Technology Gateway Instructor Guide

An Engineering/Industrial Technology Curriculum Guide

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An Engineering/Industrial Technology Curriculum Guide

2000

Contents

Technology Gateway

Introduction to *Technology Gateway*

What is Technology Gateway?

The Technology Gateway is an integrated, problem-based course of study that models the workplace through the use of industrial-type problems and student and faculty teams. Physics/technology, mathematics, and communications are taught concurrently in the context of solving six workplace-related problems.

What are the strengths of Technology Gateway?

- Targets recruitment, retention, and graduation of more highly skilled technicians.
- Supports the success of a diverse population of students, including students traditionally under-represented in industrial and engineering technology programs.
- Provides an instructional approach and curriculum that have been validated by industry. This validation has occurred through industry focus groups and endorsement of and involvement in the SC ATE Scholars education-industry partnership initiative.
- Uses open-ended problem scenarios that reflect real-world industry problems as closely as possible while, at the same time, covering the appropriate subject matter content. Problems provide a context and purpose for learning.
- Shows relationships between the subject areas of mathematics, physics/technology, and communications and helps answer student questions: Why do I need to learn this? How is it relevant? How will I use it?
- Incorporates effective teaching methodologies and concepts, such as collaborative learning/active learning, coaching, and multiple intelligences theory.
- Provides more opportunities for hands-on, inquiry-based learning, thus enabling students to immediately apply what they are learning.
- Uses student teams to solve problems, which creates an additional support system for learning and encourages student participation and retention.
- Provides additional instructor support because instructors are part of a teaching team.
- Supports technology applications for data collection and analysis, research, problem solving, and presentations.

Who should consider using the Technology Gateway?

Technology Gateway is available for use in technical colleges and high schools.

Taught in a two-year technical college setting, the Technology Gateway is a set of three courses (Engineering 104, Mathematics 104, and English 104) and includes career exploration. The curriculum is targeted for students interested in industrial or engineering technology programs, although the Gateway also may be of interest to other associate degree students wanting an introduction to technology. Technology Gateway is designed to prepare students for success in engineering technology or as a core of study for industrial technology or other technology-based majors.

Technology Gateway may meet a variety of needs at the high school level. Some students may need more skills in mathematics, science, and/or communications in order to qualify for college-level technology programs. Other students may need the Technology Gateway to experience a hands-on environment enabling them to learn teaming and other workplace readiness skills. In some cases, students may take Technology Gateway courses for dual credit (high school and technical college credit).

Titles of the six projects and recommended contact hours of instruction are listed below.

	Project # and Title	Contact Hours
1.	Introduction to Technology Careers	18
2.	Simple Machines	27
3.	Basic Electricity	27
4.	Optics A or Optics B	12-18
5.	Temperature Measuring Devices	27
6.	Hydraulic Jack	18
Total:		129-135

How does the integrated, problem-based approach work?

Interdisciplinary faculty team members coach student teams through a structured problem-based learning process that includes the following phases: preparing students to meet the problem, leading a "what do we know, what do we need to know" discussion, information gathering and sharing, generating solutions, and performance assessment. After students are introduced to a loosely structured problem, they identify what they know, how they know it (opinion versus scientific knowledge), and what information and skills they need to solve the problem. Faculty-guided workshops help students gain content-specific knowledge. Student team recommendations for solving problems are presented in written form or oral presentations.

Technology Gateway classrooms should closely model the workplace environment. For example, student team workspace may be equipped with computer stations and tables for team meetings and tools such as whiteboards, where team work may be posted throughout a project. Student teams remain in their workspace while instructors come and go to coach and deliver "just-in-time" instruction.

Is the Technology Gateway flexible?

The Technology Gateway is designed to give instructor teams and their colleges or schools as much flexibility as possible to meet local needs. Instructors determine the level of proficiency that should be required of students. While student handouts of the problem scenarios are available, instructors determine textbooks and other resources for students. Other local decisions include: how the curriculum will be taught at an individual college or school, including scheduling and teaching assignments; development of course syllabi, scope and sequence, and lesson plans; assessment and grading procedures; and, technology resources.

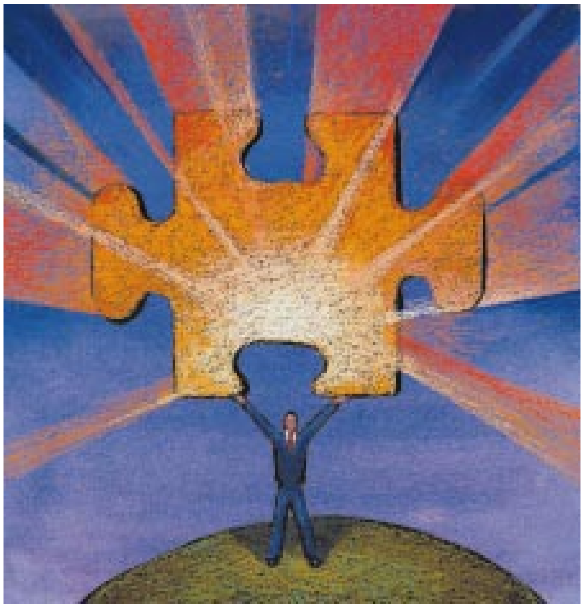
What resources are available to support instructors?

A number of resources are available in this instructor guide to assist in implementing the Technology Gateway curriculum. These resources include:

- Objectives and instructor notes with each project.
- Suggested student workshop activities.
- Content strands in each project.
- Print resources.
- Non-print resources, including web sites.
- Suggested rubrics for evaluating each project.
- A problem-based learning “Need-to-Know Chart” template.
- Student competencies for each project and a master competency list.
- A master equipment list and equipment/resource lists by project.

Student handouts of each problem scenario are included in the back section of this guide. Additional copies of these student handouts may be ordered or printed from the SC ATE Center of Excellence web site (http://scate.org).

Additional information may be found on the SC ATE web site or by contacting SC ATE at 803-896-5407 or scate@sbt.tec.sc.us.



Problem-Based Learning
Need-To-Know Chart

What do we know?	What do we need to know?	How do we find out?

Scope and Sequence Charts

Technology Gateway Projects

#1 Introduction to Technology Careers
#2 Simple Machines
#3 Basic Electricity
#4 Optics
#5 Temperature Measuring Devices
#6 Hydraulic Jack

Science and Technology Scope and Sequence (EGR 104)

Science/Technology Topic	Project Number #1	#2	#3	#4	#5	#6
Physical systems	✔					
Engineering technology careers	✔					
Internet research	✔			✔		✔
Document design	✔					
Random and systematic error		✔				
Simple machines		✔				✔
Work		✔				✔
Workplace safety		✔	✔		✔	✔
Data collection		✔	✔		✔	
Mass, weight, density		✔				✔
Inquiry skills			✔			
Resistance, current, voltage			✔			
Ohm’s Law			✔			
Power			✔			
Series and parallel circuits			✔			
Reflection/refraction				✔		
Magnification				✔		
Lenses				✔		
Precision/accuracy					✔	
Thermal energy					✔	
Temperature scales/calibration					✔	
Pressure						✔
Manufacturing processes					✔	✔
Instrumentation		✔	✔		✔	✔

Communications Scope and Sequence (ENG 104)

Communications Topic	Project Number #1	#2	#3	#4	#5	#6
Technical writing						
Short reports	✔				✔	
Memos			✔		✔	✔
E-mail messages			✔			✔
Proposals			✔	✔	✔	
Process reports		✔	✔			
Page layout	✔					
Research techniques						
Internet sources	✔		✔		✔	
Interviews	✔					
Print sources	✔		✔		✔	
Oral presentations						
Collaborative reports	✔	✔				
Visuals	✔	✔		✔		
Presentation software (PowerPoint)		✔				

Technology Gateway Projects

#1 Introduction to Technology Careers
#2 Simple Machines
#3 Basic Electricity
#4 Optics
#5 Temperature Measuring Devices
#6 Hydraulic Jack

Mathematics Scope and Sequence (MAT 104)

Mathematics Topic	Project Number					
	#1	#2	#3	#4	#5	#6
Order of operations	✔					
Linear measurement		✔				
SI[1] system	✔	✔				✔
Charts and graphs	✔					
Data tables		✔				
Mass/weight measurement		✔				
Exponents			✔		✔	
Scientific/engineering notation			✔			
Estimation						✔
Percent	✔					
Spreadsheets	✔					
Calculator/computer skills	✔	✔	✔			✔
Units and dimensional analysis						✔
Algebraic expressions		✔	✔			
Linear equations		✔	✔		✔	
Ratio and proportion		✔		✔		
Formulas				✔	✔	
Literal equations			✔	✔		
Rational equations				✔		
Slope		✔				
Statistics	✔					
Cartesian graphing			✔		✔	
Angles/angle measurements				✔		
Area		✔				✔
Volume		✔				✔
Right triangles		✔				

[1]Systeme International d'Unites, the international system of units now recommended for most scientific purposes.

Technology Gateway Student Competencies

A.1 Understand basic numeration.
- A.1.1 Perform basic calculator operations.
  - A.1.1.1 Perform basic arithmetic operations with and without a calculator.
  - A.1.1.2 Using a calculator, find the square and square root of a number.*
  - A.1.1.3 Calculate products and quotients using scientific notation.*
  - A.1.1.4 With a calculator, evaluate arithmetic expressions involving parentheses.
  - A.1.1.5 Calculate percent of a number and what percent one number is of another number.

A.2 Define and use basic measurements in solving problems.
- A.2.1 Define and use the SI system of measurement.
  - A.2.1.1 Define and use SI prefixes.
  - A.2.1.2 Convert units within the SI system of measurement.
  - A.2.1.3 Recognize the characteristics of common SI units in a working environment.

- A.2.2 Perform linear two-dimensional and three-dimensional measurements.
  - A.2.2.1 Distinguish between fundamental and derived units (measurements).*

A.3 Understand basic algebra.
- A.3.1 Evaluate algebraic expressions.
  - A.3.1.1 Evaluate and use rational expressions.
  - A.3.1.2 Simplify and evaluate radical expressions.*
  - A.3.1.3 Evaluate algebraic expressions using order of operations.
  - A.3.1.4 Evaluate algebraic expressions containing integer exponents.*
  - A.3.1.5 Simplify, evaluate, and perform operations with polynomials.*
  - A.3.1.6 Use ratio and proportion to solve problems.

- A.3.2 Solve linear equations.
  - A.3.2.1 Use linear equations to solve problems involving real-world applications.
  - A.3.2.2 Simplify and solve linear equations.
  - A.3.2.3 Simplify and solve literal equations.
  - A.3.2.4 Solve linear equations by graphing on a coordinate plane.
  - A.3.2.5 Organize data in tabular and graphical form.

- A.3.3 Solve quadratic equations.
  - A.3.3.1 Factor polynomials.*
  - A.3.3.2 Use the Pythagorean Theorem to solve problems involving right triangles.

- A.3.4 Perform basic operations using exponential expressions and logarithms.
  - A.3.4.1 Use a calculator to evaluate and perform operations with exponential expressions.

- A.3.5 Use spreadsheets to solve problems.
  - A.3.5.1 Use data tables to organize data.
  - A.3.5.2 Use spreadsheets to evaluate data and perform basic calculations.

- A.3.6 Use dimensional analysis to solve problems involving measurements.
  - A.3.6.1 Use dimensional analysis in solving problems involving a change of units such as SI to US Customary and US Customary to SI.

- A.3.7 Understand the concept of functions and functional notation.
  - A.3.7.1 Evaluate function values for given values of the independent variable.*

A.4 Understand geometric concepts.

A.4.1 Understand and use angles.
- A.4.1.1 Use a protractor to measure angles.
- A.4.1.2 Identify acute, obtuse, and right angles.
- A.4.1.3 Determine when angles are congruent.

A.4.2 Recognize two-dimensional shapes.
- A.4.2.1 Identify triangles, quadrilaterals, pentagon, and hexagon.*

A.4.3 Recognize three-dimensional shapes.
- A.4.3.1 Identify sphere, prism, pyramid, cone, and cylinder.

A.4.4 Determine perimeter, area, and volume.
- A.4.4.1 Measure the perimeter of irregular shapes.
- A.4.4.2 Determine the area of a triangle, quadrilateral, and circle.
- A.4.4.3 Determine the volume of a sphere, pyramid, cone, cylinder, and prism.

A.5 Understand basic statistics.

A.5.1 Collect, organize, and present quantitative and qualitative data.
- A.5.1.1 Collect data in a problem-solving setting using investigation, interviews, and/or experiments.
- A.5.1.2 Organize data in a logical manner.
- A.5.1.3 Present data using oral, written, and visual methods.

A.5.2 Define and calculate measures of central tendencies.
- A.5.2.1 Determine the mode, median, and mean of a set of data.

A.5.3 Know when and how to present data graphically.
- A.5.3.1 Create and interpret (x,y) graphs, bar charts, histograms, circle graphs, line charts, and pictograms.

A.6 Use right triangle trigonometry to solve problems.

A.6.1 Determine the relationships of right triangle sides and angles.
- A.6.1.1 Define and use adjacent, opposite, and hypotenuse in describing the ratios of sides in a right triangle.
- A.6.1.2 Define sine, cosine, and tangent of an angle.
- A.6.1.3 Use a calculator to determine the value of trigonometric ratios.

A.7 Understand the science of machines, electricity, and weights and measures.

A.7.1 Understand simple machines.
- A.7.1.1 Define work as it relates to simple machines.
- A.7.1.2 List the types of simple machines.
- A.7.1.3 Determine the mechanical advantage and efficiency of a simple machine.

A.7.2 Understand the basics of electricity.
- A.7.2.1 Determine the difference between alternating and direct current.
- A.7.2.2 Determine the difference between series and parallel circuits.
- A.7.2.3 Apply Ohm's Law.
- A.7.2.4 Use simple meters to measure electrical properties.

