Learning about Physics through Sports Olympiad

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Rationale

It is a well known fact that boys love sports, especially preteen boys. They idolize sports figures and memorize statistics of their favorite players and teams. At school, they play trashcan basketball or "rubber band" ball football whenever they can get permission. How can a teacher tap into this obsession? The goal for this unit is to do just that. Students will learn more about each sport and how physics plays a role. Students that love sports already will find a new found appreciation for their favorite sports and learn about new ones. "Non-athletic" students will see that sports really are fun and that they do not have to be the best athlete to enjoy watching and participating in different sports. Ultimately, students will learn that science and math are all around them, and not just a class they have to take in school.

This unit is designed for seventh grade middle school students. It is appropriate for many different ability levels including students with Exceptional Child status (both ends of the spectrum: gifted and learning disabled). It can be a difficult to incorporate activities that address their range of academic and social abilities. Female students often shy away from lab activities in science class and physical activities in general, especially when male students are present, because male students tend to be more willing to try new things in front of the group and overshadow the female students that tend to analyze the situation before they start new things. This is an additional challenge, particularly when they are the minority group during the activity. Several ideas to address these differentiation needs are included within the unit.

An introductory lesson on potential/kinetic energy and gravity is included to review the concepts with the seventh grade students. The rationale for the introductory lesson is to make sure that all students have a basic foundation on concepts of acceleration due to gravity, and the balance between levels of potential and kinetic energy. These topics are a good foundation for the other topics.

The bulk of the unit is a series of activities setup as a Sports Olympiad, using sports to reinforce the basic physics concepts of the middle school science curriculum. The activities are designed to occur outside during the fall or spring, but many could be done in a gym or a classroom. It can be adjusted to encompass one class, one team, or one grade level group of students/teachers. There are a variety of activities and roles to address the range of students by ability and interest. Scaffolding of learning occurs from beginning to end of the unit, culminating in a student presentation of what was learned during the unit.

The unit will begin in the classroom, with mini-lessons or stations and demonstrations of basic physics concepts. These may cover 1-4 class periods, depending on length of the class period (55-90 minute classes).

While working on part one of the unit, previews to the Olympiad should be given that include: list of events, criteria for choosing teams, ultimate goals and objectives, and the opportunity for student input on all of the above. Letting the students help make decisions about the Olympiad will give them ownership of the project, and will help with student engagement. Ideally, the activities are designed to be tailored to the needs of the group of students and can be modified accordingly.

The main part of the unit is the Olympiad Competition, itself. Some ideas for stations/events, with sample activities and educational goals are as follows, but can be modified based on need and available resources. Each activity will have a different product (data tables, graphs, video) based on the activity, but students will also complete a "Physics Flowchart" for each concept. They will need to: 1) name the activity, 2) list the physics concepts, 3) explain how the physic concept is demonstrated in the given activity, and 4) make real world connections about the physics concepts. These flowcharts can then be used to guide the culminating project. A sample chart is including in the unit plan.

At the beginning of the unit, students will be assigned specific tasks based on interest and ability. Some students will be recorders of data, some will be videographers, and some will be engineers or athletes. Each team will be composed of 4-5 students. The role/job may change for each student by activities. One student may want to compete as a hurdler, but want to collect data at the "Blocking Sleds" event.

Part of the competition, beyond trying to win the most points during the events, is to hypothesize the physics concepts that may be involved with the events. At the end of the competition, teams will be given a list of concepts to match to the events. More points are awarded for the teams that correctly match the physics concepts BEFORE receiving the list, than those teams that made correct matches with the list in hand. This again allows for varying degrees of difficulty and levels of success for all students. In creating teams, try to balance the teams by ability. If one team is full of athletes, then the other teams may get frustrated and not want to continue participating. Also be cognizant of the gender make up of the teams. You may want to have all girl and all boy teams. Randomizing might not be the best strategy, since you cannot control the ability levels as easily.

The culminating project for the unit will be for each team to create a technology based presentation of both the events and the concepts they learned from the events. Students will follow a rubric and will need to include video and photographs of each event, as well as, graphs, charts or other visual representations of the physics concepts. It will be required that the students show a detailed explanation of how the physic concept connects to the specific event or sport.

Background

Physical Science Concepts

Concepts that will be addressed during this unit include but are not limited to the concepts of velocity, acceleration, force (friction, gravity), Newton's Laws, Conservation of Energy, kinetic and potential energy, and simple machines (pulleys and levers).

