Principles of Technology II

9812/36 weeks

Table of Contents

Acknowledgments................................................................................................................................... 1
Course Description.................................................................................................................................. 2
Task Essentials Table .............................................................................................................................. 2
Curriculum Framework ........................................................................................................................... 3
UNIT 8: MOMENTUM .......................................................................................................................... 3
UNIT 9: WAVES and VIBRATIONS ..................................................................................................... 6
UNIT 10: ENERGY CONVERTERS ...................................................................................................... 8
UNIT 11: TRANSDUCERS .................................................................................................................... 11
UNIT 12: RADIATION .......................................................................................................................... 14
UNIT 13: LIGHT and OPTICAL SYSTEMS ........................................................................................ 17
UNIT 14: TIME CONSTANTS ............................................................................................................. 20
SOL Correlation by Task....................................................................................................................... 23
Entrepreneurship Infusion Units ............................................................................................................ 25
Appendix: Credentials, Course Sequences, and Career Cluster Information............................................ 26

Acknowledgments

The components of this instructional framework were developed by the following curriculum
development panelists:

- Cloria Barnard, Instructor, Deep Creek High School, Chesapeake Public Schools
- Dr. Charles Cartin, Associate Professor, Virginia Commonwealth University, Richmond
- Natalie Emery, Hickory High School, Chesapeake Public Schools
- Dr. Carlos Castano, Assistant Professor, Virginia Commonwealth University, Richmond
- Dr. Philip Reed, Professor, Old Dominion University, Norfolk
- Sheldon Southerland, Instructor, George Washington High School, Danville Public Schools

Correlations to the Virginia Standards of Learning were reviewed and updated by the following:

- Leslie R. Bowers, English Teacher (ret.), Newport News Public Schools
- Vickie L. Inge, Mathematics Committee Member, Virginia Mathematics and Science Coalition
- Anne F. Markwith, New Teacher Mentor (Science), Gloucester County Public Schools
- Michael L. Nagy, Social Studies Department Chair, Rustburg High School, Campbell County Public Schools

The framework was edited and produced by the CTE Resource Center:

- Averill P. Byrd, Writer/Editor
- Kevin P. Reilly, Administrative Coordinator

BJ Scott, Virginia TSA State Advisor, reviewed and updated the TSA correlations.

Virginia Department of Education Staff
Course Description

Suggested Grade Level: 11 or 12

Prerequisite: 9811

Students apply physics and mathematics concepts to conduct experiments and tackle projects in this course. Focusing on seven technical principles: momentum, waves, energy converters, transducers, radiation, optical systems, and time constants, this course emphasizes how each plays a unifying role in the operation of mechanical, fluid, electrical, and thermal systems. This hands-on project approach to studying these technical principles provides a foundation for further education and career flexibility working with technology and technical systems.

Note: Students who complete Principles of Technology I and Principles of Technology II may use these courses to satisfy one (1) physics credit in laboratory science. A student must complete both courses in the sequence to receive laboratory science credit. The sequence of Principles of Technology I and Principles of Technology II will satisfy one unit of credit in laboratory science for physics and one elective credit. Students who enroll in Principles of Technology courses for a physics credit must have completed Algebra I and two other laboratory science courses as specified by the accrediting standards prior to enrolling in Principles of Technology.

Task Essentials Table

- Tasks/competencies designated by plus icons (+) in the left-hand column(s) are essential
- Tasks/competencies designated by empty-circle icons (○) are optional
- Tasks/competencies designated by minus icons (●) are omitted
- Tasks marked with an asterisk (*) are sensitive.

<table>
<thead>
<tr>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNIT 8: MOMENTUM</strong></td>
</tr>
<tr>
<td>39 (+) Define linear momentum.</td>
</tr>
<tr>
<td>40 (+) Define angular momentum.</td>
</tr>
<tr>
<td>41 (+) Define the law of conservation of momentum.</td>
</tr>
<tr>
<td>42 (+) Predict the relationship of impulse to change in momentum.</td>
</tr>
<tr>
<td>43 (+) Research examples of how momentum affects mechanical and fluid systems.</td>
</tr>
<tr>
<td><strong>UNIT 9: WAVES and VIBRATIONS</strong></td>
</tr>
<tr>
<td>44 (+) Explain wave motion.</td>
</tr>
<tr>
<td>45 (+) Describe how waves transmit (move) energy.</td>
</tr>
<tr>
<td>46 (+) Identify the characteristics that are used to describe a wave.</td>
</tr>
<tr>
<td>47 (+) Demonstrate how waves transmit energy.</td>
</tr>
<tr>
<td>48 (+) Distinguish between longitudinal and transverse waves.</td>
</tr>
<tr>
<td>49 (+) Research workplace applications where waves and vibrations are found.</td>
</tr>
<tr>
<td><strong>UNIT 10: ENERGY CONVERTERS</strong></td>
</tr>
<tr>
<td>50 (+) Define energy converter.</td>
</tr>
<tr>
<td>51 (+) Describe what is meant by the efficiency of an energy converter.</td>
</tr>
<tr>
<td>52 (+) Research converters that change mechanical energy to fluid energy or electrical energy.</td>
</tr>
<tr>
<td>53 (+) Research converters that change fluid energy to mechanical energy.</td>
</tr>
<tr>
<td>54 (+) Research converters that change electrical to mechanical or thermal energy.</td>
</tr>
</tbody>
</table>
Task
55 ⚫ Research converters that change thermal to mechanical, fluid, or electrical energy.
56 ⚫ Construct a system that demonstrates energy conversion.