A.7.3 Understand the use of weights and measures.
- A.7.3.1 Measure or describe length in different systems of units.
- A.7.3.2 Determine area in different systems of units.
- A.7.3.3 Determine mass using various types of balances.
- A.7.3.4 Measure temperature in different systems of units.
- A.7.3.5 Use basic analog measuring scales.
- A.7.3.6 Distinguish between mass and weight.

A.7.4 Understand basic geometrical optics.
- A.7.4.1 Describe the effect of reflection or refraction on the path of a light beam.
- A.7.4.2 Determine if an image is virtual or real.
- A.7.4.3 Apply ray tracing to mirrors and lenses.

A.8 Develop and practice good laboratory skills and techniques.

A.8.1 Understand and practice lab safety procedures.
- A.8.1.1 Identify hazards of workplace equipment and tools.
- A.8.1.2 Wear proper personal protective equipment and clothing.
- A.8.1.3 Read all labels and Material Safety Data Sheets (MSDS) on chemicals.
- A.8.1.4 Read and obey all safety instructions and emergency procedures.

A.8.2 Perform laboratory experiments.
- A.8.2.1 Properly use and handle chemicals.
- A.8.2.2 Apply the scientific method to problem solving.

A.8.3 Write lab reports.
- A.8.3.1 Use appropriate format in writing lab reports (title, introduction, procedure, data, graph, calculations, results, sources of error).
- A.8.3.2 Write logical procedural steps for performing an experiment.
- A.8.3.3 Identify relevant experimental errors.
- A.8.3.4 Distinguish between random and systematic errors.

A.9 Gather information.

A.9.1 Perform library research in engineering fields.
- A.9.1.1 Use specialized general reference works including dictionaries, encyclopedias of applied science and technology, manuals, handbooks, government publications, and others.
- A.9.1.2 Use technical journals and periodicals.
- A.9.1.3 Use electronic sources/databases (NewsBank, ProQuest, WWW, Encarta, and others).
- A.9.1.4 Take notes (summarize, paraphrase, record quoted material).
- A.9.1.5 Document researched materials (for Works Consulted page and within body of paper).

A.9.2 Use non-print sources to gain information.
- A.9.2.1 Perform fact-finding interviews with individuals knowledgeable in field.
- A.9.2.2 Use pre-writing techniques (e.g., listing, clustering, journalistic questions, dramatization) to develop ideas.
- A.9.2.3 Summarize information from lectures, seminars, workshops, training sessions, laboratory experiments.

A.10 Organize information.

A.10.1 Apply basic organizational techniques.
- A.10.1.1 Outline information (working and formal).
- A.10.1.2 Develop central idea statement (thesis) with a plan of development (essay map).
- A.10.1.3 Use appropriate organizational patterns (causal analysis, compare/contrast, instructional, description, narration, persuasion, et al.).
- A.10.1.4 Develop appeals to the reader’s logic, emotion, and ethics.
- A.10.1.5 Demonstrate the five Cs of communication: clear, concise, correct, complete, coherent.

A.11 Present information.

A.11.1 Present written information.

- A.11.1.1 Identify reader(s)—demographics, number, etc.
- A.11.1.2 Identify purpose—general and specific.
- A.11.1.3 Format appropriate documents (letters, memoranda, instruction sheets, reports, manuals).
- A.11.1.4 Adapt information to knowledge level of reader.
- A.11.1.5 Apply revision techniques.
- A.11.1.6 Employ standard English grammar and rules of mechanics, spelling, and punctuation.
- A.11.1.7 Use computers to produce final draft.

A.11.2 Present oral information.

- A.11.2.1 Analyze audience—demographics, size, setting, etc.
- A.11.2.2 Identify purpose—general and specific.
- A.11.2.3 Cite research material.
- A.11.2.4 Adapt information to knowledge level of audience.
- A.11.2.5 Use standard English grammar.
- A.11.2.6 Demonstrate audience-centered techniques (eye contact, conversational tone, and others).
- A.11.2.7 Respond to questions from audience.
- A.11.2.8 Present information collaboratively (as a member of a team).

A.11.3 Present visual information.

- A.11.3.1 Incorporate visuals effectively.
- A.11.3.2 Dress in a professionally acceptable manner.

A.12 Understand teaming skills and techniques.

A.12.1 Use effective team skills.

- A.12.1.1 Demonstrate the ability to work in teams.
- A.12.1.2 Employ problem-solving skills to address a team task.
- A.12.1.3 Employ workplace interpersonal skills, including conflict-resolution techniques.
- A.12.1.4 Demonstrate listening skills.
- A.12.1.5 Collaborate with others to obtain information.
- A.12.1.6 Collaborate with others to develop and present written projects.
- A.12.1.7 Collaborate with others to create and deliver oral presentations.

**Enabling competency -– not directly related to problem scenarios.*

Technology Gateway Equipment List

Project #1, Introduction to Technology Careers
- Computer
- Office software/word processing/ spreadsheets
- Calculators
- Presentation system hardware

Project #2, Simple Machines
- Stopwatch
- Spring scales (lb. and/or Newton)
- Meter stick/knife edge/support stand
- Data logger for MBL (microcomputer-based laboratory)
- Force transducer for CBL (calculator-based laboratory) or MBL
- Protractors
- Balances
- Weights or masses
- Simple machines:
  ramps, inclined planes, pulleys, wheel & axles, wedges, levers, screw
- Pulley cord
- Blank videotapes & video camera
- Video projector

Project #3, Basic Electricity
- Digital multimeters
- Protoboard
- Resistors
- Wires
- Power supply
- Miniature light sockets
- Miniature lights
- CBL/MBL— voltage & current probes

Project #4A or #4B, Optics
- Clear tungsten lamp bulbs
- Self-reflective lens and prisms
- Optical bench or meter sticks & stands
- Plane glass plate
- Ground glass screen
- Pins
- Paper
- Calipers

Project #5, Thermal
- Thermometers
  - Liquid-in-glass (Fahrenheit, Celsius, and unmarked)
  - Thermocouple
  - Bimetallic thermometers
  - Resistance thermometers
  - Thermistor
- CBL/MBL—temperature probe

Project #6, Hydraulics
- Pressure gauge
- Computer
- Pressure sensor
- Calculator
- Calipers
- Hydraulic jack

Technology Gateway Project #1

Introduction to Technology Careers

Problem Scenario for the Student

Your team is in charge of communicating to high school juniors and seniors occupational differences of engineers, technologists, and technicians using a brochure, videotape, CD, web site, PowerPoint, or written report.

These high school students will need brief information in the electrical, mechanical, fluids, thermal, optics, and materials areas to help them make suitable career choices. Information about job opportunities and career paths, salaries, physical ability requirements, education requirements, work environment, and other relevant information about these careers also should be included.

Graphics or data charts should be used to compare the benefits for technicians with two-year degrees with other jobs requiring four-year degrees. To locate information about these occupations, your team should consult state and federal publications, on-line databases, professional journals, and other sources.

Instructor Notes

1) Organize student teams. Students work best in teams of three to four students and benefit from participation in team meetings.
2) Explain and practice the problem-based learning (PBL) process. The use of a "Need-to-Know" chart (page 8) will reinforce the PBL process.
3) Provide a good teaming environment for students, with tables to work on, as well as easel pads, whiteboards, or other devices for organizing and recording team collaborative efforts.
4) Introduce computer applications such as spreadsheets and scientific/graphing calculators as good organizing and analyzing tools for students.
5) Use word processing and publishing tools to teach and reinforce basic communication skills.
6) Relate characteristics of physical systems to engineering technology careers to increase students' awareness of typical job activities.
7) Provide students access to the Internet and visits to the workplace to facilitate students' career research.
8) Use student journals to help students crystallize, organize, and assess their learning.
9) Students may need more time to complete this project than is allocated. Completion dates may need to be extended into Project #2 or beyond.

Integrated Skills

Problem-Based Learning
Teaming Skills
Computer/Internet Skills
Calculator Skills

Objectives

- Research information about career options for technicians and develop a multimedia report (i.e., brochure, videotape, research report) suitable for high school juniors and seniors.
- Use computer software for page layout and design.
- Investigate and report information about technical career paths.
- Summarize characteristics of electrical, mechanical, and other physical systems.

Content Strands

Mathematics

Order of operations
Spreadsheets
Charts and tables
Basic statistics

Science / Technology

Characteristics of physical systems:
electrical, mechanical, thermal, fluids, optics, and materials

Communications

Research/documentation
Presenting information
Interviewing skills
Desktop publishing

Student Workshop Activities

- Teaming skills
- Problem-based learning (PBL process)
- Calculator/computer skills (spreadsheets)
- Characteristics of physical systems (electrical, mechanical, thermal, fluids, optics, materials)
- Research/documentation techniques
- Basic statistics
- Designing tables, graphs, and other visuals
- Comparing and contrasting information
- Interviewing skills
- Presenting written information—designing a brochure, visuals, other media products

Classroom Equipment

Computers -- 1 for 2 to 4 students
- Office software
  - Word processing
  - Spreadsheets
  - Presentations
- Scientific and/or graphing calculators

Student Activities

Students will gather information through researching, reading, and interviewing people who work in the fields. They will investigate the following:

- Training/education requirements
- Recommended skills/knowledge
- Certification requirements
- Internships/apprenticeships
- Physical abilities (e.g., eye/hand coordination, ability to lift 50+ pounds)
- Engineering technology job outlook—local, state, national
- Work area (inside/outside, large plant/small company, lab/office)
- Work clothes
- Salary ranges (comparison chart/graph)
- Career duties (e.g., assembling parts, studying blueprints, using machinery)
- Career fields/career paths
- Well-known people in career fields
- Pioneers in technical fields
- Titles of journals/magazines in technical fields

Classroom Resources

Print

Cheshier, Stephen R. (1998), *Studying Engineering Technology, a Blueprint for Success,* Discovery Press.

Barell, John (1998), *Problem-Based Learning, an Inquiry Approach,* Skylight Training and Publishing, Inc.

Dictionary of Occupational Titles: Volume 1 and Volume 2, U.S. Department of Labor (1993), JIST Works, Inc.

Encyclopedia of Technology and Applied Sciences (2000), Marshall Cavendisk, Inc.

Fogarty, Robin (1997), *Problem-Based Learning: Other Curriculum Models for the Multiple Intelligences Classroom,* Skylight Training and Publishing, Inc.

Johnson, David W., and Roger T. Johnson (1996), *Meaningful and Manageable Assessment Through Cooperative Learning,* Interaction Book Company, Edina, MN.

Non-Print

Library/industry visits

Access to computers and the Internet

Brochure template located on the Office 97 CD. Open the Valupack folder, then the Template folder, then the Word Folder. The file is Brochure.doc.

American Society for Engineering Education (ASEE) web site: http://www.asee.org/precollege/html/e_technology.htm

PBL web site: http://www.imsa.edu/team/cpbl/cpbl.html

SC Employment Security Commission web site: www.sces.org

Videotapes from SC ATE lending library:
Wealth, Innovation & Diversity, Joel Barker & Paul Hopkins Productions, 31 minutes;
Managing Diversity, CRM Films, 23:15 minutes.

Student Competencies for Project #1

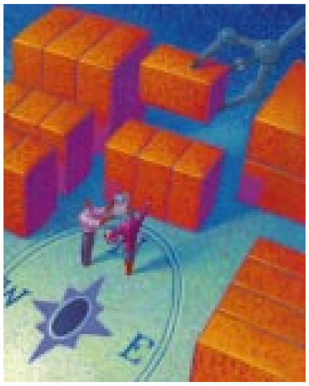
A.1.1.1	Perform basic arithmetic operations with and without a calculator.
A.1.1.2	Using a calculator, find the square and square root of a number.
A.1.1.4	With a calculator, evaluate arithmetic expressions involving parentheses.
A.1.1.5	Calculate percent of a number and what percent one number is of another number.
A.3.2.5	Organize data in tabular and graphical form.
A.3.5.1	Use data table to organize data.
A.5.1.1	Collect data in a problem-solving setting using investigation, interviews, and/or experiments.
A.5.1.2	Organize data in a logical manner.
A.5.1.3	Present data using oral, written, and visual methods.
A.5.2.1	Determine the mode, median, and mean of a set of data.
A.5.3.1	Create and interpret (x,y) graphs, bar charts, histograms, circle graphs, line charts, and pictograms.
A.9.1.1	Use specialized general reference works including dictionaries, encyclopedias of applied science and technology, manuals, handbooks, government publications, and others.
A.9.1.2	Use technical journals and periodicals.
A.9.1.3	Use electronic sources/databases (Newsbank, ProQuest, WWW, Encarta, etc.)
A.9.1.4	Take notes (summarize, paraphrase, record quoted material).
A.9.1.5	Document researched materials (for Works Consulted page and within body of paper).
A.9.2.1	Perform fact-finding interviews with individuals knowledgeable in field.
A.9.2.2	Use pre-writing techniques (e.g., listing, clustering, journalistic questions, dramatization) to develop ideas.
A.9.2.3	Summarize information from lectures, seminars, workshops, training sessions, laboratory experiments.
A.10.1.1	Outline information (working and formal).
A.10.1.3	Format appropriate documents (letters, memoranda, instruction sheets, reports, manuals).
A.10.1.4	Develop appeals to the reader's logic, emotion, and ethics.
A.10.1.5	Demonstrate the five Cs of communication: clear, concise, correct, complete, coherent.
A.11.1.1	Identify reader(s)—demographics, number, etc.
A.11.1.2	Identify purpose—general and specific.
A.11.1.5	Apply revision techniques.
A.11.1.6	Employ standard English grammar and rules of mechanics, spelling, and punctuation.
A.11.1.7	Use computers to produce final draft.
A.11.3.1	Incorporate visuals effectively.
A.12.1.1	Demonstrate the ability to work in teams.
A.12.1.2	Employ problem-solving skills to address a team task.
A.12.1.3	Employ workplace interpersonal skills, including conflict-resolution techniques.
A.12.1.4	Demonstrate listening skills.
A.12.1.5	Collaborate with others to obtain information.
A.12.1.6	Collaborate with others to develop and present written projects.

