# CAREER FOCUS

Power Line Technician

# ACADEMIC FOCUS

Discover the basic parameters of power plants and calculate power after measuring amperage and voltage as electricity moves from the plant to the city.

In PowerLine 1, students will participate in a directed inquiry discussion on how power is supplied from a power plant to cities.  Students  will be immersed in topics including  power generation, voltage, amperage, power, voltage drop, watts, conversion of watts to megawatts, correct calculation of power using a formula, and use of power grid nomenclature. Additionally, the power lost in transmission lines from the plant to the cities will be calculated and a discussion about why power is transferred via towers over long distances will be discussed.  Students will calculate power lost during transmission over the power grid.  Students will be encouraged to discuss the activity in the Whyville forums.

## Contents of this lesson plan

| | | |
|---|---|---|
| 1. | Teacher Preparation | |
| 2. | Part One | EXPLORE (directed inquiry) |
| 3. | Part Two | REFLECT (group discussion) |
| 4. | Part Three | ACCOMPLISH (the assigned task) |
| 5. | Part Four | CONNECT (to standards and real life) |
| 6. | Student Worksheets | |

## Instructional Approach

This lesson plan uses <u>directed inquiry</u> to lead students to discover the questions they should ask about a topic, and the answers to those questions.

## Teacher's Role

The teacher's role is classroom facilitator and expert consultant. You will lead students to explore and help them when they have problems. Many students will learn much more than is formally included in this lesson plan, and will also be able to help other students.

## Materials

1. Computers with Internet access and confirmed access to Whyville
2. CONNECT worksheet, included in this lesson plan
3. Calculator (optional)

Follow these instructions to prepare to facilitate for your class.

1. Log into Whyville and select *WhyPower* from the pull-down menu (see picture →).
2. Click the link *WhyPower Station.*
4. Click the link *PowerLine,* and then click the link for *Instructions*. You will arrive at the screens shown below.
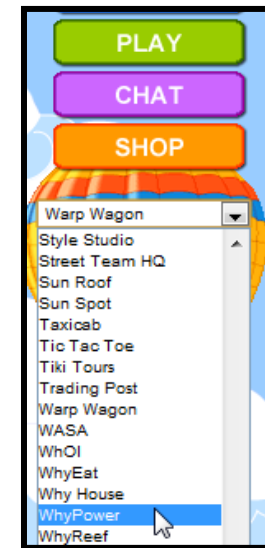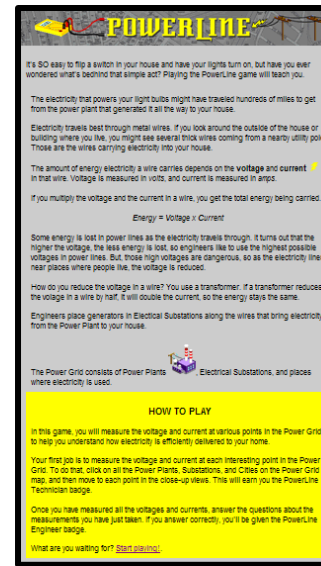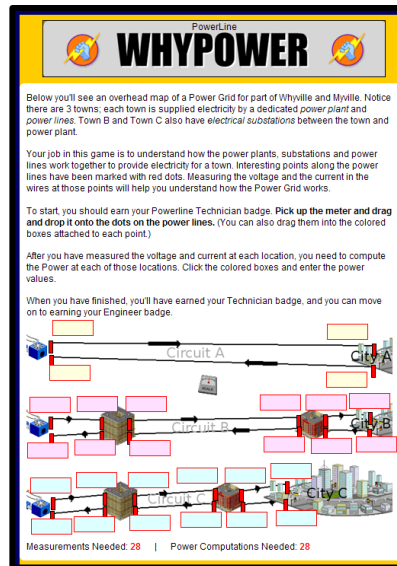


5. Click on the ***Start Playing!*** link after reading all the instructions.

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6.  Students measure voltage and amperage at various points by clicking and dragging a meter over the testing points near power plants, substations and cities on the power grid map, and then calculate voltage drops between each of the points.

| | | |
|---|---|---|
|  |  |  |
| Drag the meter in the center to each of the 28 measuring points. | Substation measurements. | Once you completed the measurements, a congratulatory dialog box appears. |
|  |  |  |
| Click on the measurement blocks to calculate the wattage at each point. | Enter the correct calculation and click the "Submit" button. | Once you complete the calculations, a congratulatory dialog box appears. |

*ENERGY MEASUREMENTS*

In the previous lesson, we exposed the students to kilowatts/kilowatt-hours and megawatts/megawatt-hours.  In this lesson, students are introduced to measurements in **volts** and **amps** in order to calculate **power** in watts, which is Power = Volts X Amps.  Once the students calculate power, they must then use the diagram to answer a series of questions and complete data tables in order to earn the PowerLine Technician badge.

