WPI Teaching Practicum

8th Grade Physical Science at Millbury Memorial Jr. / Sr. High School

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CHAPTER 1

Millbury High School

Millbury High School was built in 1952 at its present location at 12 Martin St. as a memorial to World War II veterans who lived in great numbers in the town. However, the original Millbury High School was erected in 1851 in the center of town, but was later moved to the newer building on Martin St., which is approximately one mile from the original school. Three additions have been made to the school since its construction in 1952, the most recent beginning in 2003. There is also an annexed Jr. High School Building housing 7th and 8th grade students, as well as an administration building for the town superintendent and other administrators behind the school.

The student population in Millbury High is very nearly homogenous, with 93% being Caucasian, while Asian, Black, and Hispanic students only make up 2% each, and 1% Pacific Islander. In addition to this homogeneity, no students presently in grades 8-12 have listed any other language than English as their primary language. Students are however, required to take a foreign language beginning in 8th grade, and must continue to study a foreign language for at least 3 years. Many students choose to continue on through their senior year studying their chosen language. Millbury High School would likely be considered to be on the small side, with about 906 students in grades 7-12. In 9-12, there are only 592 students, and the Jr. High School building currently has about 344. Millbury's total population according to the 2000 census was about 12,784, although that has undoubtedly increased since due to a major influx from the city and other suburbs. It's location very close to the Shoppes at Blackstone Valley as well as it's connection directly to the Massachusetts Turnpike have made it very attractive to many city dwellers in Worcester who are looking to move toward the suburbs but do not want to be disconnected with easy travel and access to shopping.

On an economic note, the residents of Millbury do well for themselves taking in a median income of about $52,415 per year. Also, with a low unemployment rate of 3.9%, the town fits in well with the suburbs, poverty not being a major problem of the area. As stated above, the recent addition of the Shoppes at Blackstone Valley has not only provided a good flow of taxable income for the town, but has also provided many jobs to the residents. All this considered the town edges very closely to high need status, with 22% of students in the high school accepting either free or reduced lunch, and in addition over 15% of the students come from a low income household. The school system spends about $1000 less than the state average on a per-student basis, spending about $8,097 per student annually, whereas the state average is approximately $9,096.

One of the most notable achievements of the school system has been its very low dropout rate, and extraordinarily high graduation rate. In 2003-2004, the dropout rate was .77% and the graduation rate for those years was 100%. The school has maintained very near to those low numbers for quite some time. This can be attributed to several factors, but one would be inclined to look at the education rate of the parents of these students. More than a majority of the town's adults have completed High School, with 83.7% holding a diploma, and according to the 2000 census, nearly 18% have a bachelor's degree or higher. Another reason for the low dropout rate and high graduation rate is likely to be the school system's advocacy program where underprivileged students and students with learning disabilities and behavioral problems are monitored closely by dedicated faculty. They are given the extra attention they need to succeed, and through the cooperation of their teachers and aids, their progress is well monitored, letting the advocacy leaders become aware of any problems early on before the turn into a major issue. Needless to say, the students at Millbury High aren't left behind, they are well shepherded toward a bright future.

One of the most notable problems that have faced the school has been the relationship between it and the local Vocational School, Blackstone Valley Regional Vocational Technical High School in Upton. This beautiful vocational school recently underwent a series of very expensive renovations that have left it one of the nicest facilities in the state, with the highest MCAS achievement status among vocational schools. Through the years, Millbury's students who wished to pursue a trade instead of traditional schooling would apply to, and then transfer to BVT. These students tended to be those less engaged by traditional classroom learning that needed to get out and get hands-on experience, and they did very well at BVT. Now however, the school has earned such prestige from its MCAS performance and college acceptance rate that it no longer holds its original stigmas. The school was at one time viewed as a place for students with disciplinary issues who were destined to study a trade and had no interest in college. More and more students from Blackstone Vocational are pursuing a 2 or 4 year college program, and due to its growing renown, many parents are eager to send their top-ranking students there. This leaves Millbury's lower-performing, trade-seeking students in a problem. Those who would originally be destined to pursue alternative hands-on learning at BVT are no longer being accepted by the vocational school, and are therefore forced to stay at Millbury High to learn in the traditional setting that simply does not suit them. In order to compensate, Millbury has made an effort to increase its culinary and engineering opportunities by adding classes and teachers to suit. It is still difficult with the budget that Millbury is on to accommodate those students without a working “trade shop” or materials to suit. It is also in some ways difficult to substitute pre-engineering classes for students who would be going to a trade school to learn carpentry, plumbing, or other trades that don’t require the higher math and science skills (as well as a 4 year degree) that engineering does. The schools efforts however are necessary if they are to maintain the interest of these students, and the school system is hopeful their efforts will pay off.

CHAPTER 2

Course Overview

The course at Millbury Jr. High School that is being focused on is Physical Science at the 8th grade level. The course is designed so that it fits into the entire sequence of science courses at the high school level, feeding off of previous courses as well as preparing students for future classes. The curriculum for this course was developed over many years, but most recently underwent a significant formatting and content change to bring it closer to today's standards and needs. It is important for the student teacher to investigate the foundations of the curriculum and where it came from, as to better understand the course material they will be developing.

Science at Millbury Jr. /Sr. High school is approached in a sequential format where students must all take the same science classes until their fourth year, where they have many more elective choices. The course sequence goes as follows: students take Life Science in 7th grade, Physical Science (the course being focused on) in 8th grade, and then take Earth Science in 9th grade. Students then take Biology as sophomores, and finally Chemistry as juniors. Although all students must take the same sequence of courses, they are offered 4 levels of rigor: honors, college prep, and business level classes, as well as an AP level class for Chemistry. Students are also offered Anatomy and Physiology, Advanced Biology, and Physics, usually taken as electives during their junior and/or senior year.

Physical science in 8th grade prepares students for later courses in Chemistry and Physics, as well as some Earth Science. Portions of the course overview as taken from the Millbury High School course descriptions are given below:

"This course covers basic physics and chemistry and earth science concepts as they relate to the requirements of the Massachusetts Physical Science and Technology/Engineering Curriculum Frameworks.

The course covers, but is not limited to, the following physical science topics: metric measurement, accuracy and precision in measurement, properties of matter, elements and molecules, compounds and mixtures, motions and forces, forms of energy, including heat energy, and solutions and mixtures."

The laboratory setting is also instrumental to the class and allows students to cooperate in hands-on activities with classmates, learning experimental technique, group cooperation, and problem solving.

All of these topics, especially becoming familiar with the lab setting, are essential to science courses that students will take in high school, most notably biology, chemistry and physics. In all three classes students will need to be able to take proper measurements in a lab setting, be able to analyze data properly, and write a thorough lab report that demonstrates their understanding of the material. The course in Physical Science gives them exposure to these important skills, which goes above and beyond the material that they learn that will also apply in their future classes.

There are four fundamental areas of learning that Physical Science needs to prepare 8th graders with: studies in properties of matter and basic chemistry, motion and forces, an understanding of energy, specifically potential and kinetic to describe and evaluate situations, and finally a thorough understanding of the lab environment and experimental procedure. The first objective will prepare students for future chemistry classes, giving them an introduction to elements, states of matter, physical and chemical changes and more. The second objective is more closely related to future physics classes the student may take, relating speed, velocity, and acceleration to practical examples. The third objective lands somewhere in the middle, incorporating skills that will be needed in both future classes, through understanding energy and heat transfers specifically focusing on potential and kinetic energy as well as thermal energy. The final objective is accomplished through experimental work in lab situations where students gain more practical knowledge of how the theory they learn in class can apply to situations witnessed in "real life." It is imperative for students to be able to make the connections between the content in their books and the things they witness every day, because that is what will allow students to fully understand and comprehend the material. This key component of the course also prepares students for lab situations they will encounter in future courses by understanding how to properly write a lab report, work in teams to hypothesize, collect data, and develop conclusions. This is the first lab-centric class they will encounter in physics and chemistry, and it is very important that they develop proper laboratory habits in order to succeed in future lab-centric courses such as Biology, Chemistry, Physics, Anatomy and Advanced Biology.

It is also important to investigate skills that students will need to possess, obtained through prior math and science classes. It is essential to be aware of what the students are capable of, and to make sure that the goals and material within the class are within their means to accomplish.

Important mathematical background for students taking 8th grade physical science includes basic arithmetic and at least some simple Pre-Algebra. Students will need to solve very simple single variable equations when handling problems dealing with motion and forces, mass, volume and density, and other simple problems. For example, students will learn to solve for density, mass or volume by using the equation density = mass/volume, when given any 2 properties. They will need the basic math skills to solve for the unknown property. These prerequisites are covered in 7th grade Pre-Algebra, as well as arithmetic skills from previous math classes throughout their education.

It is also important for students to have covered states of matter, simple atomic properties, and measurement skills in previous science classes. In 6th grade and before, students were exposed progressively to these concepts, which students only need to have a basic understanding of. Students need to have experienced certain occurrences in their daily lives, such as witnessing water boiling, a car in motion, and seeing gravity in action. Some of these experiences may have been part of a student's previous curriculum in classes prior to Physical Science, but many are simply a part of a student's daily life. Students will be relating these experiences to concepts learned in the classroom, and although it may not have been taught in a previous class, it is important for them to have real life experiences with the concepts they will be learning.

The current curriculum is developed by request of the principal in 2006 (Ann Steel), who felt it was necessary to more clearly outline any curricula that had not been updated recently. She also felt that it was important that all classes follow a specific set of guidelines, and that all curricula followed a singular setup so that all curricula throughout the entire school were formatted in the same way. A template and series of guidelines were given to teachers to follow. It forced teachers to find state standard frameworks, and essential questions for units and plans.

Much research was done through the state and national standards in order to identify the end results that needed to be achieved by the course. Once the instructors knew the ends that they had to achieve, they were able to develop a curriculum to get to that point. Although the two teachers who designed the Millbury High Physical Science curriculum had to look over the state frameworks to make sure each standard was met, it didn't simply turn into a matter of throwing lessons out and adding new ones in. A lot of the renovations made to the curriculum in 2006 were more about articulating the goals of the current unit plans, rather than establishing new plans themselves. Mastery and educational objectives were set forth to outline goals and what was necessary to achieve for each unit covered – what the students were expected to be able to do. Mastery objectives stated the things students must know when the course was over, and Educational objectives demonstrated how teachers would make sure the students met those goals. Essential questions were also developed for each unit, being questions that each student should be able to answer after completion of the unit. This is something that hadn't been used before in the Physical Science curriculum, and has helped to clarify goals that must be achieved by the designed units. These aforementioned Essential questions were based off of the frameworks, as well as the Mastery and Educational objectives stated for the unit.

The curriculum that was in place when the current Physical Science teacher at Millbury Jr. High started was very different than it is today. First of all, it was very concise, only about a page or two, and it simply outlined the different topics that would be covered during the course. No course materials were listed, and there was very little if any justification for why the material was being taught, let alone any goals for the students throughout each unit. As time went on, and the MCAS and frameworks were set into place, a lot more emphasis was put on successful scores, and therefore a more properly outlined curriculum was developed (although it was still much more concise than the one in use today). In recent years, material not found on the MCAS or on the state frameworks has been taught less and less until it reaches the point where it is dropped altogether to make more room for material that will definitely be covered on the test.

Another interesting note is that the 8^{th} grade MCAS only covers about 25% Physical Science, and in addition it also covers Earth Science. 5 additional Earth Science frameworks were necessary to cover, because students at Millbury high were not getting Earth Science until 9^{th} grade, after MCAS for 8^{th} grade was over. It is necessary to cover those frameworks because the students didn't have the material previously in 8^{th} grade, and MCAS results began to show it.

Therefore, in the revised curriculum, 8th grade Physical Science also covered 5 additional frameworks from Earth Science in order to ensure that students had covered all the frameworks up to 8th grade in science for better MCAS performance to adhere to no child left behind. Prior to this, 8th grade MCAS was not a graduation requirement, so the administration did not give the MCAS in 8th grade nearly as much attention as it is given now

CHAPTER 3

Course Materials

One of the most influential things that I learned personally throughout my experience as a student teacher was that science class is much more than learning hundreds of little details and formulas; it's about a much bigger picture of understanding, insight and inquiry. Let's face it, a lot of material is presented in most science classes, and a lot of it can be hard for a student to retain. It is very unlikely that most students will be able to recall all the individual formulas, scientific jargon, and mathematical relationships introduced to them over the course of a year, which leaves us asking; then what is the goal of the course? The goal is to have a much more broad understanding of each of the topics outlined in the frameworks, and by keeping this in mind it becomes much easier to help the students make lasting progress throughout the course.

The bigger picture begins by taking a look at the standards outlined within the frameworks, in this case, the Massachusetts state frameworks. For example, there are two standards for the topic of "Motion of Objects" in the state frameworks (found the Appendix), numbers 11 and 12. For each standard, certain mastery skills must be developed and practiced. In my Unit Plan for the unit of Motion in Physical Science (Appendix 2.1), I established five outcomes that must be completed in order to satisfy the two state standards. Although these outcomes do not get into all of the specific details, they are more focused on how the standards will be accomplished in the classroom. The outcomes serve to outline the bigger picture of the unit and its purpose, as well as specifically detailing what students will be capable of once the unit is complete. These skills will last for the students, and their purpose is to instill a greater understanding of large scale topics that they will see in future science classes in high school in college. Now, the multitude of detail that goes into accomplishing these greater goals of science class cannot be ignored either, it is necessary to learn formulas and implement them, as well as memorize certain concepts. However, the hope is that by focusing on the students' understanding of the major goals, teachers will help students understand *why* they are using a formula or a relationship, not just because they *have to*. Further on, each of the unit outcomes are listed, followed by a detailed analysis of how they will be accomplished, including lesson details, materials, and activity ideas.

The major concept behind the design of unit outcomes is working from the top down. If the unit planning is started from the frameworks (what every lesson is founded upon) it will fit well into the greater sequence of science courses, and be much more relevant to the students. Lessons that do not have deep roots in the frameworks are likely to be forgotten, which in the end is just a waste of the students' time. The bottom line here is to keep things relevant, and it helps to start with the frameworks, then working down to outcomes, and lastly how those outcomes will be achieved. I found that personally it became much easier to construct a lesson plan that I felt would be very beneficial to students, because everything was all planned out beforehand. Once I developed the individual lessons based off of the unit plan, all I had to do was find the right methods of teaching the skills necessary, not having to define the important skills as I went.

One of the important facets of the unit in motion was the interpretation and use of graphs. This was a topic that I wanted to make sure was clear to the students, considering its relevancy to future physics and mathematics courses. This portion of the unit in particular is extremely relevant to the larger structure of the course and sequence of courses at Millbury High School, and the practice of graphing speed, position and time is not merely an exercise to take up time, but is certainly one that can help students bridge the gaps between math and science. In “graphing worksheets 1 and 2” (Appendix W.1 and W.2), students were asked to make several connections to what they have learned in class, to be completed as class work, and then took the second worksheet home for homework. Prior to these two worksheets, the students had been re-introduced to the concept of slope, rise over run, and other plotting concepts that had been covered in prior math courses. In some cases in previous worksheets and homework, I found that a lack of detail and examples lead many students to not be able to make the connections between what they had learned in class, and actually practicing it themselves. For this reason I made sure to include a descriptive preface at the top of the worksheet that the students had to read prior to beginning the assignment which defined slope in a way that they would understand, and in a way that was relevant to the assignment. I truly feel that this introduction help re-familiarize the students with key words and concepts without them having to go hunting through their textbook to find out what they meant, which could certainly be a deterrent for some eighth graders from completing the assignment. Secondly, students were able to follow along with a detailed example problem very similar to the ones that they would be completing later on in the assignment. Although the example doesn’t simply serve as a “how-to” guide for the students, it allows them to check the steps that they will have to follow to successfully solve the later problems which are universal. In order to make sure the students weren't simply mimicking the examples, I made sure to include a few simple comprehension questions to make sure that the students read and understood the preface, as well as took time to read the example problem. These questions are there to make sure the student understood the greater concepts behind the problems that they are solving so that they may apply them in future situations and retain the information. This portion of the assignment is key, in that if there is one thing I wanted the students to take away, it would be things like "what does slope really mean?" or "what is the line actually representing in this graph?" If students are able to answer these questions, they demonstrate a much truer understanding of the material, which is the hope of the instructor. In a sense, this activity also served as much more of an instructive learning tool than it did an assessment. The design of the worksheet walks students through the problems, asking them leading questions that will help them move on to the next portion of the problem. In the end, the assignment was very successful and the class as a whole seemed to get a lot out of it based on evaluating their understanding before and after the worksheet. Being able to graph position vs. time as well as many other variables is a key component to many math and science courses, and so it was important to spend time with a quality educational tool, and I feel like the students will be able to graph in other courses with much more ease and versatility.

Another interesting homework assignment took place during our unit on forces, more specifically on friction. The assignment was a collaborative between 8th grade students' Physical Science class and their English class. Students were asked to write a 2 page essay on a superhero that had to fight an evil villain named "frictionless man." Their superhero would have to restore sense to the chaos caused by frictionless man removing all friction from the world. This assignment allowed students to use their creative writing skills to demonstrate a true understanding of the real-life effects of friction on the way we live and travel. In Appendices 3.1 and 3.2 are lesson plans leading up to this essay, in which students experience hands on and in lecture the forces of friction and how they act on objects. Students learned real life examples like that tires work because there is friction between the road and the tire that allows the tire to translate a force to push against the road, propelling a car. They also learned that without friction, you wouldn't be able to walk along the ground because you would just keep slipping. Students also witnessed sliding blocks, and then saw examples with free body diagrams detailing the direction that friction acts relative to motion, etc. With all of these examples and real life applications in mind, students envisioned a world without friction, and how it might affect them personally throughout their day. This really got students thinking about the world around them and how friction actually applies, as well as the fact that it really does have a huge impact on their life. This creative assessment allowed students who didn't necessarily shine on tests or quizzes to really demonstrate their understanding of the base concept of friction in a way they wouldn't normally get in science class; through writing.

CHAPTER 4

Students

My general take on the collective learning style of the class is that it revolves very heavily around hands-on activities, and group work. I tried several variations of lecture-style note giving, and none worked particularly effectively. Given the layout of the classroom, any time spent heavily in the front of the room tended to result in a chaos.

When the junior high school building was under reconstruction, the two physical science teachers at the time were given the option to choose what types of rooms they would prefer. Given the fact that the teachers favored a lab-centric curriculum and their current room situations were not conducive to frequent labs, they opted for a room with lab benches in place of desks. Now, as can be seen in the included diagram, this created a problem. Students sit four to each side of the bench, and consequently, half of the class is not facing the front of the room at any given time.

