Kinetic Energy, Mass, and Speed

Prepared By: Karie Brown-Tess

Overview & Purpose: The same physics that govern the observable world governs the movement of electrons in an electrical grid. Understanding resistance, conductivity, and how energy travels is essential to understand how a grid works and how electricity flows. It is essential in a technologically advanced world that students understand and can communicate intelligently how energy moves to power the things we use in everyday life. Understanding how electricity works also prepares students for STEM careers.

Objectives: *Students will...*

- Use real world data to predict kinetic energy outputs.
- Accurately graph data points on a coordinate plane.
- Interpret the relationship between dependent and independent variables.
- Construct graphs of the kinetic energy of electrons through various resistances.
- Demonstrate understanding of the relationship between speed and kinetic energy.
- Demonstrate understanding of the purpose of a substation and what role they play.
- Demonstrate understanding of how mass and speed affect kinetic energy.

Background Information:

- Students must have a basic understanding of a coordinate plane, limited to quadrant 1
- Students must understand how variables are related in equations.
- Students must be able to predict accurately how weight and speed might affect an object in motion.
- Students must know how to find an average. (This can be briefly taught in the lesson. It is, however, not the subject material covered in this lesson. http://phet.colorado.edu/en/simulation/energy-skate-park)

NEXT GENERATION SCIENCE STANDARDS

Performance Expectations *Students who demonstrate understanding can:*

MS-PS3-1: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and the speed of an object.

Classroom Activities/Procedures & Timeline
(60-120 minutes)

Set up: Have supplies for groups set up to avoid confusion and disarray.

Introduction: (5 min.) Video http://www.neok12.com/php/watch.php?v=zX5b4f66015f576f725d4145&t=Laws-of-Motion

Pause video at 1 min, 30 sec.

Say, *"Today, we are going to explore energy, mass, and speed as it related to electricity. You will learn what a substation is and what it does. Before we begin, we need to know what you know, so we will take a pre-test to assess to figure that out."*

Pretest should take 7-10 minutes. Collect and discuss the last question. "Do you think it's possible to get different results if everything in an experiment was completed exactly the same?"

"Let's discuss what affect the weight of the bottled might have had on the speed and distance." Show the rest of the video.

Ask: *What was it that caused the lighter ball to go farther? Can you isolate one thing: mass? Force?* Let the students estimate their sole cause and write it on a note card or post it. Collect the card and redistribute, having a couple student volunteers read what someone else had said, and state whether they agreed.

After collecting the test, have students go to assigned stations. You may want to have these instructions typed out for scaffolding. Have students predict how the weight, shape, or texture of the ball will affect speed or momentum.

Have students chart speed each ball takes to travel down the ramp. Take three trails and average results together as a class.

Have students chart force by placing an upside-down plastic cup at the end of the ramp and having a ball roll from the top of the ramp and push the cup. Measure and repeat until you have three distances and the average.

Have students write a brief summary of their findings to turn in. Students who work quickly may want to run more trials, so having more ball varieties may help. Also, this lesson may be combined with lesson two, for one lesson. In that case you may have each group test few variables. (30-40 min)

Have students summarize their findings in ten words or less or have students tweet a summary. (140 letters) Read as a class or have students share.

Have students estimate how the results might change if we double the balls or tripled the balls that rolled down the ramp. Would the cup move the same? Farther? Let them leave thinking on this.

Assessments: (e.g., lab, quiz, test, oral presentation, survey, rubric, etc.)

- Pre-test
- Oral Presentation
- Summaries

Equipment/Materials/Technology Needed:

- Board/ramp per group of students
- Several balls of varied shapes and weights
- Plastic cup or other light object to be moved by the balls at the bottom of the ramp.
- Two textbooks
- Timer
- Ruler

Teacher Resources:

(e.g., readings, set-up instructions, lecture files, data files, etc.):

Student Resources:

(e.g., handouts, worksheets, data, etc.):

- Pretest
- PPT "What is a Substation"

Accommodations & Safety Concerns:

The project this is based on requires safety goggles.

