to complete the martian periodic table worksheet. In the assignment students have to use clues relating to trends on the periodic table to correctly place a “martian element” in the correct location on the table.

Or

**Collaborative Option 2 - Periodic Trends Google Form**
Students may work in groups of 3 or 4 to answer questions pertaining to trends on the periodic table in a google form.

**Technology Option 1** - Complete 32 Multiple Choice Questions
on Castle Learning about the periodic table.

Or

**Option 2 - Complete 32 Multiple Choice Questions** on paper about the periodic table.

### Rationale

**Technology**
This lesson incorporates technology for the importance of immediate feedback for students. When using a google form or castle learning questions as soon as students submit their assignments they are told which questions they missed. The benefit of immediate feedback is that students can make changes right when the mistake is made and do not have to wait for a teacher to correct their work and explain their mistakes later.

**Collaborative**
Out of all of the collaborative options for this lesson the “Martian Periodic Table” will be the one I expect conversation to be the richest. This activity is abstract and students will need to work through the riddles together in order to correctly place the imaginary elements on their martian periodic table. I am expecting to hear discussion about the direction of the trends in electronegativity, ionization energy, and atomic radius. (Altun, 2015)

**Small group instruction**
This lesson has a small group instruction portion if students choose to work through multiple choice questions on paper. The teacher will be able to easily monitor student progress and redirect students as needed.
You will have 3 class days to work through the following list of assignments. Under the “options” column you can see how many of the activities that you have to complete. You may work on these outside of class as well. All supplemental material is located in the back of the room. You do not need to work in any specific order.

<table>
<thead>
<tr>
<th>Options</th>
<th>Activities</th>
<th>Date Completed</th>
</tr>
</thead>
</table>
| Mandatory Collaborative Groups of 2 | Color Coding the Periodic Table  
  And  
  Watch video and answer question on google classroom |                 |
| Pick 1 Collaborative Groups of 3 or 4 | Martian Periodic Table Worksheet  
  Or  
  Periodic Trends Google Form  
  [https://docs.google.com/forms/d/1r2uwHFdpjD1faeSl-icN6cEIlMaq6KUB5ALx1PFZ5w/edit](https://docs.google.com/forms/d/1r2uwHFdpjD1faeSl-icN6cEIlMaq6KUB5ALx1PFZ5w/edit) |                 |
| Pick 1 Individual           | Castle Learning (32 Questions)  
  Or  
  Practice Questions on Paper (2 worksheets 32 Questions Total) |                 |
Using colored pencils color the following two periodic tables according to the following directions.

**PERIODIC TABLE #1**

**Draw your staircase** → Use your Reference Table and a thick black marker to do this – it must be easily visible!

Now, using **THREE DIFFERENT DARK MARKERS**, draw a **BORDER** around the elements that are categorized below. Be sure to include a color key of Table #1. There should not be any empty squares when done.

**Semi-Metals (Metalloids)** → Elements that have characteristics of both metals and nonmetals (use pages 156-157 in your textbook to identify these)

**Metals** → These elements easily lose electrons and form positive ions. They have a metallic luster when polished. They also have a sea of valence electrons that aid to help bond themselves to one another. DON’T FORGET to include the two bottom-most rows on the Table!

**Nonmetals** → Elements that are highly electronegative and therefore attract electrons in order to form negative ions. They are also typically covalently bonded to each other or form ionic bonds with metals.

Now, using **THREE DIFFERENT COLORED PENCILS, SHADE IN** the elements that are:

**Liquids** (at STP) → Br and Hg are the only elements in this state

**Gases** (at STP) → H, N, O, F, Cl, and all the noble gases (group 18)

**Solids** (at STP) → All the rest of the compounds (besides liquids and gases)
PERIODIC TABLE #2

Use a different color for each of the following. Include a KEY at the top or bottom of the periodic table so that others can read and identify the following on your table:

**Diatomıc Elements** → Place a colored border (all the same color) around each of the 8 diatomic elements. Diatomic elements are elements that cannot exist in nature by themselves. They therefore bond to themselves and travel in pairs (ex: N₂ instead of N). The eight diatomic elements are H, O, F, Br, I, N, Cl, and At. The last “7” listed elements form a numeral seven on the Periodic Table and the H is found “UP” to the upper left corner (atomic number 1). Hence, the memory device “7UP.”

Color the following elements by shading in their box with a different color (each group). For the diatomic elements, just simply color within the border that you have already created for them:

**Alkali Metals** → All EXCEPT for Hydrogen (it is excluded from this group), these are the Group 1 elements. They are very reactive metals and always form +1 ions within ionic compounds.