UNIT 11: TRANSDUCERS
57 ⚫ Distinguish between a transducer and a sensor.
58 ⚫ Distinguish between an energy converter and a transducer.
59 ⚫ Identify transducers that change mechanical signals into electrical signals.
60 ⚫ Identify transducers that change fluid signals into mechanical or electrical signals.
61 ⚫ Identify transducers that change electrical signals into mechanical or thermal information.
62 ⚫ Identify transducers that change thermal signals into mechanical, fluid, or electrical information.

UNIT 12: RADIATION
63 ⚫ Define radiant energy.
64 ⚫ Define electromagnetic radiation.
65 ⚫ Define nuclear radiation.
66 ⚫ Explain physical relativity phenomena that occur at low speeds and that occur as the speed of light is approached.
67 ⚫ Research workplace applications where technicians measure or control radiation.
68 ⚫ Explain physical phenomena at the quantum-mechanical level.

UNIT 13: LIGHT AND OPTICAL SYSTEMS
69 ⚫ Describe how light can be represented by light rays.
70 ⚫ Describe how light can be represented by waves.
71 ⚫ Identify the characteristics of laser light.
72 ⚫ Identify several optical systems that “process” light.
73 ⚫ Research workplace applications where technicians measure and control light.
74 ⚫ Demonstrate how sound can be transmitted by light.

UNIT 14: TIME CONSTANTS
75 ⚫ Define the term time constant.
76 ⚫ Distinguish between uniform and nonuniform change.
77 ⚫ Research systems where time constants are needed to describe system behavior.
78 ⚫ Define three time constants.
79 ⚫ Research examples of time constants in mechanical, fluid, electrical, and thermal energy systems.
80 ⚫ Research workplace applications where technicians measure and control time constants.

Legend: ⚫ Essential ○ Non-essential □ Omitted

Curriculum Framework

UNIT 8: MOMENTUM

Task Number 39

Define linear momentum.

Definition
Definition should include the concept that momentum is the product of a moving object’s mass and its velocity \( p=m\times v \).
Process/Skill Questions

- What is the definition of linear momentum?
- What units are used to describe linear momentum in the English system? In the International System of Units (SI) system?
- What is Newton’s first law of motion?
- Upon what two things does linear momentum depend?

ITEEA National Standards: 3

TSA Competitive Events: Technology Bowl, Principles of Technology (VA only event)

Task Number 40

Define angular momentum.

Definition
Definition should include the concept that angular momentum is the product of a rotating object’s moment of inertia and its angular velocity.

Process/Skill Questions

- How is angular momentum defined?
- What units are used to describe angular momentum in the English system? In the SI system?
- Why is moment of inertia used instead of mass?

ITEEA National Standards: 3

TSA Competitive Events: Technology Bowl

Task Number 41

Define the law of conservation of momentum.

Definition
Definition should include that, in an isolated system, the momentum before an interaction is equal to the momentum after the interaction.

Process/Skill Questions

- What is the law of conservation of momentum?
- What are isolated systems?
- What are two types of collisions?
- How does the law of conservation of momentum relate to angular and linear motion?

ITEEA National Standards: 3

TSA Competitive Events: Technology Bowl

Task Number 42
Predict the relationship of impulse to change in momentum.

**Definition**
Prediction should include

- the product of a force or torque that acts on an object or fluid and the length of time that force acts
- the formula $Fx\Delta t = \Delta (mv)$
- the fact that lb•sec = slug•ft/sec and N•sec = kg•m/sec.

**Process/Skill Questions**

- How does the relationship between linear/angular impulse cause a change in linear/angular momentum?
- How can the relationship of linear/angular momentum and linear/angular impulse be written?

**ITEEA National Standards:** 3, 8

**TSA Competitive Events:** Technology Bowl, Principles of Technology (VA only event)

---

**Task Number 43**

**Research examples of how momentum affects mechanical and fluid systems.**

**Definition**
Research may include, but is not limited to

- planned or unplanned collisions
- space shuttle
- aircraft carriers
- gyroscopes
- spinning satellites
- turbines
- drones.

