Massachusetts Tests for Educator Licensure®

TEST INFORMATION BOOKLET

33 Technology/Engineering

MA-SG-FLD033-04

Massachusetts Department of Education

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Test Overview Chart: Technology/Engineering (33)

Subareas	Approximate Number of Multiple-Choice Items	Number of Open-Response Items
I. Communication	16–18	2
II. Production	13–15	
III. Power, Energy, and Transportation	13–15	
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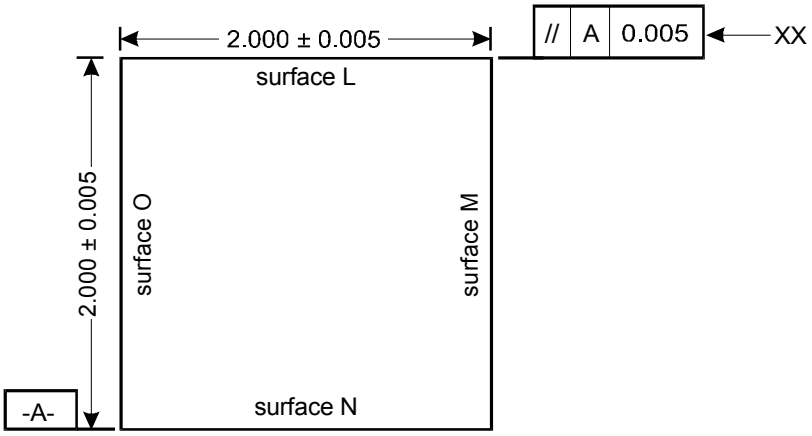
The Technology/Engineering test is designed to assess the candidate's knowledge of the subject matter required for the Massachusetts Technology/Engineering Teacher certificate. This subject matter knowledge is delineated in the Massachusetts Department of Education *Regulations for the Certification of Educational Personnel in Massachusetts* (April 1995), 603 C.M.R. 7.12, "Competencies for Specific Certificates," Section (21) (a) 2. "Competency I: Subject Matter Knowledge."

The Technology/Engineering test assesses the candidate's proficiency and depth of understanding of the subject at the level required for a baccalaureate major, according to Massachusetts standards. Candidates are typically nearing completion of or have completed their undergraduate work when they take the test.

The multiple-choice items on the test cover the subareas as indicated in the chart above. The open-response items may relate to topics covered in any of the subareas and will typically require breadth of understanding of the technology/engineering field and the ability to relate concepts from different aspects of the field. Responses to the open-response items are expected to be appropriate and accurate in the application of subject knowledge, to provide high-quality and relevant supporting evidence, and to demonstrate a soundness of argument and understanding of the technology/engineering field.

1. **Use the diagram below to answer the question that follows.**



The tolerance symbol notation labeled *XX* is used to indicate that surface *L* must be:

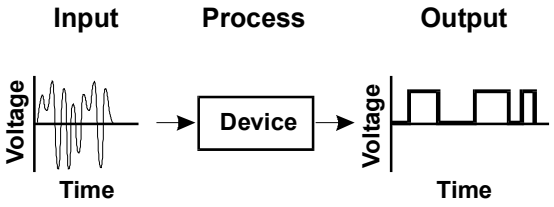
A. the correct length, plus or minus 0.005.

B. perpendicular to surface *O*, plus or minus 0.005.

C. located in its true position, plus or minus 0.005.

D. parallel to surface *N*, plus or minus 0.005.

2. **Use the diagram below to answer the question that follows.**



The diagram above represents a function carried out by which of the following devices?

A. microphone

B. modem

C. CPU

D. piezoelectric crystal

3. Fir is commonly used as a framing material in the residential construction industry primarily because of its:

A. resistance to mildew and termites.

B. high density.

C. availability and relatively low cost.

D. resistance to warping.

4. Which of the following products is most likely to be manufactured by drawing metal stock through a die?

   A. wire used to make cables

   B. rod bearings used to reduce friction in machines

   C. steel studs used in construction

   D. metal sheets used in automobile bodies

5. To achieve widespread availability of electric-powered automobiles, engineers in this research field are concentrating primarily on the design of a lightweight:

   A. battery that can be recharged a sufficient number of times.

   B. motor that can operate efficiently on the fluctuating output of available batteries.

   C. motor that can operate efficiently on the low output of available batteries.

   D. battery that can store sufficient energy with each recharging operation.

6. Which of the following is an example of a direct-gain passive solar–heating system?

   A. Solar radiation is extracted by a rock bed located below the surface of a dwelling.

   B. Air is heated by solar collectors and pumped to a thermal storage unit.

   C. Solar radiation passes though south-facing windows and is stored in walls and floors.

   D. Water is heated by solar collectors and pumped to a water tank.

7. A double-integrated switch is a machine safety feature designed to ensure that:

   A. both of the operator's hands are kept clear of moving parts.

   B. the machine will not stop unexpectedly if one switch is shut off.

   C. two people are present when the machine is being operated.

   D. the machine can be operated from more than one work position.

8. Which two of the following would be the primary advantages of using a computer simulation system as the basis of instruction?