Given this situation, lecturing for long periods in front of the board is not a wise idea. I attempted a few times to give notes on a few subjects, or go over class work problems in front of the class, and unless it was a very brief endeavor, the class would slowly lose attention, turn around and start talking.

The only solution to this problem was to be as mobile as possible, and try to stay at one of the sides of the classroom while going over any problems, instructions, or answers to exam questions. This allowed the students to be able to see me without having to turn around and shift in their seats, which generally caused a lot of commotion. Due to the fact that the board was essentially unusable, I tried to use power point notes to both catch their attention and effectively deliver the necessary information. This worked to a point, but the problem I ran into here was competing with some of the students' attention spans. Students who became easily disinterested would then disrupt other students who were trying to take notes, and so a chain reaction ensued. The solution to this was to keep the notes short, and to correct problems before they became a major issue. Keeping these points in mind, note-giving became a far easier task.

Behavioral issues are an ever present issue facing a teacher, and can throw a lesson over the edge to the point where the students no longer have a suitable learning environment. Given the fact that my classroom was a mixed-ability group, (in other words, not grouped based on learning ability), this was a particularly difficult issue. There were many students who were very well behaved, and who I could trust to sit anywhere and still pay attention. At the same time, there were always several students in each class that seemed to make it their goal to disrupt the order within the class.

With a few students, the only problem was that their attention spans and interest in the subject would wane as time went on, and as they paid less attention, they would disrupt other students around them. This was typically an easy problem to solve, because all that was necessary was to bring their disruption to their attention, and they would usually stop. It was almost as if they didn't realize they were being disrupting, but they couldn't help it. This is why, as long as I asked them to quiet down, they would usually realize what they were doing and quiet down.

The more difficult cases involved the few students who had severe behavioral problems, which seemed to stem from more deep underlying issues. One student in particular was very difficult to handle, and it was a very delicate dance to keep her from throwing my lesson plans into a downward spiral. She would come in most days with a very negative outlook on the class, and although she demonstrated a thorough understanding of most material, often times she refused to participate in classroom activities and would typically disengage in the lesson. She never seemed to interact too much with other students, at least not in a positive way, so in one sense she didn't disrupt other students. However, whenever there was a situation where group work was necessary, it was imperative to be able to motivate her so that both she and her partner(s) could get their work done. It also became difficult at times to handle her untimely outbursts or comments on things that were said in class, because they had the tendency to get everyone else off course. The difficulty in this was to try and handle the situation in a way that was stern to show that this was unacceptable behavior without making her bitter, which tended to incite more poor behavior. At first, this was a daunting and intimidating challenge, but as time went on I was able to find strategies in the middle ground that were efficient.

Another problem that could face some teachers is handling attendance problems, especially in very impoverished districts where the students' parents are less involved in the education of their children. For me this was not a huge problem because most students who were absent were only absent for a day or two at the most due to illness, and came to see me upon return for their make-up work. More difficulty was caused by the students who were on suspension for disciplinary issues, and were not able to attend classes for a few days on end. These students were also the least likely to care about getting their make-up work, or stay after for extra help. One simple way to help this was to make sure the students had any worksheets that the class might be going over that they had missed or forgotten at home. This way, they were more likely to pay attention during class because they had the sheets in front of them instead of having nothing to pay attention to. With students who were on suspension, I always tried to make sure that the students had work to do on their own that would keep them up to pace with the classes they were missing. It is also important to give incentive to these students to stay after class for extra help when they miss class, because of the sequential nature of the material. It is very easy for a student in math or science to fall desperately behind in class, to a point where it is very difficult to catch up. By staying after, students are able to learn the material through a one on one basis, and won't fall behind.

Student participation was a difficult issue to overcome in the mixed-ability classes because of the fact that the students most likely to participate were the ones who had a strong understanding of the material, as opposed to the ones who didn't understand or who weren't confident in their abilities. The mixed-ability situation made this even more difficult because of the large variation in abilities between students. This made the highly skilled students stand out as the "smart ones" and left the students who had a hard time with the material feeling unconfident in their answers, and much less likely to participate. A very simple and widely used solution to this problem is to call on students who they haven't heard from lately, or who don't have their hands raised in order to get them to participate. Another solution that I have seen in use that tends to work well is to use a rewards-based system to encourage students to participate through incentives. Those incentives can either be for classroom participation points, stickers, prizes, or candy. This tends to get students motivated to participate or come out of their shell. On a very basic level, it is also important to give the students confidence in their abilities and to make sure they feel like they can participate on an equal level with other students.

CHAPTER 5

Assessment

Assessment is an extremely useful tool to provide feedback to both teachers and students about progress and understanding of benchmark concepts and skills. Frameworks outline key points that need to be addressed by the teacher for the student to meet, and several forms of assessment allow the teacher to keep tabs on what the students have and have not accomplished.

A secondary and very important purpose for assessment is to identify how well the material is taught, in a sense. I don't necessarily mean it is meant to assess how good a teacher is, but how well the lessons and activities fit the level of understanding of the students. If the students as a whole do poorly on an assessment such as a quiz, test or homework, it may show that the material is beyond the current comprehension level of the students and that preparatory instruction may be necessary. For this reason, it is important to assess often and with a variety of methods. This way, if a problem needs to be addressed either within the lesson plan or with an individual student, it can be done early on, instead of when it's a major issue. If a student doesn't understand the material, and no assessments are performed until say, a large scale chapter test on all the concepts within a section, then the student may be several weeks behind in understanding, and you as a teacher will not know until he or she fails the large chapter test. On the other hand, if homework relating to the material is given regularly, and small quizzes are taken periodically, the teacher is in a much better position to identify any problems a student might be having early on. Once problems are identified early a teacher can recommend a student stays after for extra help, or pay additional attention to addressing the problematic concepts in class.

Assessment can also play into simply identifying where the class stands as far as knowledge from prior classes or lessons is concerned. For example, before deciding to pursue a lesson focusing on certain material, it might be important for a teacher to make sure that all students in the class have been introduced to the prerequisites for this material in classes or lessons prior to this one. At one point, I used such a tool to assess the mathematical skills of my students when it came to manipulating formulas. Due to the diverse mathematical backgrounds of the students, it was important to make sure that everyone had at least a certain level of understanding of manipulating formulas before taking a certain approach to introducing speed formulas. The goal was to make sure students were comfortable arranging various formulas in variable form before substituting numerical values, as this is the preferred method, and is actually easier for students in the long run. So, in order to test the waters, I gave the students a "Basic Skills Worksheet" (Appendix W.3) for them to complete in about 10-15 minutes or so. I anticipated the activity to go smoothly, and that students would be able to complete the activity with little difficulty. However, I was surprised to find that some students were completing the activity very easily, others were struggling a bit, and several other students were very confused, unable to complete any of the worksheet without a good bit of guidance. Unfortunately, this led to a bit of chaos in the classroom for a few minutes, because students were unaware that this was an "un-graded" worksheet, and was simply to evaluate their understanding, and they panicked because they didn't' want to get a bad grade. Luckily, I had a backup strategy worked into my lesson plan just in case things didn't go as planned, and I moved quickly to that set of materials.

To some it might seem to some like the activity was a complete failure. It might seem that a lack of preparation and research of skill levels on my part led to a chaotic few minutes in the classroom, a lot was learned from this activity, both intentionally and unintentionally. By probing the waters, I learned that some of the students clearly had covered the concept in previous math classes, and therefore the material was so easy it as almost boring. I also learned that to a significant majority of the class, the material had not been addressed before, and that it was not a good idea to pursue teaching the material through the method of manipulating variables.

It is important to note that there was nothing particularly wrong with the setup or content of the worksheet other than that it was beyond the mathematical background of many of the students. It was extremely useful to me to have pre-assessed the students, because it allowed me to properly plan my next lessons.

As discussed earlier, it is also very important to make sure to assess in a variety of ways. An important idea that variety addresses is that all students learn differently, and therefore all students demonstrate their comprehension best in different ways. Some students are very good test takers, others are best in applying concepts in hands-on activities; some do better with presentations and projects, along with many other ways of demonstrating proficiency. Along with developing lab skills, another reason why the course of Physical Science is lab-centric is to offer students an opportunity to apply concepts learned in class in a practical way, as well as demonstrate a thorough understanding of the material through lab reports. In Appendix 4.1 is the lesson plan corresponding to the Lab in Appendix W.6, the Earth Seasons Lab, which was designed in providing education as well as fair evaluation of the student's understanding of how Earth's seasons work. The motion of earth was covered over about 2 or 3 days prior to the lab, where students (among other things) witnessed a few demonstrations on how the earth spins on its axis, as well as the axis itself tilting based on the season. Although the students witnessed the demonstrations, completed homework assignments on the subject, and listened to the theory, it didn't necessarily mean that they understood. I felt that it was important for the students to get hands on experience in seeing what determines the earth's seasons so that they truly understood the concepts behind it. The activity was designed to both give the students that hands on experience, as well as evaluate their final understanding on the topic.

Other important factors into this assessment activity that I factored in were clarity, effective grading, and relevancy to the topic. Clarity is extremely important when working with Laboratory assessments because if the students are unclear on what they are supposed to be doing for procedure, it is very unlikely that they will make the connections that the lesson intends for them to make. If the students are unable to make the appropriate connections between the theory and what they are practicing in the lab nothing will really be gained by the activity. Also, if the questions and procedure are not clear, it might be difficult for the students to properly demonstrate their understanding of the topic. In other words, if they can't understand what the question is asking, they won't be able to answer it no matter how much they know about the subject. I took special care when creating this lab to take pictures of all procedure steps so that students would know exactly what to do, and made the instructions clear and concise. The questions also related directly back to what the students read the previous night, and to what they experienced in the lab, therefore everyone should have been capable of answering the questions completely, allowing me to assess their understanding of the topic.

Effective grading was accomplished by establishing a rubric (APPENDIX ENTRY NEEDED) which was given to the students ahead of time. The rubric graded the students based on 4 parameters with grades ranging from 0-4 each. The rubric was explained thoroughly beforehand so that students were clear on what they were being graded on. Each parameter and grade level (0-4) was clearly defined, stating how the grade would be determined for each parameter, and what each grade represented and required as far as work was concerned. The students were graded on the parameters of "Sketches" found in the lab, "Neatness" and organization of the lab report, "Questions" that they had to answer at the end of the lab, and finally "Lab Procedure" and how well it was followed based on viewing the lab report. This way, students were very clear on how they could fulfill all requirements of the lab, and what constituted a "good" grade, as well as what constituted a "bad" grade. Once the students received their grades, they could clearly see what they did well on, as well as what sections they were lacking in. The rubric also allowed me as a teacher to easily and fairly evaluate the students' work based on predetermined parameters. I was then able to assign number values to those parameters based on what category they fit in from 0 being the lowest, to 4 being the highest. This ensured consistency, fairness, and an overall better evaluation of the students' understanding.

APPENDIX

Unit and Lesson Plans

Chapter 2: Solids Liquids and Gasses

Section 1: States of Matter

- Matter can be classified into 3 familiar states
  - Solids, liquids, gasses, and a lesser familiar form, plasma
  - States of matter can be easily determined by looking at examples, but in order to define them, we must look at their properties
- Solids
  - Solids have a definite shape and a definite volume
  - In other words, no matter whether a square block of wood is on a table or in a bowl, it will still be square and hold the shape it has
  - Particles in a Solid
    - Particles that make up a solid are very closely packed together in an organized way
    - Although they do not move around much, they do vibrate a small amount in place
  - Types of Solids
    - Crystalline Solids – a crystalline solid has a regularly repeated pattern of particles forming crystals. Some examples of crystalline solids are table salt, sugar, and quartz (p.44)
    - Amorphous Solids – particles in an amorphous solid are not arranged in a repeating pattern. Some examples of amorphous solids are plastic, rubber, and glass. Butter (p.44)
- Liquids
  - Liquids have no definite shape, but they do have a definite volume
  - In other words, if you took 50ml of liquid water in a tall cylinder, what is its shape? It's shape is of a tall cylinder. Then, you took that 50ml of water from the cylinder and poured it into a round bowl – what shape and volume would it have then? Its shape would be that of the round bowl, but its volume is constant at 50ml
  - Particles in a Liquid
    - Particles that make up a liquid are also very closely packed together, but unlike solids they can move freely around one another. (Demonstration: marbles in a container move over one another but are still closely packed)
    - Because of this, the liquid will always take the shape of the container that is holding it.

- Properties of Liquids
  - Surface Tension – A phenomenon that results from the attraction of liquid molecules to one another. This causes the liquids to exhibit a skin-like characteristic that allows liquids to bead and hold objects on its surface.
  - Viscosity – A liquid's resistance to flowing. For example, maple syrup is an example of a highly viscous liquid, whereas water is an example of a less viscous liquid. (Compare and contrast the behaviors of maple syrup and water).

- Gases
  - Gases do not have a definite shape or a definite volume
  - If you were to take a small container of Hydrogen gas and opened it in a big room, the particles would continue to expand until it had spread all throughout.
  - That same gas would also therefore take the shape of the room or whatever other container held it, as well as the volume of its container.

Chapter 2: Solids Liquids and Gasses

Section 2: Changes of State

- Changes Between Solid and Liquid
    - Melting
        - When a substance goes from a solid state to a liquid state, it is called melting
        - The melting point is the temperature at which a substance melts
        - At an objects melting point, the particles of a solid are vibrating so fast, that they break free from their fixed positions and slide around each other as liquid particles
        - *Let's take water as an example:*
            - *The melting point of water is 0°C*
            - *We call solid water ice – let's think about what would happen if we began to heat ice.*
                - *First, the added thermal energy would raise the temperature of the ice by making the water molecules vibrate faster*
                - *Once the solid ice reached 0°C, it would no longer heat up, the added energy would then be used to break the particles free into a liquid state*
    - Freezing
        - When a substance goes from a liquid state to a solid state, it is called freezing
        - Freezing is the reverse of melting, so the melting point is the same as the freezing point
        - *Let's look at water as an example again:*
            - *The freezing point of water is the same as it's melting point - 0°C*
            - *If you were to put liquid water into a freezer, the water would lose thermal energy to the freezer and the particles would begin to slow down.*
            - *Once the particles slow down so much, they begin to form regular patterns and solidify*

- Changes Between Liquid and Gas
    - Evaporation
        - Vaporization of a liquid that only takes place on the surface
        - When the molecules on the surface of the water get added energy from the air or sun, they escape into the air as gas
        - It is easier for the molecules on the surface of the water to escape because there is less pressure holding them back
    - Boiling
        - Boiling occurs when an entire container of liquid is heated so that bubbles of vapor form and rise to the surface and escape
        - Boiling Point is the temperature when a liquid boils
        - *Boiling Point and Air Pressure:*
            - *The boiling point of a substance depends on the air pressure around it*
            - *The lower the pressure pushing down, the less energy needed for the gaseous liquid to escape into the air, so the lower the boiling point*
    - Condensation
        - Condensation occurs when a gas is cooled below its boiling point, and once again returns to the liquid state
        - *This can also happen when water vapor comes in contact with an object that is cooler than it, such as a mirror in a bathroom, and the liquid water now begins to collect on the mirror and fog it up*
- Changes Between Solid and Gas
    - Sublimation
        - Sublimation occurs when an substance goes straight from a solid to a gas without passing through a liquid state
        - *This usually occurs because there is not enough atmospheric pressure for the substance to exist as a liquid*

Unit Outcomes

Motion

By the end of the unit on motion, students will have fulfilled Massachusetts Frameworks Standards for the Motion of Objects (11 & 12)

11. Explain and give examples of how the motion of an object can be described by its position, direction of motion, and speed.

12. Graph and interpret distance vs. time graphs for constant speed.

by completing the following five outcomes:

Students will be able to:

-compute the speed of an object given the distance it travels and the time it takes to travel that distance

-differentiate between speed and velocity

-define motion as it relates to position, direction and speed

-differentiate between average speed and instantaneous speed

- interpret a graph of position vs. time for constant speeds

Through a variety of assessments (quizzes, homework, labs, classroom participation) students will be given an opportunity to demonstrate their mastery of the 5 given outcomes. Quizzes will specifically cover one or more of the listed outcomes to ensure the students fully understand the given material.

1. **Students will be able to compute the speed of an object given the distance it travels and the time it takes the object to travel that given distance**

    a. Students will be introduced to the formula s = $\frac{d}{t}$ (speed equals distance divided by time) and will be familiarized with its applications
    b. Students will learn 4 steps to solving a typical speed problem:
        i. Re-write the speed formula s = $\frac{d}{t}$
        ii. Identify distance and time in the word problem or example given and include the units of those quantities
        iii. Plug in the distance and time into the formula and calculate the result

iv. Write the solved speed and be sure to include units for full credit

c. Students will be well aware of the importance of including the units of quantities throughout a problem, and why it is done
d. Students will be expected to be able to solve for speed using the method outlined in 1.b. when given distance and time in a variety of applications and examples

2. Students will be able to differentiate between speed and velocity

a. Students will be shown that:
    i. Speed is the distance an object travels per unit o time
    ii. Velocity is the speed of an object, as well as the direction of motion of that object
b. Students will be given examples of both speed and velocity in order to be able to differentiate between the two

3. Students will be able to define motion as it relates to position, direction, and speed.

a. Reference points will be used to describe an objects motion and stationary reference points will be used to identify whether an object is in fact in motion at all

4. Students will be able to differentiate between average speed and instantaneous speed

a. Average speed will be defined as the total distance traveled by an object divided by the total time it took to travel that distance
b. Instantaneous speed will be defined as the rate an object travels at an instant in time
c. Examples of both will be given to the students to allow them to recognize and identify both and the differences between the two

5. Students will be able to interpret a graph of position vs. time for constant speeds

a. Students will first be shown graphs of position vs. time for constant speed and will be shown how to interpret them:
    i. Through slope (rise over run)

ii. Described as the distance an object goes (on one axis) and the time that corresponds to it (on the other axis)

b. Once a full understanding is shown through assessment, students will be able to plot and draw basic position vs. time graphs

Merit: Calculator and Pen/Pencil

Opening Class – - Clapping Activity (getting students attention)
- Take Merits
- Collect Homework

Review Speed Activity –

-What was your fastest speed of the run?
-How was it calculated? (Have student explain what the distance and time were and then how they used those two pieces of information to arrive at the speed)
-Check to see if the students are rounding to the correct number of significant figures. If not, explain why and how to do so.

