Physics of Technology I
A Model Course Guideline

January 2001
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Foreword

Physics of Technology I Curricular Guidelines is a model designed to assist in developing a rigorous and relevant course of study for Physics of Technology I, a course approved in the Secondary Science Program of Study (*Bulletin 741: Louisiana Handbook for School Administrators, 1997-2000*). The model includes a brief outline and more detailed course guidelines that embrace the core content essential skills and understandings embodied in *Compliance Handbook 308: Louisiana Science Framework* (May 1997)(formerly *Bulletin 1962*). It also presents a discussion of standards-based curriculum, the use of technology, inquiry-based science, laboratory safety, assessment, and the concept of rigorous and relevant learning for *all students.*

The intended audience for this publication includes science teachers, science chairpersons, supervisors of science, local curriculum developers, and school administrators who are involved in secondary science curriculum development and committed to high quality science education.

Physics of Technology I

Course Description

Physics of Technology I explores physics concepts relevant to the technological workplace using an applied approach. Studies include force, work, rate, resistance, energy, power, and force transformers. Practical problem-solving techniques are primarily taught through experimental team explorations. Mathematical skills through geometry are used in problem solving.

Content Outline

I. Getting Started (These are pervasive throughout the course work.)

- A. Cooperative Learning Strategies and Techniques
- B. Mathematical Preparation
- C. Measurement
- D. Lab Readiness (hands-on and system familiarization)

II. Force

- A. Force in Mechanical Systems
- B. Pressure in Fluid Systems
- C. Voltage in Electrical Systems
- D. Temperature in Thermal Systems

III. Work

- A. Work in Mechanical Systems
- B. Work in Fluid Systems
- C. Work in Electrical Systems

IV. Rate

- A. Rate in Mechanical Systems
- B. Rate in Fluid Systems
- C. Rate in Electrical Systems
- D. Rate in Thermal Systems

V. Resistance

- A. Resistance in Mechanical Systems
- B. Resistance in Fluid Systems
- C. Resistance in Electrical Systems
- D. Resistance in Thermal Systems

VI. Energy

- A. Energy in Mechanical and Fluid Systems I
- B. Energy in Mechanical and Fluid Systems II
- C. Energy in Electrical Systems
- D. Energy in Thermal Systems

VII. Power

A. Power in Mechanical Systems
B. Power in Fluid Systems
C. Power in Electrical Systems
D. Power in Thermal Systems

VIII. Force Transformers

A. Force Transformers in Linear Mechanical Systems
B. Force Transformers in Rotational Mechanical Systems
C. Force Transformers in Fluid Systems
D. Force Transformers in Electrical Systems

Model Curriculum Guidelines

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TOPICS	BENCHMARKS
I. Getting Started (These are pervasive throughout the course work)	
A. Cooperative Learning Strategies and Techniques	
1. Design and initiate the basic social skills needed for cooperative learning groups	SI-H-A 1 SI-H-A 2
a. Establish and use basic classroom policies and procedures	SI-H-A 3 SI-H-A 4
b. Establish and evaluate actions of effective group members	SI-H-A 5 SI-H-A 6
2. Perform and rotate cooperative learning group tasks and activities in a variety of roles (facilitator, recorder, materials manager, and clerk/timekeeper)	SI-H-A 7
3. Work as a cooperative learning team to design, conduct, and present and/or report a solution to a variety of scientific investigations or explanations	
4. Communicate results after collecting and analyzing data	
B. Mathematical Preparation	
1. Develop problem-solving skills	SI-H-B3
2. Manipulate and analyze quantitative data by using Scientific calculators	PS-H-A 1
3. Apply and utilize scientific notation, significant digit, and appropriate units of measurement in both English and SI systems of measurements	PS-H-A 1
4. Employ various methods of introduction of vectors	PS-H-E2
C. Measurement	
1. Relate the metric (SI) and English systems of measurements to problem solving by utilizing dimensional analysis	PS-H-A 1
2. Illustrate the graphical representation of data	SI-H-A3, SI-H-B3
3. Compute and discuss error analysis	PS-G-A 1