**MATH**

There is basic arithmetic in this lesson as wattage is calculated at each measurement point in the map diagram.  The key new concept is the idea that the amounts of voltage, amperage, and power change as electricity is transmitted from the power plant, through a substation, and then to the city.

## Starter Question  3 minutes

**What's the best way to get electricity from the power plant to your house?**

| **Perform these *Teacher Actions***<br>*Do these in the order indicated* | **Expect this *Student Experience***<br>*You should see your students experience the following* |
|---|---|
| 1. **ENGAGE** (3 minutes)<br>Ask students the Starter Question. Facilitate a class discussion and help the students take ownership of the lesson. | **ENGAGEMENT**<br>Students take ownership while they are discussing a question that matters to them. |
| 2. **DIRECT** (2 minutes)<br>Direct students to log into Whyville, go to *WhyPower*, and then to *WhyPower Inside*, and then to *PowerLine Engineer*. Direct them to read the instructions for the *PowerLine* activities.<br>NOTE: Avoid giving further directions. Let them explore individually and figure out for themselves what is going on, and how to be successful in the activities. | **EXPLORATION**<br>Within three minutes of the start of the lesson, students are logged into Whyville and in the PowerLine activity, exploring the activity and learning what is important and how to be successful. |
| 3. **COACH** (15 minutes)<br>Wander around the room, encourage team members to help each other, and help the students if they cannot work through problems. Ask students what the activity is, what is important to succeed, and where they have additional questions. | |

## WHERE DO THE LESSONS APPEAR?  Recognize where the core content shows up.



Measurements Needed: **16**  |  Power Computations Needed: **17**
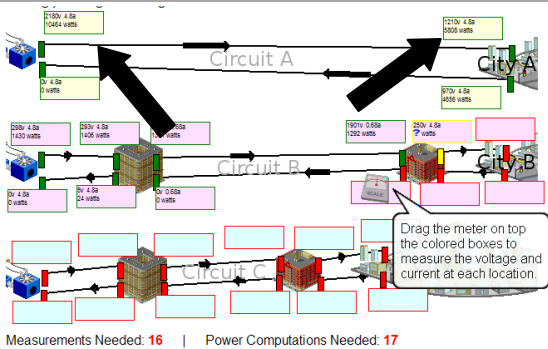
Students must recognize that when the voltage and amperage is multiplied together, the resulting answer in watts is NOT the same at every measurement point.



Measurements Needed: **0**  |  Power Computations Needed: **0**
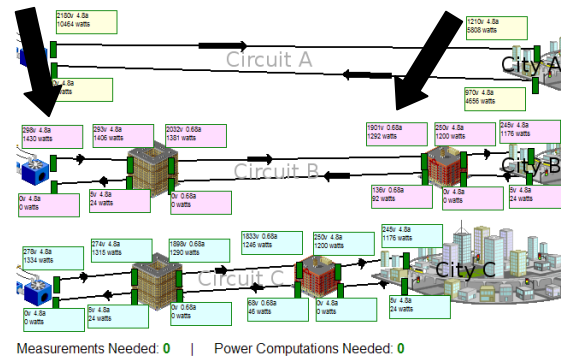
The students must also recognize that a pattern begins to emerge as the wattage is calculated at each point.  A discussion can then be initiated to speculate on the factors that may cause such changes.

### *Teacher Tip*

The patterns that students recognize should include that voltage drops as electricity is transmitted over a distance and that the greater the distance, the greater the drop.  This voltage drop significantly affects the power (wattage).  They should also note that the substations significantly "boost" the voltage as electricity is passed through them.

| Perform these *Teacher Actions*<br>*Do these in the order indicated* | Expect this *Student Experience*<br>*You should see your students experience the following* |
|---|---|
| 1. **GATHER**<br>Give students a one-minute warning that exploration time is almost over. Then, have them turn off their screens within three seconds of being told to stop. | **GATHERING**<br>Students wrap-up their self-guided exploration and turn their full attention to the discussion. |
| 2. **FACILITATE**<br>Lead students to discuss the questions below. Resist any urge to give them the answers. | **REFLECTING (group)**<br>Students share their ideas and refine their ideas in large group discussion. |

