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# Physics Curriculum using Project Based Learning

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# Physics Curriculum using Project Based Learning

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Physics Curriculum using Project Based Learning

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## Chapter One: Introduction

Problem based learning (PBL) in the classroom has been used for some time. It started out in the medical field and has made its way into the educational field due to the tremendous gains made by the students. PBL has a positive effect on knowledge retention due to the fact that PBL requires students to learn in a constructivist manner instead of just recalling facts (Kin Hang Wong & Day, 2009).

PBL allows for students to be at the center of the lesson. Studies have shown that PBL is more effective than conventional teaching approaches because it allows the students to develop greater motivation, interest in subjects, learning satisfaction, confidence in learning, knowledge acquisition, using their resources, and self-directed work. PBL is especially useful because it allows the students to solve meaningful and authentic problems through inquiry or discovery (Kin Hang Wong & Day, 2009). This knowledge retention is measured in two ways in PBL; there is the traditional form of formative and informative assessments and with the project component, a rubric as well. The students are expected to collaborate together to earn a shared grade on the outcome of their project. The students and teacher work together to ensure that everyone understands the rubric and find it fair. This rubric is then used as a reflection tool throughout the problem both on individual components and team components (McDonald, 2008). Throughout the project, students are provided feedback both from their peers and from the teacher. This feedback opportunity allows for students to learn and improve their project outcome. The use of PBL and the reflection techniques not only allow for the students to walk away from the class better understanding the concepts, but they also develop necessary career skills such as collaboration and using their resources.

In order to arrive at this satisfaction, there is some adjustment needed at the beginning of the course. The students in most cases are used to being spoon fed information, therefore it takes some time to adjust to being in the driver's seat to their learning. When implemented in the classroom students would do the bare minimum. Many students would skip brainstorming and elaborating of their ideas and try to complete the task fast and on the first try (Hung, 2011). Once the students are provided supports and become used to guiding their learning they will be able to flourish.

PBL and the use of inquiry labs can be integrated into a new structured physics class. This new structure allows for students to learn through questioning personal experiences and scenarios. The students will become successful both in the lab setting and on their assessments. He found that the students had a better grasp of basic physics concepts and a better understanding of the process of science. The students showed significant improvements in real world connection, problem solving general, and problem solving confidence (Madsen, 2011). The reconfiguration of the physics curriculum will allow for students to learn physics as it applies to their daily lives therefore making it more applicable.

My final project will consist of a series of projects making up a project based learning physics curriculum. Each project will consist of a scenario or experience the students have or could encounter at some point in their life. These scenarios and experiences will shape the flow of the curriculum as well as form the essential question to be answered at the end of each project. This curriculum will cover the same standards required of a traditional high school physics, just in a different way. Similar to curriculum created by Martinás and Tremmel, the students will learn concepts that apply to each of the scenarios (2014). Concepts can reoccur thus allowing for

more connections to be made to the concepts. It is important when creating the different projects, that over the span of the curriculum, each standard is addressed at least once in the projects. The structure of a problem is crucial to student understanding. When a problem is well-structured students have strategies to tackle the problem and be successful in project based learning (Svihla & Reeve, 2016). Drafting the project or problem is going to be a crucial first step in order to ensure a flow in the curriculum and that the students and teacher alike, understand what is expected of them.

Once the curriculum is created, it can be used as a guide or reference for educators in physics to allow for a student centered classroom in which everything applies back to the students' lives. By breaking down the projects, it will allow for educators to have a path to follow in their own classroom.

## Chapter Two: Review of Literature

### Introduction

Problem based learning (PBL) in the classroom has been used for sometime. It started out in the medical field and has made its way into the educational field due to the tremendous gains made by the students. PBL has a positive effect on knowledge retention due to the fact that PBL requires students to learn in a constructivist manner instead of just recalling facts (Kin Hang Wong & Day, 2009). This knowledge retention is measured in two ways in PBL; there is the traditional form of formative and informative assessments and with the project component, a rubric as well. The students are expected to collaborate together to earn a shared grade on the outcome of their project. Throughout the project, students are provided feedback both from their peers and from the teacher. This feedback opportunity allows for students to learn and improve

their project outcome. The students and teacher work together from there to add more detail to ensure that everyone understands the rubric and find it fair. This rubric is then used as a reflection tool throughout the problem both on individual components and team components (McDonald, 2008). Individual components can be inquiry labs that address a prompt similar to the problem they are trying to solve in the project or it could be a formative assessment. Inquiry labs follow a similar premise as PBL in that it provides a guiding question and has the students fill in the blanks. With the students doing the research, they are in charge of understanding the concepts and being able to measure them to justify their thinking. PBL and the use of inquiry labs can be integrated into a new structured physics class. This new structure allows for students to learn through questioning personal experiences and scenarios. In applying the concepts to the students lives, it will provide an interest on the students part which allows for better retention.

Contemporary Trends in Science Education: Classroom Environment

In the 21st century, the purpose of education is to create students that build knowledge based on previous knowledge, students who know when to use certain knowledge, and students that are capable of solving problems with both previous and new knowledge. It allows for the students to reflect on their learning and apply it to their daily lives. This approach creates an environment in which students take ownership for their learning. Teachers in this classroom environment would motivate their students and encourage them to stay focused, therefore taking on a role of a facilitator (Nayman, Berber, Anagun, & Yildiz, 2015). To have the opportunity to build knowledge, it is commonly believed that the teacher would need to utilize inquiry. Inquiry allows for the students to work together to discover concepts and relationships and then communicate it to their peers. Through this process, students are taking ownership of their

learning and challenging their thinking (Dickson, Kadbey, & McMinn, 2016). In order to take ownership of their learning and to build on their knowledge students would need to use strategies provided by the teacher. From the survey it concludes that the strategies a teacher utilizes impacts the learning environment in the classroom. The students stated that learning through project based learning allowed for a more enjoyable class, the teacher is supportive, and the students were more satisfied with class as a whole. The study also found that the teacher-student relationships were significantly better for the students learning through project based learning. They felt that the teacher was more helpful and sincerely cared about the students. These students found the environment to be less tense and the tasks were less difficult. This can be explained through students being more actively involved in their learning and therefore have more control of their learning (Hugert, 2016). Having a positive classroom environment is important in order for students to be willing to take risks. When a teacher has the right strategies in place and utilizes inquiry through problem based learning, it allows for the students to build on their knowledge base.

Gender in the Classroom

When one hears physics, they usually have one of two responses, oh that is interesting or physics is difficult. Physics and science in general, has created a culture that has discrete characteristics. Many think of scientists as white men in lab coats finding new discoveries. Being a female in a science field is considered an outlier or contradictory. This idea is shared in the community and therefore is being broadcasted to students. In having female students seen as outliers in science, they are being filtered out of science classes due to feeling a lack of belonging in a community (Corbett, 2016). Women continue to be underrepresented in STEM

fields and girls as early as seventh grade have a fixed mindset about science. With this fixed mindset, it is difficult to get girls interested in science let alone a career in it (Kerr, 2016). Women in the USA and in Chile are in the minority of science classes. Around 20% of females initially register in a science field as an undergraduate in the United States. Through comparisons of applications in 2010 to a Chilean University, the gender gap can be verified (Gándara & Silva, 2016). The gender gap in science can be seen as early as seventh grade and continues into careers. Due to the the lack of belonging in the science community and the fixed mindsets many people share, women continue to be underrepresented in science classes and fields.

Crosscutting Concepts

Crosscutting concepts can be used as both lenses and tools to help students gain understanding in the classroom. The use of crosscutting concepts allow for students to gain a deeper understanding of one disciplinary core idea while making connections across other disciplinary core ideas. These connections can be made through the same science discipline or other scenarios. When planning the use of crosscutting concepts through a lens it allows teachers to analyze core ideas by looking at the concept through a different perspective. The use of crosscutting concepts as a tool allows for the teacher to consider how to develop deeper learning and understanding of core ideas or concepts. Connections can also be a great avenue for the use of crosscutting concepts as a teacher because it allows for the teacher to facilitate connections across different science disciplines and different core concepts. This integration of crosscutting concepts into the planning will allow for teachers to maximize learning through the use of the Next Generation Science Standards (Fick, Arias, & Baek, 2017). These standards outline a progression of learning on a larger scale from elementary to secondary; therefore leaving

teachers to decipher and incorporate them into their lessons. This study created a rubric in the hopes of helping teachers plan how to make the connections between learning outcomes and crosscutting concepts. Through this assessment formation, the use of Bloom's Taxonomy, and the rubric, teachers should be able to plan to have students understanding concepts deeper and making connections between different sciences (Mohl, Fifield, Lafond, Michman, Saxton, & Smith, 2017). Another form of incorporation and assessment of crosscutting concepts are cross cutter cards. Cross Cutter Cards are a formative assessment to be used in the lesson to ensure the teacher is emphasizing the crosscutting concepts as well as the students using and applying them (German, 2017). Through students making connects to other concepts and scenarios, it allows for deeper understanding. The new standards require teachers to incorporate them into their classroom and therefore would need to implement and assess them. The use of a rubric or cross cutter cards, allows for a teacher to plan and assess purposefully.

Problem Solving in the High School Science Classroom

Physicists have noted that many students do not learn enough conceptual physics from the conventional way of teaching. Many students leave with the same or more misconceptions which adds on to the difficult of mathematically solving problems in physics. Both in the college and high school setting, many students are asked to "plug and chug" their way through the problem without understanding the concepts behind the variables or equations (Gok, 2015). Engagement and interest in science tends to dwindle as students get older. Other studies have claimed that technology contests that have high-pressure or are competitive can draw students back into being interested in science. These science and technology contests are based around problems that have multiple solutions. The idea behind each of these events is problem solving.

Before students can first engage in problem solving, they must determine and accept a problem. Through accepting the problem, this begins to shape the students attitude towards problem solving (Huang, Chiu, & Hong, 2016). In order to find a solution, the students need to ask questions, in the case of these Iowa students they first formulated questions they personally felt connected to in the local news. Once these questions were made, the students applied content they had learned and inquiry techniques, to answer questions they made from the news. Through this form of questioning, it provided motivating opportunities for students to interact with their peers, teachers, and community members as they search for information, consider alternative solutions, and apply these experiences to deal with a variety of real world issues (Akcay, n.d.). The use of problem solving skills can draw students interest back as well as allow for students to better understand the concepts. In better understanding concepts, the students will be able to understand the concepts behind equations instead of plugging in numbers to an equation.

Technology in the Classroom

Technology is an encouraged medium to be used in the classroom due to students savviness and interest. This study looks at the integration of technology with problem based learning to determine the outcome of the two being intertwined. When analyzing the qualitative data it was found that having a blend of face to face interactions with online work was liked and beneficial to the students. The groups found that having the mix of online discussions and face to face interactions cleared up misunderstandings and allowed for the group to in a sense make up and move on. At the end of the study, all groups were able to successfully produce a collective product. Individually the students did well when using an electronic journal for the conceptual pieces as well (Donnelly, 2010). On the questionnaire, all participants enjoyed the integration of

the technology through their high ranking remarks on positively framed questions and their low remarks on frustration related questions. Thus suggesting the experience was well perceived with levels of communication, interactions, reflection, learning, and satisfaction ranking high. When analyzing the form of communication and reflection, the findings were the students used the technology frequently as a way of communicating research done in and out of class as well as posing questions leading to the solution to the problem (Ioannou, Vasiliou, & Zaphiris, 2016). None of the students expressed a negative opinion on the online integration into the classroom. The professor also noted in observation, students did not use the online platform as a way to communicate in their group, instead they utilized face to face interactions (Tambouris, Panopoulou, Tarabanis, Ryberg, Buus, Peristeras, Lee, & Porwol, 2012). The integration of technology into the classroom provides a way to communicate in a group both in and out of the classroom. By allowing students to use technology as a resource of research, it allows the students to explore concepts and determine their own understandings.

Problem Based Learning: What Problem Based Learning is

Problem based learning first emerged in the 1960s in the medical field in an attempt to engage students in real problems doctors encounter. This idea has been translated into education, by having teachers give students a real life problem for students to solve. The idea is the problem will provide a context for learning and interest the students. The students in small groups will work together to contemplate the problem, determine what they need to learn in order to achieve or create a solution, and then work towards this goal (Pease & Kuhn, 2011). Studies have shown that PBL is more effective than conventional teaching approaches because it allows the students to develop greater motivation, interest in subjects, learning satisfaction, confidence in learning,

knowledge acquisition, using their resources, and self-directed work. PBL is especially useful because it allows the students to solve meaningful and authentic problems through inquiry or discovery (Kin Hang Wong & Day, 2009). There is evidence to support the effectiveness of PBL in helping students learn higher-order thinking skills as well as discipline-based content (Ertmer, Schlosser, Clase, Adedokun, 2014). The use of PBL in the classroom not only allows for students to develop critical thinking skills in order to learn content but life skills such as communication skills, in order to become better professionals as well.

Challenges with Problem Based Learning

Problem based learning and its outcomes for students has been praised for its theoretical soundness however the results in the classroom have been mixed. The theoretical outcomes have been supported in studies such as connecting new concepts to previous concepts, collaboration, and social interactions. Most of these studies talk about the theories and then jump to the results at the end with little if any direction on implementation. Project based learning has the students use problem solving skills in order to connect prior knowledge and current knowledge to a project or problem; thus leading to some development of self-directed learning skills (Hung, 2011). Small groups were deemed effective for students' learning especially in the areas of content integration, critical thinking, communication skills, self-directed learning, and the connection between concepts and a clinical problem. Challenges to PBL are the tutor's effectiveness, offering identical challenging and relevant cases to each group, and the shared learning environment (Long & Qin, 2014). Due to being spoon fed until arriving at this school, the students were weak in thinking skills. The students were not resourceful in looking for information or how to ask for help. To overcome this challenge, the teacher would provide the

students with tools to help them work through the thinking process, for example mind mapping (Mansor, Abdullah, Wahab, Rasul, Nor, & Raof, 2015). In using PBL in the classroom, the teacher would need to understand what PBL is and how to implement it. At first, studies found that there will be push back by the students because they want to do the bare minimum. However, if the teacher builds in necessary supports and authentic projects, the students will learn the critical thinking skills and collaboration skills.

Student Ownership

Problem or project based learning requires students to take an active role in their learning. This requires the students to be responsible and participate in the process of learning and making meaning. This process is difficult for many students at first because this role conflicts with habits they have developed over the years where they are passive recipients of knowledge. To become these active learners, students must develop self-regulated learning skills. These skills refer to how metacognitively, motivationally, and behaviorally active the student is in their own learning process. When students possess these skills, it leads to students successfully becoming active learners and thus learning the concepts in order to solve the problem or project. Newly prepared PBL teachers found the greatest struggles with PBL are the students lack of motivation, lack of ability to take responsibility for learning, poor behavior, and negative attitudes. When self-regulated learning skills become a focus in addition to the project or problem, it allows for the teacher to provide necessary supports for the students to develop these skills as well as learn the content (English & Kitsantas, 2013). Self-regulated learning is a large component of problem and project based learning. In this study, they looked at the quantitative data of student self-reports of self-regulated learning and experience of autonomy support in a

problem or project based learning environment. Based on the results, it can be implied that the project based learning courses have more effect on student self-regulated learning than problem based learning. The data also suggests that the students in the project based learning course had a greater sense of autonomy support due to the authenticity of the problems provided (Stefanou, et al., 2013). In project based learning, students need to actively frame and reframe the problems in order to learn the concepts to arrive at a solution. This added freedom and choice allowed for the students to take ownership of the problem and thus they gathered information, generated ideas, and evaluated those ideas in a purposeful manner (Svihla & Reeve, 2016). Being aware of the student ownership that is necessary in PBL allows for the teacher to address the challenge head on. Incorporating supports to allow for students to learn the self-regulated learning skills allows for them to learn how to learn in a PBL environment and in general. Once the students have these skills, the challenge will be addressed and students will be able to reap all of the benefits of PBL.

Implementing Problem Based Learning: Assessment in Problem Based Learning

Problem based learning allows for students to review their work, reflect on their work, provide feedback to peers through peer assessment, and provide feedback to themselves through self assessment. Assessment in problem based learning is different that traditional forms of testing and evaluation because it not based on fact memorization but rather knowledge application and knowledge transfer. By offering opportunities throughout a project for assessment, it thus allows for students to reflect on their learning and continue to improve (McDonald, 2008). In PBL, rubrics are used as an assessment tool for the project the students have been working on. This rubric can encompass concepts as well as other pieces needed to

complete their final product. The rubrics used should remain bias free and the teacher should fully understand the rubric (Bahri. Azli, Samah, 2012). The fairness of assessment is another piece that takes adjustment on the students part. Much of the time, students are only recorded for their work; with problem based learning, students are held individually responsible for their learning but they are also assessed in the group setting. Students fear that the their grade will be negatively impacted by weaker students in the group. However, this is an opportunity for the students to collaborate together to reach a common goal with the rubric the students have prior to starting the project. In a large study, it was found that high-achieving students placed in groups that rewarded both individual and group achievement resulted better for the students by scoring higher on a unit test as well as taking on the leadership role within their group (Kumar & Refaei, 2013). The creation and use of a rubric in PBL is essential to the project. All involved in the project, teacher and students alike, should be able to fully understand the rubric and how it will be assessed. In PBL, there are built in stages of reflection. The students submit pieces of their project to both peers and the teacher for feedback to then be applied back into the project. This added reflection in addition to traditional forms of assessment allow for students to showcase their knowledge.

Labs and Problem Based Learning

In the traditional physics classroom, labs are closed-ended. The procedure and results are known beforehand and the students have to put little if any thought into the process of completing a lab. Open-ended labs allow for students to conduct inquiry in order to draw their own conclusions. For the first and remaining labs, the teachers only provided the students with the problem and the rest was up to the students. They were to collect appropriate data, write up

their results, and analyze and interpret the results. As a result of only providing the problem, students would use each other as resources to work through and understand the lab, having small group and sometimes large group discussions. The students determined what was needed or appropriate for the lab write ups based on the procedure they conducted and used evidence to support their choices. The teachers also found that by altering the labs, the students made insightful analyses and did not blame error on simple thoughts. They reflected on their experimental methods and explained what some sources of error could be as well as why they would be a source of error. Aside from the better conceptual understanding, students also enjoyed open-ended labs more due to the investigative process and the students were far more engaged. As a result, the quality of lab write ups was far superior to previous methods. The students demonstrated science process abilities that allowed them to construct models, design experiments, solve open ended problems, and collaboratively work with their peers. (Szott, 2014). This study looked at an environmental chemistry lab and took a cookbook lab (one that provides step by step procedures for the students to follow) and turned it into what could be a real life scenario. To begin the project, the students were told that an investor wanted to purchase some property in order to turn it into a community sports complex. There is a pond in the back corner of the property that is desired to turn into a swimming space. The students were required to submit an official report that includes findings and recommendations for the company. Ninety percent of the students were able to create procedures or flow charts that were viable for separating out cations (Hicks & Bevsek, 2011). A professor at Wabash College wanted to create a new twist on a physics class for non science students. The class would be lab-centered and would provide the students hands-on practice doing science. He created a course that would

focus on the process of science by following a framework similar to that of MythBusters. In this class, the students would solve various myths in a two stage process. In each of the processes, the students would follow the experimental method followed by MythBusters. The process begins with research, the students would research the myth and determine the concepts behind the myth. Next would be design, build, and execute. In this stage, the students would be designing their own experiments to test out the concepts and the myth. Analyze is the following step. In this step, the students would analyze their results to form a conclusion. After forming a conclusion, the students would then communicate their findings using the concepts they learned, the lab they created, and the results they found (Madsen, 2011). Continuing the PBL mindset of student centered lessons, labs have been proven to provide similar results. By only posing the problem or essential question at the beginning of the lab, the students need to think about what they know and determine how to address that problem. The students will be doing the same process for an overall project therefore the students will be seeing the learning gains both in the project and in the lab.

Physics Curriculums

Traditional curriculums of physics courses follow the Newtonian approach. When students arrive in the classroom, they have preconceived ideas about how the world works around them and generally do not change their thinking or understanding through the completion of the class. Newtonian physics is based on the findings of Isaac Newton. In this traditional form of curriculum, the students would first learn about mechanics and later on learn about modern physics. When learning about these two large components, there are two different paradigms that must be understood. The shifting of the paradigms, the study suggests, leads to students

disinterest as well as misunderstanding. These misunderstandings stem from learning more about the equations associated with the concepts and scratching the surface with the concepts. But focusing more on the students daily interactions and applying the physics concepts to these scenarios, the students do not have to shift their thinking but rather apply concepts to experiences they have seen (Martinás & Tremmel, 2014). With the new Next Generation Science Standards (NGSS) being implemented, science classes are encouraged to incorporate these standards in order to promote science literacy. In order to be an exemplary teacher, they would need to include all components of the science standards; them being: content standards, science and engineering practices, connections to the nature of science, and cross-cutting concepts (Concannon & Brown, 2017). The department went from a traditional lecture based curriculum to an activity based curriculum where the students would be learning the concepts through hands on learning experiences. The classes still covered the same amount of concepts per each semester with the new method as well as remained around the same amount of teaching time. These hands on activities could range from completing an inquiry activity to interactive lecture demonstrations. No matter the activity, the students were required to complete a forced response. This response required the students to make an initial response to demonstrate what they know prior as well as identify any misconceptions. Throughout the activity as well as at the end, the students would reflect on their learning (Yoder & Cook, 2014). Restructuring the traditional physics curriculum to one that applies to scenarios or experiences the students experience daily will allow for the students to become more invested. The students will be more invested because they are able to see how concepts relate to their life and the restructuring allows for the students to not have to restructure how they think. By allowing the students to wonder about experiences

they have had and applying the concepts to these experiences, it will allow more a more meaningful connection and the students will not have the paradigm shift limiting them. The projects in the proposed curriculum would be experiences or scenarios the students have experienced or can experience. Within this curriculum shift, the science standards required will need to be incorporated. PBL lends itself to these standards because the students are already connecting different concepts, covering content standards, and designing a solution.

## Conclusion

Problem based learning allows for students to be at the center of the lesson. Studies have shown that PBL is more effective than conventional teaching approaches because it allows the students to develop greater motivation, interest in subjects, learning satisfaction, confidence in learning, knowledge acquisition, using their resources, and self-directed work. PBL is especially useful because it allows the students to solve meaningful and authentic problems through inquiry or discovery (Kin Hang Wong & Day, 2009). The use of PBL and the reflection techniques not only allow for the students to walk away from the class better understanding the concepts, but they also develop necessary career skills such as collaboration and using their resources. In order to arrive at this satisfaction, there is some adjustment needed at the beginning of the course. The students in most cases are used to being spoon fed information therefore it takes some time to adjust to being in the driver's seat to their learning. When implemented in the classroom students would do the bare minimum. Many students would skip brainstorming and elaborating of their ideas and try to complete the task fast and on the first try (Hung, 2011). Once the students are provided supports and become used to guiding their learning they will be able to flourish. The students will become successful both in the lab setting and on their assessments. He found that

the students had a better grasp of basic physics concepts and a better understanding of the process of science. The students showed significant improvements in real world connection, problem solving general, and problem solving confidence (Madsen, 2011). The reconfiguration of the physics curriculum will allow for students to learn physics as it applies to their daily lives therefore making it more applicable.

Project Outline

My final project will consist of a series of projects making up a project based learning physics curriculum. Each project will consist of a scenario or experience the students have or could encounter at some point in their life. These scenarios and experiences will shape the flow of the curriculum as well as form the essential question to be answered at the end of each project. This curriculum will cover the same standards required of a traditional high school physics, just in a different way. Similar to curriculum created by Martinás and Tremmel, the students will learn concepts that apply to each of the scenarios (2014). Concepts can reoccur thus allowing for more connections to be made to the concepts. It is important when creating the different projects, that over the span of the curriculum, each standard is addressed at least once in the projects. The structure of a problem is crucial to student understanding. When a problem is well-structured students have strategies to tackle the problem and be successful in project based learning (Svihla & Reeve, 2016). Drafting the project or problem is going to be a crucial first step in order to ensure a flow in the curriculum and that the students and teacher alike understand what is expected of them.