**Alkaline Earth Metals** → These are the Group 2 elements. They are reactive, but not as much as the alkali metals. They always form +2 ions within ionic compounds.

**Transition metals** → These metals are found in the D-block of the Periodic Table (the mid-section). They can have more than one possible positive charge when part of an ionic compound. We use Roman numerals to denote the charge when naming them. They also usually form colored solutions when mixed with water. This is one of their unique characteristics!

**Halogens** → Group 17 elements that are very reactive nonmetals. They usually have a −1 charge when in ionic compounds.

**Noble Gases** → Group 18 elements that are extremely stable & unreactive compounds that do not form bonds with other compounds in nature (AKA inert gases).

more on next page →

**Actinoid Series** → Bottom row of the bottommost two rows on table. Elements 90-103.

Draw in the trends for the following categories making sure the arrow points in the direction of an increasing value.

- Electronegativity
- Ionization Energy
- Atomic radius
- Metallic Properties
- Nonmetallic Properties
Periodic Table Video Assignment

Here is the link to the video Kahn Academy video Video
https://www.youtube.com/watch?v=t_f8bB1kf6M

Here is the questions I will post on Google Classroom for students to answer:

1. Which elements have the most similar chemical properties?

2. What is one property of metals?

3. What group on the periodic table is unreactive?
Martian Periodic Table

Introduction

The periodic table is one of the most useful tools used by chemists. The properties were found to vary periodically. The first periodic table was arranged by Dmitri Mendeleev according to atomic mass in such a way that elements with similar properties were grouped together. Henry Moseley later arranged the periodic table according to the increasing atomic number. On a periodic table, the vertical columns are called families or groups and can be named by the first element in that column (ex. Group 15: Nitrogen Family). The horizontal rows are called periods and are numbered from top to bottom. The periodic law is believed to be universal so that it should hold true not only on earth but also throughout the universe, including the planet Mars.

Purpose

The student will learn to arrange Martian elements according to properties and increasing atomic number much the way that Mendeleev and Moseley arranged Earth’s periodic table.

Procedure

1. Place the elements in their proper place in the Martian periodic table outline. Remember, same laws of reactivity apply throughout the universe.
   Elements:
   A  B  C  D  E  F  G  H  I  J  K
   L  M  N  O  P  Q  R  S  T  U  V
   W  X  Y  Z  #  +  *  $

2. There are 34 spots on the Martian periodic table but 4 of the elements have not been discovered yet so those spots should be filled with a question mark.

   *Hint: Before you are finished, go back over all properties again to be sure your table works for all of them.*

3. After finishing, place the correct atomic number for each element in the block.
Properties of Martian Elements:

1. The metal with the largest atomic radius is X.
2. The smallest element in the most reactive nonmetal group is l.
3. The noble gases are B, L, W, and J.
   a. B has the smallest mass
   b. W has the largest mass
   c. L is in period 2
4. The least massive of all elements is A
5. All of the following elements have 3 energy levels. The number given is the number of valence electrons.

   $\begin{array}{ccc}
   S & 1 & Y \\
   Z & 2 & H \\
   K & 7 & O \\
   \end{array}$

6. Element H has 14 protons
7. G has 7 electrons
8. C has an atomic mass of 5 and forms the compound Cl.
9. Q has only 1 valence electron but has 4 energy levels
10. The E family is made up of E, Y, R and + in order of increasing mass.
11. *is the most massive of all discovered elements and is radioactive.
12. P is in period 5 and usually creates a +2 ion.
13. D is in period 2 and has the formula DL₂ for one of its salts
14. F is like the Earth element carbon and is in the same family as H, T, and *.
15. The Martian universal solvent, which is like Earth's most important liquid, has the formula A₂N.
16. Here are a few compounds that typically form:

- AV
- DU
- I₂
- FA₄
- U
- 3S₂
1. The table below shows the atomic mass and natural abundance of the two naturally occurring isotopes of lithium.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Atomic Mass</th>
<th>Natural Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li-6</td>
<td>6.015</td>
<td>7.6</td>
</tr>
<tr>
<td>Li-7</td>
<td>7.016</td>
<td>92.4</td>
</tr>
</tbody>
</table>

Which numerical setup can be used to determine the atomic mass of naturally occurring lithium?
1. \((7.6)(6.015\text{ u}) + (92.4)(7.016\text{ u})\)
2. \((0.076)(6.015\text{ u}) + (0.924)(7.016\text{ u})\)
3. \((7.6)(6.015\text{ u}) + (92.4)(7.016\text{ u})\)
4. \((0.076)(6.015\text{ u}) + (0.924)(7.016\text{ u})\)

2. Which general trends in atomic radius and electronegativity are observed as the elements in Period 3 are considered in order of increasing atomic number?
1. Atomic radius decreases and electronegativity increases.
2. Atomic radius increases and electronegativity decreases.
3. Both atomic radius and electronegativity increase.
4. Both atomic radius and electronegativity decrease.