Rubric for Evaluating Project #1

Technology Gateway Project #1—Introduction to Technology Careers

STUDENT____ **Date**____

Point Value	Points Earned		Needs Improvement	Proficient	Exceeds Requirements
20	_____	**I. PROBLEM-SOLVING PROCESS**			
		• need-to know chart	_______	_______	_______
		• gathering information	_______	_______	_______
		• analyzing data	_______	_______	_______
		• stating assumptions	_______	_______	_______
		• drawing conclusions	_______	_______	_______
60	_____	**II. CONTENT**			
(20)	_____	**A. Science/Technology**			
		• understands characteristics of physical systems (electrical, mechanical, thermal, fluids, optics, materials)	_______	_______	_______
		• computer skills	_______	_______	_______
(20)	_____	**B. Mathematics**			
		• calculator skills	_______	_______	_______
		• spreadsheet skills	_______	_______	_______
		• charts and tables	_______	_______	_______
		• mean, median, mode	_______	_______	_______
(20)	_____	**C. Communication**			
		• ideas presented in organized manner	_______	_______	_______
		• accurate & complete information	_______	_______	_______
		• appropriate format	_______	_______	_______
		• standard grammar & mechanics use	_______	_______	_______
		• clear & concise information	_______	_______	_______
		• effective visuals	_______	_______	_______
20	_____	**III. TEAMING SKILLS**			
		• conflict resolution	_______	_______	_______
		• shared responsibilities	_______	_______	_______
		• self-evaluation	_______	_______	_______
		• peer/team evaluation	_______	_______	_______
100	_____	**TOTAL POINTS EARNED**			



Technology Gateway Project #2

Simple Machines

Instructor Notes

1) Students should be organized in teams of three to four students, and the Problem-Based Learning (PBL) process (pages six and eight) should be continually reinforced. Teams should investigate the following:
   - Movement of products in the workplace.
   - Cost of using machines in the workplace.
   - Safety (i.e., lifting, carrying, etc.).
   - Storage facility design.
2) Students should be encouraged to build models of simple machines to generate test data.
3) Technology (e.g., CBL/MBL) should be used to gather physical data.
4) Instructors need to be prepared to address student questions about physical limitations.
5) Videotapes of student presentations are useful as assessment tools.
6) Continue to build strong teaming skills by introducing topics as needed, e.g., consensus building.
7) Students need help in understanding types of visuals, e.g., transparencies, PowerPoint.
8) Students need to understand direct and inverse relationships.
9) Students should be allowed to construct compound machines to solve the problem.
10) Limitations on the size of the basement need to be developed (for example, ceiling height, dimensions of floor space, and number of coils).
11) Instructors are cautioned not to give too much information or be too quick to answer all students' questions.
12) Project 2 is a good place to introduce process writing.

Problem Scenario for the Student

A local siding distributor has problems with storage in its present facility because of an increase in demand for its vinyl product. While waiting for the construction of its new and improved distribution center, the distributor must maximize space for storage. The basement of the old building is going to be used to store rolls of the vinyl siding. However, rolls of aluminum coil are currently stored in the basement and must be moved before the vinyl siding can be stored there. The aluminum coil comes packaged in boxes approximately 1.5 feet wide, 1.5 feet long, and 3 feet high. These boxes can weigh from 20 to 30 pounds.

The siding distributor needs to find an efficient way to move the rolls of coil from the basement to the first floor loading dock. The owner of the distribution center does not want to invest in heavy motorized equipment but does want to make the movement of the coil manageable for her employees. In addition to the space occupied by the aluminum coil, the basement is also large enough to accommodate any human-powered machine.

Your team is in charge of determining the most efficient use of human mechanical energy (e.g., inclined plane, hand-operated conveyer belt, block and tackle elevator, wheel and axle) in order to lift the coil from the basement to the loading dock area. Your team also needs to determine how many coils can be safely moved at one time with the simple machine being used. The owner expects your engineering firm to present your recommendations and findings, as well as cost estimates of your team's solution, in an oral presentation supported by visuals.

Objectives

- Investigate the mechanical advantage of simple machines, and devise a plan for moving bulk materials from a storage basement to a loading dock.
- Measure/calculate length, area, volume, and force in SI and US Customary systems.
- Apply the conservation of energy to the operation of the simple machine.
- Determine the amount of work done by a simple machine.
- Make an oral presentation supported by visuals.

Content Strands

Mathematics

Basic measurements—SI and US Customary systems
Data tables
Algebraic expressions
Geometric concepts
Area and volume

Science / Technology

Random and systematic errors
Measurements
Mass and weight
Data collection (CBL/MBL)
Work
Simple machines
Workplace safety

Communications

Summaries
Formatting information
Collaboration
Organizing information
Visuals in presentations
Process writing

Integrated Skills

Problem-Based Learning
Teaming Skills
Computer/Internet Skills
Calculator Skills

Student Workshop Topics

- Units and measurement (SI)
- Forces and motion (friction)
- Weight vs. mass
- Work, energy, and power
- Simple machines
- Efficiency (work output vs. work input)
- Mechanical advantage vs. ideal mechanical advantage
- Random and systematic error
- Ratio and proportion
- Simplifying and evaluating algebraic expressions
- Right triangles
- Geometric concepts
- Area and volume
- Summarizing and formatting information
- Presenting information with visuals
- Collaboration and consensus building
- Process writing

Classroom Resources

- Spring scales (lb. and/or N)
- Force transducer for CBL or MBL
- Protractors
- Balances
- Calculators
- Weights or masses
- Ramps, inclined plane, pulleys, wheel and axles, wedges, levers, and screws
- Meter sticks and rulers
- Support stands
- String/cord
- Surfaces (wood, rollers, sandpaper, etc.)
- Blank videotapes and video camera
- Video projector
- Stopwatch

Books

Cunningham, James B., and Norman Herr (1994), *Hands-On Physics Activities with Real-Life Applications: Easy-To-Use Labs and Demonstrations for Grades 8-12,* Center for Applied Research in Education, West Nyack, NY.

Arcaro, Jerome S. (1995), *Teams in Education: Creating an Integrated Approach,* St. Lucie Press, Delray Beach, FL.

Web Site

American Association of Physics Teachers, http://www.aapt.org

Physics/Technology Student Activities for Simple Machines Project

1. Random and Systematic Errors

- Object—Investigate random and systematic errors by making a series of measurements of a coin drop.
- Make several sets of 25 measurements of the time it takes for a coin to fall from a height of two meters to the floor.
- Use a stopwatch to time the coin drops; make measurements to .01 seconds.
- Make one set of measures with a student who drops and times the coin fall.
- Make other sets of measurements with different students conducting and timing their own coin drop; the same student should make measurements of the set.
- Plot a histogram of the times or calculate the average for each set.
- In the class, compare the histograms or averages for all teams through guided discussion.
- Have students compare their average values to the actual value of 0.64 seconds.
- Use guided discussion to determine type of random and systematic errors.

2. Pulleys

- Give a mini-lecture on mechanical advantage and work.
- Use coached discussion with the Problem-Based Learning (PBL) Know/Need-to-Know (KNK) approach to determine quantities to measure to investigate a pulley system.
- Help students to set up a spreadsheet table to aid in the analysis of pulley systems. Be sure to have students calculate the work done by the applied force and the work done on the weight to be moved.
- Investigate pulley systems by including several loads (three or more) for each pulley configuration and the force to lift. Be sure to measure the distance the load moves and the distance the applied force moves.
- Measure applied force with a CBL/MBL force probe.
- Use coached discussion to analyze mechanical advantage and work.

3. Levers

- Use coached discussion with the PBL KNK approach to determine quantities to measure to investigate a lever system.
- Help students set up a spreadsheet table to assist with the analysis of a lever system. Have the students calculate the work done by the applied force and the work done on the weight to be moved.
- Investigate lever systems by including several loads (three or more) for each load position and the force to lift. Be sure to measure the distance the load moves and the distance the applied force moves.
- Measure applied force with a CBL/MBL force probe.
- Help students determine the relationship between the applied force and the distance from the fulcrum and the weight and the distance from the fulcrum. These relationships to mechanical advantage should be discussed. Also discuss work relationships.

4. Inclined Plane

- Use coached discussion with the PBL KNK approach to determine quantities to measure to investigate an inclined plane.
- Help students set up a spreadsheet table to aid in the analysis of an inclined plane. Have students calculate the work done by the applied force and the work done on the weight to be moved.
- Investigate an inclined plane by including several loads (three or more) for each load position and the force to lift. Also, investigations should be made at several angles of the plane. Be sure to measure the distance the load moves and the distance the applied force moves.
- Measure applied force with a CBL/MBL force probe.
- Help students determine the relationship between the applied force and the load and length of the hypotenuse and the height of the plane. This can be related to the mechanical advantage. Also discuss work relationships.

5. Conservation of Energy

- Compare the work done by the applied force and the work done on the load for all systems measured.
- Use guided discussion to introduce the concept of conservation of energy and the importance in problem solving.

Student Competencies for Project #2

A.2.1.1	Define and use SI prefixes.
A.2.1.2	Convert units within the SI system of measurement.
A.2.1.3	Recognize the characteristics of common SI units in a working environment.
A.2.2.1	Distinguish between fundamental and derived units (measurements).
A.3.2.1	Use linear equations to solve problems involving real world applications.
A.3.2.3	Simplify and solve literal equations.
A.3.2.4	Solve linear equations by graphing on a coordinate plane.
A.3.3.2	Use the Pythagorean Theorem to solve problems involving right triangles.
A.3.6.1	Use dimensional analysis in solving problems involving a change of units such as SI to US Customary and US Customary to SI.
A.4.1.1	Use a protractor to measure angles.
A.4.1.2	Identify acute, obtuse, and right triangles.
A.4.1.3	Determine when angles are congruent.
A.4.4.1	Measure the perimeter of irregular shapes.
A.4.4.2	Determine the area of a triangle, quadrilateral, and circle.
A.4.4.3	Determine the volume of a sphere, pyramid, cone, cylinder, and prism.
A.6.1.1	Define and use adjacent, opposite and hypotenuse in describing the ratios of sides in a right triangle.
A.6.1.2	Define sine, cosine, and tangent of an angle.
A.6.1.3	Use a calculator to determine the value of trigonometric ratios.
A.7.1.1	Define work as it relates to simple machines.
A.7.1.2	List the types of simple machines.
A.7.1.3	Determine the mechanical advantage and efficiency of a simple machine.
A.7.3.1	Measure or describe length in different systems of units.
A.7.3.3	Determine mass using various types of balances.
A.7.3.6	Distinguish between mass and weight.
A.8.1.1	Identify hazards of workplace equipment and tools.
A.8.2.2	Apply the scientific method to problem solving.
A.8.3.1	Use appropriate format in writing lab reports (title, introduction, procedure, graph, calculations, results, sources of error).
A.8.3.2	Write logical procedural steps for performing an experiment.
A.8.3.3	Identify relevant experimental errors.
A.8.3.4	Distinguish between random and systematic errors.
A.9.1.1	Use specialized general reference works including dictionaries, encyclopedias of applied science and technology, manuals, handbooks, government publications, and others.
A.10.1.1	Outline information (working and formal).
A.10.1.2	Develop central idea statement (thesis) with a plan of development (essay map).
A.10.1.3	Use appropriate organizational patterns (causal analysis, compare/contrast, instructional, description, narration, persuasion, etc.).
A.10.1.5	Demonstrate the five Cs of communication: clear, concise, correct, complete, coherent.
A.11.2.1	Analyze audience—demographics, size, setting, etc.
A.11.2.2	Identify purpose—general and specific.
A.11.2.3	Cite research material.
A.11.2.4	Adapt information to knowledge level of audience.
A.11.2.5	Use standard English grammar.
A.11.2.6	Demonstrate audience-centered techniques (eye contact, conversational tone, and others).
A.11.2.7	Respond to questions from audience.
A.11.2.8	Present information collaboratively (as a member of a team).
A.11.3.1	Incorporate visuals effectively.
A.11.3.2	Dress in a professionally acceptable manner.
A.12.1.1	Demonstrate the ability to work in teams.
A.12.1.2	Employ problem-solving skills to address a team task.
A.12.1.3	Employ workplace interpersonal skills including conflict-resolution techniques.
A.12.1.4	Demonstrate listening skills.
A.12.1.5	Collaborate with others to obtain information.
A.12.1.7	Collaborate with others to create and deliver oral presentations.