Once the curriculum is created, it can be used as a guide or reference for educators in physics to allow for a student centered classroom in which everything applies back to the

students lives. By breaking down the projects, it will allow for educators to have a path to follow in their own classroom.

**Chapter Three: Narrative**

High school physics classrooms tend to follow a typical curriculum. They start with mechanics and then work their way to electricity and modern physics. This style of curriculum allows for students to learn all necessary standards, however it leads to students believing that concepts taught at the beginning of the year do not connect to concepts learned at the end of the year. Gok supports the change in curriculum due to many students leaving the class with the same or more misconceptions when physics is taught in the traditional sense (2015). The proposed curriculum is taught in project based learning form. This will encompass five projects that cover all of the necessary standards, however they do not follow the traditional curriculum. In this curriculum, students will learn concepts that pertain to a certain experience or scenario. These experiences or scenarios will be made into five projects in which the students will learn concepts in order to apply them to the experience or scenario. As supported by Kin Hang Wong and Day, PBL is more effective than conventional teaching approaches because the students develop greater motivation, interest in the project or concepts, using their resources, and self-directed work. PBL is especially useful because it allows the students to solve meaningful and authentic problems through inquiry or discovery (2009). The students may see the same concept in every project, while they also may see one concept in just one project. Through recurring concepts it allows for students to see how concepts relate to each other and that they are not separated. With the recurring concepts, it will also allow for the students to continuously reflect on their learning and to see how physics relates to their lives. The change in curriculum

and continuous observations of concepts is supported by Martinás and Tremmel because it allows the curriculum to focus more on the students daily interactions and applying the physics concepts to scenarios or projects (2014). By having projects, it allows for authentic learning because each project applies to the students lives in some shape or form. The final curriculum lays out five projects to be covered over the course of one year that addresses all of the physics standards required by New York State.

Providing an authentic learning environment for students in which they can apply the projects to their lives allows for students investment. Project based learning allows for the learning to be placed in the students hands as well as allows for them to develop essential skills such as communication skills and problem solving skills. Student ownership of their learning is amplified through PBL as supported by Hugert as students were observed to be more actively involved in their learning and therefore have more control of their learning in the PBL setting (2016). With these skills and the project set up, it allows for the students to critically think about the concepts and to apply them to their daily lives. By incorporating all concepts applicable to a particular scenario or project, instead of following the traditional physics curriculum, it allows for students to continuously see concepts in order to retain the concepts and meet higher order Bloom's by applying the concepts and scenarios to their lives.

The five projects included are a public service announcement on the dangers of texting and driving, a poster and presentation meant to educate all on bow and arrow hunting, a designed and created escape room, a debate on the impact of technology, and a musical product that impacts one's mood. Each of these projects will cover the necessary New York State Standards and will flow from one project to the next. There are various resources included for each of the

projects in order to allow for a teacher to roll out the student centered curriculum. For each project there is a driving or essential question that all content and project work connects back to. From there, there is a project summary that provides the teacher with a brief overview of the project as well as an entry event to kick off the project and draw the students interest. Once the project is kicked off, the students are provided a calendar and rubric that allows for them to see exactly what is expected of them. This also allows the teacher to have an assessment tool for the project at the conclusion of the project. The calendar provides an outline for the teacher and student to follow including due dates and when content will be learned. The due dates include dates for when labs are due, quizzes that are coming as well as the formative assessment at the end of the project. To work in hand with the already mentioned resources, there are also sample lesson plans that allow for a teacher to mimic a typical day. According to the calendar there are three different typical days: content day, project day, and lab day. For each of those days there is a sample lesson plan as well as resources necessary to complete that lesson. The assessments for each project are also included to provide feedback to the students as well as the teacher as to the progress of learning.

**Project One**

Project one kicks off the school year as the first project based learning project. This project encompases the traditional kinematics with momentum, impulse, kinetic energy, and Conservation of Momentum included. This project is based on texting and driving as the students are beginning to learn to drive or are already. Within this project students will create their own PSA to communicate the dangers of texting and driving with added concepts to support their arguments.

The resources for project one are for both the teacher/instructor and student alike. There is a project outline that outlines all of the standards to be addressed in the project, the entry event, a brief description of the project, student objectives, and resources necessary. To support the outline, there is a rubric that provides the students a clear idea of what to include in their PSA as well as provides the teacher with an assessment tool for the project. The calendar also provides the teacher and students with a sense of progress through the project. Students know when to complete graded assignments as well as provides dates for assessments. The sample lessons and supporting documents allow for the teacher to gain an idea of what a typical content day, lab day, and project day would look like in this curriculum. The assessments also provide the teacher a resource to assess individual progress.

<table>
<tr><th colspan="6">Curriculum Design Template</th></tr>
<tr><td>Name of Project:</td><td colspan="3">PSA - Texting and Driving</td><td>Duration:</td><td>8 weeks</td></tr>
<tr><td>Subject/Course:</td><td>Physics/ How Things Work?</td><td>Teacher(s):</td><td>Miranda</td><td>Grade Level:</td><td>10</td></tr>
<tr><td colspan="6">Project Snapshot</td></tr>
<tr><td>Driving Question:</td><td colspan="5">What impact does texting(distracted) driving have?</td></tr>
<tr><td>Project Summary:<br>Students create a public service announcement (PSA) in groups of 2-3 that educates people on the dangers of texting and driving.</td><td colspan="5">Stained Inquiry -<br>Standards:<br>• HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.<br>• HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.<br>◦ 3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.<br>◦ 4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.<br>◦ 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.<br>◦ MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.<br>◦ MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.*<br>◦ MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.<br><br>Authenticity - The students are in cars daily.<br>Voice and Choice - The students can design and create their PSA.<br>Critique and Revision - Students will submit outlines and rough videos to receive feedback from peers and staff.<br>Public Product - Video to educate people on the dangers of texting and driving<br><br>Entry Event: Play this video (https://www.youtube.com/watch?v=l7ljxDjwDjU) . After playing the video, introduce the project with the overall goal (Create a PSA that educates the people on the dangers of texting and driving.) Following the video and goal, students will create a know / need to know list in pairs.</td></tr>
</table>

| Stage 1 – Desired Results | | |
|---|---|---|
| **Established Goals:**<br>• **I can create a storyboard that educates an audience on the dangers of texting and driving.**<br>• **I can recreate the planned storyboard in order to film our PSA.**<br>• **I can edit/revise my work provided feedback in order to improve.**<br>• **I can edit my video in order to have a smooth and comprehensible PSA.** | **Acquisition** | |
| | *Students will know…*<br>• The following concepts: distance, displacement, time, velocity, speed, initial velocity, final velocity, acceleration, motion graphs, mass, kinetic energy, momentum, impulse, Conservation of Momentum, inelastic collisions, and elastic collisions.<br>• The difference between distance and displacement.<br>• The difference between speed and velocity.<br>• How to calculate velocity.<br>• How to measure distance, time, and mass.<br>• How to calculate acceleration.<br>• How to interpret motion graphs.<br>• Describe the motion associated with the motion graph.<br>• How to calculate/use the Big 5 kinematic equations.<br>• How to calculate kinetic energy.<br>• How to calculate momentum.<br>• How to calculate impulse.<br>• How to calculate Conservation of Momentum.<br>• The difference between elastic and inelastic collisions.<br>• How to calculate elastic collisions.<br>• How to calculate inelastic collisions. | *Students will be skilled at…*<br>• Collaborating together<br>• Communicate to each other and the world<br>• Critically think and develop their PSA announcement<br>• Critically think about concepts<br>• Creatively develop a PSA on the dangers of texting and driving |
| | **Meaning** | |
| | UNDERSTANDINGS:<br>*Students will understand…*<br>• To apply the following concepts to driving and/or car accidents: distance, displacement, time, velocity, speed, initial velocity, final velocity, acceleration, motion graphs, mass, kinetic energy, momentum, impulse, Conservation of Momentum, inelastic collisions, and elastic collisions. | ESSENTIAL QUESTIONS:<br>*Students will keep considering… what are the dangers of texting and driving* |
| | • To apply the understanding of calculations to the impact it has on the car and person inside during a collision.<br>• What texting and driving is.<br>• The distance covered on a road while texting and driving.<br>• How to create a storyboard.<br>• How to film using a video camera using their storyboard.<br>• How to edit their video to make a comprehensible PSA on the dangers of texting and driving. | |
| | **Transfer** | |
| | *Students will be able to independently use their learning to…*<br>• Apply their understanding of concepts and texting and driving to provide feedback to other groups.<br>• Showcase their understanding in labs and assessments. | |

| Stage 2 – Student Evidence | | | |
|---|---|---|---|
| **Driving Question:** | **What impact does texting and driving have?** | | |
| **Final Artifact(s)**<br>Presentations, Performances, Products, and/or Services | **Learning Outcomes/Targets**<br>Content & 21st century competencies needed by students to successfully complete products | **Checkpoints/Formative Assessments**<br>To check for learning and ensure students are on track | **Instructional Strategies for All Learners**<br>Provided by teacher, other staff, experts; includes scaffolds, materials, lessons aligned to learning outcomes and formative assessments |
| **Storyboard for PSA PSA** | • Collaborating together | **Contract** | **Students will sign a contract at the beginning of the project in order to ensure collaboration of all students throughout the project.** |
| | • Communicate to each other and the world | **Contract** | **Within the contract the students will agree to communicate their work as well as praise/frustration to ensure the team completes quality work on time.** |

| | | | |
|---|---|---|---|
| | • Critically think and develop their PSA announcement | **Checkpoints (Rough Drafts) of Storyboard**<br>**Final Draft of Storyboard**<br>**Checkpoint of Video**<br>**Final Draft of PSA** | **These points will be assessed used a rubric distributed to students at the beginning of the project.** |
| | • Critically think about concepts | **Daily Practice (Entrance and Exit Tickets)**<br><br>**Labs**<br><br>**Quizzes (Given about every 2 weeks)**<br>**Final Assessment** | **The entrance and exit tickets will have a key that is used to provide feedback to the students on their progress of understanding the concept(s).**<br>**The labs will have a key that will be used to provide feedback to the students in order to assess their understanding. Students will be provided the opportunity ot improve their work within a week time frame to show their understanding.**<br>**Both quizzes and the final assessment will have a key that will assess their work and provide the students feedback on their work. The students will be provided a week to meet with the teacher to strengthen weak areas and will take a retake when ready.** |
| | • Creatively develop a PSA on the dangers of texting and driving | **Checkpoints (Rough Drafts) of Storyboard**<br>**Final Draft of Storyboard**<br>**Checkpoint of Video**<br>**Final Draft of PSA** | **Students will be provided short videos on how to develop a storyboard, how to use a video camera, and how to edit their video.**<br>**Storyboard:https://photography.tutsplus.com/tutorials/how-to-make-a-storyboard-for-video--cms-26374**<br>**Video Camera: Will demonstrate when each team has cameras.**<br>**How to edit:**<br>**https://www.youtube.com/watch?time_continue=88&v=JZXK68NS7gU** |

| **Stage 3 – Project Resources** | | |
|---|---|---|
| **Required Resources**<br>On-site people, facilities, equipment, materials, community resources | **What artifact will resource specifically support?** | **How will resource support student learning toward artifact completion?** |
| **Chromebooks** | Google Classroom, Labs, Storyboard | Students will use their chromebooks as a resource to all course information as well as will be used daily in class. |
| **Google Classroom** | Daily Practice, Labs | Students will understand and apply the following concepts: distance, displacement, time, velocity, speed, initial velocity, final velocity, acceleration, motion graphs, mass, kinetic energy, momentum, impulse, Conservation of Momentum, inelastic collisions, and elastic collisions. |
| **PASCO carts, track, software** | Labs | Students will understand, calculate, and apply the following concepts: displacement, time, velocity, initial velocity, final velocity, acceleration, motion graphs, mass, kinetic energy, momentum, impulse, Conservation of Momentum, inelastic collisions, and elastic collisions. |
| **Graphing Paper** | Daily Practice | Students will understand and apply displacement, time, velocity, and acceleration. |
| **Rulers** | Daily Practice | Students will understand and apply displacement, time, velocity, and acceleration. |
| **Calculator** | Daily Practice, Labs | Students will understand, and calculate the following concepts: displacement, velocity, initial velocity, final velocity, acceleration, kinetic energy, momentum, impulse, Conservation of Momentum, inelastic collisions, and elastic collisions. |
| **Medium for Storyboard** | Storyboard | Students will create a storyboard for their PSA using a posterboard or Google Slides to apply concepts learned and prior knowledge of the dangers of texting and driving. |
| **Videotape recorder** | PSA | Students will act and film in their PSA following their created storyboard. |
| **Editing software** | PSA | Students will edit their PSA video using the software in order to have a comprehensible PSA. |
| **Quizzes** | Daily Practice, Labs | Students will showcase their understanding of the following concepts: distance, displacement, time, velocity, speed, initial velocity, final velocity, acceleration, motion graphs, mass, kinetic energy, momentum, impulse, Conservation of Momentum, inelastic collisions, and elastic collisions. |
| **Final Assessment** | Daily Practice, Labs | Students will showcase their understanding of the following concepts: distance, displacement, time, velocity, speed, initial velocity, final velocity, acceleration, motion graphs, mass, kinetic energy, momentum, impulse, Conservation of Momentum, inelastic collisions, and elastic collisions. |

| | | |
|---|---|---|
| **Scale** | Daily Practice, Labs | Students will measure mass using a scale in order to calculate kinetic energy. |
| **Measuring Tape / Meter Stick** | Daily Practice, Labs | Students will measure distance using a meter stick or measuring tape in order to be used in various calculations. |
| **Timer** | Daily Practice, Labs | Students will measure time using a cellphone or stopwatch in order to be used in various calculations. |

| | |
|---|---|
| **Public Audience** | **The final PSA of texting and driving will be displayed at Mentor Week. (Mentor Week is a week where professionals in the fields come and speak to the students on professionalism in the workplace as well as various personal improvement seminars.)** |

| **Stage 4 - Reflection** | | | | |
|---|---|---|---|---|
| **Reflection Methods** | **Individual feedback will be provided daily to daily practice using keys.** | ☐ | **Team feedback will be provided to storyboard through peer feedback and instructor.** | ☐ |
| | **Individual feedback will be provided to labs using keys.** | ☐ | **Team feedback will be provided to PSA through peer feedback and instructor.** | ☐ |
| | **Individual feedback will be provided to quizzes and final assessment using keys.** | ☐ | **Teams will have the opportunity to improve their project work.** | ☐ |
| | **Students will have the opportunity to use feedback to improve individual work.** | ☐ | | |

| |
|---|
| **Notes:** |

*Project One Outline*: Includes standards, project overview, and resources needed for the project.

| | | 1 | 2 | 3 | 4 | Rating | |
|---|---|---|---|---|---|---|---|
| **Storyboard** | Content | In the PSA there is 1 concept supporting the story line | In the PSA there are 2 different concepts supporting the story line | In the PSA there are 3 different concepts supporting the story line | In the PSA there are 4 different concepts supporting the story line | | |
| | | The PSA lacks statistics or information | In the PSA there are 1-2 facts and/or accurate statistics | In the PSA there are 3 facts and/or accurate statistics | In the PSA there are 3 powerful facts and/or accurate statistics | | |
| | | The PSA lacks substantial solutions or advice | In the PSA there are 2 solutions or advice | In the PSA there are 3 solutions or advice | In the PSA there are 3 powerful solutions or advice | | |
| | Script | The script is appropriate, but is lacking detail in script as well as roles. | The script is appropriate, includes roles for each person, but is lacking detail. | The script is appropriate, detailed, and includes roles for each person. | The script is appropriate, detailed, and includes roles for each person. | | |
| | | The script shows little direction, is confusing, or is lacking dialogue. | The script shows a somewhat understandable flow for the PSA. | The script shows mostly clear and understandable flow for the PSA. | The script shows a clear and understandable flow for the PSA. | | |
| | | Does not create an emotional response | Creates an emotional response that does not have to do with texting and driving | Creates a rich emotion response that somewhat matches the story line | Creates a rich emotional response to story line | | |
| | Originality | The PSA lacks both creativity and originality. | The PSA shows group creativity but has no originality. | The PSA shows group creativity and some original ideas. | The PSA shows group creativity and the use of original ideas. | | |

| | | 1 | 2 | 3 | 4 | Rating |
|---|---|---|---|---|---|---|
| PSA | Sound | Voice is not heard. | Voice is heard but is unclear and hard to understand the story line. | Voice is clear or easy to understand, and communicates the story line well. | Voice is clear, easy to understand, and communicates the story line well. | |
| | Editing | The PSA is hard to follow / understand. | Editing is choppy or hard to follow. | Editing enhances the PSA. | Editing enhances the PSA and clarifies information. | |
| | Title | There is not a title slide in the PSA. | The title slide on the PSA includes the brief purpose of PSA or student names. | Title slide has all in 4, however it is not the first scene in PSA. | The title slide on the PSA includes the brief purpose of PSA and student names. | |
| | Following of Storyboard | The group does not follow any part of the storyboard that was planned prior. | | | The group attempts to follow the storyboard that was planned prior with necessary creative changes. | |

| Texting and Driving PSA Rubric | | | | |
|---|---|---|---|---|
| **Storyboard** | | | **PSA** | |
| **Comments:** | | | | **Final Score** |

*Project One Rubric:* Provides the students with an expectation of the project and the teacher with an assessment tool.

The calendar below is used for the pacing of the project as well as to determine the deadlines or due dates for work. The plan for this project was to cover a total of eight weeks, this is due to the large amounts of content to be covered as well as the opportunity for reflection on the project. Being that this is the first project, the first concept(s) the students see are essential and will be built upon in the project as well as throughout the year. It starts with kinematics and uses previous concepts to understand kinetic energy, momentum, impulse, and the Conservation of Momentum. Quizzes and formative assessments are spaced roughly every two weeks in order to showcase individual understanding in the assessment setting. The project days are also spaced

throughout the project to allow for connections of content to be continuously made back to the project.

| Sept 2018 | P1: Texting and Driving PSA | | | |
|---|---|---|---|---|
| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** |
| 3 No School | 4 Staff Development Day | 5 First Day of School | 6 | 7 Einstein Day |
| 10 Texting and Driving Kick Off - Entry Event, Know / Need to Know | 11 | 12 Distance vs. Displacement, Time, Velocity vs. Speed | 13 | 14 Acceleration, Motion Graphs |
| 17 Big 5 Kinematic Equations | 18 | 19 Big 5 Kinematic Equations / Lab | 20 | 21 Big 5 Kinematic Equations / Lab **LAB DUE** |
| 24 Storyboard Work Day **Checkpoint / Rough Draft Due** | 25 | 26 Kinetic Energy | 27 | 28 **QUIZ** Improve Storyboard ***(Improved Lab Due)*** |

| Oct 2018 | P1: Texting and Driving PSA | | | |
|---|---|---|---|---|
| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** |
| 1 Momentum, Impulse | 2 | 3 Conservation of Momentum, Elastic Collisions | 4 ***(Quiz Retake Due)*** | 5 Staff Development Day |
| 8 Columbus Day | 9 | 10 Conservation of Momentum, Inelastic Collisions | 11 | 12 Einstein Day |
| 15 Lab | 16 | 17 Lab / Improve Storyboard **LAB DUE STORYBOARD DUE** | 18 | 19 **QUIZ** Record videos |
| 22 Record Video **Checkpoint / Rough Draft Video Due** | 23 | 24 Record videos / Edit Videos ***(Improved Lab Due)*** | 25 | 26 Edit Videos ***(Quiz Retake Due)*** |
| 29 Review | 30 | 31 **FORMATIVE ASSESSMENT** | 1 | 2 **FINAL PSA DUE** Show PSA's |

*Project One Calendar:* The calendar provides the students and teacher with an expectation of what is done each day including due dates.

Sample Content Lesson

The sample content lesson included provides a lesson plan, notes, and a practice sheet for the students to complete during the span of the class period. The lesson provided allows for a teacher to see a typical day in the classroom. In PBL, there is very rarely lecturing used therefore, this lesson allows the students to discover acceleration and motion graphs through the completion of an obstacle course. The teacher is a facilitator in this setting as the students work at their own pace through the notes/obstacle course. The instructor checks the students work as they go and provides help when needed. After completing the notes in pairs or a group, the students then individually complete the practice to showcase their understanding of the concepts. The teacher provides feedback to the practice and returns it to the students to allow for growth.

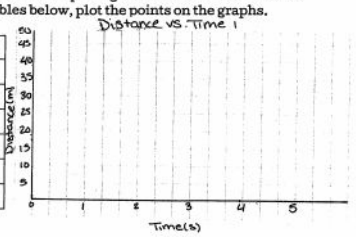
| | |
|---|---|
| **Subject/Course** | Physics 100 |
| **Topic** | Kinematics |
| **Lesson Title:** | Acceleration and Motion Graphs |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can apply my motion in an obstacle course to acceleration.<br>• I can apply my motion in an obstacle course to motion graphs. | |
| **Task List** | |
| • Students will start with independently completing 5 questions related to the class prior on their whiteboards. (Velocity and their completion of the obstacle course.)<br>• Have students hold up their answers to each question and go over as needed.<br>• Students will complete the Obstacle Course Acceleration packet with a partner.<br>• Students will call instructor over, per instruction in packet, to monitor progress and provide feedback.<br>• After completing the packet, the students will independently complete the practice to showcase their knowledge on acceleration and motion graphs. | |
| **Materials Needed** | |
| • Computers<br>• Whiteboards<br>• Rulers<br>• Whiteboard markers<br>• Erasers<br>• Obstacle Course Acceleration Packet<br>• Acceleration and Motion Graphs Practice | |

Name:_____

Now assume you are in a car completing a similar obstacle course to last class. Using the tables below, plot the points on the graphs.

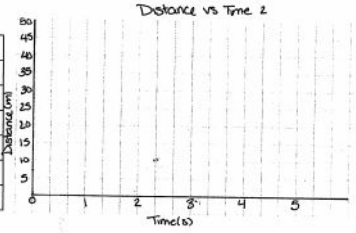
1-

| Time(s) | Position(m) |
|---|---|
| 0 | 0 |
| 1 | 10 |
| 2 | 20 |
| 3 | 30 |
| 4 | 40 |
| 5 | 50 |




2-

| Time(s) | Position(m) |
|---|---|
| 0 | 0 |
| 1 | 2 |
| 2 | 8 |
| 3 | 18 |
| 4 | 32 |
| 5 | 50 |



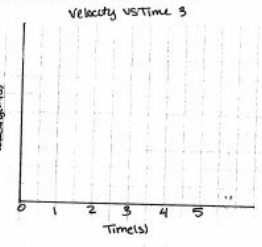

In looking at your graphs for chart 1 and 2, what is the difference?

Now using the same charts, calculate the velocities. Graph the time vs. velocities.

3-

| Time(s) | Position(m) | Velocity($\frac{m}{s}$) |
|---|---|---|
| 0 | 0 | |
| 1 | 10 | |
| 2 | 20 | |
| 3 | 30 | |
| 4 | 40 | |
| 5 | 50 | |

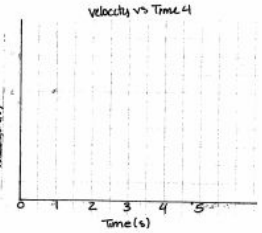
Work:




4-

| Time(s) | Position(m) | Velocity($\frac{m}{s}$) |
|---|---|---|
| 0 | 0 | |
| 1 | 2 | |
| 2 | 8 | |
| 3 | 18 | |
| 4 | 32 | |
| 5 | 50 | |

Work:




In looking at your graphs for chart 3 and 4, what is the difference?

