IMPROVING STUDENT ACHIEVEMENT THROUGH DAILY ACTIVITIES AND ASSESSMENTS IN INTRODUCTION TO PHYSICS

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ABSTRACT

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The combination of a hands-on approach to science with the accountability of daily assessments provides a greater opportunity for students who traditionally receive below-average grades to be successful in science classes. The addition of competitive elements and real world applications plays to their strengths as kinesthetic learners without sacrificing the rigor required to meet graduation standards. Further, daily assessment allows students to develop test-taking skills they will need for the standardized tests used by the state and for college admission. Finally, the combination of daily feedback and daily accountability prevents a struggling student from slipping through the cracks.

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CHAPTER 1: EATON RAPIDS

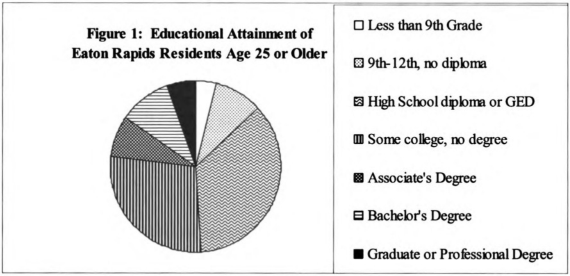
The Eaton Rapids Community

Located fifteen miles south of Lansing in Eaton County, Eaton Rapids greets you with a sign proclaiming "Welcome to the Only Eaton Rapids in the World." According to the United States Census Bureau, Eaton Rapids is home to 15,026 residents. The majority of the population is Caucasian, with less than 5% reporting as African-American, Hispanic, Latino, Asian, or Native American. The largest minority group is Hispanic, at 2.6%. Many of the Hispanic families speak Spanish at home, but their children are usually proficient speakers of English. (US Census Bureau, 2008)

10.1% of the households are single-parent homes (Standard and Poor's), and it is not uncommon for students to live in joint-custody situations with two separate homes. 11.2% of the population over the age of 15 is divorced or separated. Approximately 1% of the adult population are grandparents who are the primary care-givers to their grandchildren. (US Census Bureau, 2008)

Eaton Rapids is also home to the VFW National Home for Children, all of whom attend Eaton Rapids Public Schools. Children who live at the VFW home are the children, grandchildren, or great-grandchildren of veterans or have a parent who is actively serving in the military. These students live in homes on the VFW campus, either with their own family or as part of a group family with house parents. (VFW National Home, 2008)

Figure 1 is a break down of the educational achievements of the adult population of Eaton Rapids. While the town has a greater percentage of high school graduates than the country as a whole, it also lags behind in terms of college degrees. (US Census Bureau, 2008) While individual families may emphasize the importance of a college education, the majority of my students do not expect to attend college in the future. However, many do expect to attend some type of trade school or receive other post-high school training. We have a thriving vocational education program involving Lansing Community College and other career or technical preparation programs.



Eaton Rapids Public Schools

Eaton Rapids Public Schools consists of three K-4 elementary schools, one 5-6 intermediate school, one 7-8 middle school, one 9-12 senior high school, and one alternative and adult education high school. During the 2007-2008 school year, the district served a total of 3,048 students, of which 1,019 were in the high school. (Standard and Poor's) The district has been decreasing in size over the last several years, but this decrease is occurring at the elementary level, and has not yet reached the high school. Only the high school is on the trimester system, the rest of the district follows the traditional two semesters/four marking periods system.

Like all Michigan High Schools, Eaton Rapids High School is struggling with the requirements of the No Child Left Behind (NCLB) legislation. Test scores for the class of 2007 show 70.2% of the student population proficient in Reading and Math, with female students outperforming male students 72.3% to 67.7%. Our economically-disadvantaged students show lagging performance, with only 62.5% proficient at both reading and math. (Standard and Poor's, 2008) While the student body as a whole has shown gains for the last several years, the lagging performance of the special education students prevents the school from officially claiming Adequate Yearly Progress (AYP). It is a point of pride in the science department that our science scores, even among these cohorts, are consistently above the state average.

Eaton Rapids High School Science Graduation Requirements

When I began teaching at Eaton Rapids High School, students were required to take two years of science. During their freshman year, all students were placed in Physical Science, which covered the basics of chemistry and physics. This class served as the prerequisite for Biology for sophomores. While there were advanced sections of both Physical Science and Biology, the majority of students were placed in the regular class. These two classes were the graduation requirement for science. Further science classes in Chemistry, Physics, Human Anatomy & Physiology, and Botany were also offered.

During the 2004-2005 school year, the Science Department at Eaton Rapids High School decided to implement changes in the curriculum. This decision was influenced by several factors: lack of students in higher-level classes, apathy among bright students in the lower-level classes, and test scores indicating lack of mastery of science objectives, especially Earth Science. At the same time, the High School was making the transition from semester to trimester scheduling, and it was agreed that this change would be an excellent time to revise the science curriculum and requirements.

Graduation requirements (see Table 1) were increased to three credits of science beginning with the class of 2010. These students would begin with Biology their freshman year. From Biology, students with good academic standing (defined as a grade of B or better in Biology) would be encouraged to move on to a college-preparatory Chemistry class, while students with lower success (those earning a C or D in Biology) would be encouraged to take Introduction to Chemistry and Introduction to Physics. These classes were to provide thorough grounding in the Essential Objectives, but move at a slower pace and emphasize concepts over mathematics. Students taking the introductory class would be allowed to move on to the college-preparatory Chemistry or Physics classes as juniors and seniors if they desired. At this time, Global Science was also introduced. The graduation requirements for the class of 2010 were officially set as two terms of Biology, one term of Chemistry or Introduction to Chemistry, one term of

Physics or Introduction to Physics, one term of Global Science, and one term of elective credit.

Shortly after these changes were approved by the school board, the State of Michigan released its new graduation requirements. While we were right to increase the graduation requirements, our Introduction classes did not meet the "Full Credit of Chemistry or Physics" as defined by the State for the class of 2011 and beyond. Because we could not reschedule the class of 2010 in time, and because we did not have the staff to cover so many two-term sections of Chemistry, it was decided that Introduction to Chemistry and Introduction to Physics would be offered to the class of 2010, and would then be replaced with Chemistry Concepts and Physics Concepts for the class of 2011. These two-term Concepts classes would cover all Core and Essential Benchmarks as required by the State of Michigan.

Table 1: Graduation Requirements in Science at Eaton Rapids High School
0.5 credits = 1 trimester (or 1 semester prior to Fall, 2006)

Graduating class	2009 or before	2010	2011
Require-ments	1 credit Physical Science 1 credit Biology	1 credit Biology 0.5 credits Chemistry 0.5 credits Physics 0.5 credits Global Science 0.5 credits Elective	1 credit Biology 1 credit Chemistry or Physics 1 credit Elective
Total Required Credits	2 credits	3 credits	3 credits

All of this means that the class on which I conducted this research existed only during the 2007-2008 school year and was only available to students in the class of 2010 or earlier. Students in the class of 2011 and beyond are required to take the longer

Physics Concepts class. Further, any students who failed Introduction to Physics during the 2007-2008 school year will have to take the longer Physics Concepts class in order to earn graduation credit. Students were made aware of this situation and it may have had some effect on the pass/fail rate. An effort was made to place any student who failed Introduction to Physics in the Fall term back into the class during the Spring term.

Introduction to Physics

This research was conducted with four sections of Introduction to Physics, described in the course scheduling book as "Survey of mechanical, electromagnetic, and thermodynamic physics. Hands-on, lab-based course requires minimal math skills." The course covers Motion and Force; Electricity and Magnetism; Waves; and Energy, focusing on the major concepts and Laws, and keeping the math at the pre-algebra level. These sections occurred during the Fall term of the 2007-2008 school year, beginning September 4, 2007 and ending November 16, 2007.

Ninety-seven students signed up to take Introduction to Physics during the Fall term. Three of these students never attended class; they transferred during the summer but the schedule changes were delayed. Seven students dropped the class during the term, either to change schools or because they dropped out of school. One student transferred in part way through the term. At the end, the class held eighty-eight students.

Of the eighty-eight students who completed the class, forty-six were male and forty-two were female. The majority, eighty-one, were sophomores. The six juniors and one senior taking the class were repeating it after previously failing or were transfer students who did not enroll with similar credit from their previous school. Eleven of the students were either designated special education or were on a 504 plan for a disability such as ADHD or Tourette's Syndrome.

Students taking Introduction to Physics were generally placed there because they had average or below average grades in Biology the previous year. Using the 4.0 GPA scale and taking the highest grade achieved by students repeating the class, the average science grades of students entering the class were 1.51 in Biology A and 1.67 in Biology B. Twenty-one of the students failed at least one term of Biology as in the previous year, and seven had failed Introduction to Physics on a previous occasion.

CHAPTER 2: METHODOLOGY

Setting the Goals

"There are three things to remember when teaching: know your stuff; know whom you are stuffing; and then stuff them elegantly."
—Dr. Lola May, Math teacher

In developing Introduction to Physics, there were several important factors that I kept in mind: The type of student enrolled, the available time, the benchmarks to be covered, and the need to expand the class the following year. These four points drove many of the decisions that were made about the structure of the class. It was fortunate that I was the only one teaching the class this year, because I was allowed full creative control and did not need to create common assessments with other teachers. What I developed was not a single unit, but a complete class. I wanted something that would play to the strengths of my students and address their weakness in a way that would allow us to maintain a fast pace. In the end, I set the following goals for the class:

- Provide hands-on activities daily
- Assess and provide feedback through daily quizzes
- Limit homework to meaningful assignments
- Use classroom structure and organization tools to improve content delivery and maintain pace

The class that took shape consisted of thirty-nine different lessons, grouped into four units by topic; Energy and Motion, Forces, Electromagnetism, and Waves. Each day included a warm up question, a small amount of lecture notes limited to the day's topic, a hands-on activity, and a short quiz. Each of the four units included a review consisting of three questions for each daily topic and a vocabulary review, and a test that covered all unit objectives. While an attempt was made to present all of the Core and Essential Benchmarks, the Essential Benchmarks were emphasized. Each unit included one day for review and one day for the test. Three projects were also included in the class design, to be completed outside of class and brought in on a set due date. The class concluded with a review period and Final Exam.

Goal 1: A Lab Every Day

I hear...I forget
I see...and I remember
I do...and I understand

—Ancient Chinese Proverb

What do people remember from their science classes? While I have heard some really great lectures, and have seen plenty of fantastic demonstrations, the labs are the part of science class that everyone really enjoys and remembers. The Speak Up 2007 study, jointly conducted by Project Tomorrow and Pasco Scientific, surveyed over 350,000 students, teachers, parents, and administrators from all over the United States about their experiences in and thoughts about science and math education. In imagining their perfect science classroom, high school students placed group work (including labs) second only to an excited and enthusiastic teacher. Students also reported that their favorite memories and experiences in science were hands-on activities, especially ones that used "real professional tools." High school students reported that hands-on activities made them more interested in pursuing careers in science, technology, or engineering.

Unfortunately, this survey also exposes disheartening attitudes toward science education. Less than half of parents or teachers surveyed think that schools are adequately preparing students for science-related careers, and fewer than forty percent of students are interested in pursuing such careers. More than half of students surveyed primarily viewed learning science as necessary to graduate high school or to get into college, while only 25% of their parents viewed science as necessary to the future success of their children. (Project Tomorrow 2008)

The results of this study mirror my experiences with my students, especially those labeled as low-achieving. Knowing that the students in this class are not the type to learn from reading the book or listening to a lecture, I resolved to limit the book work and the lecturing and concentrate on the hands-on activities. Each day of the class focused on one major concept. For each concept, I found or developed a lab that demonstrated the concept and could be performed in forty-five minutes. While the students had to endure a short lecture each day, the lectures were limited to approximately ten minutes and covered only the essential information necessary to understand the concept. Students were then given the opportunity to perform the activity. The only days that did not include hands on activities were review and test days, and the first day of class.

There is research to support my decision. Gardner's Theory of Multiple Intelligences states that different people learn in different ways, and that these styles can be divided into eight different categories (Nolen 2003). In some of my classes, I give my students a Multiple Intelligences survey and we compare their scores in the different categories. While I did not give these students such a survey, my results over the last eight years show that the vast majority of my students rank highest in bodily-kinesthetic learning, and lowest in either verbal-linguistic or mathematical-logical learning.

Bodily-kinesthetic learners need to move, to touch, and to do things with their hands; to experience the material in a very physical way (Nolen 2003). Science labs in physics lend themselves well to this type of learning—riding scooters in the parking lot to study motion and force, making waves with springs, running up the stairs to experience the meanings of Work and Power, building an electric motor—these are all examples of kinesthetic activities. By presenting a large number of lab activities, I hoped to play to the strengths of my students.

Verbal-linguistic learning involves words, usually written, read, or heard. Mathematical-logical learning involves mathematics or patterns. These two types of learning are probably the most commonly addressed in classrooms (Nolen 2003). They are also the two that are the least common strengths and the most common weaknesses among my students. My students do not gain much from long, detailed lectures, and many of them will not bother to do a reading assignment. Many of my special education students have disabilities related to reading or mathematical comprehension. Limiting the amount of material presented in this fashion de-emphasizes the weakest areas for my students.

This is further reinforced by two of the principles of Kolb's Learning Cycle, which state that learning is based in concrete experiences and that learning is a process of adapting to the world. The learning cycle links together theory and practice (Vince 1998). These hands-on activities provide concrete experiences that can be spiraled together to develop a concept through a unit. This is especially critical for students who have not had a broad range of experiences. Many labs also require adapting the information that they have to different situations, such as using knowledge of Newton's Laws, friction, and motion to build a balloon-powered car. Using experience to form ideas, and then using those ideas to explore new experiences is central to the learning cycle.

However, it is vital that each activity be directly tied to the main concept of the day. In his article for Science and Children, Bill Robertson notes that "Hands-on science activities motivate not just hard-to-reach students but all students. Hands on activities just for the sake of hands-on, though, don't lead to much learning of science concepts, let alone a lasting understanding." Rather, it is necessary to provide guiding questions or goals that require the student to pay attention to what they are doing, not just to play with the "toys" that you have provided (Robertson 2006). Sometimes these goals are competitive, such as asking the students to build the car that goes the farthest or the parachute that takes the longest time to reach the ground. At other times, questions are provided that force the student to consider what the data really means, such as comparing work calculations for walking and running to see that Work really does not depend on the speed at which they travel.

Further, in her study of the relationship between hands-on activities and student achievement, Patricia Stohr-Hunt found that students who engage in hands-on activities once a week or more frequently scored significantly higher on a standardized test than students whose hands-on activities were limited to once a month or less. This was true even though the test was based on the general curriculum at their grade level and not on the specific curricula to which the students had been exposed. (Stohr-Hunt 1996) This is significant to me because this class has so little time to teach a tremendous number of benchmarks in preparation for the ACT/MME the following year.

Of course, there is no comprehensive definition of a hands-on classroom nor is there currently any way to assess hands-on learning in a standardized, nation-wide way. As Stohr-Hunt points out in her discussion of the results, teachers must work carefully to ensure that students construct the expected knowledge from their activities, that the students are evaluated appropriately, and must take the time to evaluate the program, modifying it as necessary to ensure that it serves the students. (Stohr-Hunt 1996)

My class cannot engage in inquiry-based learning because of the time constraints; all of the labs are instead designed to fit into a class period and are based on the benchmarks provided by the State of Michigan. However, these activities can engage the students in a way that lecturing or book work cannot, and can expand their thinking to experiences that they have had outside of the classroom. Further, test questions that directly reference the results of our various activities can be used to gauge student understanding.

Goal 2: A Quiz Every Day

"Will this be on the test?"

—Every Student

Students love to tell me that they are bad at tests, that they freeze on tests, that their bad grades are because of the tests. Why are they so bad at tests? My pet theory is that they lack two basics skills: the ability to identify what will be on the test, and the ability to identify what they need to study in order to pass the test. The first requires the student to analyze the material and determine the most important items. The second requires the student to inventory what they have learned and identify the gaps in their understanding, then use their study time to fill in these gaps. One would hope that these skills are developed before high school, but experience has shown that most students have minimal study skills and no formal instruction in them.

My solution to this problem was to give daily quizzes and to provide detailed feedback the next day. The quizzes, which can be found in Appendix B, are five questions or less and heavily favor multiple choice questions. These quizzes would be checked nightly and returned the next day, and some time would be devoted to providing feedback. I hypothesized that these assessments would help students learn to identify the gaps in their understanding and that, with practice, they would learn to anticipate what would be tested. Further, I hoped that being assessed on a daily basis would help to alleviate some of the "freezing" on the tests. Just as a phobia can be overcome with gradual exposure, I hoped that students who were anxious about taking tests would grow more accustomed to them through small daily doses.

In his 2002 article, Richard J. Stiggins refers to this method as assessment *for* learning, also known as formative assessments. He contrasts this with our more traditional assessments, which are known as assessments *of* learning, or summative assessments. Assessments *for* learning are embedded in the curriculum, cover discrete amounts of content, and provide feedback very quickly for individual students. They are used to steer both teaching and learning based on what students have learned in a lesson. Assessments *of* learning are the standardized tests, the end of unit tests, and end of course exams. These assess overall learning and mark the end of a period of teaching. The data are often collected for a large group rather than individuals, feedback is not normally individualized, and there is less emphasis on re-teaching or re-learning the material. They are used to compare group of students or to assign grades (Stiggins 2002).

It may help to think of formative assessment as a variation on scaffolding. In her article for Education Leadership, Lorrie Shepard compares the two. Pedagogically, scaffolding refers to the support of the teacher during the development of a skill or of knowledge, which may involve giving hints or suggestions to a student as they are learning the tasks. As the student becomes more efficient, the teacher gradually withdraws this support structure because the student is able to do the task on their own. In the same way, formative assessments allow the teacher to emphasize the gains that the student is making, while at the same time supporting the student through the more difficult aspects. Like scaffolding, formative assessments depend on effective feedback for the students. Support can only be withdrawn when the student is ready to handle a task on their own, and a summative assessment is really only appropriate when the students have developed all of the knowledge that they needed to acquire. Formative assessment and scaffolding both benefit from the self-assessment skills that the student develops as a result of these practices. Formative assessments teach a student what exemplary work looks like, allowing the student to compare his work to the goal and adapt as necessary. In the same way, scaffolding allows a student to accomplish a task, thus seeing the goal, while at the same time showing the student what skills they still need to develop. As students learn to self-assess through their interactions with the teacher, the student can become responsible for their own learning, a lesson they will carry to other endeavors (Shepard 2005).

Stiggins outlines the benefits of formative assessment. Students get to see concrete examples of their success, and to see them more often than they see a standardized or unit test. Students also become more aware of their own involvement in the learning process and may develop more of the motivation necessary to succeed in class. Teachers benefit from this motivation, but also benefit by having detailed data that can inform their teaching as they progress through a unit (Stiggins 2002).

Research shows that gains made through formative assessments are greater than gains made through other educational interventions, and that these can have a great impact on the overall performance of a group. Formative assessments have a particularly great impact on students who are learning-disabled or are classified as low-achievers. (Black & Wiliam 1998) As these two categories of students are over-represented in my classes owing to the scheduling process, the inclusion of daily quizzes should actually have a greater affect with these students than with a mix of students at all ability levels. However, the authors of this study are quick to point out that students who are content to "get by" will gain little from the formative assessments and feedback, instead putting their effort into finding clues to the right answer. Some even become afraid to ask questions for fear of failure. It is necessary for formative assessments to focus on the positive and avoid making comparisons between students. (Black & Wiliam 1998)

One drawback to these daily quizzes is the amount of time needed to correct them and provide feedback. Part of the solution to this problem is to use multiple choice questions the majority of the time, which are the fastest questions to check. As Hoachlander points out in his article "Assessing Assessment," multiple choice exams are the fastest tests to develop and administer, test factual knowledge and problems that have concrete answers, and can be standardized and normalized. (Hoachlander 1998)

However, multiple choice tests do not resemble the tasks we encounter in the real world. Most problems we face require the synthesis of knowledge from multiple sources and its application. The time constraints on the formative assessment only rarely allow for other types of assessment, such as constructed-response questions, math problems, or the performance of a skill. These types of assessments were instead included in the summative assessments at the end of the unit, or were included in lab activities and the projects. Having a variety of assessment tools available contributes to effective teaching and learning, but formative assessments such as the daily quizzes must sacrifice this variety for the sake of time.

If my pet theory is correct, then we must also be aware of a third point: Repeated failure on tests causes the student to develop an attitude of hopelessness and resignation toward failure, eventually leading them to give up altogether. In an article for Education Leadership, Rick Stiggins addresses this point. Part of the purpose of formative assessment is to show students what exemplary work looks like and to help them identify and fill in the gaps between their current work and the work we want them to achieve. Further, these formative assessments should not have a detrimental effect on the student's grade, since the purpose behind them is to help the student improve and not to act as a summative assessment (Stiggins 2007).

By providing feedback the next day, including the correct answers, the feedback sessions allow students to see exemplary work. Because the students are allowed to keep the quizzes, they will have them as a reference when studying for the test, allowing them to make sure that the previous gaps in their knowledge have been filled. Lastly, the quizzes, as a percentage of the whole, have a very low weight in the grade for the class. One quiz is worth roughly 0.25% of the class grade, as opposed to 5% for one unit test and 20% for the Final Exam. This keeps the quizzes from having an undue impact on the overall grade of the student—one bad quiz grade is unlikely to be the difference between passing and failing.

More importantly, the daily nature of the quizzes should prevent a student from developing an attitude of hopelessness due to failure. The quizzes cover discreet amounts of information—literally the things the student learned in the previous sixty-five minutes of class. Because they will be graded daily, they will also allow me to keep an eye on students and catch them before they slip too far. While one bad quiz score will not set off alarm bells, two or three bad quiz scores in a row will indicate a student who is having difficulties and allow me to gently intervene before the student loses too much time or gives up.

By providing these formative assessments each day, the students will develop confidence in test-taking, insight into what will be covered on tests, and will discover and fill gaps in their knowledge as they proceed through the unit. These gains should, in turn, lead to better scores on the summative assessments at the end of the unit and the end of the term.

Goal 3: Minimizing Homework

"School means I have to do homework.
That takes up my time when I should be riding my dirt bike."
—Dr. Richard Walker, Geography Professor

There is a great debate going on in education about the role of homework and what, exactly, homework is. Some teachers see it as extra practice, others as a way to teach skills outside of class. Does studying count as homework? Should homework include only nightly assignments, or also long-term projects? Is homework beneficial to the students at all?

"The Homework Wars," a debate held at Harvard's Askwith Education Forum in September, 2000, illustrates three differing views of homework that have become part of the national conversation on education. On one side, we have Etta Kralovec, who advocates severely reducing or abolishing homework, pointing out that teachers have no real control over work once it leaves the classroom, that it makes people unhappy, and that homework is cited by high school drop outs as one of the main reasons that they leave. Her research suggests that homework "broadens the achievement gap between students of different socio-economic backgrounds."

Defending homework was Assistant Professor of Education Janine Bempechat, who points out that homework fosters skills such as "persistence, diligence, and the ability to delay gratification," all of which are necessary to success. By shielding students from the stress or struggle that can accompany homework, she argues, those who would abolish homework actually decrease a student's chances for success.

A more moderate, practical view is provided by high school principal Kim Marshall, who states that homework is an asset if assigned properly, meaning that it "should be useful, aligned with the curriculum, and kids should be able to do it alone." Of the three, I find myself in agreement with Mr. Marshall, no doubt in part because his background is in teaching and administration rather than in research. (Gavel 2000)

According to a TIMSS Study, American students equate homework with studying, and have under-developed study skills compared to Japanese or German students. American parents are surprised at how little homework their students do, in part because students attempt to get the work done at school. Teachers expect homework to be completed before the next class period or a specific due date, and may allow class time for completion. (Stevenson 1998)

In many ways, I dread checking homework. I know that when I tackle that pile on my desk, I will find lots of blank questions, plenty of identical answers, and more than a few students who didn't bother to turn in the assignment at all. Homework has become a perpetual struggle between students and teachers, and I wanted to change this.

How do teachers view homework? I see homework as extra practice, more chances to visit the important concepts outside of our time-crunched classroom. I also see it as an opportunity to provide enrichment, since I can assign an article about a topic that is interesting but which we don't have time to cover in class. I know some teachers see it as traditional—they assign homework because that is what teachers do.

How do students view homework? Most of mine see it as a waste of their time, as busy work that they have to do "because the teacher says so." If the student does not value the class in the first place, they will not see any value in spending more time on the material at home. Even good students can have problems when different teachers manage to assign large homework assignments the same day. Further, homework is something over which they have little or no control—they cannot decide how to do it or when to do the work.

While I toyed with the idea of eliminating homework completely, I eventually decided on a compromise that limited the total amount of homework, gave the students a certain amount of control over when and how they would do it, provided extra practice on the most important concepts, and provided enrichment. My students were thrilled when I told them on the first day of class that they would only have eight homework assignments for the whole term.

I divided the homework into two types. The first type of homework was reviews. For each unit, I wrote a review that included three questions for each daily topic. Any student who could answer all of the questions on the review could expect to pass the unit test. The unit reviews also contained vocabulary reviews, in the form of crossword puzzles. The puzzles clues were the same definitions used in class. Each review was handed out on the first day of the unit and collected the day of the test.

The reviews provided the extra practice on concepts that I considered necessary, but also allowed students some control over when they did it. Students had the option of doing three questions each night, covering the review as they covered the material in class. They could also opt to do the whole review after we finished the material, in the two nights before the test. Some chose to work on the review as their schedule allowed, which usually meant doing three of four days worth at a time. While the review packet looked enormous, the fact that it was divided into concise groups of questions was beneficial to the students. A review was also provided for the final exam, though this review was graded as extra credit on the final exam score rather than as a regular assignment.

In his review of homework studies, Harris Cooper notes high school students who do homework outperform high school students that do not do homework. However, he also noted that homework is subject to the law of diminishing returns, where there is a limit to the amount of knowledge gained compared to the time spent. The studies he references indicate that the maximum homework for a sophomore should not exceed two hours per night, and no more than five days per week. Anything beyond this amount, which should be shared among all of the student's teachers, does not improve student comprehension.

Cooper recommends that homework be used as reinforcement, not as a method of teaching complex skills. He suggests that homework should involve minimal parental involvement, and that the feedback on homework should focus on the positive aspects of the student's work and provide constructive feedback where the student does not understand. Further, it is suggested that grading should be informal, with remediation required when work is not completed (Cooper 1994).

The review packets for the different units meet some of the criteria for Cooper's ideal homework. While I have no way of knowing how much work is assigned by the other teachers, my homework is specifically written to allow the students flexibility to dot he work when they have the time. We go over the work as a class, and the grades for the review packets are completion grades only.

The other type of homework was projects. Each project required students to construct a small and inexpensive device, which was then tested or demonstrated in class. The projects were tied to three of the four units of instruction. Students had the option of working with a partner and a minimum of ten days to complete each project. These projects provided students with enrichment opportunities and addressed real world applications of the material we were studying. At the same time, students could approach the projects in a number of different ways and their own creativity could be expressed. With the projects, students also had the option of doing things with increased difficulty in order to earn extra credit points.

The projects offer the students a great deal of freedom of choice. These choices are meant to combat the apathy with which students approach much of their work. Kohn feels that this apathy is the result of burnout, and that the burnout stems from lack of choice or control in their own education. In his research, Kohn cites several examples of the benefits of giving students input into the work that they are doing, from better lab reports to more work being completed on time.

Because of the constraints placed on teachers by the benchmarks, it is not often possible to give students a choice of what they will learn. However, they can be given choices about how they will approach a problem and what they will turn in at the end. This could be choosing which article to read or which project to build, or even how to set up and perform a lab. By making choices available to students, the students are more likely to be engaged in the material. Choice gives students a chance to practice making decisions and to take risks (Kohn 1993).

However, this does not mean that the students can have free rein in all things. Time constraints, the needs of others, and the requirements of the curriculum must all be factored in to the decision-making process (Kohn 1993). In many ways, giving my students choices is a lot like giving choices to my young nephew. If he is in a restaurant and is asked what he wants, there are too many possibilities and he is unable to accomplish the task at hand. Instead, he might be asked if he wants chicken or a grilled cheese sandwich—a limited choice which gives him freedom to choose but also allows us to order dinner in a reasonable amount of time. In the same way, I can give choices to my students—which musical instrument do you want to build? which song are you going to play?—but can still keep my classroom functional, because they will all build an instrument and they will all play a song.

Goal 4: Structure and Organization

"Organizing is what you do before you do something,
so that when you do it, it is not all mixed up."
—A.A. Milne, Author

With a lab every day, a quiz every day, and eleven short weeks to accomplish everything, structure and organization become key. My students are not naturally very organized, nor am I. The organization system we use has to be simple and consistent, and be largely intuitive. It needs to take minimal time to set up and little effort to maintain; and it needs to make it easy for an absent student to get caught up again without slowing down the rest of the class. Routines need to be established early and used consistently, providing structure to the class period and allowing students to feel comfortable because they can anticipate what will happen. Routines should also be time-savers. While routines can sometimes be boring, different topics and activities each day provide the necessary variety to the class, while the routine allows the class to progress through the material at the necessary pace.

As part of my effort to work on structure and organization, I developed a daily routine for the class. The average day begins with a warm up question, followed by any announcements and a look at the quiz results. Then lecture notes for ten minutes or less. The lecture notes are presented using Power Point, which allows me to make animations and include pictures or video. More importantly, a student who is absent can view the Power Point at a later time and see the same material as it was presented in class, and all classes see the same material each hour. The Power Points have not been included with this thesis, but can be obtained from the author. Lecture notes are followed by a lab or other activity, which is meant to take the majority of the class period. Quizzes are planned for the last five minutes of class, with students putting away all materials and cleaning up from the lab before returning to their seats to take them.

This simple routine is actually based in Kolb's Learning Cycle. As shown in Figure 2, Kolb's Cycle shows learning as a continuous movement from concrete experiences through observation and reflection and then formation of a concept to the testing of this concept. The testing creates a new concrete experience which may become the beginning of a new cycle (Vince 1998). The concrete experiences come from my

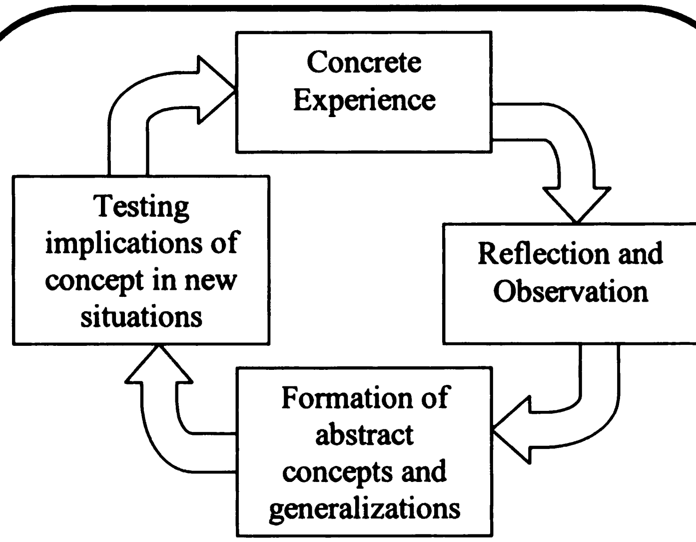


Figure 2: Kolb's Learning Cycle

students' lives or from previous class activities. The reflections and observations are created by the students as they do the warm up questions each day, which often call upon them to think about their previous experiences. Lecture notes are used to help students develop the concepts and generalizations using scientific terminology, and are followed by a lab activity to test the concepts. This lab experience may then become the concrete experience for the next day's class, usually combined with more of the students' own experiences.

Let us look at Newton's First Law as an example. Almost all of my students have used the front brakes on a bicycle without using the back brakes. This is a concrete experience that can be used to understand Newton's First Law. Their warm up question asks them to talk about what happens in this situation, and we usually spend a few minutes on their experiences. Then, during the lecture notes, we state Newton's First Law—A body in motion tends to remain in motion and a body at rest tends to remain at rest unless acted upon by an outside force. We identify the bodies in this situation—the person and the bicycle—and determine that both are in motion. We identify the outside force on the bicycle—the brakes—and determine that the brakes do not apply force to the person. We then apply the law—The bicycle will stop because it is affected by an outside force, but the person will continue to move forward because there is no outside force on the person. We also identify the ground as an outside force that will eventually cause a person to stop. This is followed up by discussions of other situations, such as skateboarding and driving, and a discussion of the factors which affect inertia and forward motion, such as friction, mass, and velocity. This is reinforced by a lab called Crash Test Dummies, which involves rolling small cars down a ramp and crashing them into barriers, then measuring how far an object on the car rolls across the floor before stopping. By varying the height of the ramp, we can vary the speed of the collision. Students make a graph showing the relationship between speed and inertial travel. This experience then becomes part of our discussion the next day on Newton's Second Law, where we relate force experienced to speed on impact.

A further benefit of this system is that it involves transitioning between different activities of moderate length. While various sources place the attention span of a high school student at anywhere from ten to fifty minutes, twenty minutes is the most commonly suggested length of time that a student can be engaged in task. Generally speaking, longer engagement seems to come with activities that the student enjoys more, or which allow for interaction with others. Research in college lecture classes, which often share my seventy-five minute length, shows that the average student tends to lose focus on a lecture after fifteen to twenty minutes. Often the student lapses for a minute or two, then returns to attentiveness. This pattern repeats, with the attentive time gradually shortening throughout the class period. However, by changing the activity from passive listening to a more intense activity such as a discussion question or small-group brainstorming session, attentiveness can be restored. The authors suggest punctuating lecture classes with a series of these "change-ups" every fifteen minutes or so (Middendorf & Kalish 1996). The structure of my classroom follows a pattern similar to that recommended by the authors, breaking the time into an initial settling period with the warm up question and announcements, a discussion-centered question-and-answer time providing feedback on the quizzes, a lecture-format section of notes and demonstrations, a highly-active laboratory period of group work, and finally a short quiz period. Only the lab period last more than fifteen minutes. By breaking up the class into segments with different levels of interaction and different focuses, I should be able to keep the attention of students on the various tasks with fewer of the behavioral interruptions that result from long, uninterrupted periods of lecture.

In order to help the students keep their work organized, I developed a method of labeling all papers that they were given. Each assignment for Introduction to Physics has a box in the corner that identifies the topic and day, for example Energy 1. The quiz for that day has the same designation, as does the review section. The warm up question, lecture notes, and lab for each day were made into a single sheet, making it easier for students to keep track of their materials. The daily materials and reviews can be found in Appendix A, while the quizzes and tests are located in Appendix B.

Each student is required to get a one inch, three ring binder for science class alone. We will need three dividers for the binder; one for Daily Work, one for Daily Quizzes, and one for Reviews. When students enter the room, any materials they need to pick up will be in baskets right next to the door. All they have to do is put each item into the correct section, at the back of the section. At the same time, students can also pick up their quizzes from the previous day, which will save time handing them out. Any student who comes in late will be able to get their materials without my having to pause the class for them.

At the end of each day, I can assemble packets for the students who were absent. This is easily tracked, since I will have their quizzes from the day before sitting in the basket. These packets are placed in a stack of trays by the door, organized by hour. If absent students know to grab their work out of the tray when they enter the next day, it saves me the trouble of hunting for their work. If a student is absent for several days and parents request homework, I can take their packet from the tray to the office and everything will be there. Lecture notes and warm up questions can be obtained from any student who was in class the day before, while students who were absent for longer periods can get a print out of the Power Point for the unit, which contains both.

Student binders will be collected every two weeks and all daily work graded. From past experience, I know that by giving up five weekend days, I will be able to keep their grades up to date without drowning in paperwork. Students receive a check sheet a few days before binders are due so that they can make certain that all of their work was complete and in order. This gives students the freedom to plan their work around their schedule, and prevents students who need to make work up after an absence from feeling overwhelmed.

In addition, I am keeping both a student binder and a Master Binder for the class. My student binder is available to any student who needs to make work up or check their organization, while the Master Binder contains the master copies of all assignments, quizzes, tests, projects, and other materials. I also have a file drawer with all of the assignments that I gave so that, if someone loses a paper, I can quickly get another one for them. By setting all of this up in advance and starting the routine on the very first day, I hope to maintain a structured environment and good organizational habits for both my students and myself.

Emphasize the Essential Benchmarks

> *"To prepare Michigan's students with the knowledge and skills to succeed in the 21st Century, the State of Michigan has enacted a rigorous new set of statewide graduation requirements that are among the best in the nation.....The Michigan High School Science Content Expectations (Science HSCE) establish what every student is expected to know and be able to do by the end of high school and define the expectations for high school science credit in Earth Science, Biology, Physics, and Chemistry."*
>
> *—Michigan High School Science Content Standards and Expectations*

The State of Michigan created the High School Science Content Standards and Expectations (hereafter abbreviated Science HSCE) as part of a program to increase the graduation requirements of all high school students. The Science HSCE includes benchmarks for the four branches of science: Biology, Chemistry, Physics, and Earth Science. The Physics benchmarks are further divided into four categories: Prerequisite, Essential, Core, and Recommended. Prerequisite Benchmarks are just that, material that the teacher can assume the student mastered in a previous grade. Essential Benchmarks include material that will be tested on the ACT/MME test in the junior year, while Core Benchmarks include material that will not be tested on the standardized test, but which should be known by any student taking the class. Core Benchmarks will probably be assessed on the State's common exit exams for the classes, which are due to be released in a few years. Finally, Recommended Benchmarks include topics that are more advanced and would be covered in advanced or college-preparatory classes, but will not be assessed on the common exit exams. (Anderson et al. 2007)

As a department, we compared the Prerequisite Benchmarks to the State's Grade Level Content Expectations for grades 5-8. We discovered that the prerequisite knowledge we were told to expect is not actually required in grades 5-8, which explains why most of our students arrive without it. I make a point to include all of the prerequisite benchmarks in my planning, since I know that I cannot make the assumption the State does.

The Essential Benchmarks are the ones on the test these students will take next year. The Core Benchmarks are not. While "teaching to the test" is considered a terrible goal, the test is the measure that is used to judge the school. Taking into account the students, the time constraints, and the sheer number of benchmarks, I made the decision to focus on the Essential Benchmarks. While the Core Benchmarks were introduced whenever possible, the Essential Benchmarks occupied our time and received greater emphasis.

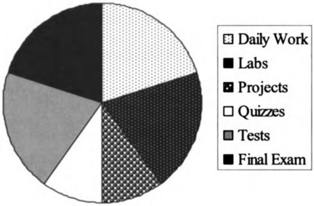
Grading System

Student achievement is judged primarily on grades, whether in the class or on a standardized test. The following is the grading system used in Introduction to Physics.

- Daily Work: The Daily Work category includes Thought Questions (warm up), Lecture Notes, Binder Organization, and Unit Reviews. Reviews were collected the day of the test, while the rest of the daily work was collected in the students' binders every two weeks. Daily Work was originally meant to be worth 10% of the overall grade but, owing to some changes made in the course of the term, they were increased to 20% of the overall grade.
- Labs: All labs were worth ten points each. Labs were collected in the students' binders every two weeks, although a certain amount of debriefing was conducted in class during and after each lab. Labs are 20% of the overall grade.
- Projects: Projects, which were long-term assignments and completed at home, were graded on a 100 point rubric. Originally, projects were meant to be worth 20% of the overall grade but, owing to changes which needed to be made in the course of the term, they were reduced to 10% of the overall grade.

- Assessments: Each daily quiz was worth five points, and quizzes as a whole were 10% of the overall grade. This meant that any single quiz would not have a significant impact on the student's grade. This was a conscious decision, made because quizzes are meant to be practice and to help students identify weaknesses. It would not be helpful if one bad quiz grade could drastically affect a student's final grade. Tests, on the other hand, were 20% of the overall grade and, with only four unit tests, a bad test score could significantly impact the student's final grade. The Final Exam was worth 20% of the overall grade, which is our science department standard.

Figure 3: Weighted Grades for Introduction to Physics



Under this grading system, 50% of the student's grade was based on assessments, while the other 50% was based on class work. 50% of the grade was also based on short term work—Daily Work, Labs, and Quizzes—while the other 50% was based on long term work—Projects, Tests, and the Final Exam.

CHAPTER 3: REFLECTIONS ON THE TERM

Class Reflections

I always start the term feeling nervous, but this was much worse than usual. Asking my students to take part in this thesis was somewhat confusing for them, mostly because they had never done anything like it before. Telling them that they would have a quiz almost every day of class didn't go down well. Telling them that they would also have a lab every day went down extremely well, though, because they equate labs with fun. They also liked the low homework idea, though several later said that they got just as much homework as any other class would, but got it earlier and had more time to finish. All in all, most of them thought the homework load was quite reasonable.

The class started off very well, and students quickly got the hang of the routine. The class was organized to take advantage of the weather, with outdoor activities planned for the beginning of the term and indoor activities planned for the end of the term. This order was altered in the last term in order to take advantage of the weather. Table 2 lists the units taught in order, along with the individual topics covered.

The greatest difficulty in teaching this class was the necessity of being there every day. Because the lecture notes and quiz results were on my personal computer, because every day involved lab equipment, and because the pace was intense, missing a day of class created greater difficulties than I had considered. This became apparent when I developed a severe ear infection in the final days of the Fall term, and again in the Spring term when a variety of problems surfaced and caused me to miss seven days. This style of teaching does not lend itself well to substitute teachers, and a solution for this problem will need to be developed because I intend to continue a number of the practices developed.

Table 2: Unit Structure and Topics of Instruction in Introduction to Physics	
Unit 1: Energy and Motion Energy Categories of Energy Energy Conversion and Conservation Nuclear Energy Thermal Energy Motion Distance vs. Displacement Speed and Velocity Acceleration Graphing Motion	Unit 3: Electricity and Magnetism Electricity Static Electricity Circuits Ohm's Law Electric Power and Energy Magnetism Source of Magnetism Electromagnetism Applications of Magnetism
Unit 2: Forces, Work, and Energy Basics of Force Balanced and Unbalanced Forces Contact and Non-Contact Forces Friction Newton's Laws of Motion Momentum Applications of Force Weight and Gravity Projectile Motion Circular Motion Work and Energy Work and Power Machines Mechanical Energy Periodic Motion	Unit 4: Waves Basics of Waves Wave Structure Wave Interactions Sound Production of Sound Doppler Effect How Hearing Works Light Parts of the Spectrum Reflection and Refraction Color How Vision Works

Modifications

It is said that no battle plan survives first contact with the enemy. Certainly no course outline, however thorough, survives the term unmodified. The changes that had to be made involved additions to the class, modification of the Waves unit, and changes in the pacing of the material.

