General Plant Operator
Testing Battery

Study Guide
Table of Contents

Section 1: Introduction

- Overview 4
- GPO Test Description 4

Section 2: Skills and Knowledge Areas

- Electrical 10
- Sample Drawings and Charts 13
- Operations 14
- Mechanical 17
- Electrical Formulas 21

Section 3: Sample Test Items

- Electrical 24
- Operations 31
- Mechanical 34
- Scoring/Answer Key 39
- Explanation of Correct Answers 40

Section 4: Additional Resources

- Additional Resources 51

Section 5: General Testing Tips 57
Section 1: Introduction
Introduction

Overview
This study guide is designed to familiarize you with the basic knowledge and skills required by Southern Company’s General Plant Operator (GPO) and covered by the General Plant Operator (GPO) Test. The guide will familiarize you with the test, assist in your preparation to take the test, and offer suggestions or strategies to use in taking the test.

Test Description

What does the GPO Test cover?
The GPO Test covers topics in these areas:

- Electrical
- Operations
- Mechanical

The content of the test includes questions related to specific subjects relevant to the three topics above. The subjects covered in each topic are listed below. Detailed descriptions of the knowledge areas and skills covered by the test follow in the next section of this guide.

What are the major subject areas included in the GPO Test?
Here is a list of subjects covering the three content areas:

**Electrical**
- General Plant Safety
- Electrical Theory
- Electronic Theory
- Electrical Troubleshooting
- Electrical Test Equipment
- Hydraulics and Pneumatics
- Safety-Electrical
- Print Reading
- Electrical Applications
- Electrical Mechanical Clearance Procedures
**Operations**

- Fire Prevention
- Plant Safety
- Plant Auxiliaries
- Electrical / Mechanical Clearances
- General Power Plant Operation
- Boiler Operation
- Turbine Operation
- Generator Operation
- Plant Electrical

**Mechanical**

- Basic Hand and Power Tools
- Rigging and Hoisting
- Precision Measurement
- Millwright Work
- Equipment Lubrication
- Welding and Cutting
- Pipe Fitting
- Fire Prevention
- General Plant Safety
- Machine Shop Operations
- Mechanical Prints and Drawings

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**What is the purpose of the GPO test?**

The purpose of the GPO Test is to measure a person’s knowledge and ability to apply concepts, terms and principles related to the electrical, operations and mechanical tasks performed by a GPO. The test contains questions that emphasize the understanding of the subjects, along with the ability to apply the knowledge.

**Who has to take the GPO Test?**

Candidates—both internal and external—for GPO positions at Southern Company’s combustion turbine and combined-cycle plants are required to take the test. GPOs at these plants are expected to perform the duties of a plant electrician, operator and plant mechanic.

**What kind of test is it?**

The GPO Test consists of three parts or subtests: an electrical test, an operations test, and a mechanical test.
Each test is a multiple-choice test in which questions have four (4) possible answers but only one that is correct. Some questions refer to figures containing diagrams, schematics, drawings and charts. Examples of the types of diagrams or drawings included in the test are provided in the next section of this guide. The test battery has a total of 264 questions.

The individual tests include the following number of questions:

<table>
<thead>
<tr>
<th>Part</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1</td>
<td>75</td>
</tr>
<tr>
<td>Part 2</td>
<td>95</td>
</tr>
<tr>
<td>Part 3</td>
<td>94</td>
</tr>
</tbody>
</table>

The individual tests are timed with the following maximum time limits:

<table>
<thead>
<tr>
<th>Part</th>
<th>Time Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1</td>
<td>2 hrs. 15 min.</td>
</tr>
<tr>
<td>Part 2</td>
<td>1 hr. 30 min.</td>
</tr>
<tr>
<td>Part 3</td>
<td>1 hr. 45 min.</td>
</tr>
</tbody>
</table>

**Calculations and Formulas**

Some questions require calculations. Calculators are permitted and will be provided for you.

Some questions also require the use of formulas. A list of formulas that might be used is provided during the test so it is not necessary to have them memorized. You will be expected to select the proper formula from the list so it is critical that you be familiar with various formulas prior to the testing session. The list of formulas provided is included in this guide so you should become familiar with each of them.

**How are scores determined?**

Scores are determined based on the number of questions answered correctly. Your score will be the total number of questions you answer correctly with no penalty for guessing. So, it is to your benefit to try to answer every question.

**What happens if a person is unsuccessful?**

People who do not score well enough to qualify will have an opportunity to take the test again according to Southern Company’s retest policy.

**What kinds of questions are**

The GPO Test includes a number of different types of test questions. The types of questions include the
on the test? following:

Terms and definitions – These questions ask for the definition of a term, the name for a concept or device, or characteristics of a component.

Example: What device is used to convert direct currents to alternating current?

Relationships and Principles – These questions ask how two concepts or measurements relate to each other.

Example: Holding currents constant, how does increasing resistance affect voltage?