Definitions:

**Acceleration:** The time rate of change of velocity.

| Concept | Variable | Unit | Equation(s) |
|---|---|---|---|
| Time | $t$ | $s$ | $a = \frac{\Delta v}{\Delta t}$ |
| Initial Time | $t_1$ | $s$ | |
| Final Time | $t_2$ | $s$ | |
| Initial Velocity | $v_i$ | $\frac{m}{s}$ | $a = \frac{v_f - v_i}{t_2 - t_1}$ |
| Final Velocity | $v_f$ | $\frac{m}{s}$ | |
| Acceleration | $a$ | $\frac{m}{s^2}$ | |

Before we apply acceleration to the obstacle course, practice solving these problems. (Have Mrs. Wharram-Santillo sign off before moving on.)

1. Calculate the acceleration of a car starting at $5\frac{m}{s}$ and ending at $20\frac{m}{s}$ in 20s.

2. Calculate the acceleration of a car from rest to $25\frac{m}{s}$ in 350s.

Now using the same charts,

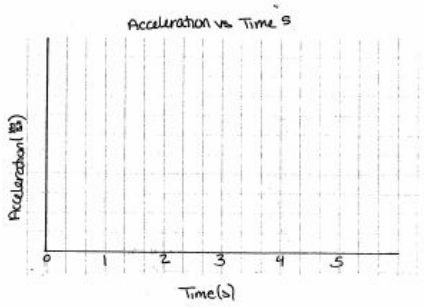
- Fill in the velocities you calculated from earlier
- Calculate the acceleration
- Graph the time vs. acceleration

5-

| Time(s) | Position(m) | Velocity($\frac{m}{s}$) | Acceleration($\frac{m}{s^2}$) |
|---|---|---|---|
| 0 | 0 | | |
| 1 | 10 | | |
| 2 | 20 | | |
| 3 | 30 | | |
| 4 | 40 | | |
| 5 | 50 | | |

Work:

Graph:

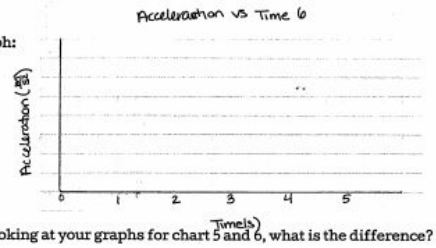


6-

| Time(s) | Position(m) | Velocity($\frac{m}{s}$) | Acceleration($\frac{m}{s^2}$) |
|---|---|---|---|
| 0 | 0 | | |
| 1 | 2 | | |
| 2 | 8 | | |
| 3 | 18 | | |
| 4 | 32 | | |
| 5 | 50 | | |

Work:

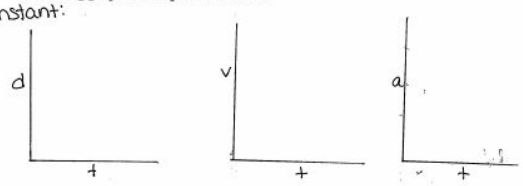
Graph:



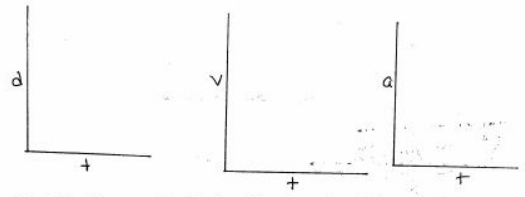

In looking at your graphs for chart 5 and 6, what is the difference?

Now that you have graphed two different types of motion, fill in the following graphs for a quick reference.

constant:




accelerating:




Have Mrs. Wharram-Santillo sign off, and complete the practice she provides you.

Name:_____

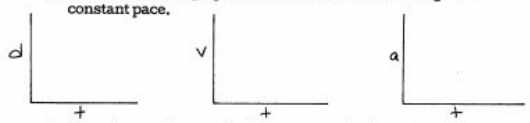
Acceleration and Motion Graph Practice

1. A car starts from rest and accelerates to $5\frac{m}{s}$ in 10s. What is their acceleration?

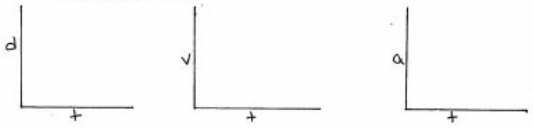
2. A car is traveling at $25\frac{m}{s}$ and looks at their phone, they do not see the car braked in front of them. They rear end them, after 3s. What was the car's acceleration while they came to a stop?

3. You are traveling at $20\frac{m}{s}$ and you look at your phone for a notification. You glance at your phone for 3s. How much distance did you cover on the road with your eyes not on the road?

4. Draw the motion graphs for someone who is walking at a constant pace.




5. Draw the motion graphs for someone who is running at an accelerating rate.



Sample Project Lesson

The project lesson included provides the teacher/instructor with a lesson plan to span the class period. Once the teacher goes over the rubric, the students then work in their groups to meet the standards of the rubric through their own pacing.

| | |
|---|---|
| **Subject/Course** | Physics 100 |
| **Topic** | PSA Project Work |
| **Lesson Title:** | Storyboard Planning |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can work together with my team to create a unique storyboard to meet the requirements found in the rubric. | |
| **Task List** | |
| • Provide students will groups as they arrive<br>• Go over the project rubric and their expectations<br>• Students work to create a storyboard for their PSA using Google Docs/Slides or on a posterboard | |
| **Materials Needed** | |
| • Chromebook<br>• Rubric<br>• Posterboard | |

Sample Lab Lesson

The sample lab lesson included provides the teacher with a lesson plan and lab for the students to complete. This lab was provided because it is inquiry based and requires the students to recall on their understanding of concepts.

| | |
|---|---|
| **Subject/Course** | Physics 100 |
| **Topic** | Conservation of Momentum |
| **Lesson Title:** | Lab |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can create an elastic collision using the materials in front of me.<br>• I can calculate an elastic collision using measurements I collected.<br>• I can create an inelastic collision using the materials in front of me.<br>• I can calculate an inelastic collision using measurements I collected. | |
| **Task List** | |
| • In pairs, students will complete the Collisions Lab<br>• Turn in progress of completed lab. (Students will have 30 minutes the following class to complete.) | |
| **Materials Needed** | |
| • PASCO tracks<br>• PASCO motion sensors<br>• PASCO carts<br>• Calculators<br>• PASCO software<br>• Scales | |

Name:_____

Kinematics and Collisions Lab

Directions: Using the materials in front of you, create a procedure and calculation for someone to follow.

1. Place both carts on the track.
   a. What is an elastic collision?

   b. Create an elastic collision
   c. Now draft a detailed procedure for someone to replicate this elastic collision. (You do not need to use all of the lines)

      i. _____
      ii. _____
      iii. _____
      iv. _____
      v. _____
      vi. _____
      vii. _____
      viii. _____
      ix. _____
      x. _____

   d. Describe why the procedure for the collision is elastic.

   e. Now, each of you hook up your laptop to a motion sensor.
   f. Place the motion sensors on either side of the track, with the carts in the middle.

   g. Replicate your collision described in your procedure, except this time, each of you record the velocity for your cart before they collide and after they collide.

**Before:**

Velocity of your cart:_____ Velocity of partner's cart:_____

**After:**

Velocity of your cart:_____ Velocity of partner's cart:_____

   h. Now, using the scales, mass each of your carts.

Mass of your cart:_____ Mass of partner's cart:_____

   i. Which equation would you use to solve an elastic collision?

   j. Using your measurements from above, solve for the velocity of your partner's cart after the collision.

   k. Does your calculation match the measured?

2. Place both carts on the track.
   a. What is an inelastic collision?

   b. Create an inelastic collision

   c. Now draft a detailed procedure for someone to replicate this inelastic collision. (You do not need to use all of the lines)

      i. _____
      ii. _____
      iii. _____
      iv. _____
      v. _____
      vi. _____
      vii. _____
      viii. _____
      ix. _____
      x. _____

   b. Describe why the procedure for the collision is inelastic.

   c. Now, each of you hook up your laptop to a motion sensor.
   d. Place the motion sensors on either side of the track, with the carts in the middle.
   e. Replicate your collision described in your procedure, except this time, each of you record the velocity for your cart before they collide and after they collide.

**Before:**

Velocity of your cart:_____ Velocity of partner's cart:_____

**After:**

Velocity of your cart:_____ Velocity of partner's cart:_____

   f. Now, using the scales, mass each of your carts.

Mass of your cart:_____ Mass of partner's cart:_____

   g. Which equation would you use to solve an inelastic collision?

   h. Using your measurements from above, solve for the combined/shared velocity after the collision.

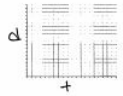
   i. Does your calculation match the measured?

*Project One Sample Lessons:* The lessons above include three types of lessons: content, lab, and project. Each of the lessons include the materials needed for the lesson.

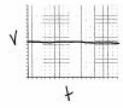
## Quiz 1

Name:_____
P1: Quiz 1
Directions: Please complete the following showing ***all*** work when necessary.

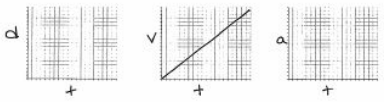
1. A car covered 50m in 2s, how fast were they traveling?
2. A person ran a mile (1609m) in 360s, what was their average velocity?
3. While traveling at 2 $\frac{m}{s}$, a person looks at their phone for 5s. How much distance did they cover?
4. What is velocity?
5. If I am standing still, complete the following distance vs. time graph.




6. What motion is displayed below?_____




7. Complete the following graph based on the previous two.

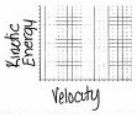



8. A snail takes 480s to cover 1m. What is their average velocity?
9. A volleyball player starts from rest and moves at a velocity of 2 $\frac{m}{s}$ in 1s to return a serve. What was the player's acceleration?
10. A puppy is sitting and suddenly smells food. It takes the puppy 1.75s to run into the kitchen at an acceleration of 2 $\frac{m}{s^2}$. What was their final velocity?
11. A running back is running at 2 $\frac{m}{s}$ and then accelerates at 1 $\frac{m}{s^2}$ to score a touchdown. They accelerated over a 10s timeframe. What was the distance they covered?
12. A striker stops a soccer ball and kicks it 10m into the back of the net with an acceleration of 9 $\frac{m}{s^2}$. How fast was it traveling just before hitting the net?

## Quiz 2

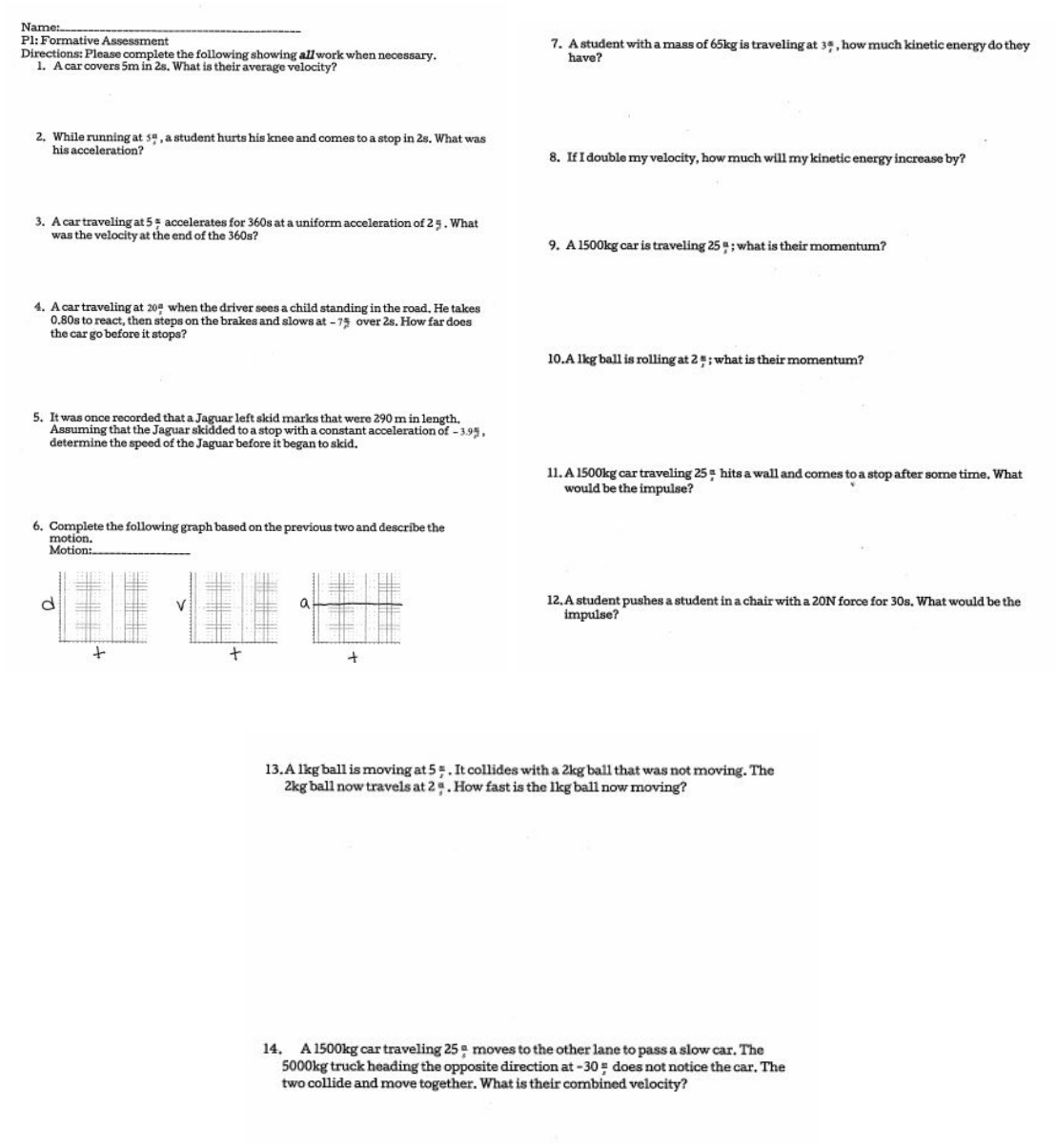
Name:_____
P1: Quiz 2
Directions: Please complete the following showing ***all*** work when necessary.

1. What is the definition of kinetic energy?
2. A student with a mass of 70kg is traveling at 5 $\frac{m}{s}$, how much kinetic energy do they have?
3. If I double my velocity, how much will my kinetic energy increase by?
4. Draw the slope for the relationship of velocity and kinetic energy below.




5. A 70kg person is traveling 25 $\frac{m}{s}$; what is their momentum?
6. What is the impulse on a box that has a 35N force applied to it for 65 seconds?
7. A 1500kg car is traveling at 25 $\frac{m}{s}$. They come to a stop in 5 seconds. What is the force needed to stop the car?
8. Two objects collide and bounce apart, what type of collision is this?
9. Two objects collide and stick/move together afterwards. What type of collision is this?
10. What is the definition of the Conservation of Momentum?
11. A 2kg ball rolls to the right at 2 $\frac{m}{s}$. A 4kg ball is rolling towards the first ball at -3 $\frac{m}{s}$. The objects collide and sends the 4kg ball rolling away at 1 $\frac{m}{s}$. What is the 2kg ball's velocity after the collision?
12. A 15000kg bus is stopped to let a students on. The 1500kg car following the bus at 25 $\frac{m}{s}$ was texting and hits the back end. The bus and car are now stuck together and moving, how fast are they moving together?

Formative Assessment



Name:_____
P1: Formative Assessment
Directions: Please complete the following showing ***all*** work when necessary.

1. A car covers 5m in 2s. What is their average velocity?
2. While running at $5\frac{m}{s}$, a student hurts his knee and comes to a stop in 2s. What was his acceleration?
3. A car traveling at $5\frac{m}{s}$ accelerates for 360s at a uniform acceleration of $2\frac{m}{s}$. What was the velocity at the end of the 360s?
4. A car traveling at $20\frac{m}{s}$ when the driver sees a child standing in the road. He takes 0.80s to react, then steps on the brakes and slows at $-7\frac{m}{s}$ over 2s. How far does the car go before it stops?
5. It was once recorded that a Jaguar left skid marks that were 290 m in length. Assuming that the Jaguar skidded to a stop with a constant acceleration of $-3.9\frac{m}{s}$, determine the speed of the Jaguar before it began to skid.
6. Complete the following graph based on the previous two and describe the motion.
   Motion:_____

d v a

+ + +

7. A student with a mass of 65kg is traveling at $3\frac{m}{s}$, how much kinetic energy do they have?
8. If I double my velocity, how much will my kinetic energy increase by?
9. A 1500kg car is traveling $25\frac{m}{s}$; what is their momentum?
10. A 1kg ball is rolling at $2\frac{m}{s}$; what is their momentum?
11. A 1500kg car traveling $25\frac{m}{s}$ hits a wall and comes to a stop after some time. What would be the impulse?
12. A student pushes a student in a chair with a 20N force for 30s. What would be the impulse?
13. A 1kg ball is moving at $5\frac{m}{s}$. It collides with a 2kg ball that was not moving. The 2kg ball now travels at $2\frac{m}{s}$. How fast is the 1kg ball now moving?
14. A 1500kg car traveling $25\frac{m}{s}$ moves to the other lane to pass a slow car. The 5000kg truck heading the opposite direction at $-30\frac{m}{s}$ does not notice the car. The two collide and move together. What is their combined velocity?

*Project One Assessments:* Above are the different assessments needed for the project. Each of the assessments follow the calendar and allow for the content to be broken up along the project. The formative assessment is included to assess all concepts learned during the project.

**Project Two**

Project two allows for the students to have an authentic connection to hunting. This project will kick off during the first few weeks of hunting season and many of the students are avid hunters or have members in their family that hunt. The students will be creating a poster to draw an audience to an educational session on hunting. The students will also create a presentation for this informational session.

The resources for project two are for both the teacher/instructor and student alike. There is a project outline that outlines all of the standards to be addressed in the project, the entry event, a brief description of the project, student objectives, and resources necessary. To support the outline, there is a rubric that provides the students a clear idea of what to include in their poster and presentation as well as provides the teacher with an assessment tool for the project. The calendar also provides the teacher and students with a sense of progress through the project. Students know when to complete graded assignments as well as provides dates for assessments. The sample lessons and supporting documents allow for the teacher to gain an idea of what a typical content day, lab day, and project day would look like in this curriculum. The assessments also provide the teacher a resource to assess individual progress.

## Curriculum Design Template

| | | | | | |
|---|---|---|---|---|---|
| **Name of Project:** | **Hunting Education** | | | **Duration:** | **9 weeks** |
| **Subject/Course:** | Physics/ How Things Work | **Teacher(s):** | Miranda | **Grade Level:** | 10 |

**Project Snapshot**

| | |
|---|---|
| **Driving Question:** | What should hunters know before going out to hunt? |
| **Project Summary:** Create a campaign to educate new hunters on hunting. | **Stained Inquiry -**<br>Standards:<br>• HS-PS2-1. Analyze data to support the claim that Newton's Second Law of Motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration<br>• HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.<br>◦ P-PS2-1. Use tools and materials to design and build a device that causes an object to move faster with a push or a pull.*<br>◦ K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.<br>◦ K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.*<br>◦ 3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.<br>◦ 5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down.<br>◦ MS-PS2-2. Plan and conduct an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.<br>◦ MS-PS3-5. Construct, use, and present an argument to support the claim that when work is done on or by a system, the energy of the system changes as energy is transferred to or from the system.<br><br>**Authenticity** - The students are hunters or have a relative that hunts. Will be pairing with the physical education teacher to co-teach the project and have the students shooting bow and arrows.<br>**Voice and Choice** - The students can design and create their campaign.<br>**Critique and Revision** - Students will submit outlines and rough drafts to receive feedback from peers and staff.<br>**Public Product** - Poster and presentation educating new hunters on hunting.<br><br>**Entry Event:** Students will watch an animated clip on archery. Clip: https://www.youtube.com/watch?v=Lq2UAVydzyE |

**Stage 1 – Desired Results**

**Established Goals:**

- **I can create a list of important information for bow hunting.**
- **I can create a list of concepts that apply to bow and arrow hunting.**
- **I can create a rough draft poster and presentation to educate new hunters.**
- **I can improve my rough drafts using feedback.**

**Acquisition**

| *Students will know…* | *Students will be skilled at…* |
|---|---|
| • The following concepts: projectile motion (horizontal and vertical motion), Newton's Laws, center of mass, free body diagrams, weight (force due to gravity), centripetal force, force due to friction, Universal Law of Gravitation, work, and power.<br>• The difference between horizontal and vertical motion.<br>• The difference between Newton's Laws.<br>• How to calculate horizontal motion (range, velocity, and acceleration).<br>• How to calculate vertical motion (height, velocity, and acceleration).<br>• How to measure distance, time, mass, motion, and force.<br>• How to calculate Newton's Second Law.<br>• How to interpret Newton's First and Third Law.<br>• Describe the center of mass for any object.<br>• How to calculate and draw a free body diagram.<br>• How to force due to gravity.<br>• How to calculate tangential velocity, centripetal acceleration, and centripetal force.<br>• How to calculate force due to friction.<br>• How to calculate the Universal Law of Gravitation.<br>• How to calculate work.<br>• How to calculate power. | • Collaborating together<br>• Communicate to each other and the world<br>• Critically think and develop their hunter poster and presentation<br>• Critically think about concepts<br>• Creatively develop a poster and presentation on the safety and concerns needed to hunt |