Newton's Laws of Motion

Newton's First Law of Inertia states that a body in motion tends to stay in motion unless acted upon by an outside force. It follows that a body at rest stays at rest unless acted upon by an outside force.

Newton's Second Law states that acceleration is equal to the net force divided by the mass of the object.

$$a = F/m$$

Newton's Third Law discusses equals and opposite forces and the results. For every action there is an equal and opposite reaction. This means that if two objects interact with each other, then they will exert forces on each other. Forces tend to come in pairs and this is a perfect example of this idea. When standing, your body exerts a force on the floor and the floor exerts a force back on your body.

Potential and Kinetic Energy

Potential Energy is the stored energy available to do work. Kinetic Energy is the energy of work. When an object is at rest, it has maximum potential energy (PE), and minimum kinetic energy (KE).

Friction

Force of Friction (F_f) is equal to the Coefficient of friction (μ), which tells us how rough the surface is, times the weight or Normal Force (F_n), which tells us how hard the surfaces are pushed together.

$$(F_f) = \mu F_n$$

Simple Machines

Machines are designed to manipulate forces, either by multiplying forces or changing the direction of forces.[1] They conserve energy by making work “easier” to do; easier because the force is being applied by the machine and not by the individual. In many cases, you cannot change the amount of force needed to do the work, but you can change how it is used overall, in order to act more efficiently or to better serve your purpose.

$$(\text{Force x distance})_{\text{input}} = (\text{Force x distance})_{\text{output}}$$

Examples of simple machines are levers and pulleys. A lever is used to give leverage when lifting or moving an object. It can be fixed at a specific point to transfer less energy into more movement of an object. An example of a lever can be simply a shovel used to move a rock, or as complex as a seesaw, which is considered a balanced level because the fulcrum (pivot point of the lever) is centered, thus not making the work “easier” since the weight/force for each side needs to be nearly equal. An ideal lever would allow a small input of force over a larger distance, which would in turn produce a large output of force over a short distance on the other side of the lever. There are three types of levers, but we do not need to go into that much detail at the middle school level. A pulley is a specialized lever that allows you to change the direction of the force. The concept is similar to a standard lever, but the purpose is slightly different. This concept is not addressed in this unit, but it is an important concept to know if asked by students.

Unit Plan

Introductory Lesson on Potential/Kinetic Energy

Students will begin the lesson with an Activating Vocabulary Strategy: “If you toss a ball across the gym to another person, why will the path of the ball be curved instead of straight?” Expected sixth grade answers should include, “because the ball is falling as it travels across the gym”, while advanced students and seventh grade students should explain the concept with basic vocabulary: gravity, change in energy, and also may be able to say “Gravity causes the ball to fall as it travels across the gym, and that the levels of kinetic and potential energy changes as the ball travels.” Have students recall information about gravity and why it affects objects.

The students will then define Potential Energy (the stored energy ready to do work), and Kinetic Energy (The energy of motion). It may also be helpful for students to define Energy (the ability to do work). These are basic definitions, but are valid with this age group. This may be done individually, or in pairs.

Students should now work in pairs, collecting data about how objects fall. Each pair should have different objects to throw and drop. Some should be round and some should be irregular shaped, and the objects should be of different masses. They should drop each object from different heights, and throw them with difference force at a wall. They should collect data on how making one change affects how the object falls. Measurements could include speed, distance, how it bounces, comparable time vs. distance for each trial, and any other observations the students can make about the trials. Discussion questions should include: 1) What is force? How does changing the force the object is thrown affect how it hits the ground/wall? 2) Did the object bounce? How did changing the height or force change how it bounced? 3) How did the shape/design of the object affect its path? 4) How does the size (or mass) of the object affect its path? 5) What is the advantage of different objects reacting differently to how they are thrown?

Students should turn in lab reports/sheets with all their data, graphs, analysis, and conclusions. Advanced students may also be asked to design an experiment to determine the best objects for specific activities based on the data they collected. They could be given specific tasks or sports and asked to determine how the balls for each sport are designed specifically for that sport, and are not good for using in other sports. Example: Why do we not play basketball with a football? Why are softballs and baseballs different even thought the sports are, on the surface, very similar?