Interpreting Facts – For these questions, a situation or problem will be described and the answer that describes what is happening or what is wrong must be selected.

Example: When measuring voltage across a circuit with a multimeter, the meter reads 0 volts. Of the following, what is an explanation for this reading?

Calculating Values – These questions require the calculation of amounts, measurements, or electrical values given specific information.

Example: If three 20-ohm resistors are placed in series, what is the total resistance in the circuit?

How-To – These questions ask how to perform a task or specific activity.

Example: When using a volt-ohm meter, how should the leads be connected to measure voltage?

How should this study guide be used?

You should use this study guide to help you determine whether or not you are ready to take the GPO Test. If you find that you are not ready to take the GPO Test, this guide will help you identify the areas in which you need development.

First, thoroughly review the knowledge and skills included in the GPO Test. These will be covered in the next section of this guide. Identify those areas that you know or are
familiar with and those that you might need to review or learn.

Make a list of those developmental areas that you will need to work on.

**Next**, answer the sample questions included in the guide to help further determine areas you know or do not know. This will also help familiarize you with the type of questions you will see on the test.

**Finally**, use the references included to identify materials or resources that you can use to help review areas you already know or learn those you need to learn.

Also review the general tips for taking tests. This information will help you prepare to take the GPO Test once you feel you have the technical knowledge or skills to do so.

This study guide was designed to assist in your preparation for the GPO Test. However, there is no guarantee that you will pass the test by simply following the guide. It is up to you to learn, study, and review the topic areas until you feel you are prepared to take the test.
Section 2: Skill and Knowledge Areas
**Electrical Test**

**What do I need to know for the Electrical Test?**

1. **General Plant Safety** – Be familiar with all aspects of general plant safety; includes knowledge of proper tool use and personal protection equipment

   a) Be prepared to answer questions about proper tool selection and use (e.g., grinders)

   b) Know personal protective equipment (e.g., types of eye protection to protect against various hazards) and its proper use

   c) Know procedures for working in confined spaces and use of respirators; includes safe oxygen levels for entry into confined space

2. **Electrical Theory** – Be familiar with all concepts, principles, symbols and calculations related to electricity; be prepared to answer questions related to definitions, theories, formulas, and different types of circuits (e.g., series, parallel and series-parallel)

   a) Know definitions of electrical concepts (e.g., capacitance, inductance, resistance, and parallel circuits); includes conversion of units of measurement

   b) Know how to identify and interpret basic symbols; understand theory of operation of circuits, types of circuits and determine electrical values (e.g., resistance, capacitance, and inductance); includes knowledge of electrical components (resistors, capacitors and inductors)

   c) Know how to read and interpret electrical diagrams; know how to calculate electrical values based on various “laws” or principles; includes Ohm’s Law, Kirshchoff’s Law, peak to peak and RMS conversions; know various formulas associated with calculations

   d) Know which characteristics are measured by various pieces of electrical test equipment (e.g., ammeter, voltmeter, ohmmeter and multimeter)

   e) Know how to calculate voltage drops and electrical values from or between specific points (e.g., total resistance, current) in series, parallel and series-parallel circuits
f) Know units of measure for all electrical terms (e.g., resistance, current, voltage, inductance, and capacitance)

g) Know basic theory of operations of transformers (e.g., potential transformers); know how to calculate line voltage on potential transformers based on ratios; know types of transformers and windings (e.g., delta, wye); know transformer protection devices; includes knowledge of power factors and reasons for/effects of grounding

3. **Electronic Theory** – Be familiar with theories and principles of electronics; be prepared to answer questions about electronic symbols and operation of devices (e.g., diodes)

   a) Know theory of operation and types of semiconductor devices (e.g., diodes and transistors); includes symbols that represent them

   b) Know definitions and terms used to describe diodes and transistors (e.g., forward- and reverse-biased); includes reading and understanding electronic diagrams and symbols (e.g., PNP)

   c) Know principles and operations of DC power supplies; includes the operation of voltage regulators and load resistors, calculation of voltage based on diagrams, and symbols

   d) Know how to convert binary coded numbers to decimals

4. **Electrical Troubleshooting** – Be familiar with methods of diagnosing problems and analyzing symptoms of problems with electrical equipment

   a) Know proper operation and maintenance of AC and DC generators; includes knowledge of visual and operational symptoms of equipment problems (e.g., brushes)

   b) Know how to troubleshoot electrical circuits (e.g., pump, motor, motor control) using elementary diagrams; includes knowledge of symbols and their use

5. **Electrical Test Equipment** – Be familiar with the types and operation of electrical test equipment

   a) Know the proper connections and procedures for determining electrical values (e.g., voltage, resistance, current) and using test equipment (e.g., voltmeter, ammeter)

   b) Know the purpose and proper operation of electronic test equipment (e.g., megohmmeter/megger)