3. At STP, which element is malleable and a good conductor of electricity?
1. xenon
2. silicon
3. platinum
4. hydrogen

4. Which list of elements contains a metal, a metalloid, and a nonmetal?
1. Ag, Si, I
2. Ge, As, Ne
3. K, Cu, Br
4. S, Cl, Ar

5. Which group on the Periodic Table has two elements that exist as gases at STP?
1. Group 1
2. Group 2
3. Group 16
4. Group 17

6. An atom that contains six protons, six neutrons, and six electrons has a mass of approximately
   1. $1.12 \text{ u}$  2. $1.21 \text{ g}$
   3. $3.18 \text{ u}$  4. $3.18 \text{ g}$

7. Which list of elements is arranged in order of increasing electronegativity?
   1. Be, Mg, Ca  2. F, Cl, Br
   3. K, Ca, Sc  4. Li, Na, K

8. Which element is least likely to undergo a chemical reaction?
   1. lithium  2. carbon
   3. fluorine  4. neon

9. The arrangement of the elements from left to right in Period 4 on the Periodic Table is based on
   1. atomic mass  2. atomic number
   3. the number of electron shells  4. the number of oxidation states

10. Which list of symbols represents non metals, only?
    1. B, Al, Ga  2. Li, Be, B

11. Which atom has the greatest attraction for the electrons in a chemical bond?
    1. hydrogen  2. oxygen
    3. silicon  4. sulfur

12. The elements on the Periodic Table are arranged in order of increasing
    1. mass number  2. atomic number
    3. number of isotopes  4. number of valence electrons

13. Rubidium and cesium have similar chemical properties because, in the ground state, the atoms of both
    elements each have
    1. one electron in the outermost shell  2. two electrons in the outermost shell
    3. one neutron in the nucleus  4. two neutrons in the nucleus
14. Which group on the Periodic Table has elements with atoms that tend not to bond with atoms of other elements?

15. Which group of elements contains a metalloid?

16. The table below gives the atomic mass and the abundance of the two naturally occurring isotopes of chlorine.

<table>
<thead>
<tr>
<th>Isotopes</th>
<th>Atomic Mass of the Isotope (u)</th>
<th>Natural Abundance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cl(^{35})</td>
<td>34.97</td>
<td>75.76</td>
</tr>
<tr>
<td>Cl(^{37})</td>
<td>36.97</td>
<td>24.24</td>
</tr>
</tbody>
</table>

Which numerical setup can be used to calculate the atomic mass of the element chlorine?
   1. \((34.97 \text{ u})(75.76) + (36.97 \text{ u})(24.24)\)
   2. \((34.97 \text{ u})(0.2424) + (36.97 \text{ u})(0.7576)\)
   3. \((34.97 \text{ u})(0.7576) + (36.97 \text{ u})(0.2424)\)
   4. \((34.97 \text{ u})(24.24) + (36.97 \text{ u})(75.76)\)

17. Which elements have the most similar chemical properties?
   1. boron and carbon  2. oxygen and sulfur  3. aluminum and bromine  4. argon and silicon

18. The numbers of protons and neutrons in each of four different atoms are shown in the table below.

<table>
<thead>
<tr>
<th>Atom</th>
<th>Number of Protons</th>
<th>Number of Neutrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>D</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>E</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>G</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Which two atoms represent isotopes of the same element?
19. All phosphorus atoms have the same
   1. atomic number
   2. mass number
   3. number of neutrons plus the number of electrons
   4. number of neutrons plus the number of protons

20. Which notations represent different isotopes of the element sodium?
   1.32-S and 34-S
   2. S$^{2-}$ and S$^{6+}$
   3. Na$^+$ and Na$^0$
   4.22-Na and 23-Na

21. Which list of elements consists of a metal, a metalloid, and a noble gas?
   1. aluminum, sulfur, argon
   2. magnesium, sodium, sulfur
   3. sodium, silicon, argon
   4. silicon, phosphorus, chlorine

22. Which statement describes the general trends in electronegativity and atomic radius as the elements in
    Period 2 are considered in order from left to right?
    1. Both electronegativity and atomic radius increase.
    2. Both electronegativity and atomic radius decrease.
    3. Electronegativity increases and atomic radius decreases.
    4. Electronegativity decreases and atomic radius increases.