**Process/Skill Questions**

- What effect does linear momentum and impulse have on a mechanical system? On a fluid system?
- What effect does angular momentum and impulse have on a mechanical system? On a fluid system?
- How could linear/angular momentum be applied in everyday life?
- How could linear/angular impulse be applied in everyday life?

**ITEEA National Standards:** 3

**TSA Competitive Events:** Prepared Presentation, STEM Careers
UNIT 9: WAVES and VIBRATIONS

Task Number 44

Explain wave motion.

Definition
Explaination should include

- stating the medium through which waves travel
- identifying the wave as a single or continuous pulse
- identifying and evaluating characteristics of wave motion.

Process/Skill Questions

- How does heat energy get transferred?
- What does the term *medium* mean?
- What is the difference between a single pulse and a continuous wave?
- What is a mechanical wave?
- What is a longitudinal wave?

ITEEA National Standards: 3, 8

TSA Competitive Events: Technology Bowl

Task Number 45

Describe how waves transmit (move) energy.

Definition
Description should include

- defining the term *molecular movement*
- describing how energy moves from one molecule to the next
- explaining how electromagnetic waves transfer energy through a vacuum.

Process/Skill Questions

- What happens if one molecule bumps into another?
- What is the difference between mechanical waves and electromagnetic waves?
- How does the term *elastic* relate to wave movement?

ITEEA National Standards: 3, 8

TSA Competitive Events: Technology Bowl

Task Number 46

Identify the characteristics that are used to describe a wave.

Definition
Identification should include
• amplitude
• phase
• wavelength
• frequency
• period
• speed.

Process/Skill Questions

• How does a wave’s amplitude affect its energy?
• What is meant by the term *phase difference* when referring to a wave?
• How is a wave’s period related to its frequency?

ITEEA National Standards: 3, 8

TSA Competitive Events: Technology Bowl

Task Number 47

Demonstrate how waves transmit energy.

Definition
Demonstration should include the use of

• amplitude
• phase
• wavelength
• frequency
• period
• speed.

Process/Skill Questions

• How would you calculate a wave's speed?
• How does a wave's frequency affect its energy?

ITEEA National Standards: 8

TSA Competitive Events: Principles of Technology (VA only event)

Task Number 48

Distinguish between longitudinal and transverse waves.

Definition
Distinction should include the direction of molecular motion in relation to the direction of the wave.

Process/Skill Questions

• What are the six characteristics of a transverse wave?
• What are the five characteristics of a longitudinal wave?
• What is meant by the term *rarefaction*?

ITEEA National Standards: 3, 8
Task Number 49

Research workplace applications where waves and vibrations are found.

Definition
Research may include, but is not limited to

- electrical work
- radar technology
- engineering
- architecture
- seismology
- telecommunications.

Process/Skill Questions

- What are some of the effects of wave interference?
- How does sonar use wave characteristics to determine water depth?

ITEEA National Standards: 3

TSA Competitive Events: Prepared Presentation, STEM Careers

UNIT 10: ENERGY CONVERTERS

Task Number 50

Define energy converter.

Definition
Definition should include

- a device that accepts one form of energy (input) and delivers energy in a different form (output)
- identifying types of energy converters for each energy system
- evaluating the efficiency of converting energy from one form to another.

Process/Skill Questions

- What are types of converters?
- What is the input energy form?
- What is the output energy form?
- How do you calculate the efficiency of a converter?

ITEEA National Standards: 3, 8

TSA Competitive Events: Technology Bowl, Principles of Technology (VA only event)
Task Number 51

Describe what is meant by the efficiency of an energy converter.

Definition
Description may include

- stating that all devices are never 100 percent efficient
- expressing the efficiency of output in the same terms
- identifying the similarities and differences in efficiency between energy converters and force transformers.

Process/Skill Questions

- How much loss results from the conversion of energy?
- Why is it important to develop energy converters?
- Why are energy converters not 100 percent efficient?
- What is a force transformer?

ITEEA National Standards: 3, 8

TSA Competitive Events: Technology Bowl, Principles of Technology (VA only event)

Task Number 52

Research converters that change mechanical energy to fluid energy or electrical energy.

Definition
Research may include, but is not limited to

- types of pumps (e.g., vane, centrifugal, gear, piston)
- alternators
- generators
- air compressors or fans.

Process/Skill Questions

- How does a pump convert mechanical energy to fluid energy?
- How does a fan convert mechanical energy to fluid energy?
- How does a generator or alternator convert mechanical energy to electrical energy?

ITEEA National Standards: 3, 8

TSA Competitive Events: Prepared Presentation

Task Number 53
Research converters that change fluid energy to mechanical energy.

Definition
Research may include, but is not limited to

- windmills
- turbine engines
- water turbines
- hydraulic lifts and pumps
- air conditioners.

Process/Skill Questions

- How does a windmill convert fluid energy to mechanical energy?
- How does a gas turbine convert fluid energy to mechanical energy?
- How does an air conditioner compressor convert fluid energy to mechanical energy?

