Web Unit Plan

Title: Phabulous Physics

Description: Use Physics! Phabulous Physics! To solve physics puzzles presented by linear motion, students learn about motion by working with challenging physics problems. Students use spreadsheet software to analyze and represent data from a physics problem and then present their physics findings to their peers by creating a brochure. To seek community input about local traffic hazards, students then produce a survey or blog and post it on a site. Armed with this community data and their own research, student groups take on the role of members of a highway safety advocacy group. Their task is to create and deliver a slideshow presentation to the city planners proposing changes to a dangerous section of road or intersection.

At a Glance

Grade Level: 11—12

Subject sort (for Web site index): Science

Subject(s): Physics

Topics: Motion

Higher-Order Thinking Skills: Synthesis, Analysis, Problem Solving

Key Learnings: Motion, Velocity, Acceleration, Vectors

Time Needed: 4 weeks, 90-minute classes, daily

Unit Summary

In this unit, students fully investigate linear motion. After reviewing essential mathematics concepts, students are introduced to laws of motion, velocity and acceleration, vectors, and Newton's Laws using a series of online simulations. After students have a thorough understanding of these basic concepts, they prepare brochures illustrating a real-world problem related to motion that answers the Unit Question, How do the laws of motion describe everyday events? Students illustrate the problem, show how to solve the problem using physics principles, and use spreadsheets to enter data and graphically show some aspect of the solution. With a firm understanding of these principles, student groups create a survey designed to gather information from the community about a given road hazard. The community data is used to prepare a slideshow presentation that will be presented to the city planners. The goal of the presentation is to persuade the leaders to make changes to a dangerous section of road or intersection.

Curriculum Framing Questions

- **Essential Question**
  Can all the events around us be anticipated and explained?
- **Unit Questions**
  Can the motion of any object be predicted?
  How can understanding the laws of nature make our lives better or safer?
  How do the laws of motion describe everyday events?
- **Content Questions**

  How are speed and velocity related?
  What are Newton’s Laws of Motion?

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Assessment Processes

View how a variety of student-centered assessments are used in the Phabulous Physics Unit Plan. These assessments help students and teachers set goals; monitor student progress; provide feedback; assess thinking, processes, performances, and products; and reflect on learning throughout the learning cycle.

Instructional Procedures

Unit Preparation

This unit presumes students have solid mathematical skills. Students should refresh their skills through the introductory homework assignment. An answer key is provided for class review. The homework serves the dual purpose of reviewing conversion skills, and providing the students and teacher with feedback about the students' readiness for the physics unit to come. Provide additional practice if necessary.

Introducing Linear Motion

Introduce the physics of linear motion with the support of the following online simulations:

Online Labs:

- Newton's Second Law*
- Newton's Third Law*

PhET Simulations:

- Forces and Motion*
- Ramp: Forces and Motion*
- Ladybug Motion 2D*

These online simulations cover the Unit Questions, *How do the laws of motion describe everyday events?* and *Can the motion of any object be predicted?* The simulations also address the Content Questions, *How are speed and velocity related?* and *What are Newton's Laws of motion?*

Students can either explore simulations in the computer lab or as homework, with discussion to follow in class to address the unit and content questions. Where necessary, review simulations as a class and provide students with additional examples from the textbook or Internet resources to reinforce these basic concepts.

At this point, give a short quiz assessing conversion skills, vector analysis, and forces. A quiz answer key is provided. The quiz serves the dual purpose of reviewing physics principles, and providing the students and the teacher with feedback about the students' readiness for the completion of the next assignment—developing a digital product. Provide additional practice if necessary.

Creating a Publication

Model the upcoming independent physics project through a whole-class practice activity. Lead the class as they work out a linear motion problem related to traveling locomotives. Guide students as they develop a paper-and-pencil solution and verify their solution. Have students copy the traveling locomotives data into a spreadsheet and create a graph to represent their data (for example, see spreadsheet with graph). If students have not used spreadsheet software to enter data and create

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graphs, provide them with whole-class guidance using a projector and/or provide them with the spreadsheet help page.

After students complete these activities, show the class the locomotive problem brochure to give them a sample of the final product.

Group students into pairs. Instruct each pair to create a brochure that illustrates a real-world problem that is related to motion and answers the Unit Question, *How do the laws of motion describe everyday events?* as well as the broader Essential Question, *Can all the events around us be anticipated and explained*?