Rubric for Evaluating Project #2

Technology Gateway Project #2—Simple Machines

STUDENT____ **Date**____

Point Value	Points Earned		Needs Improvement	Proficient	Exceeds Requirements
20	_____	**I. PROBLEM-SOLVING PROCESS**			
		• need-to know chart	_______	_______	_______
		• gathering information	_______	_______	_______
		• analyzing data	_______	_______	_______
		• stating assumptions	_______	_______	_______
		• drawing conclusions	_______	_______	_______
60	_____	**II. CONTENT**			
(20)	_____	**A. Science/Technology**			
		• random & systematic errors	_______	_______	_______
		• measurements	_______	_______	_______
		• mass & weight	_______	_______	_______
		• data collection (CBL/MBL)	_______	_______	_______
		• work	_______	_______	_______
		• simple machines	_______	_______	_______
		• workplace safety	_______	_______	_______
(20)	_____	**B. Mathematics**			
		• basic measurements	_______	_______	_______
		• data tables	_______	_______	_______
		• algebraic expressions	_______	_______	_______
		• geometric concepts	_______	_______	_______
		• area & volume			
(20)	_____	**C. Communication**			
		• summaries	_______	_______	_______
		• formatting information	_______	_______	_______
		• collaboration	_______	_______	_______
		• organizing information	_______	_______	_______
		• visuals in presentations	_______	_______	_______
		• process writing			
20	_____	**III. TEAMING SKILLS**			
		• conflict resolution	_______	_______	_______
		• shared responsibilities	_______	_______	_______
		• self-evaluation	_______	_______	_______
		• peer/team evaluation	_______	_______	_______
100	_____	**TOTAL POINTS EARNED**			

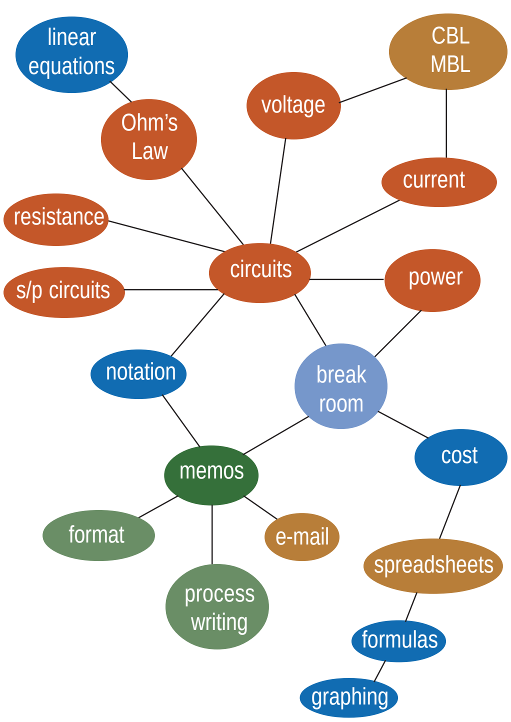
Technology Gateway Project #3

Basic Electricity

Instructor Notes

1) Use the Need-to-Know chart to lead students to decide how they will report on the project, i.e., e-mail, memo, oral presentation, or written presentation.
2) Students need to conduct lab experiments in series and parallel circuits using ammeters and voltmeters.
3) The basic characteristics of series and parallel circuits are addressed in a visual way in *Workshop Physics Unit 22,* using lights as resistance elements.
4) An introduction to measurement of voltage and current should include analog and digital measuring techniques. Data collection with the CBL or MBL systems will reinforce computer usage.
5) An explanation of voltage as a "driving force," current as rate of change, and work as "driving force" times "quantity moved" is presented in *Unified Technical Concepts*.

Concept Map



Problem Scenario for the Student

You are a physical plant employee in a small manufacturing plant. A group of employees has requested a break room. In the plant is a storage room that can be converted to a break room. Your supervisor has asked your team to develop a plan for the room and has supplied a list of the appliances requested by the employees for the room.

The power for the storage room is a single 120-volt line from a 20-amp circuit breaker on the main plant floor. Eight fluorescent lights (60 watts each) are in the room. Employees requested the following appliances (in priority order):

- Coffee maker
- Microwave oven
- Toaster
- Television/VCR
- Refrigerator
- Stereo

Your team will investigate the power requirements of these appliances and develop a plan that will make the most effective use of the room's electrical circuit yet still meet local electrical codes. The plan will indicate capital expenditures not to exceed $1,000 and will predict monthly operational costs. You will submit to your supervisor a comprehensive report describing the process necessary to complete the renovation, including time and cost projections as well as any foreseeable problems.

Objectives

- Investigate the power needed to support a number of electrical appliances and determine a plan to equip an employee break room using available electrical power and budget.
- Measure voltage and current in an electrical circuit, and determine power in an electrical circuit.
- Investigate Ohm's Law and series and parallel circuits.
- Write an interoffice memorandum.
- Write a process-based report.

Content Strands

Mathematics

Scientific & engineering notation
Algebraic expressions
Linear equations
Literal equations

Science / Technology

Electrical quantities/units
Voltage, current, power
Measure electrical quantities
Ohm's Law
Power
Series & parallel circuits
Computer-based labs
Calculator-based labs

Communications

Process analysis writing
Memo format
Electrical safety
Inquiry skills
Causal analysis

Student Workshop Activities

- Scientific notation
- Engineering notation
- Basic electricity—lab
- Solving linear equations/applications
- Electrical safety and magnetism
- Reading scales
- Memo writing
- Process writing
- Series and parallel circuits—lab
- Solving fractional equations
- Inquiry skills

Integrated Skills

Problem-Based Learning
Teaming Skills
Computer Applications

Classroom Resources

Books

Arcaro, Jerome S. (1995), *Teams in Education: Creating an Integrated Approach,* St. Lucie Press, Delray Beach, Fl.

Cunningham, James B., and Norman Herr (1994), *Hands-On Physics Activities with Real-Life Applications: Easy-To-Use Labs and Demonstrations for Grades 8-12,* Center for Applied Research in Education, West Nyack, NY.

Laws, Priscilla (1997), *Workshop Physics Activity Guide*, John Wiley & Sons, New York.

Unified Technical Concepts (1990), Cord Communications, Waco, TX.

Equipment

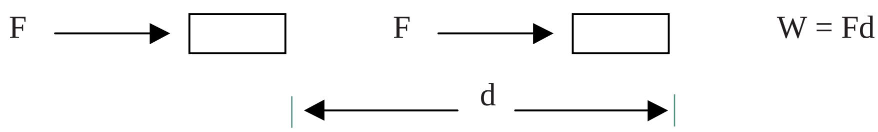
- Digital Multimeter
- CBL/MBL voltage and current probes
- Light bulbs (small 5 w and 7 w)
- Light sockets
- Wires
- Power supply DC/AC
- Protoboard
- Resistors

Web Site

American Association of Physics Teachers:
http://www.aapt.org

Background Information

In a mechanical system, you have seen that the work done is the product of the force (F) applied in the direction of the motion and the distance (d) moved. Therefore, work (W) can be thought of as the product of a quantity that causes motion and the measure of the resulting motion.



This concept can be applied in an electrical system as well. The quantity that causes motion is the voltage difference and the measure of the motion is the charge. Therefore, work in an electrical system can be calculated by:

Work = (voltage difference) x charge

W = Vq, where V = voltage difference and
q = charge

Electric motors transform electrical energy into mechanical energy to perform tasks. Motors may turn fans to move air, operate pumps to move fluids, and turn metalworking machines such as lathes, mills, and drills. Therefore, the purpose of most electrical devices is to convert electrical work into other forms of work or energy, such as energy of motion, heat, light, or sound.

The motion of charge through conductors will transform some of the electrical energy into heat. In devices such as toasters, ovens, and hair dryers, the heat is wanted and is useful. In other devices such as an incandescent light bulb, computers, and televisions, the heat is an unwanted byproduct caused by the operation of the device.

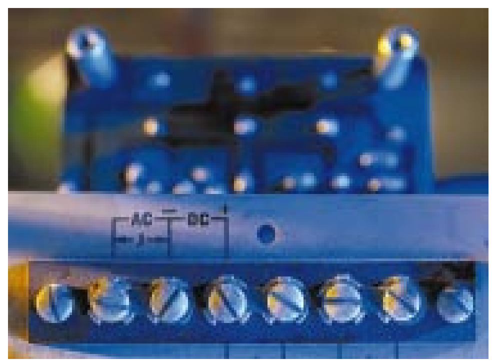
In electrical systems, the amount of electrical energy used is important. In fact, the bills that we receive from the electric company are based on the energy that we use. In many electrical systems, however, not only is the energy used important, but so is the rate at which the energy is delivered. All electrical devices are rated on the rate of use of electrical energy. This rate is called power (P) and is measured in watts.

Power = work/time

Power = (voltage x charge)/time

Power = voltage x charge/time

Power = voltage x current



Problem-Based Learning
Need-To-Know Chart

What do we know?	What do we need to know?	How do we find out?

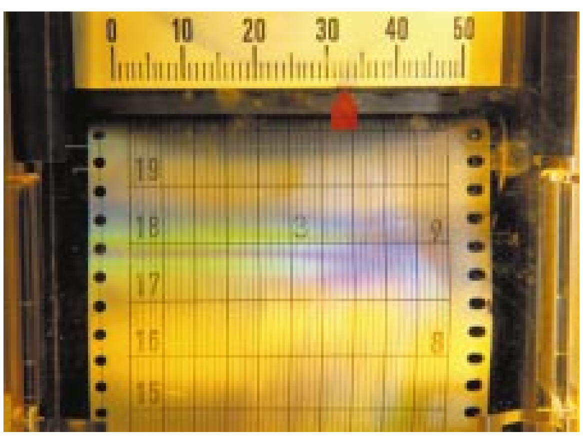
Physics/Technology Student Activities for Basic Electricity Project

1. Series and Parallel Circuits (Lights)

- Object: Determine characteristics of series and parallel circuits by investigating the brightness of small miniature lamps (6.3 V) connected with series and parallel circuits.
- Give a mini-lecture on how to wire lamps to a power supply in series and parallel circuits.
- Use guided discussion to help students determine several configurations of series and parallel connection. Have students observe the lamp's brightness to determine the characteristics of series and parallel circuits. Help students develop a table to record the results. Students need only to record brightness with a subjective value (very bright, bright, dim, very dim)
- Give the students miniature lamps and miniature screw sockets (at least three) to connect as determined above. Students should do all observations with the same voltage setting on the power supply.
- Use guided discussion to help students reach conclusions about series and parallel circuits.

2. Series and Parallel Circuits (Resistors)

- Give a mini-lecture on measurement of voltage and current with a multimeter.
- Using the same configurations as with the lights, have students connect series and parallel circuits with resistors (use same value) and measure the voltage across each resistor and current through each resistor. Help students develop a table to record the results.
- Use guided discussion to help students reach conclusions about series and parallel circuits. Compare the conclusions with those for the light experiment.



3. Ohm's Law

- Give the students resistors with at least two different values of resistance.
- Have the students connect power supply, meters, and resistors to be able to measure the voltage across the resistors and the current through the resistors.
- Begin with low voltages from the power supply, and record the voltage and current. Make measurements with at least five different voltage settings of the power supply, and record the voltage and current.
- Plot the measurements for each resistor.
- Use guided discussion to help students discover the linear relationship between voltage and current and, thus, observe Ohm's Law.

Student Competencies for Project #3

A.3.1.1	Evaluate and use rational expressions.
A.3.1.3	Evaluate algebraic expressions using order of operations.
A.3.2.1	Use linear equations to solve problems involving real world applications.
A.3.2.2	Simplify and solve linear equations.
A.3.2.3	Simplify and solve literal equations.
A.7.2.1	Determine the difference between alternating and direct current.
A.7.2.2	Determine the difference between series and parallel circuits.
A.7.2.3	Apply Ohm's Law.
A.7.2.4	Use simple meters to measure electrical properties.
A.8.1.1	Identify hazards of workplace equipment and tools.
A.8.1.2	Wear proper personal protective equipment and clothing.
A.8.1.4	Read and obey all safety instructions and emergency procedures.
A.8.2.2	Apply the scientific method to problem solving.
A.8.3.1	Use appropriate format in writing lab reports (title, introduction, procedure, data, graph, calculations, results, sources of error).
A.8.3.2	Write logical procedural steps for performing an experiment.
A.8.3.3	Identify relevant experimental errors.
A.8.3.4	Distinguish between random and systematic errors.
A.9.1.1	Use specialized general reference works including dictionaries, encyclopedias of applied science and technology, manuals, handbooks, government publications, and others.
A.9.1.2	Use technical journals and periodicals.
A.9.1.3	Use electronic sources/databases (NewsBank, ProQuest, WWW, Encarta, and others).
A.9.1.4	Take notes (summarize, paraphrase, record quoted material).
A.9.2.1	Perform fact-finding interviews with individuals knowledgeable in field.
A.9.2.2	Use pre-writing techniques (e.g., listing, clustering, journalistic questions, dramatization) to develop ideas.
A.9.2.3	Summarize information from lectures, seminars, workshops, training sessions and laboratory experiments.
A.10.1.1	Outline information (working and formal).
A.10.1.2	Develop central idea statement (thesis) with a plan of development (essay map).
A.10.1.3	Use appropriate organizational patterns (causal analysis, compare/contrast, instructional, description, narration, persuasion, etc.).
A.10.1.4	Develop appeals to the reader's logic, emotion, and ethics.
A.10.1.5	Demonstrate the five Cs of communication: clear, concise, correct, complete, coherent.
A.11.1.1	Identify reader(s)—demographics, number, etc.
A.11.1.2	Identify purpose—general and specific.
A.11.1.3	Format appropriate documents (letters, memoranda, instruction sheets, reports, manuals).
A.11.1.4	Adapt information to knowledge level of reader.
A.11.1.5	Apply revision techniques.
A.11.1.6	Employ standard English grammar and rules of mechanics, spelling, and punctuation.
A.11.1.7	Use computers to produce final draft.
A.12.1.1	Demonstrate the ability to work in teams.
A.12.1.2	Employ problem-solving skills to address a team task.
A.12.1.3	Employ workplace interpersonal skills, including conflict resolution techniques.
A.12.1.4	Demonstrate listening skills.
A.12.1.5	Collaborate with others to obtain information.
A.12.1.6	Collaborate with others to develop and present written projects.