-Take the student who had the fastest speed in the class. Then ask the class to calculate how long it would take that student to go 15m at the same speed – 22m?

Manipulating Formulas –

-Go over several examples of how to manipulate variables to solve for a selected variable
-Show practicality in how it is important when trying to find distance or time when given speed and one of the two other variables
-Allow 10-15 minutes to complete worksheet on manipulating formulas
-Work ALONE (radiation blockers?)
-Go over solutions when all students have finished

IF TIME ALLOWS

Speed vs. Velocity –

Speed – Distance travelled per unit of time

Ex. 5 meters in 1 second – 5m/s

-Doesn't matter what direction you travel in
-Demonstrate: If you went 10 meters in 5 seconds forwards what is your avg. speed? (2m/s) If you went 10 meters in 5 seconds backward what is your avg. speed? (2m/s) Sideways? North, South? All the same.

Velocity – Distance travelled per unit of time AND the direction travelled. In other words, speed + the direction travelled

Ex. 5 meters in 1 second travelling North – (5m/s N)
Ex. 9 meters in 3 seconds travelling backwards – (-3m/s) or (3m/s backwards)

Velocity includes more information than Speed does (direction)

<u>Homework –</u>

Pg. 15 – 1(abc) 2(ab)

Outcomes Covered:

- 2. Students will be able to differentiate between speed and velocity
- 3. Students will be able to define motion as it relates to position, direction, and speed

Merit: Calculator and Pen/Pencil

Concept of Reference Points –

Propose the questions "As you sit in your chair, are you moving"? Take answers from the students as they raise their hands, and take 4 or 5 responses before clarifying.

Explain that it all depends on the reference point you take:

Ex.1. If I stand here and look at you, you don't appear to be moving, but if I were standing on the moon with a telescope, looking down, you as well as the whole earth would appear to move through the sky.

Ex.2. If we're sitting in a car, and you look over, am I moving? (Demonstrate by walking as if you were driving) According to *student*, are we moving? According to you, I'm not moving, but according to them, we're both moving.

Ex.3. If you're sitting on the bus parked next to another bus, you might look out the window, and then suddenly feel like you're moving backward. Why is that? It's because the other bus is moving forward, so by using the other bus as a reference point, your bus begins to move backward.

Practice in Theory –

Have the entire students write down 3 examples of motion that they encountered this morning, what they used as a reference point for that motion, and how it may have affected their perspective of how the object was moving. Ask the students to think about any situations where they might have thought something was moving when it wasn't, or thought something was moving in a different manner than it actually was.

Review the responses by having some students read their situations aloud. Use this opportunity to note that if the students were to choose a moving reference point, they might thing that they were moving, or that they were moving more quickly or slowly than they actually were.

Switching Gears –

In order to introduce the students to the concept of velocity, we must first begin with speed.

Using the 5 meter line and a toy car, give one student a stopwatch, and push the car forward down the line at a fast pace, have them record the time. Then push the car in the reverse direction facing the opposite way so the car moves backward quickly and do the same thing. Have students on their own compute the speed and write down a few notes on all the ways they could describe the motion of the car in both examples. Students are likely to write:

- The first car moves fast and the second moves slow
- The second car moves backwards
- The first car moves towards the wall and the second car moves towards the door
- Etc.

Make connections as well to the concept covered earlier of reference points

Introduce the concept that velocity is like speed expect it adds the aspect of direction, allowing you to more fully describe the motion of the object. You can say the object is going 120 ft/s N, or -23mi/hr, as opposed to just the numbers. That way you know what way the car is moving.

Homework –

p.8 M

Look at the picture of the skydivers and the plane on page 8. Write about the three objects in the picture (the two skydivers and the plane) and how they see things as moving to them. I.e. how does the plane appear to be moving to the skydivers? How do the skydivers appear to be moving to one another?

Outcomes Covered:

- 5. Students will be able to interpret a graph of position vs. time for constant speeds

Merit: Calculator and Pen/Pencil

How to plot Distance vs. Time Graphs –

Opening Activity Setup: 2 graphs on the board of D vs. T, followed by a D vs. T problem

Instructions – Based on the graphs given, determine the speed of the object. Afterward, given the following distance and time, determine the speed of the object, and then sketch a D vs. T graph.

Spend some time going over the answers and how they were arrived at. Spend most of the time on the 3rd example because this is what the students will be doing for themselves after the lab.

Lab on Distance vs. Time –

Materials:	Ball	Stopwatch
	Ramp	Graph Paper
	Blocks	Masking Tape

Procedure:

The students will be provided with a table to fill in for the measurements in the lab first.

1. To begin, students will take one block and position it under one side of the ramp so that the ramp forms an angle.
2. Students will roll the ball down from the top of the ramp and record a time after the ball travels 2 meters. Repeat for 3 trials
3. Students will add another block and refer back to step 2, continuing the process until they have finished 3 trials for a 4 block ramp

Data Analysis:

Students will be required to complete 2 parts of the analysis stage of their lab assignment. First, they will have to complete a graph of the average speeds for all 4 ramp levels tested during their lab. Secondly, they will have to answer several questions for homework on their experiment. Cumulatively, these two assessments will make up their grade for this lab. Students will be graded for this activity based on the attached rubric.

Interpreting More Speed Graphs

Outcomes Covered: *Massachusetts Frameworks Physical Science 6-8 #12*

- 5. Students will be able to interpret a graph of position vs. time for constant speeds

Merit: Calculator and Pen/Pencil

Prerequisite Knowledge:

It is important for students to have an understanding of how to read and plot a line graph. Students have already been introduced to some examples of graphs of constant speed when considering distance vs. time. Some of them are taking Algebra and have been introduced to graphs and the concept of slope as rise/run. However, this is a heterogeneous grouping of students and therefore skill levels are not equal, and I will assume that students do not have a strong footing in the concept of slope and what it means in a speed graph. Over the past couple of lessons, they have been introduced and accustomed to finding the slope of a line

Instructional Objectives:

Students will be able to:

- draw a graph containing the slopes for multiple speeds in a distance vs. time format
- understand the relationship between slope and speed on a graph
- translate real-life data into a graphical analysis
- understand what a slope of 0 signifies on a distance vs. time graph
- be able to interpret a graph of an object moving with a constant velocity that stops in the middle of its motion, and then continues again.

Materials:

Students:

- Calculator
- Pencil
- Ruler
- Notebook
- Graph Paper

Teacher:

- Constant Velocity Car
- Meter Stick
- Stopwatch

Procedure:

Initiation:

Approximately 10 minutes

- Merit Check
- Return worksheets 1 and 2 completed on the previous day covering the graphing prerequisite knowledge that is necessary for today's activities
- Go over (In sparing detail) the answers to the problems (almost all students did exceedingly well, very few details need to be clarified)

Development:

Assessment – Approximately 25-35 minutes

- Hand out Lab Assessment – Instructions explained within assessment
- Students will complete 2 portions to the assessment on the Graphing Lab
    - Answer 4 questions pertaining to their lab experiment which address proper lab procedure as well as correlations to the graphing portion of their lab
    - Create a Distance vs. Time graph in which the student will plot 4 lines each representing the average speed for the ramp level that it corresponds to. A grading rubric is attached to the lab assessment paper
    - 4 Questions – 20pts, 50% of lab grade
    - D vs. T Graph – 20pts, 50% of lab grade

AN INTRODUCTION TO FORCE

Outcomes Covered: *N/A*

Merit: Notebook

Prerequisite Knowledge:

Students must have an understanding of the scientific definition of force as well as the Newton, the unit of measurement of force. These words will be used by the students to describe what they are observing.

Homework assigned previous night relating to topic to gain background knowledge:
Defining key terms (force, Newton, net force, unbalanced forces, and balanced forces), read p.36-39

Instructional Objectives:

Students will be able to:
- recognize that objects move because a force acts on them
- describe what happens when a force acts on an object
- describe what happens when two forces act on an object in the same direction
- describe what happens when two forces act on an object in opposing directions

Materials:

Procedure:

Initiation:

This portion of the lesson will be dedicated to helping students begin to understand how forces act on objects. A book will be placed in the center of the table, with students gathered around. Each of the three tables will be addressed separately as to control the situation. The other students will work on defining the key terms from section 1 and answering 1) b and c, and 2) a. Then, the students will be asked to (one or two at a time) demonstrate several behaviors of the book based on applied forces.

For example:

1. One student will be asked to move the book. Ask:
   "Did the book move because of a push or because of a pull?"
   "Would the book have moved without a push or a pull?"
   "What do we call that push or pull on the object in science?"
   "What direction was the force applied by you?"
2. Ask another student to do the opposite, (push or pull) of what the last student did, then ask them what direction the force they applied was in.
3. Ask a pair of students to pull on the book lightly in opposite directions
   "What was the direction of the force you applied?"
   "Why did the book stay almost in place?"
4. Ask a pair of students to pull lightly on the book in the same direction
   "What was the direction of the force you both applied?"
   "Why did the book move this time?"
5. Ask one student to push lightly on a book, and the other to push a little harder
   "What was the direction of the force applied?"
   "Why did the book still move even though the forces were opposite?"

Development:

Looking at pictures of what just happened – On the board, we will go over several force body diagrams demonstrating what the students just did to the book. Refer to examples above. Then consider a specific example looking into several situations addressed above with actual values for force.

- Draw the situation where two students push together in the same direction on a book, but with different amounts of force. Say one student pushes with 3N of force, and another pushes with 7N of force. What is the *NET FORCE* acting on the book?
- Draw the situation where one student pushes lightly on a book, and another student pushes harder in the other direction. Use student's names to get them more engaged. If one student pushes with 5N worth of force,

and another student pushes with 8N of force, which way will the book travel? What is the *NET FORCE* acting on the book? How would we draw that net force?

- Draw the situation where two students push equally on a book with 5N in opposing directions. Where does the book move? What is the *NET FORCE* acting on the book?

Closing:

Hand out the worksheet to follow up the activity done on the board. This will be used as an assessment of the student's work for the day, and will be assigned as homework if no time remains.

CONTINUATION ON FRICTION

Outcomes Covered: *N/A*

Merit: Notebook

Prerequisite Knowledge:

Students must have read Section 2 covering friction, sliding friction, static friction, rotating friction and fluid friction. Students will have also defined the key terms above, demonstrating at least a basic knowledge of their definitions. Students will also have completed the lab during the previous day covering an active measuring of sliding friction on several carts carrying varying masses. The students will have graphed their results and answered several key questions during class the previous day.

Instructional Objectives:

Students will be able to:

- understand that friction is affected by 2 factors
- recognize the four types of friction commonly encountered
- understand how friction both helps them in their daily lives and can sometimes make things more challenging through examples
- Be able to draw a very simple free-body diagram of forces acting on objects both static and in motion.

Materials:

N/A

Procedure:

Initiation:

Class will begin by going over the lab completed in class during the previous lesson entitled "Sliding Friction Investigation." Students will then hand in their completed labs for grading.

Development:

The actual lesson will begin with a few brief notes on friction. Students will be asked to take out their notebooks and refer to the board.

- Smooth surfaces produce less friction than rough surfaces
- Amount of friction depends on 2 things:
    - How hard surfaces push together
    - How rough or smooth surfaces are
- In other words, if a 50 lb weight is dragged versus a 2000lb weight, the 2000lb weight will have more friction resisting it because the force due to gravity is greater
- Four Types of Friction:
    - Static Friction – Friction acting on non-moving objects – causes you to have to use extra force to get the object moving.
    - Sliding Friction – Occurs when two solid surfaces slide over one another – Sneakers have rubber soles to increase sliding friction so they don't slip
    - Rolling Friction – Friction that resists a wheel or similar object from moving
    - Fluid Friction – Occurs when a solid object moves through a fluid (air, water, oil, etc.) Air resistance is an example of fluid friction.

A worksheet will then be gone over together with the students, explaining the method to solve 3 free-body diagram problems.

The students will then be given a similar worksheet to complete themselves in class, using what they just learned as a guideline for the method to solve.

Closing:

INTRODUCTION TO GRAVITY

Outcomes Covered: *N/A*

Merit: Notebook

Prerequisite Knowledge:

Students will have covered Sections 1 and 2.1 on Forces and Friction, as well as a basic understanding of how gravity acts. This should be sufficient previous knowledge to help them interpret the more technical aspects of gravity

Instructional Objectives:

Students will be able to:

- understand that friction is affected by 2 factors
- recognize the four types of friction commonly encountered
- understand how friction both helps them in their daily lives and can sometimes make things more challenging through examples
- Be able to draw a very simple free-body diagram of forces acting on objects both static and in motion.

Materials:

N/A

Procedure:

Initiation:

Class will begin with handing back the graded lab assignments from the previous day. Then, students will be asked to take out their homework on forces and friction from the night before to be checked, and then gone over in class. I will go around with a clipboard to check to make sure the students have completed their homework, and then as a class we will cover the correct answers and approaches for the worksheet. The homework assignment will then be collected.

Development:

The lesson on gravity will begin by going over the worksheet entitled "Talking about Gravity." This worksheet was given out during the previous class to assess where the students stood on their understanding of gravity. Major misconceptions will be addressed so that the students have the right information before they begin to learn new concepts about gravity.

The lesson will then move to a series of PowerPoint notes on introductory concepts concerning gravity. The students will take notes on the material in their notebooks.

NEWTON'S FIRST LAW OF MOTION

Frameworks Covered: *N/A*

Merit: Notebook

Prerequisite Knowledge:

Students will have covered Section 1: Force, and Section 2: Friction and Gravity prior to this lesson. Students will be familiar with the concept of balanced and unbalanced forces as well as how these concepts relate to motion. Much time has been spent on the concept that if the net force on an object is zero the object's motion will not change. Many students confuse a net force of zero with a stationary body, as opposed to a body with a constant velocity. Therefore a lot of time has been spent to debunk these misconceptions, which will aid in their understanding of Newton's First Law of motion.

Instructional Objectives:
Students will be able to:

- understand what Newton's First Law means in practical situations
- define inertia
- understand what inertia depends upon
- recognize that in order to change an objects motion, a force must act upon it
- identify those forces

Materials:

- Wooden Carts
- 200g Cylindrical Masses
- Books

Procedure:

Initiation:

Class will begin by taking merits and collecting the final draft of the "Gravity Essays" which was homework from the previous night. Students were asked to finalize an essay they had been working on which details the free fall of a ball dropped above the earth and above the moon, taking into account air resistance (or lack thereof), terminal velocity, and acceleration.

Students will then be prepped for the short "discovery activity" that will take up the majority of the day's class.

Development:

This discovery activity will involve a wooden cart, a mass, and a book. A mass will be placed on top of cart, which will be rolled into a book by the students. Before the activity begins, students will be asked to formulate a hypothesis predicting the behavior of the cart and the mass before, during, and after contact with the book.

Students will then break off into groups of two students, come up by tables to get their materials, and then be asked to follow the procedure and perform the experiment several times until they feel they have a full grasp on the behavior of the objects involved. Then, students will return the materials and return to their seats to work in their lab groups to answer a set of post-lab questions. These questions will get students to make connections between what they saw and Newton's First Law of motion. The questions will also ask students to define inertia and make relations to what role inertia played in the motion of the cart and the mass on the cart. (A copy of the questions will be given to you tomorrow morning before class because they need to be reviewed with Mark Sutphen before I present them to the class – assuming class is held)

Closing:

Provided there is time, the lab questions will be reviewed and discussed, and several other real-life examples of similar situations will be introduced to the students in order to make connections to these principles in their daily lives. For example, students will be asked to describe what happens to passengers in a car when it stops quickly. This is an example that many students have likely experienced before, and will be able to make a connection to.

Once students respond with the likely answer that "The people keep moving until the seatbelt stops them," you can once again refer to Newton's First Law. After quickly re-teaching this concept, the students will be asked how Newton's First Law explains what is happening in the car. Now, hopefully students will be able to respond with something like "The passengers keep moving until acted upon by the unbalanced force exerted by the seatbelt." If the students don't reach this conclusion immediately, then refer again to Newton's law and guide them in the proper direction.

Another example that can be related to the concept of inertia is the example of a tablecloth being swept out from under a set table of plates and glasses which all students have likely seen in a cartoon in their childhood, but never necessarily thought about the real-life forces acting here. Given time, it would also be excellent to be able to demonstrate it in class with beakers and a piece of cloth material, illustrating that a heavy water-filled beaker will not move due to its inertia, whereas a feather with little inertia will move with the cloth.

Homework:

Read p.52-54 (Newton's Second Law of Motion) and answer questions #2.a and b on page 54.

EARTH'S SEASONS LAB

Frameworks Covered: *N/A*

Merit: Pencil and Notebook

Prerequisite Knowledge:

Students will have covered Section 1: Earth in Space, involving how the earth moves including rotation and revolution. They will also be familiarized with the tilted axis of the earth, and particularly in how this affects the seasons. This is also a discovery lab, so the students can make some inferences of their own. Students have also been briefed on the lab so that they come to class prepared for the lab.

Instructional Objectives:
Students will be able to:

- **Make** an earth/sun model to observe the effect of the tilt of Earth's axis on the seasons
- **Observe** the effect that different angles of light has on the amount of energy at various places on the model
- **Infer** the amount of heat received by the model during different times of the year
- **Predict** the time of year when the model receives the most/least amount of energy

Materials:

- Books
- Flashlights
- Paper
- Pencil
- Protractor
- Toothpick
- Plastic sheet with grid lines

- Styrofoam balls mounted on sticks

Procedure:

Initiation:

Class will begin by collecting the homework from the previous night, taking attendance and merits. Then the class will move toward introducing the lab to the students and handing out the Lab Report Worksheet and going over procedure briefly. This will take no longer than 7 minutes, considering all instructions are clearly included in the Lab Report Worksheet. A few of the more difficult portions of the lab will be visually demonstrated for the students so that they will be able to imitate the activity without confusion and with a better understanding.

Development:

This lab will be used to illustrate to the students how the tilt of the Earth's axis affects the light received by Earth as it revolves around the sun.

See attached worksheet for Procedure.

Closing:

With about 8 minutes of class remaining, I will ask students to bring all lab materials up to their respective boxes and return quietly to their seats to continue working on their lab worksheet. By this time hopefully all students will have completed the experimental portion of the lab and will be working on answering the questions for their report. Anything remaining on the report will be assigned for homework. About 3 minutes before the end of class, I will get the class's attention and try to sum up what was learned today. This will hopefully provide for a milder exit from the class, and will serve to wrap up their memory from the experiment.