**Meaning**

| UNDERSTANDINGS:<br>*Students will understand…* | ESSENTIAL QUESTIONS:<br>*Students will keep considering… What should hunters know before going out to hunt?* |
|---|---|
| • To apply the following concepts to hunting: projectile motion (horizontal and vertical motion), Newton's Laws, center of mass, free body diagrams, weight (force due to gravity), centripetal force, force due to friction, Universal Law of Gravitation, work, and power. | |

| | | |
|---|---|---|
| | • To apply the understanding of calculations to shooting a bow and arrow.<br>• What hunting with a bow and arrow is.<br>• The dangers of hunting with bow and arrow (safety).<br>• The effect being in a tree stand would have on hunting vs. shooting on the ground.<br>• How to create an informative and eye catching poster.<br>• How to create an educational presentation for new hunters. | |
| | **Transfer** | |
| | *Students will be able to independently use their learning to...*<br>• Apply their understanding of concepts and hunting to provide feedback to other groups.<br>• Showcase their understanding in labs and assessments. | |

| **Stage 2 – Student Evidence** | | | |
|---|---|---|---|
| **Driving Question:** | What should hunters know before going out to hunt? | | |
| **Final Artifact(s)**<br>Presentations, Performances, Products, and/or Services | **Learning Outcomes/Targets**<br>Content & 21st century competencies needed by students to successfully complete products | **Checkpoints/Formative Assessments**<br>To check for learning and ensure students are on track | **Instructional Strategies for All Learners**<br>Provided by teacher, other staff, experts; includes scaffolds, materials, lessons aligned to learning outcomes and formative assessments |
| **Poster for Hunting Presentation for Hunting** | • Collaborating together | **Contract** | **Students will sign a contract at the beginning of the project in order to ensure collaboration of all students throughout the project.** |
| | • Communicate to each other and the world | **Contract** | **Within the contract the students will agree to communicate their work as well as praise/frustration to ensure the team completes quality work on time.** |
| | • Critically think and develop their beginning hunter poster and presentation | **Checkpoints (Rough Drafts) of poster and presentation**<br>**Final Draft of Poster**<br>**Final Draft of Presentation** | **These points will be assessed used a rubric distributed to students at the beginning of the project.** |
| | • Critically think about concepts | **Daily Practice (Entrance and Exit Tickets)**<br>**Labs**<br>**Quizzes (Given about every 2 weeks)**<br>**Final Assessment** | **The entrance and exit tickets will have a key that is used to provide feedback to the students on their progress of understanding the concept(s).**<br>**The labs will have a key that will be used to provide feedback to the students in order to assess their understanding. Students will be provided the opportunity to improve their work within a week time frame to show their understanding.**<br>**Both quizzes and the final assessment will have a key that will assess their work and provide the students feedback on their work. The students will be provided a week to meet with the teacher to strengthen weak areas and will take a retake when ready.** |
| | • Creatively develop a poster and presentation on the safety and concerns needed to hunt | **Checkpoints (Rough Drafts) of poster and presentation**<br>**Final Draft of Poster**<br>**Final Draft of Presentation** | **Students will research the safety concerns with hunting, specifically bow and arrow hunting.**<br>**Students will provide insight to each other as experts (hunters).** |

| **Stage 3 – Project Resources** | | |
|---|---|---|
| **Required Resources**<br>On-site people, facilities, equipment, materials, community resources | **What artifact will resource specifically support?** | **How will resource support student learning toward artifact completion?** |
| **Chromebooks** | Google Classroom, Labs, Storyboard | Students will use their chromebooks as a resource to all course information as well as will be used daily in class. |
| **Google Classroom** | Daily Practice, Labs | Students will understand and apply the following concepts: projectile motion (horizontal and vertical motion), Newton's Laws, center of mass, free body |

| | | |
|---|---|---|
| | | diagrams, weight (force due to gravity), centripetal force, force due to friction, Universal Law of Gravitation, work, and power. |
| **PASCO: carts, track, ballistic launcher, force sensor, motion sensor, different surfaces, software** | Labs | Students will understand, calculate, and apply the following concepts: projectile motion (horizontal and vertical motion), Newton's Laws, center of mass, free body diagrams, weight (force due to gravity), centripetal force, force due to friction, Universal Law of Gravitation, work, and power. |
| **Phet simulations** | Daily Practice, Labs | Students will understand, calculate, and apply the following concepts: projectile motion (horizontal and vertical motion), weight (force due to gravity), centripetal force, and Universal Law of Gravitation. |
| **Graphing Paper** | Daily Practice | Students will display graphical understanding of concepts. |
| **Rulers** | Daily Practice | Students will use a ruler to support their understanding of concepts. |
| **Calculator** | Daily Practice, Labs | Students will understand, and calculate the following concepts: projectile motion (horizontal and vertical motion), Newton's Laws, center of mass, free body diagrams, weight (force due to gravity), centripetal force, force due to friction, Universal Law of Gravitation, work, and power. |
| **Medium for Poster** | Poster | Students will create a poster for their presentation using a posterboard or Google Slides to apply concepts learned and prior knowledge of bow and arrow hunting. |
| **Google Slides** | Presentation | Students will create their educational presentation on bow and arrow hunting to support their poster using Google Slides. |
| **Quizzes** | Daily Practice, Labs | Students will showcase their understanding of the following concepts: projectile motion (horizontal and vertical motion), Newton's Laws, center of mass, free body diagrams, weight (force due to gravity), centripetal force, force due to friction, Universal Law of Gravitation, work, and power. |
| **Final Assessment** | Daily Practice, Labs | Students will showcase their understanding of the following concepts: projectile motion (horizontal and vertical motion), Newton's Laws, center of mass, free body diagrams, weight (force due to gravity), centripetal force, force due to friction, Universal Law of Gravitation, work, and power. |
| **Scale** | Daily Practice, Labs | Students will measure mass using a scale in order to calculate force. |
| **Measuring Tape / Meter Stick** | Daily Practice, Labs | Students will measure distance using a meter stick or measuring tape in order to be used in various calculations. |
| **Timer** | Daily Practice, Labs | Students will measure time using a cellphone or stopwatch in order to be used in various calculations. |
| **Public Audience** | **The final poster and presentation will be recorded and presented to various professionals.** | |

| **Stage 4 - Reflection** | | | | |
|---|---|---|---|---|
| **Reflection Methods** | **Individual feedback will be provided daily to daily practice using keys.** | ☐ | **Team feedback will be provided to the poster through peer feedback and instructor feedback.** | ☐ |
| | **Individual feedback will be provided to labs using keys.** | ☐ | **Team feedback will be provided to the presentation through peer feedback and instructor feedback.** | ☐ |
| | **Individual feedback will be provided to quizzes and final assessment using keys.** | ☐ | **Teams will have the opportunity to improve their project work.** | ☐ |
| | **Students will have the opportunity to use feedback to improve individual work.** | ☐ | | |

| **Notes:** |
|---|
| |

*Project Two Outline:* Includes standards, project overview, and resources needed for the project.

| | | 1 | 2 | 3 | 4 | Rating | |
|---|---|---|---|---|---|---|---|
| Poster | Content | The poster lacks statistics or information | The poster contains 1-2 facts and/or accurate statistics | The poster contains 3 facts and/or accurate statistics | The poster contains 3 powerful facts and/or accurate statistics | | |
| | Attendance | The poster does not have a way for people to attend/sign up for the presentation | | | The poster has a way for people to attend/sign up for the presentation | | |
| | Originality | The poster lacks both creativity and originality. | The poster shows group creativity but has no originality. | The poster shows group creativity and some original ideas. | The poster shows group creativity and the use of original ideas. | | |

| | | 1 | 2 | 3 | 4 | Rating | |
|---|---|---|---|---|---|---|---|
| Presentation | Content | In the presentation there is 1 concept pertaining to bow and arrow hunting | In the presentation there are 2 different concepts pertaining to bow and arrow hunting | In the presentation there are 3 different concepts pertaining to bow and arrow hunting | In the presentation there are 4 different concepts pertaining to bow and arrow hunting | | |
| | | In the presentation there is 1 important safety tip for bow and arrow hunting | In the presentation there are 2 important safety tips for bow and arrow hunting | In the presentation there are 3 important safety tips for bow and arrow hunting | In the presentation there are 4 important safety tips for bow and arrow hunting | | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Explanation of Poster | The presentation does not include a clear image of the poster | | | The presentation includes a clear image of the poster | | |
| | | The group does not explain every piece of the poster in the presentation | The group attempts to explain each piece of the poster in the presentation but seems repetitive or confusing | The group explains each piece of the poster in their presentation | The group explains and enhances each piece of the poster in their presentation | | |
| | Voice | Not all members take part in the presentation of the poster and presentation | | | All members take part in the presentation of the poster and presentation | | |

| Hunting Education Rubric | | | | |
|---|---|---|---|---|
| **Poster** | | | **Presentation** | |
| **Comments:** | | | | **Final Score** |

*Project Two Rubric:* Provides the students with an expectation of the project and the teacher with an assessment tool.

The calendar for project two is spaced over nine weeks meeting wise. This project similarly to project one includes a large amount of content therefore it requires more time to cover. In addition to the content spanning across this time, the project is also co-taught with the physical education teacher in which coordinating time in the gym to shoot archery is a factor. Due to the two breaks spanning this project, the project was broken into two pieces. Prior to the November break, the students will have taken the first quiz as well as completed a lab that involves analyzing their individual archery skills. During this time, the students will have learned projectile motion as well as taken a quiz to assess individual knowledge. The lab that is done in class is used as the first two pieces of the rubric. After returning from break, the students will learn all concepts related to forces, work, and power. The students will also take a quiz or assessment roughly every two weeks to showcase their individual understanding in an assessment setting. Project days are planned into the calendar to allow for the students to continuously connect back to the educating hunters poster and archery component.

| Nov 2018 | P2: Educating Hunters | | | |
|---|---|---|---|---|
| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** |
| 5 P2 Kick Off - Projectile Motion | 6 | 7 Soh Cah Toa Projectile motion at an angle | 8 | 9 Einstein Day |
| 12 Veteran's Day | 13 | 14 Projectile Lab | 15 | 16 Projectile Lab |
| 19 Quiz 1 | 20 | 21 Thanksgiving Holiday | 22 Thanksgiving Holiday | 23 Thanksgiving Holiday |
| 26 Hunting Safety / Poster, Presentation Work | 27 | 28 N1 N3 | 29 | 30 N2 |

| Dec 2018 | P2: Educating Hunters | | | |
|---|---|---|---|---|
| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** |
| 3 Newton's Laws | 4 | 5 COM, FBD, Weight | 6 | 7 Quiz 2 / Poster/Presentation Work |
| 10 Centripetal Force | 11 | 12 Frictional Force (Lab) | 13 | 14 Setting Forces Equal |
| 17 Gravity (Lab) | 18 | 19 Quiz 3 / Poster/Presentation Work | 20 Einstein Day | 21 Winter Recess |
| 24 Winter Recess | 25 Winter Recess | 26 Winter Recess | 27 Winter Recess | 28 Winter Recess |
| 31 Winter Recess | | | | |

| Jan 2019 | P2: Educating Hunters | | | |
|---|---|---|---|---|
| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** |
| | 1 Winter Recess | 2 Poster/Presentation Work | 3 | 4 Work/Power (Lab) |
| 7 Work/Power (Lab) | 8 | 9 Review | 10 | 11 Formative Assessment |
| 14 Improve Posters/Presentations | 15 | 16 Poster/Presentations | 17 | 18 Einstein Day |

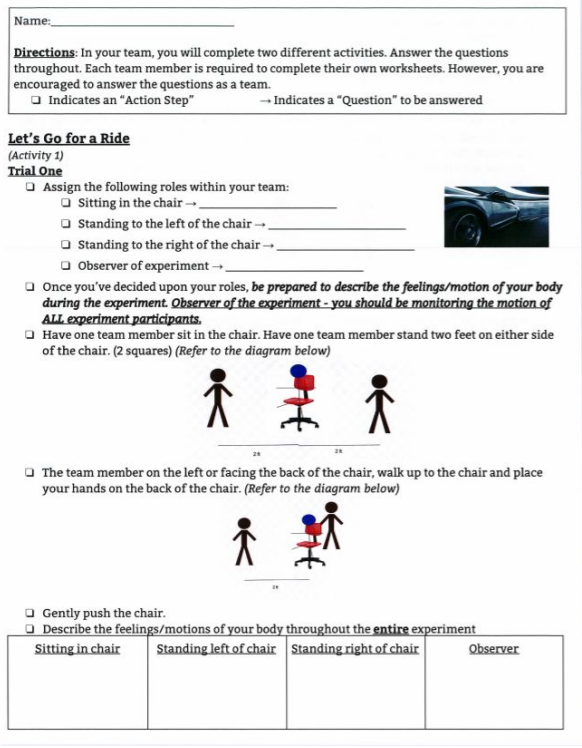
*Project Two Calendar:* The calendar provides the students and teacher with an expectation of what is done each day including due dates.

Sample Content Lesson

The sample content lesson included provides a lesson plan, notes, and a practice sheet for the students to complete during the span of the class period. The lesson provided allows for a teacher to see how Newton's First and Third Laws can be discovered in the classroom. The students use a simple activity of pushing someone in a chair to discover Newton's First Law and push each others hands to discover Newton's Third Law. The teacher is a facilitator in this setting as the students work at their own pace through the activities/notes. The instructor checks

the students work as they go and provides help when needed. After completing the notes in a group, the students then individually complete the practice to showcase their understanding of the concepts. The teacher provides feedback to the practice and returns it to the students to allow for growth.

| | |
|---|---|
| **Subject/Course** | Physics 100 |
| **Topic** | Educating Hunters |
| **Lesson Title:** | Newton's First and Third Law |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can use my movement to describe Newton's First Law.<br>• I can use my movement to describe Newton's Third Law. | |
| **Task List** | |
| • Provide students will groups as they arrive<br>• Go over packet and safety concerns<br>• Half the class go to activity one, half complete activity two (when complete switch) | |
| **Materials Needed** | |
| • Packet<br>• Chairs | |



Name:_____

**Directions**: In your team, you will complete two different activities. Answer the questions throughout. Each team member is required to complete their own worksheets. However, you are encouraged to answer the questions as a team.

❑ Indicates an "Action Step" → Indicates a "Question" to be answered

**Let's Go for a Ride**

*(Activity 1)*

**Trial One**

❑ Assign the following roles within your team:
- ❑ Sitting in the chair → _____
- ❑ Standing to the left of the chair → _____
- ❑ Standing to the right of the chair → _____
- ❑ Observer of experiment → _____

❑ Once you've decided upon your roles, ***be prepared to describe the feelings/motion of your body during the experiment. Observer of the experiment - you should be monitoring the motion of ALL experiment participants.***

❑ Have one team member sit in the chair. Have one team member stand two feet on either side of the chair. (2 squares) *(Refer to the diagram below)*

❑ The team member on the left or facing the back of the chair, walk up to the chair and place your hands on the back of the chair. *(Refer to the diagram below)*

❑ Gently push the chair.

❑ Describe the feelings/motions of your body throughout the **entire** experiment

| Sitting in chair | Standing left of chair | Standing right of chair | Observer |
|---|---|---|---|
| | | | |

**Trial Two**

❑ Assign the following roles within your team: **Should be different from before**
- ❑ Sitting in the chair → _____
- ❑ Standing to the left of the chair → _____
- ❑ Standing to the right of the chair → _____
- ❑ Observer of experiment → _____

❑ Once you've decided upon your roles, ***be prepared to describe the feelings/motion of your body during the experiment. Observer of the experiment - you should be monitoring the motion of ALL experiment participants.***

❑ Have one team member sit in the chair. Have one team member stand two feet on either side of the chair. (2 squares) *(Refer to the diagram below)*

❑ The team member on the left or facing the back of the chair, walk up to the chair and place your hands on the back of the chair. *(Refer to the diagram below)*

❑ Gently push the chair.

❑ Describe the feelings/motions of your body throughout the **entire** experiment

| Sitting in chair | Standing left of chair | Standing right of chair | Observer |
|---|---|---|---|
| | | | |

**Trial Three**

- ❑ Assign the following roles within your team: **Should be different from before**
  - ❑ Sitting in the chair → _____
  - ❑ Standing to the left of the chair → _____
  - ❑ Standing to the right of the chair → _____
  - ❑ Observer of experiment → _____
- ❑ Once you've decided upon your roles, ***be prepared to describe the feelings/motion of your body during the experiment. Observer of the experiment - you should be monitoring the motion of ALL experiment participants.***
- ❑ Have one team member sit in the chair. Have one team member stand two feet on either side of the chair. (2 squares) *(Refer to the diagram below)*

- ❑ The team member on the left or facing the back of the chair, walk up to the chair and place your hands on the back of the chair. *(Refer to the diagram below)*

- ❑ Gently push the chair.
- ❑ Describe the feelings/motions of your body throughout the **entire** experiment

| Sitting in chair | Standing left of chair | Standing right of chair | Observer |
|---|---|---|---|
| | | | |

**Trial Four**

- ❑ Assign the following roles within your team: **Should be different from before**
  - ❑ Sitting in the chair → _____
  - ❑ Standing to the left of the chair → _____
  - ❑ Standing to the right of the chair → _____
  - ❑ Observer of experiment → _____
- ❑ Once you've decided upon your roles, ***be prepared to describe the feelings/motion of your body during the experiment. Observer of the experiment - you should be monitoring the motion of ALL experiment participants.***
- ❑ Have one team member sit in the chair. Have one team member stand two feet on either side of the chair. (2 squares) *(Refer to the diagram below)*

- ❑ The team member on the left or facing the back of the chair, walk up to the chair and place your hands on the back of the chair. *(Refer to the diagram below)*

- ❑ Gently push the chair.
- ❑ Describe the feelings/motions of your body throughout the **entire** experiment

| Sitting in chair | Standing left of chair | Standing right of chair | Observer |
|---|---|---|---|
| | | | |

- ❑ Compare the motions/feelings of your entire team for each trial of the experiment.

→ Based on all of your observations, what conclusions can be made while sitting in the chair? Be sure to ***thoroughly*** explain your response.

→ Based on all of your observations, what conclusions can be made while standing to the left of the chair? Be sure to ***thoroughly*** explain your response.

→ Based on all of your observations, what conclusions can be made while standing to the right of the chair? Be sure to ***thoroughly*** explain your response.

→ Based on all of your observations, what conclusions can be made while you were the observer? Be sure to ***thoroughly*** explain your response.

- ❑ Answer the following questions:

→ Prior to being pushed, was the person sitting in the chair moving? ***Why or why not?***

→ After being pushed, what happened to the person sitting in the chair? ***Why do you think this happened?***

→ What happened to the person sitting in the chair when caught by the person standing on the right side? ***Why do you think this happened?***

**Definitions:**

**Force:** A push or a pull on a mass.

**Newton's First Law:**

- An object at rest, stays at rest unless acted on by an unbalanced force.
- An object traveling at a constant velocity, stays at a constant velocity unless acted on by an unbalanced force.

| Concept | Variable | Unit/Measured in | Example(s) |
|---|---|---|---|
| Force | F | Newtons - N |   |
| Newton's First Law | | |  |

→ How does this activity apply to Newton's First Law?

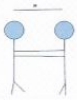
## Who's the strongest?

*(Activity 2)*

→ Make a prediction, determine who you think is your strongest team member?

_____

- ❑ Within your team, assign "roles":
  - ❑ A → _____
  - ❑ B → _____
  - ❑ C → _____
  - ❑ D → _____
- ❑ Team Members A and B:
  - ❑ Stand two feet across (two floor tiles/two arm lengths) across from each other with your feet shoulder width apart.
  - ❑ Place your hands up as though you are about to give a double high five
  - ❑ Push your team members hands.
  - ❑ The first person to move their feet or "fall over" loses



A_____ vs. B_____ : winner _____

A_____ vs. C_____ : winner _____

A_____ vs. D_____ : winner _____

B_____ vs. C_____ : winner _____

B_____ vs. D_____ : winner _____

**Person who won the most:**_____

→ When your hands are together, who is pushing who?

→ Which round took the longest to declare a winner? ***Why do you think that is?***

**Definitions:**

**Force:** A push or a pull on a mass.
**Newton's Third Law:** When one object exerts a force on a second object, the second object exerts a force on the first that is equal in magnitude and opposite in direction.

| Concept | Variable | Unit/Measured in | Example(s) |
|---|---|---|---|
| Force | F | Newtons - N |   |
| Newton's Third Law | | |  |

→ How does this activity apply to Newton's Third Law?

Name:_____

1. List three different forces ***and*** describe how they are a force.

2. A student goes bowling at the bowling alley.
   a. She rolls the bowling ball down the aisle and wants to know what law would apply to this scenario right before the ball hits the pins. Which law does this apply to and how?

   b. The bowling ball now hits the pins and gets a strike. Which law does this apply to and how?

3. Draw an "action/reaction pair" (an example of Newton's Third Law) ***and*** explain how it applies to Newton's Third Law.

Sample Project Lesson

The project lesson included provides the teacher/instructor with a lesson plan to span the class period. After providing the quiz, included in the assessment section, the students will then work on improving their posters with the provided feedback.

| | |
|---|---|
| **Subject/Course** | Physics 100 |
| **Topic** | Educating Hunters |
| **Lesson Title:** | Quiz / Improve Poster and Presentation |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can work together with my team to improve our poster and presentation according to feedback and the rubric. | |
| **Task List** | |
| • Quiz<br>• Work with team to improve poster and presentation by designating tasks according to feedback and the rubric. | |
| **Materials Needed** | |
| • Quiz<br>• Rubric<br>• Prior Rough Drafts | |

Sample Lab Lesson

The sample lab lesson included provides the teacher with a lesson plan and lab for the students to complete. This lab was provided because it is inquiry based, it requires the students to recall on their understanding of concepts, and asks the students to recall their actions done in physical education in order to complete the lab.

| | |
|---|---|
| **Subject/Course** | Physics 100 |
| **Topic** | Educating Hunters |
| **Lesson Title:** | Projectile Motion / Archery Lab |
| **Lesson Duration** | 75 minutes - 2 Classes |
| **Lesson Objectives** | |
| • I can measure my time, range, and height before shooting a target with a bow and arrow.<br>• I can analyze a video to determine the horizontal velocity of an arrow.<br>• I can calculate the range based on my measurements and video analysis.<br>• I can calculate the height based on my measurements and known values.<br>• I can calculate percent error based on measurements and calculations. | |
| **Task List** | |
| • Provide students will groups as they arrive<br>• Go over lab packet / safety instructions.<br>• Bring teams into the gym to record/shoot at a target with bow and arrows.<br>• Record 4 videos with your team and record measurements.<br>• Perform calculations. | |
| **Materials Needed** | |
| • Packet<br>• Calculator<br>• Video Camera<br>• Tripod<br>• Bow<br>• Arrows<br>• Target | |

Name:_____

**Roles while recording:**

Person Launching:_____

Person Ensuring Technique:_____

Person(s) Measuring Time/Range/Height:_____

**Measurements while recording:**

| Video #1 | Measured Time (s) | Measured Range (m) | Measured Height(m) |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

*Time: Taken from arrow leaving the bow to hitting the target.
*Range: Measured distance from tip of arrow to target.
*Height: Measured distance top of target to arrow placement.

**Video Analysis**

Using the video and capstone determine the horizontal velocity.

1. _____
2. _____
3. _____
4. _____

**Calculations**

Determine the range from the bow to the target.

| | | | |
|---|---|---|---|
| | | | |

Determine the height the arrow should hit.

| | | | |
|---|---|---|---|
| | | | |

**Percent error**

Using the below equation, calculate the percent error for your calculations and measured values. Use your calculations as the accepted values and the measured as the measured values.

$$\% \text{ Error} = \left| \frac{\text{measured} - \text{accepted}}{\text{accepted}} \right| \times 100$$

Determine the percent error in your calculation of range.

| | | | |
|---|---|---|---|
| | | | |

Determine the percent error in your calculation of height.

| | | | |
|---|---|---|---|
| | | | |

What can be done to minimize the error?

_____

_____

_____

_____

**Plan for Shooting for Grade**

Range:_____

Height of target:_____

Make sure we consider these before/while launching:

- 
- 
- 
- 

Did you hit the bullseye?_____

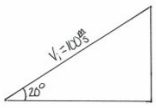
*Project Two Sample Lessons:* The lessons above include three types of lessons: content, lab, and project. Each of the lessons include the materials needed for the lesson.

# Quiz 1

Name:_____

Directions: Complete the following questions, showing all work when necessary including equations and units.

1. A maximum horizontal displacement is also known as the _____.
2. Vertical displacement is also known as the _____.
3. A projectile is shot horizontally out of a cannon with a velocity of 75 $\frac{m}{s}$. It takes 5 seconds to reach the ground.
   a. What is the projectile's horizontal velocity just before hitting the ground?
   b. What is the projectile's vertical velocity just before hitting the ground?
   c. What was the range?
4. Label the following triangle and determine the horizontal and vertical velocities for a projectile fired at 100 $\frac{m}{s}$ at an angle of 20°.




5. A cannonball is fired from a cannon at an angle of 15° and at a velocity of 200 $\frac{m}{s}$.
   a. What was the cannonballs initial horizontal velocity?
   b. What was the cannonballs initial vertical velocity?
   c. What was the cannonballs horizontal velocity just before hitting the ground?
   d. How long did it take to reach the maximum height?
   e. What was the maximum height the cannonball reached?
   f. What was the cannonball's vertical velocity just before hitting the ground?
   g. What was the range?

# Quiz Two

Name:_____

Directions: There are two parts to this quiz: one conceptual and one mathematical. Complete both parts and show all work when necessary.