Rubric for Evaluating Project #3

Technology Gateway Project #3—Basic Electricity

STUDENT____ **Date**____

Point Value	Points Earned		Needs Improvement	Proficient	Exceeds Requirements
20	_____	**I. PROBLEM-SOLVING PROCESS**			
		• need-to know chart	_______	_______	_______
		• gathering information	_______	_______	_______
		• analyzing data	_______	_______	_______
		• stating assumptions	_______	_______	_______
		• drawing conclusions	_______	_______	_______
60	_____	**II. CONTENT**			
(20)	_____	**A. Science/Technology**			
		• electrical quantities/units	_______	_______	_______
		• voltage, current, power	_______	_______	_______
		• measure electrical quantities	_______	_______	_______
		• Ohm’s Law	_______	_______	_______
		• power	_______	_______	_______
		• series & parallel circuits	_______	_______	_______
		• computer-based labs	_______	_______	_______
(20)	_____	**B. Mathematics**			
		• scientific & engineering notation	_______	_______	_______
		• algebraic expressions	_______	_______	_______
		• linear equations	_______	_______	_______
		• literal equations	_______	_______	_______
(20)	_____	**C. Communication**			
		• process analysis writing	_______	_______	_______
		• memo format	_______	_______	_______
		• electrical safety	_______	_______	_______
		• inquiry skills	_______	_______	_______
		• causal analysis	_______	_______	_______
20	_____	**III. TEAMING SKILLS**			
		• conflict resolution	_______	_______	_______
		• shared responsibilities	_______	_______	_______
		• self-evaluation	_______	_______	_______
		• peer/team evaluation	_______	_______	_______
100	_____	**TOTAL POINTS EARNED**			

Technology Gateway Project #4A

Optics

Problem Scenario for the Student

You work in the quality control section of a plant that produces tungsten filament light bulbs. Your team has been given the job of visually inspecting the filaments while the bulbs are lit. The quality control section has a machine that lights the bulb and tests the filament's life expectancy.

The team has decided the filaments are too bright and too small to observe directly. Therefore, some form of optical projection is needed to produce an enlarged image and to reduce the brightness of the filament. Your team has decided to add appropriate optics to the existing test machine to produce this image.

Your team is to decide how you want to view the filament and what magnification you will need. You must select appropriate optics to provide the needed magnification and still remain within a reasonable size for a table-top-sized test apparatus. You then must convince your supervisor that the device will work. Write a proposal that includes visuals to persuade the quality control (QC) supervisor to incorporate optics in the inspection process.

Objectives

- Design an optical system to magnify light bulb filaments for visual inspection.
- Investigate the reflection from mirrors and refraction of light through lenses to determine how images are formed.
- Use ratio and proportion to solve for object/image distance and size.
- Write a persuasive proposal.

Integrated Skills

Teaming Skills
Computer Technology
Problem-Solving Skills

Instructor Notes

1) Faculty should assist student teams with the problem-based process using the Need-to-Know chart, which should be revisited throughout the project.
2) Students should investigate the types of images formed by lenses and mirrors.
3) Similar triangles may be investigated in a lab setting.
4) If time is limited, ratio and proportion can be used for the solution of object/image distance and object/image size; however, if time permits, the lens equation can be used for the solution.
5) The solution to the problem may involve using two equations from optics.

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \quad \text{and} \quad m = \frac{d_i}{d_o}$$

Key: f = focal length of lens
d_o = distance of object to lens
d_i = distance of image to lens
m = magnification

Producing real or virtual images of items that cannot otherwise be observed is a major application of optics. Although producing real or virtual images can be quite complex, some simple designs will often be usable. An example of a simple design is a magnifying glass that produces an enlarged virtual image of the object being examined. The optical arrangement is simple and the required mathematics is not complex.

Content Strands

Mathematics	Science / Technology	Communications
Angles, measures, and drawings	Reflection	Compare and contrast
Ratio and proportion	Refraction	Persuasion
Literal equations	Lenses/mirrors	Proposal format
Rational equations	Magnification	

Student Workshop Activities

- Concepts of lenses and mirrors
- Organization of data using comparison and contrast
- Writing a simple persuasive proposal
- Literal equations
- Geometry:
  - Angles
  - Congruence
  - Vertical angles
  - Angle measures
  - Drawings
- Reflection/refraction
- Ratio and proportion

Classroom Resources

- Low wattage tungsten bulb with visible filament
- Scientific supply catalogs
- Internet access
- Transparent prism
- Plane and curved mirrors
- Plane glass plate
- Convex lenses
- Lens holders
- Meter stick optical bench set
- Chalk optics set
- Laser pointer
- Clear light bulb
- Small ground glass screen
- Straight pins
- Paper
- Protractor

Problem-Based Learning
Need-To-Know Chart

What do we know?	What do we need to know?	How do we find out?

Physics/Technology
Student Activities for Optics

1. Reflection

- Have students draw three lines on a sheet of paper and place a front surface plane mirror on the third line, with the surface facing the other two lines.
- Shine a laser pointer toward the mirror so that it reflects off at an angle.
- Place a ground glass screen on the first line so that it intercepts the laser beam as it goes toward the mirror. Mark the position of the beam on the line. Repeat for the second line.
- Place the ground glass screen on the first line so that it intercepts the laser beam as it bounces off the mirror. Mark the position of the beam on the line. Repeat for the second line.
- Draw a line through the first two points to indicate the incident laser beam. Repeat for the reflected laser beam.
- Measure the angle of incidence and reflection.
- Repeat for several angles.
- Use guided discussion to help students relate the law of reflection.

2. Refraction

- Outline a refractive block on a sheet of paper.
- Shine a laser pointer through the block.
- Observe the path of the laser beam through the block. Note the angle of the beam in the block compared to the angle of the incident beam.
- Mark the position the beam leaves the laser pointer, the position the beam enters the block, and the position the beam leaves the block.
- Draw the incident ray and the refracted ray. Measure the angle of incidence and the angle of refraction and record the values.
- Repeat for several angles of incidence.
- Use guided discussion to help students understand refraction. At this time, it is not necessary for the students to develop or use Snell's Law.

3. Converging lenses

- Draw a line across a sheet of paper. Place a converging lens perpendicular to the line in the center of the paper and mark the position of the lens.
- Draw two lines perpendicular to the central line on either side of the lens.

- Position a laser so that the beam travels parallel to the central line toward the lens.
- With a ground glass screen, mark the position of the parallel beam on the two lines on the side of the lens with the laser. With the ground glass screen, mark the position of the beam exiting the lens on the two lines. Draw a line that shows the path of the laser beam before and after the lens.
- Repeat for several positions of the laser.
- For a position off the central line, point the laser toward the center of the lens. As before, mark the path of the beam.
- Use guided discussion to arrive at ray tracing rules for a lens.

4. Image size

- Place a converging lens near the center of an optical bench.
- Place a clear tungsten lamp bulb on one side of the lens and a ground glass screen on the other.
- Position the tungsten bulb and screen until there is an image of the light filament on the screen.
- Measure the height of the filament and the image and the distance of each from the screen.
- Repeat for several positions.
- Use guided discussion to develop a rule for image size and position.

Student Competencies for Project #4A

A.3.1.1	Evaluate and use rational expressions.
A.3.1.6	Use ratio and proportion to solve problems.
A.4.1.1	Use a protractor to measure angles.
A.4.1.2	Identify acute, obtuse, and right angles.
A.4.1.3	Determine when angles are congruent.
A.5.1.1	Collect data in a problem-solving setting using investigation, interviews, and/or experiments.
A.5.1.2	Organize data in a logical manner.
A.5.1.3	Present data using oral, written, and visual methods.
A.7.3.1	Measure or describe length in different systems of units.
A.7.4.1	Describe the effect of reflection or refraction on the path of a light beam.
A.7.4.2	Determine if an image is virtual or real.
A.7.4.3	Apply ray tracing to mirrors and lenses.
A.8.1.1	Identify hazards of workplace equipment and tools.
A.8.1.2	Wear proper personal protective equipment and clothing.
A.8.2.2	Apply the scientific method to problem solving.
A.8.3.1	Use appropriate format in writing lab reports (title, introduction, procedure, data, graph, calculations, results, sources of error).
A.8.3.2	Write logical procedural steps for performing an experiment.
A.10.1.3	Use appropriate organizational patterns (causal analysis, compare/contrast, instructional, description, narration, persuasion, et. al.).
A.10.1.4	Develop appeals to the reader's logic, emotion, and ethics.
A.10.1.5	Demonstrate the five Cs of communication: clear, concise, correct, complete, coherent.
A.11.1.3	Format appropriate documents (letters, memoranda, instruction sheets, reports, manuals).
A.11.1.4	Adapt information to knowledge level of reader.
A.11.1.5	Apply revision techniques.
A.11.1.6	Employ standard English grammar and rules of mechanics, spelling, and punctuation.
A.11.1.7	Use computers to produce final draft.
A.11.3.1	Incorporate visuals effectively.
A.12.1.1	Demonstrate the ability to work in teams.
A.12.1.2	Employ problem-solving skills to address a team task.
A.12.1.3	Employ workplace interpersonal skills, including conflict resolution techniques.
A.12.1.4	Demonstrate listening skills.
A.12.1.5	Collaborate with others to obtain information.
A.12.1.6	Collaborate with others to develop and present written projects.

Rubric for Evaluating Project #4A

Technology Gateway Project #4A—Optics

STUDENT____ **Date**____

Point Value	Points Earned		Needs Improvement	Proficient	Exceeds Requirements
20	_____	**I. PROBLEM-SOLVING PROCESS**			
		• need-to know chart	_______	_______	_______
		• gathering information	_______	_______	_______
		• analyzing data	_______	_______	_______
		• stating assumptions	_______	_______	_______
		• drawing conclusions	_______	_______	_______
60	_____	**II. CONTENT**			
(20)	_____	**A. Science/Technology**			
		• reflection	_______	_______	_______
		• refraction	_______	_______	_______
		• lenses	_______	_______	_______
		• mirrors	_______	_______	_______
(20)	_____	**B. Mathematics**			
		• angles, measures & drawings	_______	_______	_______
		• ratio & proportion	_______	_______	_______
		• literal equations	_______	_______	_______
		• rational equations	_______	_______	_______
(20)	_____	**C. Communication**			
		• compare & contrast	_______	_______	_______
		• persuasion	_______	_______	_______
		• proposal format	_______	_______	_______
20	_____	**III. TEAMING SKILLS**			
		• conflict resolution	_______	_______	_______
		• shared responsibilities	_______	_______	_______
		• self-evaluation	_______	_______	_______
		• peer/team evaluation	_______	_______	_______
100	_____	**TOTAL POINTS EARNED**			

Technology Gateway Project #4B

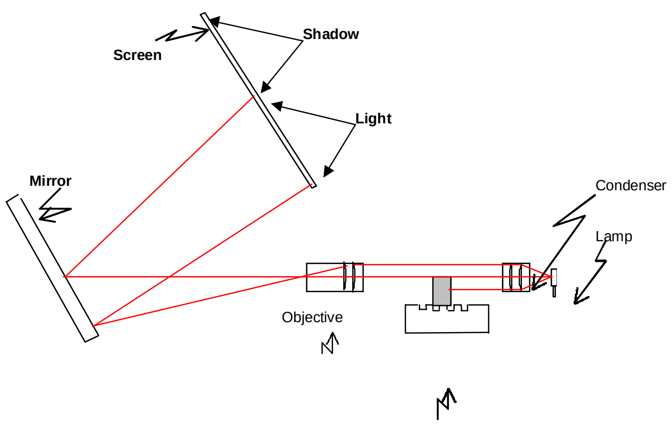
Optics

Instructor Notes

Please refer to *Instructor Notes* in Project #4A.

Optics is a major factor in our lives, from the simple application of a reflecting surface (mirror) that we use every day to the very complex use of fiber optics to transmit information for telecommunication used for telephones, computers, and television. The World Wide Web owes much of its abilities to fiber optics.

Many devices used in industry are based on fundamental concepts of reflection and refraction. In many inspection stations, a simple magnifying glass produces an enlarged virtual image to detect flaws in a product. Magnifying glasses have practical limits on how much they can magnify an object. When larger magnifications are needed, a device such as an optical comparator is used. This device is capable of giving magnifications of 10x, 20x, 50x, and 100x, depending on the optics used. The diagram below shows the basic arrangement for the optical system in an optical comparator.



Students should view the operation of an optical comparator to observe how it is used as a quality tool.

The part to be inspected is placed on the working table, and a concentrated, parallel beam of light intercepts it. The light beam then passes through the objective lens and is refracted so that it will focus on the screen. The front surface mirror serves only to reflect the beam so that the screen can be placed in a convenient location for viewing.

The solution to the problem may involve using two equations from optics.

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \quad \text{and} \quad m = \frac{d_i}{d_o}$$

Key:
- f = focal length of lens
- d_o = distance of object to lens
- d_i = distance of image to lens
- m = magnification

Problem Scenario for the Student

You work in the quality control section of your company, which does custom order machining. One of the instruments in your section is an optical comparator. This instrument is used not only to check parts but also for reverse engineering.

The comparator that you have is 20x, and the distance from the worktable to the objective lens is 135 mm. However, the objective lens in the comparator is broken. In a catalog, you have found several lenses that you could order to replace the broken lens, but you must determine which size you should order. Write a justification for the order to your supervisor, and attach a completed order form.

The picture below shows an optical comparator with a screw placed on the worktable.

Content Strands

Mathematics

Angles, measures, and drawings
Ratio and proportion
Literal equations
Rational equations

Science / Technology

Reflection
Refraction
Lenses/mirrors
Magnification

Communications

Compare and contrast
Persuasion
Justification format
Order forms

Student Workshop Activities

- Concepts of lenses and mirrors
- Organization of data using compare and contrast
- Writing a justification
- Literal equations
- Geometry:
  - Angles
  - Congruence
  - Vertical angles
  - Angle measures
  - Drawings
- Reflection/refraction
- Ratio and proportion

Objectives

- Determine the appropriate optical system replacement parts to magnify an image for visual inspection.
- Investigate the reflection from mirrors and refraction of light through lenses to determine how images are formed.
- Use ratio and proportion to solve for object/image distance and size.
- Write a justification.