Main Unit

Part One – In the Classroom "Before the Olympiad"

Before the Olympiad is used, students need the basic vocabulary with which to discuss the topics presented. This time should be used to do small activities and discuss related vocabulary, while previewing what they might learn about during the Olympiad. Students should be excited to get to the sports activities. This can be done over 1-2 90 minute class periods, and may be done as a stations activity. Each station should take no longer than 15 minutes to complete.

Activating Strategy or warm-up activity: Ask students what they think of when they are told that they are going to learn about "physics". What does the term "Physics" mean to them? Does it sound easy, hard, fun, boring? What adjectives would they use to describe what they think they are going to learn about? Students' answers should discuss gravity, acceleration, and potential/kinetic energy but may also include many other topics since the North Carolina Science Essential Standards for elementary school includes many physics concepts. The goal of this activity is to assess whether students have been truly exposed to physics and whether or not those experiences have been fun and rewarding. If students' responses reveal a negative view of physics make sure to reassess this viewpoint at the end of the lesson, and throughout the Sports Olympiad.

Stations: There should be a minimum of 5 stations (Newton's First Law, Newton's Second Law, Newton's Third Law, Friction, Simple Machines) , and it is often a good idea to also include a Timeout station. It can be utilized to give students that are having trouble focusing at their station a break to refocus. Each station should have a simple engaging activity with follow-up questions. The activity could be a simple lab, a computer simulation, or a video that shows the physics concept. Examples are provided here, but there are many different simple activities that could be used in their place. You may want to create a Station Worksheet with all the questions and data charts for each station on them.

Newton's First Law Station

Students should begin by watching the following video on Inertia: www.youtube.com/watch?v=yZMEUT-Ipv4 . Have students define Newton's First Law based on what they see in the video. Students will now do two simple activities and answer questions about them.

Activity One[2]: "Magic Washers" - You need 8 metals washers of the same size. To prepare for this experiment, stack 4 washers one on top of the other so that you form a tower of washers. Place the stack of washers on top of a textbook, desk, or on the floor so that it is on a smooth, slick surface. Aim one washer at the bottom of the stack of four washers and give it a good hard flick with your finger or hand. What happens? Flick a stack of two washers into a stack of four washers. What happens? Flick a stack of four washers into a stack of four washers. What happens? Explain your observations in terms of Newton's First Law.

Activity Two: "It's Magic! No, silly, it's Inertia!" - You need a penny, a wooden clothespin, string and two circles of paper cut slightly larger than the penny. Attach the string to one of the paper circles, leaving the other circle string-free. You will do three different setups. 1) Stand the clothespin on a flat surface, and balance the paper circle with the string and the penny on top of it. The objective is to remove the paper circle without disturbing the penny, or knocking over the clothespin. Were you able to do it? Keep trying until you get it. 2) Do the same experiment, but use the string-free paper circle and try to pull or flick the paper from underneath the penny. Keep trying until you get the penny to stay on the balanced clothespin. Was it easier or harder than with the string attached? 3) Here is a tough one! Balance the penny on one of the circles (either one) on the tip of your index finger. Try to remove the paper circle while leaving the penny balanced on your finger! Were you successful? How is this activity similar to the "pull the tablecloth" trick used by magicians? Explain how this trick works based on Newton's First Law.

Newton's Second Law Station

Students will begin by watching the following animation: http://www.youtube.com/watch?v=44dMPz_DPu8 . Have students define Newton's Second Law based off of the given information.

Meter Race: For the activity, you will need several meter sticks, textbooks, a small vehicle (Matchbox cars will work), tape, and 10 washers. You will also need to create a data chart to record your data. You may want to include the chart on their Station Worksheet.

	Trial One (cm traveled)	Trial Two (cm)	Trial Three (cm)
Vehicle Alone			
5 washers added			
10 washers added			

Setup a ramp using a meter stick and several books. Place one end of the ramp on the books and line up the other end with a piece of masking tape on the floor. You can change the height of the ramp by adding or removing books from the stack. Decide on a height for your experiment. You will do three trials for each vehicle change. 1) Place the vehicle at the top of your meter stick and roll it down the ramp. Use a meter stick to measure how far the vehicle rolls. Record measurements on your data chart. Repeat these steps for all the trials. 2) Add five washers to the vehicle and repeat the procedure. Be sure all the washers remain on the vehicle! 3) Add ten washers to the vehicle and repeat the procedure. Questions: How does increasing mass (adding more washers) affect the force of objects in motion (the distance the vehicle rolls)? Explain your answer using data from the chart. What would happen if you added fifteen washers to the car? Predict how far the car would roll. Explain the results of your experiment in terms of Newton's 2nd Law.