Extensions/Homework:

- http://phet.colorado.edu/en/simulation/energy-skate-park-basics
  (Energy Skate Park Demo)
- http://phet.colorado.edu/en/simulation/energy-skate-park
  (Another version of Energy Skate Park)

References:

- ***How Substations Work*** retrieved on September 26, 2013 from http://science.howstuffworks.com/environmental/energy/power5.htm
- ***How Substations Work*** retrieved on September 30 from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&ved=0CF4QFjAE&url=http%3A%2F%2Fwww.westsidecan.org%2FWhat_is_a_substation_-_97.ppt&ei=Cn1IUuWIA5TYyAGI-YCgBw&usg=AFQjCNGk8UHTGIqwg7UkoYT2g5erlOyS3g&sig2=5L7q47kHv0JCrWtMwyqsYw&bvm=bv.53217764,d.aWc
- ***The Journey of Electricity*** retrieved on September 26, 2013 from http://www.youtube.com/watch?v=-ZBNNcczmDM
- Pre-test bottle/board images retrieved on September 26, 2013 from http://www.rsd17.org/TeacherWebPage/HighSchool/Hferrer/CH15MassVsKELabANSWERS.pdf
- ***Energy Skate Park Basic*** retrieved on September 30 from http://phet.colorado.edu/en/simulation/energy-skate-park-basics
- ***Energy Skate Park*** retrieved on September 30 from http://phet.colorado.edu/en/simulation/energy-skate-park

Personal Comments/Notes:

This lesson is the entry lesson to understanding the use of a substation. The second plan will actually show the substation presentation mentioned in this plan. The PowerPoint used in this lesson was taken from the PowerPoint "How Substations Work." This presentation was modified for instruction in a middle school context.

Kinetic Energy, Mass, and Speed 2

Prepared By: Karie Brown-Tess

Overview & Purpose: The same physics that govern the observable world governs the movement of electrons in an electrical grid. Understanding resistance, conductivity, and how energy travels is essential to understand how a grid works and how electricity flows. It is essential in a technologically advanced world that students understand and can communicate intelligently how energy moves to power the things we use in everyday life. Understanding how electricity works also prepares students for STEM careers.

Objectives: *Students will...*

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- Interpret the relationship between dependent and independent variables.
- Construct graphs of the kinetic energy of electrons through various resistances.
- Demonstrate understanding of the relationship between speed and kinetic energy.
- Demonstrate understanding of the purpose of a substation and what role they play.
- Demonstrate understanding of how mass and speed affect kinetic energy.

Background Information:

- Students must have a basic understanding of a coordinate plane, limited to quadrant 1
- Students must understand how variables are related in equations.
- Students must be able to predict accurately how weight and speed might affect an object in motion

NEXT GENERATION SCIENCE STANDARDS

Performance Expectations *Students who demonstrate understanding can:*

MS-PS3-1: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and the speed of an object.

Classroom Activities/Procedures & Timeline
(45-60 minutes)

Introduction: Create a three column chart, three poster post its, or three posters to signify the three responses one might expect from increasing the number of balls rolled down the ramp. Have students write their name in the area that matches what they think might happen, (3 min.)

Introduce the concept of a substation: http://www.youtube.com/watch?v=t_mpCnasYcY (2.5 min.)

Show presentation on Substations and have students take notes. (This may take 25-30 Minutes)

At the end of the slideshow there are three questions. Have students pick a question to answer and present before the group. Give students about 2 minutes to read and choose a question. Then give students about 5-8 minutes to collaborate on how to best answer the questions. Then have students share their answers. (10-15 min.) You may want to give parameter: everyone must say something, points for creativity, must be communicated clearly in 2.5 minutes or less.

Have a board, several of the same ball, books and cup ready. After students finish their presentations. Show what happens when several balls are release to fall upon the cup. Propose thinking of the cup as a house and the balls as electricity. Have students brainstorm individually for solutions to safely bring the electricity to the house without overpowering it (or blowing the house up.) Create an agreed upon rubric for success. For example, what could represent sufficient electricity without over powering? Moving the cup without knocking it over? Touching the cup and staying in contact? The thing that slows the ball or softens the blow onto the cup must stay intact like a transformer would. Etc. Have the students continue to work on this until the next unit. Tell the students that in the next class, you will be testing their conjectures.