ITEEA National Standards: 3, 8
TSA Competitive Events: Prepared Presentation

Task Number 54

Research converters that change electrical to mechanical or thermal energy.

Definition
Research may include, but is not limited to

- solenoids
- heat pumps
- computers
- appliances.

Process/Skill Questions

- How does an electric motor convert electrical energy to mechanical energy?
- How does a heat pump convert electrical energy to mechanical energy?
- How does a solenoid work?

ITEEA National Standards: 3, 8
TSA Competitive Events: Prepared Presentation

Task Number 55

Research converters that change thermal to mechanical, fluid, or electrical energy.

Definition
Research may include, but is not limited to
• thermostats
• thermocouples
• engines (e.g., gasoline, diesel, gas turbine, steam turbine).

Process/Skill Questions

• What is the mechanical equivalent of heat energy?
• How does a bimetallic strip convert thermal energy to mechanical energy?
• How does a fuel mixture convert thermal energy to mechanical energy?
• How does a thermocouple convert thermal energy to electrical energy?

ITEEA National Standards: 3, 8

TSA Competitive Events: Prepared Presentation

Task Number 56

Construct a system that demonstrates energy conversion.

Definition
Construction may include

• model
• simulation
• prototype
• diagram.

Process/Skill Questions

• What units of measurement are used before and after energy conversion occurs?
• What is the input energy and what is the output energy?

ITEEA National Standards: 8

TSA Competitive Events: Computer Integrated Manufacturing

UNIT 11: TRANSDUCERS

Task Number 57

Distinguish between a transducer and a sensor.

Definition
Distinction should state the following:

• A sensor measures a physical quantity (e.g., light, sound, or space) and converts the information into a readable format; it does not divert energy from its principal operation.
• A transducer converts energy from one form to another; the goal of a transducer is efficiency in the conversion of energy.
• Most transducers are sensors.
Process/Skill Questions

- What is the difference between a transducer and a sensor?
- What is the purpose of a transducer?
- How can transducers be classified (i.e., according to the form of energy on their input side)?
- What devices are used to measure the output of a transducer?
- How much energy does a transducer typically consume?
- Why is a transducer typically read with a mechanical gauge or an electrical meter?

ITEEA National Standards: 8

TSA Competitive Events: Technology Bowl, Principles of Technology (VA only event)

Task Number 58

Distinguish between an energy converter and a transducer.

Definition
Distinction should state that

- a transducer is a general term for devices that convert energy from one system to another
- an energy converter is a transducer that takes energy from a less useful type of operation and converts it into a more useable form.

Process/Skill Questions

- What are the similarities and differences between an energy converter and a transducer?
- How does a transducer monitor a system?

ITEEA National Standards: 8

TSA Competitive Events: Principles of Technology (VA only event)

Task Number 59

Identify transducers that change mechanical signals into electrical signals.

Definition
Identification should include, but is not limited to

- strain gauges
- accelerometers
- piezoelectric crystals
- microphones
- barometers.

Identification should also include how mechanical signals are converted into electrical signals.
Process/Skill Questions

• How are mechanical signals converted into electrical signals?
• What are examples of transducers that convert mechanical signals into electrical signals?
• What are the applications of transducers that convert mechanical signals into electrical signals?

ITEEA National Standards: 8

TSA Competitive Events: Technology Bowl, Principles of Technology (VA only event)

Task Number 60

Identify transducers that change fluid signals into mechanical or electrical signals.

Definition
Identification should include, but is not limited to

• Bourdon pressure gauges
• barometers
• flow meters
• anemometers
• rotameters.

Identification should also include how the motion of a fluid is converted into mechanical or electrical signals.

Process/Skill Questions

• How are fluids converted into mechanical or electrical signals?
• What are examples of transducers that convert fluids into mechanical or electrical signals?
• What are the applications of transducers that convert fluids into mechanical or electrical signals?

ITEEA National Standards: 8

TSA Competitive Events: Technology Bowl, Principles of Technology (VA only event)

Task Number 61

Identify transducers that change electrical signals into mechanical or thermal information.

Definition
Identification should include, but is not limited to

• moving-coil meters
• electrostrictive crystals
• photoconductors and photocells
• ammeters
• voltmeters.

Identification should also include how electrical signals are converted into mechanical or thermal signals.

Process/Skill Questions

• What are examples of transducers that convert electrical signals to mechanical signals?
• What are examples of transducers that convert electrical signals to thermal signals?

ITEEA National Standards: 8

TSA Competitive Events: Technology Bowl, Principles of Technology (VA only event)

Task Number 62

Identify transducers that change thermal signals into mechanical, fluid, or electrical information.

Definition
Identification should include, but is not limited to

• bimetallic strips
• thermographs
• thermocouples
• thermistors.

Identification should also include how thermal energy is converted into mechanical, fluid, or electrical signals.