To ensure students understand the assignment and how they will be assessed, distribute the brochure scoring guide and discuss the project criteria in detail. In partners, ask students to assess the locomotive problem brochure using the rubric. Then as a class, discuss students' ratings and try to come to consensus about the ratings given for the various traits.

Have students navigate to Projectile Motion*, a PhET simulation that encourages students to fire various objects out of a cannon while manipulating variables to learn about projectile motion. After students find the solution, and hit the target, ask them to create a digital product of their learning (for example, a blog, wiki, narrated slideshow, videocast, screencast, or digital poster). The product should include the following elements:

- Statement and explanation of the problem
- Illustration of the problem (screenshot)
- Explanation of how launch angle, initial speed, initial height, mass, and air resistance affected the projectile's range, motion path, final height, and time
- Key kinematic equations and a mathematical solution to the problem
- Graph showing a mathematical representation of the problem
- Comments and insights about the problem

Have students prepare a five minute presentation about the projectile problem and its solution, supported by their digital product. Make sure to clarify or cover any additional material that is crucial and not answered by the individual presentations.

Ask students to provide feedback to their peers about the presentations using the oral presentation rubric. Allow time for partners to review the feedback and incorporate suggestions into their next presentation.

Beginning the Project

Have students create blog entries describing information obtained during the course of the project. Review entries throughout the project to check for understanding, provide feedback, and adjust instruction as necessary.

Tell students that they will take on the role of members of a transportation safety advocacy group. Their task is to create and deliver presentations to the city planners proposing changes to dangerous sections of road or intersections, and answer the Unit Question, *How can understanding the laws of nature make our lives better or*

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safer? and the broader Essential Question, *Can all the events around us be anticipated and explained?*

Ranking the Hazards

To help students compare, prioritize, and analyze different hazardous locations, introduce them to the *Visual Ranking Tool.* Before you use V*isual Ranking* with your students, examine the *Visual Ranking* Web site and become familiar with the tool.

Set up a project and add teams in the teacher workspace. Assign the students to groups and lead the class through a discussion of safe driving. Ask the class, *Since you have begun driving, how many of you have personally been in or know someone who has been in an accident*? After some discussion, have the students offer the names of sections of roads or intersections that they feel are unsafe. After brainstorming five to seven dangerous roadways, enter these into the teacher workspace of *Visual Ranking*. Have the groups log in to their *Visual Ranking* student workspace and rank the locations from most hazardous to least hazardous. Students should explain their rankings using appropriate principles of motion.

Circulate through the room while the groups work, taking anecdotal notes, questioning for understanding, and providing feedback as necessary. After all groups have finished ranking the list, have each group compare their ranking with other groups' rankings. Lead a class discussion of why the rankings might be different. Students should then individually record information in their journals. If possible, invite the head of transportation public safety to participate in the ranking and include these results in the discussion.

Creating a Survey

Either assign or have student groups pick a dangerous section of road or intersection from the list generated previously in class. Student groups will create a survey designed to gather information from the community about their given road hazard to obtain public information. Have students create their survey using an online survey maker or a blog to post their questions and collect information. A list of potential survey and blog sites is included in the Resources section. A sample survey and a sample blog were created as examples for this unit. Review the sites with students as models for expectations and to answer any questions. Send letters home and solicit parent responses. If possible, see if your local newspaper will include a brief description of your class project and include the survey or blog site link for the class. Tell the class that feedback obtained through the site will be included in the final presentation. As feedback is obtained, have students include the data in their journals.

Conducting Research

Allow students time to conduct research on their chosen hazardous roadway. Have the class look through local newspapers and resources as well as conduct Internet research. Have students write their information in their individual journals.

Schedule conferences while students are conducting research to answer questions, monitor their progress, and provide additional help as necessary.

Creating a Causal Map

To help students investigate cause-and-effect relationships, introduce them to the *Seeing Reason Tool*. Before you use *Seeing Reason* with your students, examine the *Seeing Reason* Web site and become familiar with the tool.

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Set up a project in the teacher workspace and make sure the teams are assigned. Have students look at a sample traffic causal map in *Seeing Reason* that looks at the many factors that affect road safety. Remind students that their map will look very different because it will focus on the physics involved in a hazardous roadway or intersection. Have teams log in to their *Seeing Reason* student workspace. Ask student teams to create a causal map of the factors that make their road or intersection hazardous. As responses are obtained from the student's Web site, have them modify their causal maps and add this data to their student journals. Encourage more research, and incorporate any additional information into the team causal map. Use the comments portion of the tool to provide feedback to the group as they work on this portion of the project.