Classroom Resources

- Observe an optical comparator
- Scientific supply catalogs
- Internet access
- Transparent prism
- Plane and curved mirrors
- Plane glass plate
- Convex lenses
- Lens holders
- Meter stick optical bench set
- Chalk optics set
- Laser pointer
- Clear light bulb
- Small ground glass screen
- Straight pins
- Paper
- Protractor

Integrated Skills

Teaming Skills
Computer Technology
Problem-Solving Skills

Problem-Based Learning Need-To-Know Chart

What do we know?	What do we need to know?	How do we find out?

Physics/Technology
Student Activities for Optics

1. Reflection

- Have students draw three lines on a sheet of paper and place a front surface plane mirror on the third line, with the surface facing the other two lines.
- Shine a laser pointer toward the mirror so that it reflects off at an angle.
- Place a ground glass screen on the first line so that it intercepts the laser beam as it goes toward the mirror. Mark the position of the beam on the line. Repeat for the second line.
- Place the ground glass screen on the first line so that it intercepts the laser beam as it bounces off the mirror. Mark the position of the beam on the line. Repeat for the second line.
- Draw a line through the first two points to indicate the incident laser beam. Repeat for the reflected laser beam.
- Measure the angle of incidence and reflection.
- Repeat for several angles.
- Use guided discussion to help students relate the law of reflection.

2. Refraction

- Outline a refractive block on a sheet of paper.
- Shine a laser pointer through the block.
- Observe the path of the laser beam through the block. Note the angle of the beam in the block compared to the angle of the incident beam.
- Mark the position the beam leaves the laser pointer, the position the beam enters the block, and the position the beam leaves the block.
- Draw the incident ray and the refracted ray. Measure the angle of incidence and the angle of refraction and record the values.
- Repeat for several angles of incidence.
- Use guided discussion to help students understand refraction. At this time, it is not necessary for the students to develop or use Snell's Law.

3. Converging lenses

- Draw a line across a sheet of paper. Place a converging lens perpendicular to the line in the center of the paper and mark the position of the lens.
- Draw two lines perpendicular to the central line on either side of the lens.
- Position a laser so that the beam travels parallel to the central line toward the lens.
- With a ground glass screen, mark the position of the parallel beam on the two lines on the side of the lens with the laser. With the ground glass screen, mark the position of the beam exiting the lens on the two lines. Draw a line that shows the path of the laser beam before and after the lens.
- Repeat for several positions of the laser.
- For a position off the central line, point the laser toward the center of the lens. As before, mark the path of the beam.
- Use guided discussion to arrive at ray tracing rules for a lens.

4. Image size

- Place a converging lens near the center of an optical bench.
- Place a clear tungsten lamp bulb on one side of the lens and a ground glass screen on the other.
- Position the tungsten bulb and screen until there is an image of the light filament on the screen.
- Measure the height of the filament and the image and the distance of each from the screen.
- Repeat for several positions.
- Use guided discussion to develop a rule for image size and position.

Student Competencies for Project #4B

A.3.1.6	Use ratio and proportion to solve problems.
A.4.1.1	Use a protractor to measure angles.
A.4.1.2	Identify acute, obtuse, and right angles.
A.4.1.3	Determine when angles are congruent.
A.5.1.1	Collect data in a problem-solving setting using investigation, interviews, and/or experiments.
A.5.1.2	Organize data in a logical manner.
A.5.1.3	Present data using oral, written, and visual methods.
A.7.3.1	Measure or describe length in different systems of units.
A.7.4.1	Describe the effect of reflection or refraction on the path of a light beam.
A.7.4.2	Determine if an image is virtual or real.
A.7.4.3	Apply ray tracing to mirrors and lenses.
A.7.5.1	Describe the effect of refraction on the path of a light beam.
A.7.5.2	Determine if images are virtual or real.
A.7.5.3	Apply ray tracing to mirrors and lenses.
A.8.1.1	Identify hazards of workplace equipment and tools.
A.8.1.2	Wear proper personal protective equipment and clothing.
A.8.2.2	Apply the scientific method to problem solving.
A.8.3.1	Use appropriate format in writing lab reports (title, introduction, procedure, data, graph, calculations, results, and sources of error).
A.8.3.2	Write logical procedural steps for performing an experiment.
A.10.1.3	Use appropriate organizational patterns (causal analysis, compare/contrast, instructional, description, narration, persuasion, et. al.).
A.10.1.4	Develop appeals to the reader's logic, emotion, and ethics.
A.10.1.5	Demonstrate the five Cs of communication: clear, concise, correct, complete, coherent.
A.11.1.1	Identify reader(s)—demographics, number, etc.
A.11.1.2	Identify purpose—general and specific.
A.11.1.3	Format appropriate documents (letter, memoranda, instruction sheets, reports, manuals).
A.11.1.4	Adapt information to knowledge level of reader.
A.11.1.5	Apply revision techniques.
A.11.1.6	Employ standard English grammar and rules of mechanics, spelling, and punctuation.
A.11.1.7	Use computers to produce final draft.
A.11.3.1	Incorporate visuals effectively.
A.12.1.1	Demonstrate the ability to work in teams.
A.12.1.2	Employ problem-solving skills to address a team task.
A.12.1.3	Employ workplace interpersonal skills, including conflict resolution techniques.
A.12.1.4	Demonstrate listening skills.
A.12.1.5	Collaborate with others to obtain information.
A.12.1.6	Collaborate with others to develop and present written projects.

Rubric for Evaluating Project #4B

Technology Gateway Project #4B—Optics

STUDENT____ **Date**____

Point Value	Points Earned		Needs Improvement	Proficient	Exceeds Requirements
20	_____	**I. PROBLEM-SOLVING PROCESS**			
		• need-to know chart	______	______	______
		• gathering information	______	______	______
		• analyzing data	______	______	______
		• stating assumptions	______	______	______
		• drawing conclusions	______	______	______
60	_____	**II. CONTENT**			
(20)	_____	**A. Science/Technology**			
		• reflection	______	______	______
		• refraction	______	______	______
		• lenses	______	______	______
		• mirrors	______	______	______
(20)	_____	**B. Mathematics**			
		• angles, measures & drawings	______	______	______
		• ratio & proportion	______	______	______
		• literal equations	______	______	______
		• rational equations	______	______	______
(20)	_____	**C. Communication**			
		• compare & contrast	______	______	______
		• persuasion	______	______	______
		• justification format	______	______	______
20	_____	**III. TEAMING SKILLS**			
		• conflict resolution	______	______	______
		• shared responsibilities	______	______	______
		• self-evaluation	______	______	______
		• peer/team evaluation	______	______	______
100	_____	**TOTAL POINTS EARNED**			

Technology Gateway Project #5

Temperature Measuring Devices

Instructor Notes

1) Prepare the students to work on temperature measuring devices by having the students use an unmarked liquid-in-glass thermometer and set up their own scale. They should discuss how to establish a scale, what the characteristics of the device are that make it a good thermometer, and how to calibrate.
2) Introduce the problem by having an industrial representative or faculty member describe heat treatment in industry and demonstrate the use of a furnace in heat treating metals.
3) Ask students to study the operational characteristics of several types of temperature measuring devices in a jig-saw exercise. They should investigate at least three types of temperature measuring devices and calibrate each. Calibrations can be done using CBL/MBL equipment.
4) Help students gain an understanding of temperature and heat by having them compare the temperature changes caused by mixing of same mass of water at different temperatures and different masses of water at different temperatures.
5) Set up both Fahrenheit and Celsius scales and convert temperatures from one to the other. Use the study of linear equations to develop an equation for temperature conversion. Use graphics methods to predict temperature devices that have been calibrated.
6) Pose questions for study. In working the problem, students may consider the answer to such questions as:
   - Will the device read the temperature via an infrared beam or other optical means?
   - Will you have to create a viewable port in the machine for this device?
   - Will it require physical contact with the product as through a thermocouple?
   - What is the range of temperatures to be measured, and will the device handle that range?
   - Will the device be required to automatically control the temperature or only to indicate it?
7) Provide practice in calibrating temperature scales by having students calibrate scales in their own units.

Problem Scenario for the Student

You are employed in a local industry that is upgrading its heat treatment lab. Because the temperature indicators are continually breaking down, the company wishes to replace them.

Your team is charged with the responsibility of investigating the characteristics of at least three temperature measuring devices and recommending the temperature devices and scales to be used in the heat treatment lab. Your team will write a short report in memo format to the supervisor summarizing the results of investigations and the recommendations. Include all pertinent facts, such as comparisons between indicating devices, accuracy, and dependability.

Integrated Skills

Problem-Based Learning
Teaming Skills
Computer Applications

Objectives

- Investigate the characteristics of temperature measuring devices and scales, and make recommendations based on comparisons, accuracy, and dependability.
- Develop temperature scales.
- Calibrate temperature scales.
- Measure temperature with different types of thermometers to determine the physical property changes.
- Convert temperatures from one scale to another (Fahrenheit vs. Celsius).
- Write short reports and memos.

Content Strands

Mathematics

Formula operations
Linear equations
Temperature conversion

Science / Technology

Temperature scales
Characteristics of temperature devices
Calibration of temperature devices
Lab safety

Communications

Compare and contrast
Causal analysis
Short reports

Student Workshop Activities

- Autoclave uses in industry
- Precision/accuracy
- Linear equations
- Graphs
- Heat versus temperature
- Thermal energy
- Temperature scales
- Causal analysis
- Writing short reports

Classroom Equipment and Resources

- Heat source
- Liquid-in-glass thermometers (Fahrenheit & Celsius)
- Liquid-in-glass thermometer without a scale
- Thermocouple
- Digital multimeter
- Bimetallic thermometer
- Resistance thermometer
- Thermistor
- Computers/calculators and CBL/MBL temperature probe
- Beakers
- Water and ice

Problem-Based Learning
Need-To-Know Chart

What do we know?	What do we need to know?	How do we find out?

Physics/Technology Student Activities for Thermal

1. Temperature Scales
- Introduce students to temperature scales by having them set a scale on an unmarked thermometer.
- Use guided discussion to help the students establish criteria for setting their scale. Some of the criteria should be that results are reproducible, the scale uses a common end point, students can explain to others how to set their scale, the device must have a linear change, etc.
- Students should understand that any temperature scale is a defined scale.

2. Temperature Conversion
- Give the students Celsius and Fahrenheit thermometers.
- Heat water, and record the reading with both thermometers.
- Construct a graph of the relationship between Celsius and Fahrenheit readings, and develop a conversion formula.

3. Temperature versus Heat
- Give the students a mini-lecture on kinetic energy and relation to heat energy.
- Have students mix two quantities of water and measure the final temperature. Use the same quantity at the same temperature and at different temperatures. Use different quantities at the same temperature and at different temperatures. Record the results.

- Use guided discussion to develop a relationship that explains the results.
- Repeat using a specific heat sample and water.
- Give a mini-lecture on heat units and specific heat.

Student Competencies for Project #5

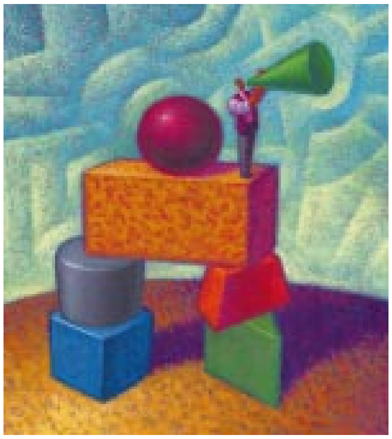
A.2.1.1	Define and use SI prefixes.
A.3.2.1	Use linear equations to solve problems involving real world applications.
A.3.2.3	Simplify and solve literal equations.
A.3.5.2	Use spreadsheets to evaluate data and perform basic calculations.
A.7.3.4	Measure temperature in different systems of units.
A.7.3.5	Use basic analog measuring scales.
A.8.1.1	Identify hazards of workplace equipment and tools.
A.8.1.4	Read and obey all safety instructions and emergency procedures.
A.10.1.1	Outline information (working and formal).
A.10.1.2	Develop central idea statement (thesis) with a plan of development (essay map).
A.10.1.3	Use appropriate organizational patterns (causal analysis, compare/contrast, instructional, description, narration, persuasion, etc.).
A.10.1.4	Develop appeals to the reader's logic, emotion, and ethics.
A.10.1.5	Demonstrate the five Cs of communication: clear, concise, correct, complete, and coherent.
A.11.1.1	Identify reader(s)—demographics, number, etc.
A.11.1.2	Identify purpose—general and specific.
A.11.1.3	Format appropriate documents (letters, memoranda, instruction sheets, reports, manuals).
A.11.1.4	Adapt information to knowledge level of reader.
A.11.1.5	Apply revision techniques.
A.11.1.6	Employ standard English grammar and rules of mechanics, spelling, and punctuation.
A.11.1.7	Use computers to produce final drafts.
A.12.1.1	Demonstrate the ability to work in teams.
A.12.1.2	Employ problem-solving skills to address a team task.
A.12.1.3	Employ workplace interpersonal skills, including conflict resolution techniques.
A.12.1.4	Demonstrate listening skills.
A.12.1.5	Collaborate with others to obtain information.
A.12.1.6	Collaborate with others to develop and present written projects.
A.12.1.7	Collaborate with others to create and deliver oral presentations.