Process/Skill Questions

• How are electrical signals converted into mechanical or thermal information?
• What are examples of transducers that convert electrical signals into mechanical or thermal information?
• What are the applications of transducers that convert electrical signals into mechanical or thermal information?

ITEEA National Standards: 8

TSA Competitive Events: Technology Bowl

UNIT 12: RADIATION

Task Number 63

Define radiant energy.
Definition
Definition should include

- describing the process of how atoms emit energy or radiate energy
- identifying the type of energy given off in the process.
- comparing fission and fusion in terms of end products, energy, advantages, and availability.

Process/Skill Questions

- What are the parts of an atom?
- What type of energy comes from the electrons?
- What type of energy comes from the nucleus of an atom?
- Why are only certain types of radiation harmful?
- Why is understanding radiation important?

ITEEA National Standards: 3, 8
TSA Competitive Events: Technology Bowl

Task Number 64

Define electromagnetic radiation.

Definition
Definition should include

- describing the transfer of energy produced by an accelerating charge
- identifying the types of waves on the electromagnetic spectrum (e.g., radio waves, microwaves, light waves, X-rays, gamma rays, and cosmic rays)
- characterizing the radiation by the wavelengths and frequency found along the electromagnetic spectrum.

Process/Skill Questions

- What is the electromagnetic spectrum?
- What are the four characteristics used to describe the electromagnetic spectrum?
- What is the relationship between photons and energy?
- Why can light push a sailboat?
- Why does an element have its own spectrum?

ITEEA National Standards: 3
TSA Competitive Events: Technology Bowl

Task Number 65

Define nuclear radiation.

Definition
Definition should include

- describing the transfer of energy away from an unstable nucleus by means of alpha particles, beta particles, or gamma rays
• understanding nuclear decay and its associated hazards
• identifying the three components of nuclear radiation, fission, and fusion
• demonstrating how to use the formula $E=mc^2$ to change mass into energy.

Process/Skill Questions

• What is nuclear decay?
• What are the three main components of nuclear radiation?
• What are the hazards associated with alpha decay? Beta decay? Gamma decay?
• What is nuclear fission?
• What is nuclear fusion?

ITEEA National Standards: 3

TSA Competitive Events: Technology Bowl

Task Number 66

Explain physical relativity phenomena that occur at low speeds and that occur as the speed of light is approached.

Definition
Explanation should include

• how electromagnetic energy is characterized
• how photons and electromagnetic energy are related
• how energy can be calculated by using $E=hf$, $E=hc/\lambda$, or $E=mc^2$.

Process/Skill Questions

• What is a photon?
• What is Planck’s constant?
• How do you calculate the energy of a photon?
• What are we calculating when we use the formula $E=mc^2$?

ITEEA National Standards: 3

TSA Competitive Events: Technology Bowl, Principles of Technology (VA only event)

Task Number 67

Research workplace applications where technicians measure or control radiation.

Definition
Research should include, but is not limited to

• communications
• medical applications
• power generation
• special precautions associated with working with electromagnetic and nuclear radiation
• shipyards.
Process/Skill Questions

- Which industries and professions use radiation?
- Where would a student encounter radiation in their own life?
- What special precautions must be in place when working with electromagnetic radiation and nuclear radiation?
- How do smoke detectors make use of radiation?

ITEEA National Standards: 3

TSA Competitive Events: Prepared Presentation

---

Task Number 68

**Explain physical phenomena at the quantum-mechanical level.**

**Definition**

Explanation should include the concepts that

- quantum mechanics is able to explain matter and light on an atomic and subatomic scale, which is not possible with classical physics
- classical physics explains the macroscopic scale, but most of the theories can be derived from quantum mechanics
- quantum tunneling that occurs during radioactive decay
- complex quantum systems using time crystals
- Heisenberg uncertainty principle.

Teacher resource: [Quantum Mechanics, Stanford Encyclopedia of Philosophy](https://plato.stanford.edu/entries/quantum-mechanics/)

Process/Skill Questions

- How are atoms changing as they decay?
- What is the Heisenberg uncertainty principle and why is it important?
- What are some of the barriers associated with nuclear fusion?
- How is quantum mechanics used in everyday life?
- What is quantum computing?

ITEEA National Standards: 3

TSA Competitive Events: Biotechnology Design, Technology Bowl

---

**UNIT 13: LIGHT and OPTICAL SYSTEMS**

Task Number 69

**Describe how light can be represented by light rays.**

**Definition**

Description should include
• understanding how light behaves
• the law of reflection, and how flat, concave, and convex mirrors work
• the law of refraction, and how light passes through concave and convex lenses.

Process/Skill Questions

• What is reflection?
• What is refraction?
• What is the angle of incidence?
• What is the angle of refraction?
• What is the index of refraction?
• What are focal point and focal length?

ITEEA National Standards: 3

TSA Competitive Events: Technology Bowl

---

Task Number 70

Describe how light can be represented by waves.