The major addition to the class was the quiz results breakdown and the resulting quiz competition. This addition, which is described in greater detail in Chapter 4, provided greater feedback to the students than originally intended, allowed students to compare their results within the hour or with the classes as a whole, and provided students with the reward of seeing their names on the board for success. The two parties that were added as incentives were received eagerly, and the competition between three of the classes was intense. One class, which fell behind very quickly at the beginning, never took the competition as seriously as the rest.

The Waves unit had to be shortened due to time constraints. The calendar that I used in planning the class was published without the proper procedures, and was not the final calendar that governed the school year. This shortened the first term by several days. By the time I became aware of this, it was too late to do more than modify the final unit. The Waves Unit contained in the appendix is the complete unit that was planned, but it was not presented in this way. Instead, the lecture notes for several days were combined into one day of notes, and then several labs were combined into two days of lab work. This cut the unit from seven days to five, which allowed us to finish the material in time. The Wave project, Sounds of Music, was also cut owing to time constraints and illness.

On two occasions I changed the pacing of the class. The lab on thermal energy (Energy 3) ran longer than anticipated, so an extra day was added to the first unit. Later, the end of the second unit and beginning of the third, combined with weather-related difficulties involving the rocket project, lead me to give the students a "catch up day." I noted in my journal:

> "Because I am sick and because I have been working the students very hard during this chaotic week (don't we all wish we could control the weather?), I chose to give the students today to catch up on work and make sure their binders are perfect. They also used the time to start planning for their second project--both to decide what they wanted to build and to start deciding how they will get their materials."

I think this decision was a timely one, because I could see that the students were getting overwhelmed by the amount of work that all happened at the same time. They were preparing for their largest unit test, finishing the rocket project, starting the electricity project, and had two unusually large labs in the same week. By giving them an extra day to finish, I gave them a chance to complete their work properly instead of giving up and taking the poor grades, a path that they have taken many times in the past. While not all students used this time wisely, those that did more than justified the extra day.

Notes from the Journal

While I do not normally keep a journal of any type, it was recommended that we do so while teaching our thesis. My journal consisted of a series of emails to my roommate. Each day, after the last class was over, I sat down to answer the following questions:

- What did we do that day?

- What went well?
- What went poorly?
- What was surprising?
- List three good things that happened.
- List one bad thing that happened.
- Note any anecdotal material that might be useful.

My roommate would respond with questions and suggestions. Sometimes several messages would pass back and forth, other times it would be limited to my own entries. Looking back through the journal entries, certain themes that are not related to the Goals developed. These themes, some academic and others more behavioral in nature, were important to the success of the class, and are worth brief consideration.

Academically, the issues that appear most often in the journals deals with basic skills that my students lack, specifically the ability to do math, to learn and use vocabulary, and to follow directions. While I understand that some of my students have very poor math skills as the result of their learning disabilities, I am continually amazed and disheartened by the number of students who cannot multiply or divide without a calculator, cannot rearrange a simple formula algebraically, and cannot use fractions. The inability to use the metric system is a small but noticeable side problem.

Vocabulary, of course, is essential to science classes, which often sound as if they are taught in their own language. I have tried a number of different approaches as a teacher—writing the definitions, crossword puzzles, vocabulary quizzes, and flashcards to name a few. The results are the same regardless of the method—the students who are naturally good with language will pick up the vocabulary easily, and the rest tend to give up without more than a half-hearted attempt. This leads to problems on the tests, because a student who doesn't know what the words in the question mean is unlikely to be able to choose the correct answer. Because vocabulary was commonly tested on the quizzes, students learned that vocabulary was necessary and were marginally batter prepared for the tests.

The ability to follow directions, or rather the lack of ability, crops up a number of times throughout the journal. Some minor improvement appeared over the course of the term, but all in all my students reacted to directions as they might react to a foreign language—blank stares of incomprehension. Strangely, the method that had the greatest effect on their ability to follow directions was my refusal to repeat myself. If I made it clear that I was going over the instructions only once, they paid greater attention and were more likely to consult the written directions by themselves. When forced, the students were self-sufficient, but when the opportunity to be helpless was available, they displayed helplessness. I think this learned helplessness, which seems to go hand-in-hand with over-protective parents, is one of the reasons that some of these students were satisfied to be in an introductory class instead of taking the college-preparatory offerings.

Behavioral themes also appeared throughout the journal, and are more varied and more difficult to approach than the academic issues. Common among these were the roles of behavior and attitude in the classroom, the need for instant gratification on the part of the students, and the contrasting problems of competitiveness and the fear of failure.

Behavior means specific actions taken by the students, which included both the larger, outward displays of inappropriate behavior—one fight breaking out in class, numerous thefts, breaking equipment—and the smaller, more subtle bad behaviors—talking instead of listening, neglecting to do the work, bringing in cell phones and iPods. Attitude means the mental approach students brought to class, which often involved hating science or other students, the belief that they would fail no matter what, and the inability to see any purpose in taking a science class.

Obviously, there is no single right way to deal with these two issues. I note that behavior problems were usually the result of a few students, and these students received a lot of extra attention and phone calls home. I also note that behavior problems were more common on days when the lab did not take up the full forty-five minutes allotted to it. One of my ongoing struggles is to anticipate the pace and timing of activities—too much time leaves the students a chance to misbehave, while too little results in poor quality work, frustration, and some students giving up. The structure of the class did a great deal to alleviate the more common misbehaviors; students were better able to focus on the lecture notes and avoid chatting because they knew that the notes would be over in ten minutes and that they could talk as much as they wanted during the lab time. I wrote fewer disciplinary referrals during this class than I have in any other term in my nine years as a teacher.

As for attitude, student attitudes underwent a fundamental shift because this class was like nothing they had ever encountered before. Students who hated quizzes found them so useful that they were upset when Introduction to Chemistry didn't offer them.

Students who hated science class were sorry to leave. Parents reported at conferences that my class was the only one their child talked about at home. One parent even came back the following term to tell me just how much the class had meant to her daughter and how much it she appreciated all of the work I had done. Two of my most apathetic students, students who wrote on their survey the first day that they hated science class, informed me one day as we walked back in from a lab that, while they still hated science, they actually really liked my class and felt they had learned something. I think this shift happened because the class was designed to play to their strengths and because they had tangible feedback every step of the way.

Another common theme in my journals was the students' need for instant gratification. Knowing that the quiz results would be available the next day, they still wanted to know immediately whether they were right or wrong. Telling them when something would be done was not good enough, they needed it instantly. I think some of this comes from the society in which they are growing up—so many things are "on demand" or "instant." I think they have also learned the behavior from their parents, who occasionally send me emails demanding to know the grade on a test before I have even finished giving the test to all of the classes. Perhaps the worst example of this occurred when I was ill and went home early. I did not check their quizzes that evening, and the howls of outrage that greeted the announcement the next day were unexpectedly fierce. It was good to know that they were so interested in their quiz results, but I also set myself up for difficulties when I set such a high standard.

Knowing that my students, as kinesthetic learners, can be very competitive, I used competitive aspects in some labs, in reviews, and in the quiz competition. While I expected competition to make a difference for some of the students, I was surprised at their devotion to competition. In some cases, it had an adverse effect. There were two labs, for example, where the students were so focused on the competition that they neglected to complete the lab questions, thus hurting their grades more than the minimal prize, usually a bonus point or two on the lab, could help them.

Strangely at odds with the competitive spirit above was an incredible fear of being wrong. I conduct a lot of informal, show-of-hands surveys during class to see how people are thinking, and I can expect a third of my students not to participate. When I walk around glancing at answers to the warm up question each day, plenty of students would leave them blank. When challenged on it, the common answer was that, since they didn't know the answer, they would wait until after I talked about it, then write down the right answer. When I pointed out that a question that begins "What comes to mind…" can't really have a wrong answer, they would just shrug and wait. More perplexing, students would leave test questions blank and, when asked why, would reply that they didn't know and so didn't try. These students preferred to be marked wrong for not answering, than to make an attempt at a question and possibly be marked wrong for being wrong. I am at a loss for how to work through this common but extraordinarily frustrating problem. How do you teach students that it is okay to make mistakes, and that trying is always better than failing without making the attempt? One of my colleagues, who encounters this problem daily in his special education classes, finds that using miniature whiteboards helps his kids. It seems that they are afraid to make a mistake in writing on a sheet of paper, but will happily make mistakes on the whiteboards. Are they afraid of the permanence of paper, but feel comfortable with the whiteboards because they mistakes can be erased, leaving no trace? When we co-teach the Physics Concepts class in 2010, it will be interesting to see if the white boards give my students the freedom to make mistakes.

The issues that come to light in the journals should not come as a surprise to any teacher; they were certainly not a surprise to me. Rather, the journal provides the opportunity to see these issues as they related to the goals of this thesis and to the individual activities that make up the project.

CHAPTER 4: RESULTS AND CONCLUSIONS

Overall Student Achievement

Of the eighty-eight students who completed the class, seventy-seven passed, which means they achieved a score of 60% or higher in the class. That is a pass rate of 87.5%. Using the 4.0 grading system, the average at the end of the Fall term 1.65. Of the eleven who failed, four dropped out of school in the following term. Five of the remaining seven were placed back in Introduction to Physics during the Spring term, resulting in four more passing grades; the fifth, who failed, is planning to drop out after turning sixteen, as is another of the students who was not rescheduled. The last student is planning to take the two-term Physics Concepts class in the future. Taking these events into consideration, the pass rate can be recalculated as eighty-one passing students out of eighty-four remaining in school, or 96.4%. Using the 4.0 grading system, the average at the end of the school year was 1.78.

This compares favorably with previous classes. Table 3 compares the data from Physical Science: Physics classes taught in the 2005 and 2006 school years with the Introduction to Physics classes taught in the Fall of 2007, a significant improvement can be seen in the pass rate.

Table 3: Comparison of Student Achievement						
	Physical Science: Physics 2004-2006		Introduction to Physics Fall Term 2007		Introduction to Physics taking into account with repeating students and drops	
Grades	Students	Percentage receiving grade	Students	Percentage receiving grade	Students	Percentage receiving grade
A	1	0.6%	0	0.0%	0	0.0%
A-	2	1.2%	2	2.3%	2	2.4%
B+	8	4.9%	2	2.3%	2	2.4%
B	10	6.2%	8	9.1%	8	9.5%
B-	10	6.2%	11	12.5%	11	13.1%
C+	15	9.3%	6	6.8%	6	7.1%
C	13	8.0%	10	11.4%	10	11.9%
C-	17	10.5%	9	10.2%	9	10.7%
D+	26	16.0%	10	11.4%	12	14.3%
D	5	3.1%	9	10.2%	10	11.9%
D-	17	10.5%	10	11.4%	11	13.1%
E	38	23.5%	11	12.5%	3	3.6%
Total Students	162	100.0%	88	100.0%	84	100.0%
Passing	124	76.5%	77	87.5%	81	96.4%
Average GPA	1.72		1.65		1.78	

Goal 1: A Lab Every Day

The Fall term of the 2007-2008 school year was fifty-three days long. Five of these days were devoted to the Final Exam; two for reviewing and the other three containing the exam periods. The other forty-eight days were devoted to the class material. In those forty-eight days, my students performed thirty-five labs and two projects. These were performed on thirty-nine of the forty-eight regular days of term. The other nine were devoted to introducing the class (one day), reviewing for tests (four days), and unit tests (four days). Leaving aside the exam days, the students performed labs on 81% of the class days.

It is difficult to compare this to previous years, because those classes were run on the semester schedule. Looking at the grade books shows that previous Introduction to Physics classes included twenty-three labs conducted in a term lasting eighty-nine days, meaning that students performed labs on 26% of days. There is a 170% improvement in the number of labs that students performed in a term.

While the quizzes required a time commitment outside of class, the labs required a time commitment in class, careful planning, and resources. It was the most difficult part of the thesis.

Goal 2: A Quiz Every Day

During the last five minutes of every day that new material was presented, the students were also given a quiz. These quizzes were five questions long or less and leaned heavily to multiple choice or math problems. The quizzes were graded each night and returned the following day. When the quizzes were checked, data was collected concerning the number of right and wrong answers and the frequency with which the wrong answers were chosen. This data was organized into a Power Point presentation, which was discussed the following day. I originally wasn't planning to do a Power Point every single day, but the students enjoyed it so much that it became part of our routine.

During our discussion of the Power Point the next day, students had the opportunity to see how they compared to others in the class, to find out what the right answers were and make note of them, and to get hints and tips on getting things right the next time. It allowed me to identify places where re-teaching was necessary and to emphasize these points without slowing the pace greatly. As I had hoped, students also became more adept at identifying the types of questions that were likely to appear on each quiz, often calling out during class that "That's a quiz question," or "I bet that's on the quiz."

At the end of each set of Quiz results, I posted the class averages for each hour and the number of students who had a perfect score. I also posted the names of the people who received a perfect score. After about a week, we turned the quiz scores into a competition, complete with a sticker chart. The class with the highest average each day got three stickers, second place got two stickers, and third place received one sticker. In addition, the class with the most perfect scores received an extra sticker. The best class at the midterm mark received a pizza party. The next best class received a donut party on the day of the final exam.

Competition on these quizzes became central to the class. Every type of student, from quietest to loudest, from least to most motivated, worked to get their names on the list of perfect scores. There were high fives in every hour, one class tended to give the perfect scorers a round of applause, and students in first hour would pass the news on to students from later classes and congratulate them in the hallway. More importantly, the quizzes gave students a day-by-day look at their progress. In most cases, a student who received a poor score on a quiz would do better the next day simply because their attention had been drawn to their performance.

Students who were absent did not have the quiz counted against them. One of my problems with quizzes and tests has always been this: How do you provide timely feedback when there are students who haven't taken the quiz? Given the sheer number of quizzes the students took, I realized it didn't matter. With thirty-five quizzes worth a total of ten percent of the student's grade, any single quiz was worth less than one half of one percent of their grade. Any absent student received a copy of the quiz the next day so that they could make note of the correct answers, and their grade was entered as "No Count." Missing the quiz neither helped nor hurt their grade, and feedback could be given to the classes with worrying about who needed to make up a quiz or how that would be accomplished in our tight time schedule.

Goal 3: Minimizing Homework

Homework is not a priority for most of my students. I did not succeed in changing this. Students approached the two types of homework in different ways, and the overall results were mixed.

The first type of homework was the review packets, which involved three questions per day covering the most important information and a vocabulary review crossword puzzle. There were four unit review packets and the final exam review. Several students observed that, if you did the review, then the test was easy. On the other hand, there were students doing the review after the test on every test day.

How do we help students develop the attitude that homework is a necessary and helpful part of learning? First, by providing only useful and meaningful homework, which I attempted to do. Second, by making that homework immediately important to their life. This is much harder to do. Our math department has a policy of no work, no test; and gives students a zero until they bring the completed work and make up the test on their own time. This policy would directly interfere with the Binder policy, which is one of the most successful additions I have made to my classroom in my time as a teacher. This policy also makes it impossible to maintain accurate grades and demands a lot in terms of availability from the teacher.

The second type of homework I gave was the three projects. The projects were a new approach for me, and the results were mixed. While there were benefits to the projects, the drawbacks and difficulties involved were enough to make me remove them for the next term and to require serious reflection before using them again.

The three projects were tied to the last three units of the class. The first, Fly Me to the Moon, required students to make a two liter soda pop bottle into a rocket, which would be launched using air pressure. The students then used an altitude tracker and stop watch to gather data on their rocket and made a series of calculations about its performance. The second, the Eaton Rapids Electrical Doohickey Emporium, required students to make a battery-powered electrical device and prepare a pamphlet detailing how it worked, its electrical specifications, and offering a suggestion as to who would buy it and how to market it. A variety of sample plans were available to students, and they were also free to create their own designs. The last project, Sounds of Music, required students to make a simple musical instrument capable of playing three distinct notes and to perform a small informational lecture and concert for the teacher.

The projects allowed students to be creative and approach the problems in their own way. They provided a link between the information they were learning and the "real world" applications of that material. The projects involved hands-on work, which complimented the strengths of my kinesthetic learners, and included portions involving writing skills, math calculation, drawing, music, and group work. These benefits are the reason the projects were created.

However, the projects ran into a number of problems as well. Student apathy for the projects was similar to their apathy toward other assignments, but had the added drawback of having a significantly higher impact on their grades. Project days required a significant amount of time during the class, only to result in low participation. The projects were a scheduling nightmare, with the rockets requiring decent weather and the electrical doohickeys requiring me to become a miniature electronics store. The personal expense seemed a waste, especially after the students broke the rocket launcher twice. My illness at the end of the term made it impossible to do the musical project at all, because the students couldn't get the materials in time to complete the projects before final exams.

In the end, the value of the projects was reduced from 20% of the overall grade to 10%, with the other 10% added to the homework scores. Only two projects, the rockets and the doohickeys, were counted toward their grades. The students expressed ambivalence about the projects—they liked the idea of projects in theory, but liking the idea didn't translate into participation. I removed the projects from the final term in order to save the time.

Goal 4: Structure and Organization

I introduced student binders in my class two years ago. I was looking for a solution to several problems; students losing their work, students not turning in their completed work, and the feeling that I was drowning in paper work every day. Student binders, which are organized into sections based on the types of assignments, are submitted for checking every two weeks. By giving up one weekend day every two weeks, I am able to check the majority of the student work. Many of these assignments are effort-based in nature.

It is difficult for a student to lose work if they bring their binder to class each day, since every assignment goes right into the binder. We go through the organization as a class during the first week of school, so most binders are organized correctly. Because the binders are turned in every two weeks, it is easy for students to make up a lost assignment before the binder is turned in. If the binder is not turned in, it is rechecked the next time binders are collected, for full credit if absence was the reason it wasn't turned in, and for half credit if the student was present on the previous turn in date. Few students forget to turn in their binder more than once.

Further, students have the opportunity to make up any work for which they did not receive full credit. At the end of the term, they are provided with a list of assignments that were checked in the binder. They are allowed to make up any work which did not receive a perfect score and resubmit the work by indicating the made up assignments on the list. These assignments are rechecked and the students receive half of the made up points.

The drawback of binders is that students do not receive timely feedback on the material that is in the binders. For this reason, I make it a point to talk about the warm up questions with the class. I work with students as they do their labs, and in many cases we pool data for the class on the board and discuss it. This allows students to receive general feedback on their work during the period between binder checks.

Binders are a success, both by the numbers and through anecdotal evidence. Students are more likely to turn in their binders than to turn in individual assignments. Former students have mentioned that they make their own binders for classes that do not require binders because they like the simple but effective organization that binders provide.

CHAPTER 5: GOING FORWARD

Work in Progress

Like all classes, Introduction to Physics has always been and will always be a work in progress. In the coming year, it will expand to two terms, now called Physics Concepts, and will be expected to cover all of the Core and Essential Benchmarks as provided by the State of Michigan. This expansion will allow me to make some changes in the material, but I plan to incorporate much of the work from this thesis into the revision.

The expansion will allow the inclusion of larger, multi-day investigations and comprehensive lab reports. I have not decided whether or not to include projects in the new class. The rocket project, for instance, could not easily be done during the Winter term, which is where it will fall for half of the students who take Physics Concepts. As a department, we have considered using projects as a form of extra credit assignment, which may be the best way to make projects available without making them a required part of the grade.

The daily quizzes are definitely staying, though they will need to be expanded to cover the new material. The quiz experiment proved more successful than any other part of my thesis. In fact many of my students, on moving to Introduction to Chemistry, complained that there weren't enough quizzes and asked for more. When was the last time you heard students demand more quizzes? The hardest part of quizzes is the daily time commitment, but our school is exploring the use of Data Manager, which may be used with the quizzes in the future.

The daily worksheets and minimal lecturing will also be maintained in the future. This style was well-suited to the students taking the class and helped prevent me from lecturing all hour, which I could easily do. The reviews will need to be modified because some topics will expand to cover multiple days, but the core idea of a review focusing on the most important ideas and vocabulary will remain.

The organizational strategy of the binders will also remain, though some larger assignments such as lab reports will have defined due dates rather than being turned in with the binder. The binders have been a great success over the last few years, and word has come back to me through my colleagues as to how much the students like them. I am adding a calendar, to be updated weekly by the students, as part of the ongoing search for an end to "I didn't know we had a test today!"

APPENDICES

APPENDIX A:

CLASS MATERIALS

APPENDIX A
DAILY SHEET I

Introduction to Physics
First Day Sheet

Name: ______________________________ Hour: ________

Thought Question: ______________________________

____

Answer: ______________________________

____

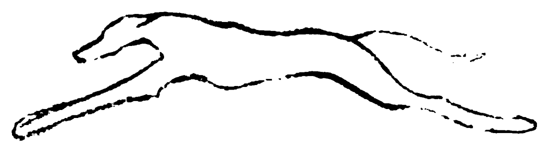
Items of Note:

- ⇨ Information Packet
    - ↳ Rules
    - ↳ Lab Safety Slip
    - ↳ Attendance
    - ↳ Assignments
    - ↳ Grades
    - ↳ Calendar
    - ↳ Signatures
- ⇨ Master's Thesis

Questions?

APPENDIX A
DAILY SHEET II

Student/Parent Information Packet
Introduction to Physics



Ms.Coppins

Eaton Rapids High School

Welcome. This packet contains a variety of information pertaining to this class. It is recommended that parents and students review it thoroughly together. <u>The signature page of the packet needs to be returned with signatures.</u>

✓ **Introduction**

Introduction to Physics is a one term, twelve week course in basic physics concepts. This course emphasizes a hands-on, lab-based approach. Topics include Mechanical Physics, with emphasis on motion, forces, and work; Electromagnetics, with emphasis on electrical circuits, static electricity, and magnetism; and Waves, with emphasis on light, sound, and technological applications.

Students in the class of 2010 are required to take one term of Physics to graduate. Students in the class of 2011 or later may take 2 terms of Physics or Chemistry in order to meet the new State of Michigan graduation requirements.

✓ **Rules and Expectations**

1. Students are expected to show up each day on time and prepared. That means being in the room when the bell rings, having all materials (paper, binder, writing utensil, homework) with you, and being prepared to learn.

2. Students are expected to behave in a mature and responsible fashion, to show respect for each other, the teacher, and classroom guests, and to solve disagreements in a reasonable manner.

3. Students are expected to put forth their best effort, to accept that they will sometimes make mistakes, and to ask for help when necessary. Students are here because they need to learn, not because they already know everything. While students will work cooperatively at times, they are expected to do their own work, not copy the work of others (which will result in a grade of 0 for all participants).

4. Students will abide by the laboratory safety agreement, which must be signed by parents and students before any lab work may begin. Failure to do so can result in loss of grade, disciplinary action, or loss of class credit.

APPENDIX A
DAILY SHEET II

5. Because this is a science classroom, food and drinks are not permitted in the room. Water and gum are acceptable provided that all trash ends up in the proper receptacles. Some labs require that all such items remain out of the room, as there is a risk of contamination.

6. Electronic devices such as MP3 players, iPods, CD players, handheld video games, Palm Pilots, pagers, and cell phones are not permitted in class. Do not bring them to class. They will be confiscated and turned over to the Administration for further action.

7. Students are expected to abide by the policies in the Student Code of Conduct.

✓ **Laboratory Safety Agreement**

All students are expected to comply with the safety guidelines at all times while working in the laboratory.

1. The laboratory is to be used for serious work only. Fooling around in the lab will not be permitted or tolerated. Perform only authorized and approved experiments.

2. Study your lab assignment BEFORE you come to the lab. Read through the entire procedure before you begin an experiment. Examine equipment for damage or malfunction before beginning.

3. Know the location and use of the following lab safety equipment: Fire blanket, fire extinguisher, eye wash, and first aid kit. Report accidents, injuries, or incorrect procedures to the teacher at once.

4. Keep work are and equipment clean and neat.

5. Safety goggles and aprons must be worn when instructed to do so. Long hair should be tied back. Long sleeves should be rolled up. Open-toed shoes should not be worn. Avoid dangling jewelry.

6. If a chemical comes in contact with your eyes, flush with water immediately for fifteen (15) minutes. If you spill any chemical on yourself, wash it off immediately with large amounts of COLD water.

7. If clothing catches fire, DO NOT RUN. Walk to a fire extinguisher or blanket while calling for help.

8. Never taste or touch any chemical with bare skin. Never directly smell any chemical—use wafting technique.

APPENDIX A
DAILY SHEET II

9. Never eat or drink anything in the lab unless instructed to do so. Do not bring food or drink into the lab.

10. Use caution when working with hot plates or other heating devices. Hot glassware looks just like cold glassware. When heating glassware, keep the mouth of the container pointed away from other students. Keep combustible materials away from all heat sources. Never reach over a heat source.

11. Exercise caution when working with electrical equipment. Keep liquids away from connections.

12. Handle chemicals carefully. Check all labels before removing contents. Follow specific directions for disposing of waste. Do not mix chemicals unless instructed to do so by the lab.

13. Place broken glass and solids in designated waste containers. Never put solid waste in the sink.

14. Always wash your hands thoroughly with soap and water at the completion of each lab.

✓ **Attendance Policy**

Under the trimester system, students spend fewer days in any given class, but more time in each class per day. That means missing a day under the trimester system costs students a greater percentage of their class time. It is vitally important that students attend class every day and take an active role in finding out what they missed on days that they are excused absent. It should be noted that unexcused absences may result in loss of credit for class work for that day.

Absences
Under Eaton Rapids High School policy, missing more than 7 days of any class results in a grade of FA--failed due to attendance. Students who exceed 7 absences have the following options:

- Make up a day in Saturday School (once per term).
- Achieve a grade of C+ or better on the final exam in order to have the grade calculated. (If you have more than 13 absences, this is not an option)
- Retake the class.
- Long-term absences due to serious medical conditions (hospitalization, mono, etc.) may be waived with proper notice from your doctor. Vacations cannot be waived.

APPENDIX A
DAILY SHEET II

Tardiness
Tardiness is inappropriate in schools and unprofessional in the workplace. In addition to other corrective measures, such as after school detention or suspension, accumulated tardies become absences, which in turn count toward a grade of FA. The third tardy becomes an absence, as does the fifth, eighth, tenth, etc.

- ✓ **Types of Assignments**

Binder Checks
Each student is expected to have a 3 ring binder with at least 3 dividers by the end of the first week. Binders are a required organizational tool for the class and will be collected every two weeks. Binder Check grades will include Thought Questions, Lecture Notes, Reviews, and Labs, as well as organization.

Thought Questions
Each day, students will enter class to find a question on the board. These daily warm ups, or "Thought Questions," are meant to get the student's brain focused on the topic at hand. Thought Questions are graded on effort, not on correctness of the answer. If a student is absent, he or she is expected to make up the missed TQ.

Lecture Notes
Each topic covered in class will include lecture notes. Students will be provided with a blank outline to fill as the class goes through the topic, and students are encouraged to make additional notes for themselves.

Review Packets
This class does not have nightly homework. Review work, organized into sections by lesson, will be handed out in packets by topic. It is up to the student to complete the review packet. Students are encouraged to work at their own pace. There will be time in class at the end of each section for questions.

Labs
Because hands-on activities increase understanding, this class will include a lab every day. Students will work alone or in groups depending on the activity. All group members are responsible for recording data and answering lab questions. Most labs will not be handed in directly, but instead will be part of the Binder Check.

Projects
Three projects will be completed by the students outside of class. Projects will require students to construct a small and inexpensive device, which will then be tested or demonstrated in class. Students will have a minimum of ten days to complete each project.

APPENDIX A
DAILY SHEET II

Quizzes and Tests

In order to gauge student understanding, students will take quizzes on a daily basis. These short quizzes will cover the topic discussed that day in class and will be returned the following day. If a student is excused absent, they will receive a copy of the quiz after they make up the work they have missed, and the quiz grade will be waived. If the absence is not excused, then the student will receive a 0 on the quiz.

There will be four larger tests during the term. Tests cover several weeks of work and occur at the end of units. A missed test must be made up within one week, unless other arrangements are made. **There are no retakes.**

Final Exam

The final exam is a comprehensive objective test covering all information for the whole term. Missing the final exam is a serious matter and must be dealt with immediately. The final exam is common to all Introduction to Physics classes at Eaton Rapids High School. The final exam also includes an optional review for extra credit.

✓ **Calculation of Grades**

Grades will be posted to the online viewer as they are available, with full updates every two weeks (as binders are entered). Binder Check Sheets list complete details of what is checked and grades received, while the online viewer reports a score summary. If you do not have access to the online viewer, please feel free to contact the school for printed copies of the grades. Student grades will be broken down as follows:

- 10% Daily work (Though Questions, Lecture Notes, and Reviews; collected in the binder)
- 20% Daily lab activities (collected in the binder)
- 10% Daily quizzes
- 20% Projects (3; collected separately)
- 20% Unit Tests (4)
- 20% Final Exam

✓ **Contact Information**

Main office phone number: (517) 663-2231
Classroom phone number: (517) 663-6252
Email address: kcoppins@erpsk12.org (preferred)

Please use the classroom number only after 1:30, or you will interrupt a class. If you call during class (7:30am-1:30pm), please contact the main office and leave a message.

APPENDIX A
DAILY SHEET II

✓ **Course Outline**

The following is a tentative course outline for the term and may be adjusted based on how students are working. Project due dates, tests, and binder checks are noted in **bold type**.

Week of	Monday	Tuesday	Wednesday	Thursday	Friday
Sept. 3	NO SCHOOL	Introduction	Energy	Energy	Energy **Binder Check 1**
Sept. 10	Energy	Motion	Motion	Motion	Motion
Sept. 17	Motion	Review Day Intro Project #1	**Test 1**: Energy and Motion	Forces	Forces **Binder Check 2**
Sept. 24	Forces	Forces	Forces	Forces	Forces
Oct. 1	Forces	Forces	Forces	Forces	Work **Binder Check 3**
Oct. 8	Work	Work	Work Conferences	Review Day Conferences	NO SCHOOL
Oct. 15	**Project #1 due**	**Test 2**: Forces and Work	Intro Project #2 E&M	E&M	E&M **Binder Check 4**
Oct. 22	E&M	E&M	E&M	E&M	E&M
Oct. 29	Review Day **Project #2 due**	**Test 3**: Electricity and Magnetism	Intro Project #3 Waves	Waves	Waves **Binder Check 5**
Nov. 5	Waves	Waves	Waves	Review Day	**Test 4:** Waves
Nov. 12	**Project #3 due**	Exam Review	**Final Exams Binder Check 6**		
Nov. 19	NO SCHOOL	NO SCHOOL	NO SCHOOL	Thanksgiving	NO SCHOOL

APPENDIX A
DAILY SHEET II

Student Name (print): ____

Signature Sheet

This sheet must be detached from the packet and returned with all signatures completed. Please initial next to each point and sign at the bottom.

	Parent Initials	Student Initials
1. We have received the information packet and reviewed its contents.		
2. We have read and understand the Rules and Expectations for this class. We understand that failure to comply with the rules will result in disciplinary action		
3. We have read and understand the lab safety agreement. We understand that failure to comply with the lab safety rules will result in removal from the lab and loss of credit for the assignment. We understand that persistent violations of these rules will result in suspension from all lab activities and may result in a loss of credit.		
4. We have read the attendance policy and understand the importance of consistent attendance to class.		
5. We have read the grading criteria and understand how grades will be calculated.		
6. We have received the contact information for Ms. Coppins.		
7. We have reviewed the course outline.		

Student Signature: ________________________________ Date: ______________
Parent Signature: _________________________________ Date: ______________
How do you prefer to be contacted? Work phone Home phone Email
Work Phone: __________________ Home Phone: __________________
Email: ________________________ Preferred Time: ____________________
Do you have access to the Internet? Yes No

Online Grade Viewer:

Please contact the school if you do not have access to the online parent viewer. The school can provide you with your identification, password, and directions on how to use it. If you do not have internet access and wish to know your child's grades, please contact the teacher for a paper copy.

APPENDIX A
DAILY SHEET III

Name: ________________________

INTRODUCTION TO PHYSICS BEGINNING STUDENT SURVEY

Please answer all of the following questions honestly while thinking about your experiences in school

Always = 100% of the time
Often = 75% of the time
Sometimes = 50% of the time
Seldom = 25% of the time
Never = 0% of the time

1. I enjoy learning about science.

   5-always 4-often 3-sometimes 2-seldom 1-never

2. I am more interested in science when it involves real world applications.

   5-always 4-often 3-sometimes 2-seldom 1-never

3. Labs help me learn about the topics we study in science.

   5-always 4-often 3-sometimes 2-seldom 1-never

4. I understand how labs relate to the material in the notes.

   5-always 4-often 3-sometimes 2-seldom 1-never

5. Answering lab questions helps me think about the concepts.

   5-always 4-often 3-sometimes 2-seldom 1-never

6. I am more involved in work when I use my own ideas or design my own experiments.

   5-always 4-often 3-sometimes 2-seldom 1-never

7. Projects are a good way to learn about science.

   5-always 4-often 3-sometimes 2-seldom 1-never

8. I ask questions when I don't understand something.

   5-always 4-often 3-sometimes 2-seldom 1-never

APPENDIX A
DAILY SHEET III

9. I do my homework.

5-always 4-often 3-sometimes 2-seldom 1-never

10. I put my best effort into my homework.

5-always 4-often 3-sometimes 2-seldom 1-never

11. I keep track of when assignments are due.

5-always 4-often 3-sometimes 2-seldom 1-never

12. I am good at staying organized.

5-always 4-often 3-sometimes 2-seldom 1-never

13. I do review work when it is assigned.

5-always 4-often 3-sometimes 2-seldom 1-never

14. I study for quizzes and tests.

5-always 4-often 3-sometimes 2-seldom 1-never

15. I am good at taking tests.

5-always 4-often 3-sometimes 2-seldom 1-never

16. I consider getting good grades to be important.

5-always 4-often 3-sometimes 2-seldom 1-never

17. I like to know my grade at all times.

5-always 4-often 3-sometimes 2-seldom 1-never

18. My grade in my last science class was ____________.

19. In this class, I expect to earn a _____________.

20. Of the units we will study, I am most interested in learning about

Energy Motion Forces Electromagnetism Waves

APPENDIX A
DAILY SHEET IV

Introduction to Physics
Energy 1

Thought Question: ____
____
Answer: ____
____

Lecture Notes
What is Energy?
Definition 1: ____
Definition 2: ____
Scientists divide energy into ___ categories
Mechanical Energy
Defined as ____
Examples: ____
Thermal Energy
Defined as ____
Examples: ____
Chemical Energy
Defined as ____
Examples: ____
Electromagnetic Energy
Defined as ____
Examples: ____
Nuclear Energy
Defined as ____
Examples: ____
What about PE and KE?
_________________________ (PE) is a term that refers to energy that is _________________. Any type of energy can be potential.
_____________________ (KE) is a term that refers to energy that is _________________. Any type of energy can be kinetic.

APPENDIX A
DAILY SHEET IV

Activity: Energy Classification Partners: ________________________
Set # _____ ________________________

Goal: Categorize different types of energy, using personal categories and scientific categories.

Directions:

1. Before the lecture notes, group the cards into categories of your own choosing.
2. After the lecture notes, rearrange the cards according to the scientific categories.
3. Answer the questions below.

Questions:

1. How did you first categorize the types of energy and why did you choose those categories?
2. How are the scientific categories similar to yours? How are they different?
3. Where did you classify each card under the scientific system?
4. Give an example of a card that you think could belong in more than one category and explain your reasoning

APPENDIX A
DAILY SHEET V

Introduction to Physics
Energy 2

Thought Question: ____

____

Answer: ____

____

Lecture Notes

What is energy conversion?

Energy conversion means ____________________________________

____

For Example: ____

Energy is often converted into more than one form. Example: _______________

____

Sometimes several conversions are required. Example: ____________________

____

Where does Earth's energy come from?

The vast majority of energy on Earth comes from _____________

Where does Earth's energy go?

Energy on Earth is eventually converted to _______________________
and escapes into space.

Law of Conservation of Energy

1. ____
2. ____
3. ____

Which means ____

____

APPENDIX A
DAILY SHEET V

Activity: Conversion Trails Partners: ________________________

Set # _____ ________________________________

Goal: Track the transformation of energy through different paths

Directions: Use the cards provided to trace the path of energy from one form to another. Write your final path in the space provided, and note the different waste energies along the way. There may be more than one correct path, so do not be surprised if different groups find different answers.

Questions:

1. Determine the path that your body uses to turn food energy into movement.

2. Determine the source of the energy released in a thunder storm.

3. Determine two different paths of energy that could produce light. No card can be used in both paths.

4. Compare using solar power for electricity to using coal power for electricity. How are they similar and how are they different?

5. Create the longest path that you can. Why don't we use these types of paths?

6. What do the waste products made by these conversions have in common?

7. What general statement can be made about the ultimate source of all energy in these conversions?

APPENDIX A
DAILY SHEET VI

Introduction to Physics
Energy 3

Thought Question: ____
____
Answer: ____
____

Lecture Notes

What is nuclear energy?

Nuclear energy is the energy stored in the _______________ of an atom.
Nuclear energy is released when the nucleus ___________________.

Three types of nuclear reactions

______________________: Two atoms collide and join to form a new, larger atom. This occurs in ______________, and is very high-energy.

______________________: An atom's nucleus is hit by a fast moving particle and the atom breaks into two or more smaller pieces. This occurs in ____________________________.

___________________________: Parts of the nucleus break down, releasing particles and/or energy. This occurs __________________ _______________ and is used for ______________________.

How much energy do you get?

When a nuclear reaction occurs, mass is lost and energy is released.
The amount of energy released can be determined using ____________, where c = __________________________.

APPENDIX A

DAILY SHEET VI

Activity: Nuke-a-Student No partners—Class Demonstration

Goal: Examine the maximum amount of nuclear energy available in an object and discuss the reasons why it is impossible to actually obtain this much energy using a nuclear reactor.

Directions: Follow along in class to determine the amount of nuclear energy in your body.

1. Your weight in pounds: ________________ / 2.2 = __________________ kg
(your mass)
2. $E=mc^2$
Energy = _______________kg * 300,000,000 m/s * 300,000,000 m/s
(your mass)
Energy = ____ Joules
(your energy)
3. How much is this?

One 60W light bulb requires 216,000 Joules of energy to run for 1 hour:

__________________________ / 216,000 = ________________________ hours
(your energy)

One house requires ~ 1,800,000,000 Joules of energy per month:

__________________________ / 1,800,000,000 / 12 = _______________ years
(your energy)

The State of Michigan requires ~ 3,600,00,000,000,000,000 Joules of electricity per year:

__________________________ / 3,600,00,000,000,000,= ____________ years
(your energy)

4. So why aren't we doing this? Why our imaginary reactor won't work.

____

____

5. Make a list of the pros and cons of using nuclear energy. Circle the side you support.

Benefits	Drawbacks

APPENDIX A

DAILY SHEET VII

Introduction to Physics
Energy 4

Thought Question: ____

____

Answer: ____

____

Lecture Notes

What is thermal energy?

Thermal energy is a measure of the movement of ____________________ _________________________.

The coldest theoretical temperature (____________________) is the temperature at which all particles stop moving.

Thermal energy moves from __________ to __________ level of energy.

There are three ways thermal energy can move:

________________: Two objects are touching and collisions between their molecules transfer thermal energy from the hot object to the cold object.

________________: Faster molecules spread out and reduce the overall density of a fluid (liquid or gas). This causes ____________ fluid to rise and __________ fluid to fall, creating currents.

________________: Thermal energy is emitted from all objects (regardless of temperature) as ________________. This energy is absorbed by ______ colored objects and reflected by ___________ colored objects.

APPENDIX A
DAILY SHEET VII

Activity: It's All in the Mix Partners: ________________________
Set # ______ ________________________

Goal: Determine a formula that calculates the final temperature when samples of water at two different temperatures are mixed.

Directions:
1. Take the temperature of each sample of water and record them below.
2. Using the graduated cylinders, measure 50mL of cold water and 50mL of hot water. Pour both into the beaker.
3. Take the temperature of the mixed samples and record it on the data table.
4. Continue mixing different amounts of hot and cold water and recording your answers. You may use any amount you like, but the total should always be 100mL when they are mixed.
5. Based on your data, develop a formula that will let you predict the final temperature of any two water samples when they are mixed.
6. Clean up your materials. Leave a hot water sample ready for the next class.

Hot Water Temperature: ________ ^{o}C Cold Water Temperature: ________ ^{o}C

Volume (mL) of Hot Water	Volume (mL) of Cold Water	Final Volume (mL)	Final Temperature (^{o}C)
50mL	50mL	100mL	

My Formula:

APPENDIX A
DAILY SHEET VIII

Introduction to Physics
Energy 5

Thought Question: ____

____

Answer: ____

____

Lecture Notes: None. Instead, complete the survey below.
Activity: Finish It's All in the Mix (Energy 4 Lab)
Survey: Circle the number which best describes your ability. (1 = lowest, 5 = highest)

I know what energy is.	1	2	3	4	5
I can identify and categorize forms of energy.	1	2	3	4	5
I know the difference between PE and KE.	1	2	3	4	5
I can track energy through conversions.	1	2	3	4	5
I can explain the Law of Conservation of Energy.	1	2	3	4	5
I know the different types of nuclear reactions.	1	2	3	4	5
I can explain how thermal energy is transferred.	1	2	3	4	5
I will pass the test on energy.	1	2	3	4	5

APPENDIX A
DAILY SHEET IX

Introduction to Physics
Motion 1

Thought Question: ____
____
Answer: ____
____

Lecture Notes
What is Motion?
Defined as a change in __________ relative to a _____________________.
Divided into four categories:
______________________: In a straight line
______________________: In a curve
__________________: In a circle or ellipse
__________________: In a repeating pattern
What is a Frame of Reference?
____
Common frames of reference include:
_______________: Used for most experiments
_______________: Used by NASA for launches
__________________: Used by your brain
How do we measure motion?
__________________: Total length traveled
____________________: Length, in a straight line, from start to current position. ("As the crow flies")
Speed, velocity, and acceleration (more on these later)

Activity: Distance vs. Displacement Partners: _________________________
Course # ______ _________________________

Goal: Understand the relationship between distance and displacement.

Directions:
1. One person will stand at point A holding the tape measure handle, and will be responsible for measuring displacement. Another person will stand nearby and record data.
2. The last person will walk the course, pulling the loose end of the tape measure with them.
3. Starting at point A, walk from flag to flag in alphabetical order. The flags are 1 m apart. At each flag, record the total distance traveled (number of flags) and the displacement (tape measure) of the walker.

APPENDIX A

DAILY SHEET IX

4. Graph your data (line graph) on the grid provide, using one color for distance and one color for displacement. Plot the flags on the X-axis and meters on the Y-axis. Answer the question.

Data Table

Flag	A	B	C	D	E	F	G	H	I	J
Distance (meters)										
Displacement (meters)										

Flag	K	L	M	N	O	P	Q	R	S	T
Distance (meters)										
Displacement (meters)										

Graph:

Key

Distance: ☐

Displacement: ☐

Question:

Compare and contrast distance and displacement.