Assessments: (e.g., lab, quiz, test, oral presentation, survey, rubric, etc.)

- Questions at the end of the PowerPoint.
- Student Presentations.

Extensions/Homework:

- http://phet.colorado.edu/en/simulation/energy-skate-park-basics (Energy Skate Park Demo)
- http://phet.colorado.edu/en/simulation/energy-skate-park (Another version of Energy Skate Park)

Equipment/Materials/Technology Needed:

- Projector/ TV with hook-up for a computer to show the slideshow.
- Notebook (to take notes)
- Poster or other materials for students to present with.
- Board/ramp per group of students
- Several balls of varied shapes and weights
- Plastic cup or other light object to be moved by the balls at the bottom of the ramp.
- Two textbooks

Teacher Resources:
(e.g., readings, set-up instructions, lecture files, data files, etc.):

How Substations Work : http://www.brighthubengineering.com/power-generation-distribution/71084-how-a-substation-works/

Student Resources:
(e.g., handouts, worksheets, data, etc.):

Accommodations & Safety Concerns:

The demonstration of blowing up the house with two much electricity may be put at beginning, before the video, to help engage students.

References:

- ***How Substations Work*** retrieved on September 26, 2013 from http://science.howstuffworks.com/environmental/energy/power5.htm
- ***How Substations Work*** retrieved on September 30 from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&ved=0CF4QFjAE&url=http%3A%2F%2Fwww.westsidecan.org%2FWhat_is_a_substation_-_97.ppt&ei=Cn1IUuWIA5TYyAGI-YCgBw&usg=AFQjCNGk8UHTGIqwg7UkoYT2g5erlOyS3g&sig2=5L7q47kHv0JCrWtMwyqsYw&bvm=bv.53217764,d.aWc
- Introduce the concept of a substation: http://www.youtube.com/watch?v=t_mpCnasYcY
- ***The Journey of Electricity*** retrieved on September 26, 2013 from http://www.youtube.com/watch?v=-ZBNNcczmDM
- Pre-test bottle/board images retrieved on September 26, 2013 from http://www.rsd17.org/TeacherWebPage/HighSchool/Hferrer/CH15MassVsKELabANSWERS.pdf
- ***Energy Skate Park Basic*** retrieved on September 30 from http://phet.colorado.edu/en/simulation/energy-skate-park-basics
- ***Energy Skate Park*** retrieved on September 30 from http://phet.colorado.edu/en/simulation/energy-skate-park

Personal Comments/Notes:

Feel free to use some of the teacher resource videos in the class as well or in lieu of another recommended video. In the presentation, there is a video. In Keynote of PPT, it must be clicked on in order to start.

Another idea would be to schedule a guest from a local substation to come to speak with you class, do a virtual tour, etc. This is the perfect spot in the plan to do that before student actually start designing something to "slow electrons" in their models.

What is a SUBSTATION?

1 What is a voltage?

2 What does a substation do?

3 What is a substation?

4 How does a substation work?

5 So why do we have substations?

Pick one of these 3

1 Explain the need for substations to a 6 year old.

2 Demonstrate what a substation does.

3 Describe how voltages need to be changed for use to use it safely.

Kinetic Energy, Mass, and Speed 3

Prepared By: Karie Brown-Tess

Overview & Purpose: The same physics that govern the observable world governs the movement of electrons in an electrical grid. Understanding resistance, conductivity, and how energy travels is essential to understand how a grid works and how electricity flows. It is essential in a technologically advanced world that students understand and can communicate intelligently how energy moves to power the things we use in everyday life. Understanding how electricity works also prepares students for STEM careers.