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TOPICS	BENCHMARKS
D. Lab Readiness (hands-on and systems familiarization) 1. Utilize safety procedures during the application of classroom discussions (review/develop safety guidelines located in textbooks and lab manuals) 2. Use appropriate measuring instruments to conduct a variety of real-world applications integrating scientific method 3. Communicate the results of data collection by analysis and graphical representation 4. Communicate the results through the use of reports (written or oral, formal or informal)	SI-H-A 7 SI-H-A 4, SI-H-B3 SI-H-B4 SI-G-A3, SI-H-A4 SI-H-B2, SI-H-B3 SI-H-A1, SI-H-A2 SI-H-A6, SI-H-B1 SI-H-B4, SI-H-B5
II. Force A. Force in Mechanical Systems 1. Define and apply the concept of force 2. Distinguish between balanced and unbalanced forces and their results 3. Define and apply the following concepts: vectors, scalars, weight and mass 4. Define and apply the concept of torque in a rotational mechanical system 5. Explain how force fits the definition of a prime mover 6. Solve problems using mass, force, and torque 7. Describe a situation in which technicians measure and apply forces in a mechanical system B. Pressure in Fluid Systems 1. Differentiate between hydraulic and pneumatic systems 2. Define and apply the terms *density*, *specific gravity*, and *buoyant force* to different substances 3. Define and apply the concept of pressure and relate the concept to atmospheric, absolute, and gauge pressure 4. Perform calculations related to pressure using appropriate measurement units	Benchmarks SI-H-A 1-A7 and SI-H-B1-B5 are used throughout this unit. PS-H-E1, PS-H-E3 PS-H-E3 PS-H-E1 PS-H-E2, PS-H-E3 PS-H-E2, PS-H-E3 PS-H-E1 PS-H-A 1 ESS-H-D7, SE-H-B5 PS-H-C3 PS-H-C3, PS-H-E1 PS-H-A1, PS-H-E1 PS-H-E1

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TOPICS	BENCHMARKS
5. Explain the relationship between pressure and depth	PS-H-E3
6. Explain how pressure fits the definition of a prime mover	ESS-H-D7, SE-H-B5
7. Perform lab activities using real-world devices such as pressure gauges, manometers, and hydrometers	ESS-H-D7, SE-H-B5
8. Describe how a technician measures and controls pressure in fluid systems	
C. Voltage in Electrical Systems	
1. Define and apply the concepts of AC and DC current and voltage	PS-H-E1, PS-H-E3
2. Construct schematic diagrams of series and parallel circuits	PS-H-G1
3. Connect circuits in series and parallel; record the effect of these connections on voltage	PS-H-G1, PS-H-G3
4. Explain how voltage fits the definition of a prime mover	PS-H-E3
5. Name and use different types of voltmeters	
6. Briefly describe situations in which technicians measure voltage	ESS-H-D7, SE-H-B5 ESS-H-D7, SE-H-B5
D. Temperature in Thermal System	
1. Define and apply the concepts of thermal energy, heat, temperature, and the kinetic theory	PS-H-C7, PS-H-F2
2. Perform temperature and temperature difference conversions with appropriate units	PS-H-A1
3. Explain how temperature difference is a prime mover	PS-H-E3
4. Use thermocouples and thermometers to measure temperatures	ESS-H-D7, SE-H-B5
5. Briefly describe situations in which technicians measure and control temperatures	ESS-H-D7, SE-H-B5

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TOPICS	BENCHMARKS
III. Work	
A. Work in Mechanical Systems	Benchmarks SI-H-A 1-A7 and SI-H-B1-B5 are used throughout this unit.
1. Define the concept of work as it applies to linear and rotational mechanical systems, including the identification of the effects of work	PS-H-F1, PS-H-E3
2. Solve linear and rotational mechanical work problems using appropriate English and SI units	PS-H-A 1
3. Explain how efficiency relates to input work and output work for a mechanical system	PS-H-F1
4. Measure the efficiency of simple and complex machines using real-world applications	ESS-H-D7, SE-H-B5
5. Identify applications of linear and rotational work on the job site	ESS-H-D7, SE-H-B5
B. Work in Fluid Systems	
1. Define the concept of work as it applies to fluid systems, differentiating between open and closed fluid systems, including identification of effects of work done by fluids	PS-H-F1, PS-H-C3
2. Solve fluid work problems ($W = p \times \Delta V$ and $W = \Delta p \times V$) using correct English and SI units	PS-H-A 1
3. Measure the efficiency of pneumatic and hydraulic systems; explain the reasons for loss of efficiency	PS-H-F1, PS-H-E3
4. Identify workplace applications in which work occurs in fluid systems	ESS-H-D7, SE-H-B5
C. Work in Electrical Systems	
1. Define the concept of work as it applies to electrical systems including the identification of the effects of work done by electricity	PS-H-F1, PS-H-G1
2. Define *coulomb* as it relates to the number of electrons	PS-H-E1, PS-H-B3 PS-H-A 1