23. In the ground state, an atom of each of the elements in Group 2 has a different
    1. oxidation state
    2. first ionization energy
    3. number of valence electrons
    4. number of electrons in the first shell

24. As the first five elements in Group 15 are considered in order of increasing atomic number, first
    ionization energy
    1.decreases  2.increases  3.decreases, then increases  4.increases, then decreases

25. At STP, which substance is a noble gas?
    1.ammonia  2.chlorine  3.neon  4.nitrogen
26. Which general trends in first ionization energy and electronegativity values are demonstrated by Group 15 elements as they are considered in order from top to bottom?
   1. The first ionization energy decreases and the electronegativity decreases.
   2. The first ionization energy increases and the electronegativity increases.
   3. The first ionization energy decreases and the electronegativity increases.
   4. The first ionization energy increases and the electronegativity decreases.

27. At STP, which element is a good conductor of electricity?
   1. chlorine  2. iodine  3. silver  4. sulfur

28. Which ion has the smallest radius?

29. The element sulfur is classified as a
   1. metal  2. metalloid  3. nonmetal  4. noble gas

30. Which quantity represents the number of protons in an atom?
   1. atomic number  2. oxidation number  3. number of neutrons  4. number of valence electrons

31. Which elements have the most similar chemical properties?
   1. Si, As, and Te  2. N\(_2\), O\(_2\), and F\(_2\)  
   3. Mg, Sr, and Ba  4. Ca, Cs, and Cu

32. An atom that has 13 protons and 15 neutrons is an isotope of the element
   1. nickel  2. silicon  3. aluminum  4. phosphorus
Periodic Table Trends Worksheet

*Use a periodic table to complete this worksheet*

1. What happens to the atomic numbers as you move from left to right on the periodic table?
   a. increase b. Decrease c. Stay the same d. Nothing

2. Which of the following elements is most likely to have similar properties to those of sodium (Na)?
   a. Magnesium (Mg) b. Sulfur (S) c. Francium (Fr) d. Titanium (Ti)

3. If scientists discover an element with 117 protons, which group will it be in on the periodic table?
   a. 1 b. 7 c. 11 d. 17

4. Which element is located in group 3?
   a. Yttrium (Y) b. Carbon (C) c. Sodium (Na) d. Lithium (Li)

5. Which element is located in period 4?
   a. Zirconium (Zr) b. Silicon (Si) c. Beryllium (Be) d. Iron (Fe)

6. Two elements that have similar physical and chemical properties are most likely in the same...
   a. period b. row c. column d. Group

7. Which element is most likely to have six valence electrons?
   a. Barium (Ba) b. Carbon (C) c. Oxygen (O) d. Americium (Am)

8. Which element is most likely to have three electron energy levels?
   a. Argon (Ar) b. Lithium (Li) c. Boron (B) d. Europium (Eu)
9. Which element is located in period 4 and group 5?
   a. Vanadium (V) b. Zirconium (Zr) c. Niobium (Nb) d. Titanium (Ti)

10. Which element is most likely to have six electrons in its 5\textsuperscript{th} energy level?
    a. Niobium (Nb) b. Tungsten (W) c. Tantalum (Ta) d. Tellurium (Te)

11. In which group would an element that is not reactive most likely be located?
    a. 1 b. 2 c. 16 d. 18

12. In which group would an element that is very reactive most likely be located?
    a. 1 b. 5 c. 5 d. 18

13. In which group would an element that is a gas most likely be located?
    a. 1 b. 3 c. 12 d. 18

Use the following chart to answer Questions 14-16

<table>
<thead>
<tr>
<th>Element</th>
<th>Atomic Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>54</td>
</tr>
<tr>
<td>X</td>
<td>16</td>
</tr>
<tr>
<td>Y</td>
<td>37</td>
</tr>
<tr>
<td>Z</td>
<td>33</td>
</tr>
</tbody>
</table>

14. Which of the following elements is most likely a metal?

15. Which two of the following elements are most likely nonmetals?
16. Which of the following elements is most likely a metalloid?

17. Which of the following elements is most likely a poor conductor of electricity?
   a. Beryllium (Be) b. Gold (Au) c. Phosphorus (P) d. Copper (Cu)

18. Which element has four neutrons? (Hint: it is located in the 2nd period on the periodic table)
   a. Calcium (Ca) b. Lithium (Li) c. Beryllium (Be) d. Oxygen (O)

19. What is the atomic mass of an element with 16 protons, 13 neutrons, and 16 electrons?
   a. 16 amu b. 13 amu c. 29 amu 3 amu

20. How many neutrons are located in the nucleus of an atom that has 12 protons, 12 electrons, and an atomic mass of 28 amu?
   a. 28 b. 12 c 16 d. 40
NAME ________________________