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- Construct graphs of the kinetic energy of electrons through various resistances.
- Demonstrate understanding of the relationship between speed and kinetic energy.
- Demonstrate understanding of the purpose of a substation and what role they play.
- Demonstrate understanding of how mass and speed affect kinetic energy

Background Information:

- Students must have a basic understanding of a coordinate plane, limited to quadrant 1.
- Students must understand how variables are related in equations.
- Students must be able to predict accurately how weight and speed might affect an object in motion.

NEXT GENERATION SCIENCE STANDARDS

Performance Expectations *Students who demonstrate understanding can:*

MS-PS3-1: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and the speed of an object.

Classroom Activities/Procedures & Timeline
(45-60 minutes)

Before class begins you will need several material. I recommend assigning Materials coordinators to each team and make them responsible for getting the material. Another option would be to have the materials ready at the group workstations.

Introduction: Watch this video of an airblast breaker and switch opening, (about 30 seconds.) http://www.youtube.com/watch?v=NfSYQRorDgM

Say, *"This video was taken at a substation as they tested a breaker. Today we will learn a bit about the parts of a substation and build a model based on those parts. Then, we will model what substations do with everyday materials."*

But first, lets look at what a substation is made up of.

Distribute *"what is a substation"* worksheet and show PowerPoint, "What is in a substation." (15-20 min)

Distribute the student worksheets and explain how the materials represent aspects of the substation. They should not write on these. In fact, you may want to laminate them or put in sheet protectors, so they can by used again in the future. Students will record their work on the *"Building a Transformer"* worksheet. Have the supplies manager get necessary materials for team or have them ready at their desks. (20-30 minutes.)

Have students present their finding to the class. (2 min. per group)

Assessments: (e.g., lab, quiz, test, oral presentation, survey, rubric, etc.)

- Pre-test (in lesson 1)

Extensions/Homework:

- http://phet.colorado.edu/en/simulation/energy-skate-park-basics (Energy Skate Park Demo)
- http://phet.colorado.edu/en/simulation/energy-skate-park (Another version of Energy Skate Park)

References:

How Substations Work retrieved on September 26, 2013 from http://science.howstuffworks.com/environmental/energy/power5.htm

How Substations Work retrieved on September 30 from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&ved=0CF4QFjAE&url=http%3A%2F%2Fwww.westsidecan.org%2FWhat_is_a_substation_-_97.ppt&ei=Cn1IUuWIA5TYyAGI-YCgBw&usg=AFQjCNGk8UHTGIqwg7UkoYT2g5erlOyS3g&sig2=5L7q47kHv0JCrWtMwyqsYw&bvm=bv.53217764,d.aWc

Introduce the concept of a substation: http://www.youtube.com/watch?v=t_mpCnasYcY

Parts of a Substation retrieved in November 11, 2013 from http://en.wikipedia.org/wiki/File:Electrical_substation_model_(side-view).PNG

The Journey of Electricity retrieved on September 26, 2013 from http://www.youtube.com/watch?v=-ZBNNcczmDM

Equipment/Materials/Technology Needed:

- Projector/ TV with hook-up for a computer to show the slideshow.
- Notebook (to take notes)
- Poster or other materials for students to present with.
- Board/ramp per group of students
- Five balls of same shapes and weights
- Plastic cup or other light object to be moved by the balls at the bottom of the ramp.

Teacher Resources:
(e.g., readings, set-up instructions, lecture files, data files, etc.):

What is a substation PowerPoint in three forms

Student Resources:
(e.g., handouts, worksheets, data, etc.):

- "Building Transformer" worksheet
- Student Worksheet
- "What is a Substation" Worksheet

Accommodations & Safety Concerns:

Be careful about the introduction video, at 38 seconds, someone may be saying a curse word.

Personal Comments/Notes:

This lesson may take more than 1 day, especially with student presentations and the experiment phase.

Kinetic Energy, Mass, and Speed 4

Prepared By: Karie Brown-Tess

Overview & Purpose: The same physics that govern the observable world governs the movement of electrons in an electrical grid. Understanding resistance, conductivity, and how energy travels is essential to understand how a grid works and how electricity flows. It is essential in a technologically advanced world that students understand and can communicate intelligently how energy moves to power the things we use in everyday life. Understanding how electricity works also prepares students for STEM careers.

