Industrial Maintenance Technology

Study Guide

Assessments:
3901 Industrial Maintenance Mechanic
3902 Fluid Power Mechanic
3903 Electrical/Electronic Mechanic
Overview

This study guide is designed to help students prepare for the following Industrial Maintenance Technology assessments: Industrial Maintenance Mechanic assessment, Fluid Power Mechanic assessment, and Electrical/Electronic Mechanic assessment. It not only includes information about the assessments, but also the skills standards upon which the assessments are based, and test taking strategies. The assessments measure a student’s ability to apply knowledge of the skills necessary for success in the Industrial Maintenance field.

Each of the four sections in this guide provides useful information for students preparing the Industrial Maintenance Technology assessments.

- CareerTech and Competency-Based Education: A Winning Combination
- Industrial Maintenance Technology Assessments
  ▶ Assessment Information
  ▶ Standards and Test Content
  ▶ Sample Questions
  ▶ Abbreviations, Symbols, and Acronyms
- Strategies for Test Taking Success
- Notes

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CareerTech and Competency-Based Education: A Winning Combination

Competency-based education uses learning outcomes that emphasize both the application and creation of knowledge and the mastery of skills critical for success. In a competency-based education system, students advance upon mastery of competencies, which are measurable, transferable outcomes that empower students.

Career and technology education uses industry professionals and certification standards to identify the knowledge and skills needed to master an occupation. This input provides the foundation for development of curriculum, assessments and other instructional materials needed to prepare students for wealth-generating occupations and produce comprehensively trained, highly skilled employees demanded by the work force.

Tools for Success

CareerTech education relies on three basic instructional components to deliver competency-based instruction: skills standards, curriculum materials, and competency assessments.

**Skills standards** provide the foundation for competency-based instruction and outline the knowledge and skills that must be mastered in order to perform related jobs within an industry. Skills standards are aligned with national skills standards and/or industry certification requirements; therefore, a student trained to the skills standards is equally employable in local, state and national job markets.

**Curriculum materials and textbooks** contain information and activities that teach students the knowledge and skills outlined in the skills standards. In addition to complementing classroom instruction, curriculum resources include supplemental activities that enhance learning by providing opportunities to apply knowledge and demonstrate skills.

**Competency Assessments** test the student over material outlined in the skills standards and taught using the curriculum materials and textbooks. When used with classroom performance evaluations, written competency assessments provide a means of measuring occupational readiness.

Each of these components satisfies a unique purpose in competency-based education and reinforces the knowledge and skills students need to gain employment and succeed on the job.

Measuring Success

Evaluation is an important component of competency-based education. Pre-training assessments measure the student’s existing knowledge prior to receiving instruction and ensure the student’s training builds upon this knowledge base. Formative assessments administered throughout the training process provide a means of continuously monitoring the student’s progress towards mastery.

Written competency assessments provide a means of evaluating the student’s mastery of knowledge and skills. Coaching reports communicate competency assessment scores to students and provide a breakdown of assessment results by standard area. The coaching report also shows how well the student has mastered skills needed to perform major job functions and identifies areas of job responsibility that may require additional instruction and/or training.
Industrial Maintenance Technology
Assessments Information

**What are the Industrial Maintenance Technology assessments?**

The Industrial Maintenance Technology assessments are end-of-program assessments for students in Industrial Maintenance programs. The assessments provide an indication of student mastery of knowledge and concepts necessary for success in careers in this area.

**How were the assessments developed?**

The assessments were developed by the CareerTech Testing Center. Items were developed and reviewed by a committee of subject matter experts.

**What do the assessments cover?**

Specifically, the test includes multiple-choice test items over the following areas:

**Industrial Maintenance Mechanic (55 questions)**
- Assemble and Disassemble Machine Mechanism: 35%
- Maintain Hydraulic Systems: 15%
- Maintain Pneumatic Systems: 7%
- Perform Electrical and Industrial Electricity Functions: 22%
- Work Metal with Hand or Portable Tools: 15%
- Perform Maintenance and Repair Functions: 5%
- Demonstrate Employability Skills: 1%

**Fluid Power Mechanic (55 questions)**
- Maintain Hydraulic Systems: 58%
- Maintain Pneumatic Systems: 33%
- Perform Maintenance and Repair Functions: 9%

**Electrical/Electronic Mechanic (55 questions)**
- Perform Electrical and Industrial Electricity functions (600 volts or less): 89%
- Maintain Industrial Robot and Motion Control Systems: 4%
- Maintain Fiber Optics and Data Communications: 2%
- Perform Maintenance and Repair Functions: 5%
What are the benefits of using these assessments?