   I. Computer simulation systems cost less than other modes of instruction.

   II. Using computer simulation software makes it easy to evaluate student progress.

   III. Computer simulation systems facilitate self-paced learning.

   IV. Using computer simulation software improves student behavior.

   A. I and II only

   B. II and III only

   C. III and IV only

   D. I and IV only

9. When a computer manufacturing company receives a shipment of computer chips, its quality control inspectors randomly select 10 percent of the chips in the shipment on which to run tests. If 10 percent or more of the chips in the sample are defective, the entire shipment is rejected. Which of the following assumptions underlies this decision to test only a sample of chips rather than the entire shipment?

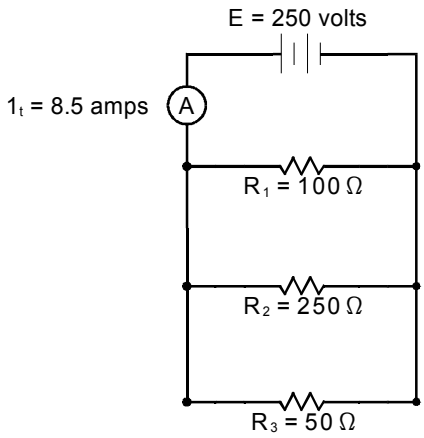
   A. If there are any defects in the shipment, they are most likely to appear in the 10 percent selected for testing.

   B. The chances of having to reject the load increase as the number of chips increases.

   C. The small sample is fairly representative of the overall shipment.

   D. The probability for human error in the testing procedures increases as the sample size increases.

10. **Use the diagram below to answer the question that follows.**



What is the current flow through resistor R_3 in this circuit?

A. 8.5 amperes

B. 5 amperes

C. 2.5 amperes

D. 1 ampere

11. **Use the information below to complete the exercise that follows.**

The Colby Engineering Company manufactures small garden tractors. Recently, managers at Colby have become aware of a quality control problem concerning one of their products. Consumer surveys indicate that a bracket that secures the seat to the seat-post is failing at a high rate. There has been no recent change in the design of the tractors or the bracket. This bracket is milled in-house from steel stock supplied by a vendor. There is currently no quality control check of this part.

Using your knowledge of manufacturing technology and quality control procedures, write an essay describing an appropriate procedure for finding and correcting Colby Engineering's problem. In your essay:

- describe three possible causes for the bracket's high rate of failure, and explain how each of the three causes could result in bracket failure; and

- suggest the most efficient procedure for identifying the source of the problem. Explain how each step in your procedure helps to isolate the true source of the problem, and analyze the effects of your procedure on production schedules and operating costs.

Answer Key and Sample Responses: Technology/Engineering (33)

Question Number	Correct Response	Test Objective*
1.	**D**	Understand the principles, processes, and procedures in design/drafting.
2.	**B**	Understand the principles, processes, and procedures in electronic communication.
3.	**C**	Understand the principles, processes, and procedures in construction.
4.	**A**	Understand the principles, processes, and procedures in manufacturing.
5.	**D**	Understand the composition and function of power, energy, and transportation technology industries.
6.	**C**	Understand generation, transformation, transmission, and control of energy.
7.	**A**	Understand environmental and safety issues related to resources used in technology education.
8.	**B**	Understand the principles, processes, and procedures in multimedia communication.
9.	**C**	Understand the principles, processes, and procedures in manufacturing.
10.	**B**	Understand the principles, processes, and procedures in engineering technology.

*Each test objective is clarified and further described by a descriptive statement, which provides examples of the types of knowledge and skills covered by the test objective. The test objectives for the Technology/Engineering test begin on page 41.

The sample response below reflects a weak knowledge and understanding of the subject matter.

The bracket's high rate of failure is caused by the process used by Colby Engineering to mill the steel while manufacturing the part. Molten steel must be cooled. If the part is not cooled correctly, it will be corrupted, causing the part to fail at a high rate. Another problem is that the steel is being melted at too high a temperature. This would cause the part to become too hard, since metals become hard when heated or "tempered."