APPENDIX A
DAILY SHEET X

Introduction to Physics
Motion 2

Thought Question: ____

____

Answer: ____

____

Lecture Notes
What is Speed?
Defined as: ____
Formula: ______________________________
Units: ______________________________
To determine speed, measure ______________ and ________, then divide.
Two ways to measure speed:
____________________: Indicates that the moving object is always going the same speed (Earth spinning, cruise control)
____________________: Indicates that the speed of the moving object changes and gives an overall value.

Activity: Matchbox Challenge   Partners: ________________________
Station # ______   ________________________

Goal: Determine which matchbox car is the fastest down a one loop track.

Directions:
1. Measure the length of a matchbox track, including loop. Record on Data Table
2. Select a car. Time it down the track and record its time in the Data Table.
3. Repeat step 2 with all 12 cars.
4. Calculate the speed of each car.
5. Enter your data in the class sheet. Use the class averages to determine speed rank.

Data Table

Car	Car Type	Distance Traveled (meters)	Time (seconds)	Speed (m/s)	Speed Rank
A					
B					
C					
D					
E					
F					
G					

APPENDIX A

DAILY SHEET X

H					
I					
J					
K					
L					

Questions

1. Was your fastest car the same as the fastest overall? ____________________

2. Why did we test each car multiple times to determine the fastest car?

   ____
   ____
   ____

3. Identify three reasons why a car could go different speeds on different tracks.
   A. ____
   B. ____
   C. ____

4. Were we calculating a constant speed or an average speed? How do you know?

   ____
   ____
   ____

APPENDIX A

DAILY SHEET XI

Introduction to Physics
Motion 3

Thought Question: ____
____

Answer: ____
____

Lecture Notes

Speed is plotted on a _________________ graph

_________________ is on the X axis

_________________ is on the Y axis

Always use a __________ graph!

What does the graph tell you?

Slope: ____

Flat line: ____

Slope downward: ___________________________

Constant speed: ____________________________

Changing speed: ____________________________

To calculate speed at any point: __________________

Activity: Graphical Analysis of Silly Walks Group #: __________

Partners: ____

Goal: Make and analyze a distance-time graph of different walking speeds.

Directions:

1. Choose five different types of movement from the list (or invent your own).
2. Measure out a distance of 100 meters and mark it at twenty meter intervals. Have five group members stand at the 20, 40, 60, 80, and 100 meter marks with stopwatches, while one member (the walker) stands at the starting line.
3. When the walker waves, ALL timers start their watches. The walker will move down the track, using a different type of motion in each section. As the walker reaches each of the timers, they will stop their watches.
4. Record all times for the walker. Repeat measurements with at least three group members, using the same movement types.
5. Make a distance-time graph showing all of the data (use a different color for each person). Then answer the questions that follow.

<u>Optional Movement Types</u>

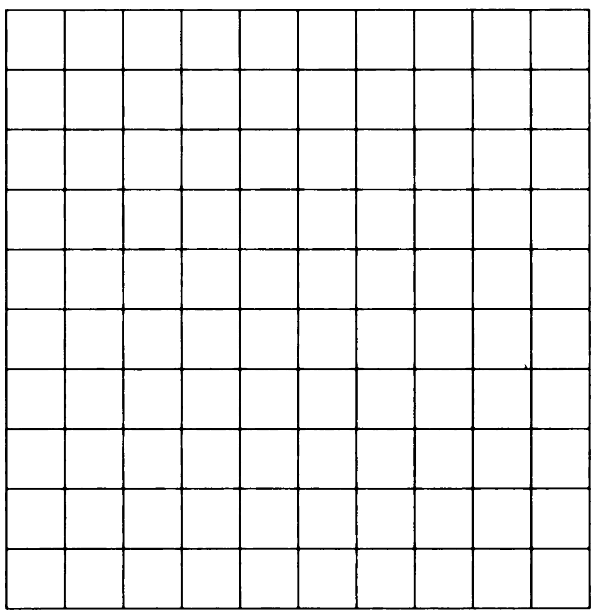
walk	crawl	sprint	gallop
hop	walk backward	baby steps	crab walk
twirl	high step	march	runway model
Godzilla stomp	skip	dance	

APPENDIX A
DAILY SHEET XI

Data Table

Type of movement:					
Walker Name	Time at 20 m	Time at 40m	Time at 60m	Time at 80m	Time at 100m

Graph Title:



Questions

1. Who was fastest overall? ______________________
   How do you know? ____
2. Which movement type was slowest? __________________
   How do you know? ____
3. Do these graphs show movement at a constant speed or a variable speed? _________
   How do you know? ____

APPENDIX A
DAILY SHEET XII

Introduction to Physics
Motion 4

Thought Question: ____
____

Answer: ____
____

Lecture Notes

What is velocity?

Defined as ____

Velocity is a __________, so is more useful to physicists than speed.

Velocity is used to calculate _________________, __________________,

and _______________.

Graphing Notes

Velocity is graphed the same way as speed.

Because velocity includes direction, it is often necessary to use

________________________ to indicate what is occurring.

APPENDIX A
DAILY SHEET XII

Activity: Treasure Hunt Partner: ____________________________
Clue Set # __________

Goal: Find the buried treasure by making a map based on velocity clues.

Directions:
The infamous Captain Charlie is the scourge of the Sea of Knowledge, and has taken many a bountiful prize. He has hidden his latest haul in a cave on an island in the Wonnet Archipelago. Since most of his crewmen are not good navigators, he wrote down the location using compass headings and velocities. You managed to steal the directions (you *are* a pirate, after all) and make your escape. Use the clues to make a map to find the hidden treasure.

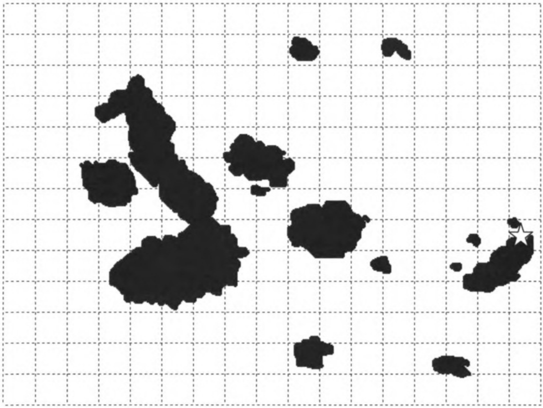
YOU MUST TURN IN YOUR MAP AT THE END OF THE HOUR TO RECEIVE CREDIT. YOUR SCORE (AND TREASURE) WILL BE BASED ON THE ACCURACY OF YOUR MAP.

Begin with your ship at Port Graham, which is marked on the map with a star.
1. Set your heading to due North (0°). Sail this heading at a speed of 50 kmh for 12 hours.
2. Sail straight to the setting sun at a heading of 270° and proceed at a speed of 100 kmh for 14 hours.
3. Bear to port with a velocity of 35 kmh, heading 200°, for 10 hours.
4. Adjust to a south-southeasterly heading of 157° and sail at 60 kmh for the next 12 hours.
5. Trim sail and adjust to east-north-east heading of 66° at speed 50 kmh for 11 hours.
6. Once past the point, adjust to course 328° and hold steady at 37 kmh for 10 hours.
7. Hard a-starboard to head into the light of dawn—heading 90° at 35kmh, for this is a tricky place. Have ye patience enough to hold this course for twenty hours?
8. Now set yourself 13° west of the Southern Cross and full sail to 80kmh for 5 hours.
9. Adjust speed to 64kmh for 5 hours, heading 249° and you will see the bonny shores that hold my treasure safe.

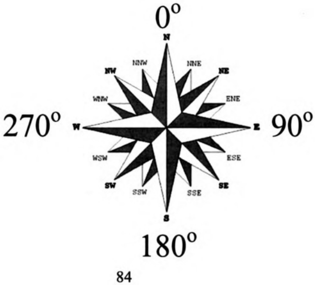
APPENDIX A
DAILY SHEET XII

Names: ______________________________ Hour: ______

____



Scale 1 cm = 100 km (This map is no longer correctly scaled)



APPENDIX A
DAILY SHEET XIII

Introduction to Physics
Motion 5

Thought Question: ____
____
Answer: ____
____

Lecture Notes
What is Acceleration?
Defined as ____
You can accelerate by:
____
____
____
Formula: ____________________________
Units: _________________________
Graphing Acceleration
Distance-time graphs
Shows a ______________ shape
Velocity-time graphs
Shows a smooth slope
Area under the slope = __________________

APPENDIX A

DAILY SHEET XIII

Activity: Marble Shoot Partners: ____________________________

Station # ________

Goal: Graph acceleration of marble; determine velocity at various points.

Directions:

1. Place the marble at the starting point at the top of the track.
2. Release marble and time to first mark. Repeat for a total of five times and take an average.
3. Repeat step two with all marks on track.
4. Use average times to calculate velocity at each point, then use velocity at first and last point to calculate acceleration.
5. Make a distance-time graph and a velocity-time graph of your data. Use these graphs to answer the questions that follow.

Mark	Distance	Time 1	Time 2	Time 3	Time 4	Time 5	Ave. Time	Velocity
1								
2								
3								
4								
Acceleration from mark 1 to mark 4:								

Graph: Distance-time **Graph: Velocity-time**

Questions:

1. Did the marble accelerate? ________ How do you know? ____________________

____

2. Calculate the area under the velocity-time graph and compare it to the distance traveled.

____

____

(Area = 0.5 x height x length)

APPENDIX A

DAILY SHEET XIV

Introduction to Physics
Forces 1

Thought Question: ______________
____
____
____
____

Answer: (draw a picture)

Lecture Notes

What is a force?

Defined as ________________________________

Forces are drawn using force diagrams.

Arrow length shows ______________________

Arrow point shows ______________________

Types of forces

______________________ are physical, with two objects touching.

Examples:____

__________________________ can occur over a distance, without the objects touching.

Examples:____

Forces on an object are either _________________ or _________________.

Balanced forces are _________________ and _____________________.

When forces are balanced, motion _________________.

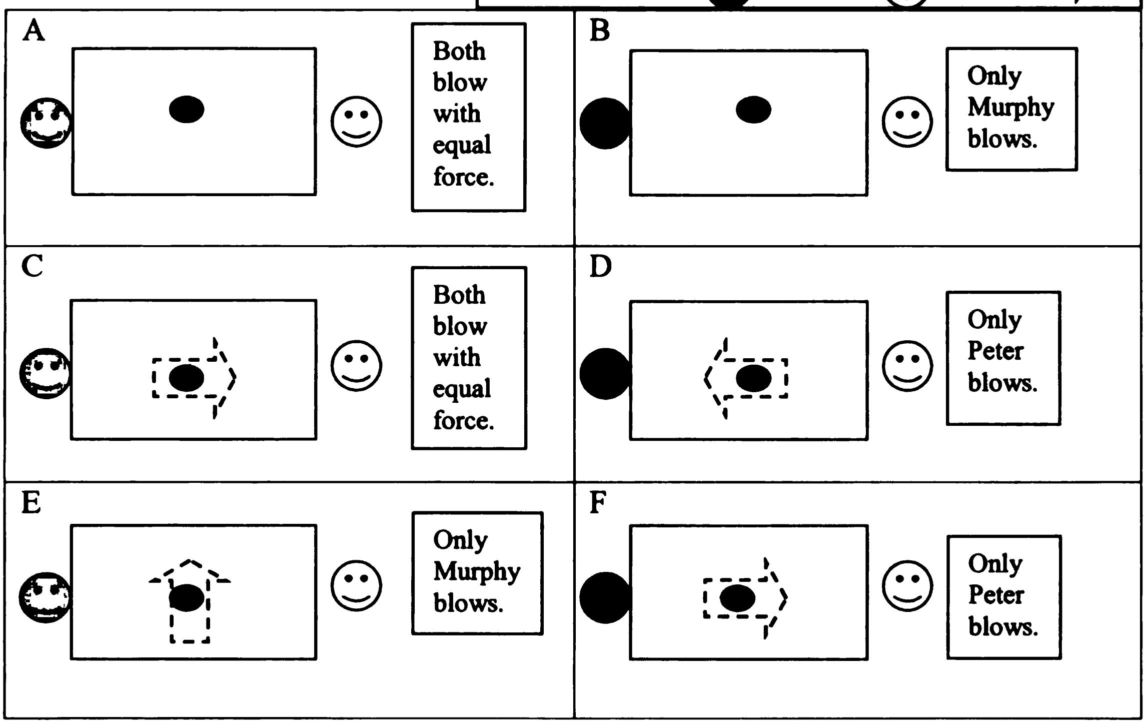
Unbalanced forces are _________________ or _________________ or both.

When forces are unbalanced, motion ________________.

APPENDIX A
DAILY SHEET XIV

Activity: Puffball Players: ______________________________
Station # ______ ______________________________

Goal: Analyze the forces involved in a game of Puffball
Directions:
1. Play Puffball for 5-10 minutes to get a feel for the game.
2. Draw arrows on the pictures below showing the direction the ball will go, based on the information provided.
3. Answer the questions that follow.



Questions:
In which situation(s) do we see...
1. Balanced forces? _______________ Unbalanced forces? _______________
2. The ball remaining at rest? _____ Why? ___________________________________
3. The resting ball starts moving? _____ Why? ___________________________________
4. The moving ball speed up? _____ Why? ___________________________________
5. The moving ball slow down? _____ Why? ___________________________________
6. The moving ball change direction? _____ Why? ___________________________________
7. The ball's motion does not change? _____ Why? ___________________________________
8. The ball's motion changes? _____ Why? ___________________________________

APPENDIX A
DAILY SHEET XV

Introduction to Physics
Forces 2

Thought Question: ____
____
Answer: ____
____

Lecture Notes
What is friction?
Defined as ____
Types of friction
____________________: Friction between any two solid objects that are touching. Examples: ______________________________
____________________: Friction that occurs when a solid object rolls across another. Examples: ______________________________
____________________: Friction involving movement through a liquid or a gas. This is also called ____________. Examples: ______________
____
________________ friction occurs between stationary objects, while ________________ friction occurs between moving objects.
In general, static friction is ____________________ kinetic friction.
In general, sliding friction is ____________________ rolling or fluid friction.
What factors affect the amount of friction?
______________ affects how surfaces interact.
____________________ change sliding friction to fluid friction.
Examples: ___________________________
_______________ increases the contact force between an object and the floor.

Activity: Does Surface Area Matter? Partners: ____________________
Set # ______ ____________________________

Goal: Determine whether or not surface area affects the amount of sliding friction an object experiences as it is dragged across a surface.

Directions: Using the equipment you have received, develop a test to determine if the amount of friction an object experiences varies with surface area. Write down your procedure, create a data table and graph for your data, and provide a written conclusion that cites data.

APPENDIX A
DAILY SHEET XVI

Introduction to Physics
Forces 3

Thought Question: ____
____
Answer: ____
____

Lecture Notes
Newton's First Law: ____
____
____

Termed ____________________: Resistance to change
The greater the ___________, the greater the inertia.
Examples: ____

Activity: Crash Test Dummies Partner: ________________ Set # _____

Goal: Analyze the relationship between velocity and inertia.

Directions:
1. Make a crash test dummy out of modeling clay and place it in a blue physics car.
2. Raise a ramp at a height of 10cm from the floor. Place a book at the end to stop the car.
3. Place the car on the ramp and release it. Measure how far the dummy's head travels after the collision. Repeat for a total of three trials and take an average.
4. Increase the height of the ramp as shown in the data table and run new trials.
5. Graph your results and answer the questions that follow.

Data Table

Height	Trial 1	Trial 2	Trial 3	Average Distance Traveled (cm)
10 cm				
20 cm				
30 cm				
40 cm				

APPENDIX A
DAILY SHEET XVI

Graph

Question: What is the relationship between velocity and inertia? Use data from the activity to support your answer.

APPENDIX A
DAILY SHEET XVII

Introduction to Physics
Forces 4

Thought Question: ____

____

Answer: ____

____

Lecture Notes
Newton's Second Law: ______________________________________

____

____

Formula: __________________
Increasing ______________, __________________, or
__________________ increases force.
Increasing ____________ decreases force.
Examples: ____

Activity: F = ma Partners: ______________________________
Set # ______ ____

Goal: Determine the amount of force needed to accelerate a human on a scooter board.
Directions:
1. Use a meter stick to measure 15 meters of distance. Mark both ends with chalk.
2. Place the scooter and rider at the starting line. Place a person with a stopwatch at the finish line.
3. Have a group member push the scooter and rider from start to finish. Time the scooter for this distance. Record the data on the data table.
4. Repeat for a total of three tries. Determine the force used to move the scooter.

Data Table

Trial	Distance (m)	Time (sec)	Accelerati on (m/s/s)	Weight of rider (lbs)	Mass of Rider (kg)	Force (N)
1						
2						
3						

Questions:
1. On average, how much force did it take to move the scooter and rider? ____________
2. If we increased the acceleration, what would happen to the force? ______________
3. If we increased the mass of the rider, what would happen to the force? ____________
4. What other factors are affecting the motion of the scooter?

____

____

APPENDIX A
DAILY SHEET XVIII

Introduction to Physics
Forces 5

Thought Question: ____

____

Answer: ____

____

Lecture Notes
Newton's Third Law: ____

____

Which means ____

____

Examples:

____

____

____

Activity: Balloon Car Races Best Distance: ________________
Goal: Build the car that will travel the furthest on the power of a single balloon.
Directions:

1. Using the materials provided, build a vehicle that is powered by an inflated balloon.
2. Vehicles will be raced on a straight course on the floor.
3. Winners will be determined by forward progress.
4. Extra balloons will not be provided.

Questions

1. Draw a force diagram showing all of the forces acting on the car while it is in motion.

2. How did you design your car to get the maximum possible distance?

____

____

3. Use Newton's Third Law to explain how your car moves.

____

____

4. Explain what would happen to the distance the car travels in each of the following situations and use your knowledge of forces to explain why it would change.
   a. The car is loaded with rocks before the race. ________________

   ____

   b. The race is run on carpet instead of on carpet instead of tile. ____________

   ____

   c. The balloon is twice as large. ______________________________

   ____

APPENDIX A
DAILY SHEET XIX

Introduction to Physics
Forces 6

Thought Question: ____
____
Answer: ____
____

Lecture Notes

What is Momentum?

Defined as ____

Formula: ____

If ________________________________ is large, then momentum will also be large.

The Law of Conservation of Momentum

____
____
____

Momentum can be __________________ from one object to another, but the energy in those moving objects cannot be ______________.

Examples: ____

Activity: Exploring Momentum   Partners: ______________________
Set # _____   ______________________

Goal: Explore momentum through a series of different collisions.

Directions:

1. To use the air pucks, inflate a balloon and place it over the neck of the puck. Weight can be added by placing washers around the neck of the puck. Twisting the balloon a few times will allow you to hold the air until you are ready to release the puck.
2. Set up the following situations and explore what happens…
3. Please wipe all air pucks with the cleaner provided and dispose of all balloons after completing the lab.

Situation	Results
Moving puck collides with stationary puck; same mass	
Moving puck collides with stationary puck; moving puck is heavier	
Moving puck collides with stationary puck; stationary puck is heavier	
Two moving pucks collide; same mass and speed	

APPENDIX A
DAILY SHEET XIX

Two moving pucks collide; one is heavier, speed is the same	
Two moving pucks collide; one is faster, mass is the same	
Two moving pucks collide; one has more mass and more speed	
Two moving pucks collide; one has more mass, the other has more speed	
Create a situation where the pucks collide and stop moving.	

Questions:

1. What effect does increasing mass have on momentum? ________________________

   ____

2. What effect does increasing speed (velocity) have on momentum? ________________

   ____

3. How is a collision between moving objects different from a collision involving one stationary object?

   ____

APPENDIX A
DAILY SHEET XX

Introduction to Physics
Forces 7

Thought Question: ____

____

Answer: ____

____

Lecture Notes

What is gravity?

Defined as ____

Newton and the Apple

Why did the apple fall? ______________________________________

____

Why did the apple fall toward Earth and not toward the tree? ___________

____

Why did the apple fall toward Earth and not toward the Sun? ___________

____

____

Newton's Law of Universal Gravitation

Increased mass (m) = ________________ force

Increased distance (r) = ________________ force

G = ____________________________________

What is weight?

Defined as ____

Formula: ____________________________________

If ____________________ increases, weight increases. If gravity is 0, then you are weightless.

How are weight and mass different?

Mass is a measure of ___________________________. It doesn't change.

Weight is a measure of ________________. It changes when gravity (acceleration) changes.

Activity: Weight-ing Around the Solar System

Goal: Determine your weight in pounds and in Newtons on different planets.

Directions:

1. Record your mass in slugs. To determine your weight in pounds on different planets, use the formula: **Weight = mass x Number of Gs**
2. Determine your mass in kilograms using the formula: **Mass in kilograms = mass in pounds ÷ 2.2**
3. Determine Your weight in Newtons on different planets using this formula:

   Weight (Newtons) = mass(kg) x gravity

APPENDIX A
DAILY SHEET XX

Questions:

1. What is the metric unit for weight? ___________________
2. Why is your mass in slugs the same as your weight in pounds here on Earth?

3. The pull of gravity on your body helped it to develop strong bones and muscles. How would your body be different if you had grown up on Jupiter? What if you grew up on the Moon?

	Mass (slugs):		Mass (kg):	
Planet	Number of Gs	Weight in pounds	Acceleration Due to Gravity	Weight in Newtons
Mercury	0.38		3.74 m/s/s	
Venus	0.9		8.82 m/s/s	
Earth	1		9.8 m/s/s	
The Moon	0.167		1.63 m/s/s	
Mars	0.4		3.92 m/s/s	
Jupiter	2.4		23.1 m/s/s	
Saturn	1.2		11.76 m/s/s	
Uranus	0.93		9.114 m/s/s	
Neptune	1.2		11.76 m/s/s	
Pluto	0.083		0.81 m/s/s	

APPENDIX A

DAILY SHEET XXI

Introduction to Physics
Forces 8

Thought Question: ____

____

Answer: ____

____

Lecture Notes

What is terminal velocity?

Defined as ____

____

This type of motion is called ________________

While gravity accelerates all objects at the same rate, regardless of _______, we must also take into account any forces against gravity.

Examples: ______________________________

Formula:

Where m = ___________ g = _______________

A = ___________ C_d = ______________

ρ = ______________________

Activity: Plastic Paratrooper Partners: ______________________

Best Time: ______________ ______________________________

Goal: Make a parachute that will slow the fall of a toy soldier.

Directions:

Using the materials provided, construct a parachute that will slow the fall of a toy soldier. We want the soldier to fall as slowly as possible. When you are finished, answer the questions below.

Questions:

1. Draw a picture of your parachute in the space provided.
2. Why did you make your parachute look the way it did?

3. Calculate the drag of your parachute

$C_d = 2mgt^2 / pAd^2$

m = mass = ________ g = gravity = 9.8 m/s/s t =time = ______________

p = fluid density = 1.204 kg/m^3 A = Area of parachute = ____________

d = distance = ____________

4. The atmosphere of Mars is about 1/3 as dense as the atmosphere on Earth. How would that change how the parachute works?
5. What effect does a parachute have on the terminal velocity of any object?

APPENDIX A
DAILY SHEET XXII

Introduction to Physics
Forces 9

Thought Question: ____

____

Answer: ____

____

Lecture Notes

What is a projectile?

Defined as ______________________________________

Examples: ______________________________________

What controls the path of a projectile?

________________: Forward motion

________________: Downward motion

________________: Shape of path

Forward motion is ______________ of downward motion.

We already know that gravity accelerates all objects at the same rate.
This is true even if the object is moving forward.
We call this ____________________.

Activity: Meteor Impact Partners: ____________________

Station # ______ ____________________

Goal: To determine the point of impact for a meteor approaching Earth.

Directions:

1. Using the stopwatch and meter stick, determine the speed of the ball bearing as it crosses the table.
2. Determine the distance the ball bearing will fall.
3. Determine the amount of time the ball bearing will take to fall.
4. Determine the distance the ball bearing will travel forward while falling.
5. When you have determined the point of impact, call the teacher over. The teacher will place a target on the floor at the location specified. Your grade will depend on how closely you have predicted the impact point.

Hints:

Mark your ramp release point. Multiple measurements and averaging tend to give better results than a single measurement. The target will sit a specified distance off of the ground. Friction can be neglected due to the materials involved. Please show your calculations.

Questions:

1. This experiment involves 2-dimensional motion. What are the two dimensions involved?
2. If gravity were increased, how would we have to move the target? Explain
3. If velocity were increased, how would we have to move the target? Explain.

APPENDIX A
DAILY SHEET XXIII

Introduction to Physics
Forces 10

Thought Question: ____

____

Answer: ____

____

Lecture Notes

Orbital motion is a special case of ________________

In orbit, the __________ of the satellite is balanced by ___________.

For Earth, a satellite must move at ___________ in order to balance the pull of gravity.

If _______ increases or ________ decreases, then the satellite will crash.

If ______ increases or ________ decreases, the satellite will escape and fly away.

The Moon is currently __________ Earth, & the Earth is currently ______________ the Sun.

______________ is the general term for motion where an object moves around a central point (or points).

The object accelerates ______________. This is called____________________.

Inertia causes the object to behave as though it is trying to move toward ___________________.

Example: ________________________

Activity: Orbital Motion Partners: _________________________

Set # _____ _________________________

Goal: Determine the relationship between gravity and inertia in orbital motion.

Directions:

1. Assemble the apparatus as demonstrated and attach 1kg mass to the bottom loop.
2. Using the tube as a handle, swing the ball. Observe what happens to the position of the weight as you increase and decrease speed. Record your observations.
3. Swing the ball so that the height of the mass remains constant. Using the stop watch, time the ball for 10 revolutions.
4. Determine the radius of the orbit (distance from ball to tube) using the colored marks on the string, which are placed every 10cm. Record the radius on the data table.
5. Increase the mass to 1.5kg. Repeat steps 3-4.
6. Decrease the mass to 0.5kg. Repeat steps 3-4.
7. Make a graph comparing Force of gravity (X axis) to Orbital Speed (Y axis)

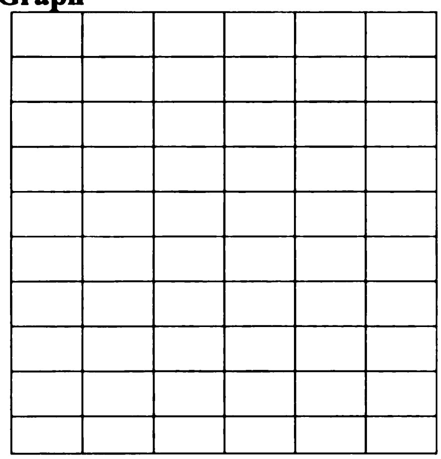
APPENDIX A
DAILY SHEET XXIII

Data

What happens when speed is increased?		What happens when speed is decreased?	
Mass	Time for 10 revolutions	Radius of orbit	Orbital Speed
1.0 kg			
1.5 kg			
0.5 kg			

Orbital Speed = $2\pi r / 10t$

Graph



Questions:

1. What does each part of the apparatus represent?
   Ball: ________________
   Tube/hand: ____________
   Mass: _________________
2. What will happen to each of the following satellites?
   Launched at speed 7,000 m/s ___________
   Launched at speed 8,000 m/s ___________
   Launched at speed 9,000 m/s ___________

APPENDIX A

DAILY SHEET XXIV

Introduction to Physics
Work 1

Thought Question: ____

____

Answer: ____

____

Lecture Notes

Work

Defined as ____

Formula: ________________________

In order to do work, you must:

1. ______________________ 2. ______________________

3. ____

Work ***does not*** involve _______. It doesn't matter if it takes 10 minutes or 10 years to slide a box across the floor, it will still take the same amount of work.

Work is measured in ________________ or in ____________________

Power

Defined as ______________________________________

Formula: ________________________

1. The ______ work you do, the more power you have.
2. The ______ time you take, the more power you have.

Power is measured in ___________ or in ________________. Large amounts of power are measured in ____________.

Horsepower

Compares ____

Was used when the horse was the most common source of power available. 1 hp = 745.56 watts

Activity: Personal Power Lab

Goal: Determine the work done and power used by the body when climbing.

Directions:

1. Record mass in pounds for each person. Convert to kilograms using **mass(kg) = mass(lbs) ÷ 2.2**
2. Convert mass in kilograms to weight in Newtons by multiplying by 9.8.
   This is the force which must be exerted to climb the stairs.
3. Use a meter stick to determine the height of a flight of stairs. Record the answer on the chart.
4. Measure and record the amount of time it takes each person to walk up the stairs.
5. Measure and record the amount of time it takes each person to run up the stairs.
6. Use **Work = Force x distance** to calculate the amount of work done walking and running.

APPENDIX A

DAILY SHEET XXIV

7. Use **Power = Work ÷ time** to calculate the power needed to walk up and run up the stairs.

Trip	Person	Mass (lbs)	Mass (kg)	Wgt. (N)	Time (s)	Dist. (m)	Work (J)	Power (W)
Walking								
Running								

Questions:

1. What was the difference in **Work** from walking to running? If there was no difference, why?

2. What was the difference in **Power** from walking to running? Why was there a difference?

3. Who did the most Work in the group? Why?

4. Who has the highest Power rating in the group? Why?

5. Could a very slow person have a lot of Power? Why or why not?

6. Could a very fast person have very little Power? Why or why not?

APPENDIX A

DAILY SHEET XXV

Introduction to Physics
Work 2

Thought Question: ____
____

Answer: ____
____

Lecture Notes

What is a machine?

Defined as ____

That means machines change the _______ and the ___________ needed to do work on an object.

By increasing __________, machines decrease the ______ you need.

Simple Machines

________________--move an object gradually up or down, but require more travel distance.

__________--transfer force applied on a wide area to a narrow edge, increasing the applied force.

__________--use less force by moving a longer distance in a compact spiral.

__________--allow the use of less force by exerting it at a longer distance.

________________--Force needed to turn small axle is transferred to a larger wheel, which covers more distance.

__________--decrease force needed to lift an object by increasing the distance through which the force is applied.

Compound Machines

Made up of __________ simple machines

Examples: ____________________________________

Efficiency and Advantage

Efficiency is a measure of how well the machine uses your ____________.

Mechanical advantage is a measure of how much easier the ______ is.

All machines lose energy to __________, which converts mechanical energy into ________________.

Activity: Finding Leverage		Partners: _____________________

Set # _____		_____________________________

Goal: Examine the relationship between force and distance using a lever.

Directions:

1. Using a pencil and a ruler, make a see-saw type of lever. The ruler should be balanced near the 15 cm mark.

2. Place 4 pennies on the ruler at the 30 cm mark. This is your Test Stack. Determine the total work being done by these pennies using the formula **Work = Force x Distance**. **Remember, the **distance** you are using is the distance from the pencil to the stack of pennies and the **Force** is the number of pennies.**

APPENDIX A
DAILY SHEET XXV

3. Using the other 11 pennies, find 8 different ways to balance the lever. You may use a single stack or multiple stacks. For each solution, record the position(s) and number of pennies used and determine the total Work being done.
4. If you have time, repeat using a test stack of 5 pennies at the 25cm mark.

Data Table 1

<table>
<tr><th colspan="3">Test Stack</th><th colspan="3">Balance Stacks</th></tr>
<tr><th># of Pennies</th><th>Position (cm)</th><th>Work</th><th># of Pennies</th><th>Position</th><th>Work</th></tr>
<tr><td rowspan="6">4</td><td rowspan="6">15cm</td><td rowspan="6"></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

Data Table 2 (optional)

<table>
<tr><th colspan="3">Test Stack</th><th colspan="3">Balance Stacks</th></tr>
<tr><th># of Pennies</th><th>Position (cm)</th><th>Work</th><th># of Pennies</th><th>Position</th><th>Work</th></tr>
<tr><td rowspan="8">5</td><td rowspan="8">10cm</td><td rowspan="8"></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

Questions

1. If we increase the force on the lever, what happens to the distance needed to make the lever balance?____

____

2. If we increase the distance from the pencil, what happens to the force needed to make the lever balance? ____

____

3. A car weighing 2000 Newtons is 1 meter from the fulcrum (pivot point) of a lever. If I can exert a force of 400 Newtons, where do I have to grab the lever to lift the car? (show your work)
4. How does a lever make it easier for a person to do work? ____________________

____

____

APPENDIX A

DAILY SHEET XXVI

Introduction to Physics
Work 3

Thought Question: ____

____

Answer: ____

____

Lecture Notes

Mechanical Energy

Defined as ____

Is used to do ______ (apply forces to objects to make them move)

Potential Energy

Mechanical Energy can be ________ by placing the object in a certain position. Ex: ____

Formula: ____

Kinetic Energy

An object in motion has _____________ Ex. ______________________________

Formula: ____

_________ is the most important factor in determining kinetic energy.

Mechanical Energy Conversion & Conservation

The total amount of mechanical energy in a situation is __________.

As PE ___________, KE __________.For this reason, the energy of a falling object can be calculated at any point as long as you know __________, ______, ___________, and ______.

Activity: It's All Down Hill Partners: ___________________________

Set # _______ ___________________________

Goal: Determine the GPE and KE of a car heading down hill.

Directions:

1. Set up the track as directed.
2. Measure the height and length of the track and the mass of the car. Record this data below.
3. Time the car down the track. Repeat for 5 total tries and determine the average time.
4. Determine the velocity of the car on the track.
5. Determine the Gravitational Potential Energy (GPE) of the car at the top and bottom.
6. Determine the Kinetic Energy (KE) of the car at the top and bottom of the track.

APPENDIX A
DAILY SHEET XXVI

Data and Calculations

Values	Top of Ramp	Bottom of Ramp	Formulas
Mass of car			---
Gravity	9.8 m/s/s	9.8 m/s/s	---
Height			---
GPE			mass x gravity x height
Length of track			---
Average time	---		add all times & divide by 5
Velocity of car	0 m/s		distance / ave. time
KE			½ x mass x velocity^2
Total Energy			GPE + KE

Questions

1. Circle the words that best complete the statement:
At the top of the ramp, GPE is (highest / zero) and KE is (highest / zero). As the car moves down the ramp, GPE (increases / decreases) and KE (increases / decreases). At the bottom of the ramp, GPE is (highest / zero) and KE is (highest / zero).
2. How does the GPE at the top of the track compare to the KE at the bottom of the track?____
3. What could account for any difference in the total amount of energy at the top and bottom of the ramp? (i.e. What else could be using the energy?)

____

APPENDIX A
DAILY SHEET XXVII

Introduction to Physics
Work 4

Thought Question: ____
____
Answer: ____
____

Lecture Notes
What is periodic motion?
Defined as ____
____
Examples: ____
What controls periodic motion?
The interaction between __________ and __________ controls periodic motion.
_________________ pulls the object down.
_________________ carries the object past the resting position, causing it to _____________________.
The object ___________________ between positions as energy is _________________, _________________, and _________________ again.
The object eventually stops as energy is lost to _________________.
Periodic motion can be thought of as constantly changing between ______________________ and _____________________

Activity: Swing Time   Partners: ______________________
Set # _____   ______________________
Goal: Investigate the effects of different variables on the motion of a pendulum.

Swing period = time / # of swings

Directions:
Part A: Effect of Mass
1. Set up the smaller pendulum on the ring stand at a length of 50cm.
2. Pull the plumb bob along its arc to 10 degrees and gently release it.
3. Count the complete swings in 30 seconds. Repeat 2 more times and take an average.
4. Repeat steps 1-3 with the large pendulum.

Pendulum	Angle	Trial 1	Trial 2	Trial 3	Ave. # of Swings	Swing period
Small	10°					
Large	10°					

APPENDIX A
DAILY SHEET XXVII

Part B: Effect of Angle

1. Set up the larger pendulum on the ring stand at length 50 cm.
2. Pull the plumb bob along its arc to 5 degrees and gently release it.
3. Count the complete swings in 30 seconds. Repeat 2 more times and take an average.
4. Repeat steps 1-3 at angles of 15 degrees and 25 degrees.

Pendulum	Angle	Trial 1	Trial 2	Trial 3	Ave. # of Swings	Swing period
Large	5^{o}					
Large	15^{o}					
Large	25^{o}					

Part C: Effect of Length

1. Set up the large pendulum on the ring stand at a length of 20cm.
2. Pull the plumb bob along its arc to 10 degrees and gently release it.
3. Count the complete swings in 30 seconds. Repeat 2 more times and take an average.
4. Repeat steps 1-3 using lengths of 30cm, 40cm, and 50cm.

Pendulum	Length	Trial 1	Trial 2	Trial 3	Ave. # of Swings	Swing period
Large	20 cm					
Large	30 cm					
Large	40 cm					
Large	50 cm					

Question: Which factor(s) affect the swing period of the pendulum? How do you know?

APPENDIX A
DAILY SHEET XXVIII

Introduction to Physics
Work 5

Thought Question: ____

____

Answer: ____

____

Lecture Notes: None. Instead, complete the survey below.

Survey: Circle the number which best describes your ability.
(1 = lowest, 5 = highest)

I know what forces are.	1	2	3	4	5
I can identify the forces acting on an object.	1	2	3	4	5
I know how gravity affects the motion of objects.	1	2	3	4	5
I can distinguish between 1-dimensional, 2-dimensional, circular, and periodic motion.	1	2	3	4	5
I can calculate work and power.	1	2	3	4	5
I understand the purpose of machines.	1	2	3	4	5
I know the relationship between work and energy.	1	2	3	4	5
I will pass the test on Force and Work.	1	2	3	4	5

Introduction to Physics
Force and Work Unit Test

Thought Question: ____

____

Answer: ____

____

APPENDIX A
DAILY SHEET XXIX

Introduction to Physics
E&M 1

Thought Question: ____
____
Answer: ____
____

Lecture Notes
What is electricity made of?
All matter is made of ____________________.
____________________ have a ____________________ charge
____________________ have a ____________________ charge
Electricity is the result of ____________________ between charges and movement of ____________________ charges (____________________).
THE RULE OF INTERACTIONS
____
____
What is Static Electricity?
If electric charge builds up in one location and does not move freely, it is called ______________________________.
There are three ways to build a static charge.
Charging by friction
When two objects rub against each other, it is possible that ____________________ will move from one to the other.

Activity: Investigation of Charging by Friction
Set # ______ Partner: __________________________
Goal: Determine the combinations that will give you the greatest and the least amount of static charge using the charge-by-friction method.
Directions: Using the materials provided, determine the cloth and rod combination that picks up the most paper dots and the cloth and rod combination that picks up the fewest paper dots (yes, ties are possible). Attach a separate sheet of paper describing your test procedure (remember, a good investigation controls variables) and provide a data table showing the different combinations you try and their results.
Questions:
1. Why do you think the best combination(s) was the best? ________________________
____
____
____
2. Why do you think the worst combination(s) was the worst? ____________________
____
____
____

APPENDIX A
DAILY SHEET XXIX

Data Tables

		Objects Tested				
		Aluminum	Wood	Steel	Cardboard	Plexiglas
Materials (used for Friction)	Polyester					
	Cotton					
	Fleece					
	Fur					
	Flannel					
	Silk					
	Paper					
	Aluminum Foil					
	Nylon					
	Poly-ethylene					

		Objects Tested				
		Polyethylene	Plastic	Rubber	PVC	Styrofoam
Materials (used for Friction)	Polyester					
	Cotton					
	Fleece					
	Fur					
	Flannel					
	Silk					
	Paper					
	Aluminum Foil					
	Nylon					
	Poly-ethylene					

APPENDIX A

DAILY SHEET XXX

Introduction to Physics
E&M 2

Thought Question: ____

____

Answer: ____

____

Lecture Notes

There are three ways to build a static charge.

Charging by friction (discussed yesterday)

Charging by conduction

If a charged object touches an uncharged object, ________________ will move until both are equal.

Charging by induction

When a charged object approaches, but ____________________, a neutral object, the __________________ in the neutral object will rearrange due to attraction or repulsion.

What happens when static electricity moves?

______________________ is the movement of a static charge from one location to another. Examples: ______________________________

____________________ is the tendency for electricity to move downward whenever possible.

____________________ allow electricity to move easily, while ____________________ prevent the movement of electrons.

Activity: Illustrious Charge Partner: ______________________

Goal: Create a poster, children's book, or comic strip illustrating static electricity.

Requirements:

- ✓ Must show at least two of the three methods of charging.
- ✓ Must show how opposite charges interact
- ✓ Must show how like charges interact
- ✓ Must show a static discharge
- ✓ Must include written explanation in addition to illustration
- ✓ Must be neat and colorful

Suggestions:

- Show how a balloon is charged up and sticks to a wall
- Show how you can zap your brother/sister with static
- Show how lightning builds up and strikes
- Explain why static cling happens
- Show how the Van der Graaf makes your hair stand on end and what happens it you then go and touch someone

Project is due on ______________________________

APPENDIX A
DAILY SHEET XXXI

Introduction to Physics
E&M 3

Thought Question:
____
____
____
____

Answer:

Lecture Notes
What is a circuit?
Defined as ____
What do you need to make a circuit?
1. ________________________ to provide ______________________
2. ________________________ to ____________________________
3. __________________ which ________________________________

What other components are found in circuits?
____________________: controls the flow of electricity through the circuit.
______________________: slows the flow of electricity
_________________________________: stops electricity in the event of a power surge

Activity: World's Simplest Circuit Set # ______
Goal: Explore the basic components of a simple circuit and how they are used.
Directions:
Using a piece of wire, a battery, and a light bulb, set up a circuit to make the bulb light up. There are four ways to set up the circuit. As you discover them, draw diagrams of the setups.

1. How do these arrangements differ from your Thought Question drawing?
2. What do all four of these arrangements have in common?

Examine the light bulb. Draw a diagram showing its internal structure.

3. What do you observe about the part of the bulb which lights up?
4. How does the structure of the light bulb help to explain your observations about the different circuits?
5. **Observe the wire.** Why is there a plastic covering over the metal parts?
6. **Observe the battery.** How are the ends of the battery different? Do you think this is important to the function of the battery?
7. What form of energy is stored in the battery? What forms of energy are produced when you make the bulb light up?

APPENDIX A
DAILY SHEET XXXII

Introduction to Physics
E&M 4

Thought Question:

____
____
____
____

Answer:

Lecture Notes

What "types" of circuits exist?

_________________: electricity is flowing.
_________________: electricity can't flow.
_________________: electricity can only follow one path through the circuit
_________________: electricity can follow more than one path through the circuit
_________________: electricity can move through the circuit without powering the load.

Activity: Series and Parallel Circuits Partners: ____________________

Set # ______ ________________________

Goal: Examine the behavior of circuits wired in series and in parallel.

Directions:

Series Circuit: In a series circuit, the current moves from one piece of equipment to the next. Set up your series circuit according to the diagram.

1. Close the switch. Record your observations.
2. Open the switch. Loosen bulb 1. Close the switch. Record your observations.
3. Open the switch. Tighten bulb 1 and loosen bulb 2. Close the switch. Record your observations.