Definition
Description should include the difference between

• shadows caused by light rays and by light waves
• wave interference and diffraction
• constructive and destructive interference.

Process/Skill Questions

• What is meant by wave interference?
• What is the difference between constructive and destructive wave interference?
• How is an interference fringe pattern created?
• What is diffraction?
• What is collimated light?
• What is a diffraction grating?
• What happens when you illuminate a DVD with a laser?

ITEEA National Standards: 3

TSA Competitive Events: Technology Bowl

---

Task Number 71

Identify the characteristics of laser light.

Definition
Identification should include

• the main types of lasers
• the main components of a laser (i.e., energy source, medium, optical resonator)
• the four ways to put energy into a laser
• the differences between characteristics of laser light and other light.
Process/Skill Questions

- What are the components of a laser?
- What are some common types of lasers?
- What is the difference between an argon laser, a carbon dioxide laser, a dye laser, and a neodymium-doped yttrium aluminum garnet (neodymium-YAG) laser?
- What makes laser light different from other types of light?
- What is radiant power and power density?
- How is a laser pointer made?
- From what acronym does the word laser derive?

ITEEA National Standards: 3, 8

TSA Competitive Events: Technology Bowl, Photographic Technology

Task Number 72

Identify several optical systems that “process” light.

Definition
Identification may include, but is not limited to

- lasers
- computers
- human eyes
- fiber-optic cables
- astronomical devices
- photographic equipment.

Process/Skill Questions

- How does the human eye form an image?
- What is the difference between nearsightedness and farsightedness?
- What is the f-number on a camera?
- What is a beam expander?

ITEEA National Standards: 3, 8

TSA Competitive Events: Technology Bowl, Photographic Technology

Task Number 73

Research workplace applications where technicians measure and control light.

Definition
Research should include, but is not limited to

- opticians
- healthcare technicians
- construction workers
- manufacturing workers
- security personnel.
Process/Skill Questions

- How do opticians use the characteristics of light to improve vision?
- Where and how are lasers used in the construction industry?
- Where might a student encounter optical systems?

ITEEA National Standards: 3

TSA Competitive Events: Technology Bowl, Prepared Presentation

Task Number 74

Demonstrate how sound can be transmitted by light.

Definition
Demonstration may include
- mirror
- light source
- microphone.

Process/Skill Questions

- How can sound be transmitted by light?
- How do fiber optic cables work?

ITEEA National Standards: 8

TSA Competitive Events: Principles of Technology (VA only event)

UNIT 14: TIME CONSTANTS

Task Number 75

Define the term time constant.

Definition
Definition should state that a time constant is the interval required for a circuit or system to change from one state to another. A system is considered to have changed its state after five time constants have elapsed.

Process/Skill Questions

- Why is a time constant important?
- When would a system make a complete change?
- How are time constants used at work? Why don’t time constants apply to systems that change at a constant or uniform rate?

ITEEA National Standards: 3

TSA Competitive Events: Technology Bowl
**Task Number 76**

**Distinguish between uniform and nonuniform change.**

**Definition**

Distinction should state that

- a system changes in a uniform way when the rate of change is constant
- a system changes in a nonuniform way when the rate of change is not constant
- nonuniform systems operate in a transient condition.

**Process/Skill Questions**

- How do systems change in a uniform way? In a nonuniform way?
- Why are systems that undergo nonuniform change important?
- What are types of systems that operate in a uniform way? A nonuniform way?

**ITEEA National Standards:** 3

**TSA Competitive Events:** Technology Bowl

---

**Task Number 77**

**Research systems where time constants are needed to describe system behavior.**

**Definition**

Research should include the concept that time constants are needed for systems that change in nonuniform ways.

**Process/Skill Questions**

- Why do we need time constants?
- What types of systems do not need time constants?

**ITEEA National Standards:** 3

**TSA Competitive Events:** Prepared Presentation

---

**Task Number 78**

**Define three time constants.**

**Definition**

Definition should include

- $T_{1/2}$, which represents the time it takes for 50 percent of the total change to take place
- $T_{90}$, which represents the time it takes for 90 percent of the total change to take place
- $\tau$ (tau), which represents the time it takes for 63 percent of the total change to take place.
Process/Skill Questions

- Why would a system approach, but never achieve, a zero value?
- What do the three time constants say about a system?

ITEEA National Standards: 3

TSA Competitive Events: Technology Bowl

Task Number 79

Research examples of time constants in mechanical, fluid, electrical, and thermal energy systems.

Definition
Research may include, but are not limited to

- mechanical—electric fan, shock absorbers
- fluid—flow rate from a tank, skydiver
- electrical—circuits with changing voltages, electronic timing devices
- thermal—insulators and refrigerators, thermocouples.

Process/Skill Questions

- Why are time constants important in thermal systems?
- What are transients in electrical systems?
- How are time constants used in fluid systems?