A procedure for identifying the source of the problem as efficiently as possible would be to take the temperature of the molten steel. The temperature should be taken at regular intervals, recorded, and plotted on a graph. If the graph is a straight line, then the problem lies in the process used to cool the molten steel.

This method for determining the problem would not have any effects on production schedules since it is easy to measure the temperature of the steel. It's also easy to adjust the cooling temperature. This can be accomplished by pouring water over the steel to reduce its temperature, or reheating it to increase its temperature. This method has the additional advantage of cutting costs since it allows any faulty part to be recycled simply by putting it back into the blast furnace for remelting. The method of measuring the steel's temperature could also be used to determine if the steel were tempered before being poured into the mold.

The sample response below reflects a strong knowledge and understanding of the subject matter.

The bracket could be failing for a number of reasons: material failure, process error, or a type of use not anticipated and planned for in the design of the part.

The stock material itself could be at fault. The metal supplied to the manufacturer could be of a grade below that specified in the order. To determine whether substandard material is the source of the problem, investigators should subject the material to standard destructive tests including tensile testing, compression testing, fatigue testing, and torsional testing and to nondestructive measures such as visual inspection, x-ray, and magnetic particle testing. The results of these tests should be compared to the findings of similar tests performed before the problem arose.

The manufacturing process should also be examined. If the metal stock is forged before the part is milled, the effect of the forging on the grain of the metal needs to be taken into account when the stock is set up for milling. An error at this point could be the source of the weakness in the finished part. Alternatively, the milling procedure could be flawed. If the part is milled by a CNC (computer-numerical control) machine, investigators should determine whether the machine's code has been changed. They should also compare the machine's program to its output to identify possible hardware problems. If the machine used to make the part is not computer-controlled, the operators should be asked whether they have changed their procedures.

It is possible that the tractor is being used in a way not anticipated by designers. For instance, consumers may be attaching a new after-market accessory such as a utility trailer to the seat post or to the bracket itself. This could put excessive strain on the bracket, causing premature failure. This type of problem could be identified through surveys or field interviews. The manufacturer could solve such a problem by modifying the tractor design, perhaps adding a properly designed trailer hitch.

The investigation should be carried out with minimal effect on production. Material testing will not interfere with schedules or procedures. Review of the manufacturing process may disrupt production, but several steps can be taken to minimize its effects. Investigators can review copies of the computer code without interrupting machine operation. If the machine to be examined is not in continuous use, operators may be able to demonstrate procedures when the machine is normally idle. Investigators can then observe the operation of the machine a second time during production hours. Whatever the outcome of the investigation, its findings should be the basis for a review of the company's quality assurance procedures, which may need to be expanded.

Test Objectives: Technology/Engineering (33)

SUBAREAS:

COMMUNICATION
PRODUCTION
POWER, ENERGY, AND TRANSPORTATION
TECHNOLOGY

COMMUNICATION

0001 Understand the composition and function of communication technology industries.

For example: types of businesses; recent industry trends; career opportunities, their characteristics, and their requirements; major markets; and major material and service providers.

0002 Understand the appropriate selection and use of resources in communication technology.

For example: appropriate tools, materials, and equipment for a given task; the safe use of selected tools and equipment in a given situation (e.g., computer-based page layout and design, audio, video, and multimedia productions, data storage and retrieval); properties of materials and supplies used in communication technology; and the selection of appropriate materials and supplies for a given application.

0003 Understand the principles, processes, and procedures in graphic arts and electronic publishing.

For example: graphic design (e.g., layout, color, typography); image generation (e.g., scaling, photo imaging, image assembly); production (e.g., image carrier, image transfer); binding and finishing; and the use of computers in graphic arts.

0004 Understand the principles, processes, and procedures in design/drafting.

For example: types of sketches and drawings and their uses; techniques and procedures for designing, producing, and interpreting technical drawings (e.g., mechanical, architectural); the production and interpretation of specifications and three-dimensional models; and the use of computers and computer software.

0005 Understand the principles, processes, and procedures in electronic communication.

For example: basic electronics (e.g., characteristics and uses of electronic components, DC and AC circuits, analog and digital circuits, integrated circuits); processes and procedures related to electronic and telecommunication systems (e.g., television, telephone, on-line communication, fiber optics satellite communication); the analysis of broadcast systems (e.g., operating parameters of broadcast systems, applying test procedures, determining appropriate systems and components for a given application); and the analysis of the capabilities of various technologies.

PRODUCTION

0006 Understand the composition and function of production technology industries.

For example: types of businesses; recent industry trends; career opportunities, their characteristics, and their requirements; major markets; and major material and service providers.

0007 Understand the appropriate selection and use of resources in production technology.

For example: the selection and safe use of appropriate tools and equipment in a given manufacturing or construction situation; the properties of materials used in production technology; and the selection of appropriate materials for a given application.