## Questions

| | Question | Expected Answer |
|---|---|---|
| 1. | What is the PowerLine activity about? | Understanding how power is lost during transmission. |
| 2. | What is success in the activity? | Making enough measurements and calculations to achieve the PowerLine Technician badge. |
| 3. | What do you need to know to succeed? | How to multiply voltage and amperage to find power. |
| 4. | What questions do you still have? | |
| 5. | Beyond being graded, do you care about this? Does this topic affect your life? | |
| 6. | Name a real world job that is like this job. | |

| **Perform these *Teacher Actions***<br>*Do these in the order indicated* | **Expect this *Student Experience***<br>*You should see your students experience the following* |
|---|---|
| 1. **DIRECT**<br>Tell the students that their goal is to earn their PowerLine Technician badge. | **ACCOMPLISHING**<br>Students work independently but can be allowed to "pair up" to discuss all the patterns they recognize. |
| 2. **CONNECT**<br>As students finish, direct them to complete the CONNECT worksheet as directed on the worksheet. | **CONNECTING**<br>Students complete the worksheet, demonstrating mastery of the relevant standards and understanding of real-world applications. |

| | |
|---|---|
| Name | |
| Date | |
| Class Period | |
| Whyville ID | |
| What was this activity about? | |
| What did you need to know to succeed? | |
| What new questions did you think of while playing this activity? | |
| What patterns did you recognize within the map? | |
| How do you calculate power? | |
| Name a real-world career that is related to what you learned today. | |
| Do you care about what you learned? Is it relevant to your life? Why or why not? | |

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All TEKS listed are impacted by this lesson plan.  **Boldfaced TEKS** represent the focus of the lesson plan.

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**TEKS: Career Investigation**

**(2)  The student knows how to locate, analyze, and apply career information. The student is expected to:**
  **(A)  access career information using print and on-line resources to complete an educational and/or training plan for a career pathway;**
  (B)  access career information using interviews with business and industry representatives to create a career resource file;
(6)  The student knows the process of career planning. The student is expected to:
  (B)  prepare an oral or written plan describing the specific factors considered in the decision-making process used to solve a simulated career problem;

**TEKS: Exploring Careers**

**1)  The student explores personal interests and aptitudes as they relate to education and career planning. The student is expected to:**
  **(D)  research current and emerging fields related to personal interest areas;**
  (F)  explore how career choices impact the balance between personal and professional responsibilities; and
**(2)  The student analyzes personal interests and aptitudes regarding education and career planning. The student is expected to:**
  (C)  develop and analyze tables, charts, and graphs related to career interests;
  **(D)  determine the impact of technology on careers of personal interest; and**
**(4)  The student evaluates skills for personal success. The student is expected to:**
  **(A)  implement effective study skills for academic success;**
  **(C)  use a problem-solving model and critical-thinking skills to make informed decisions;**
  **(D)  use effective time-management and goal-setting strategies;**
  **(E)  effectively use information and communication technology tools; and**
(5)  The student recognizes the impact of career choice on personal lifestyle. The student is expected to:
  (A)  prepare a personal budget reflecting the student's desired lifestyle;
**(7)  The student develops skills for professional success. The student is expected to:**
  **(E)  explore and model characteristics necessary for professional success such as work ethics, integrity, dedication, perseverance, and the ability to interact with a diverse population; and**
  **(F)  complete activities using project- and time-management techniques.**
**(8)  The student identifies and explores technical skills essential to careers in multiple occupations, including those that are high skill, high wage, or high demand. The student is expected to:**

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(A) complete actual or virtual labs to simulate the technical skills required in various occupations; and
(B) analyze the relationship between various occupations such as the relationship between interior design, architectural design, manufacturing, and construction on the industry of home building or the multiple occupations required for hospital administration.

**TEKS: Career Portals**

(1) **The student explores one or more career clusters of interest. The student is expected to:**
   (A) **identify the various career opportunities within one or more career clusters; and**
   (B) **identify the pathways within one or more career clusters.**
(2) The student explores pathways of interest within one or more career clusters. The student is expected to:
   (A) investigate career opportunities within the pathways;
   (B) explore careers of personal interest;
(4) The student explores the professional skills needed for college and career success. The student is expected to:
   (E) identify professional associations affiliated with a specified program of study;
   (F) employ effective leadership, teamwork, and conflict management;

**TEKS: Mathematics**

(1) **Number, operation, and quantitative reasoning. The student understands that different forms of numbers are appropriate for different situations. The student is expected to:**
   (B) **select and use appropriate forms of rational numbers to solve real-life problems including those involving proportional relationships;**
(2) **Number, operation, and quantitative reasoning. The student selects and uses appropriate operations to solve problems and justify solutions. The student is expected to:**
   (A) **select appropriate operations to solve problems involving rational numbers and justify the selections;**
   (B) **use appropriate operations to solve problems involving rational numbers in problem situations;**
   (C) **evaluate a solution for reasonableness; and**
(4) **Patterns, relationships, and algebraic thinking. The student makes connections among various representations of a numerical relationship. The student is expected to generate a different representation of data given another representation of data (such as a table, graph, equation, or verbal description).**
(5) **Patterns, relationships, and algebraic thinking. The student uses graphs, tables, and algebraic representations to make predictions and solve problems. The student is expected to:**
   (A) **predict, find, and justify solutions to application problems using appropriate tables, graphs, and algebraic equations; and**
(14) **Underlying processes and mathematical tools. The student applies Grade 8 mathematics to solve problems connected to everyday experiences, investigations in other disciplines, and activities in and outside of school. The student is expected to:**
   (A) **identify and apply mathematics to everyday experiences, to activities in and outside of school, with other disciplines, and with other mathematical topics;**