Parallel Circuit: In a parallel circuit, the current moves along multiple paths at once, reaching each piece of equipment. Set up your parallel circuit according to the diagram.

4. Close the switch. Record your observations.
5. Open the switch. Loosen bulb 1. Close the switch. Record your observations.
6. Open the switch. Tighten bulb 1 and loosen bulb 2. Close the switch. Record your observations.
7. Open the switch. Loosen both bulbs. Close the switch. Record your observations.

APPENDIX A
DAILY SHEET XXXII

8. Set up a circuit with three or more light bulbs. Draw a diagram of it below.

Questions:

9. Explain why all of the bulbs in a series circuit go out when one bulb is disconnected.

10. Explain why removing one bulb from a parallel circuit does not cause the other bulbs to go out.

11. The Number One complaint about holiday lights is that "When one goes out, they **all** go out." Based on this observation, what kind of circuit are holiday lights? Explain.

12. All of the wiring in your kitchen is effectively one circuit. Is it a series circuit or a parallel circuit? Explain your answer.

APPENDIX A

DAILY SHEET XXXIII

Introduction to Physics
E&M 5

Thought Question: ____
____

Answer: ____
____

Lecture Notes

What measurements are made in a circuit?

-__________________ is a measure of the speed at which electricity flows. It is measured in ___________________________ using a device called an __________________, which is wired in series with the rest of the circuit and counts passing electrons.

-__________________ is a measure of the "strength" or energy pushing the electrons. More importantly, it is a measure of how much of this energy is needed to make the load work. It is measured in _________________ using a device called a _____________, which is wired parallel to the load.

-____________________ is a measure of how much an object slows the flow of electricity through a circuit. Resistance is measured in ___________________, and is determined by calculation.

Ohm's Law

_______________________ (I is current)

Demonstrates relationship between the three circuit measurements.

General Rules:

If V increases, ______________________________________

If I increases, ______________________________________

If R increases, ______________________________________

Activity: Electrical Specs. Partners: ____________________________

Set # _____ ____________________________________

Goal: Measure voltage and current in different circuits and use these measurements to calculate resistance.

Directions:

1. Set up a circuit using a single bulb.
2. Wire the Ammeter in series with the bulb, making sure that the negative feed is connected to the black connector and the positive feed is connected to the center.
3. Attach wires to the Voltmeter and test the voltage across the bulb.
4. Record the voltage and current for the single bulb.
5. Set up a circuit with two bulbs and the Ammeter wired in series. Use the Voltmeter to check the voltage of each bulb. Record current and voltage.
6. Set up a circuit with two bulbs wired in parallel. Place the Ammeter in series after the two bulbs. Use the Voltmeter to find the voltage of each bulb. Record current and voltage

APPENDIX A
DAILY SHEET XXXIII

7. Use Ohm's Law to calculate the resistance of each bulb.**(resistance=voltage/current)**

Data

Circuit	Bulb	Current	Voltage	Resistance
Single Bulb	1			
Series	1			
	2			
Parallel	1			
	2			

Questions:

1. As you add more bulbs, what happens to the current? ________________________

2. As you add more bulbs, what happens to the voltage? _________________________

3. How does current in a series circuit compare with current in a parallel circuit? ______
   ____

4. How does resistance in bulb 1 of the series circuit compare with resistance in bulb 2 of the series circuit?
   ____

5. Why is there a limit to the bulbs that can/should be placed in a row in a series circuit?
   ____

APPENDIX A
DAILY SHEET XXXIV

Introduction to Physics
E&M 6

Thought Question: ____

____

Answer: ____

____

Lecture Notes

How does electricity get billed?

Step 1: Electric Power

Power is a measure of how much electricity is needed to make something work. Formula: ________________ Unit: ___________

If there is not enough power, then the item will not turn on.

Step 2: Electrical Energy

Energy is a measure of how much power is used as time passes.

Formula: _________________ Unit: __________

Electric energy is measured by the meter on the outside of your home.

Step 3: Billing

_____________________________set the price for 1 kWh of energy.

Some charge different rates for "green power"—electricity from non-polluting sources.

Local price: _________________ (residential average for MI, 2007, according to the Energy Information Admin of the US Federal gov't)

Activity: Calculating your Power Bill No Partners

Goal: Estimate the cost of the electricity you used in the past week.

Directions

1. List 10 items that you or your family used this week that required electricity.
2. Look up the power rating for each item on the table provided.
3. Estimate the number of hours you use this item in one week.
4. Calculate the Energy Used Formula: Energy Used = Power Rating X Time Used
5. Calculate the cost in dollars using this formula: Cost = Energy Used X $0.1016
6. Add up the costs for these ten items to get your Total Power Bill for the week.

APPENDIX A
DAILY SHEET XXXIV

Item	Power Rating (Kilowatts)	Time Used (Hours)	Energy Used (Kilowatt-hours)	Cost (Dollars)
1.				
2.				
3.				
4.				
5.				
6.				
7				
8.				
9.				
10.				
	Total Cost for One Week:			

Questions

1. Which item had the highest power rating? _______________ lowest? ____________

2. Which item used the most electric energy? ______________ least? _____________

3. Which item cost the most to run? ___________________ least?_________________

4. In general, does it take more electricity to make light, to make movement, or to make heat? Why do you think this is the case?

5. List three things you can do to reduce the cost of energy in your home.

6. Obviously there isn't a member of the power company lurking in your home recording every item you use and how long you use it. How does the electric company actually track your electricity use?

APPENDIX A

DAILY SHEET XXXV

Introduction to Physics
E&M 7

Thought Question: ____
____

Answer: ____
____

Lecture Notes

What causes magnetism?

In atoms, electrons are usually __________________.
In these pairs, the electrons spin in ____________________ directions.
This creates canceling magnetic fields.
If all of the ___________________ electrons in an object spin
_____________________, this will create a magnetic field.

How does electricity make a magnet?

As electricity travels through a wire, the movement creates a
________________________.
If the wire is twisted into a __________, the magnetic field will be stronger.
If the solenoid has an _____ core, the electrons in the core will try to match the spin of the electrons in the coil, making the magnet stronger.

Where is electromagnetism used?

________________________: Use repulsion between magnets to lift the train and a combination of attraction and repulsion to move it forward. Practically frictionless; very fast.
___________________________: Use the interaction between electromagnets and standard magnets to convert between electricity and sound waves.
___________________: Use magnetic repulsion to fire a projectile at a high velocity.

Activity: Building a Better Electromagnet   Partners: ____________________
Set # ______   ______________________________
Goal: Determine the effects of solenoid size on the strength of an electromagnet.

Directions:

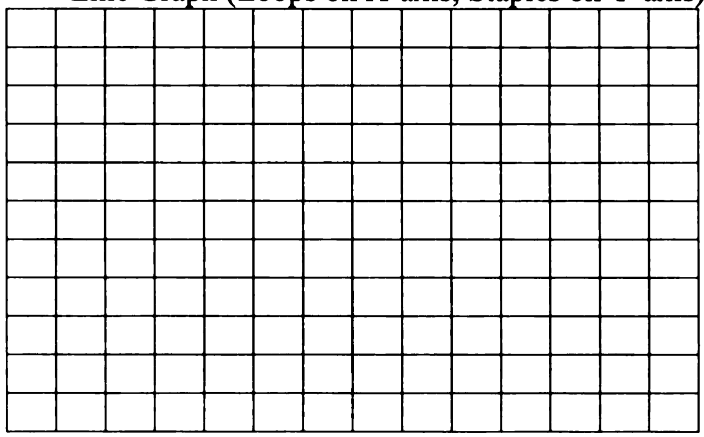
1. Leaving ~10 centimeters for connecting the circuit, wind ten loops of copper wire tightly around the nail, beginning near the head. Keep the loops as close and tight as possible.
2. Set up the circuit. **Do not connect the magnet for more than 3 seconds at a time.**
3. See how many staples the electromagnet can lift. Record your data in the chart.
4. Add ten more loops of wire retest the magnet. Repeat until you reach the end of the wire.

APPENDIX A
DAILY SHEET XXXV

Data Table

Loops	Staples
10	
20	
30	
40	
50	
60	
70	
80	
90	
100	

Line Graph (Loops on X-axis, Staples on Y-axis)



Questions

1. What happens to the strength of the magnet when you add more loops?

2. How does the flow of electrons through the wire create magnetism?

3. What else could you do to increase the strength of the magnet?

APPENDIX A
DAILY SHEET XXXVI

Introduction to Physics
E&M 8

Thought Question: ____
____

Answer: ____
____

Lecture Notes

What is an electric motor?

Electric motors convert ______________________ energy into ___________________ energy.

A ___________________ has the same structure, but is run in reverse.

How do electric motors work?

Electric motors are an interaction between a standard magnet and an electromagnet.

When electricity enters the solenoid, the electromagnet is ______________ by the standard magnet and turns away from it.

This movement breaks the flow of electricity through the ______________ (a type of switch), and momentum carries the solenoid the rest of the way through its spin. This restarts the process.

Activity: Build a Simple Electric Motor Solo Activity

Goal: To build an electric motor and experiment with possible improvements.

Directions:

1. Follow the directions to build a simple electric motor. Sketch it here.
2. Brainstorm three ways you could improve your motor. Test these improvements and report your results.

	Improvement	Results
1		
2		
3		

Questions

1. What is the purpose of each part of the motor?
   a. Battery: ____
   b. Magnet: ____
   c. Armature: ____
   d. Commutator: ____
   e. Solenoid: ____
2. How do you think this motor differs from the motor in a blender? ______________
   ____
   ____
3. Where can you find electric motors in your home? __________________________
   ____

APPENDIX A

DAILY SHEET XXXVII

Introduction to Physics
E&M 9

Thought Question: ____

____

Answer: ____

____

Lecture Notes: None. Instead, complete the survey below.

Survey: Circle the number which best describes your ability.
(1 = lowest, 5 = highest)

I know what electricity is.	1	2	3	4	5
I can identify different ways to build static	1	2	3	4	5
I know the difference between static and current.	1	2	3	4	5
I know the different parts of a circuit.	1	2	3	4	5
I can identify different types of circuits.	1	2	3	4	5
I can trace the flow of electricity through a circuit.	1	2	3	4	5
I can use Ohm's Law for calculations.	1	2	3	4	5
I know what magnetism is and where it comes from	1	2	3	4	5
I can explain how electromagnets and electric motors work.	1	2	3	4	5
I will pass the test on Electricity and Magnetism.	1	2	3	4	5

Introduction to Physics
E&M Test

Thought Question: ____

____

Answer: ____

____

APPENDIX A
DAILY SHEET XXXVIII

Introduction to Physics
Waves 1

Thought Question: ____
____

Answer: ____
____

Lecture Notes

What is a wave?

A wave is a ________________ that moves ______________ through ________________.

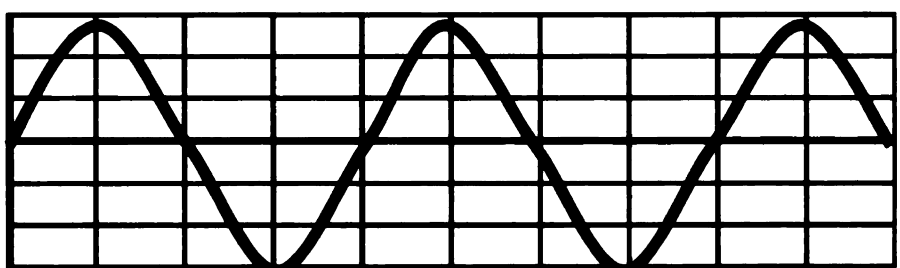
Examples:_______________, _______________, _______________, _______________, _______________

Parts of a wave

___________________: The high and low points of the wave.

_________________: The distance needed to make one full crest and one full trough.

__________________: The maximum height of a wave. This also indicates the amount of energy in the wave.



____________________: Measure of how often the wave comes through.

Formula: _______________________

Wave speed uses the formula _________________________________.

The speed of a wave in a given medium is _______________.

There are two types of waves

___________________: The particles of the medium move up and down, while the wave moves forward. Examples: Stadium waves, water waves, light.

___________________: The particles of the medium move forward with the wave. Examples: Sound, some earthquakes, Slinky going down the stairs.

APPENDIX A

DAILY SHEET XXXVIII

Activity: Slinky Waves Part 1 Partners: ________________________

Set # ______ ________________________

Goal: Examine the behavior of waves under different conditions.

Directions

1. Lay the spring on the floor and DO NOT OVERSTRECTH OR TANGLE IT ($15.00)
2. Make sure that you always use the springs at the same length and same tension.
3. With one person holding the low density spring at each end, make a wave by moving your hand back and forth quickly from left to right (about 2 feet). Larger waves travel better and are easier to observe. **Conduct the following tasks and record your observations**

a. Using a stopwatch, time how long it takes for the wave to get from one person to the other.

Trial 1	Trial 2	Trial 3	Average

b. Move your hand faster to see if the wave will travel faster. Was there a noticeable difference?________________________

c. Time waves in the high density spring.

Trial 1	Trial 2	Trial 3	Average

d. Does the density of the spring affect the speed of the wave? Explain why or why not.

____

____

e. What type of wave requires a medium to move? ________________________

f. What type of wave needs no medium to move? ________________________

g. Move your hand quickly back and forth to send lots of waves down the spring. Note the distance from one wave peak to the next. This is the wavelength. Determine how you can make the wavelength change.

Smaller: ________________________

Larger: ________________________

h. What name is given to the number of waves in a certain amount of time?__________

APPENDIX A
DAILY SHEET XXXIX

Introduction to Physics
Waves 2

Thought Question: ____
____
Answer: ____
____

Lecture Notes

Waves can interact with objects

_________________: When a wave encounters a surface, it bounces off at the same angle as it hit.

_________________: When waves pass from one medium to another, they bend because they change speed.

_________________: Waves passing through openings tend to spread out and create patterns through interference (more later).

_________________: Waves spread out in a cone shape, reducing their energy according to the inverse-square law.

Waves can interact with each other

______________________: Two waves combine to form a larger wave.

______________________: Two waves exert opposite forces and cancel.

Activity: Slinky Waves Part 2 Partners: ______________________
Set # ______ ______________________

Goal: Examine the behavior of waves under different conditions. This is a continuation of the Waves 1 Lab.

Directions:

i. Stand up and hold the spring between two people like a jump rope (but do not let it touch the ground). Can you make a wave so that there is one crest and one trough on the spring at all times? (Do this with the high density spring). Measure the length of the wave and time it for ten total waves, then determine the speed.

Number of waves	Time	Frequency (waves/time)	Wavelength	Speed (frequency * wavelength)
10				

j. This type of wave is called a standing wave. Why do you think it has this name?
____

k. What do you have to do to get three crests/troughs on the wave at the same time?
____

l. Your hand moves left to right to make the wave, but the wave moves away from you. What type of wave are you making?______________________________

APPENDIX A
DAILY SHEET XXXIX

m. What type of wave do you make if you pull a handful of coils toward you and then release them (try this with the low density spring). ____________________________

n. Have both people make a wave at the same time. What happens when the waves collide?____

o. What happens if you make waves on opposite sides of the spring?

____

p. The spring moves for a moment and the returns to its original position each time a wave passes. That means that the wave is not transmitting material. What is the wave transmitting?____

q. If you sent a wave with more energy through the spring, what would change?

____

APPENDIX A
DAILY SHEET XL

Introduction to Physics
Waves 3

Thought Question: ____

____

Answer: ____

____

Lecture Notes

Sound is ________________ traveling through a ______________.

You cannot have sound without a ________________. Sound cannot travel through space because there is nothing to vibrate.

Generally, the ____________ the medium or the more _____________ the medium, the faster the sound travels.

Sound and Measurements

The higher the frequency, the higher the ___________ of the sound.

The shorter the wavelength, the higher the __________ of the sound.

The greater the amplitude, the ___________ the sound.

Interactions of Sound Waves

Reflection: A reflected sound is known as an ___________.

Refraction: Sounds change speeds in different media.

Constructive interference: Makes _______________ or increases volume.

Destructive interference: Decreases volume or cancels sounds.

The Doppler Effect

When a source of sound is moving, the movement affects the __________ between sound waves. As the source approaches, the pitch __________.

After the source passes, the pitch __________.

How do we hear?

Vibrations in the air hit the _________________, which vibrates.

This pulls on a group of three _____________, which transfer the vibration to the _____________.

_____________ in the cochlea vibrate at different frequencies, pulling on _____________ which signal the brain.

The brain compares these signals to past experience and/or stores them.

Activity: Clucking Chickens Partner: ______________________

Goal: Explore sound production by a classic noisemaking toy.

Directions:

Part A: Make a Clucking Chicken

1. Use the nail to punch a hole in the center of the bottom of the cup.
2. Feed the piece of string through the hole.
3. Tie the paper clip to the end of the string inside the cup.
4. Tie a damp piece of sponge to the other end of the string.

APPENDIX A
DAILY SHEET XL

5. While holding the cup in one hand, grip the sponge with the fingers of your other hand and pull it along the string.
6. Vary the pull to create different sounds.

Part B: Variations on the Theme of Chicken

7. Change the size of the cup. Observe what happens when the cup is larger or smaller
8. Change the length of the string. Observe what happens with a longer or shorter string
9. Change the type of string. Observe what happens when different strings are used.

Data

	Observations	
Original Chicken	Normal Use	Varied Pull
Changed Cup	Smaller	Larger
Changed String Length	Shorter	Longer
Changed String Type	Fishing line	Clothes line

Questions

1. How are the vibrations produced? ______________________________

2. What does the cup do? ______________________________

3. How can you vary the pitch? ______________________________

4. How can you vary the volume? ______________________________

5. How else can you vary the sound? ______________________________

APPENDIX A
DAILY SHEET XLI

Introduction to Physics
Waves 4

Thought Question: ____
____
Answer: ____
____

Lecture Notes

What is light?

Light is made of little packets of energy called ______________.
When an atom absorbs energy, the energy makes ______________ jump to higher levels. When they fall back, they release the energy.
Light does not need a medium because it creates its own in the form of ______________________________.

The Electromagnetic Spectrum

All light is organized into a list by increasing ______________ (decreasing ______________).
The spectrum is divided into seven categories:
____
____

Radio Waves
Frequency: ______________ Wavelength: ______________
Uses: 1. ______________ 2. ______________ 3. ______________

Microwaves
Frequency: ______________ Wavelength: ______________
Uses: 1. ______________ 2. ______________ 3. ______________

Infrared Light (IR)
Frequency: ______________ Wavelength: ______________
Uses: 1. ______________ 2. ______________ 3. ______________

Visible Light
Frequency: ______________ Wavelength: ______________
Uses: 1. ______________

Ultraviolet (UV)
Frequency: ______________ Wavelength: ______________
Uses: 1. ______________ 2. ______________ 3. ______________

X-rays
Frequency: ______________ Wavelength: ______________
Uses: 1. ______________

Gamma Rays
Frequency: ______________ Wavelength: ______________
Uses: 1. ______________ 2. ______________

APPENDIX A

DAILY SHEET XLI

Activity: Black Light Analysis Partners: ____________________________

Set # ______ ____________________________

Goal: Examine the ultraviolet region of the spectrum and some interactions between UV light and different materials.

Directions:

Part 1

1. Predict which objects will glow under black light
2. Test the objects under black light. Record which objects are affected.

Object	Prediction	Result	Object	Prediction	Result

a. Which objects were affected? ____________________________

b. Why were they affected? ____________________________

Part 2

3. Apply glow germ to the hands of one group member.
4. Examine their hands under the black light.

c. What do you see? ____________________________

5. Have the affected member shake hands with others and/or touch objects.
6. Use the black light to examine these objects

d. What do your see? ____________________________

7. Have the group member wash their hands thoroughly at the sick and dry them.
8. Re-examine their hands under the black light

e. Did they wash it all off? ________ If not, what places did they miss? ____________

____

f. This product is sometimes used to teach doctors and nurses how to wash their hands properly. Why would this be an important skill for these professionals?

____

____

APPENDIX A
DAILY SHEET XLII

Introduction to Physics
Waves 5

Thought Question: ____
____

Answer: ____
____

Lecture Notes
What is reflection?

___________ reflections are the kind of reflections we get from mirrors—you see an image because the rays of light reflect in an orderly fashion.

___________ reflections occur when light bounces off of an irregular surface. The rays of light are scattered.

How does a mirror work?

_______ mirrors are flat. They are what most people are familiar with. Light bounces off of the mirror and travels to the eye in straight lines.

__________ mirrors curve inward. Light striking is angled inward by this curve. They can focus light (headlights), make things appear upside-down (spoons), make things appear larger (magnifying mirrors), and make "real images" (holograms) depending on the placement of the object reflected.

__________ mirrors curve outward. Light striking is angled outward by this curve. They are used to give a wider field of view (car mirrors, "fish eyes"), but also make objects appear smaller.

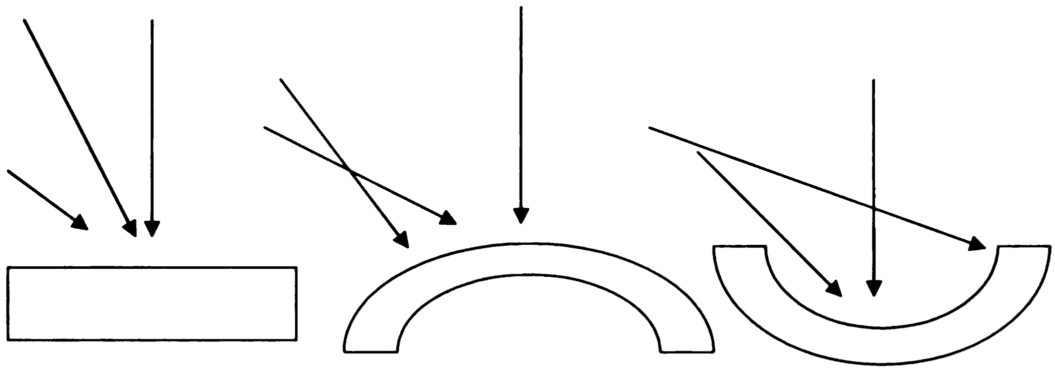
Activity: Reflection　　　　　　Partners: _________________________

Set # _____　　　　　　　　　　　　_________________________________

Goal: Explore reflection and refraction of light.

Directions:
1. Set up the projector using the single slit mask.
2. Project the light on the plane mirror, concave mirror, and convex mirror as shown by the arrows in the pictures.
3. Draw a diagram showing what happens to the reflected light in each situation.

APPENDIX A
DAILY SHEET XLII

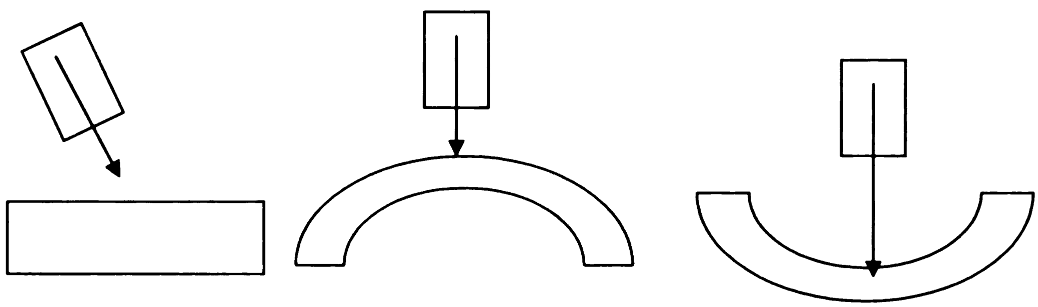


Plane Mirror Convex Mirror Concave Mirror

Question: What general statement can you make about the angle at which the ray of light hits the mirror, compared to the angle at which it reflects?

____
____
____

4. Place the 4 slit mask in the projector.
5. Shine the lights on three different mirrors and draw pictures showing what happened.



Plane Mirror Convex Mirror Concave Mirror

DAILY SHEET XLIII

Introduction to Physics
Waves 6

Thought Question: ____
____

Answer: ____
____

Lecture Notes

What is refraction?

Refraction is the __________ of a wave as it moves from one medium to another.

Refraction occurs because waves travel at different _______ in different media.

How much bend?

How much light bends depends on which substances the light is traveling through.

Generally, the greater the change in _________, the greater the bend.

The measurement of how much light will bend in a given substance is called the ___________________.

Refraction and the Spectrum

Because the different colors of visible light have different ___________, they bend slightly differently when entering a prism.

This separates the colors into a _________.

What do lenses do?

__________ lenses focus light at a point by bending the rays together.

__________ lenses spread light by bending the rays away from each other.

How do lenses help with eye problems?

Light is focused on the back of the eye by your natural lens.

If the eye is ________ than average, the focus point is in the wrong place.

By placing a _______ lens in front of the eye, the beams of light will travel a corrected path.

If the eye is _______ than average, then the problem is corrected using _______ lenses.

APPENDIX A
DAILY SHEET XLIII

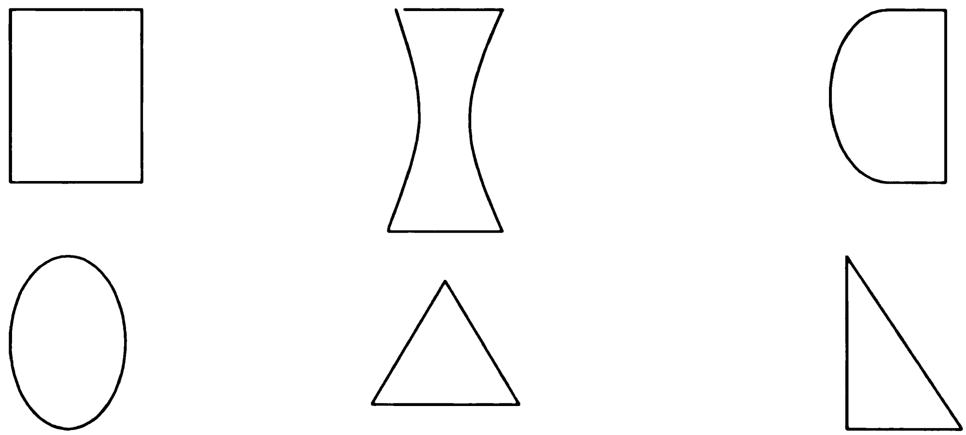
Activity: Refraction Partners: ______________________

Set # _____ ______________________

Goal: Explore refraction of light.

Refraction

1. Set up the projector using the single slit mask.
2. Shine the light through each of the lenses and prisms available and draw the path the light takes through it. Always place the light to the left side of the lens.



Question: What happens to the beam of light when it enters a shape? ____________

What happens when it leaves a shape? ______________ Why does this happen?

____

3. Set up the projector with the 4 slit mask. Find a way to make all 4 beams of light cross at the same spot. Draw your answer below.

APPENDIX A
DAILY SHEET XLIV

Introduction to Physics
Waves 7

Thought Question: ____
____

Answer: ____
____

Lecture Notes

Where does color come from?

White light is made of the seven colors of the visible spectrum:__________
(____)

Additive Mixing of light

Primary colors __________________

Secondary colors

Red + Blue = _________________

Blue + Green = _______________

Red + Green = ________________

Red + Blue + Green = __________

Subtractive color and objects

When white light encounters an object, some colors are __________ and some are __________. The color we see is the __________ color because that is what reaches the eyes.

If no color is reflected, then the object looks __________.

How do we see?

Light passes through the _________ and enters the eye through the ______

Light is focused by the _____ on to the __________.

________ cells register light level and ________ cells register colors (red, blue, and green)

The ____________ carries these signals to the brain for processing.

Common Eye Problems:

______________: One or more cone cells are not properly formed. Cannot tell the difference between two or more colors. No cure.

_____________: Cornea develops filmy coating. Treated with laser removal.

_____________: Pressure inside eye destroys retina. No cure.

Activity: Color Addition and Subtraction Partners: ______________________
Set # _____ ______________________________

Goal: Analyze what happens when colors of light are combined.

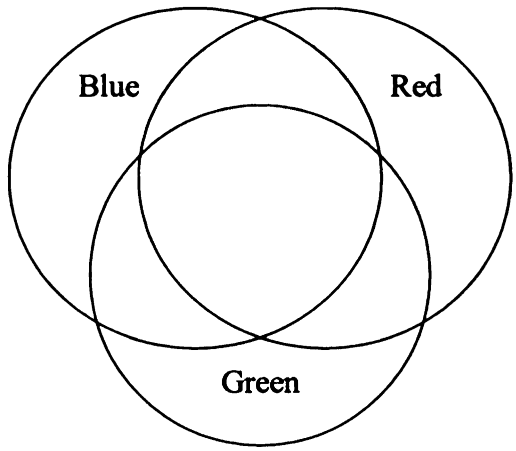
Directions

Part A: Color Addition

1. Set up the light projector. We will be using the end with the mirrors.
2. Tape a piece of white paper to the side of the box and place it in front of the projector.

APPENDIX A
DAILY SHEET XLIV

3. Place the red color filter in the slot on the front of the projector. Place the blue filter in the slot next to one mirror and the green filter in the slot next to the other filter.
4. Open the mirror on the blue side so that the red and blue lights are shining on the same place. Record the color you see in the chart below.
5. Shut the blue side and open the green side so that red and green combine. Record the color you see.
6. Place the no slit mask over the red filter and open both blue and green so that blue and green mix. What color do you see?



Part B: Color Subtraction

7. Remove the red, blue, and green filters. Place the magenta filter in the front slot.
8. Place the red filter in front of the magenta filter. What color comes out? (Fill in table)
   Replace the red filter with the blue filter. What color comes out?
   Replace the blue filter with the green filter. What color comes out?
9. Remove the magenta filter and replace it with the cyan filter. Repeat step 8.
10. Remove the cyan filter and replace it with the yellow filter. Repeat step 8.

Filter 1	Filter 2	Color	Filter 1	Filter 2	Color	Filter 1	Filter 2	Color
Magenta	Red		Cyan	Red		Yellow	Red	
Magenta	Blue		Cyan	Blue		Yellow	Blue	
Magenta	Green		Cyan	Green		Yellow	Green	

APPENDIX A

DAILY SHEET XLIV

Part C: Color of Objects

11. Place the solid colored slides on table in front of the light box.
12. Place the red filter in the light box and observe the colors of each of the different slides. Record your observations.
13. Repeat step 12 using each of the different colored filters.

Filters	Red	Orange	Yellow	Green	Blue	Violet	Magenta	Cyan
Red								
Orange								
Yellow								
Green								
Blue								
Violet								
Magenta								
Cyan								

Part D: Prism

14. Place the triangular prism in front of the light.
15. Place the red filter in the projector. What color(s) come through the prism?
16. Repeat with each of the different filters. Record your observations.

Filter	Results	Filter	Results
Red		Blue	
Orange		Violet	
Yellow		Magenta	
Green		Cyan	

APPENDIX A
UNIT REVIEW XLV

Introduction to Physics
Waves 8

Thought Question: ____
____
Answer: ____
____

Circle the number which best describes your ability. (1 = lowest, 5 = highest)

I know what waves are.	1	2	3	4	5
I can identify the crests and troughs of a wave.	1	2	3	4	5
I can find frequency, wavelength, and amplitude	1	2	3	4	5
I can calculate wave speed.	1	2	3	4	5
I can explain reflection and refraction	1	2	3	4	5
I know the difference between constructive and destructive interference	1	2	3	4	5
I can explain the relationship between frequency and pitch for sound waves.	1	2	3	4	5
I can explain how sounds are produced.	1	2	3	4	5
I can identify the different types of light in the spectrum and explain what each does.	1	2	3	4	5
I can explain how mirrors work.	1	2	3	4	5
I can explain how lenses fix vision problems.	1	2	3	4	5
I can explain why objects have color.	1	2	3	4	5
I can explain how ears and eyes detect waves.	1	2	3	4	5
I will pass the test on Waves.	1	2	3	4	5

Introduction to Physics
Waves Unit Test

Thought Question: ____
____
Answer: ____
____

APPENDIX A

UNIT REVIEW XLVI

Name: ________________________ Hour: _____ **Unit 1 Review: Energy and Motion**

This review is due on the day of the test ________________. It is divided into sections covering each day of class, and also includes some overall review material. It is suggested that you do a little bit of the review each day. There will be a question and answer session in class before the test.

Energy 1: Types of Energy

1. What are the two definitions of energy?
   a. ____
   b. ____

2. Identify the type of energy for each of the following examples:

_______________	Spinach	_______________	Hydrogen Bomb
_______________	Condensation	_______________	Lightning
_______________	Writing	_______________	Sun
_______________	Thunder	_______________	Boiling
_______________	Kerosene	_______________	X-ray

List all types of energy observed:

Toaster: ____

Television: ____

Fireworks: ____

3. Complete the sentence: The different between kinetic energy and potential energy is that kinetic energy is _______________ while potential energy is _________________.

Energy 2: Conversion and Conservation

4. Identify the energy conversions in a hair dryer.

5. Before a nuclear reaction, the nucleus of an atom has 100 J of energy. After the reaction, the nucleus retains 75 Joules of energy. An electron is emitted with 14 J of energy and 6 J of thermal energy are released, increasing the temperature in the area. Scientists insisted that something else, probably a particle must have been produced, and searched for over 20 years before discovering a new particle. Why were they so certain that there was something they were missing?

6. In terms of energy, explain why the Earth is dependent on the Sun.

Energy 3: Nuclear Energy

7. Identify the three types of nuclear reactions and give an example of each:
   a. ____
   b. ____
   c. ____

APPENDIX A
UNIT REVIEW XLVI

8. What do the letters stand for in the formula $E=mc^2$?
E = ______________ m = ______________ c = ________________

9. Identify one benefit and one drawback of using nuclear energy to make electricity.
Benefit: ____
Drawback: ____

Energy 4: Thermal Energy

10. Complete the sentence: When two objects are different temperatures, thermal energy always moves from __________________ to __________________.

11. Identify the three different ways thermal energy is transferred and explain what happens in each case.
a. ____
b. ____
c. ____

12. What happens at absolute zero? ____
Why is there no temperature below absolute zero? ________________________
____

Motion 1: Defining Motion

13. What is motion? ____

14. A player hits a pop fly. Describe what happens to the ground from the ball's frame of reference. ____
____

15. Which is greater—the distance you travel to get to school or the displacement between your home and the classroom? Why?
____
____
____

Motion 2: Speed

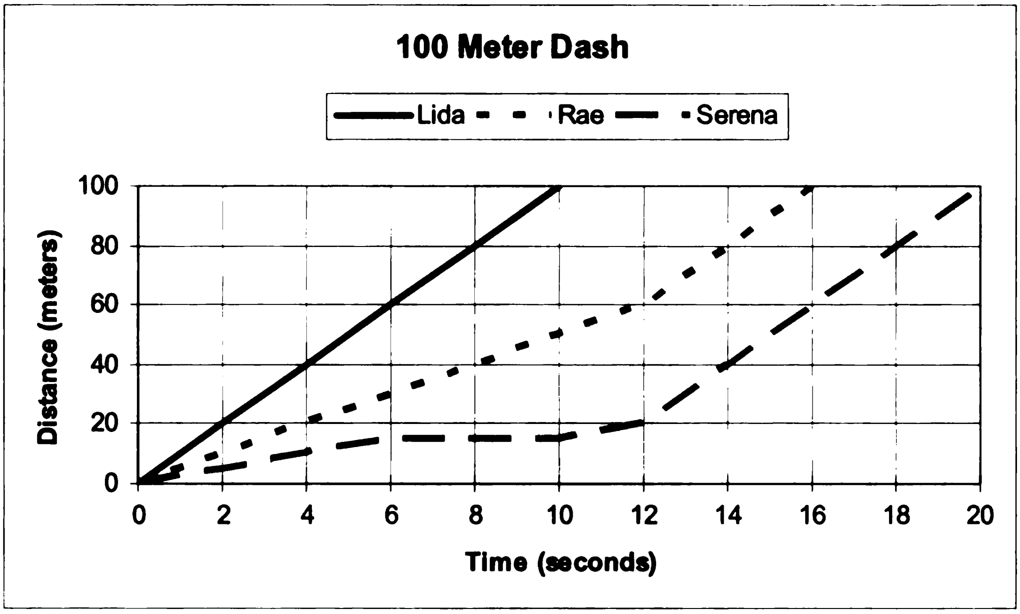
16. In the list below, circle the units that are used to measure speed:
meters seconds meters/second
meters/second, North m/s/s

17. Explain how to determine the speed of a runner using a meter stick and a stopwatch.
____
____

18. If a car travels at an average speed of 75 km/h, how far will it travel in 5 hours?

____

Motion 3: Graphing Speed



19. In the graph above, which runner stopped to tie her shoe? _______________
    How do you know? _______________

20. In the graph above, which runner won the race? _______________
    How do you know? _______________

21. Use the graph above to determine Rae's average speed.

____

Motion 4: Velocity

22. What is the difference between speed and velocity? _______________

____

23. Draw a motion diagram of a basket ball bouncing.

24. What is the velocity of an airplane that flies from Orlando to Detroit, a distance of 1000 km, in 5 hours?

____

APPENDIX A
UNIT REVIEW XLVI

Motion 5: Acceleration

25. Most people think acceleration only means speeding up. What other two situations count as acceleration?
    a. ________________________ b. ___________________________

26. What shape on a graph indicates acceleration? ____________________________

27. You are driving at 30 m/s when you see a deer in the road ahead of you. You step on the brakes and come to a stop in 3 seconds. What was you acceleration?

____

Vocabulary Crossword Review

The following list was placed in the Variety Puzzles online crossword puzzle maker, which generated a crossword puzzle. The term in capital letters is the answer, while the statement following the / is the clue.

ENERGY/The ability to do work or to cause changes
MECHANICAL/Energy involving moving objects
THERMAL/Energy of moving particles within objects
CHEMICAL/Energy stored in the bonds between atoms
ELECTROMAGNETIC/Energy of moving electrons
NUCLEAR/Energy stored in the nucleus of an atom
POTENTIAL/_____ energy is stored
KINETIC/____ energy is being used
CONVERSION/Energy _____ changes energy from one form to another
CONSERVATION/The Law of _____ of Energy says it cannot be created or destroyed
FUSION/When two atoms join to form one larger atom
FISSION/When an atom breaks into two or more pieces
DECAY/Atoms naturally break down through a process called radioactive _____
ABSOLUTEZERO/The coldest possible temperature (2 words)
CONDUCTION/Heat transfer between objects that are touching.
CONVECTION/Heat transfer involving fluids of different temperatures
RADIATION/Heat transfer involving infrared light
MOTION/Change in position relative to a frame of reference
FRAMEOFREFERENCE/Point used to determine motion (3 words)
DISPLACEMENT/Distance (in a straight line) from starting position to current position
SPEED/Distance traveled per unit time
SLOPE/On a d-t graph, the steeper the _____, the greater the speed
VELOCITY/Speed in a direction
ACCELERATION/Change in velocity over time
DIRECTION/You can accelerate by speeding up, slowing down, or changing _____

Coppins, Kelly Ann
Improving student achievement -- .

APPENDIX A

UNIT REVIEW XLVII

Name: ______________________ Hour: ____ **Unit 2 Review: Forces and Work**

This review is due on the day of the test _______________. It is divided into sections covering each day of class. It is suggested that you do a little bit of the review each day. There will be a question and answer session in class before the test.

Forces 1: What are forces?

1. What is a force? ____

2. What is the difference between contact and non-contact forces? Give an example of each. ____

____

3. Draw a force diagram of a car driving down the road. Include gravity, normal, friction, the car's force, and air pressure.

Forces 2: Friction

4. Identify the three types of friction and give and example of each.

a. ____

b. ____

c. ____

5. Suggest two different ways to decrease and two different ways to increase the amount of friction between a person and the floor.

Decrease by a. ____

and b. ____

Increase by a. ____

and b. ____

6. Circle the phrases that best complete the statement:

In general, static friction is (greater / less) than kinetic friction and sliding friction is (greater / less) than fluid or rolling friction.

Forces 3: Newton's First Law

7. State Newton's First Law in your own words.

____

____

8. Explain why it is dangerous to use the front bicycle brakes without the back ones.

____

____

9. Explain how the magic table cloth trick works.

____

____

Forces 4: Newton's Second Law

10. What is the formula for Newton's Second Law? ______________

11. Determine the force applied by an object with mass 2.5 kg if it accelerates at 4 m/s/s.

Answer: ________

12. Use Newton's Second Law to explain why smaller cars get better gas mileage than SUVs.

____

____

____

Forces 5: Newton's Third Law

13. State Newton's Third Law: ______________________

____

14. Identify the action and reaction in a rocket launching.

____

15. In a tug of war, the rope pulls on you just as hard as you pull on the rope. How is it possible for anyone to win?

____

____

____

Forces 6: Momentum

16. According to the Law of Conservation of Momentum, what happens to the momentum of objects during a collision?

____

____

17. What is the momentum of an object of mass 8 kg traveling at a velocity of 20 m/s West?

Answer: ________

18. Describe a situation where momentum is changed by a collision.

____

____

Forces 7: Gravity & Weight

19. What two factors affect the amount of gravitational attraction between two objects?
    a. ______________________ b. ______________________

20. If you were to travel to the Moon, what would change about your body?
    weight height volumemass shoe size IQ

21. If Joe has a mass of 100 kg on Earth, what is his mass on Zorg (gravity = 20 m/s/s)?

    Answer: ____________

Forces 8: Terminal Velocity

22. What does terminal velocity mean? ______________________

23. What factors affect terminal velocity? ______________________

24. Explain why a parachute allows sky divers to land safely.
    ____
    ____
    ____

Forces 9: Projectile Motion

25. What is a projectile? ______________________

26. What three factors influence the motion of a projectile?
    a. ____________ b. ____________ c. ____________

27. An airplane is 1000 meters off the ground and flying forward at a constant velocity of 10 m/s. If a person wants to land on a target, and falls at 50 m/s, when/where should they jump out of the plane?

    Answer: ____________

Forces 10: Circular Motion

28. What two factors control the orbit of the Moon around Earth?
    a. ______________________ b. ______________________

29. If you change the speed of the Moon, what will happen to the orbit?
    Increase speed: ______________________
    Decrease speed: ______________________

APPENDIX A
UNIT REVIEW XLVII

30. If you tie a bucket of water to a rope and swing it over your head, the water will stay in the bucket. Use what you know about circular motion to explain why this happens.

____
____
____

Work 1: Work and Power

31. How is the scientific definition of work different from the social definition of work?

____
____

32. How much work is done moving a 30 N mass a distance of 15 meters?

Answer: ____________

33. If the above work is done in 50 seconds, how much Power was required?

Answer: ____________

Work 2: Machines

34. What is a machine? ____

35. Machines do not change the amount of work being done. What do they change?

a. ____________________ and b. ____________________

36. Explain how a lever makes it easier to lift a load.

____
____

Work 3: Mechanical Energy

37. What three factors determine the gravitational potential energy of an object?

a. ______________ b. ______________ c. ______________

38. What two factors influence the kinetic energy of an object?

a. ______________ b. ______________

39. An object with a mass of 30 kg is pushed off of a cliff 100 m high. What is its velocity when it is half way to the ground?