Newton's Third Law Station

Students will watch on of the following videos: http://www.youtube.com/watch?v=NRKmJgIokxg or http://www.youtube.com/watch?v=8bTdMmNZm2M You may also want to have them watch one of the Mythbuster's videos on the topic. There are extra video links in the classroom resources section of the bibliography for each station.

Fun with Newton and Balloons: You will need a medium sized balloon, a straight pin, a bendy straw, tape, and a pencil eraser. First, attach an uninflated balloon to the end of the bendy straw with tape. Attach it to the end that isn't flexible. Second, push the straight pin through the straw halfway between the balloon and were the bend of the straw starts. Fasten the pin to the straw with the pencil eraser to hold it in place. You will blow up the balloon four different times. 1) Blow up the balloon, but before you allow any air to escape, bend the straw to a 90^{o} angle. Describe what happens. 2) This time follow the same procedure, but bend the straw at a 45^{o} angle. Describe what happened. Was it similar or different that when it was bent at a 90^{o} angle? 3) Again, follow the same procedure again but leave your straw straight (technically at a 180^{o} angle!) Describe what happens compared to the other trials. 4) Finally, remove the pin and blow up the balloon again. This time, release the straw? What happens? Explain all of your observations in terms of Newton's Third Law.

	What Happened?	Similar or Different?	How does this show Newton's 3rd Law
90^{o} angle			
45^{o} angle			
180^{o} angle			

Friction Station

Students will use the following online simulation program to see how friction affects motion: http://phet.colorado.edu/en/simulation/energy-skate-park . It can be played from the site, or downloaded. Ask students to define Friction based on what they observe.

Friction, what Friction? Activity: Students will design their own experiments to show friction at work. They should design two apparatus, one that shows high levels of friction and one that shows a low level of friction. Supplies can include whatever objects you want, but should include surfaces with different textures and objects of different sizes and shapes. They need to design a complete experiment/demonstration and write an explanation of how both setups demonstrate the concepts of friction.

Simple Machines Station

Students will learn about levers using the following online simulation: http://phet.colorado.edu/en/simulation/balancing-act . Objectives of the activity: Predict how objects of various masses can be used to make a plank balance. Predict how changing the positions of the masses on the plank will affect the motion of the plank. Write rules to predict which way a plank will tilt when objects are placed on it. Use your rules to solve puzzles about balancing.

Predictions on how changing the objects will affect the motion of the plank:	1. 2.
Rules you observed about the movement:	1. 2.

	3. 4.
Observations on solving the puzzles: (What did you learn about levers?)	1. 2. 3.

Conversely, the stations can be done in conjunction with each related Olympiad activity, having a different topic on different days, with a mini-lesson on the required topics immediately before the sports activities. This would ideally be done for students that require more direct instruction, because the activity would correlate directly with the lesson that was taught in conjunction with the activity. The unit is adaptable to the needs of your students.

Sports Olympiad

Each activity of the Olympiad will follow a similar procedure. In addition to the data collected for each activity, students will also fill out the aforementioned flowchart for each activity. They will need to: 1) name the activity, 2) list the physics concepts, 3) explain how the physic concept is demonstrated in the given activity, and 4) make real world connections about the physics concepts. Here is a sample Flowchart:

Activity:	
Physics Concepts shown in activity:	
How was the physics concept shown?	
What is another real world connection to this physics concept?	
Other observations about the activity:	

The first set of activities are the Track and Field events. The 100 meter dash event will have students running the 100 meter dash and measuring the runners speed and acceleration for every 10 meters. Place a cone every 10 meters. Have the students take turns running the course, while another student videotapes the run. When reviewing the tape, students will record the overall time and the time for each 10 m interval. The students can then graph the position vs. time for all the runners and then they can compare their speeds to each other and to data from different world class sprinters, like Usain Bolt. The average speed can be figured out by using the slope of each line. (Slope = rise/run). This activity will help them understand the concepts of speed and acceleration and allow them to practice their graphing skills. Here is a link to a video of Bolt running the 100 meters: http://www.youtube.com/watch?v=YFE1ctdRc88 . Students can analyze his speeds at different parts of his 100 meter run, and compare them to the runners from class. Where is he the fastest? Where are the students the fastest? What could Bolt do to increase his time even more? (He has a slow start, but accelerates quickly at the end of his run.)

