## 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

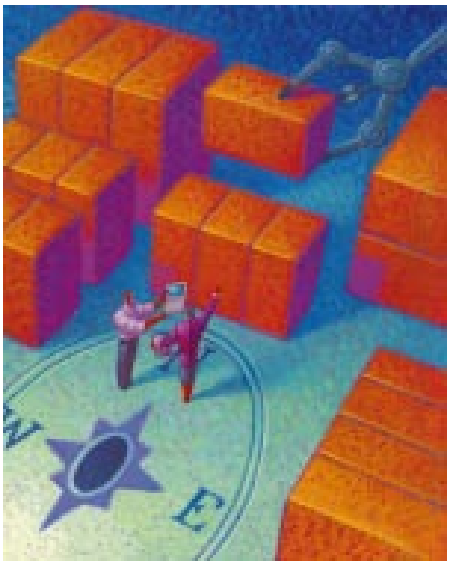
Your team is in charge of communicating to high school juniors and seniors occupational differences of engineers, technologists, and technicians using a brochure, videotape, CD, web site, PowerPoint, or written report.

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

## 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.

## 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.

## 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.

*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.*

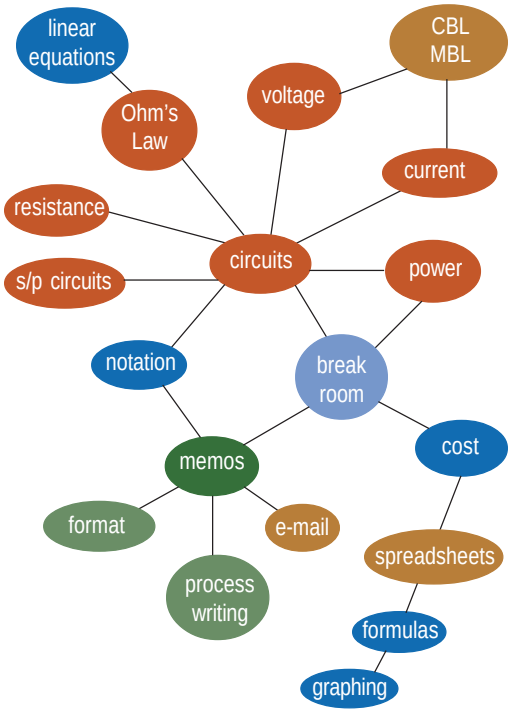
## Student Handout: Technology Gateway Project #3

# 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

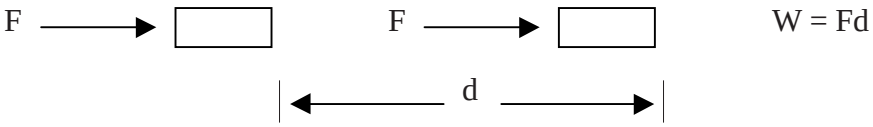
Your team will investigate the power requirements of these appliances and develop a plan that will make the most effective use of the room's electrical circuit yet still meet local electrical codes. The plan will indicate capital expenditures not to exceed $1,000 and will predict monthly operational 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.




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.

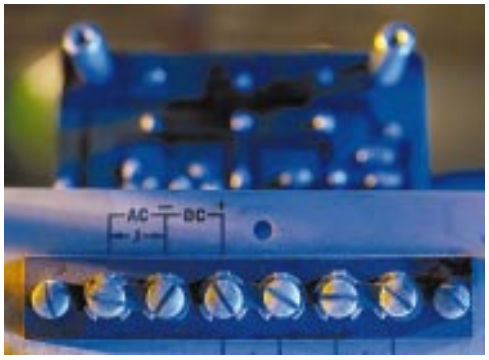
In electrical systems, the amount of electrical energy used is important. In fact, the bills that we receive from the electric company are based on the energy that we use. In many electrical systems, however, not only is the energy used important, but so is the rate at which the energy is delivered. 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

### 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.*

### 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.

### 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

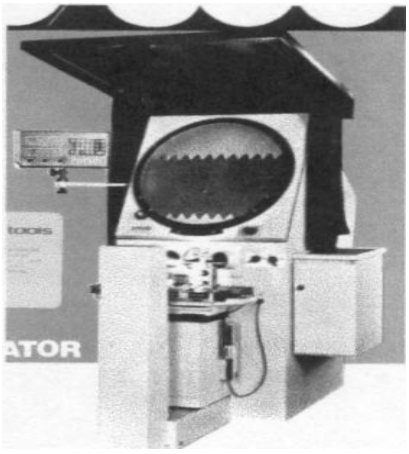
# Optics

### 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.

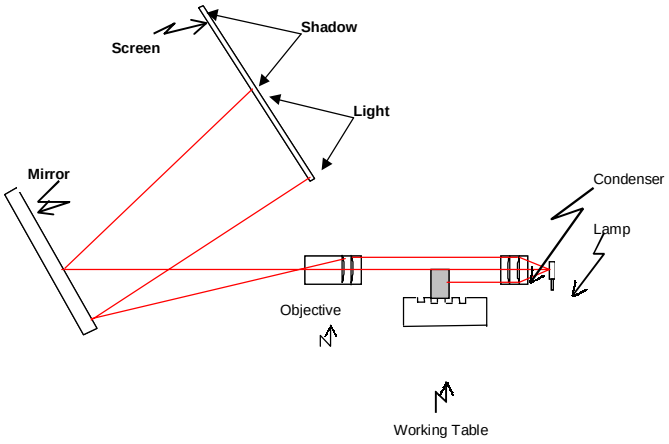
### Performance Expectations

- ❑ 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:
- $f$ = 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

# Temperature Measuring Devices

### 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.

### 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

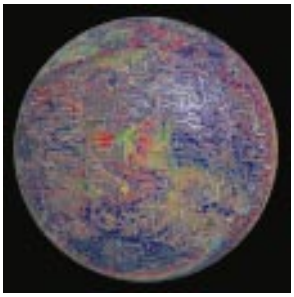
- Instructors will evaluate student teams and individual students on the project; the evaluation will include problem-solving and teaming skills used by students and student teams.
- Students will have opportunities for self-evaluation, peer evaluation, and team evaluation.
- Individual instructors will 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)
= $1.013 \times 10^5$ 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.