Answer: ____________________

Work 4: Periodic Motion

40. What is periodic motion? ____

APPENDIX A
UNIT REVIEW XLVII

41. How do gravity and inertia influence the motion of a pendulum?
Gravity: ____________________
Inertia: ____________________

42. If the pendulum just keeps swinging back and forth, then we could hook it to a generator and use it to make free electricity forever. Why doesn't this plan work?
____
____

Vocabulary Crossword Review
The following list was placed in the Variety Puzzles online crossword puzzle maker, which generated a crossword puzzle. The term in capital letters is the answer, while the statement following the / is the clue.

FORCE/A push or a pull on an object
BALANCED/When forces are equal and opposite, they are ____ forces.
UNBALANCED/Forces which are not equal or are not opposite are ____ forces.
CONTACT/ Objects which are touching exert ____ forces on each other.
NONCONTACT/ Magnetism and gravity are examples of ____ forces.
FRICTION/The force that opposes all motion
SLIDING/Type of friction between two solid surfaces
ROLLING/Type of friction between wheels and the ground
FLUID/Type of friction you experience when sky diving or swimming
STATIC/General term for friction between stationary objects
KINETIC/General term for friction involving a moving object
LUBRICANT/Material that changes sliding friction to fluid friction
NEWTON/Unit used to measure force (named for a scientist)
INERTIA/Property of matter that causes it to resist change
REACTION/For every action, there is an equal and opposite ____
GRAVITY/The greater your mass, the greater the force of ___ you exert.
DISTANCE/The greater the ___, the smaller the gravitational attraction between objects
WEIGHT/Measure of the force you apply to the ground due to gravity.
MASS/Measure of the amount of "stuff" in your body.
ANGLE/In addition to inertia and gravity, ___ also affects projectile motion.
PROJECTILE/Any object that is thrown or launched.
CIRCULAR/Type of motion shown by orbits
WORK/Using force to move an object a certain distance
POWER/The rate at which work is done
MACHINE/Any device that makes it easier to do work
POTENTIAL/When you put an item on a shelf, you are storing Gravitational ___ Energy
KINETIC/A moving object has ____ energy.
PERIODIC/Pendulums and springs display this type of motion.

APPENDIX A

UNIT REVIEW XLVIII

Name: ____________________ Hour: ___ **Unit 3 Review: Electricity and Magnetism**

This review is due the day of the Unit 3 test, ____________________. It is divided into sections that match what is covered in class, and it is recommended that you do one section per night in order to keep pace with class. There will be a Q&A session.

E&M 1

1. What is the charge on a proton? __________ On an electron? ____________
   Which can move? ______________________________
2. What is the Rule of Interactions (AKA The Law of Electrostatic Force)?
   ____
3. Explain how charging by friction works. ____________________________
   ____

E&M 2

4. Explain how charging by conduction works. __________________________
   ____
5. Explain how charging by induction works. ___________________________
   ____
6. Using the three forms of charging, explain how shuffling your socks on the carpet can lead to a static shock.
   ____
   ____

E&M 3

7. What three parts are needed in all circuits? What is the purpose of each?
   a. ____
   b. ____
   c. ____
8. What is the purpose of a switch? ___________________________________
9. How do circuit breakers and fuses protect us from electrical fires? ___________
   ____

E&M 4

10. What is the difference between an open and a closed circuit? _____________

11. What is the difference between a series and a parallel circuit? ____________

12. Explain why short circuits get hot without doing any work. ____________

____

E&M 5

13. Define each of the following and list the units it is measured in.

Current: ____________ Units: ______
Voltage: ____________ Units: ______
Resistance: ____________ Units ______

14. If Resistance increases, what happens to

Current? ____________ Voltage? ____________

15. Use Ohm's Law to determine the current necessary to overcome a resistance of 12 Ohms with a voltage of 4 Volts.

____

E&M 6

16. What things do you need to know to determine the amount of money you spend on electricity? ____________

17. If an appliance requires 100 Volts at 120 Amps, what is its Power Rating?

____

18. If the above appliance is on for 24 hours, how much energy did it use?

____

E&M 7

19. What causes magnetism? ____________

____

20. How does electricity make a magnet? ____________

____

21. Compare and contrast regular magnets and electromagnets.

____

____

E&M 8

22. In terms of energy, what does an electric motor do? ____________

____

23. Explain in your own words how an electric motor works. ____________

24. Identify three places that electromagnets are used in real life.
    a. ____________________
    b. ____________________
    c. ____________________

Vocabulary Crossword Review

The following list was placed in the Variety Puzzles online crossword puzzle maker, which generated a crossword puzzle. The term in capital letters is the answer, while the statement following the / is the clue.

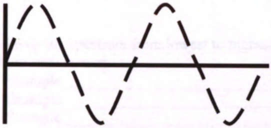
PROTON/Subatomic particle with a positive charge
ELECTRON/Subatomic particle with a negative charge
STATIC/Electricity that doesn't move freely is called ____ electricity
FRICTION/Charging by rubbing two objects together
CONDUCTION/Charging by touching a charged object to a neutral one
INDUCTION/Charging that does NOT require touching
DISCHARGE/Release of static charge
GROUNDING/Tendency of electricity to move downward
CURRENT/Electricity that flows from place to place is called ___ electricity.
OPEN/Circuit with a break
CLOSED/Complete circuit
SHORT/Circuit that bypasses the load
SERIES/Circuit with only one path
PARALLEL/Circuit with more than one path
CURRENT/Speed of electricity
VOLTAGE/Strength of electricity
RESISTANCE/Anything that slows electricity
AMPERE/Unit of current
VOLT/Unit of voltage
OHM/Unit of resistance
OHMSLAW/Math formula that relates current, voltage, and resistance (2 words)
LOAD/Circuit component that uses the electricity
CIRCUITBREAKER/Safety feature that is reusable
SWITCH/Controllable break in a circuit
SPIN/Magnetism occurs when unpaired electrons ___ in the same direction.
MOTOR/Converts electromagnetic energy into mechanical energy
GENERATOR/Converts mechanical energy into electromagnetic energy
SOLENOID/Coil used to make electromagnet

Name: ______________________________ Hour: _____ **Unit 4 Review: Waves**

This review is due the day of the Unit 4 test, _____________. It is divided into sections that match what is covered in class, and it is recommended that you do one section per night in order to keep pace with class. There will be a Q&A session on ____________.

Waves 1: What is a wave?

1. On this wave, label
   - ✓ a crest and a trough
   - ✓ the wavelength
   - ✓ the amplitude



2. If a wave has a frequency of 6 hertz and a wavelength of 12 meters, what is its speed?
   ____

3. If you change the frequency of a wave, what happens to the
   a. Wavelength ________________ b. Speed __________________

Waves 2: Interactions of Waves

4. Describe what a wave does in each of the following situations:
   a. Reflection ____
   b. Refraction ____
   c. Diffraction ____

5. What happens when waves collide during
   a. Constructive interference ______________________________
   b. Destructive interference ________________________________

6. Describe one use of each of the five interactions:
   a. Reflection ____
   b. Refraction ____
   c. Diffraction ____
   d. Constructive interference ______________________________
   e. Destructive interference ________________________________

Waves 3: Sound

7. What must happen to the sound wave in order to:
   a. Increase pitch ____
   b. Decrease pitch ____
   c. Increase volume _______________________________________

8. Explain the Doppler Effect in your own words. ______

9. Explain how your ears hear sounds. ______

Waves 4: Types of Light

10. List the seven types of light that make up the spectrum from lowest to highest frequency. Give an example of where/how each is used.

a. ______ Example ______
b. ______ Example ______
c. ______ Example ______
d. ______ Example ______
e. ______ Example ______
f. ______ Example ______
g. ______ Example ______

Waves 5: Reflection

11. What is the difference between a regular reflection and a diffuse reflection? ______

12. How does the shape of a mirror affect the reflection in it? ______

13. Draw the shapes of the three types of mirrors:

a. Plane b. Concave c. Convex

Waves 6: Refraction

14. Explain how a prism makes a rainbow. ______

15. What happens to light as it passes through different lenses?

a. Convex lens ______
b. Concave lens ______

16. Explain how sunlight and a magnifying glass can be used to start a fire. ______

APPENDIX A
UNIT REVIEW XLIX

Waves 7: Color

17. Explain why a red apple looks red under white light, but looks black under green light. ____________________

____

18. What colors of light do your eyes actually detect? ____________________

19. Explain how your eyes see light and images. ____________________

____

____

Vocabulary Crossword Review

The following list was placed in the Variety Puzzles online crossword puzzle maker, which generated a crossword puzzle. The term in capital letters is the answer, while the statement following the / is the clue.

WAVE/Disturbance that moves energy through matter or space
MEDIUM/Material that a wave moves through
AMPLITUDE/Height of a wave
WAVELENGTH/One crest and one trough
CREST/High point of a wave
TROUGH/Low point of a wave
FREQUENCY/Number of waves per second
HERTZ/Unit used to measure frequency
CONSTANT/The speed of a wave in a medium is ___.
REFLECTION/When a wave bounces
REFRACTION/When a wave changes medium and speed
INTERFERENCE/When waves interact with each other
ECHO/Reflected sound
DOPPLEREFFECT/Changes in the sound of a moving object
COCHLEA/Part of ear that signals the brain
VIBRATION/The source of all sounds
PHOTON/Packet of light energy
ELECTROMAGNETICSPECTRUM/List of all types of light
VISIBLE/Light we can see
ULTRAVIOLET/Light that causes burns
DIFFUSE/Type of reflection made by uneven surfaces
CONCAVE/Mirror that makes things look bigger
CONVEX/Lens that works on the farsighted
RETINA/Part of eye that detects light
GREEN/The three colors we see are red, blue, and ___.
SEISMIC/Earthquakes are the result of ___ waves.

APPENDIX A
FINAL EXAM REVIEW L

Name: ______________________ Hour: _______ **Final Exam Review**

This review is due the day you take the Final Exam. There are NO EXCEPTIONS. If this review is complete and turned in on time, you will earn extra credit points toward your final exam score.

Energy

1. Identify the 5 forms of energy and give an example of each.
   a. ______________________
   b. ______________________
   c. ______________________
   d. ______________________
   e. ______________________

2. The difference between potential energy and kinetic energy is that PE is __________ and KE is __________.

3. What energy conversions take place in a car engine?
   ____

4. What energy conversions take place in a battery-powered flashlight?
   ____

5. State the three parts of the Law of Conservation of Energy.
   a. ______________________
   b. ______________________
   c. ______________________

6. Which formula can be used to determine the amount of energy in any object? _______

7. Where is nuclear energy stored? ______________________

8. What are the three types of nuclear reaction and where does each occur?
   a. ______________________
   b. ______________________
   c. ______________________

9. There is enough nuclear energy in a person to run Michigan for ____________ years.

10. What causes thermal energy? ______________________

11. What do we call the temperature where all molecules stop moving? ____________

12. Identify the three ways thermal energy is transferred and give an example of each.
    a. ______
    b. ______
    c. ______

Motion

13. Define motion. ______

14. What do we call motion where only one direction is involved? ______

15. What is the most common frame of reference? ______

16. What is the difference between distance and displacement? ______
______

17. What do you need to know to determine speed? ______

18. How is velocity different from speed? ______

19. Define acceleration. ______

20. What three situations count as acceleration?
    a. ______
    b. ______
    c. ______

21. Graphing on a distance-time graph
    a. What is on the X-axis? ______
    b. What is on the Y-axis? ______
    c. The steeper the slope, the ______ the speed.
    d. What shape indicates no motion? ______
    e. What shape indicates acceleration? ______

Forces

22. What is a force? ______

23. What is the difference between contact and non-contact forces? ______
______

24. What are balanced forces? ______

25. Which force opposes motion? ______

26. Moving objects experience ___________ friction, while stationary objects experience ____________ friction.

27. Identify the tree types of kinetic friction and give an example of each.

a. ______________________________
b. ______________________________
c. ______________________________

28. Describe two ways to decrease the friction on a playground slide.

a. ______________________________
b. ______________________________

29. State Newton's First Law. ______________________________
____

30. What term means resistance to changes in motion? ______________________

31. According to Newton's Second Law, what two factors determine the force exerted by an object? a. ______________________ b. ______________________

32. State Newton's Third Law. ______________________________

33. Identify the action and reaction forces of a gun firing.

Action: ____________________ Reaction: ____________________

34. If you increase the ____________ or the ___________ of an object, its momentum increases.

35. According to the Law of Conservation of Momentum, momentum is ____________ in a collision.

36. According to Newton's Law of Universal Gravitation, increasing the ________ of objects increases their gravitational attraction, while increasing the ___________ between objects decreases the gravitational attraction between them.

37. What term refers to the force your mass exerts on the ground due to gravity? ______

38. What three factors influence the motion of a projectile?

a. ______________________________
b. ______________________________
c. ______________________________

39. Projectile motion involves objects moving in two different ways at the same time. What do we call this type of motion? ______________________

40. What do we call motion where an object moves around a central point or points? ___

41. During circular motion, the object accelerates toward ______________ and inertia carries it toward ______________.

42. In orbit motion, object will fly away if ______________ or ______________. Orbiting objects will crash if ______________ or ______________.

Work

43. What three things must be true in order for something to count as work?
   a. ______________
   b. ______________
   c. ______________

44. To increase the Power of a machine, you can increase ________ or decrease ______.

45. Gravitational Potential energy is based on which three things?
   a. ______________
   b. ______________
   c. ______________

46. Kinetic Energy of moving objects is based on ____________ and ____________.

47. The Total Energy of a falling object is ____________, because as ____________ decreases, ____________ increases.

48. What do we call devices that are designed to make work easier? ______________

49. Most machines make work easier by decreasing the ____________ needed and increasing the ____________ traveled.

50. Name the 6 simple machines.
   a. ______________ d. ______________
   b. ______________ e. ______________
   c. ______________ f. ______________

51. What do we call motion that repeats in a pattern and causes changes in potential and kinetic energy? ______________________

52. What two factors influence periodic motion?
   a. ____
   b. ____

53. In the swing of the pendulum, where is the kinetic energy the greatest? __________________ Where is the kinetic energy the lowest? __________________

Electricity and Magnetism

54. What is the charge on a proton? ___________ On an electron? ___________ Which can move? ____________________

55. State the Rule of Interactions (also known as the Law of Electrostatic Forces) ____

56. Identify the three types of static charging and give an example of each.
   a. ____
   b. ____
   c. ____

57. What name is given to the release of a static charge? ________________________

58. Static electricity generally heads downward. This is called ____________________

59. What do we call a complete path for electricity to follow? ____________________

60. If a circuit is incomplete, it is called a/an __________ circuit.

61. If a circuit has only one path, it is a ______________ circuit.

62. If a circuit contains multiple paths, it is a ________________ circuit.

63. What are the three required parts of all circuits and what does each do?
   a. ____
   b. ____
   c. ____

64. What does a switch do in a circuit? ____________________________________

65. What do we call a circuit component that purposely slows electricity? ___________

66. What are the two safety features that prevent power surges? _____ and __________

67. What are the three things we measure in a circuit and what does each tell us?
a. ____
b. ____
c. ____

68. What do we call the amount of electricity needed to make an appliance turn on?_____

69. What do we call the amount of electricity an appliance uses during the whole time that it is on?____________________

70. Magnetism is the result of __________ electrons ___________ in the same direction.

71. What do we call a coil of wire used to make a magnetic field? ________________

72. List three ways to increase the strength of an electromagnet.
a. ____
b. ____
c. ____

73. List three places where you can find electromagnets being used.
a. ____
b. ____
c. ____

74. In an electric motor, what is the function of each of the following parts?
a. Solenoid: ____
b. Armature: ____
c. Commutator: ____
d. Power Source: ____
e. Standard magnet: ____

75. An electric motor converts ______________ energy into ______________ energy, while a generator does the opposite.

Waves

76. What is a wave? ____

77. What do we call the substance that a wave is traveling in? ________________

78. Draw a wave and label the crest, trough, wavelength, and amplitude.

79. If we want to know how much energy the wave has, what should we look at? ______

80. The speed of a wave in a given medium is ____________________.

81. If you increase the frequency of a wave, the wavelength ____________________.

82. When a wave bounces off a surface, it is called ____________________.

83. When a wave bends as it travels from one medium to another, it is called _________.

84. The further you stand from the source of a wave, the lower the ________________.

85. When two waves combine to form a bigger wave, it is ______________ interference.

86. When two waves combine and cancel each other, it is ______________ interference.

87. The pitch of a sound increases when frequency __________ or wavelength ________.

88. The volume of a sound is related to the ______________________.

89. When a source of sound approaches you, it gets higher. When it moves away, it gets lower. What do we call this phenomenon? ___________________________.

90. In your ear, the sound vibrates the _______________, which causes _____ bones to vibrate, which in turn pull on the ______________. The __________ in this part of the ear pull on nerves to signal your brain.

91. What do we call the individual "bits" of light? ___________________

92. List the 7 parts of the electromagnetic spectrum in order of increasing frequency (decreasing wavelength) and give an example of how each is used.

a. ____________________
b. ____________________
c. ____________________
d. ____________________
e. ____________________
f. ____________________
g. ____________________

93. List the seven colors of the visible spectrum.

a. ____________ e. ____________
b. ____________ f. ____________
c. ____________ g. ____________
d. ____________

APPENDIX A
FINAL EXAM REVIEW L

94. A mirror makes a ______________ reflection while a wall makes a ____________ reflection.

95. Nearsightedness is corrected using _______________ lenses, while farsighted people require _______________ lenses.

96. What are the three primary colors of light? _________________________________
What are the three secondary colors of light? __________________________________

97. When all colors of light are mixed, we see _______________.

98. When we look at an object, the color we see is the color that is _________________.
If no light is reflected, we see that as _______________.

99. Light passes through the ____________ of the eye and enters the eyeball through the ____________. It is focused by the _________ on to the _______________.

100. The _________ cells sense light, while the _________ cells sense color.
________________ happens when the cone cells don't work properly and send the same signal to the brain for two different colors.

YES, you NEED to KNOW your UNITS!

For each item, write the unit that is used to measure it. A "word bank" is provided.

	Value	Unit		Value	Unit
1	Acceleration		13	Mechanical Power	
2	Current		14	Momentum	
3	Distance		15	Resistance	
4	Electric Energy		16	Speed	
5	Electric Power		17	Time	
6	Energy		18	Velocity	
7	Force		19	Voltage	
8	Frequency		20	Wave Speed	
9	Gravitational Potential Energy		21	Wavelength	
10	Gravity		22	Weight	
11	Kinetic Energy		23	Work	
12	Mass				

Units			
Amperes (A)	Joules (J)	meters (m)	Newtons (N)
Hertz (Hz)	kgm/s in a direction	meters (m)	Ohms (Ω)
Joules (J)	kilograms (kg)	meters/second (m/s)	seconds (s)
Joules (J)	Kilowatt-hours (kWh)	meters/second (m/s)	Volts (V)
Joules (J)	m/s/s	meters/second in a direction	Watts (W)
	m/s/s	Newtons (N)	Watts (W)

APPENDIX A

FINAL EXAM REVIEW L

1. What is the speed of a car that travels 100 km in 2 hours? ____________

2. What's the velocity of a plane that flies 2000 km from Michigan to Florida in 5 hours? ____________

3. What is the acceleration of a car that slows from 30 m/s to a complete stop in 6 s? ____________

4. What force is needed to accelerate a 20 kg mass at 4 m/s/s? ____________

5. What is the momentum of a 10kg bicycle traveling at a velocity of 5 m/s, West? ____________

6. How much does a 50 kg box weigh on the Moon (g = 1.6m/s/s)? ____________

7. What is the mass of a 200kg person on Zorg (g = 100 m/s/s)? ____________

8. How much work must be done to move a 30 Newton object a distance of 15 meters? ____________

9. How much Power is needed to do 400 Joules of Work in 20 seconds? ____________

10. If a 200 Newton person sits 2 meters from the center of a seesaw, how far from center will an 80 Newton person have to sit to balance them? ____________

11. How much current is needed to overcome a resistance of 25 Ohms at 175 Volts? ____________

12. What is the power rating of a device that draws .25 Amps of current at 200 volts? ____________

13. How much electrical energy is used by a 6 kilowatt space heater in 24 hours? ____________

14. If electricity costs $0.10 per kWh, how much will it cost to run the space heater? ____________

15. What is the frequency of a wave that makes 15 complete waves in 3 seconds? ____________

16. What is the speed of a wave that has a wavelength of 10 m and a frequency of 4 Hz? ____________

APPENDIX A
PROJECT SHEET LI

Forces Unit Project

Fly Me to the Moon

Perhaps the most incredible feat of mechanical engineering in the last century was the race to the space. This race required extensive work by different engineers, chemists, and astronomers. The goal—the first people in space, the first people on the moon.

We will not set our sights on quite so lofty a goal. Instead, we will focus on the rocket. Your job is to design and build a pressure rocket, then measure or calculate various factors of its performance.

Step 1: Build a Rocket
You need to construct a rocket using a two liter pop bottle. The rocket will be launched by pressurizing the air inside. The neck of the bottle must be the bottom of the rocket. Fins, nose cones, or other additions can be made of any reasonable material. Students will also be required to construct the device used to determine height (instructions will be provided).

Step 2: Launch Window
The rockets must be brought to school for launch on ______________. Rockets will be launched during class, with each rocket being launched once. Students will pressurize their own rockets. They will also be responsible for determining the height the rocket reaches and the full flight time of the rocket.

Step 3: Calculations
Using the height of the rocket and the time in air, students must calculate the following values for their rocket. All work must be shown to receive full credit.

Launch velocity
Fall velocity
Force at launch
Total Energy of the rocket

Other:

- Students may work alone or with one partner from any hour of Intro to Physics. If partners are in different hours, they will each have to collect data.
- Students may test rockets after school during the weeks before the project is due, but must make an appointment.
- Grades will be based on construction, performance, and calculations. Bonus points will be awarded for the rockets that fly highest

APPENDIX A
PROJECT SHEET LII

Introduction to Physics
Rocket Project Launch Day

Thought Question: ____
____

Answer: ____
____

Basics (To be measured at launch)

Mass of Rocket: ___________ Time in air: _______________

Angle at top of rise: ___________ Baseline: _______________

Height of Rocket: ___________ (Height = Tangent of angle * baseline)

Calculations

GPE at top of rise: ___________ (GPE = mass * gravity * height)

Velocity at launch: ___________ (velocity = √(2 * GPE / mass)

Rise time: ___________ (time = launch velocity / height)

Acceleration: ___________ (acceleration = ½ * height * rise time^2)

Force of launch: ___________ (Force = mass * acceleration)

Fall time: ___________ (Fall time = time in air – rise time)

Fall Velocity: ___________ (Velocity = gravity * fall time)

Momentum on impact: ___________ (momentum = mass * fall velocity)

Questions:

1. What is the purpose of the side fins on a rocket? ______________________
2. What is the purpose of the nose cone on the rocket? ______________________
3. What factors influence the flight of the rocket? ______________________
____
____
____
4. How could you change the rocket or launch to make the rocket go higher? ________
____
____
____

APPENDIX A
PROJECT SHEET LIII

Electricity and Magnetism
Unit Project

Welcome to the Eaton Rapids **Due: ___________**
Electrical Doohickey Emporium

You are a prototype engineer for a company specializing in battery-powered gadgets. The boss has just informed you that she expects to see a new invention on her desk in a few weeks, complete with all the specs and suggested marketing.

Requirements

Construct a working electrical device:

May be battery or solar powered, but not AC powered.
You may design your own or use instructions provided.
Must include power source, conductor path, load, and switch.
Difficulty points are based on the complexity of the device.

Create a companion pamphlet that includes:

Name of the device
Diagram showing the various parts of the device.
Price list of all items used.
Explanation of how the device works.
Electrical Specifications (current, voltage, and resistance of load)
Suggested target market (who should own this and why)
Advertisement for your device

Scoring

Brochure (50 total):

Name	5
Schematic of Device	10
Price List	5
Explanation of function	10
Electrical specifications	10
Target Market	5
Advertisement	5

Device (30 total):

Functionality	25
Difficulty	5+

Other (20 total):

Completed on time	5
Workmanship (device)	10
Neatness (brochure)	5

APPENDIX A
PROJECT SHEET LIV

Students: ________________________________ Hour: ______

Project Results/Grade Sheet
Eaton Rapids Electrical Doohickey Emporium

Device

Functionality	________	/ 25
Difficulty	________	/ 5+

Brochure

Name	________	/ 5
Schematic of Device	________	/ 10
Price List	________	/ 5
Explanation of function	________	/ 10
Electrical specifications	________	/ 10
Target Market	________	/ 5
Advertisement	________	/ 5

Other

Completed on time	________	/ 5
Workmanship (device)	________	/ 10
Neatness (brochure)	________	/ 5

TOTAL	________	/ 100

APPENDIX A
PROJECT SHEET LV

Waves Unit Project
Due: ________________

Sounds of Music

You are a world famous concert musician, and a virtuoso on a most unique instrument. What that instrument is, you decide!

Build a musical instrument:
- Must play at least 3 different notes

Perform for the teacher:
- Must perform a song involving at least three different notes.
- Can be performed by a group, but all instruments must play at least three different notes and play the whole song.
- Performance times will be available in class for soloists and groups from the same hour. Groups involving people from different classes will perform at lunch or after school.

Provide a program* of your performance:
- Biography of performer
- Family to which your instrument belongs and explain why it belongs there.
- Schematic of the instrument's construction
- Explain how it produces sound waves
- Explain how the pitch (note) is varied
- Identify the song to be performed and provide sheet music for it.

*You may create one program for the entire orchestra, provided that all information is given for each person and their instrument.

Grading Criteria

Instrument construction: 25 points
Performance: 25 points
Program: 50 points
Biography: 5 points
Instrument family and explanation: 10 points
Schematic: 5 points
Explanation of sound: 10 points
Explanation of motes: 10 points
Music: 5 points
Neatness: 5 points

APPENDIX A
PROJECT SHEET LVI

Sound of Music Song List

Bonnie Bee

B B B B A A B
Bless you, bless you, Bonnie Bee
B B B B A A B
Say when will your wedding be?
B B B B A A B
If it be tomorrow day,
B B B B A A G
Take your wings and fly away.

Hot Cross Buns

B A G
Hot cross buns
B A G
Hot Cross buns
G G G G A A A A
One-a penny, two-a penny
B A G
Hot cross buns

Mary Had A Little Lamb

B A G A B B B
Mary had a little lamb
A A A
little lamb
B B B
little lamb
B A G A B B B
Mary had a little lamb
B A A B A G
Whose fleece was white as snow

APPENDIX A
PROJECT SHEET LVI

Au Claire De La Lune

G G G A B A
If you go to Pa-ris,
G B A A G
You must parle Francais
G G G A B A
They won't understand you
G B A A G
If you parle Anglais.

Lightly Row (in G)

D B B
Lightly row
C A A
Lightly row
G A B C D D D
O'er the sparkling waves we go
D B B
Lightly row
C A A
Lightly row
G B D D G
O'er the waves we go

Aunt Rhodie

B B A G G
Go tell Aunt Rhodie
A A B A G
Go tell Rho-O-die
D D C B B
Go tell Aunt Rhodie
A G A B G
Old grey goose is dead

APPENDIX A
PROJECT SHEET LVI

When the Saints Go Marching In

G B C D
Oh when the saints
G B C D
Go marchin' in
G B C D B G B A
Oh when the saints go marchin' in
B B A G B D D C
I want to be in that number
B C D B G A G
When the saints go marchin' in

Ode to Joy (in G)

B B C D D C B A
G G A B B A A
B B C D D C B A
G G A B A G G
A A B G A BC B G
A BCB A G A A
B B C D D C B A
G G A B A G G

Good King Wenceslas

C C C D C
Good King Wenceslas
C G
looked out
A G A B C C
o'er the feast of Stephen
C C C
And the snow
D C C G
lay round about
A G A B C C
cool and crisp and even

APPENDIX A
PROJECT SHEET LVI

Jingle Bells

B B B
Jingle Bells
B B B
Jingle Bells
B D G A B
Jingle all the way
C C C C C B B
Oh what fun it is to ride
B B B A A B A D
In a one horse open sleigh hey!
B B B
Jingle Bells
B B B
Jingle Bells
B D G A B
Jingle all the way
C C C C C B B
Oh what fun it is to ride
B B D D B A G
In a one horse open sleigh

Michael Row the Boat Ashore

F A C A C D C
Michael row the boat ashore
A C D C
Hal-le-lu-jah
A C C A C A G
Michael row the boat ashore
F G A G F
Hal-le-lu-jah

APPENDIX A
PROJECT SHEET LVI

Blackbird

G G G G GG G D D
Blackbird singing in the dead of night,
B G A A A G C D B
Take these broken wings and learn to fly.
A B G
All your life,
G G GA BA G E A G B
You were only waiting for this moment to
A G
arise.

Annie's Song

C C B A C B
You fill up my senses
A A A BC G E
Like a night in a forest
G G G A B C B
Like the mountains in springtime
A A A B C B
Like a walk in the rain
C C C B A C B
Like a storm in the desert
A A A B C G E
Like a sleepy blue ocean
G G A B C B
You fill up my senses
A B C D C
Come fill me again

Hush Little Baby

d BB B C B A A A
Hush little baby, don't say a word.
d d A A A A B A G G
Mama's going to buy you a mockingbird.
d d B B C B A A
And if that mockingbird won't sing,
d d A A A A B A G G
Mama's going to buy you a diamond ring.

APPENDIX A
PROJECT SHEET LVII

Name: ____________________

INTRODUCTION TO PHYSICS
FINAL STUDENT SURVEY

Please honestly rate all of the following classroom activities or ideas using the scale provided. Additional comments or suggestions are welcome.

5 = This was a great idea and helped me learn; keep it for next year.
4 = This was a good idea and helped me learn, but needs some work.
3 = This was neither a good nor a bad idea; it didn't help or hurt my learning.
2 = This was a bad idea that made it harder for me to learn; it needs serious changes.
1 = This was a bad idea that made it difficult for me to learn, and it should be dumped.

Activities and Ideas	Rank					Comments
1. Binders & Binder Checks	5	4	3	2	1	
2. Thought Questions	5	4	3	2	1	
3. PowerPoint lecture notes	5	4	3	2	1	
4. Daily Labs	5	4	3	2	1	
5. Daily Quizzes	5	4	3	2	1	
6. Unit Projects	5	4	3	2	1	
7. Classroom presentations	5	4	3	2	1	
8. Lab Competitions	5	4	3	2	1	
9. Limited Homework	5	4	3	2	1	
10. Test reviews organized by day	5	4	3	2	1	

Best Project: ____________________ Worst Project: ____________________

Best Lab: ____________________ Worst Lab: ____________________

Best Unit: ____________________ Worst Unit: ____________________

APPENDIX B:

FORMATIVE AND SUMMATIVE ASSESSMENTS

APPENDIX B

ASSESSMENT I

Name: ______________________ **Hour:** ______ **Date:** ________________

Introduction to Physics Pretest

Multiple Choice

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

____ 1. What type of circuit allows electricity to flow through more than one path?

a. Open b. Parallel c. Closed d. Series

____ 2. If you were transported to another planet, what would change about you?

a. Your weight c. Your personal gravity

b. Your mass and your weight d. Your mass

____ 3. Which of the following illustrated Newton's Third Law?

a. Flying over the handlebars of your bicycle when you use the front brake.
b. Gas mileage of a VW bug is better than the gas mileage of an SUV.
c. The greater the mass of a planet, the greater the force of gravity it exerts.
d. Recoil of a gun when a bullet is fired.

____ 4. Light travels from air into water. What will happen to the beam when it encounters the water?

a. It will refract only
b. It will reflect only
c. It will only be absorbed.
d. Some will reflect, some will refract, and some will be absorbed.

____ 5. How does a lever make it easier to do the work of lifting something?

a. Levers increase the energy you apply.
b. Levers increase the power of your arms.
c. Levers decrease the amount of force you must use.
d. Levers decrease the amount of work that has to be done.

____ 6. Which of the following best explains the energy transformation in a gasoline engine?

a. Chemical becomes mechanical and heat c. Electromagnetic becomes mechanical

b. Mechanical becomes chemical d. Nuclear becomes mechanical

____ 7. Why does a balloon get a static charge when you rub it on your head?

a. Electrons from the balloon move to your head.
b. Protons from your head move to the balloon.
c. Electrons from your head move to the balloon.
d. Protons from the balloon move to your head.

APPENDIX B
ASSESSMENT I

____ 8. What type of energy is in a stretched rubber band?

a. Kinetic Nuclear
b. Kinetic Chemical
c. Potential Mechanical
d. Potential Electromagnetic

____ 9. What type of motion is demonstrated by a pendulum?

a. Periodic motion
b. Circular motion
c. Two dimensional motion
d. One dimensional motion

____ 10. Which of the following is not accelerating?

a. A car parked on a hill
b. A car speeding up
c. A car turning a corner
d. A car slowing down

____ 11. If you double the distance between two planets, what happens tot he gravitational attraction between them.

a. It decreases to one half.
b. It remains the same.
c. It decreases to one quarter.
d. It increases to double.

____ 12. Which force(s) keep the Moon in orbit around the Earth?

a. Gravitational force
b. Inertial force
c. Gravitational and Inertial forces
d. Gravitational and Tidal forces

____ 13. John beat James in a tug of war. Which of the following best explains why John won?

a. John exerts more force on the ground than James.
b. John exerts less force on the ground than James.
c. John exerts less force on the rope than James.
d. John exerts more force on the rope than James.

____ 14. Which of the following rules describes how electric charges interact?

a. Negative charges attract positive charges.
b. Positive charge attract other positive charges.
c. Neutral objects repel both positive and negative charges.
d. Negative charges attract both positive and negative charges.

____ 15. Which of the following devices uses the relationship between electricity and magnets to function?

a. Electric motor
b. Electric generator
c. Stereo speaker
d. All of the above

____ 16. If we increase the frequency of a wave, what else will happen?

a. Wavelength will increase.
b. Speed will decrease.
c. Wavelength will decrease.
d. Speed will increase.

APPENDIX B
ASSESSMENT I

____ 17. You walk five steps forward, then two steps back. What is your displacement form your original position?

a. 7 steps b. 5 steps c. 3 steps d. 2 steps

____ 18. How come a choir doesn't need microphones to be heard?

a. Destructive interference increases their wavelength.
b. Constructive interference increases their amplitude.
c. Constructive interference increases their frequency.
d. Destructive interference decreases their frequency.

____ 19. If a bicyclist experiences equal amounts of wind from the front and the back while bicycling, which of the following will occur?

a. He will tip over.
b. He will continue at a constant speed.
c. He will slow down.
d. He will speed up.

____ 20. If we increase the wavelength of green light, which of the following will occur?

a. The light will get brighter.
b. The color will shift to yellow.
c. The light will get dimmer.
d. The color will shift to blue.

APPENDIX B
ASSESSMENT II

Introduction to Physics
Energy 1 Quiz

Name: ____

1. What is energy?
    A. The ability to do work
    B. The ability to cause changes
    C. Both of the above
    D. None of the above

____

2. Which of the following is an example of chemical energy?
    A. Sunlight　　B. Candy bar
    C. Boiling water　　D. Sound

____

3. Which of the following is NOT a form of electromagnetic energy?
    A. Light　　B. Electricity
    C. Magnetism　　D. Sound

____

4. Your Mom wakes you up early on a Saturday morning. When you don't leap cheerfully out of bed, she says "You don't have a single bit of energy!" Is your mother correct? Explain your answer.

____

____

____

____

____

____

APPENDIX B
ASSESSMENT III

Introduction to Physics
Energy 2 Quiz

Name: ____

1. What happens during an energy conversion?
   A. Energy is lost
   B. Energy is gained
   C. Energy changes form
   D. Energy is created

____

2. Which of the following machines converts chemical energy into mechanical energy?
   A. Hair dryer B. Gasoline engine
   C. Solar panel D. Thermocouple

____

3. Which of the following machines converts mechanical energy into electromagnetic energy?
   A. Generator B. Hair dryer
   C. Battery D. Electric motor

____

4. Which of the following best describes the conversions taking place in a battery-powered flashlight?
   A. Electromagnetic to thermal
   B. Chemical to mechanical
   C. Nuclear to electromagnetic
   D. Chemical to electromagnetic and thermal

____

5. Which of the following statements is part of the Law of Conservation of Energy?
   A. Energy can be created
   B. Energy cannot be destroyed
   C. Energy must remain in one form
   D. None of the above

____

APPENDIX B
ASSESSMENT IV

Introduction to Physics
Energy 3 Quiz

Name: ____

1. Where is nuclear energy stored?
   A. In electrons
   B. In moving objects
   C. In the center of the atom
   D. In bonds between atoms

   ____

2. Which type of nuclear reaction releases energy slowly as parts of the nucleus break?
   A. Fusion B. Fission
   C. Radioactive Decay D. None of these

   ____

3. Which type of nuclear reaction releases the most energy?
   A. Fusion B. Fission
   C. Radioactive Decay D. None of these

   ____

4. In Einstein's formula $E=mc^2$, what does m stand for?
   A. Matter B. Mass
   C. Motion D. Momentum

   ____

5. A person's body contains enough nuclear energy to light a light bulb for _____ years.
   A. 2 hundred B. 2 thousand
   C. 2 million D. 2 billion

   ____

APPENDIX B
ASSESSMENT VI

Introduction to Physics
Energy 4 Quiz

Name: ______________________________

1. Where does thermal energy come from?
   A. Bonds between atoms
   B. The nucleus of the atom
   C. Movement of electrons
   D. Movement of molecules

   ____

2. Which form of heat transfer creates air currents?
   A. Conduction   B. Convection
   C. Radiation   D. Fusion

   ____

3. A hot plate heats things in direct contact with the heating surface. This is an example of which kind of heating?
   A. Conduction   B. Convection
   C. Radiation   D. Fusion

   ____

4. The temperature at which all molecular motion stops is called:
   A. Freezing Point   B. Sublimation Point
   C. Boiling Point   D. Absolute Zero   ________

5. The absorption of infrared light by an object is an example of which kind of heating?
   A. Conduction   B. Convection
   C. Radiation   D. Fusion

   ____

APPENDIX B
ASSESSMENT VI

Introduction to Physics
Energy 5 Quiz

Name: ____

1. Which of the following is an example of chemical energy?
   A. Lightning B. Thunder
   C. Atomic Bomb D. Gasoline

____

2. Which of the following best describes the conversions taking place in a hair dryer?
   A. Nuclear to Mechanical
   B. Electromagnetic to Chemical
   C. Electromagnetic to Mechanical and Thermal
   D. Chemical to Electromagnetic and Thermal

____

3. Which type of nuclear reaction could occur within the human body without killing the person?
   A. Fusion
   B. Fission
   C. Radioactive Decay
   D. None of the above

4. Which of the following is an example of thermal energy transfer by conduction?
   A. Hot air rising from a vent in the floor
   B. Tongue getting frozen to a cold flagpole
   C. The basement is the coldest room in the house.
   D. Black T-shirt getting warm in the sun

____

5. You mix 20 mL of 100 degree water with 80 mL of 50 degree water. What is the final temperature?
   A. 50 degrees B. 60 degrees
   C. 90 degrees D. 100 degrees

____

APPENDIX B
ASSESSMENT VII

Introduction to Physics
Motion 1 Quiz

Name: ____

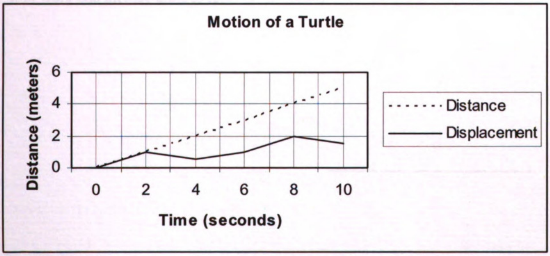
1. What term means a change in position relative to a frame of reference?
   A. Motion B. Distance
   C. Displacement D. Acceleration
   ____

2. Which frame of reference is most commonly used for experiments?
   A. Sun B. Scientist
   C. Earth D. Body
   ____

3. A person walks 3 meters east and then 4 meters north. How much distance has he traveled?
   A. 1 meter B. 7 meters
   C. 5 meters D. 3.5 meters
   ____

4. Refer to the graph below. What was the turtle's displacement at time=5 seconds?
   ____

5. Refer to the graph below. How much distance had the turtle traveled in 8 seconds?
   ____



APPENDIX B
ASSESSMENT VIII

Introduction to Physics
Motion 2 Quiz

Name: ______________________________________

1. How is speed defined?
   A. Distance traveled per unit time
   B. Change in position relative to a frame of reference
   C. Change in velocity over time
   D. Displacement of object per unit time

   ____

2. What type of speed measurement is used for long distance travel?
   A. Constant speed
   B. Velocity
   C. Acceleration
   D. Average speed

   ____

3. Which of the following is *not* a unit of speed?
   A. Meters per second
   B. Centimeters per year
   C. Weeks per inch
   D. Kilometers per hour

   ____

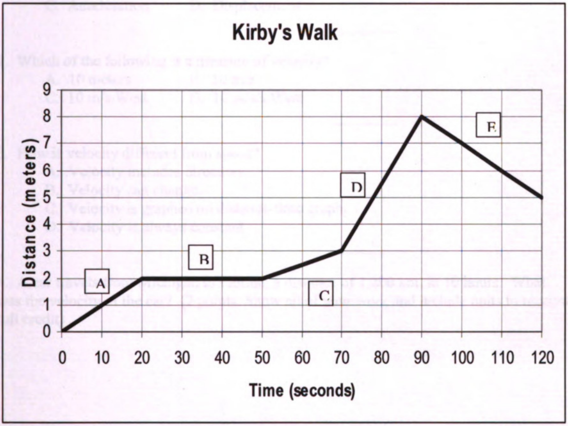
4. A track athlete runs 400 meters in 20 seconds. What is her speed? (2 points. Show all of your work and include units to receive full credit)

APPENDIX B
ASSESSMENT IX

Introduction to Physics
Motion 3 Quiz

Name: ______________________________________

Mr. Anderson's tortoise, Kirby, was roaming the halls one day after school. Use the graph below to answer the questions about Kirby's travels.