Students receive a competency certificate for each assessment that he/she passes. This certificate may be included in his/her portfolio and used to communicate the student’s mastery of the subject matter to potential employers.

When should the assessments be taken?

The CareerTech Testing Center recommends that students take these assessments as soon as possible after receiving all standards-related instruction, rather than waiting until the end of the school year.

Are the assessments timed?

No. Although students may take as long as they need, most finish the assessment within one hour.

What resources can students use on these assessments?

Students are allowed to use calculators and scratch paper on CTTC competency assessments; however, these items must be provided by the testing proctor and returned to the proctor before the student’s exam is submitted for scoring. Calculator apps on cell phones and other devices may not be used on these assessments.

Students taking any of the four Industrial Maintenance tests may use a publisher-bound National Electrical Code Reference.

What accommodations can be made for students with Individualized Education Plans (IEPs)?

Accommodations are allowed for students with an Individualized Education Plan. Examples of allowable accommodations include:

- Extended time — This assessment is not timed; therefore, students may take as much time as needed to finish. The assessment must be completed in one testing session.

- Readers — A reader may be used to read the assessment to a student who has been identified as needing this accommodation.

- Enlarged text — Students needing this accommodation can activate this feature by clicking the AA icon in the upper right corner of the screen.
What can students expect on Test Day?

All CTTC assessments are web-based and delivered exclusively by a proctor in the school’s assessment center. The proctor cannot be an instructor or anyone who was involved with the student during instruction.

Assessments are delivered in a question-by-question format. When a question is presented, the student can select a response or leave the question unanswered and advance to the next question. Students may also flag questions to revisit before the test is scored. All questions must be answered before the test can be submitted for scoring.

After the assessment is scored, the student will receive a score report that not only shows the student’s score on the assessment, but also how the student performed in each standard area.

Can students retake the test?

Students may retake the test unless their school or state testing policies prohibit retesting. Students who can retest must wait at least three days between test attempts.
Standards and Test Content
Industrial Maintenance Technology

Assemble and Disassemble Machine Mechanisms (19 questions)

1. Align and tension a belt drive
2. Align/maintain belt and pulley drive
3. Install belts and pulleys
4. Install/align tension a chain and sprocket drive
5. Maintain chain and sprocket drives
6. Install/align closed gear drives
7. Clean and lubricate gear drive
8. Install/align flexible coupling
9. Disassemble/reassemble couplings
10. Install and align pillow block bearings
11. Install and align a shaft assembly
12. Maintain safety guards
13. Measure speed of rotating equipment
14. Read and interpret mechanical drawing
15. Lubricate air compressor
16. Adjust air compressor to
   • Minimize noise
   • Reduce overload
17. Remove foreign debris from cooling tower
18. Replace air filters

Maintain Hydraulic Systems (8 questions)

1. Replace/clean/maintain hydraulic strainer/filters
2. Refill hydraulic system
3. Measure and adjust hydraulic pressure
4. Fabricate hydraulic lines (tubing, hoses, and pipes)
5. Inspect/replace damaged or faulty hydraulic lines/fittings
6. Read and interpret hydraulic schematics
7. Draw sample of hydraulic fluid for analysis
8. Assemble circuits from prints and diagrams
9. Identify hydraulic components, fittings (threads and types) and lines
Maintain Pneumatic Systems (4 questions)

1. Check/replace pneumatic lines/fittings
2. Read and interpret pneumatic schematics
3. Replace/regulate and maintain an automatic lubricating device in a pneumatic line
4. Check operation of water separator/drain as necessary
5. Clean and flush pneumatic systems
6. Align piston (rod) of pneumatic cylinder
7. Measure and adjust pneumatic regulators

Perform Electrical and Industrial Electricity Functions (600 volts or less) (12 questions)