Creating Presentations

Have students create and deliver a 10- to 15-minute slideshow presentation outlining a given section of road or intersection. Have students use kinematic equations to explain the problem and their proposed solution to the road hazard. The presentations answer the Unit Questions, *How do the laws of motion describe everyday events?* and *Can the motion of any object be predicted?* as well as the bigger Essential Question, *Can all the events around us be anticipated and explained?* To ensure students understand the assignment and how they will be assessed, distribute the project scoring guide and presentation guide. Discuss the project criteria in detail with the class. Remind students that they will take on the role of members of a transportation safety advocacy group. Their task is to make presentations to the city planners proposing changes to dangerous sections of road or intersections. Make sure to clarify any project questions and remind students to incorporate the peer feedback from their previous presentation as they plan and practice for their final presentation.

Completing Final Presentations

On the day of presentations, tell students that they will take turns making presentations and asking questions about each team's road hazard and the research behind it. When the audience is asking questions, they take on the roll of city planners trying to determine the best use of limited transportation funds to change a dangerous section of road or intersection. When answering the questions, the presenters take on the role of members of a transportation safety advocacy group. Invite administrators and teachers with planning periods during this class to participate.

After all presentations are complete, debrief the activity and summarize the suggestions. To wrap up, pose the Unit Question, *How can understanding the laws of nature make our lives better or safer?* and the broader Essential Question, *Can all the events around us be anticipated and explained?* Facilitate a class discussion that targets the study of roadways and intersections and then draws some final conclusions about the study of linear motion in the real world.

As a final reflection, ask students to complete the self-assessment on group contribution form to help them plan for future project work.

Prerequisite Skills

- Solid unit conversion and mathematical skills
- Familiarity with the equation editor (for digital products and final presentations)

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Differentiated Instruction

Resource Student

- Distribute project storyboards and guidelines to help guide the student's work and monitor the student's progress regularly
- Provide the student with additional templates or scaffolds to ensure project success
- Place the student in cooperative groups that will help the student achieve
- Allow additional time for when necessary

Gifted Student

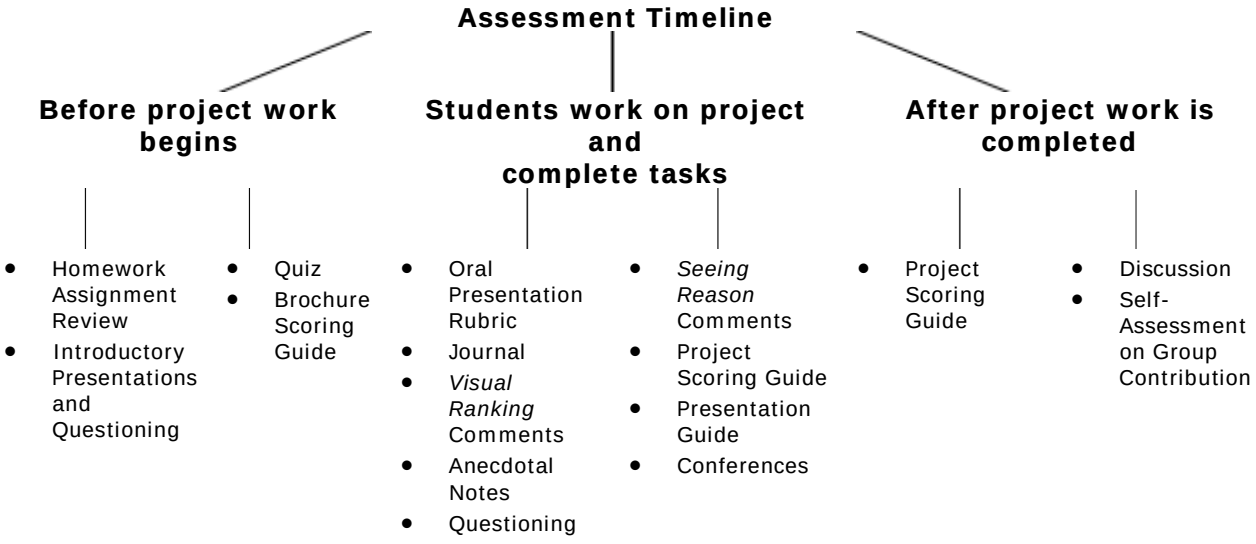
- Challenge the student to apply acquired learning to the development of working models and to the explanation of everyday phenomena of motion
- Provide the student with the option to substitute or participate in enhanced components of each project throughout the unit