1. What was Kirby's maximum displacement? ____________

2. What was Kirby's speed in Section A? ________________

3. In which section does Kirby move the fastest? __________

4. In which section is Kirby returning home? ______________

5. Kirby found some lettuce in the hallway and stopped to eat it. Which section shows Kirby staying still?

____

APPENDIX B
ASSESSMENT X

Introduction to Physics
Motion 4 Quiz

Name: ______________________________

1. What term means speed in a given direction?
   A. Motion B. Velocity
   C. Acceleration D. Displacement
   ____

2. Which of the following is a measure of velocity?
   A. 10 meters B. 10 m/s
   C. 10 m/s West D. 10 m/s/s West
   ____

3. How is velocity different from speed?
   A. Velocity includes direction.
   B. Velocity can change.
   C. Velocity is graphed on distance-time graph.
   D. Velocity is always constant
   ____

4. A car travels from Michigan to Florida, a distance of 1,200 km, in 10 hours. What was the velocity of the car? (2 points. Show all of your work and include units to receive full credit)

____

APPENDIX B
ASSESSMENT XI

Introduction to Physics
Motion 5 Quiz

Name: ______________________________________

1. What is acceleration?
    A. Change in position relative to a frame of reference
    B. Distance traveled per unit time
    C. Speed in a given direction
    D. Change in velocity over time

____

2. Which of the following is not accelerating?
    A. A car traveling in reverse at a constant speed.
    B. A car braking.
    C. A car turning a corner.
    D. A car stepping on the gas.

____

3. What shape on a graph indicates acceleration?
    A. Smooth slope
    B. Horizontal line
    C. Vertical line
    D. Curve

____

4. A roller coaster's velocity increases from 2 m/s to 20 m/s in 3 seconds as it moves down the first hill. What is its acceleration? (2 points. Show all of your work and include units to receive full credit)

____

APPENDIX B
ASSESSMENT XII

Introduction to Physics
Forces 1 Quiz

Name: ______________________________

1. What term means a push or a pull on an object?
    - A. Gravity B. Force
    - C. Magnitude D. Inertia

____

2. What type of force acts only when objects are touching?
    - A. Contact B. Non-contact
    - C. Balanced D. Unbalanced

____

3. What types of forces do not change motion?
    - A. Contact forces B. Non-contact forces
    - C. Balanced forces D. Unbalanced forces

____

4. You and a friend are trying to slide a heavy desk. You push from the left with a force of 10 N while your friend pulls from the right with a force of 8 N. Draw a force diagram showing all of the forces acting on the desk. (2 points)

APPENDIX B
ASSESSMENT XIII

Introduction to Physics
Forces 2 Quiz

Name: ______________________________

1. Which force opposes motion?
   - A. Gravity
   - B. Normal
   - C. Friction
   - D. Buoyancy

____

2. What type(s) of friction affect a downhill skier?
   - A. Sliding
   - B. Fluid
   - C. Sliding and Rolling
   - D. Sliding and fluid

____

3. Why can a car remain parked on a hill without moving down it?
   - A. Static friction is greater than gravity.
   - B. Kinetic friction is greater than gravity.
   - C. Static friction is less than gravity.
   - D. Kinetic friction is less than gravity.

____

4. List two ways you could decrease the friction you experience on a playground slide. (2 points)

   a. ______________________________________

   b. ______________________________________

APPENDIX B
ASSESSMENT XIV

Introduction to Physics
Forces 3 Quiz

Name: ______________________________

1. What term means "resists changes?"
   A. Acceleration B. Force
   C. Momentum D. Inertia

   ____

2. What effect does increasing mass have on inertia?
   A. Inertia increases
   B. Inertia decreases
   C. Inertia remains constant

   ____

3. Explain how seatbelts protect you from Newton's First Law. (3 points)

____

____

____

____

____

____

APPENDIX B
ASSESSMENT XV

Introduction to Physics
Forces 4 Quiz

Name: ________________________________

1. Which of the following exerts the greatest force?
    A. A 10 kg mass accelerating at 5 m/s/s
    B. A 75 kg person with a velocity of 1 m/s
    C. A 100 kg motorcycle accelerating at 0.5 m/s/s
    D. A 0.1 kg bullet accelerating at 800 m/s/s

____

2. If we increase the mass of a car, what happens to the force needed to move it?
    A. Force needed increases
    B. Force needed decreases
    C. Force needed does not change?

____

3. What effect does an airbag have on the body's force of impact during a car accident?
    A. Increases time of impact, which decreases force.
    B. Decreases mass at impact, which decreases force.
    C. Increases velocity of impact, which decreases force
    D. Increases acceleration, which decreases force.

____

4. Calculate the mass of a ball that accelerates at a rate of 15 m/s/s when kicked with a force of 45 Newtons. (2 points. Show all of your work and include units to receive full credit)

____

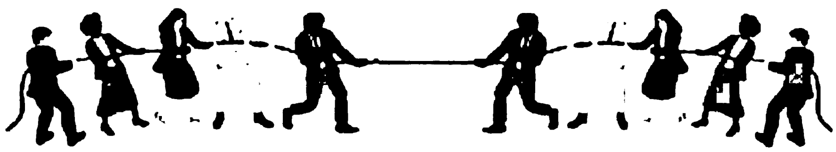
APPENDIX B
ASSESSMENT XVI

Introduction to Physics
Forces 5 Quiz

Name: ______________________________

1. According to Newton's Third Law, every force has...
   A. A change in velocity B. An opposing force
   C. No acceleration D. An unbalancing effect

____



Team A Team B

Two teams are playing tug of war. Team B is winning

2. If we measured the force on the rope, which end would show more force?
   A. Team A's end
   B. Team B's end
   C. The force is the same at both ends.

____

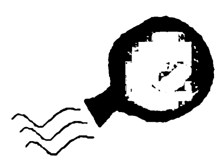
3. If we measure the force on the ground, which team is applying more force?
   A. Team A
   B. Team B
   C. Both apply the same force on the ground.

____

4. Identify the action and reaction forces in a flying balloon.

   Action: __________________

   Reaction: _________________



APPENDIX B
ASSESSMENT XVII

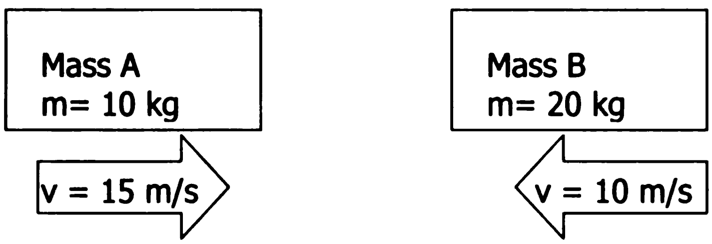
Introduction to Physics
Forces 6 Quiz

Name: ________________________________

1. According to the Law of Conservation of Momentum, momentum is _____ in a collision.

   A. Transferred B. Gained
   C. Lost D. Destroyed

____



2. What is the momentum of Mass A? (2 points; include units and direction)

____

3. Predict what would happen if these two objects collided and stuck together:

   a. Which direction would they travel? ____________

   b. What would the overall speed be?
      A. More than 15 m/s
      B. Between 10 and 15 m/s
      C. Less than 10 m/s

____

APPENDIX B
ASSESSMENT XVIII

Introduction to Physics
Forces 7 Quiz

Name: ______________________________

1. According to Newton's Law of Universal Gravitation, increasing _____________ will **increase** the attraction between two objects, while increasing _____________ will **decrease** gravitational attraction between two objects.

2. Which of the following occurs because of gravity?
   A. Satellites stay in orbit
   B. Apples fall from trees
   C. The oceans have tides
   D. All of the above.

____

3. What name is given to the force you exert as a result of gravity?
   A. Weight B. Momentum
   C. Inertia D. Mass

____

4. How much would a 50 kilogram person weigh on the Moon (g_{Moon}=1.6 m/s/s)? (2 points. Show all of your work and include units to receive full credit)

____

APPENDIX B
ASSESSMENT XIX

Introduction to Physics
Forces 8 Quiz

Name: ______________________________

1. What term is used to refer to the fastest speed at which an object can fall?
   A. Free fall B. Terminal velocity
   C. Momentum D. G-force

   ____

2. What force opposes an object's fall in Earth's atmosphere?
   A. Normal B. Buoyancy
   C. Ytivarg D. Drag

   ____

3. When a human skydiver reaches terminal velocity, what happens to her acceleration?
   A. Increases
   B. Decreases
   C. Remains constant at 9.8m/s/s
   D. Remains constant at 0 m/s/s

   ____

4. When a human skydiver reaches terminal velocity, what happens to her speed?
   A. Increases
   B. Decreases
   C. Remains constant at ~56 m/s
   D. Remains constant at 0 m/s

   ____

5. What does a parachute do for a skydiver?
   A. Increases drag
   B. Decreases terminal velocity
   C. Both of the above
   D. None of the above

   ____

APPENDIX B
ASSESSMENT XX

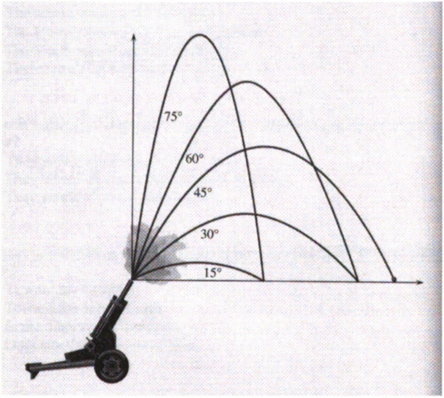
Introduction to Physics
Forces 9 Quiz

Name: ________________________________

1. In addition to angle, name the two factors that affect the flight path of a projectile. (2 points)

a. ________________________________
b. ________________________________

2. Look at the picture below. If we increase the launch angle of a projectile, what happens?



A. Distance traveled always increases
B. Distance traveled always decreases
C. Maximum height always increases
D. Maximum height always decreases

____

3. A bullet is fired from a gun held horizontally at a height of 2 meters off the ground. If g = 4 m/s/s, and the velocity of the bullet is 300 m/s, how far forward will the bullet travel before it hits the ground? (2 points. Show all of your work and include units to receive full credit)

____

APPENDIX B
ASSESSMENT XXI

Introduction to Physics
Forces 10 Quiz

Name: ________________________________

1. What general name is given to any motion around a central point or points?
   A. Orbital motion   B. Circular motion
   C. Centripetal acceleration   D. The Hokey-pokey

____

2. If the speed of the Moon were to increase, what would happen to the Moon's orbit?
   A. The Moon would crash into Earth
   B. The Moon's orbit would remain constant
   C. The Moon would escape Earth orbit
   D. There would always be a full moon

____

3. If the Earth's gravity suddenly increased, what would happen to the satellites we have in orbit now?
   A. They would all fly away
   B. They would all stay in their current positions
   C. They would all crash into Earth

____

4. If an object is undergoing centripetal acceleration, which direction is it accelerating toward?
   A. Toward the center
   B. Toward the outside edge
   C. In the direction of the spin
   D. Opposite the direction of spin

____

5. Which of the following is an example of circular motion?
   A. Running around the track
   B. A toy top spinning
   C. Both of the above
   D. None of the above

____

APPENDIX B
ASSESSMENT XXII

Introduction to Physics
Work 1 Quiz

Name: ________________________________

1. What do you have to do in order to do work?
   - A. Apply a force
   - B. Move an object
   - C. Move in the direction of force
   - D. All of the above

____

2. What term means "the rate at which work is done?"

   A. Work B. Power
   C. Joules D. Watts

____

3. Which of the following would increase the power of a machine?
   - A. Increasing the force it applies
   - B. Increasing the amount of time it takes to work
   - C. Both of the above
   - D. None of the above

____

4. How much work must be done to lift a 500 Newton weight a distance of 4 meters? (2 points. Show all of your work and include units to receive full credit)

____

APPENDIX B
ASSESSMENT XXIII

Introduction to Physics
Work 2 Quiz

Name: ______________________________

1. If a machine increases the distance you must move, what happens to the force you must use?
    A. Force needed increases
    B. Force needed decreases
    C. Force needed remain the same

____

2. What prevents a machine from using all of your energy to do work?
    A. Mechanical Advantage B. Efficiency
    C. Friction D. Force

____

3. Which of the following is an example of a simple machine?
    A. Scissors B. Screw
    C. Bicycle D. Pencil sharpener

____

4. A teacher weighing 600 Newtons is sitting 1 meter from the center of a teeter-totter. How far along the other side does a 200 Newton 3rd grader have to sit to balance the adult? (2 points; Show your work and include units to receive full credit)

____

APPENDIX B

ASSESSMENT XXIV

Introduction to Physics

Work 3 Quiz

Name: ______________________________

1. What term means "energy of moving objects?
   A. Friction
   B. Potential Energy
   C. Mechanical Energy
   D. Thermal Energy

____

2. Which of the following is storing mechanical energy?
   A. A bowling ball on a high shelf
   B. A bowling ball rolling along the lane
   C. A bowling ball sitting on the floor
   D. A bowling ball in a hole in the ground

____

3. Which factor is most important in determining kinetic energy?
   A. Mass
   B. Velocity
   C. Height
   D. All are equally important

____

4. What is the gravitational potential energy of a 5 kg mass sitting on a 40 meter tall cliff on the Moon (g = 1.6 m/s/s)? (2 points; Show your work and include units to receive full credit)

____

APPENDIX B
ASSESSMENT XXV

Introduction to Physics
Work 4 Quiz

Name: ______________________________

1. What term means patterned, repetitive motion that can be timed?
   A. One-dimensional motion
   B. Two-dimensional motion
   C. Circular motion
   D. Periodic Motion

____

2. What two factors control periodic motion?

   a. ______________________________

   b. ______________________________

3. Which of the following is an example of periodic motion?
   A. Orbiting the Earth
   B. Driving down the road
   C. Bouncing on a trampoline
   D. Projectile flying through the air

____

4. A child is playing on a swing set. Where is her kinetic energy the highest?
   A. At the highest point of the swing
   B. At the lowest point of the swing
   C. Her kinetic energy is constant

____

APPENDIX B
ASSESSMENT XXVI

Introduction to Physics
E&M 1 Quiz

Name: ________________________________

1. What part of an atom has an electric charge?
   A. Electrons B. Protons
   C. Both of these D. None of the above

____

2. Which electric charge(s) can move?
   A. Protons only
   B. Electrons only
   C. Neutrons only
   D. Protons and Electrons

____

3. Why does rubbing a balloon on your head give the balloon a charge?
   A. Electrons move from the balloon to your head.
   B. Protons move from the balloon to your head
   C. Electrons move from you head to the balloon
   D. Protons move from your head to the balloon

____

4. Fill in the blanks for the Law of Electrostatic Forces

_______________ charges attract.

_______________ charges repel.

APPENDIX B
ASSESSMENT XXVII

Introduction to Physics
E&M 2 Quiz

Name: ______________________________

1. What will happen if the two objects shown touch each other?

4+ 4-	6+ 2-

A. Protons will move from left to right and both will be positive
B. Protons will move from right to left and both will be negative
C. Electrons will move from left to right and both will be positive.
D. Electrons will move from right to left and both will be negative.

____

2. What term is given to the general downward movement of static charges?

A. Discharge B. Induction
C. Friction D. Grounding

____

3. On the back of this sheet, explain in your own words why a statically-charged balloon will stick to a neutral wall. You may include diagrams to aid your explanation, but must include a WRITTEN answer. (3 points)

APPENDIX B
ASSESSMENT XXVIII

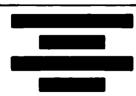
Introduction to Physics
E&M 3 Quiz

Name: ______________________________

Match each circuit part to its function and drawing.
(Each answer will be used twice)

A. Power Source
B. Conductor
C. Load—light bulb
D. Switch
E. Resistor

Functions	
1.	Carries electrons to the positive charge.
2.	Controls flow of electrons through the circuit.
3.	Produces electrons and attractive positive charge.
4.	Slows the flow of electricity.
5.	Uses energy from electrons.

Diagrams	
1.	
2.	
3.	
4.	
5.	

APPENDIX B
ASSESSMENT XXIX

Introduction to Physics
E&M 4 Quiz

Name: ______________________________

1. If Bulb 1 is removed from the circuit below, which other bulb(s) will go out?

____

2. If the switch is opened in the circuit below, which bulb(s) will go out?

____

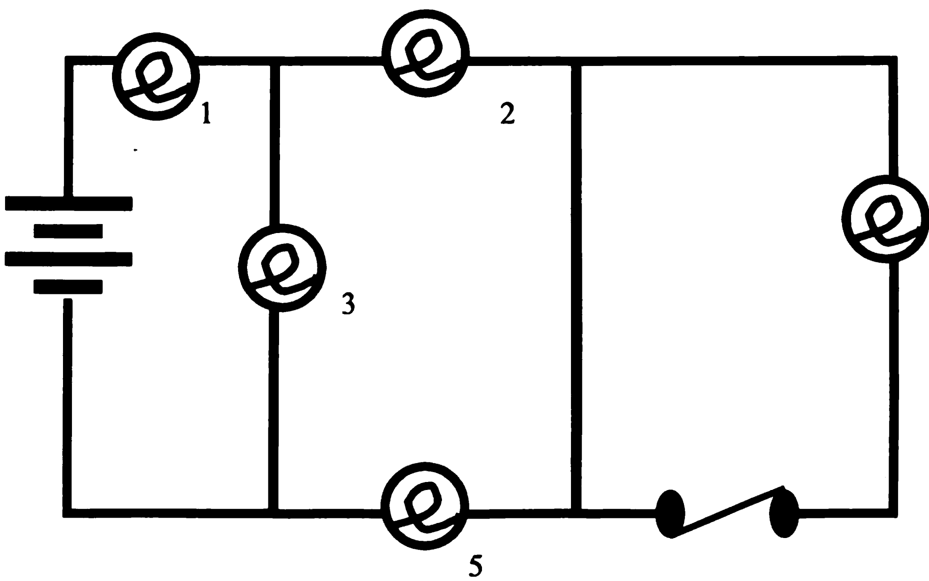
3. How many paths can electricity take through this circuit?

____

4. Are bulbs 2 and 3 wired in series or in parallel?

____

5. Where would be the best place to put a fuse it you were afraid of possible power surges and wanted to protect all bulbs?
Place an X at your answer.



APPENDIX B
ASSESSMENT XXX

Introduction to Physics
E&M 5 Quiz

Name: ________________________________

1. What term refers to the speed of moving electrons?
   A. Current B. Voltage
   C. Resistance D. Ohms

____

2. What term refers to anything which attempts to slow moving electrons?
   A. Current B. Voltage
   C. Resistance D. Ohms

____

3. What term refers to the strength of moving electrons?
   A. Current B. Voltage
   C. Resistance D. Ohms

____

4. You set up a circuit with a resistor that provides 3 Ohms of resistance. If the reading on the Voltmeter is 12 volts, how much current is flowing through the circuit? (2 points. Show all of your work and include units to receive full credit)

____

APPENDIX B
ASSESSMENT XXXI

Introduction to Physics
E&M 6 Quiz

Name: ________________________________

1. What term means the amount of electricity needed to make a device work?
   A. Electric Power B. Electric Energy
   C. Voltage D. Current

____

2. What term means the total amount of electricity used by an appliance in a certain amount of time?
   A. Electric Power B. Electric Energy
   C. Voltage D. Current

____

3. What unit is used to measure electric power?
   A. Amperes B. Volts
   C. Kilowatt-hours D. Watts

____

4. What is the power rating of a light bulb that draws 30 volts at a current of 3 Amperes? (2 points. Show all of your work and include units to receive full credit)

____

APPENDIX B
ASSESSMENT XXXII

Introduction to Physics
E&M 7 Quiz

Name: ________________________________

1. Which subatomic particle(s) is responsible for magnetism?
   A. Protons B. Neutrons
   C. Electrons D. Protons and Electrons

____

2. What do we call a coil of wire used to make a magnetic field?
   A. Iron B. Compass
   C. Solenoid D. Galvanometer

____

3. Which basic rule describes interactions between magnets?
   A. Like poles attract, opposite poles repel
   B. Opposite poles attract, like poles repel
   C. All magnets attract
   D. All magnets repel

____

4. Which of the following would increase the strength of an electromagnet?
   A. Increasing the number of loops in the solenoid
   B. Putting an iron core in the center
   C. Using more electrons
   D. All of the above

____

5. Which of the following uses magnetism?
   A. Hand-powered pencil sharpener
   B. Gasoline-powered car engine
   C. Compact discs and DVDs
   D. Telephone handset (the part you talk & listen with)

____

APPENDIX B
ASSESSMENT XXXIII

Introduction to Physics
E&M 8 Quiz

Name: ______________________________

1. What does an electric motor do?
   A. Converts thermal energy to mechanical energy
   B. Converts nuclear energy to electromagnetic energy
   C. Converts mechanical energy to electromagnetic energy
   D. Converts electromagnetic energy to mechanical energy

____

2. What is the purpose of the commutator of the motor?
   A. Provides electricity
   B. Carries electricity
   C. Repels the solenoid
   D. Switches the current on and off

____

3. Why does the electric motor require a regular magnet?
   A. It provides electricity
   B. It carries electricity
   C. It repels the solenoid
   D. It switches the current on and off

____

4. Which of the following would increase motor speed?
   A. Increasing the current
   B. Decreasing the voltage
   C. Decreasing the size of the solenoid
   D. Using wire with greater resistance

____

5. Which of the following devices uses an electric motor?
   A. A CD player B. A blender
   C. A hair dryer D. All of these

____

APPENDIX B
ASSESSMENT XXXIV

Introduction to Physics
Waves 1 Quiz

Name: ______________________________

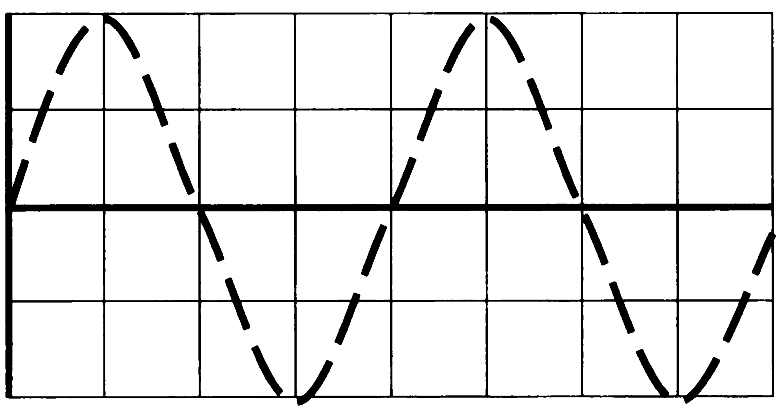
1. Label one crest and one trough on the wave below.

2. What is the wavelength of this wave? ______________

3. What is the amplitude of this wave? ________________

4. If the frequency of this wave is 6 hertz, what is its speed? (2 points. Show all of your work and include units to receive full credit)

____



1 box = 1 centimeter

APPENDIX B
ASSESSMENT XXXV

Introduction to Physics
Waves 2 Quiz

Name: ________________________________

1. What happens when a wave encounters a surface and bounces?
    A. Reflection B. Refraction
    C. Diffraction D. Interference

____

2. What happens when two waves interact with each other?
    A. Reflection B. Refraction
    C. Diffraction D. Interference

____

3. What term refers to the bending of a wave as it passes through different materials?
    A. Reflection B. Refraction
    C. Diffraction D. Interference

____

4. What terms refers to the spreading of light as it passes through openings, creating patterns?
    A. Reflection B. Refraction
    C. Diffraction D. Interference

____

5. Which wave interaction makes surround sound speakers sound so good?
    A. Diffraction
    B. Refraction
    C. Constructive interference
    D Destructive interference

____

APPENDIX B
ASSESSMENT XXXVI

Introduction to Physics
Waves 3 Quiz

Name: ______________________________

1. Which of the following is true for sound waves?
    A. Sound travels faster in low-density mediums.
    B. Sound cannot travel in space
    C. Sound waves are faster than light waves
    D. Sound is the result of movement of electrons

____

2. What is the relationship between frequency and pitch?
    A. Higher frequency makes higher pitch
    B. Higher frequency makes lower pitch
    C. Frequency does not change pitch

____

3. What determines the volume of a sound?
    A. Frequency   B. Wavelength
    C. Pitch   D. Amplitude

____

4. Based on the Doppler Effect, as a moving object approaches you, what happens to the sound?
    A. Pitch increases because wavelength decreases
    B. Pitch increases because wavelength increases
    C. Pitch decreases because wavelength decreases
    D. Pitch decreases because wavelength increases

____

5. What is the role of the ear drum in hearing?
    A. It signals the brain
    B. It collects the sound
    C. It tugs on the cochlea
    D. It makes the bones vibrate

____

APPENDIX B
ASSESSMENT XXXVII

Introduction to Physics
Waves 4 Quiz

Name: ________________________________

1. What do we call the packets of energy that make up light?
   A. Electrons B. Photons
   C. Wavelengths D. Hertz

____

2. Which of the following lists types of light in order of increasing frequency (decreasing wavelength)?
   A. Radio, IR, UV, X-ray, Gamma
   B. Gamma, X-ray, UV, IR, Radio
   C. IR, UV, Radio, Gamma, X-ray
   D. Radio, UV, IR, Gamma, X-ray

____

3. Which types of light can damage the human body?
   A. Radio, microwave, IR
   B. UV, X-rays, Gamma
   C. IR, Visible, UV
   D. Microwaves, IR, UV

____

4. Which of the following is used for sending signals?
   A. Radio Waves B. Microwaves
   C. Visible light D. All of the above

____

5. Which type of light is produced by the black light?
   A. Infrared B. Visible
   C. Ultraviolet D. Microwaves

____

APPENDIX B
ASSESSMENT XXXVIII

Introduction to Physics
Waves 5 Quiz

Name: ________________________________

1. What term is given to the bouncing of a wave off of a surface?
   A. Refraction B. Reflection
   C. Diffraction D. Interference

   ____

2. What type of mirror will give you a large but upside-down image?
   A. Plane
   B. Concave
   C. Convex

   ____

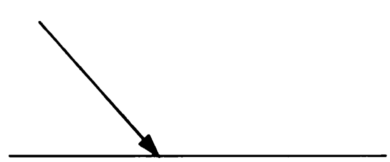
3. What shape of mirror is used in car rear-views mirrors and store security?
   A. Plane
   B. Concave
   C. Convex

   ____

4. What type of reflection comes off of a wall?
   A. Regular B. Plane
   C. Convex D. Diffuse

   ____

5. The picture below shows a beam of light hitting a plane mirror. Draw the reflected beam of light.



APPENDIX B
ASSESSMENT XXXIX

Introduction to Physics
Waves 6 Quiz

Name: ______________________________

1. What term is given to the bending of a wave as it passes between mediums?
   - A. Refraction B. Reflection
   - C. Diffraction D. Interference

____

2. What type of lens is used to correct nearsightedness?
   - A. Plane
   - B. Concave
   - C. Convex

____

3. What do we call a cut piece of glass or plastic that can separate light based on wavelength?
   - A. Concave mirror B. Concave lens
   - C. Convex lens D. Prism

____

4. What do we call the measurement that tells us how much light bends?
   - A. Curvature B. Interference Index
   - C. Index of Refraction D. Concavity

____

5. Sunlight is going into the convex magnifying glass below. Draw the beams of sunlight coming out.

APPENDIX B
ASSESSMENT XL

Introduction to Physics
Waves 7 Quiz

Name: ________________________________

1. What are the three primary colors of light?
   A. Red, Blue, Yellow
   B. Magenta, Cyan, Yellow
   C. Red, Blue, Green
   D. Magenta, Cyan, Green

____

2. What colors of light are reflected by yellow objects?
   A. Red and Blue
   B. Red and Green
   C. Blue and Green
   D. Cyan and Blue

____

3. What do we see when no light is reflected?
   A. White B. Magenta
   C. Ultraviolet D. Black

____

4. What color is made when Red and Blue light are mixed?
   A. Cyan B. Magenta
   C. Blue D. White

____

5. What part of the eye detects light?
   A. Pupil B. Iris
   C. Cornea D. Retina

____

APPENDIX B
ASSESSMENT XLI

Intro to Physics Unit 1 Test--Energy & Motion

Matching

Match each type of energy to its description.

a. Chemical
b. Electromagnetic
c. Mechanical
d. Nuclear
e. Thermal

1. Energy of moving atoms and molecules--"atomic wiggle."
2. Energy of moving electrons.
3. Energy holding together an atom's nucleus.
4. Energy in the bonds between atoms.
5. Energy of moving objects.

Identify the type of energy in each example.
Answers may be used **more than once**, but there is **only one answer** for each question.

a. Mechanical
b. Thermal
c. Chemical
d. Electromagnetic
e. Nuclear

6. Falling
7. Radio Waves
8. Firewood
9. Hamburger
10. Stars
11. Siren
12. Air conditioning
13. Atomic Bomb
14. Static shock
15. Evaporation

APPENDIX B
ASSESSMENT XLI

Match each unit to the quantity it measures (ex. Money is measured in Dollars)

a. meters
b. seconds
c. meters/second
d. meters/second, West
e. m/s/s

16. Acceleration
17. Distance
18. Speed
19. Time
20. Velocity

Multiple Choice

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

21. What is energy?

a. The ability to do work
b. The ability to cause changes
c. Both of the above
d. None of the above

22. Which of the following is an example of potential energy?

a. A burning candle
b. A vibrating guitar string
c. An unlit match
d. Lightning striking the ground

23. What happens during an energy conversion?

a. Energy is lost
b. Energy is gained
c. Energy changes form
d. Energy is created

24. Which of the following machines converts electromagnetic energy into mechanical energy?

a. Hair dryer
b. Gasoline engine
c. Solar panel
d. Thermocouple

25. Which of the following best describes the conversions taking place in a battery-powered flashlight?

a. Electromagnetic to thermal
b. Chemical to mechanical
c. Nuclear to electromagnetic
d. Chemical to electromagnetic and thermal

26. Which of the following machines converts electromagnetic energy into thermal energy?

a. Generator
b. Hair dryer
c. Battery
d. Car engine

APPENDIX B
ASSESSMENT XLI

27. Which of the following statements is part of the Law of Conservation of Energy?
a. Energy cannot be created
b. Energy can be destroyed
c. Energy must remain in one form
d. None of the above

28. Which of the following is an example of kinetic energy?
a. Food on your dinner plate
b. Gasoline in the tank
c. Batteries in their package
d. Music playing

29. Which type of nuclear reaction releases energy slowly as parts of the nucleus break?
a. Fusion
b. Fission
c. Radioactive Decay
d. None of these

30. Which type of nuclear reaction releases the most energy?
a. Fusion
b. Fission
c. Radioactive Decay
d. None of these

31. The border patrol is scanning vehicles for incoming nuclear materials. One car shows signs of nuclear energy coming from a bag of kitty litter. Which type of nuclear reaction could be occurring in the kitty litter?
a. Fusion
b. Fission
c. Radioactive Decay
d. None of the above

32. In Einstein's formula $E=mc^2$, what does m stand for?
a. Momentum b. Motion c. Matter d. Mass

33. A person's body contains enough nuclear energy to light a light bulb for _____ years.
a. 2 hundred b. 2 thousand c. 2 million d. 2 billion

34. Which of the following is an example of thermal energy transfer by conduction?
a. Hot air rising from a vent in the floor
b. Tongue getting frozen to a cold flagpole
c. The basement is the coldest room in the house.
d. Black T-shirt getting warm in the sun

35. Which form of heat transfer creates air currents?
a. Conduction b. Convection c. Radiation d. Fusion

APPENDIX B
ASSESSMENT XLI

36. The absorption of infrared light by an object is an example of which kind of heating?

a. Conduction b. Convection c. Radiation d. Fusion

37. Which form of heat transfer is used by the hot plate to heat up water?

a. Conduction b. Convection c. Radiation d. Fusion

38. The temperature at which all molecular motion stops is called...

a. Freezing Point c. Boiling Point
b. Sublimation Point d. Absolute Zero

39. You mix 30 mL of 100 degree water with 70 mL of 50 degree water. What is the final temperature?

a. 50 degrees b. 65 degrees c. 85 degrees d. 100 degrees

40. What term means a change in position relative to a frame of reference?

a. Motion b. Displacement c. Distance d. Acceleration

41. Which type of motion repeats in a pattern?

a. One dimensional b. Two dimensional c. Circular d. Periodic

42. Which frame of reference is most commonly used for experiments?

a. Sun b. Scientist c. Earth d. Body

43. A baseball player hits a foul ball. It is traveling away from him at 100 kmh and is moving upward. Using the ball as the frame of reference, what is the motion of the player?

a. He is not moving.
b. He is moving up and away at 100 kmh.
c. He is moving down and away at 100 kmh.
d. He is moving away at 100 kmh with no change in height.

44. A person walks 4 meters east and then 4 meters north. How much distance have the traveled?

a. 0 meters b. 8 meters c. 16 meters d. 5.5 meters

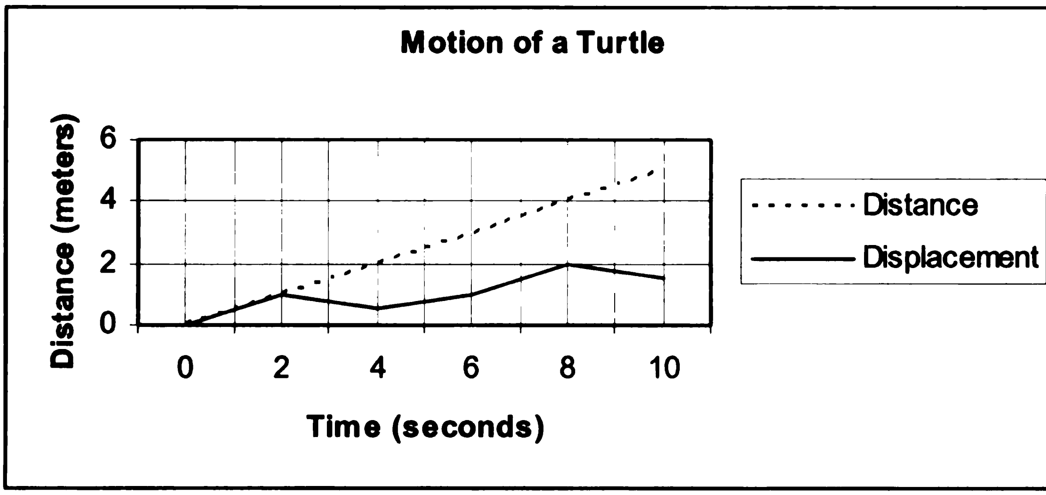
45. A man travels north 40 steps, then turns around and walks south for 15 steps. What is his displacement?

a. 55 steps b. 35 steps c. 40 steps d. 25 steps

APPENDIX B
ASSESSMENT XLI

46. How is speed defined?

a. Distance traveled per unit time
b. Change in position relative to a frame of reference
c. Change in velocity over time
d. Displacement of object per unit time



47. Refer to the graph above. What is the turtle's maximum displacement?

a. 1 meter b. 2 meters c. 5 meters d. 10 seconds

48. Refer to the graph above. At what time were the distance and displacement the same?

a. 2 seconds b. 4 seconds c. 6 seconds d. 8 seconds

49. Refer to the graph above. What was the average speed of the turtle?

a. 0.5 m/s b. 2 m/s c. 0.15 m/s d. 5 m/s

50. What type of speed measurement is used for long distance travel?

a. Constant speed b. Velocity c. Acceleration d. Average speed

51. What is the speed of an object at rest?

a. 15 km/h b. 0 km/h c. 1 km/h d. None of these.

52. What term means speed in a given direction?

a. Motion b. Velocity c. Acceleration d. Displacement

APPENDIX B

ASSESSMENT XLI

53. How is velocity different from speed?

a. Velocity includes direction.
b. Velocity can change.
c. Velocity is graphed on d-t graph.
d. Velocity is always constant

54. Which of the following does *not* indicate velocity?

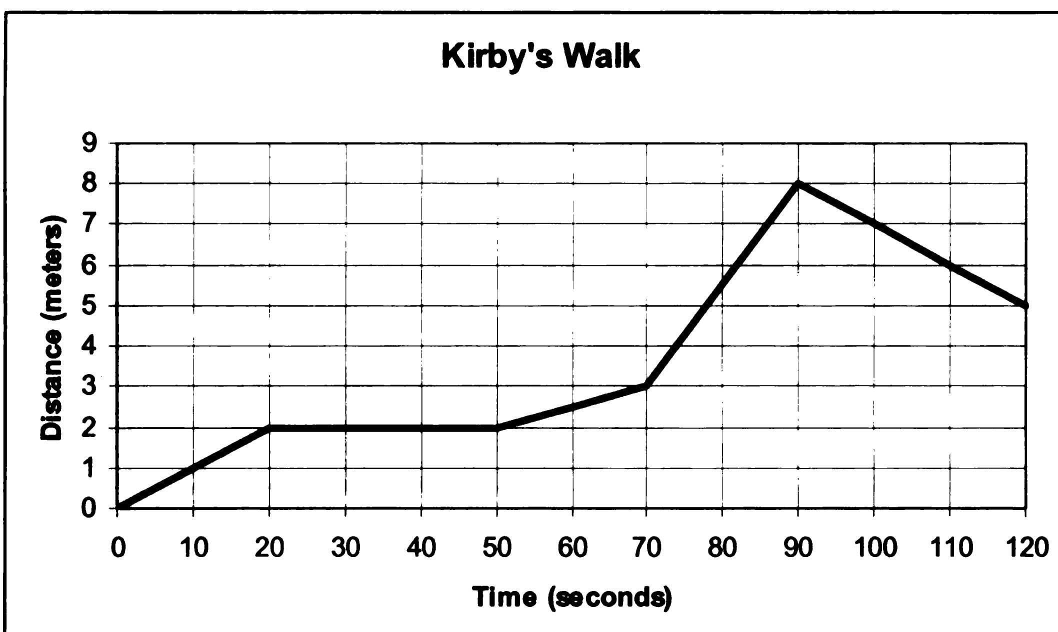
a. 14 m/s SSE
b. 40 km/h toward the town square
c. 80 km/h New York to New Jersey
d. 28 km from Los Angeles to Catalina

55. What is acceleration?

a. Change in position relative to a frame of reference
b. Distance traveled per unit time
c. Speed in a given direction
d. Change in velocity over time

56. Which of the following is not accelerating?

a. A car traveling at a constant speed.
b. A car slamming on the brakes.
c. A car "doing donuts" in a parking lot.
d. A car stepping on the gas.



57. Refer to the graph above. Which section of the graph shows Kirby standing still?

a. 0-20 seconds b. 20-50 seconds c. 70-90 seconds d. 90-120 seconds

58. Refer to the graph above. In which section is Kirby moving the fastest?

a. 0-20 seconds b. 20-50 seconds c. 70-90 seconds d. 90-120 seconds

59. Refer to the graph above. In which section is Kirby return home?
a. 0-20 seconds b. 20-50 seconds c. 70-90 seconds d. 90-120 seconds

60. Refer to the graph above. What is Kirby's maximum displacement?
a. 5 meters b. 8 meters c. 11 meters d. 90 seconds

Math Problems: Solve the following math problems. **You must show all of your work and include units to receive full credit.** You may use a calculator. All formulas you may need are provided.

Formulas	
(Temp.1 X Vol.1) + (Temp.2 X Vol.2) = Final Temp. X Final Vol.	velocity = distance ÷ time distance = velocity X time time = distance ÷ velocity
speed = distance ÷ time distance = speed X time time = distance ÷ speed average speed = total distance ÷ total time	acceleration = (final velocity - initial velocity) ÷ time time = (final velocity - initial velocity) ÷ acceleration final velocity - initial velocity = acceleration X time

61. You fly from Washington D.C. to Los Angeles, a distance of 5000 km, in 4 hours. What was the velocity of the plane?

Answer: ____________________

62. You are driving south at 40 m/s when you see brake lights in front of you. You step on the brakes and gently slow to a stop after 8 seconds. What is your acceleration?

Answer: ____________________

APPENDIX B
ASSESSMENT XLI

Written Portion: Answer each of the following questions using complete sentences. Make sure your answers are thorough and use science terms where appropriate.

63. You have your head down in class and the teacher gives you a vicious jab and says "You don't have a single bit of energy." As a good physics student, you know that there is plenty of energy in your body. Politely explain to your teacher that she is wrong, giving at least three examples to support your response.

64. Explain how you would determine the speed of a jogger using a meter stick and a stopwatch.

APPENDIX B
ASSESSMENT XLII

Unit 2 Test: Forces and Work

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

1. What term means a push or a pull on an object?
a. Gravity b. Magnitude c. Inertia d. Force

2. What type of force acts only when objects are touching?
a. Contact b. Non-contact c. Unbalanced d. Balanced

3. What types of forces **do not** change motion?
a. Balanced b. Contact c. Non-contact d. Unbalanced

4. Which force opposes motion?
a. Buoyancy b. Friction c. Gravity d. Normal

5. What type(s) of friction affect a downhill skier?
a. Sliding and Fluid
b. Sliding and Rolling
c. Sliding
d. Fluid

6. Why can a car remain parked on a hill without moving down it?
a. Static friction is greater than gravity.
b. Static friction is less than gravity.
c. Kinetic friction is less than gravity.
d. Kinetic friction is greater than gravity.

7. Which of the following would decrease the amount of friction you experience on a playground slide?
a. Greasing the slide with wax
b. Losing weight
c. Wearing clothes made of silk
d. All of the above

8. What term means "resists changes?"
a. Force b. Inertia c. Momentum d. Acceleration

9. What effect does mass have on inertia?
a. Mass does not affect inertia
b. Increasing mass decreases inertia
c. Decreasing mass increases inertia
d. Increasing mass increases inertia

10. Which of the following exerts the greatest force?
a. A 0.5 kg bullet accelerating at 200 m/s/s
b. A 1000 kg car accelerating at 0.5 m/s/s
c. A 20 kg ball accelerating at 10 m/s/s
d. An 80 kg person falling at 1.6 m/s/s

APPENDIX B
ASSESSMENT XLII

11. If we increase the mass of a car, what happens to the force needed to move it?

a. Force needed increases
b. Force needed remains constant
c. Force needed decreases

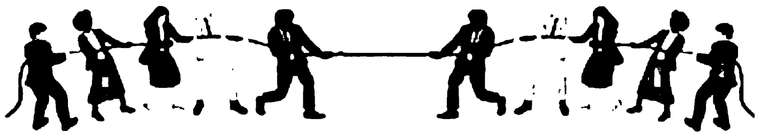
12. What effect does an air bag have on force of impact in a car accident?

a. Airbag decreases mass at impact, decreasing force.
b. Airbag increases acceleration on impact, decreasing force.
c. Airbag increases time of impact, decreasing force.
d. Airbag increases velocity at impact, decreasing force

13. According to Newton's Third Law, every force has...

a. Resistance to change
b. An unbalancing effect
c. Mass and acceleration
d. An opposite force

Team A Team B



Two teams are playing tug of war. Team B is winning.