PERIODIC TABLE - CHARACTERISTICS

1. A property of most nonmetals in the solid state is that they are
   1. Good conductors of heat
   2. Good conductors of electricity
   3. Brittle
   4. Malleable

2. What is the total number of elements in group 17 that are gases at room temperature and standard pressure?
   1. 1  2. 2  3. 3  4. 4

3. At STP which list of elements consists a solid, liquid, and gas?
   1. Hf, Hg, He
   2. Cr, Cl₂, C
   3. Ba, Br₂, B
   4. Se, Sn, Sr

4. At STP, an element that is a brittle solid and a poor conductor of heat and electricity could have an atomic number of
   1. 12  2. 13  3. 16  4. 17

5. Which element is malleable and ductile?

6. An atom of argon rarely bonds to an atom of another element because an argon atom has?
   1. 8 valence electrons
   2. 2 electrons in the first shell
   3. 3 electron shells
   4. 22 neutrons
7. Which element is most chemically similar to chlorine?

8. An atom in the ground state has seven valence electrons. This atom could be an atom of which element?

9. Which element exists as a diatomic molecule at STP?

10. Which element exhibits a Crystalline structure at STP

12. Which of the following Group 18 elements would be most likely to form a compound with fluorine?
    (1) He (2) Ne (3) Ar (4) K.
<table>
<thead>
<tr>
<th>Title</th>
<th>Solubility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NYS Chemistry Standard</strong></td>
<td>3.1ooA solution is a homogeneous mixture of a solute dissolved in a solvent. The solubility of a solute in a given amount of solvent is dependent on the temperature, the pressure, and the chemical natures of the solute and solvent.</td>
</tr>
</tbody>
</table>
| **Skills**            | (3.1xxv) - Interpret and construct solubility curves  
(3.1xxviii) - Use solubility curves to distinguish among saturated, supersaturated and unsaturated solutions                                       |
| **Time**              | 3 days                                                                                                                                                                                                   |
| **Supplies**          | POGIL  
Notes (using computer)                                                                                                                                                                               |
| **Objective**         | Students will be able to explain at a molecular level what a saturated, unsaturated, and supersaturated solution is.                                                                                     |
|                       | Students will be able to use Reference Table G to answer questions on saturation.                                                                                                                                 |
|                       | Students will create their own solubility curve.                                                                                                                                                           |
| **Key Questions**     | What must be true for a solution to be saturated?  
What must be true for a solution to be unsaturated?  
What must be true for a solution to be supersaturated?  
What does a solubility curve explain and how do you use it? |
| **Summary**           | Stations: Each day students will be working on a different component of this lesson. On the beginning of the fourth day all work will be handed in, so any work not completed during class time will be homework. |
|                       | POGIL - At the POGIL station students will work together to complete the inquiry assignment.                                                                                                             |
|                       | Lab - When at the Lab station students will be assigned a letter A-D and will complete the lab procedure according to the letter that they were assigned. Students will need to share their |
results with others in their group in order to have data from all four letters.

**Notes** - Using the internet and the notes outline provided students will need to complete the outline as well as learn how to use table G on their own. They can use websites and videos in order to accomplish this.

<table>
<thead>
<tr>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology</strong></td>
</tr>
<tr>
<td>Sometimes students need to hear information from another perspective. This lesson allows students the opportunity to obtain information from both websites and/or videos in order to obtain the understanding that they need. This portion also allows for students choice as they get to choose if they would rather watch videos or read articles to obtain the information that they need. (Cavegnetto et al., 2010)</td>
</tr>
<tr>
<td><strong>Collaboration</strong></td>
</tr>
<tr>
<td>The Process Oriented Guided-Inquiry Learning (POGIL) assignment is designed in a way to foster student discussion. Because of the design of the assignment and the wording of the questions students are forced to work together to come to a final conclusion.</td>
</tr>
<tr>
<td><strong>Small Group Instruction</strong></td>
</tr>
<tr>
<td>A lab setting is a great place for small group instruction because students are able to hear directions more clearly. In a lab setting it is easy for a teacher to identify students misconceptions because they can physically see them manipulating something wrong. In addition typically in lab students ask me, “is this what I should have gotten?” What a perfect opportunity to have a one on one conversation with a student about their hypothesis.</td>
</tr>
</tbody>
</table>
Solubility Notes

Solubility; the amount of that substance required to form a saturated solution with a specific amount of a solvent at a specific temperature
- Different substances have different solubilities.

Rates of dissolution: How can we make solutes dissolve faster?

1.
2.
3.