ITEEA National Standards: 3

TSA Competitive Events: Prepared Presentation, SEM Careers

Task Number 80

Research workplace applications where technicians measure and control time constants.

Definition
Research may include, but not be limited to

- electronics
- thermodynamics and fluid mechanics
- meteorology
- thermal systems
- heating and air conditioning systems
- aeronautics
- mechanical systems
- automotive technology
- healthcare industry.

Process/Skill Questions

- Why are time constants important to a computer technician?
- Why are time constants important to an air-conditioning technician?
- Why are time constants important to a technician who works with mechanical motors?
- Why are time constants important to a technician working in the papermaking industry?
- Why are time constants important to a healthcare professional?

**ITEEA National Standards: 3**

**TSA Competitive Events: STEM Careers, Prepared Presentation, Essays on Technology**

---

**SOL Correlation by Task**

<table>
<thead>
<tr>
<th>Task</th>
<th>SOL Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNIT 8: MOMENTUM</strong></td>
<td></td>
</tr>
</tbody>
</table>
| 39 Define *linear momentum*. | English: 11.3, 12.3  
Mathematics: ALGII.3, MA.7  
Science: PH.5, PH.6 |
| 40 Define *angular momentum*. | English: 11.3, 12.3  
Mathematics: ALGII.3, T.2, T.9, MA.7  
Science: PH.6 |
| 41 Define the law of conservation of momentum. | English: 11.3, 12.3  
Mathematics: ALGII.3, T.2, T.9, MA.7  
Science: PH.6 |
| 42 Predict the relationship of impulse to change in momentum. | English: 11.5, 12.5  
Mathematics: ALGII.3, T.9  
Science: PH.6 |
| 43 Research examples of how momentum affects mechanical and fluid systems. | English: 11.5, 12.5 |
| **UNIT 9: WAVES and VIBRATIONS** | |
| 44 Explain wave motion. | English: 11.5 12.5  
Mathematics: T.3  
Science: PH.8 |
| 45 Describe how waves transmit (move) energy. | English: 11.5, 12.5  
Science: PH.8 |
| 46 Identify the characteristics that are used to describe a wave. | English: 11.5 12.5  
Mathematics: T.3  
Science: PH.8 |
| 47 Demonstrate how waves transmit energy. | English: 11.5, 12.5  
Mathematics: ALGII.3, T.3  
Science: PH.8 |
<p>| 48 Distinguish between longitudinal and transverse waves. | English: 11.5 12.5 |</p>
<table>
<thead>
<tr>
<th>Task</th>
<th>SOL Correlations</th>
</tr>
</thead>
</table>
| 49   | **Mathematics:** ALGII.3, T.6  
      | **Science:** PH.8  
      | **English:** 11.8, 12.8  
      | **Science:** PH.8  |
| **UNIT 10: ENERGY CONVERTERS** | |
| 50   | Define *energy converter.*  
      | **English:** 11.3, 12.3  
      | **Mathematics:** ALGII.3  |
| 51   | Describe what is meant by the efficiency of an *energy converter.*  
      | **English:** 11.5, 12.5  
      | **Mathematics:** ALGII.3  |
| 52   | Research converters that change mechanical energy to fluid energy or electrical energy.  
      | **English:** 11.8, 12.8  
      | **Mathematics:** ALGII.3  |
| 53   | Research converters that change fluid energy to mechanical energy.  
      | **English:** 11.8, 12.8  
      | **Mathematics:** ALGII.3  |
| 54   | Research converters that change electrical to mechanical or thermal energy.  
      | **English:** 11.8, 12.8  
      | **Mathematics:** ALGII.3  |
| 55   | Research converters that change thermal to mechanical, fluid, or electrical energy.  
      | **English:** 11.8, 12.8  
      | **Mathematics:** ALGII.3  |
| 56   | Construct a system that demonstrates energy conversion.  
      | **English:** 11.5, 12.5  
      | **Mathematics:** ALGII.3  |
| **UNIT 11: TRANSUDCERS** | |
| 57   | Distinguish between a transducer and a sensor.  
      | **English:** 11.5, 12.5  
      | **Mathematics:** ALGII.3  |
| 58   | Distinguish between an energy converter and a transducer.  
      | **English:** 11.5, 12.5  
      | **Mathematics:** ALGII.3  |
| 59   | Identify transducers that change mechanical signals into electrical signals.  
      | **English:** 11.5, 12.5  
      | **Mathematics:** ALGII.3  |
| 60   | Identify transducers that change fluid signals into mechanical or electrical signals.  
      | **English:** 11.5, 12.5  
      | **Mathematics:** ALGII.3  |
| 61   | Identify transducers that change electrical signals into mechanical or thermal information.  
      | **English:** 11.5, 12.5  
      | **Mathematics:** ALGII.3  |
| 62   | Identify transducers that change thermal signals into mechanical, fluid, or electrical information.  
      | **English:** 11.5, 12.5  
      | **Mathematics:** ALGII.3  |
| **UNIT 12: RADIATION** | |
| 63   | Define *radiant energy.*  
      | **English:** 11.3, 12.3  
      | **Science:** PH.9  |
| 64   | Define *electromagnetic radiation.*  
      | **English:** 11.3, 12.3  
      | **Mathematics:** T.3  
      | **Science:** PH.9  |
| 65   | Define *nuclear radiation.*  
      | **English:** 11.3, 12.3  
      | **Mathematics:** ALGII.3  
      | **Science:** PH.12  |
| 66   | Explain physical relativity phenomena that occur at low speeds and that occur as the speed of light is approached.  
      | **English:** 11.5, 12.5  
      | **Mathematics:** ALGII.3  
      | **Science:** PH.9  |
| 67   | Research workplace applications where technicians measure or control radiation.  
      | **English:** 11.8, 12.8  
      | **Mathematics:** ALGII.3  
      | **Science:** PH.9  |
| 68   | Explain physical phenomena at the quantum-mechanical level.  
      | **English:** 11.5, 12.5  
      | **Mathematics:** ALGII.3  
<pre><code>  | **Science:** PH.9  |
</code></pre>
<table>
<thead>
<tr>
<th>Task</th>
<th>SOL Correlations</th>
</tr>
</thead>
</table>
|   | Mathematics: ALGII.3, T.8, MA.10  
Science: PH.12 |
| **UNIT 13: LIGHT and OPTICAL SYSTEMS** | |
| 69 | Describe how light can be represented by light rays.  
English: 11.5, 12.5  
Mathematics: ALGII.3, T.8, MA.6, MA.10  
Science: PH.8 |
| 70 | Describe how light can be represented by waves.  
English: 11.5, 12.5  
Science: PH.8 |
| 71 | Identify the characteristics of laser light.  
English: 11.5, 12.5 |
| 72 | Identify several optical systems that “process” light.  
English: 11.5, 12.5 |
| 73 | Research workplace applications where technicians measure and control light.  
English: 11.8, 12.8 |
| 74 | Demonstrate how sound can be transmitted by light.  
English: 11.5, 12.5  
Science: PH.8 |
| **UNIT 14: TIME CONSTANTS** | |
| 75 | Define the term *time constant*.  
English: 11.3, 12.3 |
| 76 | Distinguish between uniform and nonuniform change.  
English: 11.5, 12.5 |
| 77 | Research systems where time constants are needed to describe system behavior.  
English: 11.8, 12.8 |
| 78 | Define three time constants.  
English: 11.3, 12.3 |
| 79 | Research examples of time constants in mechanical, fluid, electrical, and thermal energy systems.  
English: 11.5, 12.5 |
| 80 | Research workplace applications where technicians measure and control time constants.  
English: 11.8, 12.8 |