0008 Understand the principles, processes, and procedures in construction.

For example: processes and procedures used to construct various types of structures; the importance of legal requirements associated with construction projects (e.g., regulatory agencies, zoning laws, building inspection services); purposes of construction documents such as permits and licenses; problems related to construction systems; and appropriate applications and modifications of processes and procedures.

0009 Understand the principles, processes, and procedures in manufacturing.

For example: characteristics and types of manufacturing systems (e.g., automated, robotics, continuous, custom, intermittent, just-in-time); types and characteristics of manufacturing processes (e.g., casting, forming, separating, conditioning) and their capabilities; procedures for ensuring and maintaining quality control; procedures for managing manufacturing operations; and the management and financial impact of operational and line decisions.

POWER, ENERGY, AND TRANSPORTATION

0010 Understand the composition and function of power, energy, and transportation technology industries.

For example: types of businesses; recent industry trends; career opportunities, their characteristics, and their requirements; major markets; and major material and service providers.

0011 Understand resources used in power, energy, and transportation technologies.

For example: the selection and safe use of appropriate tools and equipment in a given situation (e.g., conversion, control, storage, and transmission of energy); properties of materials and supplies used in power, energy, and transportation technologies; and the selection of appropriate materials for a given application.

0012 Understand generation, transformation, transmission, and control of energy.

For example: scientific principles, processes, and equipment involved in generating power (e.g., nuclear, fossil fuel, solar, hydro, wind); conversions among electrical, mechanical, chemical, and nuclear forms; the transmission, control, and storage of energy; and concepts of efficiency and energy loss.

0013 Understand transportation technology.

For example: principles, processes, and equipment related to propulsion, suspension, guidance, control, support, and structural components of land, air, and sea transportation systems; technological problems related to transportation systems; and analysis of situations to determine appropriate applications and modifications of processes and procedures.

TECHNOLOGY

0014 Understand career opportunities in technology career paths.

For example: characteristics of these careers (e.g., educational requirements, working conditions, responsibilities); the relationship between the characteristics of careers and the goals of individuals; preparation requirements for careers; skills for seeking employment; functions and resources of professional organizations; and the importance and development of social skills, leadership skills, and pride in the quality of one's work.

0015 Understand environmental and safety issues related to resources used in technology education.

For example: procedures for the safe operation of tools and equipment; recognition of safety hazards and potentially dangerous situations; the importance of a safe and clean work environment in the laboratory and workplace; procedures and equipment for maintaining a safe and clean environment; procedures and issues related to environmentally sound disposal of materials; and the importance of personal safety and instruction of safety practices.

0016 Understand independent and integrated systems.

For example: the systems approach (e.g., input, process, output, feedback); how technological systems operate individually and interdependently; interrelationships that commonly exist among technological systems (e.g., communication, energy, production); the critical role of evaluation and quality control in technological systems; and procedures for setting and meeting specifications.

0017 Understand the principles, processes, and procedures in multimedia communication.

For example: capabilities of multimedia systems; procedures for interfacing various communication media; and the planning and designing of a multimedia communication product intended to teach, inform, or sell.

0018 Understand new and emerging technologies.

For example: capabilities of new and emerging technologies (e.g., biotechnology, laser technology); scientific principles related to these technologies; sources of information concerning emerging technologies; and likely uses for these technologies.

0019 Understand the interrelationships among technology, science, and mathematics.

For example: the flow of information among technology, science, and mathematics; the analysis of technological systems in terms of mathematical and scientific principles; and the influence of technology on science and mathematics.

0020 Understand technology and society.

For example: current political, economic, and social trends and how they relate to industrial technology; ethical considerations; the role of business, government, society, and the individual in shaping the field of technology; and the history of technology and its significance in global, political, and social contexts.

0021 Understand the interdisciplinary nature of technology education.

For example: the value of an integrated approach that uses knowledge of other academic subjects to help understand and solve technological problems (e.g., the use of effective language skills for the communication of ideas, the application of the principles of social systems to analyze the impact of technology and society on one another).

0022 Understand the principles, processes, and procedures in engineering technology.

For example: the basic principles of design, technology, physics, chemistry, and electronics (e.g., dimensional analysis, force, Ohm's law) related to the solution of engineering problems; and basic mathematical procedures and processes (e.g., quadratic equations, graphing, trigonometric functions) related to the solution of engineering problems.

0023 Understand the design process for solving problems in technology.

For example: identifying a problem; proposing designs and choosing between alternative solutions; evaluating a solution; communicating the problem, process, and solution; and redesigning the solution.