1. Measure the following in AC and DC circuits
   - Voltage
   - Current
   - Power (wattage)
   - Power factors
   - Resistance
2. Remove/replace/test fuses
3. Reset circuit breaker after overload
4. Test and replace faulty electrical control components
5. Change rotation of three-phase electric motor
6. Replace faulty electrical cords and plugs
7. Replace electrical motor brushes
8. Lubricate electric motors
9. Wire electric motor
10. Clean electric motors
11. Define/apply theory of Ohm’s law
12. Remove and replace GFI receptacle
13. Read and interpret electrical circuit diagrams
14. Replace over-current protection for control circuits within NEC guidelines
15. Install electric motor
Work Metal with Hand or Portable Tools (8 questions)

1. Cut metal stock with a hand hacksaw
2. Cut threads with
   • Hand taps
   • Dies
3. Ream holes with hand reamer
4. Remove damaged screws and other threaded hardware
5. Drill holes in metal with portable device
   • Select proper drill bit, speed, and feed
6. Grind surfaces with portable electric hand grinder

Perform Maintenance and Repair Functions (3 questions)

1. Order materials needed for a job
2. Record preventive maintenance activities
3. Observe/evaluate corrective maintenance/repair on machinery

Demonstrate Employability Skills (1 question)

Career Success

1. Demonstrate personal characteristics desired by employers
   • Good communication skills
   • Good attendance
   • Neat appearance
   • Honest/ethical
   • High self-esteem
   • Flexible
   • Goal-oriented
   • Commitment
   • Cooperative
   • Initiative
   • Responsible
   • Positive attitude
   • Self management
   • Drug free/alcohol free
2. Demonstrate effective interpersonal skills
3. Demonstrate a positive attitude
4. Demonstrate customer service skills
5. Demonstrate personal resource skills
6. Utilize proper telephone techniques
7. Use job-related terminology, symbols, and abbreviations
8. Interpret and follow oral and written directions
9. Recognize the importance of team work and participate as a team member
10. Use critical; thinking skills in workplace situations
11. Demonstrate negotiation skills
12. Demonstrate leadership skills
13. Understand organization structure and employee roles
14. Understand cultural diversity in the workplace
15. Explore opportunities for advanced training
16. Participate in computer literacy training, when applicable
17. Perform self-evaluation to establish/modify career goals
18. Identify employment opportunities
19. Identify levels of training recommended for related careers
20. Understand salary, wages, and benefits packages
21. Complete an employment application
22. Prepare a resume
23. Complete an employment interview
24. Complete a W-4 form
25. Create an employment portfolio

Safety
26. Explain the purpose for safety policies
27. Discuss the role of OSHA and EPA
   • Locate information in MSDS
28. Participate in OSHA training
   • Lockout/Tagout
   • HAZCOM
     • MSDS
   • Blood borne pathogens
   • Confined spaces
   • Job briefing
   • Electrical safety
   • Fire safety
29. Explain the proper steps in reporting an accident or emergency
30. Explain the hazards associated with specific types of equipment and tools
31. Perform machine operator safety checks of equipment and accessories, when necessary
32. Practice tool safety
33. Demonstrate and use appropriate tools for the job
34. Describe the types of fire hazards found in the workplace
35. Understand/demonstrate prevention of electrical hazards
36. Demonstrate safe use of personal protective equipment
37. Demonstrate safe material handling techniques
   - Lifting
   - Transporting
   - Storing

38. Understand established first aid procedures

39. Practice good housekeeping

40. Comply with company policies

**Academic Skills**

41. Apply reading and writing skills, when necessary

42. Apply mathematical operations involving whole numbers, fractions, decimals, percentages, mathematical word problems, ratios, etc., when necessary
   - Addition
   - Subtraction
   - Multiplication
   - Division

43. Apply advanced mathematical operations, when necessary
   - Algebra
   - Geometry
   - Trigonometry

44. Apply scientific principles, when necessary
   - Physics
   - Chemistry

45. Interpret charts, table, graphs

**Quality Assurance and Problem Solving**

46. Understand the principles of quality assurance

47. Participate in the implementation of quality assurance programs
   - Material and labor utilization

48. Identify the effects of continuous quality improvement

49. Utilize problem solving and critical thinking techniques to identify and solve problems
   - Brainstorming

50. Discuss data collection techniques for the quality assurance and problem solving process

51. Identify opportunities for applying problem solving skills

**Blueprints**

52. Identify basic elements of blueprints
   - Terms
   - Component
     - Revisions
   - Symbols
53. Discuss different types of drawings
54. Interpret drawings
   • Bill of materials
   • Revisions
   • Tolerances
   • Document system changes
   • Modify prints
55. Interpret symbols