**Entrepreneurship Infusion Units**

Entrepreneurship Infusion Units may be used to help students achieve additional, focused competencies and enhance the validated tasks/competencies related to identifying and starting a new business venture. Because the unit is a complement to certain designated courses and is not mandatory, all tasks/competencies are marked “optional.”
Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- College and Work Readiness Assessment (CWRA+)
- National Career Readiness Certificate Assessment
- Workplace Readiness Skills for the Commonwealth Examination

Concentration sequences: A combination of this course and those below, equivalent to two 36-week courses, is a concentration sequence. Students wishing to complete a specialization may take additional courses based on their career pathways. A program completer is a student who has met the requirements for a CTE concentration sequence and all other requirements for high school graduation or an approved alternative education program.

- Principles of Technology I (9811/36 weeks)

Career Cluster: Science, Technology, Engineering and Mathematics

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Occupations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering and Technology</td>
<td>Chemical Engineer</td>
</tr>
<tr>
<td></td>
<td>Electrical Engineer</td>
</tr>
<tr>
<td></td>
<td>Electrical Engineering Technician</td>
</tr>
<tr>
<td></td>
<td>Electro-Mechanical Technician Engineer</td>
</tr>
<tr>
<td></td>
<td>Engineering Technician</td>
</tr>
<tr>
<td></td>
<td>Industrial Engineer</td>
</tr>
<tr>
<td></td>
<td>Industrial Engineering Technician</td>
</tr>
<tr>
<td></td>
<td>Manufacturing Systems Engineer</td>
</tr>
<tr>
<td></td>
<td>Mechanical Engineer</td>
</tr>
<tr>
<td></td>
<td>Mechanical Engineering Technician</td>
</tr>
<tr>
<td>Science and Mathematics</td>
<td>Atmospheric Scientist</td>
</tr>
<tr>
<td></td>
<td>Hydrologist</td>
</tr>
<tr>
<td></td>
<td>Secondary School Teacher</td>
</tr>
</tbody>
</table>