**PART 1: Conceptual**

| Word Bank (Words can be used more than once or not at all) | | | | |
|---|---|---|---|---|
| Motion | Mass | Scalar | Force | Equal |
| Velocity | Rest | Vector | Opposite | Constant |
| Acceleration | Net | Unbalanced | Direction | Momentum |

Newton's First Law states:

- An object traveling at _____ _____ stays at _____ _____ unless acted on by an _____ force.
- An object at _____ stays at _____ unless acted on by an _____ force.

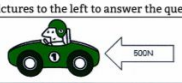
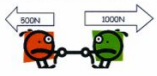
Newton's Second Law states:

- The _____ of an object depends directly upon the _____ _____ acting upon the object, and inversely upon the _____ of the object.

Newton's Third Law states:

- When one object exerts a force on a second object, the second object exerts a force on the first that is _____ in magnitude and _____ in direction.

Use the pictures to the left to answer the questions to the right.

| | |
|---|---|
| 1.   | The car moves to the left / right with a force of 500N / 200N |
| 2.   | The rocket moves up / down with a force of 1000N / 2000N |
| 3.   | Orange blob is pulling with a force of ____N<br>Green blob is pulling with a force of ____N<br>The force to the left / right is bigger than the force to the left / right. |

**PART 1: Mathematical**

Complete the following questions showing all work when necessary.

→ What is the unbalanced force required to accelerate a 2kg mass at 4 $\frac{m}{s^2}$?

→ Someone hits a golf ball with a mass of 0.3kg which accelerates at a rate of 15 $\frac{m}{s^2}$. What amount of force acted on the ball?

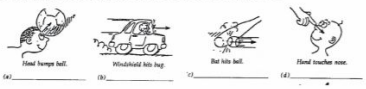
→ You push your brother on a sled down the hill. The mass of the sled and your brother is 40kg and they accelerate at 5 $\frac{m}{s^2}$. What force did you push with?

→ What effect does doubling the net force have on acceleration? (Don't just say it increases or decreases, by what factor does it increase or decrease?)

→ What effect does doubling the mass have on acceleration? (Don't just say it increases or decreases, by what factor does it increase or decrease?)

→ What effect does doubling the acceleration have on the net force? (Don't just say it increases or decreases, by what factor does it increase or decrease?)

→ Write the following reaction pairs for the four scenarios below.



# Quiz Three

Name:_____
Directions: Complete the following questions, showing all work when necessary.

→ Draw a school and label its center of mass.

→ Which of the following would have the smallest inertia and **why**?

Pencil School Bus Water bottle

| Explanation: |
|---|

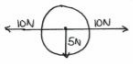
→ Which of the following would have the largest inertia and **why**?

Pencil School Bus Water bottle

| Explanation: |
|---|

→ Draw a free body diagram of a chair that has a force of 2N down, 4N up, and 8N to the left.

→ Complete the following FBD so that is in equilibrium.




→ An adult has landed on the moon and has a mass of 60kg. What is the weight of the person on the moon? (acceleration due to gravity on the moon = -1.62 $\frac{m}{s^2}$)

→ A steel roller coaster car has a mass of 750kg. It is just about to move on the steel tracks, assuming the roller coaster is on Earth, what is the frictional force felt by the coaster?

→ A 4kg ball on a string takes 5s to complete a circle of radius 3m.

| What is the tangential velocity if the string was to be cut? |
|---|
| What is the centripetal acceleration? |
| What is the centripetal force? |
| Draw the tangential velocity vector, the centripetal acceleration vector, and the centripetal force vector at **ONE** of the following points.  |

→ A 5000kg truck is traveling on dry asphalt, drives around a curve on Earth with a 15m radius. What is the tangential velocity of the car?

# Formative Assessment

Name:_____
Directions: Please complete the following problems and show all work when necessary.

1. A constant horizontal force ($\theta = 0°$) of 6N is applied to a box 3m. It took 1.5s to move the box 3m.
   a. How much work did it require to move the box?

   b. How much power was needed?

2. A constant force of 18N is applied to a box to move it 10m at an angle of 45°. It took 2s to move the box the 10m.
   a. How much work did it require to move the box?

   b. How much power was required to move the box?

3. Choose one of the following activities
   a. Bowling
   b. Driving

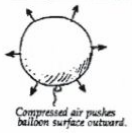
   Explain how the activity you choose applies to each of Newton's Laws.

| 1st Part of N1 | 2nd Part of N1 | N2 | N3 |
|---|---|---|---|
| Explanation: | Explanation: | Explanation: | Explanation: |

4. Someone hits a golf ball with a mass of 0.3kg which accelerates at a rate of 15 $\frac{m}{s^2}$. What amount of force acted on the ball?

5. You push your brother on a sled down the hill. The mass of the sled and your brother is 45kg and they accelerate at 5 $\frac{m}{s^2}$. What force did you push with?

6. Write the reaction pair for each of the scenarios below.


(f)_____ (g)_____

7. Draw a cellphone and label its center of mass.

8. A cell phone and a table are next to each other. Which object would have the greatest inertia and why?

9. Complete the following FBD's so that they are in equilibrium.


10. An adult has landed on jupiter and has a mass of 75kg. What is the weight of the person on jupiter? (acceleration due to gravity on jupiter = $-24.5 \frac{m}{s^2}$)

11. A 5500kg truck is driving on dry asphalt on Earth. What is the frictional force?

12. A 2kg ball on a string takes 0.5s to complete a circle of radius 1.2m.

| |
|---|
| What is the tangential velocity if the string was to be cut? |
| Calculate the centripetal acceleration |
| Calculate the centripetal force |

13. Complete the following table assuming projectile motion by circling the correct choice.

| | Horizontal Motion | Vertical Motion |
|---|---|---|
| Force | No / Yes | No / Yes |
| Acceleration | No / Yes | No / Yes |
| Velocity | No<br>Yes - Constant<br>Yes- Changes | No<br>Yes - Constant<br>Yes- Changes |

*Project Two Assessments:* Above are the different assessments needed for the project. Each of the assessments follow the calendar and allow for the content to be broken up along the project. The formative assessment is included to assess all concepts learned during the project.

**Project Three**

Project three allows for the students to get creative and create an escape room based on the concepts they learn during the project. This project will kick off by having them escape a room that the instructor created using concepts the students have learned throughout the year. In getting creative, the teams will create problems/questions/riddles for a team to solve as well as set up the room in a way that allows for a unique experience.

The resources for project three are for both the teacher/instructor and student alike. There is a project outline that outlines all of the standards to be addressed in the project, the entry event, a brief description of the project, student objectives, and resources necessary. To support

the outline, there is a rubric that provides the students a clear idea of what to include in their escape room as well as provides the teacher with an assessment tool for the project. The calendar also provides the teacher and students with a sense of progress through the project. Students know when to complete graded assignments as well as provides dates for assessments. The sample lessons and supporting documents allow for the teacher to gain an idea of what a typical content day, lab day, and project day would look like in this curriculum. The assessments also provide the teacher a resource to assess individual progress.

| Curriculum Design Template | | | | | |
|---|---|---|---|---|---|
| **Name of Project:** | **Escape Room** | | | **Duration:** | **4 weeks** |
| **Subject/Course:** | Physics/ How Things Work | **Teacher(s):** | Miranda | **Grade Level:** | 10 |
| **Project Snapshot** | | | | | |
| **Driving Question:** | What concepts do I need to know to work my way out of this room? | | | | |
| **Project Summary:** Create a series of problems for someone to solve to be able to escape a locked room. | **Stained Inquiry -**<br>Standards:<br>• HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.<br>• HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).<br>• HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.<br>○ 4-PS3-2. Make observations to provide evidence that energy is conserved as it is transferred and/or converted from one form to another<br>○ 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.<br>○ MS-PS3-2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.<br><br>**Authenticity** - The students have heard or been in an escape room. They can use their problem solving skills in order to figure their way out of the room.<br>**Voice and Choice** - The students can design and create their problems and escape room set up.<br>**Critique and Revision** - Students will submit rough drafts to receive feedback from peers and staff.<br>**Public Product** - Escape room for others to partake in.<br><br>**Entry Event: S**tudents will walk into an escape room that I have set up. They will solve a series of problems they have learned thus far to "escape" the room. | | | | |

| **Stage 1 – Desired Results** | | |
|---|---|---|
| **Established Goals:**<br>• **I can determine the number of problems I want someone to solve in order to escape.**<br>• **I can create at least 5 problems for someone to solve in order to escape.**<br>• **I can design the layout of the room in order to hide clues/problems.**<br>• **I can improve my rough drafts using feedback.** | **Acquisition** | |
| | *Students will know…*<br>• The following concepts: conversions, vector addition, free fall, gravitational potential energy, and the Conservation of Energy.<br>• The difference between x and y components of a vector.<br>• How to calculate vertical motion as it pertains to freefall (height, velocity, and acceleration).<br>• How energy can be converted to different forms.<br>• How to calculate gravitational potential energy.<br>• How to calculate the Conservation of Energy. | *Students will be skilled at…*<br>• Collaborating together<br>• Communicate to each other and the world<br>• Critically think and develop problems and design of their escape room<br>• Critically think about concepts<br>• Creatively develop an escape room |
| | **Meaning** | |
| | UNDERSTANDINGS:<br>*Students will understand…*<br>• To apply the following concepts to an escape room: conversions, vector addition, free fall, gravitational potential energy, and the Conservation of Energy.<br>• What an escape room is and how to get out of it.<br>• How to create an escape room that is engaging. | ESSENTIAL QUESTIONS:<br>*Students will keep considering… What concepts do I need to know to work my way out of this room?* |
| | **Transfer** | |
| | *Students will be able to independently use their learning to…*<br>• Apply their understanding of concepts and escape rooms to provide feedback to other groups.<br>• Showcase their understanding in labs and assessments. | |

| Stage 2 – Student Evidence | | | |
|---|---|---|---|
| **Driving Question:** | What concepts do I need to know to work my way out of this room? | | |
| **Final Artifact(s)**<br>Presentations, Performances, Products, and/or Services | **Learning Outcomes/Targets**<br>Content & 21st century competencies needed by students to successfully complete products | **Checkpoints/Formative Assessments**<br>To check for learning and ensure students are on track | **Instructional Strategies for All Learners**<br>Provided by teacher, other staff, experts; includes scaffolds, materials, lessons aligned to learning outcomes and formative assessments |
| **Questions for inside the escape room**<br><br>**Key for the questions**<br><br>**Design set up of the escape room**<br><br>**Key for how to solve the escape room** | • Collaborating together | **Contract** | **Students will sign a contract at the beginning of the project in order to ensure collaboration of all students throughout the project.** |
| | • Communicate to each other and the world | **Contract** | **Within the contract the students will agree to communicate their work as well as praise/frustration to ensure the team completes quality work on time.** |
| | • Critically think and develop problems and design of their escape room | **Checkpoints of questions and room design**<br>**Final Draft of Questions with Keys**<br>**Final Draft of Room setup with key** | **These points will be assessed used a rubric distributed to students at the beginning of the project.** |
| | • Critically think about concepts | **Daily Practice (Entrance and Exit Tickets)**<br><br>**Labs** | **The entrance and exit tickets will have a key that is used to provide feedback to the students on their progress of understanding the concept(s).**<br>**The labs will have a key that will be used to provide feedback to the students in order to assess their understanding. Students will be provided the opportunity to improve their work within a week time frame to show their understanding.** |
| | | **Final Assessment** | **The final assessment will have a key that will assess their work and provide the students feedback on their work. The students will be provided a week to meet with the teacher to strengthen weak areas and will take a retake when ready.** |
| | • Creatively develop an escape room | **Checkpoints of questions and room design**<br>**Final Draft of Questions with Keys**<br>**Final Draft of Room setup with key** | **Students will research different ways to set up an escape room for example riddles, combination locks, and puzzles.** |

| Stage 3 – Project Resources | | |
|---|---|---|
| **Required Resources**<br>On-site people, facilities, equipment, materials, community resources | **What artifact will resource specifically support?** | **How will resource support student learning toward artifact completion?** |
| **Chromebooks** | Google Classroom, Labs, Questions for Escape Room | Students will use their chromebooks as a resource to all course information as well as will be used daily in class. |
| **Google Classroom** | Daily Practice, Labs | Students will understand and apply the following concepts: conversions, vector addition, free fall, gravitational potential energy, and the Conservation of Energy. |
| **Foam tracks and marbles** | Lab | Students will understand, calculate, and apply the following concepts: gravitational potential energy and the Conservation of Energy. |
| **Phet simulations** | Daily Practice, Lab | Students will understand, calculate, and apply the following concepts: gravitational potential energy and the Conservation of Energy |
| **Graphing Paper** | Daily Practice | Students will display graphical understanding of concepts. |
| **Rulers** | Daily Practice | Students will use a ruler to support their understanding of concepts. |
| **Calculator** | Daily Practice, Labs | Students will understand, and calculate the following concepts: conversions, vector addition, free fall, gravitational potential energy, and the Conservation of Energy. |
| **Google Document** | Questions | Students will create their questions for the escape room in a Google Document to ensure clarity. |

| | | |
|---|---|---|
| **Final Assessment** | Daily Practice, Labs | Students will showcase their understanding of the following concepts: conversions, vector addition, free fall, gravitational potential energy, and the Conservation of Energy. |
| **Scale** | Daily Practice, Labs | Students will measure mass using a scale in order to calculate different forms of energy. |
| **Measuring Tape / Meter Stick** | Daily Practice, Labs | Students will measure distance using a meter stick or measuring tape in order to be used in various calculations. |
| **Timer** | Daily Practice, Labs | Students will measure time using a cellphone or stopwatch in order to be used in various calculations. |

| | |
|---|---|
| **Public Audience** | **The escape room can be replicated or completed by anyone with the knowledge of physics.** |

| **Stage 4 - Reflection** | | | | |
|---|---|---|---|---|
| **Reflection Methods** | **Individual feedback will be provided daily to daily practice using keys.** | ☐ | **Team feedback will be provided to the questions through peer feedback and instructor feedback.** | ☐ |
| | **Individual feedback will be provided to labs using keys.** | ☐ | **Team feedback will be provided to the room setup through instructor feedback.** | ☐ |
| | **Individual feedback will be provided to the final assessment using a key.** | ☐ | **Teams will have the opportunity to improve their project work.** | ☐ |
| | **Students will have the opportunity to use feedback to improve individual work.** | ☐ | | |

| |
|---|
| **Notes:** |

*Project Three Outline*: Includes standards, project overview, and resources needed for the project.

| | | 1 | 2 | 3 | 4 | Rating |
|---|---|---|---|---|---|---|
| **Questions / Problems** | Number of Questions | The team creates 1-2 questions, riddles, or problems to be solved. | The team creates 3 questions, riddles, or problems to be solved. | The team creates 4 questions, riddles, or problems to be solved. | The team creates 5 questions, riddles, or problems to be solved. | |
| | Quality of Questions | The team puts little to no effort into the questions. | The team creates questions that are too difficult or too easy for the reader. (More than 7 minutes or less than 2 minutes) | The team creates questions that challenge the reader. (Roughly 3-7 minutes per question) | The team creates questions that vary in difficulty. (Roughly 3-7 minutes per question) | |
| | Application of Questions | The team does not use content learned during this project for the questions, riddles, or problems. | | | The team uses content learned during this project for the questions, riddles, or problems. | |
| | Key for Questions | The team creates an accurate key to solve the created questions with a lot of errors. | The team creates an accurate key to solve the created questions with many errors. | The team creates an accurate key to solve the created questions with a few errors. | The team creates an accurate key to solve the created questions. | |

| | | 1 | 2 | 3 | 4 | Rating | |
|---|---|---|---|---|---|---|---|
| Escape Room Setup | Design | The team does not show creativity in the room setup by using different materials or locations for hints or questions. | | The team shows creativity in the room setup by using different materials or locations for hints or questions. | The team shows creativity in the room setup by using different materials and locations for hints or questions. | | |
| | Creativity | The team does not show a variety of problem solving techniques in their escape room and the placement of the questions. | | The team shows a variety of problem solving techniques in their escape room and/or the placement of the questions. | The team shows a variety of problem solving techniques in their escape room and the placement of the questions. | | |
| | Key for Escape Room | The team does not create a key to show how to successfully complete the escape room. | | | The team creates a key to show how to successfully complete the escape room including: which spot in the room to go to, which question to answer, and what action to do. | | |

| Escape Room Rubric | | | | |
|---|---|---|---|---|
| Questions / Problems | | | Escape Room Setup | |
| Comments: | | | | Final Score |

*Project Three Rubric:* Provides the students with an expectation of the project and the teacher with an assessment tool.

Project three is a shorter project in respect to the other projects as it spans four weeks on the calendar. There is less content in this project which leads to the smaller timeline and the placement of this project allows for the students to have a "break" from the longer projects to work on a smaller one. Though it is shorter, the project's content is not any less valuable. It starts with vector addition and potential energy which leads to Conservation of Energy. This project only has the formative assessment due to the content load, however there are labs that are given every week to ensure that the students understand the concepts and the application of them. Aside from the first day, the project days are placed at the end of this project to allow for them to plan and create the room in consecutive days.

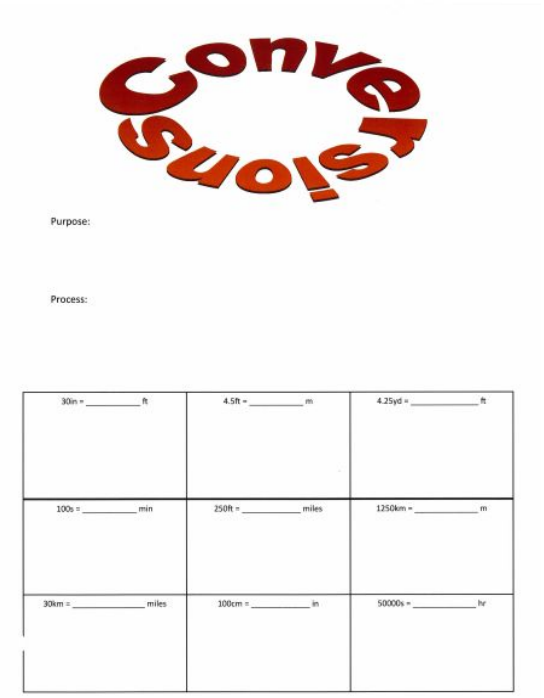
| Jan/Feb 2019 | P3: Escape Room | | | |
|---|---|---|---|---|
| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** |
| 21 Martin Luther King Jr. Day | 22 | 23 P3 Kick Off, Example Escape Room | 24 | 25 Staff Development Day |
| 28 Conversions | 29 | 30 Vector Addition | 31 | 1 Lab |
| 4 Potential Energy / Free Fall | 5 | 6 Conservation of Energy | 7 | 8 Lab |
| 11 Review | 12 | 13 Formative Assessment | 14 | 15 Einstein Day |
| 18 President's Recess | 19 President's Recess | 20 President's Recess | 21 President's Recess | 22 President's Recess |
| 25 Escape Room Plan | 26 | 27 Escape Room Build | 28 | 1 Complete Team's Escape Rooms |

*Project Three Calendar:* The calendar provides the students and teacher with an expectation of what is done each day including due dates.

Sample Content Lesson

The sample content lesson included provides a lesson plan, notes, and a practice sheet for the students to complete during the span of the class period. This lesson was chosen to include as there are some concepts that require repetition in order to master the process, conversions is one of those processes. After completing the notes in pairs, the students then individually complete the practice to showcase their understanding of the concepts. The teacher provides feedback to the practice and returns it to the students to allow for growth.

| | |
|---|---|
| **Subject/Course** | Physics 100 |
| **Topic** | Escape Room |
| **Lesson Title:** | Conversions |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can apply my knowledge of conversions to convert different concepts I have learned thus far. | |
| **Task List** | |
| • Conversions Notes - As a team<br>• Conversions Practice - Independent | |
| **Materials Needed** | |
| • Conversion Notes<br>• Conversion Practice | |




Sample Project Lesson

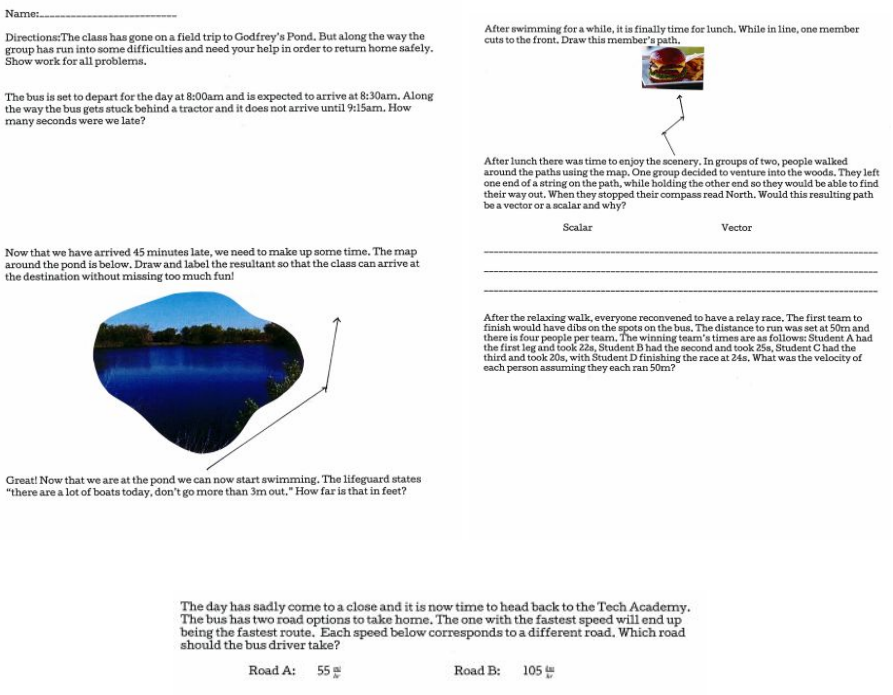
The project lesson included provides the teacher/instructor with a lesson plan to span the class period. The students will use their rubric in their groups to meet the standards through their own pacing.

| **Subject/Course** | Physics 100 |
|---|---|
| **Topic** | Escape Room |
| **Lesson Title:** | Escape Room Planning |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can apply my knowledge conversions, free fall, potential energy, and Conservation of energy to create problems/questions for a team to solve.<br>• I can create a key for my questions/problems.<br>• I can draw where I plan to place each of my questions in the room.<br>• I can draw a key of a successful completion of the escape room. | |
| **Task List** | |
| • Design Escape Room with team<br>• Create a key for the Escape Room<br>• Create the questions/problems to be solved in the room<br>• Create a key for the questions/problems | |
| **Materials Needed** | |
| • Google Document<br>• Materials brought from home for the Escape Room (combination locks, boxes, etc.) | |

Sample Lab Lesson

The sample lab lesson included provides the teacher with a lesson plan and lab for the students to complete. This lab was provided because it applies to the students lives by using a park they regularly attend.

| | |
|---|---|
| **Subject/Course** | Physics 100 |
| **Topic** | Escape Room |
| **Lesson Title:** | Conversions and Vector Addition Lab |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can apply my knowledge of conversions to Summer Camp.<br>• I can apply my knowledge of vector addition to a real scenario (summer camp). | |
| **Task List** | |
| • Conversion and Vector Addition Lab with partner | |
| **Materials Needed** | |
| • Conversion and Vector Addition Lab<br>• Rulers<br>• Colored Pencil (Red)<br>• Calculator | |



Name:_____

Directions:The class has gone on a field trip to Godfrey's Pond. But along the way the group has run into some difficulties and need your help in order to return home safely. Show work for all problems.

The bus is set to depart for the day at 8:00am and is expected to arrive at 8:30am. Along the way the bus gets stuck behind a tractor and it does not arrive until 9:15am. How many seconds were we late?