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- Demonstrate understanding of the purpose of a substation and what role they play.
- Demonstrate understanding of how mass and speed affect kinetic energy

Background Information:

- Students must have a basic understanding of a coordinate plane, limited to quadrant 1
- Students must understand how variables are related in equations.
- Students must be able to predict accurately how weight and speed might affect an object in motion.
- Students must know how to find an average. (This can be briefly taught in the lesson. It is, however, not the subject material covered in this lesson. http://phet.colorado.edu/en/simulation/energy-skate-park)

NEXT GENERATION SCIENCE STANDARDS

Performance Expectations *Students who demonstrate understanding can:*

MS-PS3-1: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and the speed of an object.

Classroom Activities/Procedures & Timeline

(120 minutes)

Set up: Have supplies for groups set up to avoid confusion and disarray.

Introduction: (5 min.) Video: http://ocw.mit.edu/courses/physics/8-01-physics-i-classical-mechanics-fall-1999/video-lectures/lecture-11/ (Start video at 45:45 stop the video at 48:47.)

Equipment/Materials/Technology Needed:

- ProjectorEnergy Skate Park downloaded or accessed from the web
- Test Data 1,2, & 3
- Wkst, « How to set up your experiement »

Ask: (5 min) *"What do you think will happen?"* Let the students and write it on a note card. Collect the cards and redistribute, having each student read what someone else had said.

Say, *"Today we are going to do a set of experiments to learn more about physics. You will begin with Test 1 and move to Test 2, then Test 3"* You may want to have these out already so students may get the next test.

Experiments (50 minutes, about 2 days)

In order to do the test, you will have to access the energy skate park game. Use the "How to set up your Experiments" sheet to guide you. As students log on and follow the instructions on the sheet, you may need to walk around, checking to see if anyone needs any assistance.

Have students complete the experiments, checking the affects of friction, gravity, and mass on kinetic and potential energy. Test 2 allows students to make conclusions on their findings.

Before students leave each day, have students share a 30 second summary of what they found.

Assessments: (e.g., lab, quiz, test, oral presentation, survey, rubric, etc.)

- Notecards responses (pre-test), Test Data 2 (post-test)
- Oral Presentation
- Summaries

Extensions/Homework:

- http://phet.colorado.edu/en/simulation/energy-skate-park-basics (Energy Skate Park Demo)
- http://phet.colorado.edu/en/simulation/energy-skate-park (Another version of Energy Skate Park)
- Educational videos: http://www.neok12.com/Law-of-Conservation.htm

It would be a great "special day " activity to garner the support of your community to show how this lesson is applied to our everyday life. The weight of a car has had a significant part in reducing fuel usage. We were able to partner with the city to give the students exposure to the Mitsubishi IEV. Your city may also use electric vehicles. Other places to try may be your local car dealer.

References:

How Substations Work retrieved on September 26, 2013 from http://science.howstuffworks.com/environmental/energy/power5.htm

Test 3 based in a High School lesson drafted by Jessica Mullins of Conifer High School, retrieved on November 23 from http://phet.colorado.edu/en/contributions/view/2937

http://en.wikipedia.org/wiki/Conservation_of_energy

Energy Skate Park Basic retrieved on September 30 from http://phet.colorado.edu/en/simulation/energy-skate-park-basics

- Notecards
- Computers (Mac or PC)

Teacher Resources:

(e.g., readings, set-up instructions, lecture files, data files, etc.):

What is a Substation PowerPoint in three forms

Student Resources:

(e.g., handouts, worksheets, data, etc.):

- Pretest
- PPT "What is a Substation"

Personal Comments/Notes:

This lesson is a stand alone lesson and is modified for instruction in a middle school context.

Kill a Watt

Prepared By: Karie Brown-Tess

Overview & Purpose: This lesson will allow young adolescents and opportunity to explore energy usage of their favorite devices while learning how algebra applies in real-world situations.