Rubric for Evaluating Project #5

Technology Gateway Project #5—Temperature Measuring Devices

STUDENT______________________________________ **Date**______________________________________

Point Value	Points Earned		Needs Improvement	Proficient	Exceeds Requirements
20	_____	**I. PROBLEM-SOLVING PROCESS**			
		• need-to know chart	_______	_______	_______
		• gathering information	_______	_______	_______
		• analyzing data	_______	_______	_______
		• stating assumptions	_______	_______	_______
		• drawing conclusions	_______	_______	_______
60	_____	**II. CONTENT**			
(20)	_____	**A. Science/Technology**			
		• temperature scales	_______	_______	_______
		• characteristics of temperature devices	_______	_______	_______
		• calibration of temperature devices	_______	_______	_______
		• lab safety	_______	_______	_______
(20)	_____	**B. Mathematics**			
		• formula operations	_______	_______	_______
		• linear equations	_______	_______	_______
		• temperature conversion	_______	_______	_______
(20)	_____	**C. Communication**			
		• compare & contrast	_______	_______	_______
		• causal analysis	_______	_______	_______
		• short reports	_______	_______	_______
		• standard grammar & mechanics use	_______	_______	_______
		• clear & concise information	_______	_______	_______
20	_____	**III. TEAMING SKILLS**			
		• conflict resolution	_______	_______	_______
		• shared responsibilities	_______	_______	_______
		• self-evaluation	_______	_______	_______
		• peer/team evaluation	_______	_______	_______
100	_____	**TOTAL POINTS EARNED**			



Technology Gateway Project #6

Hydraulic Jack

Problem Scenario for the Student

Our shift supervisor has just informed you that a new quick-change procedure will be put into operation to change the dies in the injection-molding machine used to form plastic seals.

The molds are to be removed from the storage rack, moved to the machine, and inserted into position. A pallet jack would be ideal to move the mold, but it is not able to make all the height adjustments necessary. Your supervisor has consulted with the machine shop, and the shop can machine a new master cylinder for the pallet jack. The machine shop will need to have information on the size of the new master cylinder.

Prepare an e-mail report memo to your supervisor providing information the machine shop needs to machine a new master cylinder for the pallet jack. Attach the methods you used to determine the size of the new master cylinder.

Integrated Skills

Problem-Based Learning
Teaming Skills

Objectives

- Determine the size of a master cylinder to be installed in a pallet jack, and report findings to a machine shop.
- Use pressure-measuring devices.
- Investigate the operation of a hydraulic jack, and relate the cylinder sizes to mechanical advantage.
- Write an e-mail report memo.
- Estimate quantities in industry.

Instructor Notes

1) Prepare the students for the problem by having them list the uses of fluid in an automobile. Once the list is created, have students identify the physical **quality, not quantity,** (pressure, temperature, volume, density, etc.) that is important in the operation of the fluid.

2) In the introduction of the problem, role-play the part of the shift supervisor and describe a process that requires the use of molding machines, molds, and the need for quick-change. In addition to the discussion, the students should be given:
   - Diagram of the storage rack for the molds.
   - Drawing of the molds, including the dimensions and material (dimensions should be such that they require an adjustment of 10-20 inches).
   - Target time for the change over (set information so that once the pallet jack is in place, it must be raised 10-20 inches in 10-15 seconds).
   - Information on pallet jacks, including the areas of the cylinders (typical jacks make an adjustment of up to six inches).

3) Introduce students to pressure measuring devices and their operational characteristics.

4) Through this project, review concepts and calculations involving mass, weight, density, volume, area and displacement.

5) Use this project to help students understand how estimating is used in industry. The weight of the mold can be estimated by using density and dimensions but ignoring or estimating the cavity volume. Also, students will have to estimate the time necessary to pump the jack handle and the height it can be raised in the given time frame.

Content Strands

Mathematics

Basic algebraic equation review
Estimating
Volume & area calculations

Science / Technology

Pressure & pressure measurements
Hydraulic jacks
Review mass, weight, & density

Communications

Teamwork
E-mail report memos
Oral & written communication

Student Workshop Activities

- Pressure and pressure measurements
- Pressure units and conversions
- Mass, weight, and density
- Volume and area calculations
- Manufacturing process—injection molding, mold set-up
- Teaming techniques
- E-mail reports
- Hydraulics systems, including "jacks"

Classroom Equipment and Resources

- Pressure gauge
- CBL/MBL pressure probe
- Calipers
- Hydraulic jack

Problem-Based Learning
Need-To-Know Chart

What do we know?	What do we need to know?	How do we find out?

Student Competencies for Project #6

A.3.4.1	Use a calculator to evaluate and perform operations with exponential expressions.
A.3.6.1	Use dimensional analysis in solving problems involving a changes of units such as SI to US Customary and US Customary to SI.
A.4.3.1	Identify sphere, prism, pyramid, cone, and cylinder.
A.4.4.2	Determine the area of a triangle, quadrilateral, and circle.
A.4.4.3	Determine the volume of a sphere, pyramid, cone, cylinder, and prism.
A.5.1.1	Collect data in a problem-solving setting using investigation, interviews, and/or experiments.
A.5.1.2	Organize data in a logical manner.
A.5.1.3	Present data using oral, written, and visual methods.
A.7.3.1	Measure or describe length in different systems of units.
A.7.3.2	Determine area in different systems of units.
A.8.1.1	Identify hazards of workplace equipment and tools.
A.8.1.2	Wear proper personal protective equipment and clothing.
A.8.1.3	Read all labels and Material Safety Data Sheets (MSDS) on chemicals.
A.8.1.4	Read and obey all safety instructions and emergency procedures.
A.8.2.1	Properly use and handle chemicals.
A.8.2.2	Apply the scientific method to problem solving.
A.8.3.1	Use appropriate format in writing lab reports (title, introduction, procedure, data, graph, calculations, results, sources of error).
A.10.1.2	Develop central idea statement (thesis) with a plan of development (essay map).
A.10.1.3	Use appropriate organizational patterns (causal analysis, compare/contrast, instructional, description, narration, persuasion, et. al).
A.10.1.5	Demonstrate the five Cs of communication: clear, concise, correct, complete, and coherent.
A.11.1.2	Identify purpose—general and specific.
A.11.1.3	Format appropriate documents (letters, memoranda, instruction sheets, reports, manuals).
A.11.1.4	Adapt information to knowledge level or reader.
A.11.1.5	Apply revision techniques.
A.11.1.6	Employ standard English grammar and rules of mechanics, spelling, and punctuation.
A.11.1.7	Use computers to produce final draft.
A.11.3.1	Incorporate visuals effectively.
A.12.1.1	Demonstrate the ability to work in teams.
A.12.1.2	Employ problem-solving skills to address a team task.
A.12.1.6	Collaborate with others to develop and present written projects.

Rubric for Evaluating Project #6

Technology Gateway Project #6—Hydraulic Jack

STUDENT____ **Date**____

Point Value	Points Earned		Needs Improvement	Proficient	Exceeds Requirements
20	_____	**I. PROBLEM-SOLVING PROCESS**			
		• need-to know chart	______	______	______
		• gathering information	______	______	______
		• analyzing data	______	______	______
		• stating assumptions	______	______	______
		• drawing conclusions	______	______	______
60	_____	**II. CONTENT**			
(20)	_____	**A. Science/Technology**			
		• pressure & pressure measures	______	______	______
		• hydraulic jacks	______	______	______
		• mass, weight & density	______	______	______
		• industry safety	______	______	______
(20)	_____	**B. Mathematics**			
		• algebraic equations	______	______	______
		• estimating	______	______	______
		• volume & area calculations	______	______	______
(20)	_____	**C. Communication**			
		• e-mail report	______	______	______
		• calculations, methods & procedures	______	______	______
		• standard grammar & mechanics use	______	______	______
		• clear & concise information	______	______	______
20	_____	**III. TEAMING SKILLS**			
		• conflict resolution	______	______	______
		• shared responsibilities	______	______	______
		• self-evaluation	______	______	______
		• peer/team evaluation	______	______	______
100	_____	**TOTAL POINTS EARNED**			

Student Handouts:

Problem Scenarios

Student Handout: Technology Gateway Project #1

Objectives

- ❑ Research information about career options for technicians and develop a multimedia report (i.e., brochure, videotape, research report) suitable for high school juniors and seniors.
- ❑ Use computer software for page layout and design.
- ❑ Investigate and report information about technical career paths.
- ❑ Summarize characteristics of electrical, mechanical, and other physical systems.

Performance Expectations

- ❑ Instructors will evaluate student teams and individual students on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- ❑ Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- ❑ Individual instructors will test and grade students individually on content workshops and activities.
- ❑ The team product (brochure, report, or other product) will be evaluated and graded by the faculty team.

Introduction to Technology Careers

Problem Scenario

Your team is in charge of communicating to high school juniors and seniors occupational differences of engineers, technologists, and technicians using a brochure, videotape, CD, web site, PowerPoint, or written report.

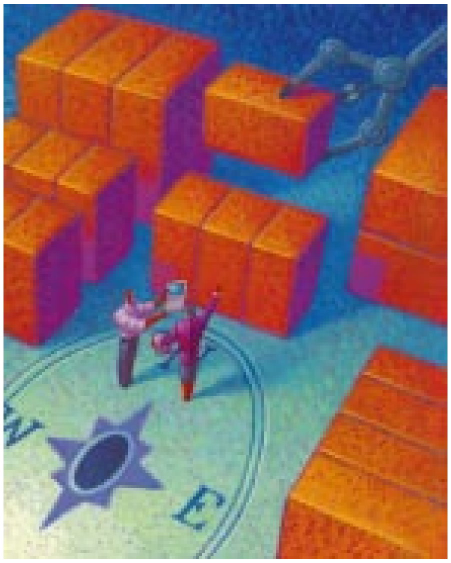
These high school students will need brief information in the electrical, mechanical, fluids, thermal, optics, and materials areas to help them make suitable career choices. Information about job opportunities and career paths, salaries, physical ability requirements, education requirements, work environment, and other relevant information about these careers should also be included.

Graphics or data charts should be used to compare the benefits for technicians with two-year degrees with other jobs requiring four-year degrees. To locate information about these occupations, your team should consult state and federal publications, on-line databases, professional journals, and other sources.

The terms *engineer*, *technologist*, and *technician* are frequently used interchangeably; however, in the industrial/engineering field, they do not have the same meaning. Education requirements, job duties, salaries, and many other characteristics of these occupations vary widely.

Student Handout: Technology Gateway Project #2

Simple Machines



Performance Expectations

- ❑ Instructors will evaluate student teams and individual students on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- ❑ Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- ❑ Individual instructors will test and grade students individually on content workshops and activities.
- ❑ The team presentation will be evaluated and graded by the faculty team.

A general misconception is that machines can decrease the amount of work required to complete a specific task. Work in science deals with force and distance.

Even though holding a five-gallon bucket full of water may be difficult, you are not doing work in science because no distance is involved. When you lift or move the bucket, however, you are doing work.

We find that machines can only make the work we do easier, but they can never decrease the work that we do. In industry, having an understanding of work and simple machines allows us to use these devices efficiently without wasting energy.

Problem Scenario

A local siding distributor has problems with storage in its present facility because of an increase in demand for its vinyl product. While waiting for the construction of its new and improved distribution center, the distributor must maximize space for storage. The basement of the old building is going to be used to store rolls of the vinyl siding. However, rolls of aluminum coil are currently stored in the basement and must be moved before the vinyl siding can be stored there. The aluminum coil comes packaged in boxes approximately 1.5 feet wide, 1.5 feet long and 3 feet high. These boxes can weigh from 20 to 30 pounds.

The siding distributor needs to find an efficient way to move the rolls of coil from the basement to the first floor loading dock. The owner of the distribution center does not want to invest in heavy motorized equipment but does want to make the movement of the coil manageable for her employees. In addition to the space occupied by the aluminum coil, the basement is also large enough to accommodate any human-powered machine.

Your team is in charge of determining the most efficient use of human mechanical energy (e.g., inclined plane, hand-operated conveyer belt, block and tackle elevator, wheel and axle) in order to lift the coil from the basement to the loading dock area. Your team also needs to determine how many coils can be safely moved at one time with the simple machine being used. The owner expects your engineering firm to present your recommendations and findings, as well as cost estimates of your team's solution, in an oral presentation supported by visuals.

Objectives

- ❑ Investigate the mechanical advantage of simple machines, and devise a plan for moving bulk materials from a storage basement to a loading dock.
- ❑ Measure/calculate length, area, volume, and force in SI and US Customary systems.
- ❑ Apply the conservation of energy to the operation of the simple machine.
- ❑ Determine the amount of work done by a simple machine.
- ❑ Make an oral presentation supported by visuals.

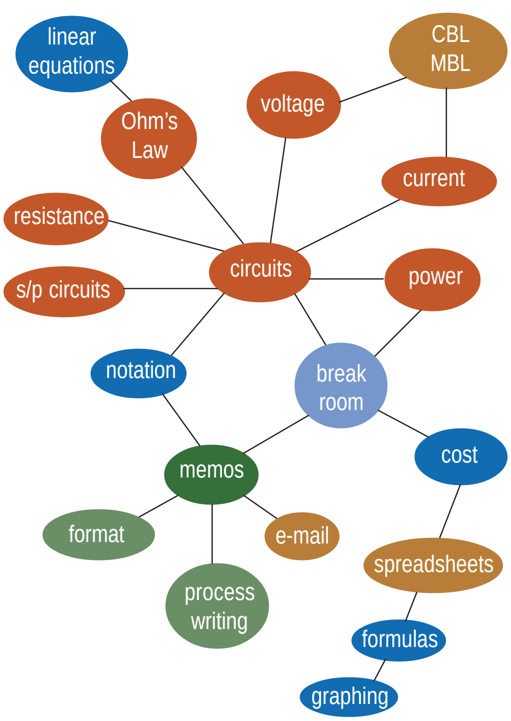
Student Handout: Technology Gateway Project #3

Basic Electricity

Objectives

- ❑ Investigate the power needed to support a number of electrical appliances, and determine a plan to equip an employee break room using available electrical power and budget.
- ❑ Measure voltage and current in an electrical circuit, and determine power in an electrical circuit.
- ❑ Investigate Ohm's Law series and parallel circuits.
- ❑ Write an interoffice memorandum.
- ❑ Write a process-based report.