Now that we have arrived 45 minutes late, we need to make up some time. The map around the pond is below. Draw and label the resultant so that the class can arrive at the destination without missing too much fun!

Great! Now that we are at the pond we can now start swimming. The lifeguard states "there are a lot of boats today, don't go more than 3m out." How far is that in feet?

After swimming for a while, it is finally time for lunch. While in line, one member cuts to the front. Draw this member's path.

After lunch there was time to enjoy the scenery. In groups of two, people walked around the paths using the map. One group decided to venture into the woods. They left one end of a string on the path, while holding the other end so they would be able to find their way out. When they stopped their compass read North. Would this resulting path be a vector or a scalar and why?

Scalar Vector

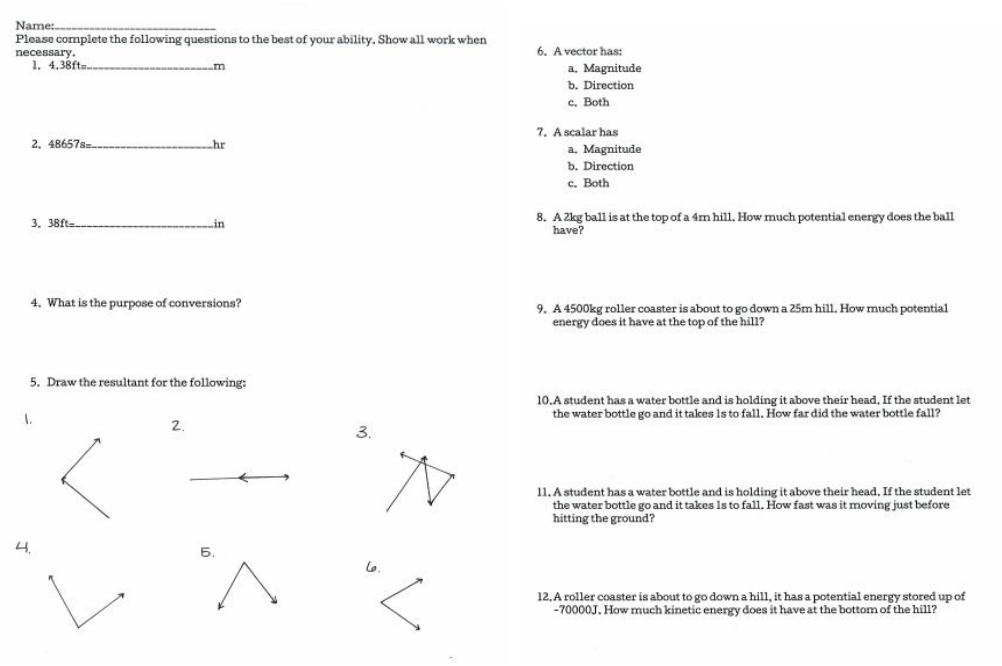
After the relaxing walk, everyone reconvened to have a relay race. The first team to finish would have dibs on the spots on the bus. The distance to run was set at 50m and there is four people per team. The winning team's times are as follows: Student A had the first leg and took 22s, Student B had the second and took 25s, Student C had the third and took 20s, with Student D finishing the race at 24s. What was the velocity of each person assuming they each ran 50m?

The day has sadly come to a close and it is now time to head back to the Tech Academy. The bus has two road options to take home. The one with the fastest speed will end up being the fastest route. Each speed below corresponds to a different road. Which road should the bus driver take?

Road A: $55 \frac{mi}{hr}$ Road B: $105 \frac{mi}{hr}$

*Project Three Sample Lessons:* The lessons above include three types of lessons: content, lab, and project. Each of the lessons include the materials needed for the lesson.

Formative Assessment

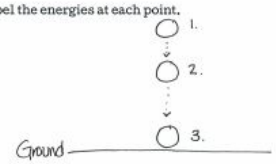


Name:_____
Please complete the following questions to the best of your ability. Show all work when necessary.

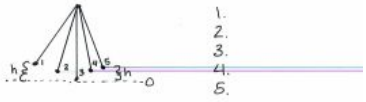
1. 4.38ft=_____m
2. 48657s=_____hr
3. 38ft=_____in
4. What is the purpose of conversions?
5. Draw the resultant for the following:

1. 2. 3. 4. 5. 6.

6. A vector has:
   a. Magnitude
   b. Direction
   c. Both
7. A scalar has
   a. Magnitude
   b. Direction
   c. Both
8. A 2kg ball is at the top of a 4m hill. How much potential energy does the ball have?
9. A 4500kg roller coaster is about to go down a 25m hill. How much potential energy does it have at the top of the hill?
10. A student has a water bottle and is holding it above their head. If the student let the water bottle go and it takes 1s to fall. How far did the water bottle fall?
11. A student has a water bottle and is holding it above their head. If the student let the water bottle go and it takes 1s to fall. How fast was it moving just before hitting the ground?
12. A roller coaster is about to go down a hill, it has a potential energy stored up of -70000J. How much kinetic energy does it have at the bottom of the hill?
13. Label the energies at each point.




14. A pendulum is lifted to a height and is then let go. Label the energies at each point.




*Project Three Assessment:* Above is the assessment needed for the project. The formative assessment is included to assess all concepts learned during the project.

**Project Four**

Project four allows for the students to utilize research strategies to support their side of the debate. This project will kick off by having them read two different, conflicting articles on the effect technology has on one's health. Through their research the students will be able to

form an argument as well as research the opposers viewpoint to have a well rounded debate. The students will also get creative in the creation of the concept overview. In the overview, the students will address each of the concepts learned during the project in order to inform someone who does not know physics.

The resources for project four are for both the teacher/instructor and student alike. There is a project outline that outlines all of the standards to be addressed in the project, the entry event, a brief description of the project, student objectives, and resources necessary. To support the outline, there is a rubric that provides the students a clear idea of what to include in their debate plan and concept overview as well as provides the teacher with an assessment tool for the project. The calendar also provides the teacher and students with a sense of progress through the project. Students know when to complete graded assignments as well as provides dates for assessments. The sample lessons and supporting documents allow for the teacher to gain an idea of what a typical content day, lab day, and project day would look like in this curriculum. The assessments also provide the teacher a resource to assess individual progress.

<table>
<tr><th colspan="6">Curriculum Design Template</th></tr>
<tr><td>Name of Project:</td><td colspan="3">Electronics Debate</td><td>Duration:</td><td>6 weeks</td></tr>
<tr><td>Subject/Course:</td><td>Physics/ How Things Work</td><td>Teacher(s):</td><td>Miranda</td><td>Grade Level:</td><td>10</td></tr>
<tr><td colspan="6">Project Snapshot</td></tr>
<tr><td>Driving Question:</td><td colspan="5">Do electronics have a negative impact on one's health?</td></tr>
<tr><td>Project Summary:<br>Students will debate whether electronics have a negative impact on one's health.</td><td colspan="5">Stained Inquiry -<br>Standards:<br>• HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.<br>• HS-PS2-5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.<br>HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction<br>• HS-PS3-6. Analyze data to support the claim that Ohm's Law describes the mathematical relationship among the potential difference, current, and resistance of an electric circuit.<br>○ 3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.<br>○ MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.<br>○ MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects and the distance between them.<br>○ MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact<br><br>Authenticity - The students all have technology whether that is a cell phone, television, or some form of gaming system.<br>Voice and Choice - The students will choose the side they prefer for the debate. Students will also be able to express creativity in their concept overview document.<br>Critique and Revision - Students will submit rough drafts to receive feedback from peers and staff.<br>Public Product - The debate will be recorded and the concept overviews will be displayed.</td></tr>
</table>

| | |
|---|---|
| | **Entry Event:** Students will read two articles on electronics and health. The first article will provide a positive side to electronics and health while the second article will provide a negative side to electronics and health. The students will then have to decide which "side" they support for the debate. |

**Stage 1 – Desired Results**

**Established Goals:**

- **I can find 3 articles to support my argument.**
- **I can find 3 articles to refute my argument.**
- **I can create a debate plan that has key points for when I debate.**
- **I can create a document that describes each of the concepts learned during this project.**
- **I can improve my rough drafts using feedback.**

**Acquisition**

*Students will know…*

- The following concepts: atom, nucleus, Coulomb's Law, power, energy, magnetic fields, electric fields, voltage, current, resistance, series circuits, and parallel circuits.
- The difference between series and parallel circuits.
- How to calculate Coulomb's Law.
- How to calculate electrical power.
- How to calculate electrical energy.
- How to identify magnetic fields.
- How to identify electric fields.
- How to calculate voltage.
- How to calculate current.
- How to calculate resistance.
- How to calculate series circuits.
- How to calculate parallel circuits.

*Students will be skilled at…*

- Collaborating together
- Communicate to each other and the world
- Critically think and develop the debate plan
- Critically think about concepts

**Meaning**

UNDERSTANDINGS:
*Students will understand…*

- To apply the following concepts to their debate: atom, nucleus, Coulomb's Law, power, energy, magnetic fields, electric fields, voltage, current, resistance, series circuits, and parallel circuits.
- What a debate is and how to conduct themselves professionally in a debate
- How to create a concept overview that is informative and inviting

ESSENTIAL QUESTIONS:
*Students will keep considering… Do electronics have a negative impact on one's health?*

**Transfer**

*Students will be able to independently use their learning to…*

- Apply their understanding of concepts to provide feedback to other groups.
- Showcase their understanding in labs and assessments.

**Stage 2 – Student Evidence**

**Driving Question:** Do electronics have a negative impact on one's health?

| **Final Artifact(s)** Presentations, Performances, Products, and/or Services | **Learning Outcomes/Targets** Content & 21st century competencies needed by students to successfully complete products | **Checkpoints/Formative Assessments** To check for learning and ensure students are on track | **Instructional Strategies for All Learners** Provided by teacher, other staff, experts; includes scaffolds, materials, lessons aligned to learning outcomes and formative assessments |
|---|---|---|---|
| **Concept Overview Document**<br><br>**Debate Plan** | • Collaborating together | **Contract** | **Students will sign a contract at the beginning of the project in order to ensure collaboration of all students throughout the project.** |
| | • Communicate to each other and the world | **Contract** | **Within the contract the students will agree to communicate their work as well as praise/frustration to ensure the team completes quality work on time.** |
| | • Critically think and develop their debate plan. | **Checkpoints of debate research**<br>**Final Draft Debate Plan** | **These points will be assessed used a rubric distributed to students at the beginning of the project.** |
| | • Critically think about concepts | **Daily Practice (Entrance and Exit Tickets)**<br><br>**Labs** | **The entrance and exit tickets will have a key that is used to provide feedback to the students on their progress of understanding the concept(s).**<br>**The labs will have a key that will be used to provide feedback to the students in order to assess their** |

| | | | |
|---|---|---|---|
| | | **Final Assessment** | **understanding. Students will be provided the opportunity to improve their work within a week time frame to show their understanding. The final assessment will have a key that will assess their work and provide the students feedback on their work. The students will be provided a week to meet with the teacher to strengthen weak areas and will take a retake when ready.** |

| **Stage 3 – Project Resources** | | |
|---|---|---|
| **Required Resources** On-site people, facilities, equipment, materials, community resources | **What artifact will resource specifically support?** | **How will resource support student learning toward artifact completion?** |
| **Chromebooks** | Google Classroom, Labs | Students will use their chromebooks as a resource to all course information as well as will be used daily in class. |
| **Google Classroom** | Daily Practice, Labs | Students will understand and apply the following concepts: atom, nucleus, Coulomb's Law, power, energy, magnetic fields, electric fields, voltage, current, resistance, series circuits, and parallel circuits. |
| **Phet simulations** | Daily Practice, Lab | Students will understand, calculate, and apply the following concepts: atom, nucleus, Coulomb's Law, magnetic fields, electric fields, voltage, current, resistance, series circuits, and parallel circuits. |
| **Circuit Materials (Wires, batteries, resistors, multimeters, etc.)** | Daily Practice, Lab | Students will understand, calculate, and apply series and parallel circuits through constructing and measuring circuits. |
| **Graphing Paper** | Daily Practice | Students will display graphical understanding of concepts. |
| **Rulers** | Daily Practice | Students will use a ruler to support their understanding of concepts. |
| **Calculator** | Daily Practice, Labs | Students will understand, and calculate the following concepts: conversions, vector addition, free fall, gravitational potential energy, and the Conservation of Energy. |
| **Google Document** | Concept Overview | Students will create a document describing the concepts they have learned during this project. |

| | | |
|---|---|---|
| **Final Assessment** | Daily Practice, Labs | Students will showcase their understanding of the following concepts: atom, nucleus, Coulomb's Law, power, energy, magnetic fields, electric fields, voltage, current, resistance, series circuits, and parallel circuits. |
| **Public Audience** | **The debate will be recorded and the concept overviews will be displayed.** | |

| **Stage 4 - Reflection** | | | | |
|---|---|---|---|---|
| **Reflection Methods** | **Individual feedback will be provided daily to daily practice using keys.** | ☐ | **Students will have the opportunity to use feedback to improve individual work.** | ☐ |
| | **Individual feedback will be provided to labs using keys.** | ☐ | **Team feedback will be provided to the debate plan through peer feedback and instructor feedback.** | ☐ |
| | **Individual feedback will be provided to the final assessment using a key.** | ☐ | **Teams will have the opportunity to improve their project work.** | ☐ |

| **Notes:** |
|---|
| |

*Project Four Outline*: Includes standards, project overview, and resources needed for the project.

| | | 1 | 2 | 3 | 4 | Rating | |
|---|---|---|---|---|---|---|---|
| Concept Overview | Concepts Identified | I cannot clearly identify all of the topics learned during this project. | | | I can clearly identify all of the topics learned during this project. (11 Total) | | |
| | Concepts Described | I can accurately describe 8 of the 11 topics. | I can accurately describe 9 of the 11 topics. | I can accurately describe each of the 11 topics. | I can clearly and accurately describe each of the 11 topics. | | |
| | Example of Concept | I can include an accurate mathematical or conceptual example for 6 of the 11 topics. | I can include an accurate mathematical or conceptual example for 7-8 of the 11 topics. | I can include an accurate mathematical or conceptual example for 9 of the 11 topics. | I can include an accurate mathematical or conceptual example for each of the 11 topics. | | |
| | Document Flow | I can create a document or presentation that is unclear and hard to follow. | | I can create a document or presentation that is clear or easy to follow. | I can create a document or presentation that is clear and easy to follow. | | |

| | | 1 | 2 | 3 | 4 | Rating | |
|---|---|---|---|---|---|---|---|
| Debate Plan | Positive Effect | I can research 1 article on the positive effects of technology on one's health. | I can research 2 different articles on the positive effects of technology on one's health. | | I can research 3 different articles on the positive effects of technology on one's health. | | |
| | | I cannot make a bulleted list of the points made in each article for the positive effects technology has on one's health. | | | I can bullet the points made in each article for the positive effects technology has on one's health. | | |
| | Negative Effect | I can research 1 article on the negative effects of technology on one's health. | I can research 2 different articles on the negative effects of technology on one's health. | | I can research 3 different articles on the negative effects of technology on one's health. | | |
| | | I cannot make a bulleted list of the points made in each article for the negative effects technology has on one's health. | | | I can bullet the points made in each article for the negative effects technology has on one's health. | | |
| | Notecard | I cannot create notecard that has all of the points for my argument on one side and points for my opposers on the opposite side. | | | I can create notecard that has all of the points for my argument on one side and points for my opposers on the opposite side. | | |

| Electronics Debate Rubric | | | | |
|---|---|---|---|---|
| **Concept Overview** | | | **Debate Plan** | |
| **Comments:** | | | | **Final Score** |

*Project Four Rubric:* Provides the students with an expectation of the project and the teacher with an assessment tool.

Project four spans six weeks to include all of the traditional electricity and magnetism unit. Each concept in this project builds on each other starting with an atom and working its way up to parallel circuits. Electronics some would argue is an essential piece of daily life therefore the students will continuously throughout the project connect back to the debate. Quizzes and the formative assessment are spaced roughly every two weeks to allow for individual assessment data. Though there is only one lab in this project, there are hands on opportunities nearly every day to ensure the students are applying their understanding of concepts.

| Mar 2019 | P4: Electronics Debate | | | |
|---|---|---|---|---|
| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** |
| | | | | 1 Two Articles on Cell Phones, Know / Need to Know |
| 4 Atom, Nucleus, Coulomb's Law | 5 | 6 Power, Energy, B-Field | 7 | 8 E-Field, Voltage, Current |
| 11 Resistors, Resistance | 12 | 13 Quiz, Debate Research | 14 | 15 Staff Development Day |
| 18 Series Circuits | 19 | 20 Parallel Circuits | 21 | 22 Einstein Day |
| 25 Lab | 26 | 27 Quiz, Finish Lab | 28 | 29 Debate Research |

| Apr 2019 | P4: Electronics Debate | | | |
|---|---|---|---|---|
| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** |
| 1 Topics Overview | 2 | 3 Topics Overview Due | 4 | 5 Formative Assessment |
| 8 Debate Plan Due | 9 | 10 Debate Day | 11 | 12 Einstein Day |
| 15 Spring Recess | 16 Spring Recess | 17 Spring Recess | 18 Spring Recess | 19 Spring Recess |

*Project Four Calendar:* The calendar provides the students and teacher with an expectation of what is done each day including due dates.

Sample Content Lesson

The sample content lesson included provides a lesson plan, notes, and a practice sheet for the students to complete during the span of the class period. The lesson provided allows for a teacher to see what it looks like for students to discover atoms and Coulomb's Law through a simulation. After completing the notes in pairs, the students then individually complete the

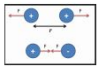
practice to showcase their understanding of the concepts. The teacher provides feedback to the practice and returns it to the students to allow for growth.

| | |
|---|---|
| **Subject/Course** | Physics 100 |
| **Topic** | Electronics Debate |
| **Lesson Title:** | Atoms, Coulomb's Law |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can manipulate a simulation to understand Coulomb's Law.<br>• I can calculate Coulomb's Law. | |
| **Task List** | |
| • Coulomb's Law Discovery<br>• Atoms/Coulomb's Law Notes - As a team<br>• Atoms/Coulomb's Law Practice - Independent | |
| **Materials Needed** | |
| • Coulomb's Law Discovery<br>• https://www.physicsclassroom.com/Physics-Interactives/Static-Electricity/Coulomb-s-Law/Coulomb-s-Law-Interactive<br>• Atoms/Coulomb's Law Notes<br>• Atoms/Coulomb's Law Practice | |

Name:_____

**Equal and Opposite?**

1. Name one variable you can manipulate in the interactive.



2. Name a different variable you can manipulate in the interactive.

3. What do you think the vectors represent?

4. Which way do the vectors point if the particles are different charges?

5. Why do you think that is?

6. Which way do the vectors point if the particles are the same charge?

7. Why do you think that is?

8. What happens when you increase the charges?

9. What happens when you increase the distance between the particles?

| Atom | | |
|---|---|---|
| **Definition**<br>The basic element of a chemical unit. | **Nucleus**<br>Made up of protons and neutrons in the center of the atom. | **Electrons**<br>Surround the nucleus.<br><br>Atoms/Objects become charged through the gain or loss of electrons.<br><br>Atom/object is positively charged if there are fewer electrons than protons.<br><br>Atom/object is negatively charged if there are more electrons than protons. |

→ What three subatomic particles make up atoms?

| Subatomic Particles | Mass | Charge |
|---|---|---|
| **Proton** | $1.67 \cdot 10^{-27} kg$ | $+1.6 \cdot 10^{-19} C$ |
| **Electron** | $9.11 \cdot 10^{-31} kg$ | $-1.6 \cdot 10^{-19} C$ |
| **Neutron** | $1.67 \cdot 10^{-27} kg$ | 0 |

→ What happens when two of the same charges are brought together? (2 N side of magnet)

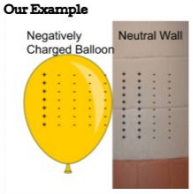
Like charges:_____

→ What happens when two different charges are brought together? (N and S side of magnet)

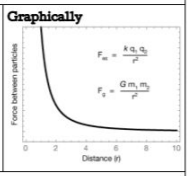
Opposite charges:_____

| Elementary Particles | |
|---|---|
| **Definition**<br>Equal in magnitude to the charge of a proton or electron. | **Units**<br>e = $1.6 \cdot 10^{-19} C$<br>*The net charge of an object is always a multiple of e. |
| **Our Example**<br>2e, 4e, 7e | **Your Example(s)** |

| Transfer of Charge | | |
|---|---|---|
| **Definition**<br>When a system consists of only neutral objects, the total net charge is 0.<br><br>Electrons can be transferred between objects - making one positively charged and the other negatively charged. | **Our Example**<br>Running a comb through your hair. Electrons transfer from your hair to the comb making the comb negative and your hair positively charged. | **Your Example** |

| Law of Conservation of Charge | | |
|---|---|---|
| **Definition**<br>In a closed, isolated system, the total charge of the system remains constant.<br><br>Charges within the system may be transferred, but charge is neither created or destroyed | | |
| **Separation of Charge**<br>When a charged object is brought near a neutral object, the charges inside the object will separate. | **Our Example**<br>  <br> | **Your Example** |

Have Mrs. Wharram-Santillo sign off and move onto the next piece.

| Coulomb's Law | | |
|---|---|---|
| **Definition**<br>The magnitude of the electrostatic forces that one point charge exerts on another point charge is directly proportional to the product of the charges and inversely proportional to the square of the distance between them. | **Equation / Units**<br>$F_e = \frac{kq_1q_2}{r^2}$<br>$F_e$ - Electrostatic Force (N)<br>q - charge (C)<br>r - distance between charges (m)<br>k - electrostatic constant<br>$8.99 * 10^9 \frac{Nm^2}{C^2}$ | **Graphically**<br>  <br> |

**Our Example**
Calculate the electrostatic force that a small sphere of a net charge of $+2*10^{-6}$C exerts on a small sphere of $-3*10^{-6}$C when they are separated by 1m.

r = 1m
$q_1 = 2*10^{-6}$C
$q_2 = -3*10^{-6}$C
$k = 8.99*10^9 \frac{Nm^2}{C^2}$

$F_e = \frac{kq_1q_2}{r^2}$

$F_e = \frac{(8.99*10^9)(2*10^{-6})(-3*10^{-6})}{1^2}$

$F_e = -0.05N$

**Your Example**
A balloon with a charge of $2 * 10^{-5} C$ is 0.10m away from a second balloon with the same charge. What is the repulse force?

Have Mrs. Wharram-Santillo sign off and move onto the next piece.

Name:_____
Atoms and Coulomb's Practice

1. What subatomic particle has a negative charge?

2. What subatomic particle has a positive charge?

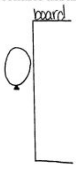
3. What two subatomic particles make up a nucleus?

4. Determine the electrical force of attraction between two balloons with separate charges of $+3.5 \times 10^{-8}$ C and $-2.9 \times 10^{-8}$ C when separated a distance of 0.65 m.

5. Calculate the electrostatic force that a small sphere A, possessing a net charge of $2x\ 10^{-6}$ C exerts on another small sphere, B, possessing a net charge of $-3x\ 10^{-6}$ C when the distance between their centers is 10m.