14. Refer to the illustration above. Which team is applying more force to the rope?

a. Team A
b. Team B
c. Both apply the same force

15. Refer to the illustration above. Which team applies more force to the ground?

a. Team A
b. Team B
c. Both exert the same force

APPENDIX B
ASSESSMENT XLII

16. Which of the following correctly identifies the action and reaction forces observed when releasing a balloon

a. Action: The balloon moves forward Reaction: Air is released
b. Action: Air leaves the balloon Reaction: The balloon moves forward
c. Action: Inflating balloon. Reaction: Deflating balloon
d. Action: Pushing the balloon Reaction: The balloon moves

17. Which of the following situations demonstrates Newton's First Law?

a. Flying over your bicycle handles when you use the front brakes.
b. Apples fall toward the Earth, not toward the Sun
c. Guns recoil when fired
d. SUVs get worse gas mileage than VW bugs

18. Which of the following situations demonstrates Newton's Second Law?

a. Apples fall toward the Earth, not toward the Sun
b. Guns recoil when fired
c. SUVs get worse gas mileage than VW bugs
d. Flying over your bicycle handles when you use the front brakes.

19. Which of the following situations demonstrates Newton's Third Law?

a. Flying over your bicycle handles when you use the front brakes.
b. Apples fall toward the Earth, not toward the Sun
c. Guns recoil when fired
d. SUVs get worse gas mileage than VW bugs

20. According to the Law of Conservation of Momentum, momentum can be _____ during a collision.

a. borrowed b. destroyed c. transferred d. created

21. According to the Law of Universal Gravitation, increasing ___ will increase the gravitational attraction between two objects.

a. Distance b. Mass c. Acceleration d. Inertia

22. According to Newton's Law of Universal Gravitation, why doesn't the Sun pull apples upward?

a. The Sun is further away than the Earth.
b. The Sun has more inertia than Earth
c. The Sun has less gravity than Earth
d. The Sun has more gravity than Earth

APPENDIX B
ASSESSMENT XLII

23. Which of the following situations demonstrates Newton's Law of Universal Gravitation?

a. Apples fall toward the Earth, not toward the Sun
b. SUVs get worse gas mileage than VW bugs
c. Guns recoil when fired
d. Flying over your bicycle handles when you use the front brakes.

24. Which of the following is the result of gravity?

a. The Moon stays in orbit
b. Things fall down
c. Earth has tides
d. All of the above

25. What name is given to the force you exert on the ground due to gravity?

a. Weight
b. Inertia
c. Friction
d. Mass

26. What term refers to the fastest speed at which an object can fall?

a. Free fall
b. Terminal Velocity
c. G-Force
d. Momentum

27. What force opposes gravity in Earth's atmosphere?

a. Drag
b. Normal
c. Ytivarg
d. Buoyancy

28. What force opposes gravity when you are sitting in your chair?

a. Buoyancy
b. Drag
c. Normal
d. Ytivarg

29. What happens to a skydiver's **acceleration** when she reaches terminal velocity?

a. Increases greatly
b. Decreases slightly
c. Remains constant at 9.8 m/s/s
d. Remains constant at 0 m/s/s

30. What happens to a skydiver's velocity when she reaches terminal velocity?

a. Increases
b. Decreases
c. Remains constant at 56 m/s down
d. Remains constant at 0 m/s down

31. What does a parachute do for a skydiver?

a. Decreases terminal velocity
b. Increases drag
c. Both of the above
d. None of the above

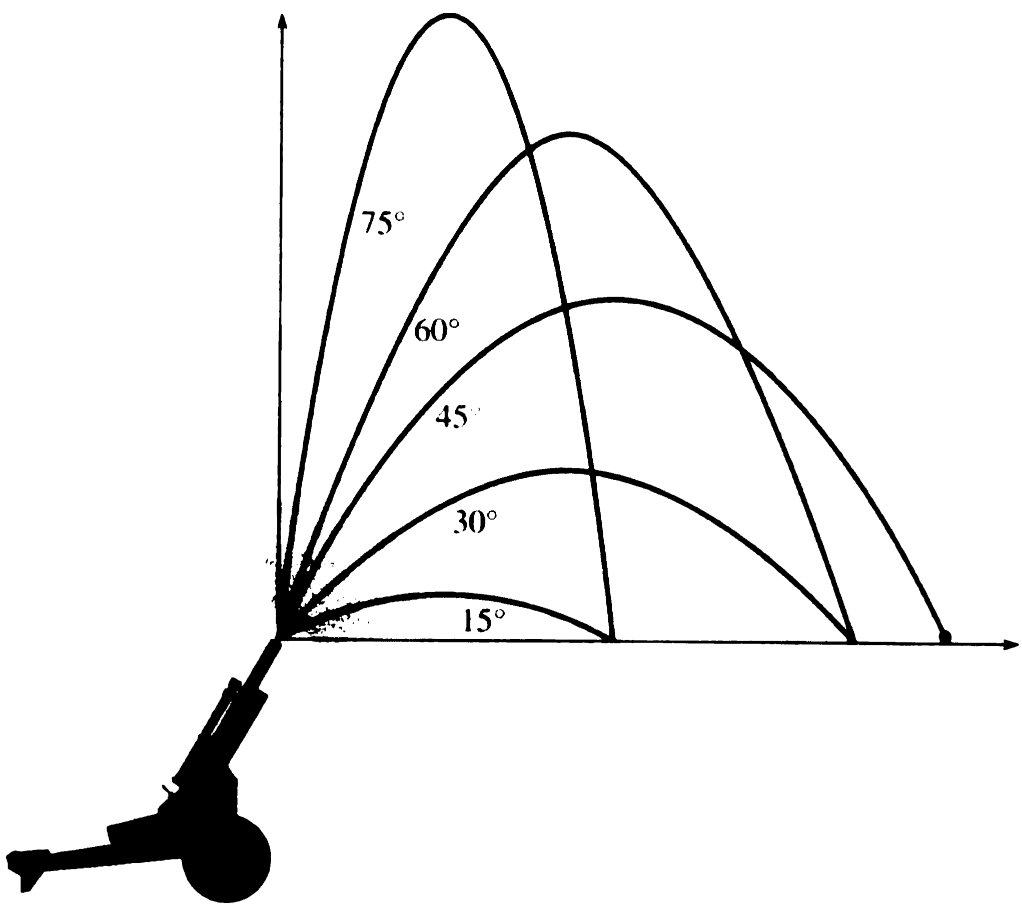
APPENDIX B
ASSESSMENT XLII

32. What general name is given to any motion around a central point or points?

a. Orbital Motion
b. Circular Motion
c. Centripetal Acceleration
d. Periodic Motion

33. What do you need to know to determine the path of a projectile?

a. Mass and velocity
b. Inertia and gravity
c. Mass, Inertia, and Angle
d. Inertia, Gravity, and Angle



34. Refer to the illustration above. At what angle does the projectile achieve the greatest distance?

a. 15 degrees b. 30 degrees c. 45 degrees d. 60 degrees e. 75 degrees

APPENDIX B

ASSESSMENT XLII

35. Refer to the illustration above. At which angle does the projectile achieve its greatest height?

a. 15 degrees b. 30 degrees c. 45 degrees d. 60 degrees e. 75 degrees

36. Refer to the illustration above. Which of the following statements is true?

a. Increasing angle always decreases distance
b. Increasing angle always increases height
c. Increasing angle always increases distance
d. Increasing angle always decreases height

37. If the speed of the Moon were to increase, what would happen to the Moon's orbit?

a. It would always be full moon
b. It would remain constant
c. It would crash into Earth
d. It would escape Earth

38. If Earth's gravity suddenly increased, what would happen to the satellites in orbit?

a. They would fly away
b. They would collide with each other
c. They would stay where they are
d. They would crash into Earth

39. If an object is undergoing centripetal acceleration, which way is it accelerating?

a. In the direction of motion
b. Toward the outer edge
c. Against the direction of motion
d. Toward center

40. Which of the following is an example of circular motion?

a. A spinning top
b. A swinging pendulum
c. Both of the above
d. None of the above

41. You fill a bucket with water and swing it over your head on a rope. What force keeps the water in the bucket?

a. Inertia b. Acceleration c. Weight d. Gravity

42. What do you have to do in order to do work?

a. Apply a force
b. Move an object
c. Move in the direction of a force
d. All of the Above

43. Which term means "rate at which work is done?"

a. Watts b. Power c. Joules d. Work

44. Which of the following would decrease the power of a machine?

a. Making it do less work
b. Making it take less time
c. Both of the above
d. None of the above

APPENDIX B
ASSESSMENT XLII

45. If a machine decreases the force you need to do work, what happens to the distance you must move?
a. Distance increases
b. Distance remains the same
c. Distance decreases

46. What prevents a machine from converting all of the energy it is given into Work?
a. Inertia
b. Mechanical Advantage
c. Friction
d. Efficiency

47. A child who weighs 300 Newtons is sitting 2 meters from the center of a seesaw. Where does her younger brother, who weighs 150 Newtons, have to sit in order to balance her?
a. 1 meter from center
b. 2 meters from center
c. 3 meters from center
d. 4 meters from center

48. Which of the following is storing mechanical energy?
a. A bowling ball sitting on the floor
b. A bowling ball in a hole in the ground
c. A bowling ball rolling along the lane
d. A bowling ball on a high shelf

49. Which factor is most important in determining kinetic energy?
a. Mass
b. Velocity
c. Height
d. All are equally important

50. What term means "energy of moving objects?"
a. Thermal Energy
b. Mechanical Energy
c. Potential Energy
d. Friction

51. What term means patterned, repetitive motion that can be timed and results in energy conversions?
a. Periodic Motion
b. Two-dimensional motion
c. Circular motion
d. One-dimensional motion

52. Which of the following is an example of periodic motion?
a. Orbiting the Earth
b. Bouncing on a trampoline
c. Projectile flying through the air
d. Driving down the road

53. A child is playing on a swing set. Where is her kinetic energy the highest?
a. At the highest point of the swing
b. Her kinetic energy is constant
c. At the lowest point of the swing

APPENDIX B

ASSESSMENT XLII

Matching

Match each unit with what it measures.
Answers will be used more than once.

a. Newton (N)
b. Joule (J)
c. Watt (W)
d. Kilogram (kg)
e. Meters per second per second (m/s/s)

54. Acceleration
55. Energy
56. Force
57. Gravity
58. Mass
59. Power
60. Weight
61. Work

Match each simple machine to its example

a. Inclined Plane
b. Wedge
c. Screw
d. Lever
e. Wheel and Axle

62. Ramp
63. Teeter-totter
64. Boat Propeller
65. Axe blade
66. Bicycle Tire

APPENDIX B
ASSESSMENT XLII

Math Questions

Solve the following problems. Be sure to show your work and include units to receive full credit.

Force = mass * acceleration mass = Force / acceleration acceleration = Force / mass	Work = Force * distance Force = Work / distance distance = Work / Force
weight = mass * gravity mass = weight / gravity gravity = weight / mass	Power = Work / time Work = Power * time Time = Work / Power
Kinetic Energy = 1/2 * mass * velocity^2 Gravitational Potential Energy = mass * gravity * height Total Energy = Kinetic Energy + Potential Energy	

67. How much Force is needed to accelerate a 50 kg person at 10 m/s/s?

____

68. How much does a 100kg person weigh on the Moon, where gravity=1.6 m/s/s?

____

69. How long does it take an engine with a power rating of 50 Watts to do 800 Joules of Work?

____

70. A ball with a mass of 20 kg is falling at a velocity of 5 m/s downward. If it is 50 meters from the ground, what is the total energy of the ball? (g = 10 m/s/s)

____

Force Diagram

71. Draw a force diagram showing all of the forces that are acting on your body right now. Be certain to label your diagram.

APPENDIX B
ASSESSMENT XLII

Essay Questions

Answer each of the following questions using complete sentences. It is not necessary to use all of the lines provided. You may include drawings or diagrams, but you must include a written explanation as well.

72. Use one of Newton's Laws to explain why it is dangerous to use the front brakes on a bicycle without using the back brakes.

73 Explain the relationship between gravity and inertia in the motion of a pendulum and discuss how the energy changes as the pendulum swings.

APPENDIX B
ASSESSMENT XLIII

Unit 3 Test: Electricity and Magnetism

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

1. Which part of an atom has a charge?
a. Protons
b. Electrons
c. Neutrons
d. Protons and electrons

2. Which part(s) of an atom can move?
a. Protons only
b. Electrons only
c. Protons and neutrons
d. Protons and electrons

3. Which subatomic particle has a negative electric charge?
a. Proton
b. Electron
c. Neutron
d. Nucleus

4. If an object contains more protons than electrons, what is its charge?
a. negatively charged
b. positively charged
c. neutral
d. energized

5. Which type of static charging starts with two neutral objects and makes one positive and the other negative by rubbing them together?
a. Friction
b. Conduction
c. Induction
d. Discharge

6. Why does rubbing a balloon on your head give the balloon a charge?
a. Electrons move from the balloon to your head.
b. Protons move from the balloon to your head
c. Electrons move from you head to the balloon
d. Protons move from your head to the balloon

7. A person trudging across a carpet is building up a static charge by what process?
a. Friction
b. Induction
c. Resistance
d. Grounding

8. Which type of charging occurs when a charged object touches a neutral object?
a. Friction
b. Conduction
c. Induction
d. Discharge

9. Which particles can be moved by friction or conduction to build an electric charge?
a. only the protons move
b. both the protons and neutrons move
c. only the electrons move
d. both protons and electrons move

APPENDIX B
ASSESSMENT XLIII

10. Which type of charging occurs when a charged object moves the electrons in a neutral object *without* actually touching it?

a. Friction   b. Conduction   c. Induction   d. Discharge

4+ 4-	6+ 2-
Object 1	Object 2

11. Refer to the diagram above. What is the overall charge on Object 1?

a. +4   b. -4   c. Neutral   d. +2

12. Refer to the diagram above. What is the overall charge on Object 2?

a. +6   b. -2   c. +4   d. Neutral

13. Refer to the diagram above. What will happen if these two objects touch?

a. Protons will move from left to right and both will be positive
b. Protons will move from right to left and both will be negative
c. Electrons will move from left to right and both will be positive.
d. Electrons will move from right to left and both will be negative.

14. What term refers to the general downward motion of electricity?

a. Discharge   b. Induction   c. Friction   d. Grounding

15. Lightning is a powerful form of what?

a. current   b. toys   c. discharge   d. circuit

16. What is a complete path that electricity flows through?

a. Circuit   b. Load   c. Power Source   d. Switch

17. What is a common example of a conductor?

a. Motor   b. Wires   c. Light Bulb   d. Battery

18. Circuit breakers and fuses protect a circuit under what conditions?

a. Voltage is too high   c. Voltage is too low
b. Current is too high   d. Current is too low

19. What do we call a circuit that has a break or gap?

a. Open   b. Closed   c. Series   d. Parallel

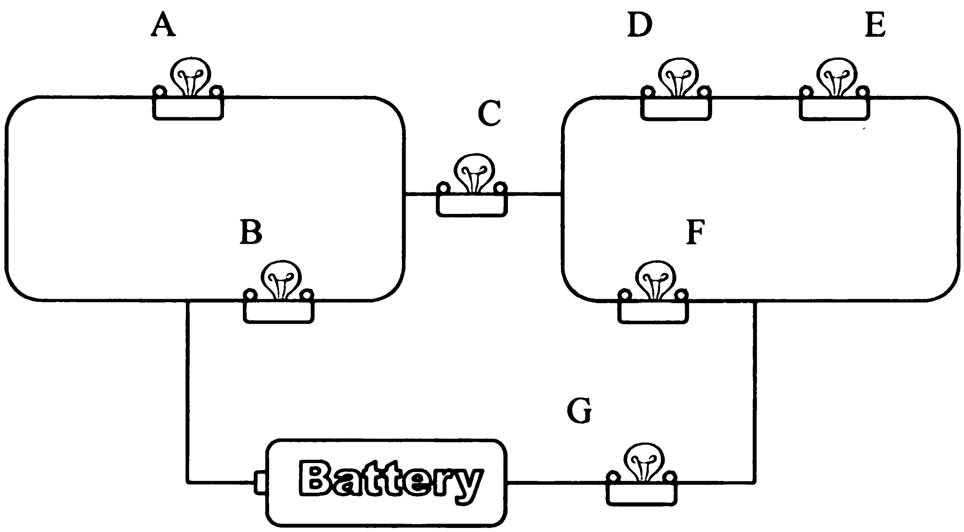
APPENDIX B
ASSESSMENT XLIII

20. What do we call a circuit that has only one path through it?

a. Open b. Closed c. Series d. Parallel

21. What do we call a circuit with multiple paths through it?

a. Open b. Closed c. Series d. Parallel



22. What bulbs remain lit if bulbs A and D are blown?

a. B C E F G
b. B C F G
c. A C F G
d. none

23. Which bulb does the electricity reach first?

a. Bulb A
b. Bulb B
c. Bulb G
d. Bulbs A and B at the same time

24. What bulbs remain lit if bulbs D and F are blown?

a. A B C E G
b. A B C F G
c. A C F G
d. none

25. Are bulbs A and B wired in series or in parallel?

a. Series
b. Parallel

26. Are bulbs D and E wired in series or in parallel?

a. Series
b. Parallel

APPENDIX B
ASSESSMENT XLIII

27. If a switch were placed between bulbs D and E, which bulbs would go out when the switch is opened?

a. Bulb D only
b. Bulb E only
c. Bulbs D and E
d. Bulbs D, E, F, and G

28. Where would be the best location for a fuse to protect all of the light bulbs in the circuit?

a. Between the battery and Bulb B
b. Between the Battery and Bulb G
c. Between Bulbs A and C
d. Between Bulbs F and G

29. What bulbs remain lit if Bulb C is blown?

a. All of them
b. Bulbs A D E G
c. Bulbs B F G
d. None of them

30. What term refers to the speed of electrons?

a. Current
b. Voltage
c. Resistance
d. Power

31. What term refers to the strength of moving electrons?

a. Current
b. Voltage
c. Resistance
d. Power

32. What term refers to anything which attempts to slow electrons?

a. Current
b. Voltage
c. Resistance
d. Power

33. What term means the amount of electricity needed to make a device work?

a. Electric Power
b. Electric Energy
c. Voltage
d. Current

34. What term means the total amount of electricity used by an appliance in a certain amount of time?

a. Electric Power
b. Electric Energy
c. Voltage
d. Current

35. What information do you need in order to calculate your energy bill?

a. The amount of time an appliance is used.
b. Cost of electricity per kilowatt hour.
c. The number of kilowatts used by an appliance
d. All of the above.

36. Which subatomic particle(s) is responsible for magnetism?

a. Protons
b. Electrons
c. Neutrons
d. Protons and Electrons

37. What do we call a coil of wire used to make a magnetic field?

a. Iron
b. Compass
c. Solenoid
d. Galvanometer

APPENDIX B
ASSESSMENT XLIII

38. Which of the following would increase the strength of an electromagnet?

a. Increasing the number of loops in the solenoid
b. Putting an iron core in the center
c. Using more electrons
d. All of the above

39. What does an electric motor do?

a. Converts thermal energy to mechanical energy
b. Converts nuclear energy to electromagnetic energy
c. Converts mechanical energy to electromagnetic energy
d. Converts electromagnetic energy to mechanical energy

40. What is the purpose of the commutator of the motor?

a. Provides electricity
b. Carries electricity and holds the solenoid
c. Repels the solenoid
d. Switches the current on and off

41. Why does the electric motor require a regular magnet?

a. It provides electricity
b. It carries electricity and holds the solenoid
c. It repels the solenoid
d. It switches the current on and off

42. What is the purpose of the armature of an electric motor?

a. It provides electricity
b. It carries electricity and holds the solenoid
c. It repels the solenoid
d. It switches the current on and off

43. Which of the following would increase motor speed?

a. Increasing the current
b. Decreasing the voltage
c. Decreasing the size of the solenoid
d. Using wire with greater resistance

44. Which of the following uses magnetism?

a. Hand-powered pencil sharpener
b. Gasoline-powered car engine
c. Compact discs and DVDs
d. Telephone handset (the part you talk & listen with)

45. Which of the following devices uses an electric motor?

a. A CD player b. A blender c. A hair dryer d. All of these

APPENDIX B
ASSESSMENT XLIII

Matching

Match each circuit component to its function.

a. Power source
b. Conductor
c. Load
d. Resistor
e. Switch

46. Carries electric current
47. Opens and closes circuit
48. Produces electric current
49. Slows electrons
50. Uses electricity

Match each unit to what it measures.

a. Ampere
b. Kilowatt-hour
c. Ohm
d. Volt
e. Watt

51. Current
52. Voltage
53. Resistance
54. Power
55. Energy

APPENDIX B
ASSESSMENT XLIII

Math Questions

Solve the following problems. Be sure to show your work and include units to receive full credit.

current = voltage / resistance	power = current x voltage
voltage = current x resistance	energy = power x time
resistance = voltage / current	cost = energy x $.1016

56. You set up a circuit with a resistor that provides 32 Ohms of resistance. If the reading on the Voltmeter is 8 volts, how much current is flowing through the circuit?

____

57. What is the power rating of a light bulb that draws 150 volts at a current of 0.5 Amperes?

____

58. How much energy is required to run a 0.1 kilowatt light bulb for 24 hours?

____

59. How much does it cost to run the light bulb in question 3?

____

APPENDIX B
ASSESSMENT XLIII

Essay Questions

Answer each of the following questions using complete sentences. It is not necessary to use all of the lines provided. You may include drawings or diagrams, but you must include a written explanation as well.

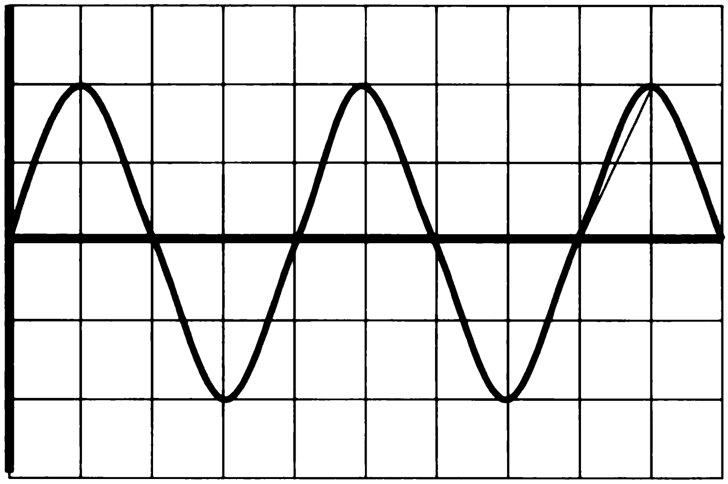
60. State the Rule of Interactions (also known as the Law of Electrostatic Forces).

61. Starting with a neutral balloon, a neutral person, and a neutral wall, explain how the person can use static electricity to get the balloon to stick to the wall. Be detailed and use proper terminology.

APPENDIX B
ASSESSMENT XLIV

Unit 4: Waves

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



1 box = 1 cm

1. Refer to the diagram above. What is the wavelength of this wave?
a. 2 cm b. 4 cm c. 8 cm d. 10 cm

2. Refer to the diagram above. What is the amplitude of this wave?
a. 2 cm b. 4 cm c. 8 cm d. 10 cm

3. Refer to the diagram above. How many wavelengths are shown?
a. 1 b. 2.5 c. 5 d. 10

4. What do we call a disturbance that moves energy through matter or space?
a. Frequency b. Wavelength c. Amplitude d. Wave

5. If we increase the frequency of a wave, what happens to its wavelength?
a. Wavelength increases
b. Wavelength decreases
c. Wavelength remains constant

6. If we increase the frequency of a wave, what happens to its speed?
a. Speed increases
b. Speed decreases
c. Speed remains constant

APPENDIX B
ASSESSMENT XLIV

7. What happens when a wave strikes a solid surface that it cannot pass through?

a. Reflection b. Refraction c. Diffraction d. Interference

8. What happens when a wave passes from one medium to another, changing speed as it does so?

a. Reflection b. Refraction c. Diffraction d. Interference

9. Two people are singing together in choir. To the listener, there is only one large sound wave. What has happened?

a. Refraction c. Constructive Interference
b. Diffraction d. Destructive Interference

10. A jackhammer has a speaker in the top that plays the same sound as the jack hammer, but the sound wave has been flipped upside-down by a computer. When you hear the jackhammer and the speaker at the same time, the two sounds cancel. What is this called?

a. Refraction c. Constructive Interference
b. Diffraction d. Destructive Interference

11. Which of the following is true for sound waves?

a. Sound travels faster in low-density mediums.
b. Sound cannot travel in space
c. Sound waves are faster than light waves
d. Sound is the result of movement of electrons

12. What is the relationship between frequency and pitch?

a. Higher frequency makes higher pitch
b. Higher frequency makes lower pitch
c. Frequency does not change pitch

13. What determines the volume of a sound?

a. Frequency b. Wavelength c. Pitch d. Amplitude

14. Based on the Doppler Effect, as a moving object approaches you, what happens to the sound?

a. Pitch increases because wavelength decreases
b. Pitch increases because wavelength increases
c. Pitch decreases because wavelength decreases
d. Pitch decreases because wavelength increases

APPENDIX B
ASSESSMENT XLIV

15. What is the role of the ear drum in hearing?

a. It signals the brain
c. It tugs on the cochlea
b. It collects the sound
d. It makes the bones vibrate

16. What do we call the packets of energy that make up light?

a. Electrons b. Photons c. Wavelengths d. Hertz

17. Which of the following lists types of light in order of increasing frequency (decreasing wavelength)?

a. Radio, IR, UV, X-ray, Gamma
b. Gamma, X-ray, UV, IR, Radio
c. IR, UV, Radio, Gamma, X-ray
d. Radio, UV, IR, Gamma, X-ray

18. Which types of light can damage the human body?

a. Radio, microwave, IR
c. IR, Visible, UV
b. UV, X-rays, Gamma
d. Microwaves, IR, UV

19. Which of the following is used for sending signals?

a. Radio Waves b. Microwaves c. Visible light d. All of the above

20. Which type of light is produced by the black light?

a. Infrared b. Visible c. Ultraviolet d. Microwaves

21. What type of mirror will give you a large but upside-down image?

a. Plane b. Concave c. Convex

22. What type of lens is used to correct nearsightedness?

a. Plane b. Concave c. Convex

23. What do we call a cut piece of glass or plastic that can separate light based on wavelength?

a. Concave mirror b. Concave lens c. Convex lens d. Prism

24. If I want to reflect all light to one place, what type of mirror should I use?

a. Plane b. Concave c. Convex

25. If I want to see a wide field of view, such as in a rear view mirror, what type of mirror should I use?

a. Plane b. Concave c. Convex

APPENDIX B
ASSESSMENT XLIV

26. What are the three primary colors of light?

a. Red, Blue, Yellow
c. Red, Blue, Green
b. Magenta, Cyan, Yellow
d. Magenta, Cyan, Green

27. What colors of light are reflected by yellow objects?

a. Red and Blue
c. Blue and Green
b. Red and Green
d. Cyan and Blue

28. What do we see when no light is reflected?

a. White b. Ultraviolet c. Magenta d. Black

29. What color is made when Red and Blue light are mixed?

a. Cyan b. Blue c. Magenta d. White

30. What part of the eye detects light?

a. Pupil b. Iris c. Cornea d. Retina

Math Questions

Solve the following problems. Be sure to show your work and include units to receive full credit.

speed = frequency X wavelength	frequency = speed / wavelength
wavelength = frequency / speed	frequency = # of waves / time

31. What is the speed of a wave with a frequency of 6 Hertz and a wavelength of 12 meters?

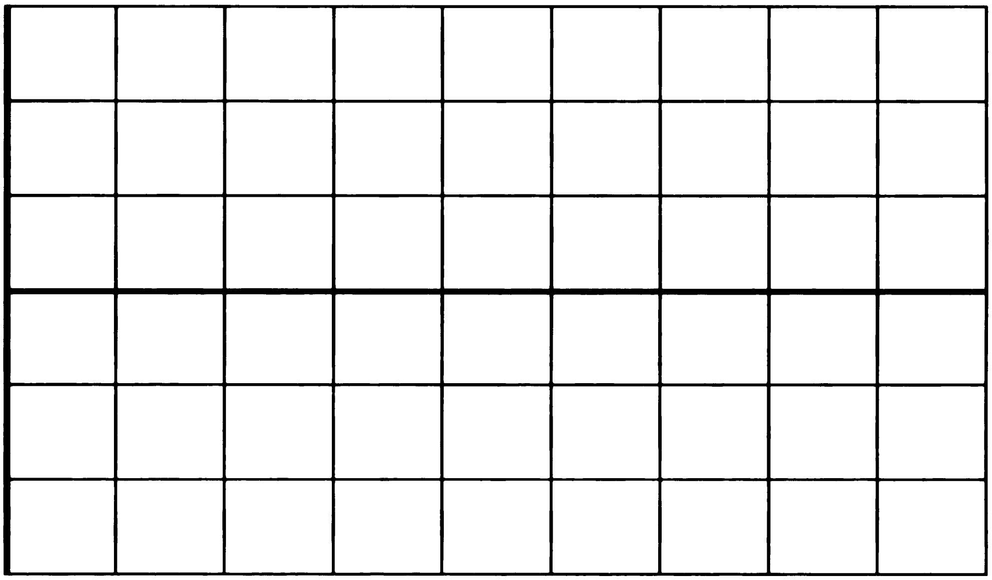
Answer with Units: ______________________________

32. What is the frequency of a wave that makes 12 waves in 4 seconds?

Answer with Units: ______________________________

APPENDIX B
ASSESSMENT XLIV

33. Draw two full wavelengths of a wave with an amplitude of 2 cm and a wavelength of 4 cm. The squares are 1 cm squares.



Essays

Answer each of the following questions using complete sentences. It is not necessary to use all of the lines provided. You may include drawings or diagrams, but you must include a written explanation as well.

34. Explain why a red apple looks red in sunlight, but why is looks black under green light.

APPENDIX B
ASSESSMENT XLIV

35. Explain why someone living in the Sahara desert would rather wear white clothing from head to toe than wear black shorts and a black T-shirt. (Hint: Consider both the color and the amount of covering)

APPENDIX B
ASSESSMENT XLV

Introduction to Physics   Final Exam   Fall 2007

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

1. What is energy?

a. The ability to do work
b. The ability to cause changes
c. Both of the above
d. None of the above

2. What type of energy is in a stretched rubber band?

a. Kinetic Chemical
b. Potential Mechanical
c. Kinetic Nuclear
d. Potential Electromagnetic

3. Which of the following is an example of chemical energy?

a. Sunlight
b. Pizza
c. Boiling water
d. Nuclear bomb

4. Which of the following is an example of potential energy?

a. A burning candle
b. A vibrating guitar string
c. An unlit match
d. Lightning striking the ground

5. Which of the following is an example of kinetic energy?

a. Food on your dinner plate
b. Gasoline in the tank
c. Batteries in their package
d. Music playing

6. What happens during an energy conversion?

a. Energy is lost
b. Energy is gained
c. Energy changes form
d. Energy is created

7. Which of the following best explains the energy transformation in a gasoline engine?

a. Mechanical becomes chemical
b. Chemical becomes mechanical and heat
c. Nuclear becomes mechanical
d. Electromagnetic becomes mechanical

8. Which of the following best describes the conversions taking place in a battery-powered flashlight?

a. Electromagnetic to thermal
b. Chemical to mechanical
c. Nuclear to electromagnetic
d. Chemical to electromagnetic and thermal

APPENDIX B
ASSESSMENT XLV

9. Which of the following statements is part of the Law of Conservation of Energy?

a. Energy cannot be created
b. Energy can be destroyed
c. Energy must remain in one form
d. None of the above

10. In Einstein's formula $E=mc^2$, what does m stand for?

a. Momentum b. Motion c. Matter d. Mass

11. Where is nuclear energy stored?

a. In electrons
b. In moving objects
c. In the center of the atom
d. In bonds between atoms

12. Which type of nuclear reaction releases the most energy?

a. Fusion
b. Fission
c. Radioactive Decay
d. None of these

13. Where does thermal energy come from?

a. Bonds between atoms
b. The nucleus of the atom
c. Movement of electrons
d. Movement of molecules

14. Which form of heat transfer is used by the hot plate to heat up water?

a. Conduction b. Convection c. Radiation d. Fusion

15. The temperature at which all molecular motion stops is called...

a. Freezing Point
b. Sublimation Point
c. Boiling Point
d. Absolute Zero

16. What term means a change in position relative to a frame of reference?

a. Motion b. Displacement c. Distance d. Acceleration

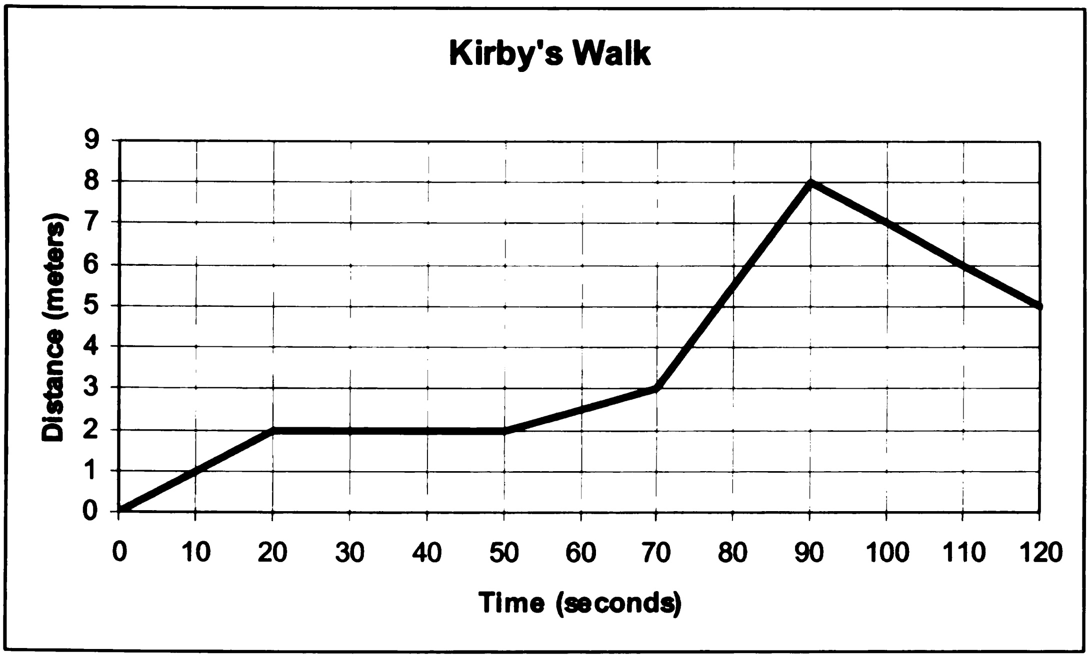
17. What frame of reference is most commonly used in science experiments involving motion?

a. The scientist b. The Earth c. The Sun d. The Moon

18. You walk five steps forward, then two steps back. What is your displacement form your original position?

a. 5 steps b. 7 steps c. 2 steps d. 3 steps

APPENDIX B
ASSESSMENT XLV



19. Refer to the graph above. Which section of the graph shows Kirby standing still?

a. 0-20 seconds
b. 20-50 seconds
c. 70-90 seconds
d. 90-120 seconds

20. Refer to the graph above. In which section is Kirby moving the fastest?

a. 0-20 seconds
b. 20-50 seconds
c. 70-90 seconds
d. 90-120 seconds

21. Refer to the graph above. What is Kirby's maximum displacement?

a. 5 meters
b. 8 meters
c. 11 meters
d. 90 seconds

22. How is velocity different from speed?

a. Velocity includes direction.
b. Velocity can change.
c. Velocity is graphed on distance-time graph.
d. Velocity is always constant

23. What is acceleration?

a. Change in position relative to a frame of reference
b. Distance traveled per unit time
c. Speed in a given direction
d. Change in velocity over time

APPENDIX B
ASSESSMENT XLV

24. Which of the following is not accelerating?

a. A car speeding up
b. A car slowing down
c. A car parked on a hill
d. A car turning a corner

25. What shape on a distance-time graph indicates acceleration?

a. Smooth slope b. Horizontal line c. Vertical line d. Curve

26. What term means a push or a pull on an object?

a. Gravity b. Force c. Magnitude d. Inertia

27. What type of force acts only when objects are touching?

a. Contact b. Non-contact c. Balanced d. Unbalanced

28. If a bicyclist experiences equal amounts of wind from the front and the back while bicycling, which of the following will occur?

a. He will speed up.
b. He will slow down.
c. He will continue at a constant speed.
d. He will tip over.

29. Which force opposes motion?

a. Gravity b. Friction c. Normal d. Buoyancy

30. What type(s) of friction affect a downhill skier?

a. Sliding
b. Fluid
c. Sliding and Rolling
d. Sliding and Fluid

31. Why can a car remain parked on a hill without moving down it?

a. Static friction is greater than gravity.
b. Kinetic friction is greater than gravity.
c. Static friction is less than gravity.
d. Kinetic friction is less than gravity.

32. Which of the following would decrease the amount of friction you experience on a playground slide?

a. Greasing the slide with wax
b. Wearing clothes made of silk
c. Losing weight
d. All of the above

33. What term means "resists changes?"

a. Acceleration b. Momentum c. Force d. Inertia

34. Which of the following situations demonstrates Newton's First Law?

a. Flying over your bicycle handles when you use the front brakes.
b. SUVs get worse gas mileage than VW bugs
c. Guns recoil when fired
d. Apples fall toward the Earth, not toward the Sun

APPENDIX B
ASSESSMENT XLV

35. Which of the following situations demonstrates Newton's Second Law?
a. Flying over your bicycle handles when you use the front brakes.
b. SUVs get worse gas mileage than VW bugs
c. Guns recoil when fired
d. Apples fall toward the Earth, not toward the Sun

36. Which of the following correctly identifies the action and reaction forces observed when releasing a balloon?
a. Action: Inflating balloon. Reaction: Deflating balloon
b. Action: Pushing the balloon Reaction: The balloon moves
c. Action: Air leaves the balloon Reaction: The balloon moves forward
d. Action: The balloon moves forward Reaction: Air is released

37. John beat James in a tug of war. Which of the following best explains why John won?
a. John exerts more force on the rope than James.
b. John exerts less force on the rope than James.
c. John exerts more force on the ground than James.
d. John exerts less force on the ground than James.

38. Which of the following situations demonstrates Newton's Third Law?
a. Flying over your bicycle handles when you use the front brakes.
b. SUVs get worse gas mileage than VW bugs
c. Guns recoil when fired
d. Apples fall toward the Earth, not toward the Sun

39. According to the Law of Conservation of Momentum, momentum can be _____ during a collision.
a. transferred b. destroyed c. created d. borrowed

40. Which of the following situations demonstrates Newton's Law of Universal Gravitation?
a. Flying over your bicycle handles when you use the front brakes.
b. SUVs get worse gas mileage than VW bugs
c. Guns recoil when fired
d. Apples fall toward the Earth, not toward the Sun

41. What name is given to the force you exert on the ground due to gravity?
a. Mass b. Friction c. Inertia d. Weight

42. If you were transported to another planet, what would change about you?
a. Your mass c. Your mass and your weight
b. Your weight d. Your personal gravity

APPENDIX B
ASSESSMENT XLV

43. If you double the distance between two planets, what happens to the gravitational attraction between them.

a. It remains the same.
b. It increases to double.
c. It decreases to one half.
d. It decreases to one quarter.

44. Which force(s) keep the Moon in orbit around the Earth?

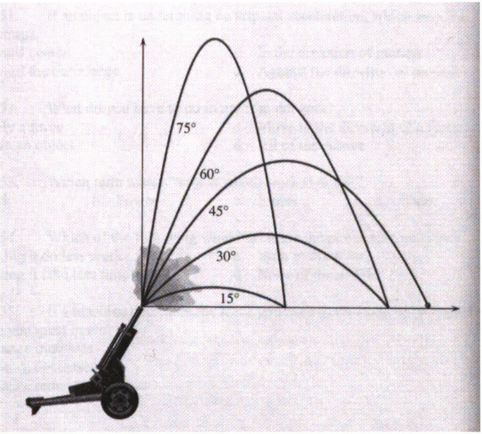
a. Gravitational force
b. Inertial force
c. Gravitational and Inertial forces
d. Gravitational and Tidal forces

45. If the speed of the Moon were to increase, what would happen to the Moon's orbit?

a. It would crash into Earth
b. It would remain constant
c. It would escape Earth
d. It would always be full moon

46. What do you need to know to determine the path of a projectile?

a. Inertia and gravity
b. Mass and velocity
c. Mass, Inertia, and Angle
d. Inertia, Gravity, and Angle



APPENDIX B
ASSESSMENT XLV

47. Refer to the illustration above. At what angle does the projectile achieve the greatest distance?
a. 15 degrees b. 30 degrees c. 45 degrees d. 60 degrees e. 75 degrees

48. Refer to the illustration above. At which angle does the projectile achieve its greatest height?
a. 15 degrees b. 30 degrees c. 45 degrees d. 60 degrees e. 75 degrees

49. Refer to the illustration above. Which of the following statements is true?
a. Increasing angle always increases distance
b. Increasing angle always decreases distance
c. Increasing angle always increases height
d. Increasing angle always decreases height

50. What general name is given to any motion around a central point or points?
a. Orbital Motion
b. Circular Motion
c. Centripetal Acceleration
d. Periodic Motion

51. If an object is undergoing centripetal acceleration, which way is it accelerating?
a. Toward center
b. Toward the outer edge
c. In the direction of motion
d. Against the direction of motion

52. What do you have to do in order to do work?
a. Apply a force
b. Move an object
c. Move in the direction of a force
d. All of the Above

53. Which term means "rate at which work is done?"
a. Work b. Power c. Joules d. Watts

54. Which of the following would decrease the power of a machine?
a. Making it do less work
b. Making it take less time
c. Both of the above
d. None of the above

55. If a machine decreases the force you need to do work, what happens to the distance you must move?
a. Distance increases
b. Distance decreases
c. Distance remains the same

APPENDIX B

ASSESSMENT XLV

56. How does a lever make it easier to do the work of lifting something?

a. Levers decrease the amount of work that has to be done.
b. Levers decrease the amount of force you must use.
c. Levers increase the power of your arms.
d. Levers increase the energy you apply.

57. Which of the following is storing mechanical energy?

a. A bowling ball on a high shelf
b. A bowling ball rolling along the lane
c. A bowling ball sitting on the floor
d. A bowling ball in a hole in the ground

58. Which factor is most important in determining kinetic energy?

a. Mass
b. Velocity
c. Height
d. All are equally important

59. What type of motion is demonstrated by a pendulum?

a. One dimensional motion
b. Two dimensional motion
c. Circular motion
d. Periodic motion

60. Which part of an atom has a charge?

a. Protons
b. Electrons
c. Neutrons
d. Protons and electrons

61. Which part(s) of an atom can move?

a. Protons only
b. Electrons only
c. Protons and neutrons
d. Protons and electrons

62. Why does a balloon get a static charge when you rub it on your head?

a. Electrons from the balloon move to your head.
b. Electrons from your head move to the balloon.
c. Protons from the balloon move to your head.
d. Protons from your head move to the balloon.