Homework:

Finish Lab Report for tomorrow

POTENTIAL AND KINETIC ENERGY

Frameworks Covered: *N/A*

Merit: Pen or Pencil

Prerequisite Knowledge:

Students will have spent time in class both observing and practicing with examples illustrating the concepts behind potential energy. Students will have observed a demonstration involving a mass being hauled up by a pulley to a known height. They were then shown how you can calculate the potential energy of that object based on knowing its height and mass, as well as the acceleration force due to gravity. More importantly, students were shown the practicality behind calling this a form of "energy" by releasing the mass to fall to the ground on top of a cup. The cup was crushed, demonstrating the work done to the cup by the mass as it fell after it had accumulated potential energy.

The students then duplicated this activity in a similar fashion in lab groups, with a few subtle variations. They had a scale to measure the force in Newtons that they applied to the rope in order to pull the mass up a certain distance. They were then able to calculate the work that they did on the mass to give it that potential energy. This practice will prepare them for the theoretical calculations they will perform during the activity.

Instructional Objectives:
Students will be able to:

- Calculate the Gravitational Potential Energy of an object
- Understand what GPE means
- Calculate the Kinetic Energy of an object and understand how it relates to the objects velocity.
- Understand that as a body falls toward earth, its GPE decreases as its KE increases up to terminal velocity
- Use the relationships between Mechanical Energy, Kinetic Energy and

Potential Energy to solve between the three

Materials:

- N/A

Procedure:

Initiation:

Class will begin by taking merits and collecting the final draft of the “Gravity Essays” which was homework from the previous night. Students were asked to finalize an essay they had been working on which details the free fall of a ball dropped above the earth and above the moon, taking into account air resistance (or lack thereof), terminal velocity, and acceleration.

Students will then be prepped for the short “discovery activity” that will take up the majority of the day’s class.

Development:

This discovery activity will involve a wooden cart, a mass, and a book. A mass will be placed on top of cart, which will be rolled into a book by the students. Before the activity begins, students will be asked to formulate a hypothesis predicting the behavior of the cart and the mass before, during, and after contact with the book.

Students will then break off into groups of two students, come up by tables to get their materials, and then be asked to follow the procedure and perform the experiment several times until they feel they have a full grasp on the behavior of the objects involved. Then, students will return the materials and return to their seats to work in their lab groups to answer a set of post-lab questions. These questions will get students to make connections between what they saw and Newton’s First Law of motion. The questions will also ask students to define inertia and make relations to what role inertia played in the motion of the cart and the mass on the cart. (A copy of the questions will be given to you tomorrow morning before class because they need to be reviewed with Mark Sutphen before I present them to the class – assuming class is held)

Closing:

Provided there is time, the lab questions will be reviewed and discussed, and several other real-life examples of similar situations will be introduced to the students in order to make connections to these principles in their daily lives. For example, students will be asked to describe what happens to passengers in a car when it stops quickly. This is an example that many students have likely experienced before, and will be able to make a connection to.

Once students respond with the likely answer that "The people keep moving until the seatbelt stops them," you can once again refer to Newton's First Law. After quickly re-teaching this concept, the students will be asked how Newton's First Law explains what is happening in the car. Now, hopefully students will be able to respond with something like "The passengers keep moving until acted upon by the unbalanced force exerted by the seatbelt." If the students don't reach this conclusion immediately, then refer again to Newton's law and guide them in the proper direction.

Another example that can be related to the concept of inertia is the example of a tablecloth being swept out from under a set table of plates and glasses which all students have likely seen in a cartoon in their childhood, but never necessarily thought about the real-life forces acting here. Given time, it would also be excellent to be able to demonstrate it in class with beakers and a piece of cloth material, illustrating that a heavy water-filled beaker will not move due to its inertia, whereas a feather with little inertia will move with the cloth.

Homework:

Read p.52-54 (Newton's Second Law of Motion) and answer questions #2.a and b on page 54.

WPI TEACHER PREPARATION PROGRAM

Motion with Constant Acceleration

Ryan Weaver

Unit Objectives

Students will

- Be able to recognize an accelerating body both visually and graphically
- Understand the difference between velocity and acceleration
- Be able to interpret and recognize the difference between:
    - Acceleration vs. Time Graphs
    - Velocity vs. Time Graphs
    - Position vs. Time Graphs
- Be able to recognize the difference between constant and non-constant acceleration
- Understand that the force of gravity is constant acceleration
- Be able to recall and recognize formulas for motion
- Recognize the difference between a scalar quantity and a vector
- Be able to apply formulas for motion in order to solve a problem
- Understand that gravity acts on all objects with the same acceleration regardless of mass or volume

Frameworks Covered

Introductory Physics, High School

1. Motion and Forces

1.2 Distinguish and contrast vector quantities (e.g., displacement, velocity, acceleration force, linear momentum) and scalar quantities (e.g. distance, speed, energy, mass, work).

1.3 Create and interpret graphs of 1 dimensional motion, such as position vs. time, distance vs. time, speed vs. time, velocity vs. time, and acceleration vs. time where acceleration is constant.

Part 1:

Velocity and Constant Acceleration

Objectives:

- Get students thinking about the technical definitions of velocity and acceleration
- Begin presenting graphs of motion and get students to be able to explain what is occurring in varying graphs of position, velocity and acceleration
- Introduce the basic equations of calculating position, velocity and acceleration

Activator:

- Present to the class general questions such as "What is Velocity?" and "What is Acceleration?"
- This is intended to get them thinking about what they already know about these terms, and to hopefully bring out some misconceptions and/or assess the class's understanding of the topic

Development of the Topic

- Wrap up the discussion and provide the students with more technical definitions, i.e.; velocity is the change in position of an object over time, and acceleration is the change in an object's velocity over time.
- Pose the question, "Can velocity be negative?" and observe the student's responses – many students will likely say no, as they have never seen a car doing -55mph
- There will likely be a confusion among students as to the difference between the scalar quantity of speed and the vector that is velocity
- Clarify that a vector has both a magnitude (i.e. 50mph) and a direction (in the case of a straight line, + or – depending on the orientation of the axis.
- Now pose the question "Can acceleration be negative?" The students will likely be less quick to jump to saying no, but they will likely be unclear as to why it can be negative
- Explain how negative acceleration would be slowing down over time as opposed to positive acceleration

Notes

- It is now important to provide the students with a "toolbox" of relations and equations in preparation for solving problems
- $v = v_0 + at$ (constant acceleration only)
- Here, acceleration is the constant rate of change of velocity, t being the time interval over which the motion occurs. Therefore the product of a*t is the total change in velocity from t=0 to t_{final}
- That being the general equation for velocity, we now explore the equation for position at any given time
- $x = x_0 + v_0t + \frac{1}{2}at^2$ (constant acceleration only)
- Help the students understand that x_0 and v_0 are the quantities for position and velocity at time t=0, in other words, at the very beginning
- $v^2 = v_0^2 + 2a(x - x_0)$ (constant acceleration only)
- $x - x_0 = ((v_0^2 + v)/2)t$

Closing and Example to Show Applications

- By now it is likely that the students are a bit done with board work, so it is a good time to switch gears and give them an example
- A good example that will show them how the formulas are used would be as follows:

  A motorcyclist heading west down the mass pike accelerates after he passes the exit for Millbury. His acceleration is a constant 4.0 m/s^2. At time t=0 he is 5.0m west of the exit, moving west at 15 m/s. Find his position and velocity at the time t=2.0s

- Take the signpost as the origin of the coordinates (i.e. x=0) and demonstrate that for convenience's sake, we will select west as the positive x direction. At time t=0 the motorcycle is 5.0m positive x and v_0 is 15m/s. The constant acceleration has already been defined as 4.0m/s^2
- Show that the knowns are t, x_0, a, v_0 and the question asks us for x at t=2 and v when t=2
- Ask the students to think about what equations they have in their "toolbox" that they might be able to use to solve the problem
- Solution: (guide the students through the process, but let them "do" the problem)
  - $x = x_0 + v_0t + \frac{1}{2}at^2$
  - $x = 5.0\text{m} + (15\text{m/s})(2.0\text{s}) + \frac{1}{2}(4.0\text{m/s}^2)(2.0\text{s})^2$

- $x = 43m$
- This shows that the motorcycle is 43m past the exit ramp after 2 seconds
  - $v = v_0 + at$
  - $v = 15m/s + (4.0m/s^2)(2.0s)$
  - $v = 23m/s$
- This shows that the velocity after 2 seconds is 23m/s

Assignment

- Read Pg 52-55, section 2.4
- Pg. 71 2.21, 2.23, 2.25 to be discussed in class afterward

Part 2:

Freely Falling Bodies

Objectives:

- Students will understand that gravity acts on all objects with the same acceleration regardless of mass or volume
- Get students to recognize that a body acted on by gravity is an example of a body under constant acceleration
- Students will be able to solve problems involving free fall using the equations of motion they already know

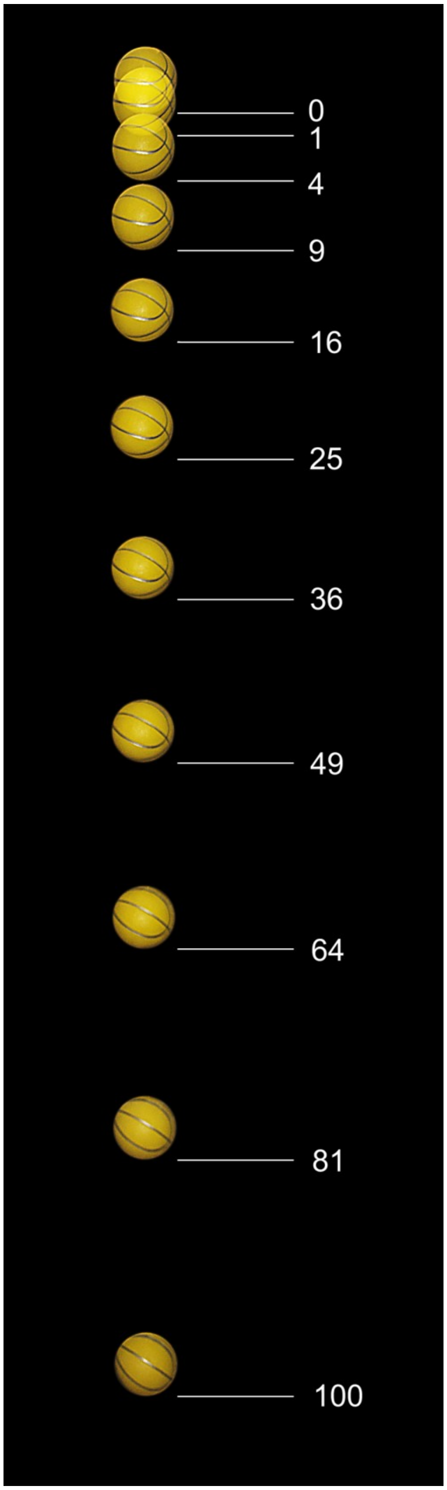
Activator:

- Pose the following questions to the students: "Do heavier objects fall faster than lighter ones? Discounting air resistance, what do you think? What evidence in your experiences do you have to support your response?"

Development of the Topic

- Discuss Galileo's bullet and cannonball experiment, and the results
- Students might want to see for themselves this somewhat difficult to believe concept. If you were to take a shot-put in one hand, and a marble in the other, then drop them either indoors or out, you could demonstrate to the students that the two objects hit the ground at the same time – confirming the theory. You can even offer for some of the other students to release the two objects at the same time and get themselves involved.
- Show a picture such as photo 2.21

Figure 2.21



A multi flash photo of a freely falling ball. The photograph is taken with a stroboscopic light source that produces a series of intense flashes at equal time intervals. Each flash is so short (a few millionths of a second) that there is little blur in the image of even a rapidly moving body. As each flash occurs, the position of the ball at that instant is recorded on the film. Because of the equal time intervals between flashes, the average velocity of the ball between any two flashes is proportional to the distance between corresponding images in the photograph. The increasing distances between images show that the velocity is continuously changing; the ball is accelerating downward. Careful measurement shows that the velocity change is the same in each time interval, so the acceleration of the freely falling ball is constant.

- Introduce the concept that the acceleration due to earth's gravity is 9.8 m/s^2 denoted by g
- Now make sure the students understand that "free fall" just means that the object falling has constant acceleration due to gravity
- Therefore, it's just a special case of what we've seen so far for constant acceleration

Example

- A marble is dropped from the Leaning Tower of Pisa. It starts from rest and falls freely. Compute its position after 3s. You drop the marble 50m off of the ground, has it hit the ground after 3s?
- Our origin will be our starting point, and we'll use the y axis instead of the x, with the negative being downward. Here is what we know:
    - $y_0 = 0$
    - $v_0 = 0$
    - $a = -g = -9.8\ m/s^2$
- Here's what we want to know:
    - y_3
    - v_3
- $y = y_0 + v_0t + \frac{1}{2}at^2$

  $y = 0 + 0 + \frac{1}{2}(-g)3^2$

  $y = -44.1$ m
- So, the response is, no, the marble has not hit the ground after 3 seconds
- However, what if we wanted to find how long it would take the marble to hit the ground?
- $y = y_0 + v_0t + \frac{1}{2}at^2$

  $y = \frac{1}{2}at^2$

  $t^2 = \frac{2y}{a}$

  $t = \sqrt{\frac{2y}{a}}$

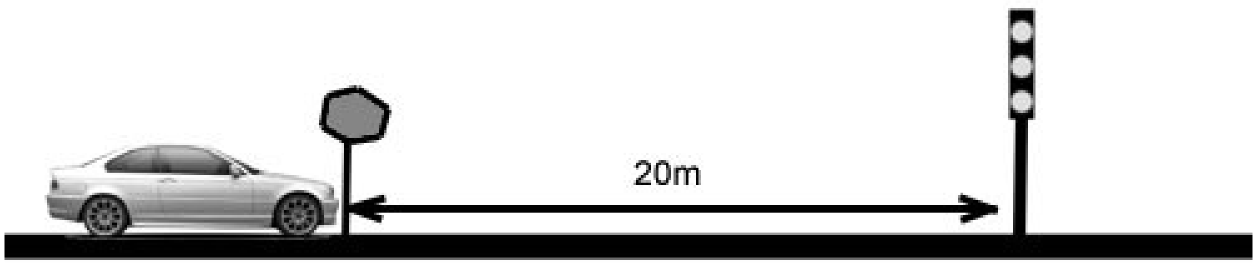
  $t = \sqrt{\frac{2(50)}{9.8}}$

  $t = 3.19$s
- So as you can see, it would take 3.19s for the marble to hit the ground.
- Going back to how two objects fall at the same rate regardless of how heavy they are. We can now easily show that this is true by simply examining the equations used and asking ourselves a couple of questions: What if instead of dropping a marble, we

dropped a slab of granite weighing 2000lbs. If we ran through the same calculations as we did with the marble, we would find that the granite also hits the ground after just 3.19s. If we look at the equation, we notice that there is no component for mass, volume or density, which are the only characteristics that are different between the marble and the huge hunk of granite.

Name: ___________________ Date: ___/___/___

Motion Along a Straight Line



1. A car comes to a complete stop at a stop sign. The driver notices that the traffic light 50m away is still green, and starts driving towards it with a constant acceleration of $3m/s^2$. The light will turn red just 6 seconds after he stopped at the stop sign. Will the driver make it through the light before it turns red? How long does it take him to reach the set of lights?

2. A hot air balloonist rising vertically with a constant velocity of magnitude 5m/s releases a sandbag at an instant when the balloon is 40m above the ground. After it is released, the sandbag is in free fall.
   A) Compute the position and velocity of the sandbag at 0.25s and 1s after its release.
   B) How many seconds after its release will the bag strike the ground?

Activity

Materials: *(per group of students)*

- Motion Sensor
- Computer with software to record from the motion equipment
- A “nerf” ball (one soft enough not to damage the motion detectors in any way)
- Tape measure
- Masking tape
- Notebook for recording data

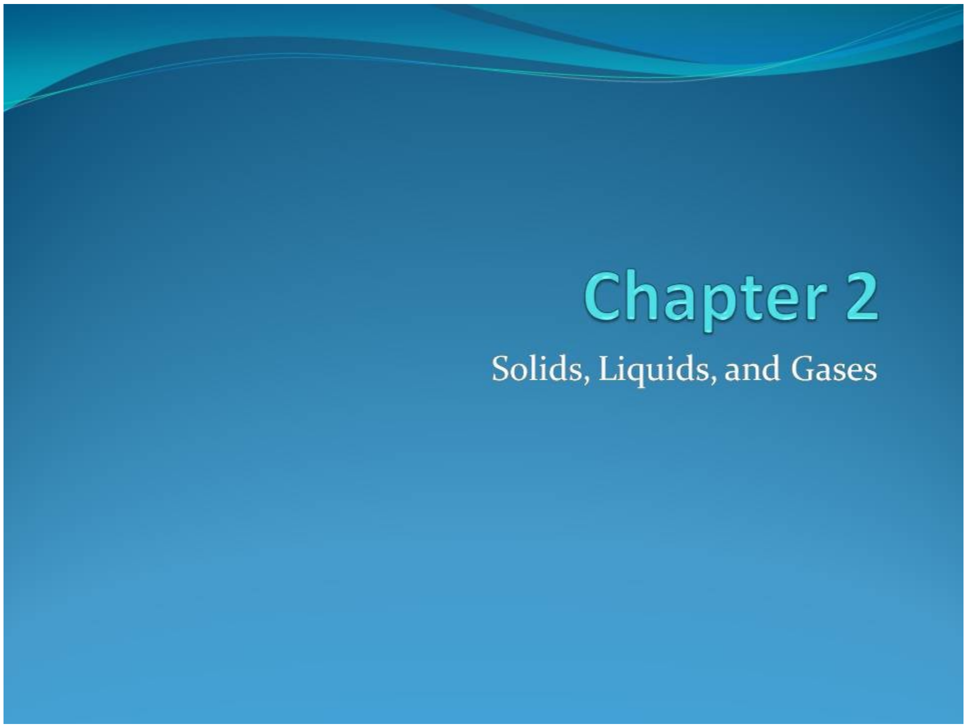
Procedure:

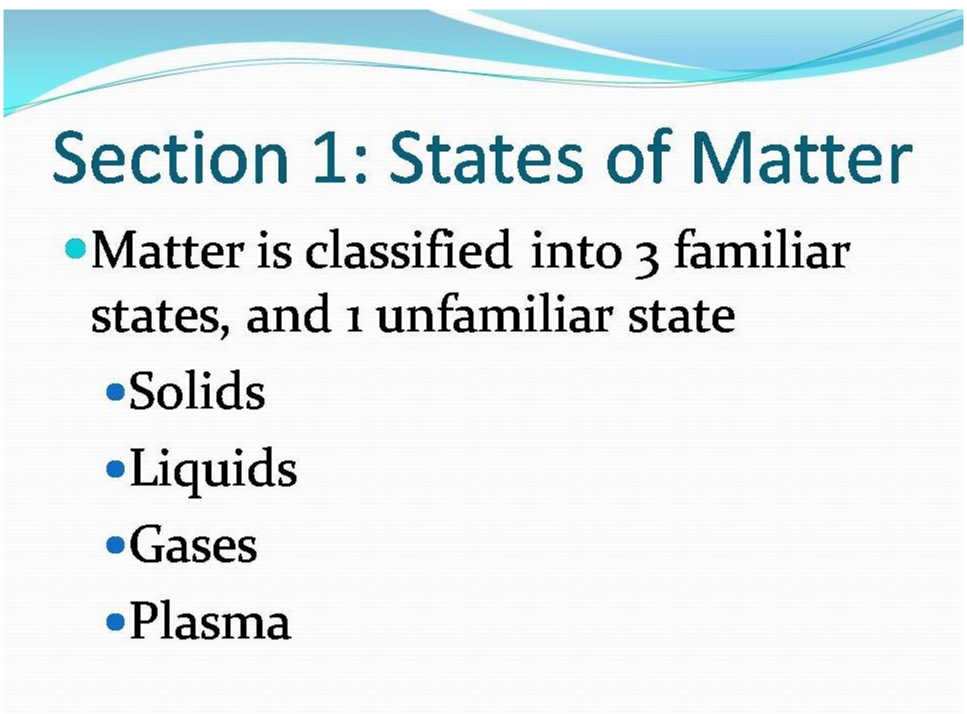
- Students will be asked to set up their motion detectors to their computers, and then test to make sure they are working
- Students will then lay the masking tape on the wall, using the tape measure to mark off several intervals
- Students will drop the nerf ball from increasing heights from the sensor, recording the velocity, and duration of free fall.