6. Describe the slope for the relationship between the electrostatic force and the distance between two particles.

7. Draw the charges for the following scenario assuming the board is neutral.



Sample Project Lesson

The project lesson included provides the teacher/instructor with a lesson plan to span the class period. After completing their quiz, included in the assessments portion, the students will then individually research articles for their debate.

| **Subject/Course** | Physics 100 |
|---|---|
| **Topic** | Electronics Debate |
| **Lesson Title:** | Debate Research |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can showcase my knowledge of what I have learned in this project thus far.<br>• I can research the positive effects of technology on one's health.<br>• I can research the negative effects of technology on one's health. | |
| **Task List** | |
| • Quiz<br>• Research 3 articles on positive effects<br>• Research 3 articles on negative effects | |
| **Materials Needed** | |
| • Quiz<br>• Chromebook | |

Sample Lab Lesson

The sample lab lesson included provides the teacher with a lesson plan and lab for the students to complete. This lab was provided because it is inquiry based and requires the students to recall on their understanding of concepts to construct different types of circuits.

| **Subject/Course** | Physics 100 |
|---|---|
| **Topic** | Electronics Debate |
| **Lesson Title:** | Series and Parallel Lab |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can apply my knowledge of circuits to create circuits.<br>• I can apply my knowledge of circuits to calculate current, voltage, and resistance.<br>• I can use lab equipment (wires, resistors, light bulbs, multimeters) to build circuits. | |
| **Task List** | |
| • Series and Parallel Lab with partner | |
| **Materials Needed** | |
| • Series and Parallel Lab<br>• Wires<br>• Resistors<br>• Battery Pack<br>• Multimeters<br>• Rulers<br>• Calculator | |

Name:----------
Lab
There are four different stations. You must complete each station prior to moving on another station. (Stations can be completed in any order and no more than **4** students at each station.) Please be respectful to your peers and equipment by cleaning up each station prior to moving on.

Station 1: Series Circuit
1. Using the resistors at your station create a series circuit. You must use a minimum of 3 resistors. (Maximum of 5 resistors)
2. Once you have your circuit built
   a. Draw a circuit diagram of your series circuit
   b. Label your series circuit
   c. Show all calculations for the circuit
      i. Total Potential Difference
      ii. Total Current
      iii. Equivalent Resistance
      iv. Current at **each** resistor
      v. Potential difference across **each** resistor
3. Before connecting to a potential difference you must get your drawing and circuit approved.

Station 2: Series Circuit
1. Using the light bulbs at your station create a series circuit. You must use a minimum of 2 light bulbs. (Maximum of 6 light bulbs)
2. Once you have your circuit built
   a. Draw a circuit diagram of your series circuit
   b. Label your series circuit
   c. Show all calculations for the circuit
      i. Total Potential Difference
      ii. Total Current
      iii. Equivalent Resistance
      iv. Current at **each** resistor/light bulb
      v. Potential difference across **each** resistor/light bulb
3. Before connecting to a potential difference you must get your drawing and circuit approved.

Station 3: Parallel Circuit
1. Using the light bulbs at your station create a parallel circuit. You must use a minimum of 2 light bulbs. (Maximum of 6 light bulbs)
2. Once you have your circuit built
   a. Draw a circuit diagram of your parallel circuit
   b. Label your parallel circuit
   c. Show all calculations for the circuit
      i. Total Potential Difference
      ii. Total Current
      iii. Equivalent Resistance
      iv. Current at **each** resistor/light bulb
      v. Potential difference across **each** resistor/light bulb
3. Before connecting to a potential difference you must get your drawing and circuit approved.

Station 4: Parallel Circuit
1. Using the resistors at your station create a parallel circuit. You must use a minimum of 3 resistors. (Maximum of 5 resistors)
2. Once you have your circuit built
   a. Draw a circuit diagram of your parallel circuit
   b. Label your parallel circuit
   c. Show all calculations for the circuit
      i. Total Potential Difference
      ii. Total Current
      iii. Equivalent Resistance
      iv. Current at **each** resistor
      v. Potential difference across **each** resistor
3. Before connecting to a potential difference you must get your drawing and circuit approved.

*Project Four Sample Lessons:* The lessons above include three types of lessons: content, lab, and project. Each of the lessons include the materials needed for the lesson.

# Quiz 1

Name:_____
Quiz 1
Please complete all questions to the best of your ability. Be sure to include all equations, given table/units, and answers with units.

1. Complete the following table.

| Particle | Charge |
|---|---|
| Proton | |
| Electron | |
| Neutron | |

2. A balloon with a charge of $4*10^{-5}$C is 0.10m away from a second balloon with the same charge. What is the repulsive force?

3. Draw the magnetic field lines for the following scenario.


4. What is the electrical power for a 24V, 3A circuit?

5. Determine the electrical energy at a given point on a power line carrying 1500 MW for 2 seconds.

6. Draw the electric field lines for a positive charge and a negative charge.


7. An ammeter is connected in
   a. SERIES
   b. PARALLEL

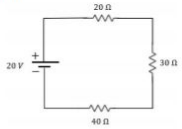
8. A voltmeter is connected in
   a. SERIES
   b. PARALLEL

9. A resistor of 100Ω has a potential difference of 120V. What is the current measured across the resistor?

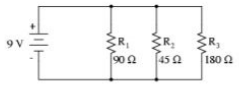
# Quiz 2

Name:_____
Quiz 2
Please complete all questions to the best of your ability. Be sure to include all equations, given table/units, and answers with units.

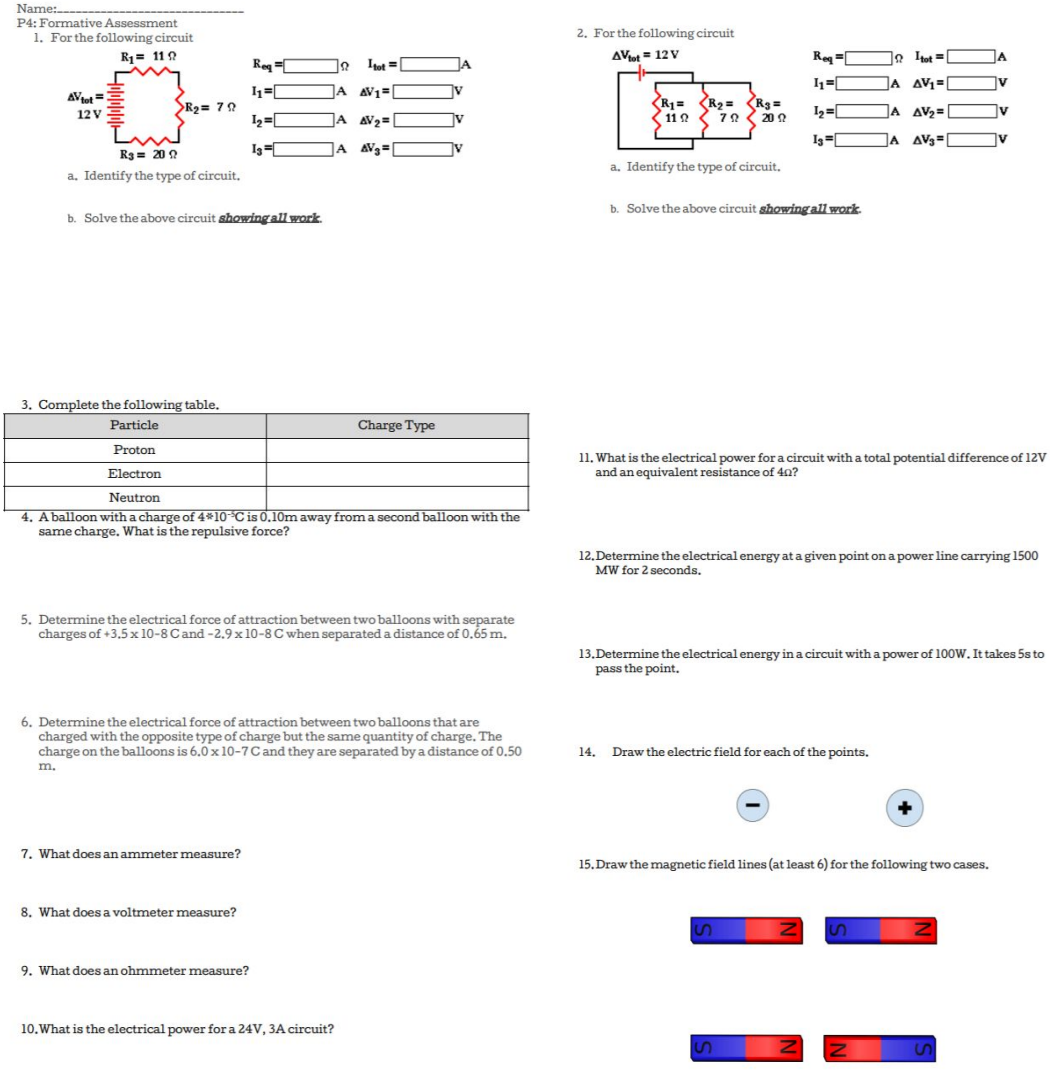
1. Solve the following series circuit. Determine the equivalent resistance, the total circuit current, and the voltage drop across and current at each resistor.




2. Solve the following parallel circuit. Determine the equivalent resistance, total current, total potential difference, potential difference at each resistor, and current at each resistor.



Formative Assessment



Name:_____
P4: Formative Assessment

1. For the following circuit

$R_1 = 11\ \Omega$, $\Delta V_{tot} = 12$ V, $R_2 = 7\ \Omega$, $R_3 = 20\ \Omega$

$R_{eq} =$ ____ Ω  $I_{tot} =$ ____ A
$I_1 =$ ____ A  $\Delta V_1 =$ ____ V
$I_2 =$ ____ A  $\Delta V_2 =$ ____ V
$I_3 =$ ____ A  $\Delta V_3 =$ ____ V

a. Identify the type of circuit.

b. Solve the above circuit ***showing all work***.

2. For the following circuit

$\Delta V_{tot} = 12$ V, $R_1 = 11\ \Omega$, $R_2 = 7\ \Omega$, $R_3 = 20\ \Omega$

$R_{eq} =$ ____ Ω  $I_{tot} =$ ____ A
$I_1 =$ ____ A  $\Delta V_1 =$ ____ V
$I_2 =$ ____ A  $\Delta V_2 =$ ____ V
$I_3 =$ ____ A  $\Delta V_3 =$ ____ V

a. Identify the type of circuit.

b. Solve the above circuit ***showing all work***.

3. Complete the following table.

| Particle | Charge Type |
|---|---|
| Proton | |
| Electron | |
| Neutron | |

4. A balloon with a charge of $4*10^{-5}$C is 0.10m away from a second balloon with the same charge. What is the repulsive force?

5. Determine the electrical force of attraction between two balloons with separate charges of +3.5 x 10-8 C and -2.9 x 10-8 C when separated a distance of 0.65 m.

6. Determine the electrical force of attraction between two balloons that are charged with the opposite type of charge but the same quantity of charge. The charge on the balloons is 6.0 x 10-7 C and they are separated by a distance of 0.50 m.

7. What does an ammeter measure?

8. What does a voltmeter measure?

9. What does an ohmmeter measure?

10. What is the electrical power for a 24V, 3A circuit?

11. What is the electrical power for a circuit with a total potential difference of 12V and an equivalent resistance of 4Ω?

12. Determine the electrical energy at a given point on a power line carrying 1500 MW for 2 seconds.

13. Determine the electrical energy in a circuit with a power of 100W. It takes 5s to pass the point.

14. Draw the electric field for each of the points.



15. Draw the magnetic field lines (at least 6) for the following two cases.



*Project Four Assessments:* Above are the different assessments needed for the project. Each of the assessments follow the calendar and allow for the content to be broken up along the project. The formative assessment is included to assess all concepts learned during the project.

**Project Five**

Project five allows for the students to utilize research strategies to understand how music can or does affect one's mood. After researching, the students will then create a product

that makes music and impacts one's mood. This project will kick off by having the students listen to various types of music. While listening to the music, the students will record how they feel during the song. Through their research the students will be able to create an annotated bibliography that explains how music impacts one's mood. Using this research, the students will get creative in the constructing of their product as to what it looks like, how it makes music, and they type of impact the music will have.

The resources for project five are for both the teacher/instructor and student alike. There is a project outline that outlines all of the standards to be addressed in the project, the entry event, a brief description of the project, student objectives, and resources necessary. To support the outline, there is a rubric that provides the students a clear idea of what to include in their annotated bibliography and musical product as well as provides the teacher with an assessment tool for the project. The calendar also provides the teacher and students with a sense of progress through the project. Students know when to complete graded assignments as well as provides dates for assessments. The sample lessons and supporting documents allow for the teacher to gain an idea of what a typical content day, lab day, and project day would look like in this curriculum. The assessments also provide the teacher a resource to assess individual progress.

<table>
<tr><th colspan="6">Curriculum Design Template</th></tr>
<tr><td>Name of Project:</td><td colspan="3">Music Affecting Mood</td><td>Duration:</td><td>6 weeks</td></tr>
<tr><td>Subject/Course:</td><td>Physics/ How Things Work</td><td>Teacher(s):</td><td>Miranda</td><td>Grade Level:</td><td>10</td></tr>
<tr><td colspan="6">Project Snapshot</td></tr>
<tr><td>Driving Question:</td><td colspan="5">How does music impact one's mood?</td></tr>
<tr><td>Project Summary:<br>Students will research how music affects one's mood. After researching, students will create a product that has an impact on one's mood.</td><td colspan="5">Stained Inquiry -<br>Standards:<br>• HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the period, frequency, wavelength, and speed of waves traveling and transferring energy (amplitude, frequency) in various media.<br>• HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model (quantum theory), and that for some situations one model is more useful than the other<br>• HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter<br>• HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*<br>• HS-PS4-6. Use mathematical models to determine relationships among the size and location of images, size and location of objects, and focal lengths of lenses and mirrors.<br>◦ P-PS4-1. Plan and conduct investigations to provide evidence that sound is produced by vibrating materials.<br>◦ 1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.<br>◦ 4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move<br>◦ MS-PS4-1. Develop a model and use mathematical representations to describe waves that includes frequency, wavelength, and how the amplitude of a wave is related to the energy in a wave.<br>◦ MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.</td></tr>
</table>

| | |
|---|---|
| | **Authenticity** - The students enjoy listening to music and creating products.<br>**Voice and Choice** - The students will choose the articles they research as well as will have creative freedom in creating their product.<br>**Critique and Revision** - Students will submit rough drafts to receive feedback from peers and staff.<br>**Public Product** - The products will be displayed around the school.<br><br>**Entry Event:** Students will listen to various genres of music. They will record how each song makes them feel. |

**Stage 1 – Desired Results**

**Established Goals:**

- **I can find 5 articles that describe how music affects one's mood.**
- **I can design a product that will produce music.**
- **I will create a product that makes music.**
- **I can describe how the product should impact one's mood.**
- **I can improve my rough drafts using feedback.**

**Acquisition**

*Students will know…*

- The following concepts: pulse, types of waves, the characteristics of waves, the electromagnetic spectrum, resonance, interference, node, antinode, diffraction, reflection, and refraction.
- The difference between transverse and longitudinal waves.
- How to create a wave.
- How to label a transverse wave.
- How to label a longitudinal wave.
- How to identify a type of wave through reading the Electromagnetic Spectrum.
- How to add two types of waves.
- How to draw a ray diagram.
- How to calculate Snell's Law.

*Students will be skilled at…*

- Collaborating together
- Communicate to each other and the world
- Critically think and develop the product
- Critically think about concepts

**Meaning**

UNDERSTANDINGS:

*Students will understand…*

- To apply the following concepts to their research and product: pulse, types of waves, the characteristics of waves, the electromagnetic spectrum, resonance, interference, node, antinode, diffraction, reflection, and refraction.
- How to find scholarly articles
- How music scientifically affects one's mood

ESSENTIAL QUESTIONS:

*Students will keep considering… How does music impact one's mood?*

| | |
|---|---|
| | **Transfer**<br>*Students will be able to independently use their learning to…*<br>• Apply their understanding of concepts to provide feedback to other groups.<br>• Showcase their understanding in labs and assessments. |

**Stage 2 – Student Evidence**

**Driving Question:** How does music impact one's mood?

| **Final Artifact(s)**<br>Presentations, Performances, Products, and/or Services | **Learning Outcomes/Targets**<br>Content & 21st century competencies needed by students to successfully complete products | **Checkpoints/Formative Assessments**<br>To check for learning and ensure students are on track | **Instructional Strategies for All Learners**<br>Provided by teacher, other staff, experts; includes scaffolds, materials, lessons aligned to learning outcomes and formative assessments |
|---|---|---|---|
| **Annotated Bibliography of articles read**<br><br>**Musical Product** | • Collaborating together | **Contract** | **Students will sign a contract at the beginning of the project in order to ensure collaboration of all students throughout the project.** |
| | • Communicate to each other and the world | **Contract** | **Within the contract the students will agree to communicate their work as well as praise/frustration to ensure the team completes quality work on time.** |
| | • Critically think and develop their product. | **Checkpoints of scientific research**<br>**Final Draft of Annotated Bibliography**<br>**Musical Product** | **These points will be assessed used a rubric distributed to students at the beginning of the project.** |
| | • Critically think about concepts | **Daily Practice (Entrance and Exit Tickets)**<br><br>**Labs** | **The entrance and exit tickets will have a key that is used to provide feedback to the students on their progress of understanding the concept(s).**<br>**The labs will have a key that will be used to provide feedback to the** |

| | | | |
|---|---|---|---|
| | | **Quiz**<br>**Final Assessment** | **students in order to assess their understanding. Students will be provided the opportunity to improve their work within a week time frame to show their understanding.**<br>**Both the quiz and the final assessment will have keys that will assess their work and provide the students feedback on their work. The students will be provided a week to meet with the teacher to strengthen weak areas and will take a retake when ready.** |

| **Stage 3 – Project Resources** | | |
|---|---|---|
| **Required Resources**<br>On-site people, facilities, equipment, materials, community resources | **What artifact will resource specifically support?** | **How will resource support student learning toward artifact completion?** |
| **Chromebooks** | Google Classroom, Labs | Students will use their chromebooks as a resource to all course information as well as will be used daily in class. |
| **Google Classroom** | Daily Practice, Labs | Students will understand and apply the following concepts: pulse, types of waves, the characteristics of waves, the electromagnetic spectrum, resonance, interference, node, antinode, diffraction, reflection, and refraction. |
| **Phet simulations** | Daily Practice, Lab | Students will understand, calculate, and apply the following concepts: pulse, types of waves, the characteristics of waves, the electromagnetic spectrum, resonance, interference, node, antinode, diffraction, reflection, and refraction. |
| **Wave generator/slinkies** | Daily Practice, Lab | Students will understand, calculate, and apply pulse, types of waves, and the characteristics of waves. |
| **Graphing Paper** | Daily Practice | Students will display graphical understanding of concepts. |
| **Rulers** | Daily Practice | Students will use a ruler to support their understanding of concepts. |
| **Calculator** | Daily Practice, Labs | Students will understand, and calculate the following concepts: interference, reflection, and refraction. |
| **Musical Product** | Product | Students will create a product that makes music to affect one's mood. |
| **Final Assessment** | Daily Practice, Labs | Students will showcase their understanding of the following concepts: pulse, types of waves, the characteristics of waves, the electromagnetic spectrum, resonance, interference, node, antinode, diffraction, reflection, and refraction. |

| | |
|---|---|
| **Public Audience** | **The products will be displayed in the hallways.** |

| **Stage 4 - Reflection** | | | | |
|---|---|---|---|---|
| **Reflection Methods** | **Individual feedback will be provided daily to daily practice using keys.** | ☐ | **Students will have the opportunity to use feedback to improve individual work.** | ☐ |
| | **Individual feedback will be provided to labs using keys.** | ☐ | **Team feedback will be provided to the annotated bibliography through peer feedback and instructor feedback.** | ☐ |
| | **Individual feedback will be provided to the quiz using a key** | | **Team feedback will be provided to the musical product through peer feedback and instructor feedback.** | |
| | **Individual feedback will be provided to the final assessment using a key.** | ☐ | **Teams will have the opportunity to improve their project work.** | ☐ |

| |
|---|
| **Notes:** |

*Project Five Outline*: Includes standards, project overview, and resources needed for the project.

| | | 1 | 2 | 3 | 4 | Rating | |
|---|---|---|---|---|---|---|---|
| **Annotated Bibliography** | Quantity of Sources | The annotated bibliography has 0-2 sources. | The annotated bibliography has 3 sources. | The annotated bibliography has 4 sources. | The annotated bibliography has 5 sources. | | |
| | Reliability of Sources | Little or no reliable and/or trustworthy sources are cited | Some sources can be considered reliable and/or trustworthy | Most sources cited can be considered reliable and/or trustworthy | All sources cited can be considered reliable and/or trustworthy | | |
| | Writing Fluency | Most annotations are lacking in completeness, thought, and/or writing quality | Some annotations are well written but some are lacking in completeness thought, and/or writing quality | Most annotations are thoughtful, complete, and well written | All annotations are thoughtful, complete, and well written | | |
| | APA Formatting | There is little or no adherence to APA format in the annotated bib. | There are many and/or frequent formatting errors in the annotated bib. | There are a few formatting errors in the annotated bib. | Annotated bib. is formatted correctly | | |

| | | 1 | 2 | 3 | 4 | Rating | |
|---|---|---|---|---|---|---|---|
| **Musical Product** | Creativity | The product lacks both creativity and originality. | The product shows group creativity but has no originality. | The product shows group creativity and some original ideas. | The product shows group creativity and the use of original ideas. | | |
| | Music | I cannot create a product that makes music. | I can design a product that makes music. | | I can design and create a product that makes music. | | |
| | Explanation | I cannot explain how my product will/does make music. | | | I can explain how my product will/does make music. | | |
| | | I cannot explain how my product impacts one's mood. | | | I can explain how my product impacts one's mood. | | |

| Music and Mood Rubric | | | | |
|---|---|---|---|---|
| **Annotated Bibliography** | | | **Musical Product** | |
| **Comments:** | | | | **Final Score** |

*Project Five Rubric:* Provides the students with an expectation of the project and the teacher with an assessment tool.

The curriculum wraps up with the fifth project which is typically the waves unit in other curriculums. This project spans six weeks and allows for the concepts to be learned on the front end with the project work to be done on the back end. This is done in part due to the timing of the project and the end of the school year as well as it allows the groups to continue constructing their pieces over a span of days. There are two individual assessments placed in this project to showcase individual understanding in the assessment setting. The students will have a lab to work on in between the two assessments in order to showcase their knowledge as well. Throughout this project, the students will have many opportunities to have either hands on work or simulation work to apply each of the concepts.

| Apr/May/June 2019 | P5: Music and Mood | | | |
|---|---|---|---|---|
| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** |
| 22 Spring Recess | 23 | 24 Project Kick Off | 25 | 26 Pulse, Types of Waves, Characteristics of Waves |
| 29 EM Spectrum, v, Resonance | 30 | 1 Interference | 2 | 3 Quiz 1 Project Work (Research) |
| 6 Node / Antinode Diffraction | 7 | 8 Reflection Refraction / Snell's | 9 | 10 Lab |
| 13 Mentor Week | 14 Mentor Week | 15 Mentor Week | 16 Mentor Week | 17 Mentor Week |
| 20 Lab Project Work (Research) | 21 | 22 Project Work (Research) | 23 | 24 Memorial Day |
| 27 Memorial Day | 28 | 29 Review | 30 | 31 Formative Assessment |
| 3 Project Work (Creation) | 4 | 5 Project Work (Creation) | 6 | 7 Project Work (Creation) |

*Project Five Calendar:* The calendar provides the students and teacher with an expectation of what is done each day including due dates.