63. Which type of static charging starts with two neutral objects and makes one positive and the other negative by rubbing them together?

a. Friction
b. Conduction
c. Induction
d. Discharge

64. Which type of charging occurs when a charged object touches a neutral object?

a. Friction
b. Conduction
c. Induction
d. Discharge

65. Which type of charging occurs when a charged object moves the electrons in a neutral object *without* actually touching it?

a. Friction
b. Conduction
c. Induction
d. Discharge

APPENDIX B

ASSESSMENT XLV

66. Which of the following rules describes how electric charges interact?

a. Positive charge attract other positive charges.
b. Negative charges attract both positive and negative charges.
c. Negative charges attract positive charges.
d. Neutral objects repel both positive and negative charges.

67. Refer to the diagram above. What is the overall charge on Object 1?

a. +4 b. -4 c. Neutral d. +2

68. Refer to the diagram above. What is the overall charge on Object 2?

a. +6 b. -2 c. +4 d. Neutral

69. Refer to the diagram above. What will happen if these two objects touch?

a. Protons will move from left to right and both will be positive
b. Protons will move from right to left and both will be negative
c. Electrons will move from left to right and both will be positive.
d. Electrons will move from right to left and both will be negative.

70. Lightning is a powerful form of what?

a. current b. toys c. discharge d. circuit

71. What term refers to the general downward motion of electricity?

a. Discharge b. Induction c. Friction d. Grounding

72. What type of circuit allows electricity to flow through more than one path?

a. Closed b. Open c. Series d. Parallel

73. What is a complete path that electricity flows through?

a. Circuit b. Load c. Power Source d. Switch

74. What do we call a circuit that has a break or gap?

a. Open b. Closed c. Series d. Parallel

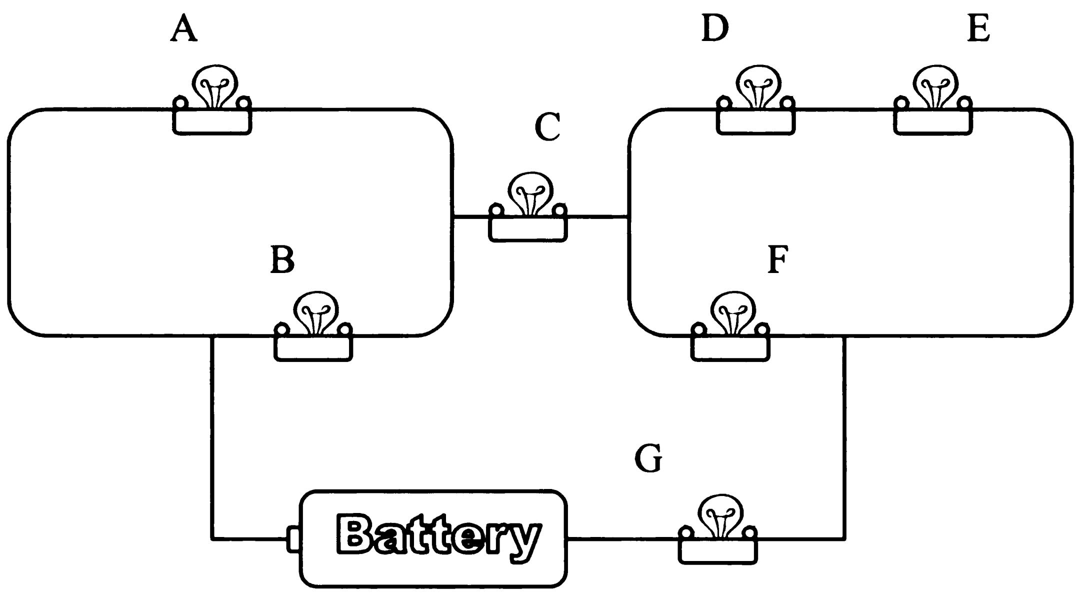
75. What is a common example of a conductor?

a. Motor b. Wires c. Light Bulb d. Battery

APPENDIX B
ASSESSMENT XLV

76. What do we call a circuit that has only one path through it?
a. Open b. Closed c. Series d. Parallel

77. Circuit breakers and fuses protect a circuit under what conditions?
a. Voltage is too high
b. Current is too high
c. Voltage is too low
d. Current is too low



78. What bulbs remain lit if bulbs A and D are blown?
a. B C E F G
b. B C F G
c. A C F G
d. none

79. What bulbs remain lit if bulbs D and F are blown?
a. A B C E G
b. A B C F G
c. A C F G
d. none

80. Are bulbs A and B wired in series or in parallel?
a. Series
b. Parallel

81. Are bulbs D and E wired in series or in parallel?
a. Series
b. Parallel

82. If a switch were placed between bulbs D and E, which bulbs would go out when the switch is opened?
a. Bulb D only
b. Bulb E only
c. Bulbs D and E
d. Bulbs D, E, F, and G

APPENDIX B
ASSESSMENT XLV

83. Where would be the best location for a fuse to protect all of the light bulbs in the circuit?

a. Between the battery and Bulb B
b. Between the Battery and Bulb G
c. Between Bulbs A and C
d. Between Bulbs F and G

84. What term refers to the speed of electrons?

a. Current b. Voltage c. Resistance d. Power

85. What term refers to the strength of moving electrons?

a. Current b. Voltage c. Resistance d. Power

86. What term refers to anything which attempts to slow electrons?

a. Current b. Voltage c. Resistance d. Power

87. What term means the amount of electricity needed to make a device work?

a. Electric Power b. Electric Energy c. Voltage d. Current

88. What information do you need in order to calculate your energy bill?

a. The amount of time an appliance is used.
b. Cost of electricity per kilowatt hour.
c. The number of kilowatts used by an appliance
d. All of the above.

89. Which subatomic particle(s) is responsible for magnetism?

a. Protons
b. Electrons
c. Neutrons
d. Protons and Electrons

90. What do we call a coil of wire used to make a magnetic field?

a. Iron b. Compass c. Solenoid d. Galvanometer

91. Which of the following would increase the strength of an electromagnet?

a. Adding loops to the solenoid
b. Putting an iron core in the center
c. Using more electrons
d. All of the above

92. What does an electric motor do?

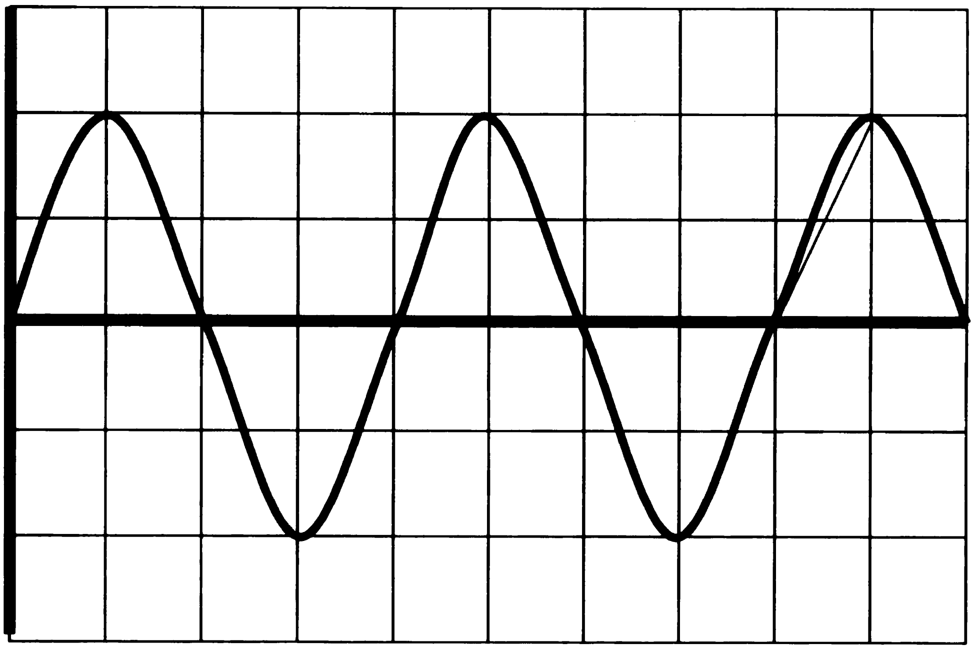
a. Converts thermal energy to mechanical energy
b. Converts electromagnetic energy to mechanical energy
c. Converts mechanical energy to electromagnetic energy
d. Converts nuclear energy to electromagnetic energy

APPENDIX B

ASSESSMENT XLV

93. Which of the following devices uses the relationship between electricity and magnets to function?

a. Electric motor b. Stereo speaker c. Generator d. All of the above



1 box = 1 cm

94. Refer to the diagram above. What is the wavelength of this wave?

a. 2 cm b. 4 cm c. 8 cm d. 10 cm

95. Refer to the diagram above. What is the amplitude of this wave?

a. 2 cm b. 4 cm c. 8 cm d. 10 cm

96. Refer to the diagram above. How many wavelengths are shown?

a. 1 b. 2.5 c. 5 d. 10

97. If we increase the frequency of a wave, what else will happen?

a. Wavelength will increase.
b. Wavelength will decrease.
c. Speed will increase.
d. Speed will decrease.

98. What do we call a disturbance that moves energy through matter or space?

a. Frequency b. Wavelength c. Amplitude d. Wave

99. What happens when a wave strikes a solid surface that it cannot pass through?

a. Reflection b. Refraction c. Diffraction d. Interference

APPENDIX B
ASSESSMENT XLV

100. What happens when a wave passes from one medium to another, changing speed as it does so?

a. Reflection b. Refraction c. Diffraction d. Interference

101. Light travels from air into water. What will happen to the beam when it encounters the water?

a. It will refract only
b. It will reflect only
c. It will only be absorbed.
d. Some will reflect, some will refract, and some will be absorbed.

102. A jackhammer has a speaker in the top that plays the same sound as the jack hammer, but the sound wave has been flipped upside-down by a computer. When you hear the jackhammer and the speaker at the same time, the two sounds cancel. What is this called?

a. Refraction
b. Diffraction
c. Constructive Interference
d. Destructive Interference

103. How come a choir doesn't need microphones to be heard?

a. Constructive interference increases their amplitude.
b. Constructive interference increases their frequency.
c. Destructive interference increases their wavelength.
d. Destructive interference decreases their frequency.

104. What is the relationship between frequency and pitch?

a. Higher frequency makes higher pitch
b. Higher frequency makes lower pitch
c. Frequency does not change pitch

105. What determines the volume of a sound?

a. Frequency b. Wavelength c. Pitch d. Amplitude

106. Based on the Doppler Effect, as a moving object approaches you, what happens to the sound?

a. Pitch increases because wavelength decreases
b. Pitch increases because wavelength increases
c. Pitch decreases because wavelength decreases
d. Pitch decreases because wavelength increases

107. What is the role of the ear drum in hearing?

a. It signals the brain
b. It collects the sound
c. It tugs on the cochlea
d. It makes the bones vibrate

APPENDIX B
ASSESSMENT XLV

108. What do we call the packets of energy that make up light?
a. Electrons b. Photons c. Wavelengths d. Hertz

109. Which of the following lists types of light in order of increasing frequency (decreasing wavelength)?
a. Radio, IR, UV, X-ray, Gamma
b. Gamma, X-ray, UV, IR, Radio
c. IR, UV, Radio, Gamma, X-ray
d. Radio, UV, IR, Gamma, X-ray

110. Which types of light can damage the human body?
a. Radio, microwave, IR
b. UV, X-rays, Gamma
c. IR, Visible, UV
d. Microwaves, IR, UV

111. Which of the following is used for sending signals?
a. Radio Waves b. Microwaves c. Visible light d. All of the above

112. What type of mirror will give you a large but upside-down image?
a. Plane b. Concave c. Convex

113. If I want to see a wide field of view, such as in a rear view mirror, what type of mirror should I use?
a. Plane b. Concave c. Convex

114. What type of lens is used to correct nearsightedness?
a. Plane b. Concave c. Convex

115. If we increase the wavelength of green light, which of the following will occur?
a. The color will shift to yellow.
b. The color will shift to blue.
c. The light will get brighter.
d. The light will get dimmer.

116. What are the three primary colors of light?
a. Red, Blue, Yellow
b. Magenta, Cyan, Yellow
c. Red, Blue, Green
d. Magenta, Cyan, Green

117. What colors of light are reflected by yellow objects?
a. Red and Blue
b. Red and Green
c. Blue and Green
d. Cyan and Blue

118. What do we see when no light is reflected?
a. White b. Ultraviolet c. Magenta d. Black

APPENDIX B
ASSESSMENT XLV

119. What part of the eye detects light?

a. Pupil b. Iris c. Cornea d. Retina

120. What is the speed of a car that travels 100 km in 2 hours?

a. 50 m/s
c. 50 km/hr
b. 200 m/s
d. 200 km/hr

121. What is the velocity of an airplane that flies 2000 km from Michigan to Florida in 5 hours?

a. 10,000 km/hr
c. 400 km/hr South
b. 400 km/hr
d. 400 km/hr North

122. What is the acceleration of a car that slows from 30 m/s to a complete stop in 6 seconds?

a. 5 m/s
c. 5 m/s/s
b. -5 m/s
d. -5 m/s/s

123. How much force is needed to accelerate a 20 kg mass at 4 m/s/s?

a. 80 N
c. 5 N
b. 80 kg
d. 5 kg

124. What is the momentum of a 10 kg bicycle traveling at a velocity of 5 m/s West?

a. 2 kgm/s West
c. 50 kgm/s West
b. 10 kgm/s West
d. 500 kgm/s West

125. How much does a 50 kg person weigh on the Moon (g = 1.6 m/s/s)?

a. 50 kg
c. 80 kg
b. 50 N
d. 80 N

126. What is the mass of a 200 kg person on Zorg (g = 100 m/s/s)?

a. 20,000 N
c. 200 kg
b. 20,000 kg
d. 2 N

127. How much work must be done to move a 30 Newton object a distance of 15 meters?

a. 450 Joules
c. 2 Joules
b. 450 Watts
d. 2 Watts

128. How much power is needed to do 400 Joules of work in 20 seconds?

a. 20 Watts
c. 20 Newtons
b. 20 Joules
d. 20 Newton-meters

APPENDIX B
ASSESSMENT XLV

129. If a 200 Newton person sits 2 m from the center of a seesaw, how far from center will an 80 Newton person have to sit to balance them?

a. 50 meters	c. 0.5 meters
b. 5 meters	d. 10 meters

130. How much current is needed to overcome a resistance of 25 Ohms at 175 Volts?

a. 0.14 Amperes	c. 7 Amperes
b. 0.14 Watts	d. 7 Watts

131. What is the power rating of a device that draws 0.25 Amps at 200 Volts?

a. 800 Watts	c. 50 Watts
b. 800 kWh	d. 50 kWh

132. How much electrical energy is used by a 6 kilowatt space heater in 24 hours?

a. 144 Watts	c. 144 Joules
b. 144 kWh	d. 4 kWh

133. If electricity costs $0.10 per kilowatt-hour, how much will it cost to run the space heater in the question above?

a. $1.44	c. $144.00
b. $14.40	d. $0.14

134. What is the frequency of a wave that makes 15 complete waves in 3 seconds?

a. 0.33 Hertz	c. 5 Hertz
b. 0.33 seconds	d. 5 seconds

135. What is the speed of a wave that has a wavelength of 10 meters and a frequency of 4 Hertz?

a. 40 m/s	c. 2.5 m/s
b. 40 cm/s	d. 2.5 cm/s

APPENDIX B
ASSESSMENT XLV

Match each unit to the quantity it measures (ex. Money is measured in Dollars)

a. meters
b. seconds
c. meters/second
d. meters/second, West
e. m/s/s

136. Acceleration
137. Distance
138. Speed
139. Time
140. Velocity

Match each unit with what it measures.

a. Newton (N)
b. Joule (J)
c. Watt (W)
d. Kilogram (kg)
e. Meters per second per second (m/s/s)

141. Work
142. Power
143. Force
144. Gravity
145. Mass

Match each unit to what it measures.

a. Ampere
b. Kilowatt-hour
c. Ohm
d. Volt
e. Watt

146. Current
147. Voltage
148. Resistance
149. Power
150. Energy

APPENDIX B
ASSESSMENT XLV

INTRODUCTION TO PHYSICS
FINAL EXAM ESSAYS

Choose **two** of the following questions to answer. Make sure you indicate on your answer sheets which essays you are answering. Use complete sentences and scientific terminology. You may include diagrams to help with your explanations, but **must** include a written answer.

A. Your Mom wakes you up early on a Saturday morning. When you don't leap cheerfully out of bed, she says "You don't have a single bit of energy!" Is your mother correct? Give evidence to support your answer.

B. Explain how you would determine the speed of a jogger using a meter stick and a stopwatch.

C. Use one of Newton's Laws to explain why it is dangerous to use the front brakes on a bicycle without using the back brakes.

D. Explain the relationship between gravity and inertia in the motion of a pendulum and discuss how the energy changes as the pendulum swings.

E. Starting with a neutral balloon, a neutral person, and a neutral wall, explain how the person can use static electricity to get the balloon to stick to the wall. Be detailed.

F. Based on your knowledge of light, explain why someone living in the Sahara desert would rather wear white clothing from head to toe than wear black shorts and a black T-shirt.

APPENDIX C:

STUDENT DATA

APPENDIX C

Table 4: Overall Student Performance

	Homework	Project	Lab	Quiz	Test	Exam	Final
Student	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1	81.0%	20.0%	50.6%	59.3%	48.1%	55.3%	54.9%
2	68.3%	77.5%	64.5%	68.9%	75.0%	71.2%	70.4%
3	97.2%	80.0%	99.3%	75.6%	72.0%	87.1%	86.7%
4	81.4%	102.5%	63.9%	68.5%	59.1%	61.2%	70.2%
5	84.8%	50.0%	65.6%	79.4%	82.8%	85.3%	76.6%
6	70.0%	72.5%	74.1%	60.3%	56.6%	67.1%	66.8%
7	81.7%	35.0%	71.7%	70.3%	68.3%	68.8%	68.6%
8	94.5%	50.0%	76.2%	67.3%	71.4%	82.9%	76.7%
9	97.9%	50.0%	84.2%	75.3%	70.7%	88.2%	80.7%
10	78.6%	45.0%	61.7%	50.6%	58.2%	54.7%	60.2%
11	94.1%	102.5%	75.8%	74.7%	73.7%	84.7%	83.4%
12	99.3%	90.0%	90.1%	81.4%	83.3%	89.4%	89.6%
13	91.7%	87.5%	80.1%	69.4%	65.3%	80.0%	79.1%
14	94.5%	50.0%	74.1%	67.4%	61.4%	67.6%	71.2%
15	93.4%	62.5%	80.4%	69.1%	68.0%	70.6%	75.7%
16	97.2%	40.0%	81.8%	68.9%	62.4%	72.9%	73.8%
17	86.6%	62.5%	56.2%	65.3%	63.5%	80.0%	70.0%
18	73.1%	62.5%	69.9%	57.3%	52.1%	49.4%	60.9%
19	99.7%	50.0%	93.9%	72.2%	57.9%	68.2%	76.2%
20	93.8%	87.5%	94.2%	62.9%	70.8%	69.4%	80.7%
21	92.8%	77.5%	83.5%	57.1%	52.8%	68.2%	72.9%
22	93.4%	97.5%	89.2%	66.2%	71.7%	66.5%	80.5%
23	96.6%	87.5%	90.2%	62.0%	48.8%	70.6%	76.2%
24	100.0%	70.0%	97.5%	73.0%	69.2%	83.5%	84.3%
25	50.3%	50.0%	46.8%	68.1%	51.4%	60.0%	53.5%
26	99.0%	90.0%	98.3%	73.5%	78.6%	84.1%	88.3%
27	95.2%	92.5%	86.9%	52.3%	59.7%	64.7%	75.8%
28	100.0%	102.5%	98.0%	72.2%	77.0%	89.4%	90.3%
29	44.1%	75.0%	50.4%	54.1%	30.5%	43.5%	46.6%
30	99.7%	10.0%	98.6%	83.8%	89.9%	94.1%	85.8%
31	86.6%	100.0%	88.6%	63.1%	55.9%	67.6%	76.0%
32	63.1%	20.0%	43.7%	49.4%	51.6%	50.6%	48.7%
33	52.4%	25.0%	39.0%	88.7%	64.9%	80.6%	58.8%
34	73.8%	92.5%	54.9%	68.4%	80.7%	69.4%	71.9%
Average	85.5%	66.7%	75.7%	67.5%	64.8%	72.0%	73.0%

APPENDIX C

Table 5: Test Scores

	Pretest	Unit 1	Unit 2	Unit 3	Unit 4	Exam
Student	100.0%	100	100	100	100	100.0%
1	45.0%	55	47.4	45.6	44.3	55.3%
2	35.0%	77.5	77.4	79.4	65.7	71.2%
3	50.0%	61.3	76.9	86	63.6	87.1%
4	35.0%	63.8	60.3	52.2	60	61.2%
5	60.0%	93.8	79.5	70.6	87.1	85.3%
6	55.0%	56.3	60.3	60.3	49.3	67.1%
7	50.0%	68.8	74.8	76.5	52.9	68.8%
8	20.0%	72.5	53.8	85.6	73.6	82.9%
9	50.0%	65	69.2	75	73.6	88.2%
10	40.0%	67.5	55.6	67.6	42.1	54.7%
11	45.0%	77.5	78.8	75	63.6	84.7%
12	35.0%	81.3	82.5	98.1	71.4	89.4%
13	40.0%	67.5	64.6	76	52.9	80.0%
14	40.0%	68.8	51.9	65.4	59.3	67.6%
15	45.0%	73.8	65.8	73.1	59.3	70.6%
16	35.0%	65	65.2	70.1	49.3	72.9%
17	55.0%	65	60.1	54	75	80.0%
18	30.0%	47.5	52.4	58.4	50	49.4%
19	45.0%	63.8	65.4	56.6	45.7	68.2%
20	65.0%	61.3	66	82.4	73.6	69.4%
21	55.0%	48.8	56.2	59.6	46.4	68.2%
22	15.0%	67.5	65.2	81.9	72.1	66.5%
23	65.0%	61.3	28	31.6	74.3	70.6%
24	35.0%	71.3	72.9	79	53.6	83.5%
25	45.0%	37.5	53.7	56.6	57.9	60.0%
26	40.0%	77.5	85.9	76.5	74.3	84.1%
27	45.0%	61.3	50	61.8	65.7	64.7%
28	35.0%	71.3	79.9	85.3	71.4	89.4%
29	40.0%	51.3	39.6	30.9	0	43.5%
30	60.0%	90	96.6	88.5	84.3	94.1%
31	55.0%	63.8	51.7	49.3	58.6	67.6%
32	25.0%	57.5	42.3	49.3	57.1	50.6%
33	0.0%	86.3	82.5	0	90.7	80.6%
34	40.0%	83.8	76.1	94.4	68.6	69.4%
Average	42.1%	67.1	64.4	66.3	61.4	72.0%

APPENDIX C

Table 6: Unit 1 Quizzes

	Energy 1	Energy 2	Energy 3	Energy 4	Energy 5
Student	5	5	5	5	5
1	4	2	1	3	1
2	3	4	5	2	3
3	4	5	4	5	5
4	4	3	2	5	0
5	4	3	5	5	4
6	4	*	*	4	3
7	4	5	3	2	2
8	5	*	4	5	4
9	2	4	3	4	3
10	2	3	3	0	1
11	5	3	2	5	2
12	4	2	5	5	3
13	2	4	4	2	2
14	4	4	3	5	1
15	5	*	4	3	2
16	4	1	1	3	4
17	2	3	2	2	3
18	3	4	5	1	4
19	4	2	3	5	4
20	4	3	3	1	2
21	4	1	4	1	4
22	2	1	1	1	3
23	4	3	4	2	3
24	3	2	4	5	4
25	2	3	4	*	*
26	3	4	5	5	3
27	2	2	4	2	3
28	4	3	2	3	4
29	2	4	0	1	2
30	5	5	4	3	4
31	4	3	3	3	3
32	3	3	3	2	3
33	3	5	*	*	2
34	3	5	4	3	1
Average	3.4	3.2	3.3	3.1	2.8

APPENDIX C

Table 6: Unit 1 Quizzes, continued

	Motion 1	Motion 2	Motion 3	Motion 4	Motion 5
Student	5	5	5	5	5
1	5	4	3.5	*	0.5
2	2	3.5	4	3.5	5
3	4	4.5	3	4.5	1.5
4	3	3.5	4	4.5	3.5
5	5	4.5	4.5	5	4
6	3	1	3	3.5	4
7	3	3.5	4.5	2.5	3
8	*	4.5	4	*	5
9	4	4.5	4	1.5	5
10	1	1	3	2.5	2.5
11	1	3.5	4.5	4.5	*
12	5	3.5	3.5	4.5	4
13	4	5	4	3	3
14	5	4.5	4	3.5	3
15	4	5	3.5	4.5	3.5
16	4	3.5	3	3.5	4.5
17	4	4	4	3.5	4.5
18	3	3	3	1.5	2
19	4	4	3	4.5	4
20	4	4.5	3	3.5	0.5
21	2	3	2.5	1	2.5
22	4	4.5	3	4.5	4.5
23	4	5	4	4.5	3.5
24	5	5	3	4.5	3.5
25	*	4.5	*	4.5	4.5
26	5	5	4.5	4.5	5
27	2	4.5	*	1.5	3.5
28	4	2.5	3	3.5	4
29	2	4.5	*	3.5	2.5
30	5	5	4.5	5	5
31	5	3.5	2.5	4.5	4.5
32	2	4.5	3	4.5	1.5
33	5	5	5	*	4.5
34	3	5	3.5	4.5	5
Average	3.6	4.0	3.6	3.7	3.5

APPENDIX C

Table 7: Unit 2 Quizzes

	Forces 1	Forces 2	Forces 3	Forces 4	Forces 5
Student	5	5	5	5	5
1	4.5	*	4	2.5	2
2	4.5	4	3	3.5	4
3	4.5	4	5	3	4
4	3	*	4	2.5	2
5	4.5	5	4	2.5	2
6	3	3	*	3.5	2
7	4	4	4	4	4
8	2.5	5	3	4.5	2
9	4.5	3	4	2.5	1
10	*	3	2	2.5	4
11	3.5	3	4	4.5	3
12	3	4	5	3	5
13	3	4	4	4	2
14	2.5	3	4	2.5	1
15	3.5	5	4	*	3
16	3.5	4	1	3	3
17	4	4	3	1.5	3
18	3.5	4	3	2.5	4
19	3	5	4	2.5	2
20	3.5	4	3	3.5	*
21	3	2	3	3.5	3
22	4	2	4	2.5	2
23	3.5	3	4	3.5	5
24	3.5	3	4	3.5	4
25	4.5	4	4	4.5	1
26	3.5	4	3	2.5	3
27	0.5	2	3	0.5	2
28	4.5	2	3	4.5	5
29	*	2	5	2.5	3
30	4.5	5	4	5	2
31	4.5	5	2	4	3
32	0.5	2	*	0.5	2
33	4.5	4	4	5	5
34	2.5	4	3	4	4
Average	3.5	3.6	5.9	3.2	2.9

APPENDIX C

Table 7: Unit 2 Quizzes, continued

	Forces 6	Forces 7	Forces 8	Forces 9	Forces 10
Student	5	5	5	5	5
1	2	*	*	3.5	2
2	3.5	2.5	3	2.5	5
3	4.5	2	3	3.5	5
4	2.5	2.5	2	4	*
5	3	3.5	2	4	5
6	3	1.5	2	2.5	2
7	2.5	4.5	4	2	3
8	0	3.5	*	2.5	0
9	4.5	4	3	*	2
10	2.5	2.5	0	5	5
11	4	3	4	3.5	*
12	4	3.5	4	3	4
13	4	4	*	2.5	3
14	2.5	*	1	4	2
15	2.5	2.5	4	1.5	4
16	4	3.5	4	2.5	4
17	1.5	3.5	2	4	3
18	1	1.5	1	3	3
19	3.5	3.5	4	3.5	4
20	3.5	4	4	1.5	2
21	3.5	3.5	1	3.5	1
22	2.5	4.5	3	3	4
23	2.5	3	4	2.5	4
24	3.5	2	2	4	3
25	*	2	*	1	3
26	2.5	3.5	2	2.5	4
27	2	3.5	1	2.5	2
28	3.5	2.5	3	0.5	3
29	1.5	3	*	1.5	5
30	4	3	3	3.5	3
31	1.5	1.5	1	2.5	3
32	3.5	3	2	2.5	2
33	*	*	5	3.5	*
34	3.5	0.5	3	3.5	4
Average	2.9	2.9	2.7	2.9	3.2

APPENDIX C

Table 7: Unit 2 Quizzes, continued

	Work 1	Work 2	Work 3	Work 4
Student	5	5	5	5
1	*	*	2.5	4
2	4	2	2.5	4
3	3	4	2.5	4
4	3	3	*	5
5	4	5	4.5	4
6	4	4.5	1.5	3
7	4	3	2.5	4
8	2.5	3.5	2.5	4
9	5	4	4.5	5
10	3.5	2.5	3.5	4
11	4	3.5	4	4
12	4	3	4.5	4
13	4	4	2.5	4
14	2.5	3	*	4
15	1.5	3	2.5	4
16	4	5	4.5	4
17	4	1	3.5	3
18	3.5	1.5	1.5	5
19	3.5	4	3.5	4
20	3.5	4	3.5	4
21	*	3	2.5	5
22	4	1.5	4	5
23	3	*	1.5	4
24	4	3	4	4
25	2.5	5	3.5	4
26	3.5	4	3.5	3
27	2.5	3	1.5	4
28	5	5	4.5	4
29	2.5	2.5	1.5	5
30	5	5	3	4
31	*	4	2.5	4
32	3.5	2	1.5	4
33	*	5	5	5
34	4	1	3.5	5
Average	3.6	3.4	3.1	4.1

APPENDIX C

Table 8: Unit 3 Quizzes

	E&M 1	E&M2	E&M3	E&M4	E&M5	E&M6	E&M7	E&M8
Student	5	5	5	5	5	5	5	5
1	4	2	2	2	*	1.5	*	4
2	0	4	2.5	4	3.5	2.5	5	3
3	2	3	4	5	3.5	*	5	5
4	4	5	3.5	2	4	4.5	5	*
5	3	2	5	*	5	4	4	5
6	2	2	5	1	*	5	5	3
7	5	5	5	4	*	3	4	*
8	5	2	1.5	3	0	3	4	5
9	5	5	*	4	2.5	*	5	4
10	4	2	0	1	1.5	3	3	4
11	*	5	3	4	4	4.5	5	4
12	4	5	3	4	5	5	4	3
13	4	3	5	3	3.5	3	4	4
14	5	3	3.5	4	4.5	5	4	4
15	4	2	4	4	1.5	5	4	2
16	3	5	5	2	3.5	5	3	1
17	3	3	4	2	3	4.5	3	*
18	3	3	2.5	0	3.5	1.5	5	3
19	4	3	2.5	4	2.5	4	5	*
20	2	1	*	1	3.5	5	5	2
21	5	2	2.5	1	3	4	3	3
22	4	2	3.5	4	3	4	5	5
23	3	1	2.5	0	1	1.5	3	3
24	2	3	5	5	5	2.5	3	4
25	4	3	3	3	4.5	2.5	5	3
26	4	3	3.5	5	3.5	1.5	5	2
27	5	1	2.5	0	5	*	4	2
28	4	3	2	1	5	5	5	5
29	1	2	3.5	2	2.5	1.5	3	4
30	5	5	4	5	5	5	4	5
31	4	3	1.5	2	1.5	1.5	4	3
32	1	2	1.5	3	2.5	*	*	2
33	*	4	*	5	*	*	*	*
34	5	3	3.5	2	2.5	3.5	4	4
Average	3.5	3.0	3.2	2.8	3.3	3.5	4.2	3.5

APPENDIX C

Table 9: Unit 4 Quizzes

	Waves 1	Waves 2	Waves 3	Waves 4
Student	5	5	5	5
1	2.5	4	*	5
2	3	3	4	5
3	2	4	2	3
4	3	5	2	4
5	2	*	3	4
6	1.5	4	2	3
7	1	2	*	*
8	4.5	4	3	4
9	3.5	5	3	4
10	3.5	3	1	1
11	3	5	3	3
12	5	4	5	5
13	2.5	3	4	3
14	4	3	1	3
15	5	2	4	3
16	*	2	4	4
17	5	4	4	4
18	2	4	2	4
19	3.5	3	2	4
20	*	3	3	4
21	*	4	4	1
22	1.5	5	2	4
23	*	1	2	5
24	3	4	3	4
25	4	4	1	2
26	3	3	4	5
27	2.5	4	3	3
28	2.5	4	4	5
29	2	3	3	3
30	3.5	4	2	3
31	2.5	3	4	4
32	0.5	3	2	3
33	3.5	5	4	5
34	3.5	3	3	2
Average	3.0	3.5	2.9	3.6

APPENDIX C

Table 10: Unit 1 Labs

	Lab Safety	Energy 1	Energy 2	Energy 3	Energy 4
Student	5	10	10	10	10
1	5	10	8	10	10
2	5	10	10	10	10
3	5	10	10	10	10
4	5	10	10	10	10
5	5	10	10	10	0
6	5	10	6	7	10
7	5	10	10	10	10
8	5	10	10	10	10
9	5	10	6	8	10
10	5	10	6	4	10
11	5	8	10	10	5
12	5	10	8	10	10
13	5	10	10	10	10
14	5	10	6	10	10
15	5	10	10	10	10
16	5	10	9	10	10
17	5	8	4	10	10
18	5	10	10	9	0
19	5	10	10	10	10
20	5	10	6	10	10
21	5	10	6	10	10
22	5	10	10	10	10
23	5	10	10	10	10
24	5	10	7	10	10
25	5	10	4	7	0
26	5	10	10	10	10
27	5	10	10	9	10
28	5	10	10	10	10
29	5	2	4	8	6
30	5	10	7	10	10
31	5	10	4	10	10
32	5	10	6	8	10
33	5	0	8	0	10
34	5	8	8	9	10
Average	5.0	9.3	8.0	9.1	8.9

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Table 10: Unit 1 Labs, continued

	Motion 1	Motion 2	Motion 3	Motion 4	Motion 5
Student	10	10	10	10	10
1	8	7	3	10	7
2	10	8	10	10	3
3	10	10	10	10	10
4	8	10	7	10	10
5	10	10	10	10	8
6	10	9	10	10	4
7	10	10	10	10	8
8	1	10	8	10	4
9	10	5	10	10	10
10	8	7	6	10	10
11	8	9	8	10	5
12	10	8	10	10	8
13	10	10	10	10	10
14	10	10	7	10	10
15	10	5	10	10	10
16	10	10	8	10	9
17	10	2	10	10	10
18	8	5	10	10	8
19	10	5	10	10	10
20	10	10	10	10	10
21	10	5	10	10	10
22	10	5	10	10	10
23	10	5	10	10	10
24	10	10	10	10	10
25	0	10	0	10	10
26	10	10	10	10	10
27	10	6	10	10	10
28	10	10	10	10	10
29	6	2	0	10	4
30	10	10	10	10	10
31	10	10	10	10	10
32	8	0	10	10	3
33	10	10	10	10	10
34	8	10	9	10	8
Average	8.9	7.7	8.7	10.0	8.5

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Table 11: Unit 2 Labs

	Forces 1	Forces 2	Forces 3	Forces 4	Forces 5
Student	10	10	10	10	10
1	5	0	6	2	0
2	4	10	5	10	0
3	10	10	10	10	10
4	0	0	5	0	2
5	8	0	5	10	10
6	5	10	0	7	10
7	5	6	2	10	10
8	5	0	6	10	9
9	5	4	10	10	8
10	*	4	5	10	8
11	3	8	5	10	10
12	10	10	7	10	10
13	5	8	5	4	10
14	10	10	2	10	0
15	5	8	2	10	2
16	5	10	5	10	2
17	5	10	2	2	0
18	0	10	5	10	6
19	5	10	10	10	10
20	5	10	10	10	10
21	5	6	10	10	8
22	5	10	5	10	10
23	5	10	10	8	10
24	5	10	10	10	10
25	5	0	10	0	0
26	10	10	7	10	10
27	5	6	7	10	10
28	5	10	10	10	10
29	10	0	7	1	0
30	8	8	7	10	10
31	8	10	10	10	10
32	10	0	0	1	0
33	5	10	5	10	0
34	5	10	5	8	0
Average	5.8	7.0	6.2	8.0	6.3

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Table 11: Unit 2 Labs, continued

	Forces 6	Forces 7	Forces 8	Forces 9	Forces 10
Student	10	10	10	10	10
1	6	10	0	8	10
2	0	8	2	8	10
3	10	10	10	10	10
4	2	6	0	0	*
5	2	10	4	10	0
6	10	10	10	10	10
7	10	10	2	10	2
8	10	10	4	10	7
9	10	10	4	10	7
10	0	8	2	10	8
11	2	9	4	10	*
12	10	9	6	10	10
13	10	10	0	10	9
14	0	4	4	10	7
15	2	10	6	6	8
16	10	10	4	10	8
17	4	10	4	0	10
18	6	4	4	6	10
19	10	6	6	10	10
20	10	10	8	10	8
21	10	10	4	10	10
22	10	8	6	8	10
23	10	10	8	10	8
24	10	10	8	10	10
25	0	10	0	8	10
26	10	10	10	8	10
27	10	10	4	10	10
28	10	8	10	10	10
29	8	0	0	2	0
30	10	10	10	10	10
31	10	10	10	10	10
32	8	0	4	2	10
33	0	0	0	10	0
34	0	10	2	6	10
Average	6.8	8.2	4.7	8.3	8.2

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Table 11: Unit 2 Labs, continued

	Work 1	Work 2	Work 3	Work 4
Student	10	10	10	10
1	0	0	10	8
2	10	10	10	5
3	10	10	10	8
4	10	10	10	8
5	4	0	10	10
6	10	10	10	0
7	10	10	4	10
8	10	2	10	8
9	10	0	8	10
10	6	0	10	8
11	10	10	10	10
12	6	10	10	10
13	10	10	10	10
14	4	2	0	8
15	10	2	10	10
16	10	2	10	8
17	4	2	10	8
18	6	2	10	10
19	10	10	10	8
20	10	10	10	8
21	0	10	10	8
22	10	10	10	8
23	10	10	10	8
24	10	10	10	10
25	4	1	6	10
26	10	10	10	10
27	10	10	10	8
28	10	10	10	10
29	1	4	5	5
30	10	10	10	10
31	10	1	10	10
32	2	0	5	4
33	0	2	4	8
34	4	1	4	8
Average	7.4	5.9	8.7	8.3

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Table 12: Unit 3 Labs

	E&M 1	E&M 2	E&M 3	E&M 4	E&M 5	E&M 6	E&M 7
Student	10	10	10	10	10	10	10
1	10	10	4	0	1	10	0
2	0	3	0	0	10	0	0
3	10	10	10	10	10	10	10
4	5	9	4	10	10	10	10
5	0	10	0	1	10	6	0
6	3	10	4	0	10	10	6
7	2	3	5	0	10	0	0
8	0	10	10	1	10	0	10
9	0	9	10	10	10	10	10
10	4	6	7	9	9	2	0
11	0	9	1	10	10	10	8
12	10	9	10	9	9	10	6
13	2	10	4	10	10	10	9
14	10	10	10	10	10	8	10
15	10	10	10	5	2	2	9
16	10	10	10	0	10	8	6
17	7	5	2	8	7	2	0
18	0	9	10	10	8	8	6
19	10	10	10	10	10	10	10
20	10	10	10	10	10	10	10
21	10	9	6	10	10	4	4
22	8	9	9	5	10	10	10
23	10	10	0	10	9	10	10
24	10	10	10	10	10	10	10
25	0	10	10	1	10	10	4
26	10	10	10	10	10	10	10
27	10	10	6	10	9	4	4
28	10	10	10	10	10	10	10
29	5	5	3	5	5	5	2
30	10	10	10	10	10	10	9
31	10	10	10	1	10	10	10
32	5	4	2	5	5	0	3
33	0	0	6	0	0	0	0
34	0	4	0	2	7	2	5
Average	5.9	8.3	6.6	6.2	8.6	6.8	6.2

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Table 13: Unit 4 Labs

	Waves 1	Waves 2	Waves 3	Waves 4	Waves 5
Student	10	10	10	10	10
1	0	0	0	0	0
2	0	10	10	6	10
3	10	10	8	10	10
4	7	10	4	0	3
5	0	0	0	8	10
6	10	10	0	5	0
7	7	10	10	8	3
8	10	10	10	10	10
9	10	10	10	10	10
10	0	6	10	0	10
11	5	10	4	5	7
12	9	2	10	7	10
13	10	10	0	0	2
14	5	5	10	5	10
15	10	8	10	8	10
16	10	0	10	10	10
17	3	2	4	0	0
18	5	5	5	10	7
19	10	10	8	9	10
20	8	10	5	10	10
21	10	10	10	10	5
22	6	8	10	9	10
23	8	10	5	10	10
24	10	10	10	10	10
25	0	0	0	0	0
26	1	10	10	10	10
27	10	10	10	10	5
28	10	10	10	10	8
29	5	10	10	10	4
30	10	10	10	10	10
31	6	10	5	5	8
32	3	0	10	0	0
33	0	0	2	2	0
34	2	4	3	3	3
Average	6.2	7.1	6.9	6.5	6.6

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Table 14: Homework Scores

	Organization	Warm Ups	Lecture Notes and Reviews
Student	30	94	166
1	30	78	127
2	30	30	138
3	30	86	166
4	30	63	143
5	30	66	145
6	25	65	113
7	30	56	151
8	30	87	157
9	30	88	165
10	30	75	115
11	30	90	150
12	30	92	166
13	25	88	153
14	25	92	156
15	25	89	157
16	30	94	158
17	20	64	166
18	30	51	130
19	30	94	165
20	30	77	165
21	15	89	165
22	30	79	162
23	30	88	162
24	30	94	166
25	5	55	86
26	30	90	166
27	30	87	159
28	30	94	166
29	16	22	90
30	30	92	166
31	30	68	158
32	20	44	119
33	10	50	92
34	25	42	147
Average	26.5	74.1	146.8

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Table 15: Project Scores

	Fly Me to the Moon	Electrical Doohickey
Student	100	100
1	40	0
2	80	75
3	50	110
4	100	105
5	55	45
6	75	70
7	70	0
8	100	0
9	50	50
10	50	40
11	100	105
12	80	100
13	100	75
14	100	0
15	60	65
16	80	0
17	75	50
18	50	75
19	50	50
20	100	75
21	100	55
22	100	95
23	100	75
24	100	40
25	100	0
26	100	80
27	100	85
28	100	105
29	50	100
30	20	0
31	100	100
32	0	40
33	50	0
34	100	85
Average	76.0	57.4

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