Report

- Students will be asked to report their findings
- The goal is to make sure students were able to calculate the acceleration to be constant at 9.8 m/s^2
- If the students acceleration varies from 9.8 m/s^2, they will be asked to account for the margin of error (resulting from air resistance, sensor error, etc.)

Power Point Lectures


Chapter 2
Solids, Liquids, and Gases

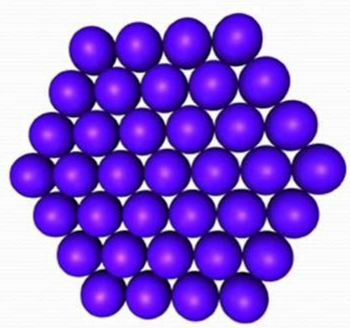

Section 1: States of Matter
Matter is classified into 3 familiar states, and 1 unfamiliar state
Solids
Liquids
Gases
Plasma

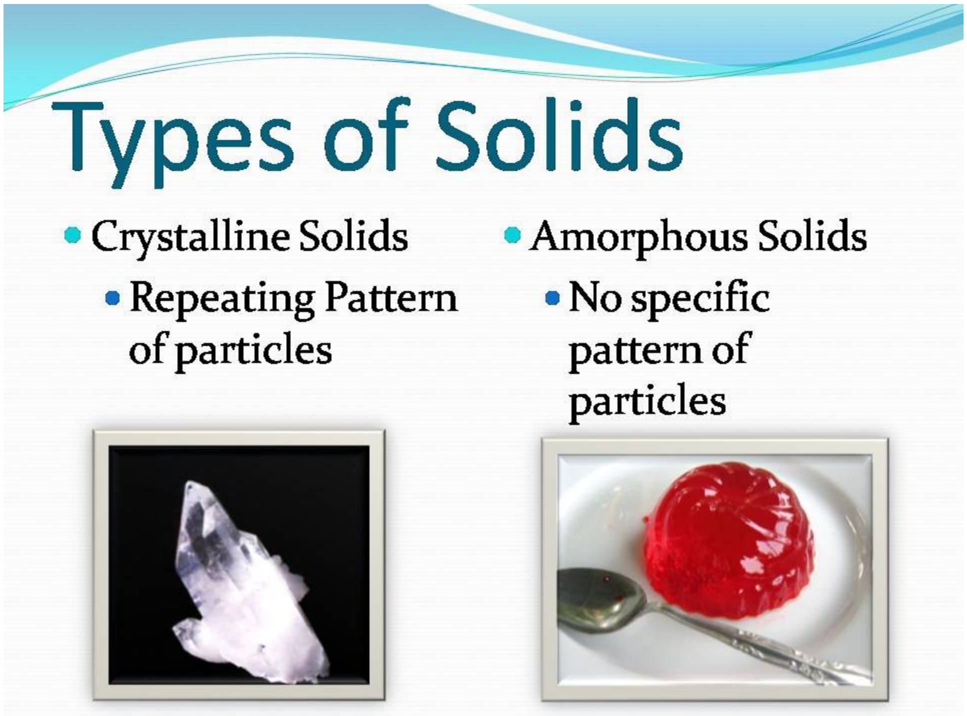
Solids

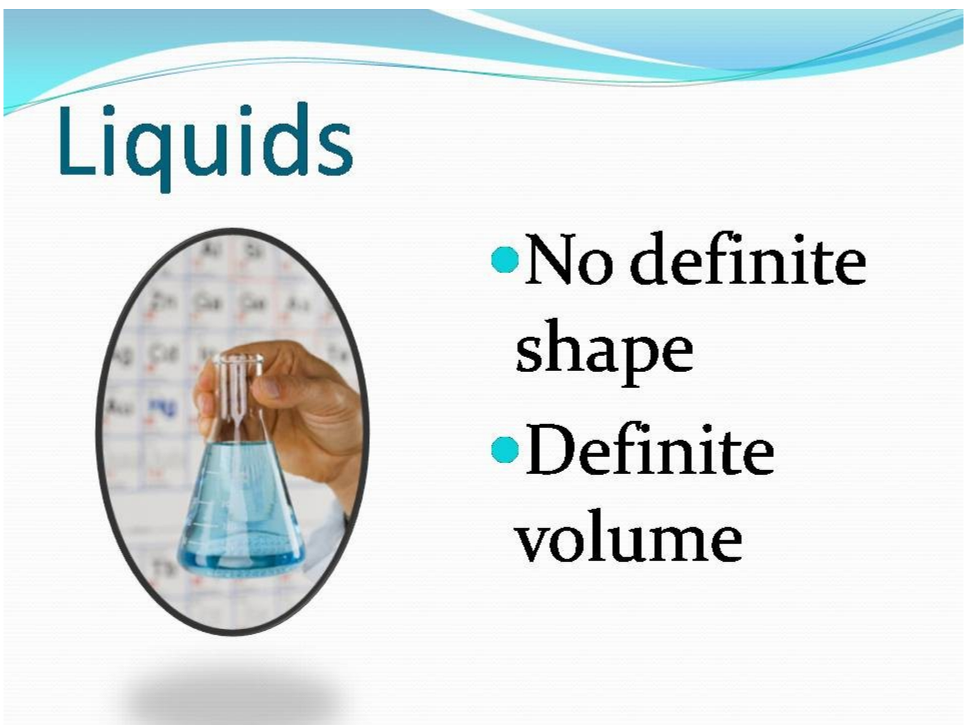
- Have a definite shape
- Have a definite volume

Particles in a Solid

- Very closely packed
- Very Organized
- Do not move much
- Only vibrate in place

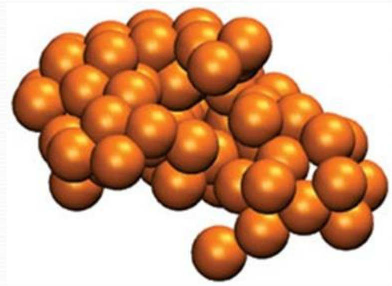



Types of Solids
Crystalline Solids
Repeating Pattern of particles
Amorphous Solids
No specific pattern of particles


Liquids
No definite shape
Definite volume

Particles in a Liquid

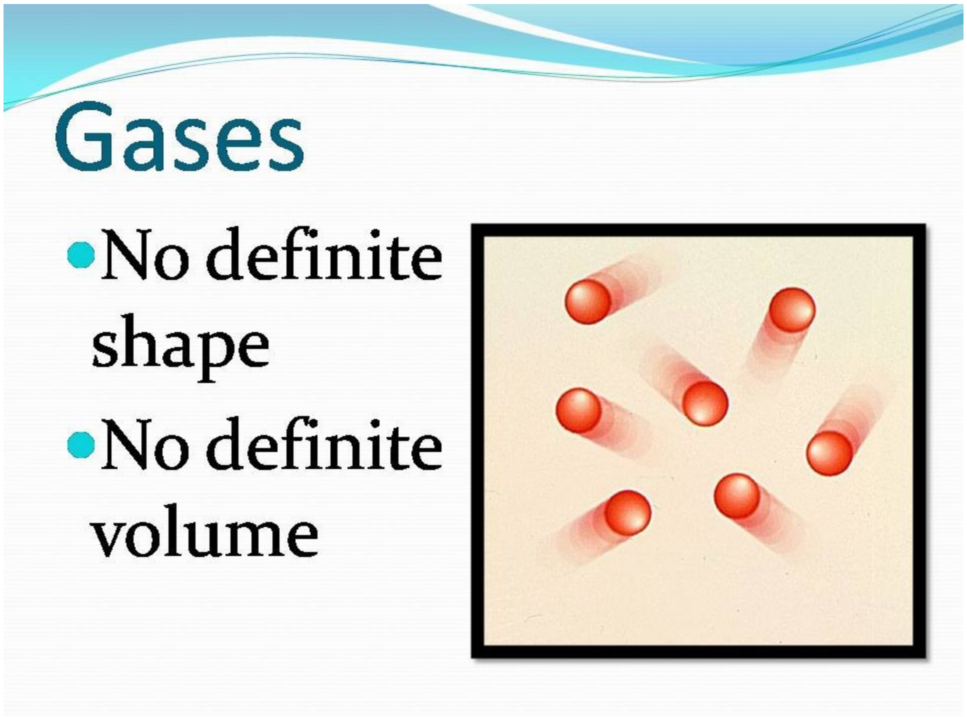
- Closely packed together
- Move freely
- Take shape of container



Properties of Liquids

- Surface Tension

- Viscosity


Gases
No definite shape
No definite volume

Section 2 : Changes of State

Chapter 2

Melting

- **Melting** – Substance goes from Solid to Liquid
- **Melting Point** – Temperature when a substance melts

Freezing

- **Freezing** – Substance goes from Liquid to Solid
- **Freezing Point** is the same as melting point (*Freezing is the reverse of melting*)

Sublimation

- **Sublimation** occurs when a substance goes straight from a **solid to a gas** without becoming a liquid first

Condensation

- **Condensation** – **gas** is cooled **below boiling point** and returns to **liquid** state

Boiling

- **Boiling** occurs when all the liquid is heated to **Boiling Point** so that **bubbles of vapor** form and rise to the surface and escape as gas

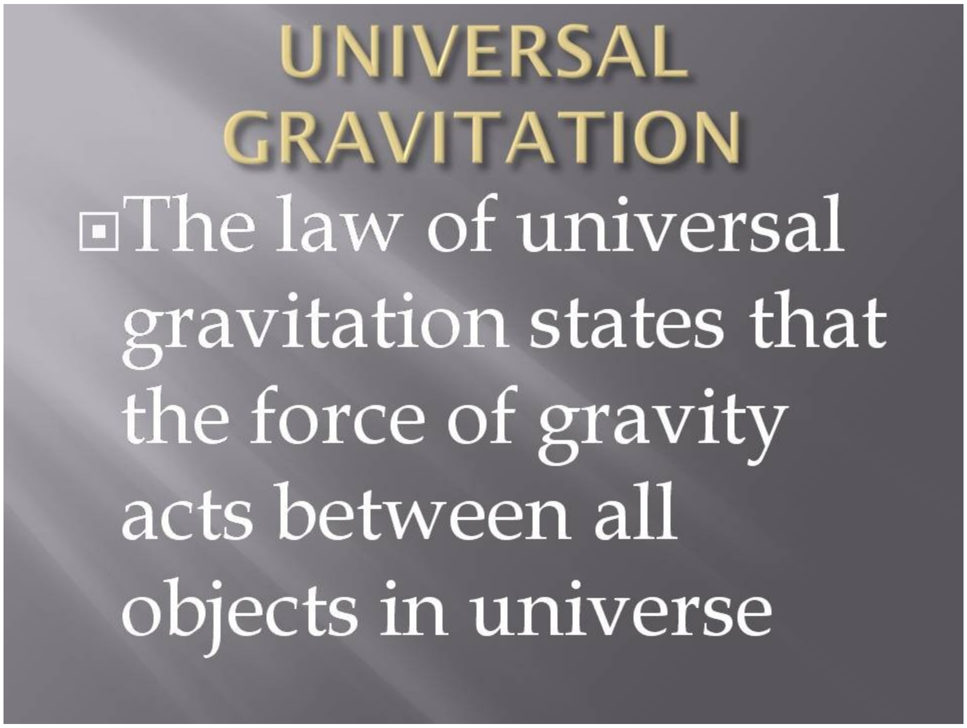
Evaporation

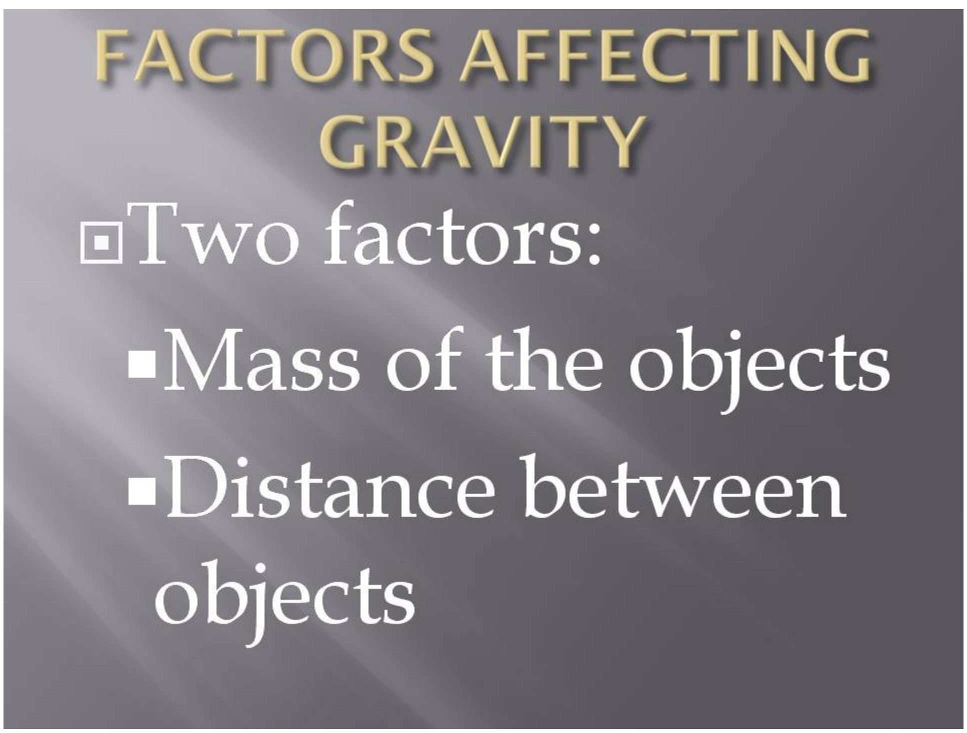
- **Vaporization** that only takes place on surface
- When molecules get extra **energy** from sun or air, they escape as a **gas**

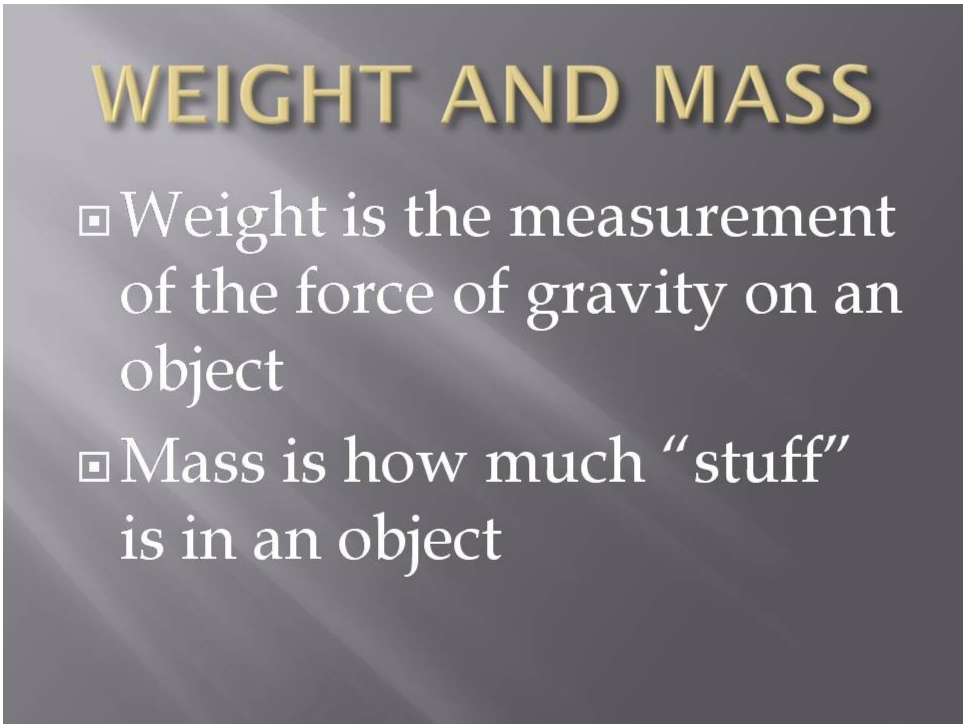
GRAVITY

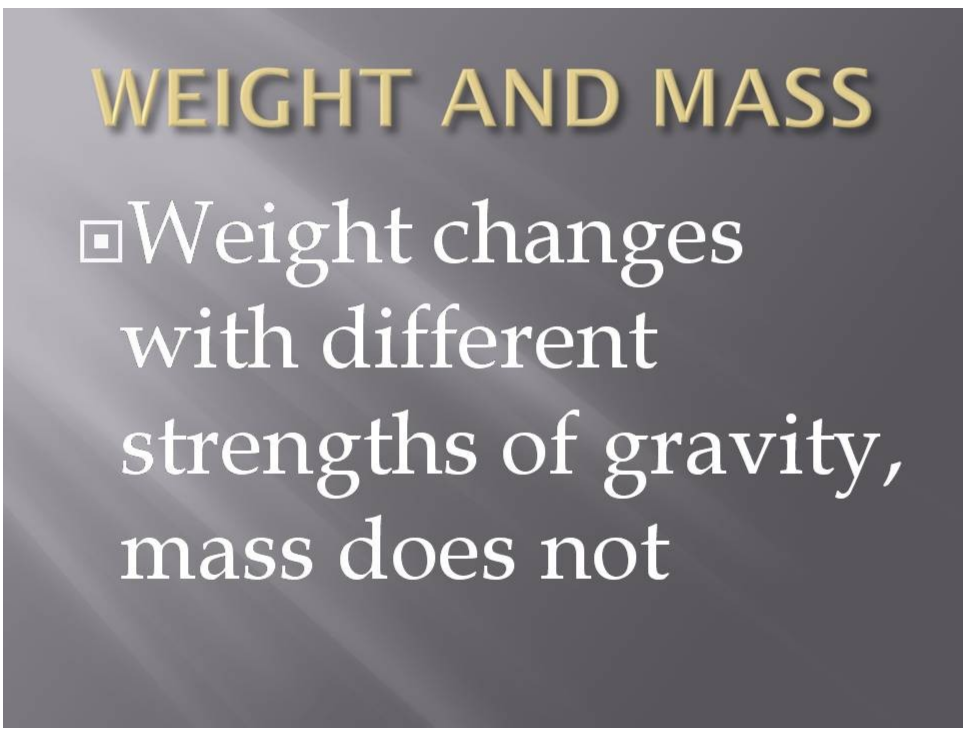
UNIVERSAL GRAVITATION

- Gravity is the force that pulls objects toward the center of the earth


UNIVERSAL GRAVITATION
The law of universal gravitation states that the force of gravity acts between all objects in universe