Objectives: *Students will be able to...*

- Measure the energy usage of various electronics
- Use variable and equations to solve real-world problems
- Construct equations to compare
- Make decisions based on what their math is telling them about the real world

Background Information:

- Students must have a basic understanding of one and two step equations
- Students must understand how variables are related in equations.
- Students must know how to find an average.
- Student will need to have a basic understanding of conversions

NEXT GENERATION SCIENCE STANDARDS

Performance Expectations *Students who demonstrate understanding can:*

MS-PS3-1: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and the speed of an object.

Classroom Activities/Procedures & Timeline
(120 minutes)

Pre-lesson prep: Have the first quadrant of the coordinate plane on the board or on a large wall post-it for graphing once the students have complete the Consumption Worksheet. The x-axis should be months (1, 2, 3, …) and the y-axis should represent cost. It will also be good to post energy ratings from appliance card on walls or board before students arrive.

Warm-up: As students walk into the room, give them an appliance card and have them put their name on it and tape it under where they think it should go, "Energy Rock Star" "Energy Average" or "Energy Drag." Teachers can change these names to have a little fun with the students, or not, depending on teaching style. Take 5-10 minutes to ask a few students what appliance they had and where did they think the appliance fit and discuss as a class to build interest. Have the students decide which items will use the most and the least amount of energy. These items should be graphed as a class at the end.

Divide students into group. Try to make sure that groups have a variety of devices to measure the energy consumption. If asked to bring devices, many students will bring cell phones. To get a greater variety of readings, it would be better to organize groups by items to bring or have extra items available for those who forget or a group of four with nothing but cell phones. You may also want to plan groups according to the number of accessible outlets.

It will be helpful to have the Kill a Watt already plugged in. Have students plug in their device and push the "watt" button. Have the students read their meters and record the watts in column A of the consumption worksheet. Repeat this process for all of the devices the group brought. Once they have the watts used for each appliance, they may calculate the kilowatts. The students will need to decide how much they would use this device on average for column C. The rest of the worksheet is a bit self-explanatory, but a teacher may need to scaffold for students who do not understand ratios and conversions.

After most students have finished their worksheet, have them come to the graph previously drawn on the board or on the wall post-it to graph an appliance on the graph. The teacher may want to select which appliance based on the class discussion at the start of class. It may be beneficial for each student to make a separate graph of all the appliances they tested to be used with the worksheet as an assessment of understanding. They can use the class graph as an example.

Once everyone has finished collecting data and the chart has several items to analyze, call the group back together. Ask, *"where we right about what we predicted about how much energy the different appliances would take?"* "What should we qualify as Energy Rock Star?" *"What should we What should we change?"* Based on the class discussion, move the appliances that were taped in the wrong places."

Assessments: (e.g., lab, quiz, test, oral presentation, survey, rubric, etc.)

The Consumption Worksheet and graph as well as class discussion.

Equipment/Materials/Technology Needed:

- Appliance from home
- Kill-a-Watt Meter
- Calculator
- Pencil

Teacher Resources:
(e.g., readings, set-up instructions, lecture files, data files, etc.):

Appliance Cards

Student Resources:
(e.g., handouts, worksheets, data, etc.):

Consumption Worksheet

Extensions/Homework:

- For exploration, this simulation may be helpful: https://phet.colorado.edu/en/simulation/circuit-construction-kit-ac-virtual-lab
- Research the energy usage of various appliances: http://energy.gov/public-services/homes/saving-electricity/appliances-electronics
- An interesting article: http://science.howstuffworks.com/environmental/green-tech/sustainable/5-energy-hungry-appliances.htm
- Fun Video, could be used for open or review: https://www.youtube.com/watch?v=1-g73ty9v04

References:

- Lesson adapted from http://www.fuelcelleducation.org/wp-content/uploads/2011/07/Watts-Your-Consumption.pdf for Illinois and math and science standards
- http://instituteforenergyresearch.org/media/state-regs/pdf/Illinois.pdf
- http://www.eia.gov/environment/emissions/carbon/