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TOPICS	BENCHMARKS
3. Solve electrical work problems, given appropriate values: voltage, charge, current, and time	PS-H-A 1
4. Stress that English and SI units for electricity are the same	
5. Measure the efficiency of electrical devices as related to electrical work input and mechanical work output	
6. Identify workplace applications in which work in electrical systems occurs	ESS-H-D7, SE-H-B5
IV. Rate	
A. Rate in Mechanical Systems	Benchmarks SI-H-A 1-A7 and SI-H-B1-B5 are used throughout this unit.
1. Calculate, measure, and distinguish between linear and rotational velocity using appropriate English and SI units	PS-H-A1, PS-H-E2
2. Calculate, measure and distinguish between linear and rotational acceleration using appropriate English and SI units	PS-H-E4 PS-H-A1, PS-H-E2
3. Identify workplace applications in which technicians measure and/or control rate in mechanical systems	PS-H-E4 ESS-H-D7, SE-H-B5
B. Rate in Fluid Systems	
1. Define and distinguish between *volume and mass flow rates*	PS-H-E2
2. Calculate volume and mass flow rates using appropriate equations with both English and SI units	PS-H-A1, PS-H-E2
3. Measure pneumatic and hydraulic fluid flow rates with real-world measuring instruments	ESS-H-D7, SE-H-B5
3. Identify workplace applications in which technicians measure and/or control rate in fluid systems	ESS-H-D7, SE-H-B5

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TOPICS	BENCHMARKS
C. Rate in Electrical Systems	
1. Define and calculate *current* given the appropriate charge and time values in relation to DC and AC current	PS-H-A1, PS-H-E2 PS-H-G1
2. Explain how current and frequency are two types of electrical rate; calculate both	PS-H-G1, PS-H-G2 PS-H-G3, PS-H-E2
3. Explain how frequency and period are related	PS-H-G1
4. Measure a current traveling through a circuit	ESS-H-D7, SE-H-B5
5. Measure the frequency of an AC circuit	ESS-H-D7, SE-H-B5
6. Identify workplace applications in which technicians measure and/or control electrical rate	ESS-H-D7, SE-H-B5
D. Rate in Thermal Systems	
1. Define and calculate both *heat* and *heat-flow rate* using appropriate English and SI units	PS-H-A1, PS-H-E2 PS-H-F2
2. Define *specific heat* and distinguish it from heat capacity, calorie, and BTU	PS-H-A1, PS-H-F1
3. Explain the concept of change of state using the kinetic molecular theory; differentiate between sensible and latent heat	PS-H-C7
4. Measure heat-flow rate using thermocouples	
5. Identify workplace applications in which technicians measure and/or control rate in thermal systems	ESS-H-D7, SE-H-B5 ESS-H-D7, SE-H-B5
V. Resistance	
A. Resistance in Mechanical Systems	Benchmarks SI-H-A1-A7 and SI-H-B1-B5 are used throughout this unit.
1. Define and apply the *concept of resistance* as it relates to friction and drag	PS-H-E2, PS-H-E3
2. Distinguish between static, kinetic, and rolling friction	
3. Define, measure, and calculate the coefficient of friction and drag resistance with appropriate English and SI units	PS-H-E1, PS-H-E3 PS-H-A1