FACTORS AFFECTING GRAVITY
Two factors:
Mass of the objects
Distance between objects


WEIGHT AND MASS
Weight is the measurement of the force of gravity on an object
Mass is how much "stuff" is in an object


WEIGHT AND MASS
Weight changes with different strengths of gravity, mass does not

WEIGHT AND MASS

- A 120lb person on earth would have a **weight** of about 20lbs on the moon
- A person with a **mass** of 54 kilograms on earth would have a **mass** of 54 kilograms on the moon

WEIGHT AND MASS

- The amount of "stuff" inside the object does not change, the gravitational pull does

Tests and Quizzes

Name:____________________ Period:____

Chapter 2: Solids, Liquids, and Gases *Quiz*

SECTION 1: STATES OF MATTER

Please answer the question appropriately or fill in the blanks with the correct response

1. Matter can be classified into 4 states – please list all 4.

2. Maple Syrup is an example of a liquid with high ________________ whereas water is an example of a liquid with low ________________.

3. ______________________ solids is a type of solids that has a repeating pattern of particles, and ____________________ solids is a type of solids that has no specific pattern of particles.

4. Do liquids have a definite shape?

   What about a definite volume?

5. Describe how particles behave in a solid object.

Chapter 2 Test Make-Up Policy

Due to the low scores for the test on chapter 2, there will be a make-up test available for students to take in order to allow them to properly demonstrate their competence in the subject material studied. Students may also choose to keep the original grade they received for this test. If they choose to make up the test, there are a few terms that need to be adhered to:

- Students that wish to make up the Chapter 2 Test must stay after for a review session on Monday, November 17 from approximately 2:10-2:40. If the student cannot make this review session for any reason, they must speak with Mr. Weaver separately to arrange an alternative plan.

- The student may then arrange to take their make-up test during their study (if possible), or after school. Don't wait to arrange your make-up time, because if you put it off too long, you will miss your opportunity to take the test!

- Students will be able to keep the higher of the two grades between the actual test and the make-up, and their make-up exam will be worth full credit

Name: ___________________________ Date: _______________ Period:______

Chapter 2 Make-up Quiz

States of Matter

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question

____ 1. Which of the following would cause the particles in a substance to increase their motion?
a. they lost energy
b. substance went from a liquid to a solid
c. they gained energy
d. substance was put in a freezer

____ 2. What is the order of the states of matter from **highest** energy to **lowest** energy?
a. liquid, gas, solid
b. solid, liquid, gas
c. gas, liquid, solid
d. solid, gas, liquid

____ 3. What happens when water condenses?
a. it goes from a gas to a liquid
b. it produces heat
c. it gains energy
d. it goes from a solid to a gas

____ 4. The proper scientific definition of temperature that we should use is: "Temperature is the measure of…"
a. how hot or cold something is
b. how much volume a particle takes up
c. how many molecules are in a substance
d. the energy of the particles in a substance

____ 5. The two types of vaporization that occur when particles of a substance go from a liquid to a gas are:
a. boiling and sublimation
b. evaporation and boiling
c. condensation and evaporation
d. crystallization and condensation

Matching

Match the correct state of matter with the properties that belong to it

S. solid **L**. liquid **G.** gas

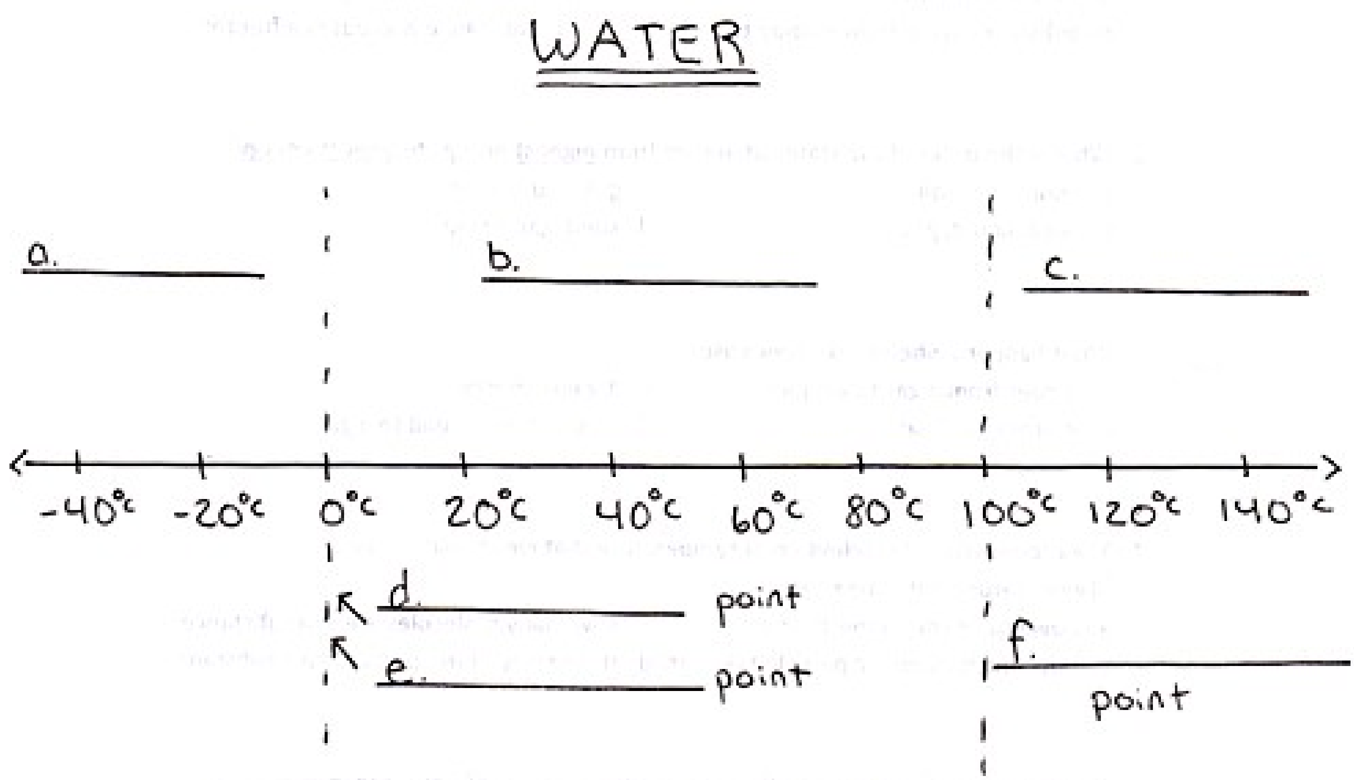
____ 6. Has a definite volume, but no definite shape

____ 7. Particles in this state spread out to fill as much volume as is available

____ 8. Particles in this state are touching, but are free to move around each other

____ 9. In this state, particles are tightly packed together in fixed positions

____ 10. If a substance goes directly from this state to a gas, it is known as sublimation



a, b, c – Identify the state of matter the water is when it is in the temperature range indicated

d – the temperature point when a solid turns into a liquid

e – the temperature point when a liquid turns into a solid

f – the temperature point when a liquid turns into a gas

Name: ___________________________ Date: ___________ Period: ___________

Speed and Graphing Quiz

Motion

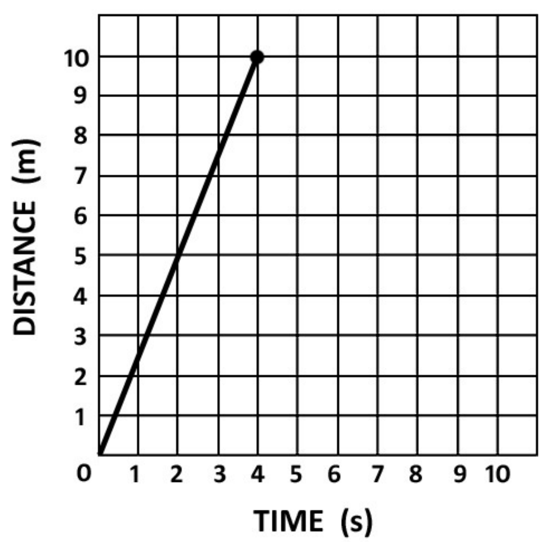
Please use the formula for speed and your knowledge of the motion of objects to solve the unknown average speeds for the given situations. In order to receive full credit ***please show all work.***

1. A 2001 Ford Mustang GT can cover a distance of 1320 ft in just 13 seconds when going from a dead stop – That's faster than a Ferrari Testarossa! What is the average speed for the Mustang on its 13 second run?

2. When crawling at its very fastest, a typical garden snail can cover about 1 meter every 77 seconds. What is the snail's average speed during its 1 meter trip?

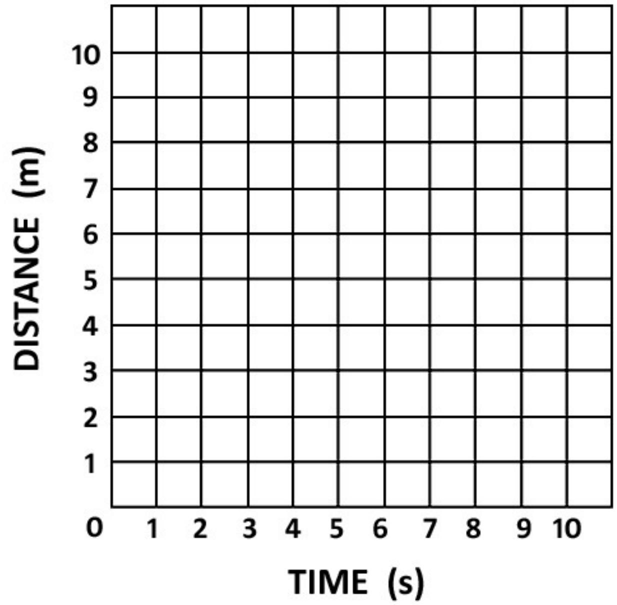
3. In order to exit the orbit of earth, a rocket must travel the 600 kilometers (km) of the atmosphere in just .014 hours (hr). If you were an Astronaut, what speed would you have to fly the rocket at to make sure you could leave earth?

4. This distance vs. time graph was plotted for Vince Vanderblain, a professional speed-walker during a short portion of one of his races. Based on the graph, what is his average speed for the walk?



5. Please graph the average speed of a toy truck being rolled a distance of 9 meters in 7 seconds. Then write the average speed for that truck during the 9 meter run.

   Average Speed _____



The next 4 problems refer to the graph handed out to you separately. Please use the graph to answer the questions and then write your answers in the space provided below. Be sure to show all work for full credit.

The Distance vs. Time graph that you have been given plots the motion for an electric car moving at constant speeds.

6. What is the average speed for the electric car from 0-8 seconds? (Point A)

7. What is the average speed for the electric car from 8-18 seconds? (Point B) (Make sure you use the 8-18 seconds time interval, not 0-18 seconds)

8. What is the average speed for the electric car from 18-30 seconds? (Point C) (Make sure you use the 18-30 seconds time interval, not 0-30 seconds)

9. The graph tells us a story about the motion of the electric car by telling us how fast it was moving and when – as well as whether it was stopped or in motion. Please write the story of the electric car's motion according the graph. Include things like speeds, and whether the car was in motion. You can reference points like A, B and C.

★BONUS★

If the SR-71 Blackbird SuperJet flies at a rate of 2194 mph, how long would it take the jet to once around the world? (The distance around the earth is 24,901 miles)

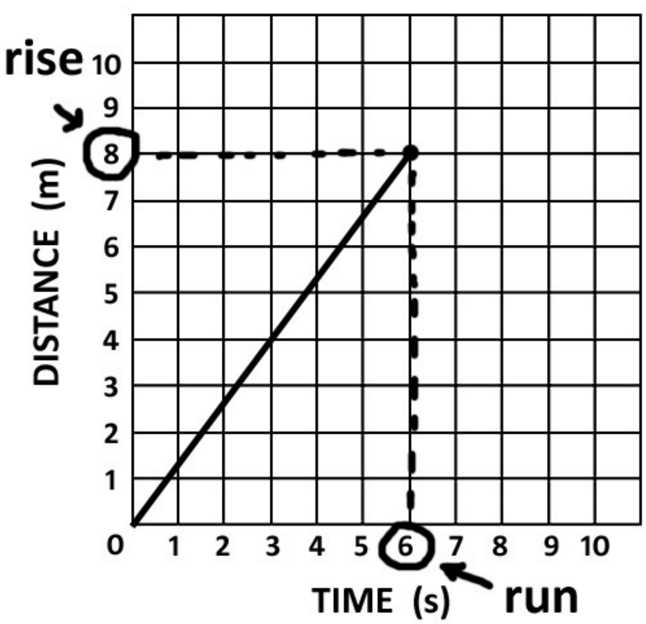
Worksheets and Handouts

Name: Date: Period:

Graphing Worksheet 1
Motion

In order to calculate the speed of an object by looking at a graph, we must calculate the **slope** of the line that represents the speed of the object. Slope might sound like a confusing math word, but it really just means the **rise/run.** In other words **how far the line goes up divided by how far the line goes to the right**.

EXAMPLE 1:



If we want to calculate the **slope** of the line that represents speed, all we have to do is do **rise/run.** For this example, we can see the line **"rises" 8** and **"runs" 6**. If **slope = rise/run, then the slope would be 8/6, or 1.33.** The important thing to remember here is that **the slope of the line in the graph = the speed of the object.** So, since we had **8m/6s** our final answer would be

1.33 m/s

Please answer the following questions

1. What is slope? ____

2. If we calculate the slope of the line in a distance vs. time graph, we will find the ____________ of that object.

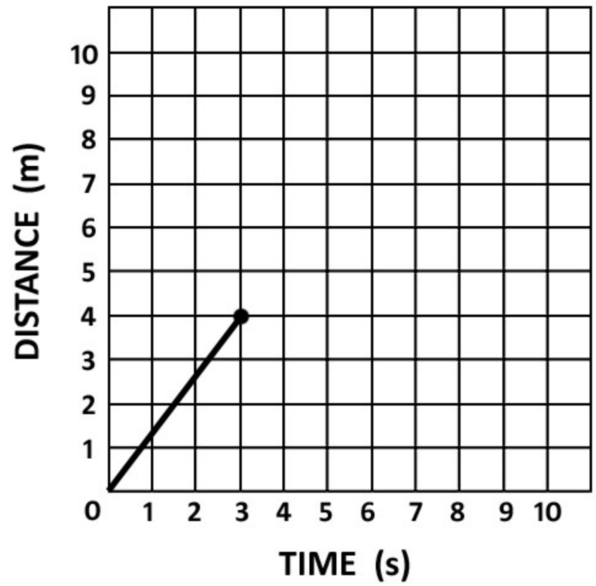
Please follow the steps in the example problem to calculate the speed for the given graphs of motion.