Concept Map



Problem Scenario for the Student

You are a physical plant employee in a small manufacturing plant. A group of employees has requested a break room. In the plant is a storage room that can be converted to a break room. Your supervisor has asked your team to develop a plan for the room and has supplied a list of the appliances requested by the employees for the room.

The power for the storage room is a single 120-volt line from a 20-amp circuit breaker on the main plant floor. Eight fluorescent lights (60 watts each) are in the room. Employees requested the following appliances (in priority order):

- ◆ Coffee maker
- ◆ Microwave oven
- ◆ Toaster
- ◆ Television/VCR
- ◆ Refrigerator
- ◆ Stereo

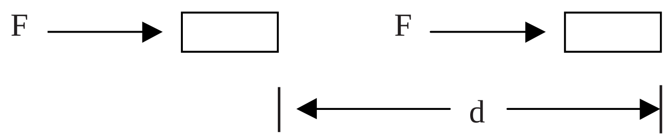
Your team will investigate the power requirements of these appliances and develop a plan that will make the most effective use of the room's electrical circuit yet still meet local electrical codes. The plan will indicate capital expenditures not to exceed $1,000 and will predict monthly operational costs. You will submit to your supervisor a comprehensive report describing the process necessary to complete the renovation, including time and cost projections as well as any foreseeable problems.

Performance Expectations

- ❑ Instructors will evaluate student teams and individual students on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- ❑ Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- ❑ Individual instructors will test and grade students individually on content workshops and activities.
- ❑ The team presentation will be evaluated and graded by the faculty team.

Background Information

In a mechanical system, you have seen that the work done is the product of the force (F) applied in the direction of the motion and the distance (d) moved. Therefore, work (W) can be thought of as the product of a quantity that causes motion and the measure of the resulting motion.



$W = Fd$

This concept can be applied in an electrical system as well. The quantity that causes motion is the voltage difference and the measure of the motion is the charge. Therefore, work in an electrical system can be calculated by:

Work = (voltage difference) x charge

$W = Vq$, where V = voltage difference and
q = charge

Electric motors transform electrical energy into mechanical energy to perform tasks. Motors may turn fans to move air, operate pumps to move fluids, and turn metalworking machines such as lathes, mills, and drills. Therefore, the purpose of most electrical devices is to convert electrical work into other forms of work or energy, such as energy of motion, heat, light, or sound.

The motion of charge through conductors will transform some of the electrical energy into heat. In devices such as toasters, ovens, and hair dryers, the heat is wanted and is useful. In other devices such as an incandescent light bulb, computers, and televisions, the heat is an unwanted byproduct caused by the operation of the device.

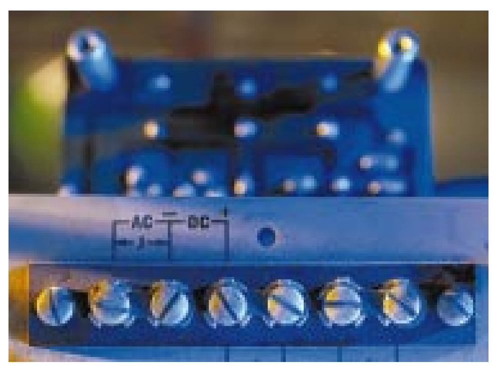
In electrical systems, the amount of electrical energy used is important. In fact, the bills that we receive from the electric company are based on the energy that we use. In many electrical systems, however, not only is the energy used important, but so is the rate at which the energy is delivered. All electrical devices are rated on the rate of use of electrical energy. This rate is called power (P) and is measured in watts.

Power = work/time

Power = (voltage x charge)/time

Power = voltage x charge/time

Power = voltage x current



Student Handout: Technology Gateway Project #4A

Optics

Problem Scenario

You work in the quality control section of a plant that produces tungsten filament light bulbs. Your team has been given the job of visually inspecting the filaments while the bulbs are lit. The quality control section has a machine that lights the bulb and tests the filament's life expectancy.

The team has decided the filaments are too bright and too small to observe directly. Therefore, some form of optical projection is needed to produce an enlarged image and to reduce the brightness of the filament. Your team has decided to add appropriate optics to the existing test machine to produce this image.

Your team is to decide how you want to view the filament and what magnification you will need. You must select appropriate optics to provide the needed magnification and still remain within a reasonable size for a table-top-sized test apparatus. You then must convince your supervisor that the device will work. Write a proposal that includes visuals to persuade the quality control (QC) supervisor to incorporate optics in the inspection process.

Objectives

- ❑ Design an optical system to magnify light bulb filaments for visual inspection.
- ❑ Investigate the reflection from mirrors and refraction of light through lenses to determine how images are formed.
- ❑ Use ratio and proportion to solve for object/ image distance and size.
- ❑ Write a persuasive proposal.

Producing real or virtual images of items that cannot otherwise be observed is a major application of optics. Although producing real or virtual images can be quite complex, some simple designs often will be usable. An example of a simple design is a magnifying glass that produces an enlarged virtual image of the object being examined. The optical arrangement is simple, and the required mathematics is not complex.

Performance Expectations

- ❑ Instructors will evaluate student teams and individual students on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- ❑ Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- ❑ Individual instructors will test and grade students individually on content workshops and activities.
- ❑ The team-generated proposal will be evaluated and graded by the faculty team.

Student Handout: Technology Gateway Project #4B

Optics

Problem Scenario

You work in the quality control section of your company, which does custom order machining. One of the instruments in your section is an optical comparator. This instrument is used not only to check parts but also for reverse engineering.

The comparator that you have is 20x, and the distance from the worktable to the objective lens is 135 mm. However, the objective lens in the comparator is broken. In a catalog, you have found several lenses that you could order to replace the broken lens, but you must determine which size you should order. Write a justification for the order to your supervisor, and attach a completed order form.

The picture below shows an optical comparator with a screw placed on the worktable.

Objectives

- ❑ Determine the appropriate optical system replacement parts to magnify an image for visual inspection.
- ❑ Investigate the reflection from mirrors and refraction of light through lenses to determine how images are formed.
- ❑ Use ratio and proportion to solve for object/image distance.
- ❑ Write a justification.

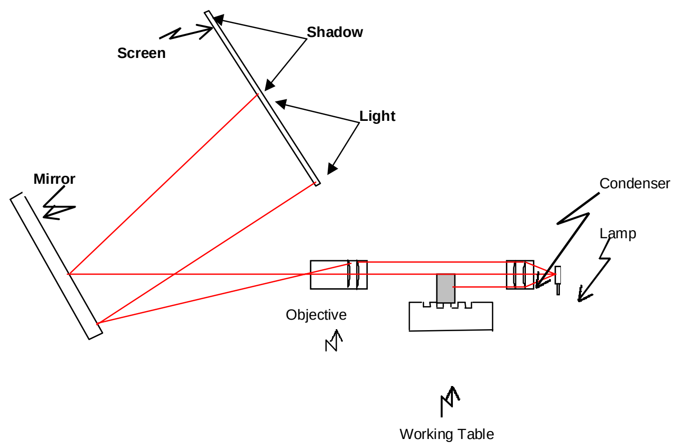
Performance Expectations

- ❑ Instructors will evaluate student teams and individual students on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- ❑ Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- ❑ Individual instructors will test and grade students individually on content workshops and activities.
- ❑ The team-generated lens order form and justification will be evaluated and graded by the faculty team.

Background Information

Optics is a major factor in our lives, from the simple application of a reflecting surface (mirror) that we use every day to the very complex use of fiber optics to transmit information for telecommunication used for telephones, computers, and television. The World Wide Web owes much of its abilities to fiber optics.

Many devices used in industry are based on fundamental concepts of reflection and refraction. In many inspection stations, a simple magnifying glass produces an enlarged virtual image to detect flaws in a product. Magnifying glasses have practical limits on how much they can magnify an object. When larger magnifications are needed, a device such as an optical comparator is used. This device is capable of giving magnifications of 10x, 20x, 50x, and 100x, depending on the optics used. The diagram below shows the basic arrangement for the optical system in an optical comparator.



The part to be inspected is placed on the working table, and a concentrated, parallel beam of light intercepts it. The light beam then passes through the objective lens and is refracted so that it will focus on the screen. The front surface mirror serves only to reflect the beam so that the screen can be placed in a convenient location for viewing.

The solution to the problem may involve using two equations from optics.

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \quad \text{and} \quad m = \frac{d_i}{d_o}$$

Key:

Key:	f	=	focal length of lens
	d_o	=	distance of object to lens
	d_i	=	distance of image to lens
	m	=	magnification

Student Handout: Technology Gateway Project #5

Objectives

- ❑ Investigate the characteristics of temperature measuring devices and scales, and make recommendations based on comparisons, accuracy, and dependability.
- ❑ Develop temperature scales.
- ❑ Calibrate temperature scales.
- ❑ Measure temperature with different types of thermometers to determine the physcial property changes.
- ❑ Convert temperatures from one scale to another (Fahrenheit vs. Celsius).
- ❑ Write short reports and memos.

Performance Expectations

- ❑ Instructors will evaluate student teams and individual students on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- ❑ Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- ❑ Individual instructors will test and grade students individually on content workshops and activities.
- ❑ The team report will be evaluated and graded by the faculty team.

Temperature Measuring Devices

Problem Scenario

You are employed in a local industry that is upgrading its heat treatment lab. Because the temperature indicators are continually breaking down, the company wishes to replace them.

Your team is charged with the responsibility of investigating the characteristics of at least three temperature measuring devices and recommending the temperature devices and scales to be used in the heat treatment lab. Your team will write a short report in memo format to the supervisor summarizing the results of investigations and the recommendations. Include all pertinent facts, such as comparisons between indicating devices, accuracy, and dependability.

Background Information

Most people find it hard to give a precise definition of heat or temperature. Even though heat and temperature are not the same, these terms are often used interchangeably. For example, to raise the temperature, someone might say he or she is going to turn up the heat.

Temperature, which can be determined by temperature sensors, is related to whether objects are hot or cold. One type of temperature sensor is the human body. For instance, if one bowl of water is filled with hot water and the another bowl is filled with cold water, a person can determine which is which by touching the water in each bowl.

However, if a person has three bowls, one filled with hot water, one filled with cool water, and one filled with cold water, it may be more difficult to determine which is which by touching the water in each bowl. If the person places one hand in the hot water and the other in the cold water and then places both hands in the cool water, the cool water will seem cold to one hand and hot to the other.

To avoid this dilemma, relative temperature scales and sensors are needed to give consistent results. All temperature devices use the change in some physical characteristic to determine the temperature. Since these devices all give relative measurements, the devices must be calibrated to a standard. Several temperature scales commonly used today are Celsius, Fahrenheit, and Kelvin.

Student Handout: Technology Gateway Project #6

Hydraulic Jack

Objectives

- Determine the size of a master cylinder to be installed in a pallet jack, and report findings to a machine shop.
- Use pressure-measuring devices.
- Investigate the operation of a hydraulic jack, and relate the cylinder sizes to mechanical advantage.
- Write an e-mail report memo.
- Estimate quantities in industry.

Performance Expectations

- Instructors will evaluate student teams and individual students on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- Individual instructors will test and grade students individually on content workshops and activities.
- The team report will be evaluated and graded by the faculty team.

Problem Scenario

Our shift supervisor has just informed you that a new quick-change procedure will be put into operation to change the dies in the injection-molding machine used to form plastic seals.

The molds are to be removed from the storage rack, moved to the machine and inserted into position. A pallet jack would be ideal to move the mold, but it is not able to make all the height adjustments necessary. Your supervisor has consulted with the machine shop, and the shop can machine a new master cylinder for the pallet jack. The machine shop will need to have information on the size of the new master cylinder.

Prepare an e-mail report memo to your supervisor providing information the machine shop needs to machine a new master cylinder for the pallet jack. Attach the methods you used to determine the size of the new master cylinder.

Background Information

A fluid is a liquid or gas that must be confined to a container. Liquids will conform to the shape of the container, but will have the same volume for all containers. Gases will conform to the shape of the container and will have the volume of the container. Therefore, gases must be in a closed system and liquids may or may not be in closed system. The term *hydraulic* is used to refer to a liquid and *pneumatic* is used to refer to a gas.

One of the important measurements for a fluid is pressure. Pressure is defined as the force per unit area and is exerted through out the fluid. When there is a pressure difference between two points in a fluid, the fluid will flow from high pressure to low pressure. If the fluid is static, the pressure will be the same throughout the fluid. This is known as Pascal's Law.

For fluids with a large depth, such as water in a lake or ocean or the air around us, the pressure is due to the weight of the fluid above the point at which the pressure is measured. For the air around us, the pressure is called atmospheric pressure. It is:

1 atmosphere	=	14.7 lb. per in^2 (psi)
	=	1.013×10^5 Newton/meters^2 (N/m^2)
	=	33.92 ft of H_2O
	=	760 mm of Mercury (Hg)
	=	29.92 in of Hg

Many times pressure is measured as the pressure above atmospheric. This is called *gage pressure*. The total pressure or *absolute pressure* is:

Total pressure = gage pressure + atmospheric pressure

In many devices and systems, a hydraulic fluid is used to transmit pressure or force. Depending on the design of the system, such a device can be used as a force multiplier, giving a mechanical advantage like the simple machines for an earlier project.

NOTES

NOTES

NOTES

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The Technology Gateway curriculum was written and refined by SC ATE technical college faculty curriculum writing teams, with review by a National Peer Review Panel and industry focus groups.

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Central Carolina Technical College
Denmark Technical College
Florence-Darlington Technical College
Greenville Technical College
Horry-Georgetown Technical College
Midlands Technical College
Northeastern Technical College
Orangeburg-Calhoun Technical College
Piedmont Technical College
Spartanburg Technical College
Technical College of the Lowcountry
Tri-County Technical College
Trident Technical College
Williamsburg Technical College
York Technical College

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