Sample Content Lesson

The sample content lesson included provides a lesson plan, notes, and a practice sheet for the students to complete during the span of the class period. The lesson provided allows for a teacher to see a lesson where students use online resources and simulations to discover the characteristics of waves. After completing the notes in pairs, the students then individually complete the practice to showcase their understanding of the concepts. The teacher provides feedback to the practice and returns it to the students to allow for growth.

| **Subject/Course** | Physics 100 |
|---|---|
| **Topic** | Music and Mood |
| **Lesson Title:** | What is a wave? |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can manipulate a simulation to understand how to create a wave.<br>• I can interpret boundary behavior, production of waves, and particle behavior from the simulation.<br>• I can understand how to make a wave.<br>• I can understand the different types of waves.<br>• I can understand the characteristics of waves. | |
| **Task List** | |
| • Wave Discovery<br>• What is a wave? Notes - As a team<br>• What is a wave? Practice - Independent | |
| **Materials Needed** | |
| • What is a wave? Notes<br>• https://phet.colorado.edu/sims/html/wave-on-a-string/latest/wave-on-a-string_en.html<br>• https://www.physicsclassroom.com/class/waves<br>• What is a wave? Practice | |

Name:_____
What is a wave? Notes

- ❑ Open the *Wave on a String* PhET simulation.
- ❑ Ensure the simulation is on manual.
  - ❑ Choose fixed end.
  - ❑ Make a wave using the wrench.

→ Describe how you made a wave.

→ Describe what happens to the wave after you let go of the wrench. *Consider: size (width and depth), direction (left/right vs. up/down), how the wave acts at the end of the rope.*

  - ❑ Choose loose end.
  - ❑ Make a wave using the wrench.

→ Describe how you made a wave.

→ Describe what happens to the wave after you let go of the wrench. *Consider: size (width and depth), direction (left/right vs. up/down), how the wave acts at the end of the rope.*

→ How do the waves compare when there is a fixed end versus a loose end?

  - ❑ Choose no end.
  - ❑ Make a wave using the wrench.

→ Describe how you made a wave.

→ Describe what happens to the wave after you let go of the wrench. *Consider: size (width and depth), direction (left/right vs. up/down), how the wave acts at the end of the rope.*

→ How do the waves compare when there is a fixed end versus no end?

- ❑ Restart the simulation.
- ❑ Select the pulse option.
- ❑ Slide the damping scale to none.
- ❑ Make a wave.

→ Describe what happens when you start a wave. *Consider: size (width and depth), direction (left/right vs. up/down), how the wave acts at the end of the rope.*

  - ❑ Increase the amplitude.

→ Compared to the wave before, what do you notice about this wave?

  - ❑ Restart the simulation.
  - ❑ Decrease the amplitude.

→ Compared to the original wave, what do you notice about this wave?

  - ❑ Restart the simulation.
  - ❑ Increase the pulse width.

→ Compared to the original wave, what do you notice about this wave?

  - ❑ Restart the simulation.
  - ❑ Decrease the pulse width.

→ Compared to the original wave, what do you notice about this wave?

- ❑ Restart the simulation.
- ❑ Select the Oscillate option.
- ❑ Set the amplitude to 0.75cm.
- ❑ Set the frequency to 1.50Hz.
- ❑ Restart the simulation.

→ Describe the wave.

→ Draw the wave.

_____

→ Describe how the green marbles move. (Hint vertically or horizontally)

→ Describe how the wave moves. (Hint vertically or horizontally.)

Have Mrs. Wharram-Santillo sign off and move onto the next piece.

Now, using the resources on the Classroom, complete the following.

→ What is a wave?

→ What is a medium?

→ What is equilibrium?

→ What is a pulse?

→ How did you create a pulse in the simulation?

→ What does a wave transfer?

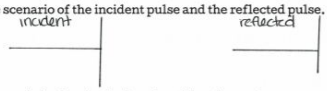
→ What is a boundary?

→ What is a fixed end?

→ Describe what will happen when a pulse is introduced on the left end of a fixed rope.

→ When the introduced pulse reaches the fixed end, what happens to the reflected pulse?

→ Draw the scenario of the incident pulse and the reflected pulse.



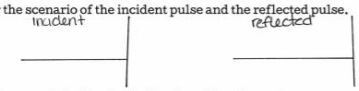

→ Which scenario in the simulation does this relate to?

→ What is a free end?

→Describe what will happen when a pulse is introduced on the left end of a fixed rope.

→ When the introduced pulse reaches the fixed end, what happens to the reflected pulse?

→ Draw the scenario of the incident pulse and the reflected pulse.




→ Which scenario in the simulation does this relate to?

→ What are the two types of waves?

→ What makes a longitudinal wave?

→ What are some examples of longitudinal waves?

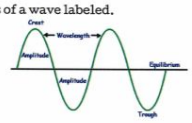
→ Draw what a longitudinal wave looks like.

→ What makes a transverse wave?

→ What are some examples of transverse waves?

→ Draw what a transverse wave looks like.

Here are the characteristics of a wave labeled.




→ What is amplitude?

→ What is a crest?

→ What is a trough?

→ What is a wavelength ($\lambda$)?

→ What is a compression?

→ What is a rarefaction?

→ What is the frequency of the wave?

→ What symbol do you use for frequency?

→ What are the units of frequency?

→ What is the period of the wave?

→ What symbol do you use for period?

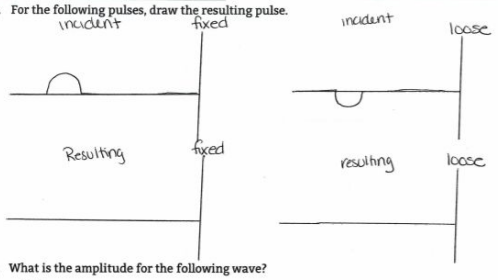
→ What are the units of period?

→ How are frequency and period related?

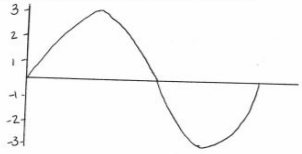
Have Mrs. Wharram-Santillo sign off and move onto the next piece.

Name:_____ What is a wave? Practice

1. For the following pulses, draw the resulting pulse.

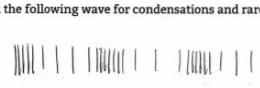



2. What is the amplitude for the following wave?




3. Label the following wave with troughs and crests.

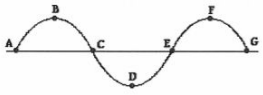
4. Label the following wave for condensations and rarefactions.



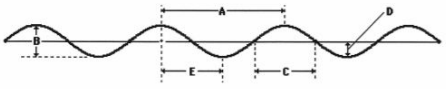
5. Label a wavelength for the following wave.

6. Label a wavelength for the following wave.

7. Indicate all intervals that represents one full wavelength.




8. Consider the diagram below in order to answer the following questions



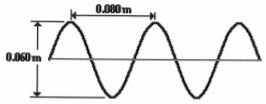

The wavelength of the wave in the diagram above is given by letter _____.

The amplitude of the wave in the diagram above is given by letter _____.

9. **TRUE** or **FALSE**: In order for John to hear Jill, air molecules must move from the lips of Jill to the ears of John.

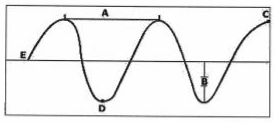
10. A transverse wave is transporting energy from east to west. The particles of the medium will move_____.

11. What is the amplitude of the wave in the diagram below?

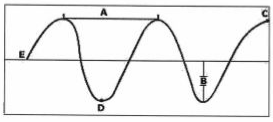



12. The wavelength of the wave in question 11 is: _____

13. The wavelength is represented by which letter?




14. The wave trough is represented by which letter?




15. A wave is transporting energy from left to right. The particles of the medium are moving back and forth in a leftward and rightward direction. What type of wave is this?

16. If the frequency of a sound wave is 440 Hz, what is the period of the wave?

17. If the frequency of a sound wave is doubled, the period of the sound wave is
    a. Halved
    b. Doubled
    c. Unchanged
    d. Quadrupled

18. Frieda the fly flaps its wings back and forth 121 times each second. The period of the wing flapping is ...

19. A wave is introduced into a thin wire held tight at each end. It has an amplitude of 3.8 cm, a frequency of 51.2 Hz and a distance from a crest to the neighboring trough of 12.8 cm. Determine the period of such a wave.

20. A tennis coach paces back and forth along the sideline 10 times in 2 minutes. The frequency of her pacing is ...

Sample Project Lesson

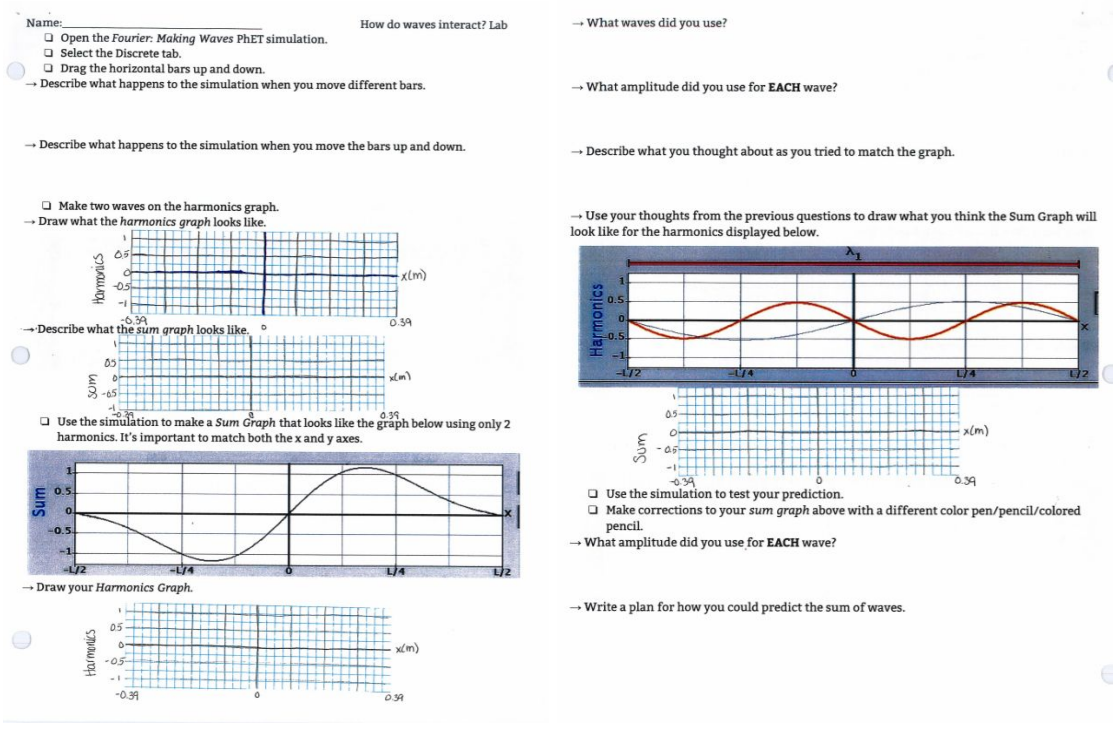
The project lesson included provides the teacher/instructor with a lesson plan to span the class period. After showcasing their individual understanding, the students will then in groups research articles on how music can affect one's mood, to be later used in creating a product.

| **Subject/Course** | Physics 100 |
|---|---|
| **Topic** | Music and Mood |
| **Lesson Title:** | Music and its effects research |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can showcase my knowledge of what I have learned in this project thus far.<br>• I can research how music impacts one's mood. | |
| **Task List** | |
| • Quiz<br>• Research 5 articles on how music can/does impact one's mood. | |
| **Materials Needed** | |
| • Quiz<br>• Chromebook | |

Sample Lab Lesson

The sample lab lesson included provides the teacher with a lesson plan and lab for the students to complete. This lab was provided because it is simulation based and it provides the students with some choice in their lab completion.

| | |
|---|---|
| **Subject/Course** | Physics 100 |
| **Topic** | Music and Mood |
| **Lesson Title:** | How do waves interact? Lab |
| **Lesson Duration** | 75 minutes |
| **Lesson Objectives** | |
| • I can apply my knowledge of waves and interference to a simulation. | |
| **Task List** | |
| • How do waves interact Lab with partner | |
| **Materials Needed** | |
| • https://phet.colorado.edu/en/simulation/fourier<br>• How do waves interact lab | |



Name:_____ How do waves interact? Lab

❑ Open the *Fourier: Making Waves* PhET simulation.
❑ Select the Discrete tab.
❑ Drag the horizontal bars up and down.

→ Describe what happens to the simulation when you move different bars.

→ Describe what happens to the simulation when you move the bars up and down.

❑ Make two waves on the harmonics graph.

→ Draw what the *harmonics graph* looks like.

Harmonics x(m)

→ Describe what the *sum graph* looks like.

Sum x(m)

❑ Use the simulation to make a *Sum Graph* that looks like the graph below using only 2 harmonics. It's important to match both the x and y axes.

Sum

→ Draw your *Harmonics Graph*.

Harmonics x(m)

→ What waves did you use?

→ What amplitude did you use for **EACH** wave?

→ Describe what you thought about as you tried to match the graph.

→ Use your thoughts from the previous questions to draw what you think the Sum Graph will look like for the harmonics displayed below.

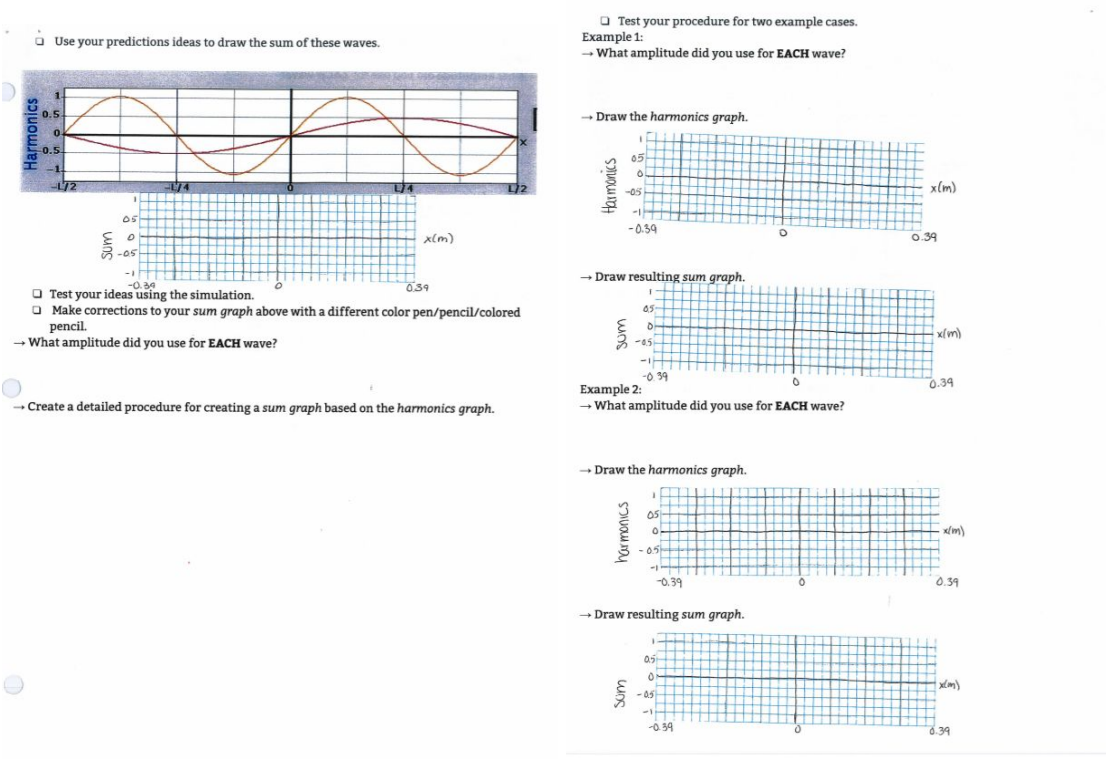
Harmonics

Sum x(m)

❑ Use the simulation to test your prediction.
❑ Make corrections to your *sum graph* above with a different color pen/pencil/colored pencil.

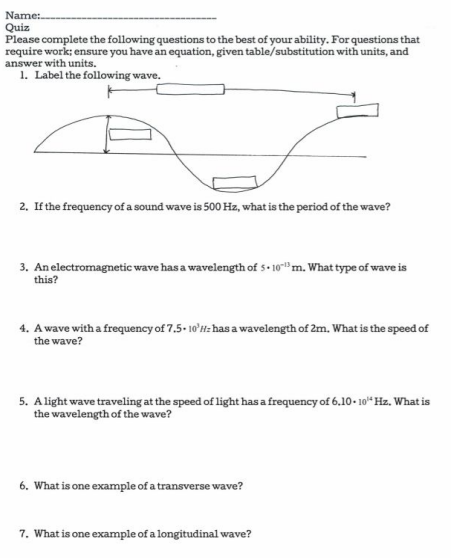
→ What amplitude did you use for **EACH** wave?

→ Write a plan for how you could predict the sum of waves.




*Project Five Sample Lessons:* The lessons above include three types of lessons: content, lab, and project. Each of the lessons include the materials needed for the lesson.

Quiz 1



Name:_____

Quiz

Please complete the following questions to the best of your ability. For questions that require work; ensure you have an equation, given table/substitution with units, and answer with units.

1. Label the following wave.

2. If the frequency of a sound wave is 500 Hz, what is the period of the wave?

3. An electromagnetic wave has a wavelength of $5 \cdot 10^{-13}$ m. What type of wave is this?

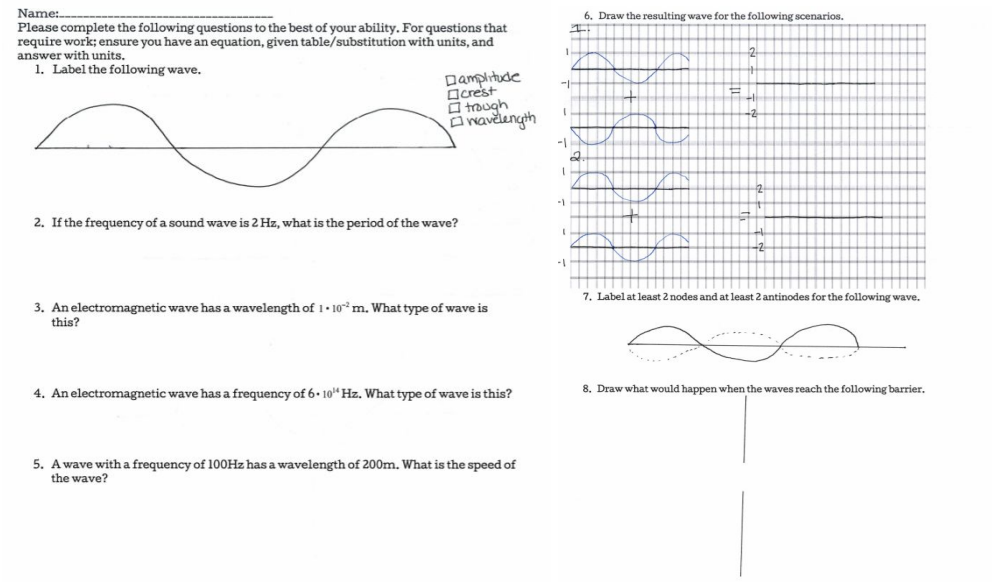
4. A wave with a frequency of $7.5 \cdot 10^{7}$ Hz has a wavelength of 2m. What is the speed of the wave?

5. A light wave traveling at the speed of light has a frequency of $6.10 \cdot 10^{14}$ Hz. What is the wavelength of the wave?

6. What is one example of a transverse wave?

7. What is one example of a longitudinal wave?

Formative Assessment



Name:_____

Please complete the following questions to the best of your ability. For questions that require work; ensure you have an equation, given table/substitution with units, and answer with units.

1. Label the following wave.

☐ amplitude
☐ crest
☐ trough
☐ wavelength

2. If the frequency of a sound wave is 2 Hz, what is the period of the wave?

3. An electromagnetic wave has a wavelength of $1 \cdot 10^{-2}$ m. What type of wave is this?

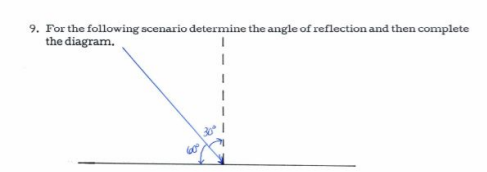
4. An electromagnetic wave has a frequency of $6 \cdot 10^{14}$ Hz. What type of wave is this?

5. A wave with a frequency of 100Hz has a wavelength of 200m. What is the speed of the wave?

6. Draw the resulting wave for the following scenarios.

7. Label at least 2 nodes and at least 2 antinodes for the following wave.

8. Draw what would happen when the waves reach the following barrier.



9. For the following scenario determine the angle of reflection and then complete the diagram.

10. A light wave is traveling towards a mirror at an angle of 40°. The ray is completely reflected. What is the resulting reflected angle?

11. A ray of light is traveling in a water and strikes a water/corn oil interface. If the angle of incidence is 15°, what is the angle of refraction?

12. A ray of light is traveling in a air and strikes a air/diamond interface. If the angle of incidence is 35°, what is the angle of refraction?

*Project Five Assessments:* Above are the different assessments needed for the project. Each of the assessments follow the calendar and allow for the content to be broken up along the project. The formative assessment is included to assess all concepts learned during the project.

**Reflective Discussion**

This five project, project based learning (PBL) curriculum allows for a student centered classroom and allows the students to take ownership of their learning. Through this, students actively frame and reframe the problems in order to learn the concepts to arrive at a solution to the project. The freedom and choice provided through PBL allows for the students to take ownership of the problem and thus they gather information, generate ideas, and evaluate those ideas in a purposeful manner (Svihla & Reeve, 2016). Through each of the projects, the students are able to find a personal connection to the material in a way they take ownership of and invest in their learning. The PBL way of learning allows the students to have an overarching essential or driving question to continuously connect to, whether it be a content, lab, or project day. Hung agrees that project based learning has the students use problem solving skills in order to connect prior knowledge and current knowledge to a project (2011). The resources provided aid the teacher and student alike in order for the curriculum to meet New York State Standards as well as allow for the students to reflect, get creative, and express their learning in additional ways. While the project is group oriented, there are opportunities for individual assessment in order to gauge individual learning as well as group progress. PBL allows for students to not only develop understanding of concepts in physics but also to learn necessary skills for the workplace such as collaboration, meeting deadlines, and improving work based on feedback. Small groups were deemed effective for students' learning especially in the areas of content integration, critical thinking, communication skills, self-directed learning, and the connection between concepts and a problem (Long & Qin, 2014). Therefore this PBL curriculum not only meets what is asked for by state requirements but also develops students into individual thinkers that will better the

future workplace.

In compiling this curriculum, it has allowed for me to reflect on my planning in order to be detail oriented. Being detail oriented in creating the resources has forced me to think about the overarching driving or essential question. In this curriculum I wanted the students to find value therefore I choose projects that apply to their daily lives in some form. By having the concepts and projects apply to their daily lives the students are more apt to invest in the project as well as persevere when times get difficult. In being detail oriented with my planning, it has allowed for me to look at the flow of the typical physics curriculum and move it around in a way that students are revisiting concepts and having the projects dictate the concepts instead of shaping labs and projects around the concepts. These big picture projects allow for students to think not only about the concepts, but also about the world around them and allows for them to begin thinking scientifically outside of the classroom through questioning and application. The rubrics and calendars reflect this because it is shaped by the project and content fills in the gaps. The lessons also show how the concepts connect back to the project by either including questions that relate to the project or by providing information the students can use in each project. The assessments allow for the teacher and student alike to gauge the individual students' understanding of the concepts, therefore within the projects it allows for students to develop all these necessary skills as well as learn physics. McDonald agrees that by offering opportunities throughout a project for assessment, it allows for students to reflect on their learning and continue to improve (2008). The research done prior to the creation of this curriculum is also appreciated as it is nice to know that there are studies supporting a changed physics curriculum as well as all of the skills the students develop in addition to concepts in PBL. I have appreciated

rolling this curriculum out into the classroom as I have found the students are more interested and invested because they are able to be creative while learning about physics through seeing the continuous connections.

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