**Measurement Tools and Techniques**
56. Identify types of measuring instruments
57. Use appropriate measurement instrument for a measurement task
58. Read measuring instruments
59. Identify the appropriate formula and units for a measurement task
60. Differentiate between English and metric measurement systems, when necessary
61. Communicate measurements using proper symbols or words
62. Demonstrate the importance of calibration
Standards and Test Content
Fluid Power Mechanics

Maintain Hydraulic Systems (32 questions)

1. Replace/clean/maintain hydraulic strainer/filters
2. Clean and flush hydraulic systems
3. Refill hydraulic system
4. Align piston (rod) of hydraulic cylinder
5. Measure and adjust hydraulic pressure
6. Install and align hydraulic motor or pump
7. Replace hydraulic O-rings and seals
8. Fabricate hydraulic lines (tubing, hoses, and pipe)
9. Inspect/replace damaged or faulty hydraulic lines/fittings
10. Replace damaged or faulty hydraulic components
11. Replace valve in hydraulic system
12. Measure/adjust flow within hydraulic system
13. Read and interpret hydraulic schematics
14. Draw basic hydraulic circuits using standard ISO graphic symbols
15. Check operation of
   • Pumps
   • Valves
   • Actuators
   • Accessories
16. Check pre-charge pressure and charge accumulators as necessary
17. Draw sample of hydraulic fluid for analysis

Maintain Pneumatic Systems (18 questions)

1. Check/replace cylinders and motors
2. Check/replace valves
   • Directional
   • Flow control
   • Pressure regulators
   • Receiver
   • Relief
   • Quick exhaust
3. Check/replace/maintain silencers and filters
4. Inspect and service air dryers
   • Refrigeration
   • Chemical
5. Check/replace pneumatic lines/fittings
6. Read and interpret pneumatic schematics
7. Replace/regulate and maintain an automatic lubricating device in a pneumatic line
8. Check operation of water separator/drain as necessary
9. Inspect and maintain vacuum systems
10. Clean and flush pneumatic systems
11. Align piston (rod) of pneumatic cylinder
12. Measure and adjust pneumatic regulators
13. Replace pneumatic O-rings and seals

**Perform Maintenance and Repair Functions (5 questions)**

1. Order materials needed for a job
2. Record preventative maintenance activities
3. Observe/evaluate corrective maintenance/repair on machinery
Standards and Test Content
Electrical/Electronic Mechanic

Perform Electrical and Industrial Electricity Functions (600 volts or less) (49 questions)

1. Measure the following in AC and DC circuits
   • Voltage
   • Current
   • Power (wattage)
   • Power factors
   • Resistance

2. Maintain the following in AC and DC circuits
   • Voltage
   • Current
   • Power (wattage)
   • Power factors
   • Resistance

3. Test/troubleshoot solid state components
   • Board level
   • Variable speed drives

4. Remove/replace/test fuses
5. Reset circuit breaker after overload
6. Replace circuit breakers
7. Remove electrical overloads
8. Remove/replace protective control components
9. Test and replace faulty electrical control components
10. Install electric motors
11. Change rotation of three-phase electric motor
12. Replace faulty electrical cords and plugs
13. Replace electrical motor brushes
14. Lubricate electric motors
15. Wire electric motors
16. Clean electric motors
17. Define/apply theory of Ohm's law
18. Wire low voltage (less than 110 volts) control circuit
19. Remove and replace GFI receptacle
20. Install raceways and wiring on equipment
21. Install/program/modify PLC
22. Install/remove/replace motor control circuitry on equipment
23. Install/test variable speed AC/DC drive on equipment
24. Read and interpret electrical circuit diagrams
25. Maintain proper ground requirements
26. Install transformer on equipment for
   • Delta Wye configurations
   • Wye Delta configurations
27. Replace/maintain/troubleshoot 3-phase reversing motor starters
28. Construct common control circuits using switches and relays
29. Determine appropriate types of motors for a given mechanical load and
    determine the over-current protection
    • Universal
    • Shaded-pole
    • Capacitor-start
30. Replace over-current protection for control circuits within NEC guidelines
31. Correct problems associated with “AC hum”/single phase condition in motor control circuits