	Usain Bolt	Runner #1	Runner #2	Runner #3
(0 meters)	0 meters/second	0 meters/second	0 meters/second	0 meters/second
10 m				
20 m				
30 m				
40 m				
50 m				
60 m				
70 m				
80 m				
90 m				
100 m (final)				

The hurdles event will help students can understand the conversion of KE vs. PE as their center of mass rises as they go over the hurdle. Obviously the best hurdlers keep the center of mass as low as possible so that they don't lose much KE. The procedure of the activity can be similar to that of the 100m dash event.

The Shot-Put/Discus event allows them to learn how the speed and height of object as it is thrown is related to resulting distance thrown. Students will watch a video or skilled individual demonstrating proper throwing techniques before actually doing it themselves. Discussion Questions should include "how does the speed of the throw affect its distance?", "Which seems to be more important: the height that it is released or the speed that it is released?"

A Weightlifting activity can be done to teach the concepts of pulleys, lever and torque. Students are to design an event using boards and a fulcrum. The object is to see who can lift the most weight with the least amount of initial force. Ideally, students will not be given much background information. This will allow them to explore all the possibilities with the given materials.

Friction concepts are covered in two activities. The first is a football related activity. Blocking sleds on different surfaces and with different weights on them – would introduce the concept of friction and the effect of normal force on friction. If blocking sleds are not available, other items such as rugs (with different weight boxes) can be used. The second activity for friction is the "Sock vs. Shoes" debate. Students will run barefoot, in socks, and in different types of shoes to answer the question: "Am I faster in running shoes or in my socks?" An extension of this activity could include a discussion of why different sports use different types of shoes and the technology used to design them.

Basketball can be used to teach the concepts of Kinetic Energy versus Potential Energy. It can be formatted as free throws or game of H.O.R.S.E. with a small group. Video taping is not required, but students will enjoy watching the arc of the shots and discussing what similarities successful shots have. Discussion questions can include, “Which is more important: the force the ball is thrown or the technique with which it is thrown?”, “At what point of the path is the KE increasing? At what point of the path is the PE at its lowest?”

Soccer goal shots can be used for both Velocity and Acceleration concepts, as well as KE/PE concepts. Many other sports and activities can be utilized, including volleyball, baseball, and hockey. Teachers can tailor the rest of the activities to meet the needs of their students. The possibilities are almost endless!

Culminating Project

The culminating project for the unit will be for each team to create a technology based presentation of both the events and the concepts they learned from the events. There are links in the Classroom resources section of the bibliography for free online animation software presentation tool such as Prezi and Glogster. Both tools allow students to reach beyond simple PowerPoint presentations. Students will follow a rubric, and they will need to include video and photographs of each event, graphs, charts or other visual representations of the concepts. It will be required that the students show a detailed explanation of how the physic concept connects to the specific event or sport. Their flowcharts that were created during the Olympiad can be used to facilitate the timeline of the project, and provide a framework for their final product.

Annotated Bibliography

Resources for Teachers

Books:

Bonnet, Robert L., and Dan Keen. *Home run!: science projects with baseball and softball*. Berkeley Heights, NJ: Enslow Publishers, 2009. The physics of softball and baseball; it shows how softball and baseball are similar and different.

Brenkus, John. *The perfection point: Sport Science predicts the fastest man, the highest jump, and the limits of athletic performance*. New York: Harper, 2010. Great book, provides examples of different athletic performances and basic physics concepts of different sports.

Gardner, Robert. *Experimenting with science in sports*. New York: Franklin Watts, 1993. Simple experiments that students can do to demonstrate how science can be found in sports.

Gardner, Robert, and Dennis Shortelle. *Slam dunk! science projects with basketball*. Berkeley Heights, NJ: Enslow Publishers, 2010. Basketballs can be used to show different physics concepts, including acceleration due to gravity and potential/kinetic energy.

Goodstein, Madeline P.. *Sports science projects: the physics of balls in motion*. Berkeley Heights, NJ: Enslow Publishers, 1999. This book shows the physics concepts that can be demonstrated with different types of balls. It gives many simple things that can be done to show physics at work.