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TOPICS	BENCHMARKS
4. Describe ways to reduce or increase friction in mechanical systems	PS-H-E3, ESS-H-D7
5. Identify workplace applications in which technicians measure and control resistance in mechanical systems	ESS-H-D7, SE-H-B5
B. Resistance in Fluid Systems	
1. Define and apply the *concept of resistance* as it relates to streamlined and turbulent flow	PS-H-E3, PS-H-C3
2. Identify the sources and effects of resistance in a fluid system and compare that resistance to resistance in a mechanical system	PS-H-E3
3. Measure and calculate fluid resistance as it relates to area, length, inside surface of pipe, and type of fluid using appropriate English and SI units	PS-H-A1, PS-H-E3
4. Describe how to reduce resistance in a fluid system	PS-H-E3, ESS-H-D7
5. Identify workplace applications in which fluid resistance is important	ESS-H-D7, SE-H-B5
C. Resistance in Electrical Systems	
1. Define, measure, and calculate *electrical resistance* as it relates to Ohm's law	PS-H-A1
2. Show how wire resistance is dependent on length, cross-sectional area, and the type of wire	PS-H-G1, PS-H-E3
3. Relate electrical resistance to fluid resistance	PS-H-E3
4. Connect resistors in series and in parallel; calculate total resistance in both circuits	PS-H-A1, ESS-H-D7
5. Distinguish among conductors, semiconductors, and insulators	PS-H-C3, PS-H-B3
6. Identify workplace applications in which technicians measure and control resistance in electrical systems	ESS-H-D7, SE-H-B5

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TOPICS	BENCHMARKS
D. Resistance in Thermal Systems	
1. Define, calculate, and measure *resistance in a thermal system* including identification of the effects of this resistance	PS-H-A1, PS-H-E3 PS-H-C7
2. Distinguish between thermal conductivity and thermal resistance	PS-H-C3
3. Explain the meaning of *R-factor* as a measure of relative thermal resistance of insulation	ESS-H-D7, SE-H-B5
4. Identify ways to reduce or increase thermal resistance	ESS-H-D7, SE-H-B5
5. Identify workplace applications in which technicians measure and control resistance in thermal systems	ESS-H-D7, SE-H-B5
VI. Energy	Benchmarks SI-H-A 1-A7 and SI-H-B1-B5 are used throughout this unit.
A. Energy in Mechanical and Fluid Systems I	
1. Define, measure, and calculate *gravitational potential energy* and *elastic potential energy* in mechanical and fluid systems using appropriate English and SI units	PS-H-A1, PS-H-F1 PS-H-E1
2. Define and calculate spring constant 3. Identify workplace applications in which technicians measure and control potential energy	PS-H-A1, PS-H-E1 ESS-H-D7, SE-H-B5
B. Energy in Mechanical and Fluid Systems II	
1. Define, measure, and calculate *linear and rotational kinetic energy* using appropriate English and SI units	PS-H-A1, PS-H-F1
2. Describe the work-energy theorem	PS-H-F2
3. Explain how mass and moment of inertia are similar	PS-H-E3, PS-H-C3
4. State and apply the law of conservation of energy	PS-H-F2
5. Identify workplace applications in which technicians measure and control kinetic energy	ESS-H-D7, SE-H-B5

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TOPICS	BENCHMARKS
C. Energy in Electrical Systems	
1. Define, measure, and calculate *energy in electrical systems* as it applies to capacitors and inductors	PS-H-A1, PS-H-F1
2. Describe the relationship between work and electrical energy	PS-H-F1
3. Explain the effects of capacitors versus inductors 4. Identify workplace applications in which technicians measure and control energy in an electrical system	PS-H-G3 ESS-H-D7, SE-H-B5
D. Energy in Thermal Systems	
1. Define, calculate, and measure *thermal energy*; describe how it is transferred between objects using appropriate English and SI units	PS-H-A1, PS-H-C7
2. Define and apply the three methods of heat energy transfer	PS-H-G1, PS-H-E1, PS-H-E3
3. Define *change of phase* and calculate *energy requirements* among solids, liquids, and gases	PS-H-A1, PS-H-C7
4. Explain how the law of conservation of energy applies to heat energy	
5. Explain the relationship between thermal energy and work; explain how this relationship applies to the mechanical equivalent of heat	PS-H-F1
6. Identify workplace applications in which technicians Measure or control energy in thermal systems	ESS-H-D7, SE-H-B5
VII. Power	Benchmarks SI-H-A 1-A7 and SI-H-B1-B5 are used throughout this unit.
A. Power in Mechanical Systems	
1. Define, measure, and calculate power in linear and rotational mechanical systems using appropriate English and SI units	PS-H-A1, PS-H-F1
2. Distinguish between power efficiency and work efficiency	
3. Identify workplace applications in which technicians measure and control power in mechanical systems	PS-H-F1 ESS-H-D7, SE-H-B5