General Solubility Rule -> _______dissolves____________

- Polar solvents will dissolve_________ & _____________ Solutes
- Non-polar solvents will dissolve_______________ solutes

- Miscible:
  o example:

— Immiscible:
  o Example:

Saturation & Solubility Curves

Saturation
- For every solvent / solute combination there is a limit to the amount of solute that can dissolve

The three types of solutions: Saturated, unsaturated, supersaturated
- ________________________: Less solute than a saturated solution under the same condition. More can be dissolved
--- Contains the maximum amount of dissolved solute

--- Contains more dissolved solute than a saturated solution under the same condition.

**Factors Affecting Solubility**

- **Pressure**
  - **Gas**: the solubility of a gas increases with added pressure

  **Ex:**

  - Solid / Liquid

- **Temperature**
  - **Gas**: solubility DECREASES with increasing temperature

  **Ex:**

  - **Solid:**
-Solubility Curve:
  o Graph that shows how likely a solute is to dissolve in a solvent at any given temperature (solubility curve on the next page)
  o y-axis: grams of solute / 100 grams of solvent
  o X-axis; temperature (°C)

1. At what temperature will the solubility of potassium chloride be 49 grams per 100 g water?
2. Between sodium nitrate and potassium nitrate, which has a higher solubility at 50 C?
3. What is the solvent shown in the graph?
4. List any three solutes shown in the graph.
5. What solute decreases in solubility as the temperature increases?
6. At what temperature potassium nitrate and sodium nitrate have the same solubility?
7. Which solute is most likely a gas?
LAB ACTIVITY: SOLUBILITY OF SALT

Pre-Lab Discussion:

The solubility of a pure substance in a particular solvent is the quantity of that substance that will dissolve in a given amount of the solvent. Solubility varies with the temperature of the solvent. Thus, solubility must be expressed as a quantity of solute per quantity of solvent, at a specific temperature. For most ionic solids, especially salts, in water, solubility varies directly with temperature. That is, the higher the temperature of the solvent, (water), the more solute, (salt), that will dissolve in it.

In this experiment you will study the solubility of potassium nitrate (KNO3) in water. You will dissolve different quantities of this salt in a given amount of water, at a temperature close to the water's boiling point. Each solution will be observed as it cools, and the temperature at which crystallization of the salt occurs will be noted and recorded. The start of crystallization indicates that the solution has become saturated. At this temperature, the solution contains the maximum quantity of solute that can be dissolved in that amount of solvent.

After solubility data for several different quantities of solute have been collected, the data will be plotted on a graph. A solubility curve for KNO3 will be constructed by connecting the plotted points.

PROBLEM. How can we construct a solubility curve based on experimental data?

Materials
thermometer balance 250-mL beaker 10-mL graduated cylinder Hoř Plaše test tube
potassium nitrate test tube, holder graph paper

Note: There are to be four groups of students for this lab: A, B, C, and D.

Procedure
1. Weighing the Solute: Group A should weigh out 12 grams of potassium nitrate KNO, group B should weigh out 8 grams, group C should weigh out 6 grams, and group D should weigh out 4 grams. Record your data.

Data Table
2. Preparing the Water Bath: Fill a 250-mL beaker about half full with water and place it on a hot plate.

3. Making the Solution: Accurately measure out 10 mL of water in a graduated cylinder. Add it to a test tube. Add the weighed potassium nitrate to the test tube.

4. Place the test tube in the water bath. Gently agitate the mixture with a stirring rod to dissolve the solid. Do not allow undissolved solid to stick to the test tube.

5. Crystallizing Dissolved Solute: As soon as the potassium nitrate has completely dissolved, carefully place the test tube in the test tube rack. Allow the solution to cool. While cooling, shake the test tube frequently to prevent supersaturation. As soon as the first crystal appears in the test tube, record the temperature.

6. Clean-up: Clean your thermometer with plain water and leave your tube for your teacher.

7. Data analysis and Conclusion: Collect data from each of the other groups to complete the summary data table.

<table>
<thead>
<tr>
<th>Weight of solute</th>
<th>g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of water in test tube</td>
<td>mL</td>
</tr>
<tr>
<td>Temperature of crystallization</td>
<td>°C</td>
</tr>
</tbody>
</table>
**Conclusions**

1. Plot the solubility vs. temperature curve using the data from section A, B, C, and D. Your Y axis should be labeled grams of KNO\(_3\)/100mL of HO, and your X axis should be labeled temperature (in Celsius degrees),

2. What information must be specified when a chemist describes the solubility of a solute in water?

3. What does the solubility graph show?

4. How does the solubility of KNO\(_3\) change as the temperature of the solution increases?

5. How many grams of KNO\(_3\) can be dissolved in 100 mL of H\(_2\)O at the following temperatures? (HINT: Use your graph from the class data)
   a. 30°C
   b. 60°C
   c. 70°C