(B)   use a problem-solving model that incorporates understanding the problem, making a plan, carrying out the plan, and evaluating the solution for reasonableness;

(D)   select tools such as real objects, manipulatives, paper/pencil, and technology or techniques such as mental math, estimation, and number sense to solve problems.

(15)   Underlying processes and mathematical tools. The student communicates about Grade 8 mathematics through informal and mathematical language, representations, and models. The student is expected to:

(A)   communicate mathematical ideas using language, efficient tools, appropriate units, and graphical, numerical, physical, or algebraic mathematical models; and

(B)   evaluate the effectiveness of different representations to communicate ideas.

(16)   Underlying processes and mathematical tools. The student uses logical reasoning to make conjectures and verify conclusions. The student is expected to:

(A)   make conjectures from patterns or sets of examples and nonexamples; and

(B)   validate his/her conclusions using mathematical properties and relationships.

**TEKS: Science**

(3)   Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to:

(A)   in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;

(B)   use models to represent aspects of the natural world such as an atom, a molecule, space, or a geologic feature;

(C)   identify advantages and limitations of models such as size, scale, properties, and materials;

## Blooms (Taxonomy):

| | |
|---|---|
| X | Knowledge: arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state. |
| X | Comprehension: classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate |
| X | Application: apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write. |
| X | Analysis: analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test. |
| X | Synthesis: arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write. |
| X | Evaluation: appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support, |

Instructional Strategies:

| | |
|---|---|
| X | Identifying similarities and differences |
| X | Summarizing and note taking |
| X | Reinforcing effort and providing recognition |
| | Homework and practice |
| X | Nonlinguistic representations |
| X | Cooperative learning |
| X | Setting objectives and providing feedback |
| X | Generating and testing hypotheses |
| X | Cues, questions, and advanced organizers |

All standards listed are impacted by this lesson plan. **Boldfaced** standards represent the focus of the lesson plan.

## Sixth Grade

| Subcategory | Standard ID | Standard Description |
|---|---|---|
| **The Number System** | **6.NS.3** | **Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.** |
| **Expressions and Equations** | **6.EE.2.C** | **Write, read, and evaluate expressions in which letters stand for numbers. c. Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving wholenumber exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). For example, use the formulas $V = s^3$ and $A = 6s^2$ to find the volume and surface area of a cube with sides of length $s = 1/2$.** |
| **Expressions and Equations** | **6.EE.6** | **Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.** |
| **Expressions and Equations** | **6.EE.7** | **Solve real-world and mathematical problems by writing and solving equations of the form $x + p = q$ and $px = q$ for cases in which $p$, $q$ and $x$ are all nonnegative rational numbers.** |

| Subcategory | Standard ID | Standard Description |
|---|---|---|
| Expressions and Equations | 6.EE.9 | Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation d = 65t to represent the relationship between distance and time. |

## Seventh Grade

| Subcategory | Standard ID | Standard Description |
|---|---|---|
| The Number System | 7.NS.2.A | Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers. a. Understand that multiplication is extended from fractions to rational numbers by requiring that operations continue to satisfy the properties of operations, particularly the distributive property, leading to products such as (–1)(–1) = 1 and the rules for multiplying signed numbers. Interpret products of rational numbers by describing real-world contexts. |
| **The Number System** | **7.NS.2.C** | **Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers. c. Apply properties of operations as strategies to multiply and divide rational numbers.** |
| **The Number System** | **7.NS.3** | **Solve real-world and mathematical problems involving the four operations with rational numbers.** |

| Subcategory | Standard ID | Standard Description |
|---|---|---|
| Expressions and Equations | 7.EE.3 | Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. For example: If a woman making $25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or $2.50, for a new salary of $27.50. If you want to place a towel bar 9 3/4 inches long in the center of a door that is 27 1/2 inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation. |
| **Expressions and Equations** | **7.EE.4.A** | **Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. a. Solve word problems leading to equations of the form px + q = r and p(x + q) = r, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?** |

# Eighth Grade

| Subcategory | Standard ID | Standard Description |
|---|---|---|
| Functions | 8.F.4 | Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values. |