Goodstein, Madeline P.. *Goal!: science projects with soccer*. Berkeley Heights, NJ: Enslow Publishers, 2009. Soccer can also be used to showcase various physics concepts. Kicking a soccer ball can be used to teach trajectory and Newton's Laws of Motion.

Hewitt, Paul G.. *Conceptual Physics*. Reading, Mass.: Addison Wesley, 1987. A great physics textbook. It has simple examples and straightforward explanations.

Kemp, Robert. *The physics of baseball*. New York: Harper & Row, 1994.Physics of hitting, catching, and batting. Great resource for potential/kinetic energy, friction, and acceleration concepts.

Physics and Sports Website Resources:

The Physics Classroom Project. "Definition and Mathematics of Work." The Physics Classroom. This website is an excellent resource for basic physics concepts. It has both students and teacher resources. http://www.physicsclassroom.com/Class/energy/U5L1a.cfm

Wikimedia. "Kinetic energy - Wikipedia, the free encyclopedia." Wikipedia, the free encyclopedia. (accessed November 27, 2011). Wikipedia provides several good examples and definitions of basic physics concepts, in addition to this page. http://en.wikipedia.org/wiki/Kinetic_energy

Exploratorium. “Baseball Science from the Exploratorium.” One of the Exploratorium's Sport Science series that includes features on hitting a fastball, throwing a curve ball, and more. http://www.exploratorium.edu/baseball/

Alan M. Nathan. “Physics of Baseball.” Includes history of baseball, the science beyond baseball, and links to other related sites. http://webusers.npl.uiuc.edu/~a-nathan/pob/

National Public Radio. “The Science Behind Baseball.” Ira Flatow of NPR's Science Friday gives a 35 minute report on the science behind one of our beloved sports. http://www.npr.org/templates/story/story.php?storyId=89188499

University of Wisconsin. “The Science of Baseball.” From the Why files. Interesting facts and trivia about baseball. http://whyfiles.org/152baseball/

Exploratorium. “The Science of Cycling.” From aerodynamics to the wheel, bicycles make for interesting science. Check out an interview with top mountain bikers, and learn about frames and materials from a custom bike maker. Try interactive activities that calculate braking distances, energy consumption, and other interesting topics! http://www.exploratorium.edu/cycling/

Exploratorium. “The Science of Hockey.” Learn about the mechanics, energy, motion and other physics concepts of hockey. There is an excellent section on how to calculate reaction time. http://www.exploratorium.edu/hockey/

KidzWorld. “The Science of Skateboarding.” Skaters use laws of physics to perform cool style skateboard tricks. Gives examples and great basic definitions of different related physics topics. http://www.kidzworld.com/article/5207-the-science-of-skateboarding

KidzWorld. “The Science of the Slam.” About Slam Dunks in basketball. Explains how the height a player jumps depends on how much force he uses to push off the floor when he jumps. http://www.kidzworld.com/article/4093-the-science-of-the-slam

Resources for Classroom Use

Online technology tools for students:

Prezi Presentation Software. http://www.prezi.com

Glogster Digital Posters. http://edu.glogster.com

Go Animate online animation software. http://www.goanimate.com

Additional Videos:

Mythbuster's Newton's Second Law. http://www.youtube.com/watch?v=iK519OxeMZs

Discovery Channel. Newton's Laws of Motion.
http://dsc.discovery.com/videos/assignment-discovery-shorts-newtons-laws-of-motion.html

Additional Physics Simulations that may be of use:

University of Colorado at Boulder. "Interactive Simulations." Numerous physics and science simulations, with student and teacher resources.
http://phet.colorado.edu/en/simulations/category/physics

Andrew Duffy. Boston University. This site includes iPhone apps that demonstrate physics concepts. http://physics.bu.edu/~duffy/classroom.html

Mr. Mont. "Physics Games." Links to different physics games, grouped by categories.
http://www.mrmont.com/games/index.html

NASA. "Aerodynamics of Baseball." An excellent site with simulations of different pitches and information on how a baseball moves through the air.
http://www.grc.nasa.gov/WWW/K-12/baseball/index.html

Notes

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[1] Hewitt, Paul G.. *Conceptual Physics*. Reading, Mass.: Addison Wesley, 1987.

[2] ScienceSpot.net. Ideas for some of the stations can be found on this site.
http://sciencespot.net/Media/newtonlab.pdf