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TOPICS	BENCHMARKS
B. Power in Fluid Systems	
1. Define, measure, and calculate power in fluid systems using appropriate English and SI units	PS-H-A1, PS-H-F1
2. Identify workplace applications where technicians measure and control power in fluid systems	ESS-H-D7, SE-H-B5
C. Power in Electrical Systems	
1. Define, measure, and calculate *power in electrical systems*	PS-H-A1, PS-H-F1
2. Identify workplace applications in which technicians measure and control power in electrical systems	ESS-H-D7, SE-H-B5
D. Power in Thermal Systems	
1. Define, measure, and calculate *power in thermal systems* as it relates to thermal rate using appropriate English and SI units	PS-H-A1, PS-H-F1
2. Identify workplace applications in which technicians measure and control power in thermal systems	ESS-H-D7, SE-H-B5
VIII. Force Transformers	Benchmarks SI-H-A1-A7 and SI-H-B1-B5 are used throughout this unit.
A. Force Transformers in Linear Mechanical Systems	
1. Define, measure, and calculate *work input* and *work output* for linear force transformers using appropriate English and SI units	PS-H-A1, PS-H-F1 PS-H-E3
2. Distinguish between and measure ideal mechanical advantage and actual mechanical advantage of a force transformer	PS-H-A1, PS-H-F1
3. Explain the differences among the three classes of levers	PS-H-E3

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TOPICS	BENCHMARKS
4. Identify the different kinds of force transformers and determine the efficiency of each	PS-H-A1, PS-H-F1
5. Identify workplace applications in which technicians use force transformers	ESS-H-D7, SE-H-B5
B. Force Transformers in Rotational Mechanical Systems	
1. Define, measure, and calculate the *mechanical advantage* and *efficiency* of various rotational systems using appropriate English and SI units	PS-H-A1, PS-H-F1
2. Explain the relationship between input work and output work; explain how this relationship pertains to rotational force transformers	PS-H-F1
3. Identify workplace applications in which technicians use rotational force transformers	ESS-H-D7, SE-H-B5
C. Force Transformers in Fluid Systems	
1. Measure and calculate input work, output work, and the mechanical advantage of a hydraulic jack	PS-H-A1, PS-H-F1
2. Define *pressure intensifier*; calculate intensifier efficiency	PS-H-A1, PS-H-F1
3. Identify workplace applications in which technicians use fluid transformers	ESS-H-D7, SE-H-B5
D. Force Transformers in Electrical Systems	
1. Measure and calculate input and output power, efficiency, and the electrical advantage of a voltage transformer	PS-H-A1, PS-H-F1
2. Distinguish between "step-up" and "stepdown" transformers	PS-H-G2
3. Identify workplace applications in which technicians use electrical transformers	ESS-H-D7, SE-H-B5

Acknowledgements

The team of educators who developed this document is to be commended for their dedicated work and generous contribution of time and talent. The collaborative efforts of these experienced and committed professionals made possible curricular guidelines that reflect contemporary thinking about science education and that support high quality science education for *all* students.

We are grateful to local school districts that generously released the following high school teachers, the curriculum specialists, and supervisors to participate in this project.

Alicia Courville
Calcasieu Parish

Tom Daniel
Bossier Parish

Warren Sensat
Lafayette Parish

The work for this project was coordinated by Gary Kratzer, Science Program Coordinator, Division of Student Standards and Assessments, Louisiana Department of Education. Special acknowledgement goes to Marlene Ritter, former Director of the Bureau of Secondary Education, who initiated the project. Sincere appreciation for technical editing is extended to Chris Parmentier, Division of Student Standards and Assessments, Louisiana Department of Education, for the development of the *Checklist for Safety in the Science Classroom*, a special thanks is owed to Martha Newchurch, Nicholls State University, and Julie Brown, LaSIP Site Coordinator, Nicholls State University.