GRAPH A)

Rise (Distance) _________

Run (Time) __________

Slope (Speed) __________

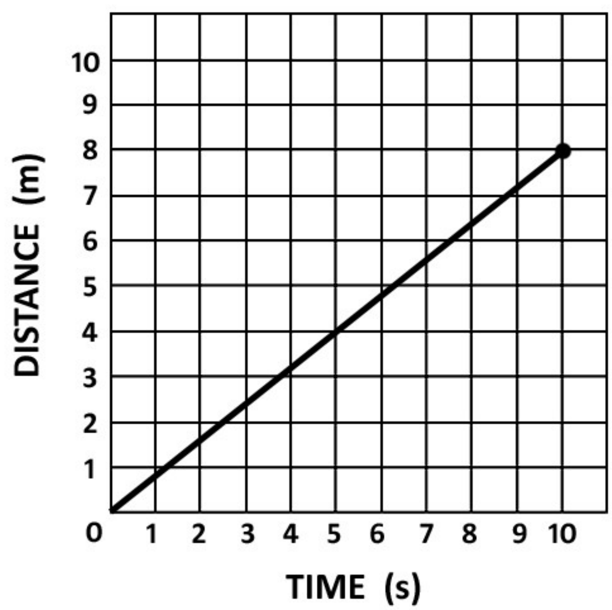


GRAPH B)

Rise (Distance) _________

Run (Time) __________

Slope (Speed) __________

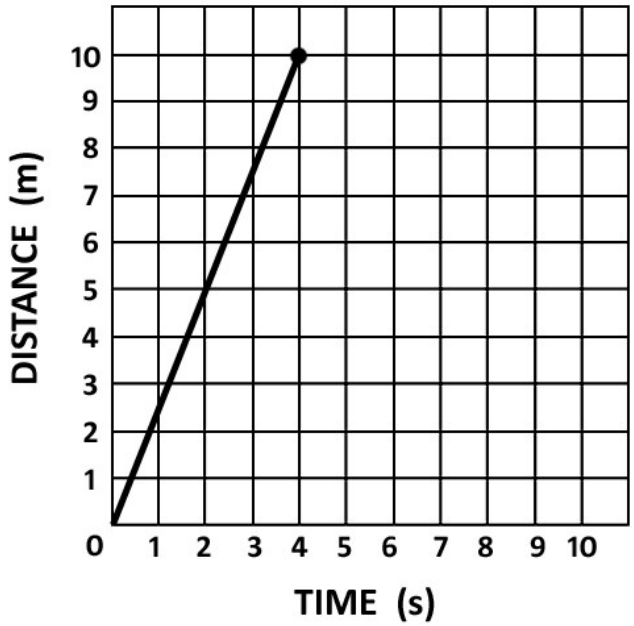


GRAPH C)

Rise (Distance) _________

Run (Time) __________

Slope (Speed) __________



3. Do you see a relationship between the way the line looks (the way it's slanted) and the value of its slope (speed)?
____
____
____

Name: Date: Period:

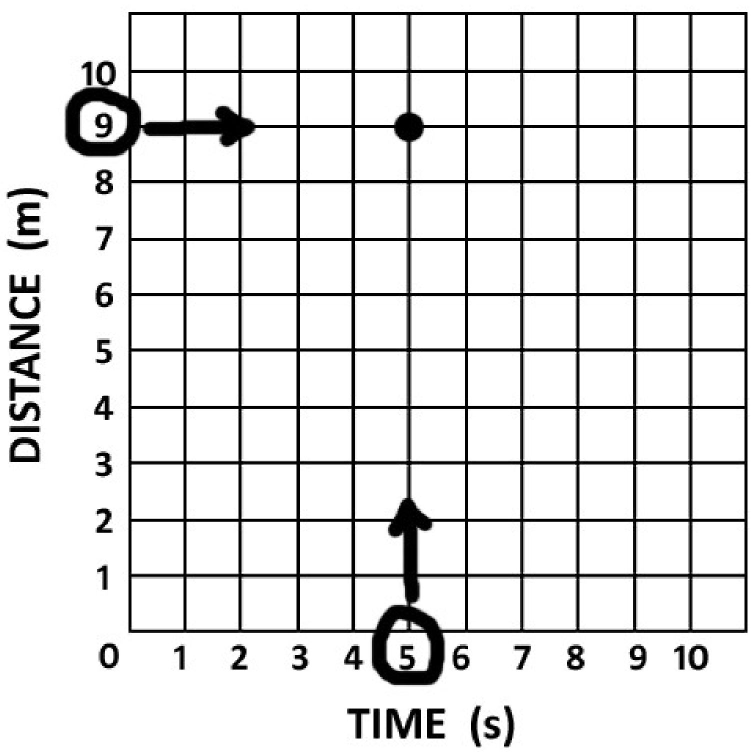
Graphing Worksheet 2
Motion

In the last worksheet we were given a graph and had to calculate the speed by finding the slope of the line. Now, you will be given the **distance** the object travelled and the **time** it took. From this information you will be asked to **graph** the line with a slope that corresponds to the speed of the object. You will have to check your answer by making sure that the slope of the line you draw matches up with the speed of the object.

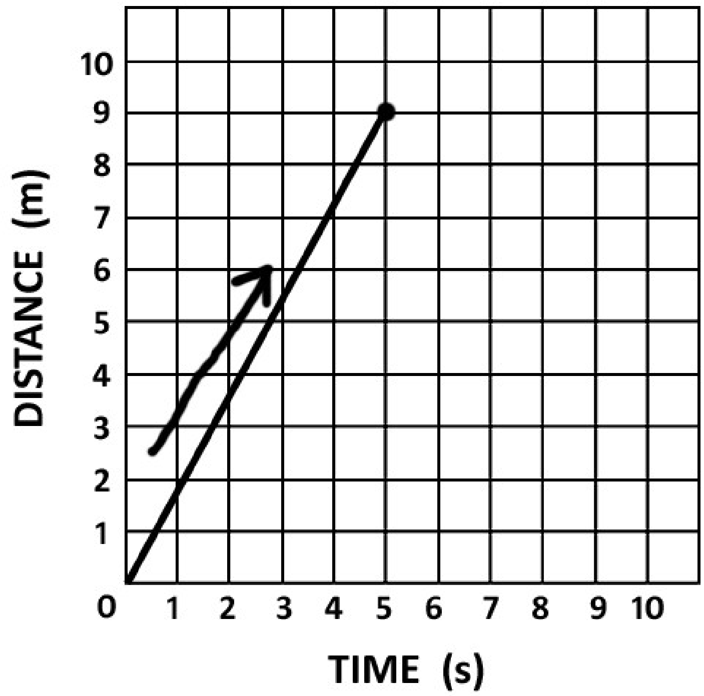
EXAMPLE 2:

You must graph the speed for a rabbit that hops 9 meters in 5 seconds.

*The first thing you need to do is look on the graph and under **"TIME"** go over to the **"5"** mark. Then, on the **"DISTANCE"** axis, find the **"9"** mark. Now, **go up from the 5 mark** and **to the right of the 9 mark** to find where the two meet **AND DRAW A POINT**:*



Next, use a ruler to draw a line connecting the starting time and distance (**in this case 0**) to the dot you just drew. This will draw a line with the correct slope to match the speed you just plotted. There you go, It's as simple as that!

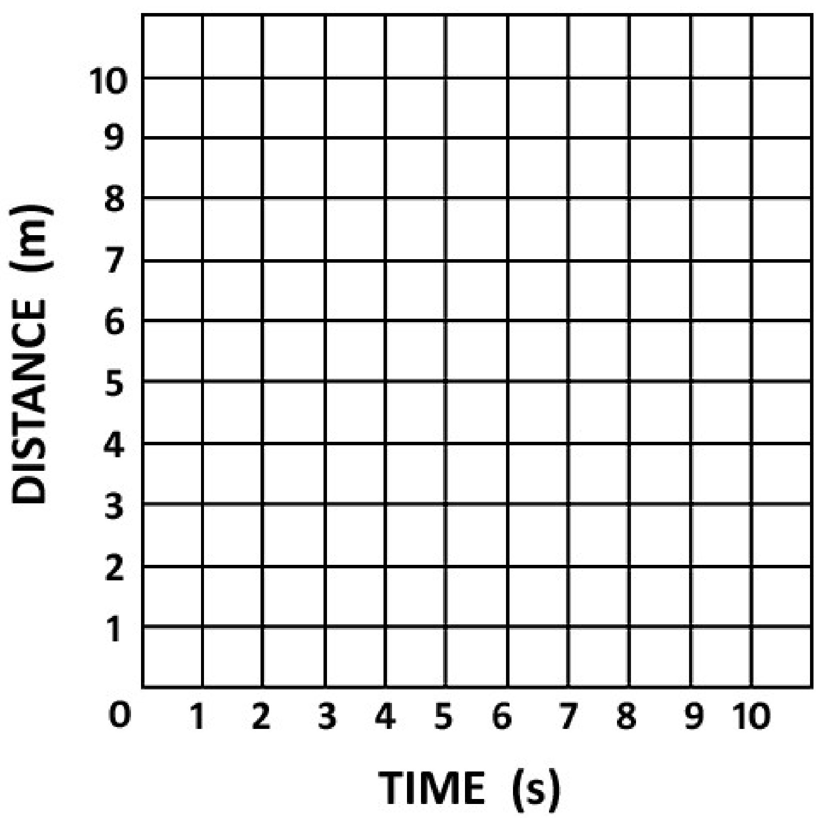


Graph 2A)

Please Graph the following data:

A toy car is pushed down a ramp, and then stopped after it goes
4 meters. When you look at the stopwatch, you see it took 5 seconds.

Also, what is the average speed for the car for that run?
(Don't forget units)



____

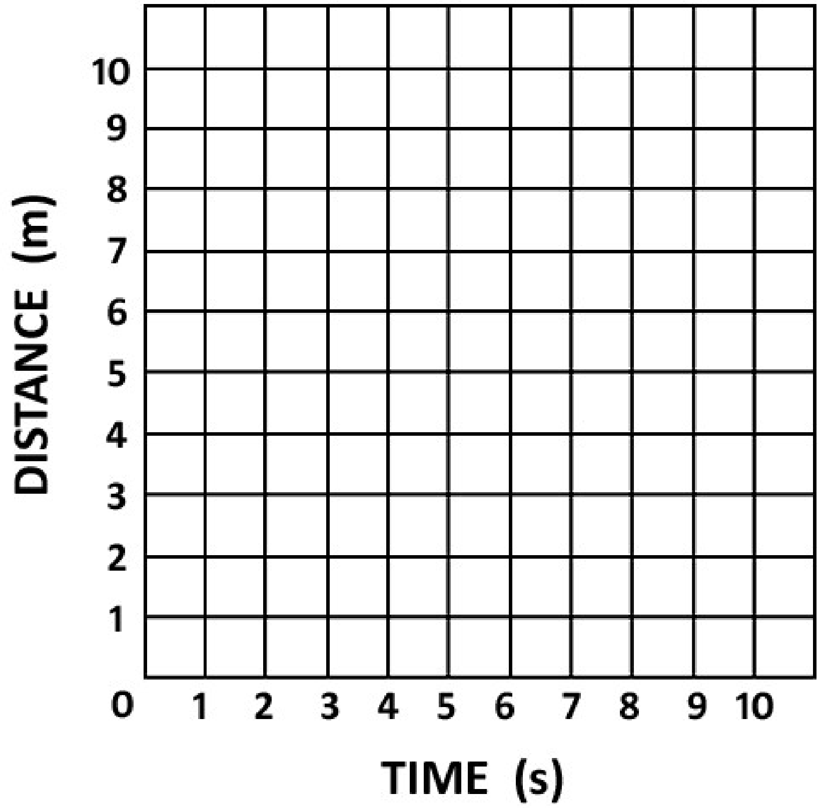
Graph 2B)

Please Graph the following data:

A snail crawls for 10 seconds, and looks back to find that he's gone and incredible 2 meters!

Also, what is the average speed for the snail during his crawl?

____



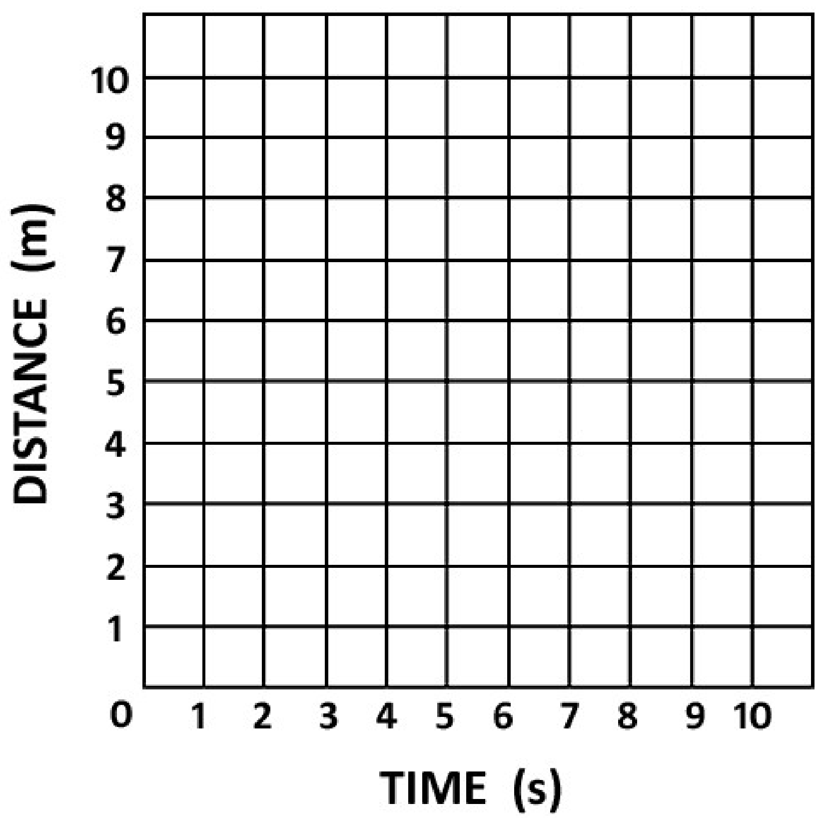
Graph 2C)

Please Graph the following data:

A motorcycle racer tracks his speed over a 10 meter distance – he finds it's only taken him 1 second.

Also, what is the average speed for the racer during his run?

____



Name: Date: Period:

Basic Skills Worksheet
Section 1.1

Manipulating Formulas
Use algebraic steps to solve for the given variable

1. y = x • n (solve for n)

2. p = $\frac{b}{4}$ (solve for b)

3. 2r = x • y (solve for r)

4. f • t = 2x (solve for f)

5. s = $\frac{d}{t}$ (solve for t)

Solving Speed, Distance and Time Problems
Use what you know about the formula for speed to solve the problem

1. An African lion runs 100.0 meters in 8.00 seconds. What is its average speed for that run?

2. You drive 50.0 miles to Boston and your average speed for the trip is 70.0 miles per hour. How long does the trip take you?

3. A boat sails for 30 minutes at 20 $\frac{meters}{minute}$. How far has it gone after the 30 minute time span?

4. If a horse runs 40 meters in 10 seconds, how far will it go in 30 seconds at the same speed?

Physical Science Lab

Name:

Graphing Speed

Grade Received: /40

Please write the averages for the speeds of each ramp level

1 Block: 2 Blocks:

3 Blocks: 4 Blocks:

Analysis and Inference

please answer in complete sentences

1. Do you think it was a good idea to do more than 1 trial per ramp height? Why?

____
____
____
____

2. Did you find that there was a connection between ramp height and speed? If so, how would you describe it?

____
____
____
____

3. When you plotted the speeds on the Distance vs. Time graph, what relationship did the slope of the line have with the speeds of the objects?

____
____
____
____

4. Did you find any inconsistencies within the lab that you didn't expect to see? In other words, did anything happen that surprised you? If so, what might have caused them?
____
____
____
____

Evaluation Rubric

Graph

Category	4	3	2	1
Labeling of X Axis	The X axis has a clear neat label that describes the units used.	The X axis has a label that describes the units used.	The X axis has a label.	The X axis is not properly labeled.
Labeling of Y Axis	The Y axis has a clear neat label that describes the units used.	The Y axis has a label that describes the units used.	The Y axis has a label.	The Y axis is not properly labeled.
Accuracy of Plot	All points are plotted correctly and are easy to see. A ruler is used to connect the points.	All points are plotted correctly and are easy to see.	All points are plotted.	Points are not all plotted correctly.
Choice of Scale	The scales are neatly written next to the axes of the graph and are ideal to fit the given space.	The scales are next to the axes and fit the given space.	The scales are next to the axes and mostly fit the given space.	The scales do not fit the space given OR are not next to the axes on the graph.
Neatness and Attractiveness	Exceptionally well designed, neat and attractive. A ruler is clearly used. Much effort demonstrated.	Neat and relatively attractive. Ruler is used for graphing. Reasonable amount of effort shown.	Lines are somewhat neatly drawn but the graph is lacking effort.	Appears messy and a great lack of effort shown.

Name: _____________________________ Period: _____

Physical Science Survey

What are a few of the things that you like to do outside of class? Do you have any interesting hobbies or things you like to do after school or at home?

____
____
____
____

What is your favorite class in school? Why? ("None" is not an acceptable answer)

____
____
____
____

What do you think you'd like to be when you grow up? What classes in Jr. High and High school do you think would be most important for you?

____
____
____
____

What inspired you to have that career when you grow up?

____
____
____
____

Do you have any plans to attend Blackstone Valley Tech next year? If so, why, and what might you be interested in studying?

____
____
____
____

Do you think that your career interests might involve science in any way?

____
____
____
____

What is your favorite thing about Science Class? Least favorite?

____
____
____
____

Do you have any relatives that work in any “Science” related jobs?
(Some examples of scientific jobs could be biologists, veterinarians, engineers, computer scientists, chemists, doctors, electricians and many more)

____
____
____
____

Name: ___________________________Period: _______Date: _____________

EARTH'S SEASONS LAB

Report Worksheet

This lab will be used to illustrate to the students how the tilt of the Earth's axis affects the light received by Earth as it revolves around the sun.

Procedure:

1. Make a pile of books roughly 6" high

2. Place the flashlight on the pile of books, making sure it doesn't roll off (See figure 1)

Figure 1

3. Use your protractor to measure an angle of 23.5° away from the flashlight sun with the "Earth" on a stick(66.5° on the protractor)(See figure 2)**This represents Winter in the Northern Hemisphere, and Summer in the Southern Hemisphere**

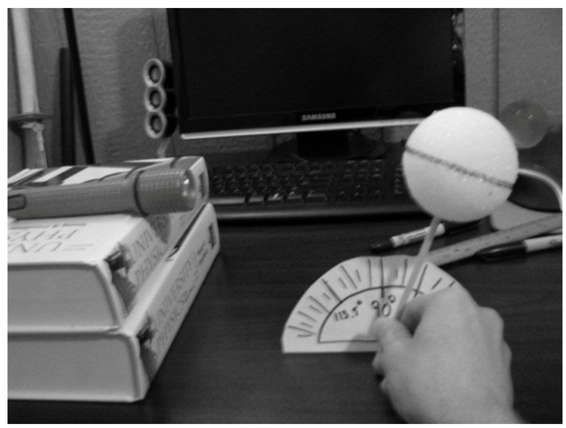


Figure 2
Note that the stick is at 65°on the protractor

4. Making sure the ball is in the line of light from the flashlight; turn it on while keeping the angle with the protractor.