6. Define the following terms:
   a. Saturated
   b. Unsaturated
   c. Supersaturated

7. Classify the following KNO\(_3\) solutions as saturated, unsaturated, or supersaturated. Explain your answer. (HINT: Use your graph)
   a. 75 g KNO\(_3\)/100 mL H\(_2\)O at 40°C
   b. 60 g KNO\(_3\)/100ml H\(_2\)Oat 50°C
Explanation:

8. Molarity is the ratio of moles of solute to liters of solution. Showing your work below calculate the molarity of the saturated solution from each group:

Group A:

Group B:

Group C:

Group D:
POGIL Saturated and Unsaturated Solutions Is there a limit to the amount of solute that will dissolve in a solvent?

Why? We use solutions every day. People who wear contact lenses use “lens solution” to rinse their contacts and keep them wet. Athletes who consume sports drinks after exercising benefit from the electrolytes in those solutions. This activity will explore whether or not there is a limit to how much of one substance can dissolve in another.

Model 1 – Saturated and Unsaturated Solutions

<table>
<thead>
<tr>
<th>Unsaturated Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaker A</td>
</tr>
<tr>
<td>1.0 g of solute added</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>Beaker B</td>
</tr>
<tr>
<td>2.0 g of solute added</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Saturated Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaker C</td>
</tr>
<tr>
<td>3.6 g of solute added</td>
</tr>
<tr>
<td>17</td>
</tr>
<tr>
<td>Beaker D</td>
</tr>
<tr>
<td>7.0 g of solute added</td>
</tr>
<tr>
<td>18</td>
</tr>
<tr>
<td>Beaker E</td>
</tr>
<tr>
<td>9.0 g of solute added</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
1. Which illustration below represents
   a. solute particles in a solid state in water?
   b. solute particles in an aqueous state?

2. What variables are controlled in all five beakers of Model 1?

3. Count the particles present in each beaker of Model 1.

   Fill in the table to show the number of dissolved solute particles and the number of solid solute particles.

4. Consider the beakers in Model 1.

   a. Which beakers represent unsaturated solutions?

   b. Which beakers represent saturated solutions?

5. Beakers A–E in Model 1 are depicted as representing five different or separate solutions. They could also be considered as five “snapshots” of the same beaker over time. In other words, if additional measured quantities of solute were stirred into beaker A in small increments over time, then beakers B–E would result.

   a. When a small amount of additional solute is added to an unsaturated solution, what happens to the number of dissolved particles? Provide specific evidence from Model 1 to support your answer.

   b. When a small amount of additional solute is added to a saturated solution, what happens to the number of dissolved particles? Provide specific evidence from Model 1 to support your answer.
c. Predict what would happen if a small amount of additional solute were stirred into beaker E in Model 1.

6. Have each person in your group provide an example of the word “saturated” as it is used in an everyday context. Summarize the meaning of the word in the space below.

7. Use a grammatically correct sentence to explain why beakers D and E in Model 1 are labeled as “saturated.” Be sure to incorporate the words “solute” and “solvent” in your explanation, and reach a consensus within your group.

8. What feature in the beakers in Model 1 would typically enable a student to distinguish a saturated solution from an unsaturated one simply by looking at the beaker?

9. Beaker C in Model 1 is shown as “saturated.” Explain why this is the correct category for beaker C even though the typical feature listed in Question 8 is not present.

10. If you were handed a beaker containing a clear solution (with no solid solute at the bottom), and asked to identify it as “saturated” or “unsaturated,” what simple test could you perform to determine the answer.
Model 2 – Solute Dissolved vs. Solute Added The following data refer to an experiment in which a measured mass of solid is added to 10.0 g of 20 °C water. The mixture is stirred and allowed to sit for 3 hours. Ten separate trials are conducted for the experiment.

<table>
<thead>
<tr>
<th>Trial Number</th>
<th>Mass of solute added (grams)</th>
<th>Mass of solute dissolved (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>3</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>4</td>
<td>4.0</td>
<td>3.6</td>
</tr>
<tr>
<td>5</td>
<td>5.0</td>
<td>3.6</td>
</tr>
<tr>
<td>6</td>
<td>6.0</td>
<td>3.6</td>
</tr>
<tr>
<td>7</td>
<td>7.0</td>
<td>3.6</td>
</tr>
<tr>
<td>8</td>
<td>8.0</td>
<td>3.6</td>
</tr>
<tr>
<td>9</td>
<td>9.0</td>
<td>3.6</td>
</tr>
<tr>
<td>10</td>
<td>10.0</td>
<td>3.6</td>
</tr>
</tbody>
</table>

11. Four of the trials in Model 2 correspond to beakers A, B, D, and E from Model 1. Write the letters for those beakers next to the corresponding trial numbers in Model 2.