English Language Learner

- Provide the student with a list of basic vocabulary words and definitions ahead of time
- Provide additional visual and graphic displays to teach content area material
- Allow the student to choose to demonstrate understanding of the academic concepts with models, drawings, diagrams, and so forth
- Provide the student with additional templates or scaffolds to ensure project success

THINGS YOU NEED

Assessment Plan



Assess prior knowledge through a homework assignment, questioning during background multimedia presentations, and a quiz on content knowledge. Based on the results of these assessments, provide additional instruction as necessary.

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Informally assess students using questioning, feedback, journal reviews, and anecdotal notes while they conduct research and use *Visual Ranking* and *Seeing Reason*. Schedule teacher conferences with teams periodically to assess student understanding and redirect teaching as needed. Provide the brochure scoring guide, presentation guide, and project scoring guide to help students monitor their work on the brochure and multimedia presentations. Use the same scoring guides to assess the brochure and final presentation. Provide the oral presentation rubric for peers to give feedback on presentation skills and provide time for students to incorporate the feedback into their final presentation. Have students use the self-assessment on group contribution form to self-assess their work during the project and to help them plan for future project work.

Content Standards and Objectives

Targeted Content Standards and Benchmarks

National Science Standards

Motions—Grades 9–12

- Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship F = ma, which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object.
- Gravitation is a universal force that each mass exerts on any other mass. The strength of the gravitational attractive force between two masses is proportional to the masses and inversely proportional to the square of the distance between them.

Students will be able to:

- Use general relationships among position, velocity, and acceleration for the motion of a particle along a straight line to predict where an object will stop
- Predict the motion of a projectile in a uniform gravitational field
- Determine cause-and-effect relationships among physics concepts

Technology and Resources

Internet Resources

Websites

- Welcome to Zona Land
  http://id.mind.net/~zona*
  Provides educational and entertaining items pertaining to physics, mathematical sciences, and mathematics in general
- National Highway Traffic Safety Administration
  www.nhtsa.dot.gov*
  Provides information designed to help save lives, prevent injuries, and reduce vehicle-related crashes

Simulations

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- Amrita University: Newton's Second Law
  http://amrita.olabs.co.in/index.php?sub=1&brch=1&sim=44&cnt=1*
  Learn about mass, acceleration, force and momentum as it relates to Newton's Second Law
- Amrita University: Newton's Third Law of Motion Using Two Spring Balances
  http://amrita.olabs.co.in/index.php?sub=1&brch=1&sim=105&cnt=1*
  Explore equal and opposite reactions using spring balances
- PhET: Forces and Motion
  http://phet.colorado.edu/en/simulation/forces-and-motion*
  Create an applied force and see the resulting friction force and total force acting on the object. Graphs show the forces, position, velocity, and acceleration vs. time
- PhET: Ramp Forces and Motion
  http://phet.colorado.edu/en/simulation/ramp-forces-and-motion*
  Lower and raise a ramp to see how the angle of inclination affects the parallel forces. Graphs show forces, energy and work
- PhET: Ladybug Motion 2D
  http://phet.colorado.edu/en/simulation/ladybug-motion-2d*
  Set the position, velocity and acceleration of a ladybug and see how the vectors change. Choose linear, circular or elliptical motion, then record and playback the motion to analyze the behavior
- PhET: Projectile Motion
  http://phet.colorado.edu/en/simulation/projectile-motion*
  Fire various objects out of a cannon while manipulating variables to learn about projectile motion

Blogs

- Blogger
  www.blogger.com/start*
  Free, customizable blog templates and layouts. Requires a Google* account.
- Edublogs
  http://edublogs.org*
  Blogs designed for educators and students, privacy and access controlled.
- WordPress
  http://wordpress.com*
  Use design templates to build a blog site, ad-free on paid version only.

Online Surveys

- SurveyMonkey
  www.surveymonkey.com*
  An easy-to-use online survey creation tool. Survey templates include many types of questions and visual themes.
- Polldaddy
  http://polldaddy.com*
  An online survey tool that places polls on blogs, Web sites, and social networks.

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