**Maintain Industrial Robot and Motion Control Systems (2 Questions)**

1. Interface a robot to external peripheral equipment
2. Specify safety considerations
3. Test and verify operation of servo robot using operator interface device
4. Maintain specialized safety peripherals or apparatus

**Maintain Fiber Optics and Data Communications (1 Question)**

1. Measure/troubleshoot synchronous data communication equipment
2. Install pre-manufactured fiber optics lines
   • Proper installation procedures
   • Proper terminators
   • Temperature limitations

**Perform Maintenance and Repair Functions (3 Questions)**

1. Order materials needed for a job
2. Record preventive maintenance activities
3. Observe/evaluate corrective maintenance/repair on machinery
Sample Questions

1. What can cause a V-belt to become hardened or cracked?
   a. excessive heat
   b. inadequate tension
   c. overloaded drive
   d. slipped belt

2. What is the most important safety rule to observe when inspecting or repairing belt drives?
   a. Check the pulley size for the proper ratio.
   b. Lock the on-off switch in the “off” position.
   c. Note all emergency exits.
   d. Turn off all electricity within 50 feet.

3. What occurs when cracking pressure is present?
   a. fluid begins to flow past the pressure relief valve
   b. fluid levels rise high, causing damage to the system
   c. pressure differential is maximized
   d. pressure relief valve is disabled

4. The only way to precisely position air cylinders is to use:
   a. equal pressure.
   b. internal stops.
   c. mechanical stops.
   d. pressure regulators

5. What can an industrial mechanic use to connect machinery to a power source?
   a. magnetic starter
   b. rotor clip
   c. speed reducer
   d. stator field
6. What type of wire is commonly used in installations when layout lines are used as reference lines for machinery positioning?
   a. piano
   b. plain steel
   c. viola
   d. wound copper

7. What kind of threads does an oxygen cylinder have?
   a. female left-hand
   b. female right-hand
   c. male left-hand
   d. male right-hand

8. How is a hacksaw blade properly installed?
   a. down and away from the handle
   b. down and towards the handle
   c. up and away from the handle
   d. up and towards the handle

9. Which drill cutting tool comes with various cutting edge degrees?
   a. counterbore
   b. countersink
   c. tap
   d. tapered shank drill

10. What is the most common cause of gear failure?
    a. heavy loads
    b. high speeds
    c. improper lubrication
    d. incorrect gear ratios
## Sample Questions — Key

1. What can cause a V-belt to become hardened or cracked?
   
   a. excessive heat  
   b. inadequate tension  
   c. overloaded drive  
   d. slipped belt  
   
   a. Correct  
   b. Incorrect  
   c. Incorrect  
   d. Incorrect  

2. What is the most important safety rule to observe when inspecting or repairing belt drives?
   
   a. Check the pulley size for the proper ratio.  
   b. Lock the on-off switch in the “off” position.  
   c. Note all emergency exits.  
   d. Turn off all electricity within 50 feet.  
   
   a. Incorrect  
   b. Correct  
   c. Incorrect  
   d. Incorrect  

3. What occurs when cracking pressure is present?
   
   a. fluid begins to flow past the pressure relief valve  
   b. fluid levels rise high, causing damage to the system  
   c. pressure differential is maximized  
   d. pressure relief valve is disabled  
   
   a. Correct  
   b. Incorrect  
   c. Incorrect  
   d. Incorrect  

4. The only way to precisely position air cylinders is to use:
   
   a. equal pressure.  
   b. internal stops.  
   c. mechanical stops.  
   d. pressure regulators  
   
   a. Incorrect  
   b. Incorrect  
   c. Correct  
   d. Incorrect  

5. What can an industrial mechanic use to connect machinery to a power source?
   
   a. magnetic starter  
   b. rotor clip  
   c. speed reducer  
   d. stator field  
   
   a. Correct  
   b. Incorrect  
   c. Incorrect  
   d. Incorrect
6. What type of wire is commonly used in installations when layout lines are used as reference lines for machinery positioning?
   a. piano  Correct
   b. plain steel  Incorrect
   c. viola  Incorrect
   d. wound copper  Incorrect