12. Identify the following variables in the experiment in Model 2.

   Dependent variable
   Independent variable
   Controlled variable(s)

13. Sketch a graph of the data for the experiment in Model 2. A space has been provided next to the data table. Be sure to consider which variable belongs on each axis.

14. Consider the data in Model 2.

   a. Which trials represent solutions that are unsaturated?

   b. Which trial numbers represent solutions that are saturated?

   c. Describe the feature in the graph that can help you identify the saturated solutions.
15. Which trials in the experiment in Model 2 would have visible amounts of solid on the bottom of the beaker?

16. For Trial 8 in Model 2, determine the mass of solid solute remaining on the bottom of the beaker. Show your calculation.

17. Imagine that the contents of the beaker for Trial 8 in Model 2 are vigorously stirred and then poured into filter paper in a funnel.
   a. Is the liquid that drips from the filter (the filtrate) unsaturated or saturated? Explain.
   b. Which beaker in Model 1 best represents the filtrate that would be obtained?

Saturated and Unsaturated Solutions 5

**Extension Questions**

18. Predict what would happen to the mass of solid solute sitting on the bottom of the beaker in Trial 8 in Model 2 when the following changes occur. Use complete sentences to support your predictions.
   a. More water is added to the beaker.

   b. The beaker is heated (assume no evaporation occurs).

   c. The beaker is allowed to sit uncovered for two days and some water evaporates.
Summary

As an educator our job is to always do what is best for students. The traditional lecture style classroom where the teacher stands in front of the class all period while students mindlessly copy down notes has been proven to not be what is best for students. All Students learn differently and while some may benefit from listening to the teacher talk, others might benefit from collaborating with a peer or reading an article online. What is best for students is for information to be expressed to them in a way that is engaging and in addition put some of the responsibilities on the student. In addition we need to take into consideration that students now need a new set of skills that students did not need thirty years ago. There are four main 21st century skills that students need to prepare them for life after high school which include digital age literacy, inventive thinking, effective communication and high productivity (Husin et. al, 2016). Through personalized learning these specific skills can be taught. The personalized learning approach will be the new look of a classroom in the twenty first century for many reasons.

The first reason is that technology is the new normal. Many districts have gone one to one technology for students whether it be chromebooks or ipads. Students are constantly plugged in to some type of device at all times so for them technology is just another part of life. Not only do students enjoy using technology they also need to learn how to use technology appropriately for educational purposes. By incorporating technology into a lesson it gives the students the opportunity to explore information in a way that is familiar to them and a way that they are comfortable with.
In addition technology offers students the chance to visualize concepts in a class like chemistry where most of the material is abstract and cannot be seen with the naked eye. Simulations can really help engage the visual learners in a classroom who might be struggling with the concept of an atom because they can’t see it. Through the use of technology students are able to be more hands on with the material and gain a deeper understanding.

The second reason that personalized learning will be the new look of classrooms in the twenty first century is because students need to be able to work collaboratively to be successful after high school. While working collaboratively students are able to bounce ideas off one another to hopefully come to a greater understanding. By creating this dialogue students are thinking about the content with a deeper level then they would be if they were working individually. In addition it is true that some students just need to hear information explained to them from a different perspective such as a peer. Many times in class I have been trying to explain something to a student and their friend will come over and say exactly what I am saying and then the student understands. When students are talking with one another they are improving their social skills in addition to making deeper connections with content.

The third reason why personalized learning will be making its way into twenty first century classrooms is because some students need that one on one attention. Through the implementation of personalized learning the teacher is able to give students the one on one attention that they need. Some models for personalized learning allow for the teacher to monitor and pull aside students who they can see are struggling while other models allow the teacher to have a more personal small group lecture or explanation to students. Research has found that when a student is in a smaller class setting they feel more comfortable both asking and answering
questions (Cavegnetto et al., 2010). Small group instruction also is beneficial to the teacher because they are monitoring fewer students at a specific time which means that they are able to focus more on individual students needs.

Personalized learning allows us to reach the majority of our students in a way that is best suited for them whether it be through technology, peer collaboration, or small group instruction. In addition to the three modalities another reason that personalized learning is best for students is because it includes student choice. By placing some of the control for their learning in their hands students are more apt to become engaged with the material at hand. This is why I chose to make lesson plans following a personalized learning model as my capstone project. My goal was to have a set of lessons and supplemental material that any chemistry teacher could make copies of and implement the following day in class. By taking away the majority of the planning component my hope is that these lessons will help other teachers implement their own personalized learning in their classrooms because I feel that it truly is the best fit for today's students.
References