5. Observe and record what you see on the earth, including the grid lines. Draw a picture of the shadows and grid lines (what you observe) in **BOX 1 on page 3**

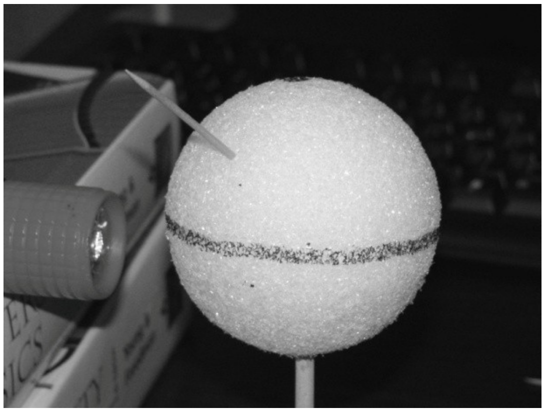


Figure 3

6. Place a toothpick in the model about halfway between the equator and the north pole – observe and record the shadow in **BOX 2 on page 3** (See Figure 3)

7. Without changing its tilt, rotate the earth on its axis and observe how the shadow of the toothpick changes.

8. Now tilt the model Earth 23.5° toward the flashlight (113.5° on the protractor)(See Figure 4) **This represents Summer in the Northern Hemisphere, and Winter in the Southern Hemisphere**

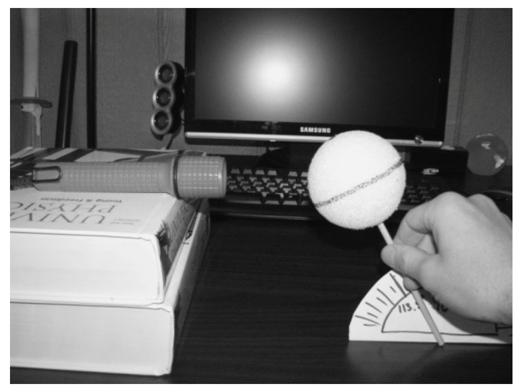


Figure 4

9. Observe and record what you see on the earth, including the grid lines in **BOX 3 on page 4**
10. Observe and record the shadow caused by the toothpick on the earth in **BOX 4 on page 4**

11. Without changing its tilt, rotate the earth on its axis and observe how the shadow of the toothpick changes.

BOX 1 Please draw the picture of the earth when the northern hemisphere has winter

BOX 2 Please draw the picture of the shadow of the toothpick on earth when the northern hemisphere has winter

BOX 3 Please draw the picture of the earth when the northern hemisphere has summer

BOX 4 Please draw the picture of the **shadow of the toothpick** on earth when the northern hemisphere has summer

Lab Report Questions

Answer the following questions in complete sentences based on your observations during the lab and your knowledge of the season.

1. When it is winter in the Northern Hemisphere, which areas on Earth get the most concentrated light? Which areas get the most concentrated light when it is summer in the Northern Hemisphere?

   ____
   ____
   ____
   ____
   ____

2. According to your observations, which areas on Earth are consistently coolest? Which areas are consistently warmest? Why?

   ____
   ____
   ____
   ____
   ____

3. Is the sun's energy most concentrated in the areas where the grid squares are smaller, or where the grid squares are more spread out?

   ____
   ____
   ____
   ____
   ____

4. Why is it warmer in the summertime? Based on what you observed, what causes summer to be warmer than winter?

____
____
____
____
____

Name: ______________________________Date:_________________Period:_____

Roller Coaster Questions

Helpful Formulas:

Gravitational Potential Energy = m•g•h Kinetic Energy = $\frac{1}{2}$m•v^2

Mechanical Energy = Potential Energy + Kinetic Energy

m – mass
g – acceleration due to gravity (9.8 m/s^2)
h – height from the ground

Please solve for each of the following questions and show all work

1. A) Determine the **Gravitational Potential Energy** at point **A**

   B) Determine the **Gravitational Potential Energy** at point **B**

   C) Determine the **Gravitational Potential Energy** at point **C**

   D) Determine the **Gravitational Potential Energy** at point **D**

E) Determine the **Gravitational Potential Energy** at point **E**

2. Using ME = PE + KE, determine the total **Mechanical Energy** at **POINT A** **(Hint: if the velocity is zero, what is the kinetic energy?)**

3. **NOW, ASSUMING THE MECHANICAL ENERGY NEVER CHANGES**, determine the kinetic energy at each of the following points:

B)

C)

D)

E)

4. At which point did the roller coaster cart have its greatest **Gravitational Potential Energy?** Explain why.

____
____
____
____
____

5. As the car is falling down the first hill, what transformation happens between kinetic energy and potential energy?
(Hint: Does the potential energy increase or decrease? How about the kinetic energy?)

____
____
____
____
____

6. Describe the relationship between the cart's velocity and its kinetic energy.

____
____
____
____
____

7. In real life, a roller coaster's total Mechanical Energy decreases along the length of the ride. However, due to the Law of Conservation of Energy, energy is not lost or destroyed, it is merely transformed. What happens to the total Mechanical Energy of a real roller coaster as it moves along the tracks?

____

____

____

____

____

Observation Notes

Observation – Millbury High School

Friday, August 29, 2008

<u>Period 1</u> *8th Grade Physical Science*

- Go over merit system
- Cover metrics and measurement
  - Assessment activity – measuring lines in cm and converting them to mm to determine where the students are at from their previous knowledge
- Hand out books

<u>Period 3</u> *8th Grade Physical Science*

- Go over Metric vs. Imperial system
- Estimation in measurement, precision
  - Assessment activity – measuring lines in cm and converting them to mm to determine where the students are at from their previous knowledge
- Fire drill

<u>Period 4</u> *8th Grade Physical Science*

- Introduce Expectations for Measurement
- Go over Metric vs. Imperial system
- Estimation in measurement, precision
  - Assessment activity – measuring lines in cm and converting them to mm to determine where the students are at from their previous knowledge

Observation – Millbury High School

Tuesday, September 2, 2008

<u>Period 1</u> *8th Grade Physical Science*

- Go over answers and methods to the measuring activity on Friday
- Volume:
    - Definition
    - How to Measure
    - *(l)(w)(h)*
    - Volume Activity
        - Measure a wooden block and then use length, width and height to calculate volume

<u>Period 3</u> *8th Grade Physical Science*

- Volume:
    - Definition
    - How to Measure
    - *(l)(w)(h)*
    - Look at a cubic centimeter
    - Talk about units (cm^3)
    - Volume Activity
        - Measure a wooden block and then use length, width and height to calculate volume
            - Estimate volume
            - Determine volume

<u>Period 4</u> *8th Grade Physical Science*

- Volume:
    - Definition
    - How to Measure
    - *(l)(w)(h)*
    - Look at a cubic centimeter
    - Talk about units (cm^3)
    - Volume Activity

- Measure a wooden block and then use length, width and height to calculate volume
    - Estimate volume
    - Determine volume

Observation – Millbury High School

Thursday, September 4, 2008

Period 1 *8th Grade Physical Science*

- Lab: Use a graduated cylinder to measure the volume of 3 objects
    - Lab partner activity:
        - Draw this →

Period 2 *9th Grade Earth Science*

- Take out decorated Science Folders
    - Positive comments for everyone
- Go over Goals (grades, hw, class work, etc.)
    - Names in a basket for reading, etc.
- Read from the book out loud, alternating between students – teacher steps in to clarify or discuss topics read as they go

Period 3 *8th Grade Physical Science*

- Lab: Use a graduated cylinder to measure the volume of 3 objects
    - Lab partner activity: (activity takes between 8-10 minutes)

Period 4 *8th Grade Physical Science*

- Lab: Use a graduated cylinder to measure the volume of 3 objects
    - Lab partner activity: (activity takes between 8-10 minutes)

Observation – Millbury High School

Friday, September 5, 2008

Period 1 *8th Grade Physical Science*

- Measuring Volume Quiz – Describe and Discuss the two methods used to measure volume that you have learned and used so far. Explain them to me as if I knew nothing about the subject of volume

Period 3 *8th Grade Physical Science*

- Introduce displacement vessels as a third method of measuring volume
- Lab: Measure 3 objects using 2 out of the 3 methods known (lxwxh, graduated cylinder, displacement vessel)

Period 4 *8th Grade Physical Science*

- Introduce displacement vessels as a third method of measuring volume
- Lab: Measure 3 objects using 2 out of the 3 methods known (lxwxh, graduated cylinder, displacement vessel)

Observation – Millbury High School

Monday, September 08, 2008

Period 1 *8th Grade Physical Science*

- Go over results for Lab from Friday
  - Asking the students leading questions to get them to make connections between concepts
- Demonstrate proper use of a triple-beam balance
  - Clarify difference between *mass* and *weight*
- Activity: Practice using a triple beam balance to find the masses for several different objects used in the volume Labs
- Cover formula manipulation on the board – solving for the unknown variable (many of the students are unfamiliar with the process of solving an equation for and unknown variable)
- Introduce d=m/v as well as solving for the individual components

Period 3 *8th Grade Physical Science*

- Go over results for Lab from Friday
  - Asking the students leading questions to get them to make connections between concepts
  - Emphasize the need to write down your measurements
- Demonstrate proper use of a triple-beam balance
  - Clarify difference between *mass* and *weight*
- Activity: Practice using a triple beam balance to find the masses for several different objects used in the volume Labs – finish any incomplete activity on the previous volume lab
- Go over results from the mass activity to assess where students may have gone wrong in their measuring

Period 4 *8th Grade Physical Science*

- Go over results for Lab from Friday
  - Recall the proper method of using equipment, specifically graduated cylinders, so that your measurements are accurate
- Demonstrate proper use of a triple-beam balance
  - Clarify difference between *mass* and *weight*

- Activity: Practice using a triple beam balance to find the masses for several different objects used in the volume Labs – finish any incomplete activity on the previous volume lab

Observation – Millbury High School

Tuesday, September 09, 2008

Period 1 *8th Grade Physical Science*

- Quick measuring activity on paper
- Go over homework about formula manipulation involving density formulas
- Covering the topic of density:
    - Cover how to derive density given the mass and volume
    - D=$^{m}/_{v}$
    - Introduce the following concept
        - If you had a cubic centimeter of a rock that had a density of 4.31$^{g}/_{cc}$ and then you weighed that cubic centimeter of rock, it would have a mass of exactly 4.31g

Period 2 *9th Grade Earth Science*

- Magnetism Activity:
    - All equipment in appropriate bins so that students have easy access to them
    - Preface the importance of organization and cooperation between groups so that the activity goes smoothly and timely
    - Look at common magnets and the earth's magnetic field
    - Make the activity concise enough so that the students have enough time to explore and play around a bit with the magnets
    - Anything remaining on the written portion of the activity is for homework

Period 3 *8th Grade Physical Science*

- Quickly go over homework and clarify how to perform formula manipulations
- Covering the topic of density:
    - Cover how to derive density given the mass and volume
    - D=$^{m}/_{v}$
    - Introduce the following concept
        - If you had a cubic centimeter of a rock that had a density of 4.31$^{g}/_{cc}$ and then you weighed that cubic centimeter of rock, it would have a mass of exactly 4.31g
    - Do the "which is more dense" activity with students
    - Give them 2 objects and ask them which one is more dense

- The best answer to such a question is "I don't know, there is not enough information given.

Period 4 *8^{th} Grade Physical Science*

- Go over homework
- Covering the topic of density:
    - Cover how to derive density given the mass and volume
    - D=$^{m}/_{v}$
    - Introduce the following concept
        - If you had a cubic centimeter of a rock that had a density of 4.31$^{g}/_{cc}$ and then you weighed that cubic centimeter of rock, it would have a mass of exactly 4.31g
    - Do the "which is more dense" activity with students
    - Give them 2 objects and ask them which one is more dense
        - The best answer to such a question is "I don't know, there is not enough information given.
- Cover the concept of x *per* y – in terms of miles *per* hour, mass *per* volume, grams *per* cubic centimeter, or dollars *per* hour.

Observation – Millbury High School

Wednesday, September 10, 2008

Period 1 *8th Grade Physical Science*

- Spend a significant amount of time going over the homework thoroughly (Homework covered calculating density given mass and volume, etc.)
  - Whether the student completed the homework, forgot it at home, or has it incomplete, make sure the student has a copy of the homework in front of them so that they can take notes from the board when going over the homework. This is very important so that the student does not fall behind regardless of whether or not they actually completed the homework.
- Do a quick demonstration of the fact that oil is less dense than water because of the fact that it floats on water – and due to the calculation and comparison of the density of water and oil from the homework. Students will have calculated the density of water to be 1.0 $^{g}/_{cc}$ and vegetable oil to be approximately 0.92 $^{g}/_{cc}$
  - Add food coloring to the water, and have the oil in a test tube, add the red water to the vegetable oil – students will note that the red water beads and sinks to the bottom
- Prepare for tomorrow's lab – *First Density Lab*

Period 3 *8th Grade Physical Science*

- Do a quick demonstration of the fact that oil is less dense than water because of the fact that it floats on water – and due to the calculation and comparison of the density of water and oil from the homework. Students will have calculated the density of water to be 1.0 $^{g}/_{cc}$ and vegetable oil to be approximately 0.92 $^{g}/_{cc}$
  - Add food coloring to the water, and have the oil in a test tube, add the red water to the vegetable oil – students will note that the red water beads and sinks to the bottom
- Same as period 1

Period 4 *8th Grade Physical Science*

- Do a quick demonstration of the fact that oil is less dense than water because of the fact that it floats on water – and due to the calculation and comparison of the density of water and oil from the homework. Students will have calculated the density of water to be 1.0 $^{g}/_{cc}$ and vegetable oil to be approximately 0.92 $^{g}/_{cc}$

  - Add food coloring to the water, and have the oil in a test tube, add the red water to the vegetable oil – students will note that the red water beads and sinks to the bottom
- Same as period 1

Observation – Millbury High School

Thursday, September 11, 2008

<u>Period 3</u> *8th Grade Physical Science*

- Set up lab notebooks for *First Density Lab*
- *First Density Lab*
    - Take 8 cubic objects of different materials
        - Calculate the mass of each object by using a triple-beam balance
        - Calculate the volume of each object by using length, width, and height
        - Calculate the density of each object by relating mass and volume
        - Relate the densities to each of the objects and order them from most dense to least dense
    - Figure out which objects would float or sink on water based on the known density of water

<u>Period 4</u> *8th Grade Physical Science*

- Set up lab notebooks for *First Density Lab*
- *First Density Lab*
    - Take 8 cubic objects of different materials
        - Calculate the mass of each object by using a triple-beam balance
        - Calculate the volume of each object by using length, width, and height
        - Calculate the density of each object by relating mass and volume
        - Relate the densities to each of the objects and order them from most dense to least dense
    - Figure out which objects would float or sink on water based on the known density of water

<u>Period 5</u> *8th Grade Physical Science*

- Find the density of 20 ml of water for use in comparison against the densities of other objects used during the *First Density Lab*

Observation – Millbury High School

Monday, September 15, 2008

Period 1 *8th Grade Physical Science*

- Go over homework
  - It is important that students who had trouble with the homework have the opportunity to pay attention when reviewing. In a deep classroom it is advisable to bring the students to the front of the room who had trouble with the homework, and allow the students who did the homework fully and correctly to sit in the back of the room
- Go over lab results
  - Remind the students to still use common sense when measuring, and make sure that your results match closely with what you might have guessed an object would measure as. This will prevent highly erroneous results from making it to a data table

Period 3 *8th Grade Physical Science*

- Finish working on the lab from Friday (wrap up anything left incomplete)

Period 4 *8th Grade Physical Science*

- Take a quiz
  - Students use “radiation blockers” (2 binders propped up in a cubicle fashion) to ensure privacy and academic honesty while testing

Massachusetts State Frameworks

Physical Sciences (Chemistry and Physics), Grades 6–8

LEARNING STANDARD	IDEAS FOR DEVELOPING INVESTIGATIONS AND LEARNING EXPERIENCES
Properties of Matter	
1. Differentiate between weight and mass, recognizing that weight is the amount of gravitational pull on an object.	Determine the weight of a dense object in air and in water. Explain how the results are related to the different definitions of mass and weight.
2. Differentiate between volume and mass. Define density.	
3. Recognize that the measurement of volume and mass requires understanding of the sensitivity of measurement tools (e.g., rulers, graduated cylinders, balances) and knowledge and appropriate use of significant digits.	Calculate the volumes of regular objects from linear measurements. Measure the volumes of the same objects by displacement of water. Use the metric system. Discuss the accuracy limits of these procedures and how these limits explain any observed differences between the calculated volumes and the measured volumes.
4. Explain and give examples of how mass is conserved in a closed system.	Melt, dissolve, and precipitate various substances to observe examples of the conservation of mass.
Elements, Compounds, and Mixtures	
5. Recognize that there are more than 100 elements that combine in a multitude of ways to produce compounds that make up all of the living and nonliving things that we encounter.	Demonstrate with atomic models (e.g., ball and stick) how atoms can combine in a large number of ways. Explain why the number of combinations is large, but still limited. Also use the models to demonstrate the conservation of mass in the modeled chemical reactions.
6. Differentiate between an atom (the smallest unit of an element that maintains the characteristics of that element) and a molecule (the smallest unit of a compound that maintains the characteristics of that compound).	Use atomic models (or Lego blocks, assigning colors to various atoms) to build molecules of water, sodium chloride, carbon dioxide, ammonia, etc.
7. Give basic examples of elements and compounds.	Heat sugar in a crucible with an inverted funnel over it. Observe carbon residue and water vapor in the funnel as evidence of the breakdown of components. Continue heating the carbon residue to show that carbon residue does not decompose. Safety note: sugar melts at a very high temperature and can cause serious burns.
8. Differentiate between mixtures and pure substances.	

Physical Sciences (Chemistry and Physics), Grades 6–8

Learning Standard	Ideas for Developing Investigations and Learning Experiences
Elements, Compounds, and Mixtures (cont.)	
9. Recognize that a substance (element or compound) has a melting point and a boiling point, both of which are independent of the amount of the sample.	
10. Differentiate between physical changes and chemical changes.	Demonstrate with molecular ball-and-stick models the physical change that converts liquid water into ice. Also demonstrate with molecular ball-and-stick models the chemical change that converts hydrogen peroxide into water and oxygen gas.
Motion of Objects	
11. Explain and give examples of how the motion of an object can be described by its position, direction of motion, and speed.	
12. Graph and interpret distance vs. time graphs for constant speed.	
Forms of Energy	
13. Differentiate between potential and kinetic energy. Identify situations where kinetic energy is transformed into potential energy and vice versa.	
Heat Energy	
14. Recognize that heat is a form of energy and that temperature change results from adding or taking away heat from a system.	
15. Explain the effect of heat on particle motion through a description of what happens to particles during a change in phase.	
16. Give examples of how heat moves in predictable ways, moving from warmer objects to cooler ones until they reach equilibrium.	Place a thermometer in a ball of clay and place this in an insulated cup filled with hot water. Record the temperature every minute. Then remove the thermometer and ball of clay and place them in an insulated cup of cold water that contains a second thermometer. Observe and record the changes in temperature on both thermometers. Explain the observations in terms of heat flow, including direction of heat flow and why it stops.