7. What kind of threads does an oxygen cylinder have?
   a. female left-hand  Incorrect
   b. female right-hand  Incorrect
   c. male left-hand  Incorrect
   d. male right-hand  Correct

8. How is a hacksaw blade properly installed?
   a. down and away from the handle  Correct
   b. down and towards the handle  Incorrect
   c. up and away from the handle  Incorrect
   d. up and towards the handle  Incorrect

9. Which drill cutting tool comes with various cutting edge degrees?
   a. counterbore  Incorrect
   b. countersink  Correct
   c. tap  Incorrect
   d. tapered shank drill  Incorrect

10. What is the most common cause of gear failure?
    a. heavy loads  Incorrect
    b. high speeds  Incorrect
    c. improper lubrication  Correct
    d. incorrect gear ratios  Incorrect
## Abbreviations, Symbols and Acronyms

The following is a list of abbreviations, symbols, and acronyms used in the Industrial Maintenance Technology study guide and on the Industrial Maintenance Technology assessments.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>°</td>
<td>Degree</td>
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<td>'</td>
<td>Feet</td>
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<td>&quot;</td>
<td>Inches</td>
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<td>%</td>
<td>Percent</td>
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<tr>
<td>A</td>
<td>Ampere</td>
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<tr>
<td>AC</td>
<td>Alternating current</td>
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<tr>
<td>ANSI</td>
<td>American National Standards Institution</td>
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<tr>
<td>CRS</td>
<td>Corrosion-Resistant Steel</td>
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<tr>
<td>DC</td>
<td>Direct current</td>
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<td>EPA</td>
<td>Environmental Protection Agency</td>
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<tr>
<td>GFI</td>
<td>Ground Fault Interrupter</td>
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<td>HAZCOM</td>
<td>Hazard Communication</td>
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<tr>
<td>Hp</td>
<td>Horsepower</td>
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<tr>
<td>I.D.</td>
<td>Inside Diameter</td>
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<tr>
<td>IEP</td>
<td>Individualized Education Plan</td>
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<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
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<td>L1</td>
<td>Line 1</td>
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<td>L2</td>
<td>Line 2</td>
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<td>L3</td>
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<tr>
<td>MSDS</td>
<td>Material Safety Data Sheets</td>
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<tr>
<td>NEC</td>
<td>National Electronic Code</td>
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<tr>
<td>O.D.</td>
<td>Outside Diameter</td>
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<td>OSHA</td>
<td>Occupational Safety and Health Association</td>
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<tr>
<td>PM</td>
<td>Preventive Maintenance</td>
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<tr>
<td>PLC</td>
<td>Programmable Logic Controller</td>
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<tr>
<td>PSI</td>
<td>Per square inch</td>
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<tr>
<td>PVC</td>
<td>Polyvinyl Chloride</td>
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<tr>
<td>RPM</td>
<td>Revolutions per minute</td>
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<tr>
<td>SFFPM</td>
<td>Surface feet per minute</td>
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<tr>
<td>SCR</td>
<td>Silicon-Controlled Rectifier</td>
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<tr>
<td>THHN</td>
<td>Thermoplastic High Heat-Resistant Nylon</td>
</tr>
<tr>
<td>V</td>
<td>Volt</td>
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Test Taking Strategies

This section of the study guide contains valuable information for testing success and provides a common-sense approach for preparing for and performing well on any test.

General Testing Advice

1. Get a good night’s rest the night before the test — eight hours of sleep is recommended.
2. Avoid junk food and “eat right” several days before the test.
3. Do not drink a lot or eat a large meal prior to testing.
4. Be confident in your knowledge and skills!
5. Relax and try to ignore distractions during the test.
6. Focus on the task at hand — taking the test and doing your best!
7. Listen carefully to the instructions provided by the exam proctor. If the instructions are not clear, ask for clarification.

Testing Tips

1. Read the entire question before attempting to answer it.
2. Try to answer the question before reading the choices. Then, read the choices to determine if one matches, or is similar, to your answer.
3. Do not change your answer unless you misread the question or are certain that your first answer is incorrect.
4. Answer questions you know first so you can spend additional time on the more difficult questions.
5. Check to make sure you have answered every question before you submit the assessment for scoring — unanswered questions are marked incorrect.