6. **Hydraulics and Pneumatics** – Be familiar with the basic principles of hydraulics

   a) Know how to calculate hydraulic pressure and factors that affect pressure
b) Know safety procedures and safety equipment involved in use of welding and cutting equipment; includes storage and movement of equipment

7. **Safety** – Be familiar with safety concerns and precautions when working with electrical equipment

   a) Know procedures for safely working with energized equipment; includes isolation procedures and protective equipment and its use (e.g., rubber blankets)

   b) Know purpose of and proper procedures for grounding sensitive electronic devices (e.g., level sensing device)

8. **Print Reading** – Be familiar with various types of schematics and diagrams (e.g., circuit diagrams, P & ID, relay logic); be prepared to answer questions about equipment components, equipment operation and electrical values (e.g., current) based on drawings [See sample below]

9. **Electrical Applications** – Be familiar with various types of electrical applications, their principles and their operation; includes batteries, protective devices, solenoids, and motors

   a) Know principles of operation, use and maintenance of batteries; includes charging process and procedures for checking condition (e.g., specific gravity readings)

   b) Know different types of protective devices (e.g., relays, fuses, breakers); includes their purpose or use, operation, coding, and troubleshooting

   c) Know definition, operation and components of solenoids

   d) Know different types of motors (e.g., three-phase), motor components, maintenance procedures (e.g., cleaning); includes knowledge of load current charts [See example below]

10. **Electrical/Mechanical Procedures** – Be familiar with all clearance and isolation procedures for safely removing and/or returning equipment from or to service

    a) Know the procedures for implementing, releasing, or transferring clearances and switching orders (e.g., who initiates or issues, reviews, or releases); includes knowledge of purposes for clearances

    b) Know procedures for isolating breakers (e.g., racking out or in) and switches; includes knowledge of all steps and check points to ensure process has been performed properly
Sample Drawings and Charts

Be prepared to troubleshoot electrical systems using elementary diagrams like the one below.

Be prepared to read and interpret P & ID drawings like the one below.
Operations Test

What do I need to know for the Operations Test?

1. **Fire Prevention** – Be familiar with the different classes of fires, how they differ, and what type of extinguisher is used for each class (e.g., water, carbon dioxide); includes proper procedures for use of extinguishers and knowledge of different extinguishing systems

2. **Plant Safety** – Be familiar with Section O (e.g., standards for working in confined spaces) and different categories of injuries

3. **Plant Auxiliaries** – Be familiar with plant equipment (e.g., pumps, motors) that runs, controls, or operates different systems (e.g., boiler, turbine)
   
   a) Know the design and definition of a boiler feed pump and how it operates; different types (e.g., those associated with drum type boilers); pressure and temperature standards/limits; means to protect boiler feed pumps during their operation; symptoms of pump problems and how to troubleshoot (e.g., excess vibration, increase/decrease in pressure)
   
   b) Know types of heat exchangers and their function/purpose
   
   c) Know different types of motors (e.g., three-phase, variable speed); includes operating temperatures and factors that affect it

4. **Electrical/Mechanical Clearances** – Be familiar with procedures for safely issuing and executing switching orders (e.g., step-by-step procedure for electrical or mechanical isolation of a piece of equipment); know terms used to describe isolation of equipment (e.g., breakers) [Note: internal reference SCG-SH-0200 – Generation Clearance Procedure; external OSHA utility standards (OSHA website – 29CFR1910)]

5. **General Power Plant Operation** – Be familiar with various power plant equipment and components (e.g., valves); characteristics of substances used in the generation of electricity (e.g., steam, gases); unit start-up and shut-down procedures; and procedures for handling environmental situations (e.g., oil spill)
a) Know characteristics and types of steam, fluids, and gases (e.g., superheated steam) and how they are used; includes how to measure density, temperature-related characteristics and factors that affect their temperature

b) Know different types of valves and traps (e.g., steam); includes how and why they are used, their function/operation and their purpose

c) Know different types of gases (e.g., nitrogen, hydrogen); includes their characteristics, their safety hazards and safety precautions

d) Know different types of heat transfer (e.g., conduction, convection), conversion of fluids to gas and terminology for the conversion, and measurement characteristics of heat (e.g., BTU)

e) Know how to read and convert information to monitor heat transfer and plant operating conditions (e.g., barometric readings, temperature readings); conversion of Celsius and Fahrenheit temperature readings using a conversion table; units of measure; different types of pressure (e.g., gauge, absolute) and how to convert pressure from one unit of measurement to another using a conversion table

f) Know standard procedures for starting and shutting down a unit (e.g., proper venting and settings, unit efficiency or heat rate standards; procedures for handling or removing unit from service in emergency situations)

g) Know condensate/feedwater cycles and related components (e.g., deaerator, surge/storage tank); purpose and operation of components and cycles; temperature and pressure settings for cycle and components

6. **Boiler Operation** – Be familiar with the characteristics and types of boilers; includes boiler operation and components in the system

   a) Know the characteristics of combustion and factors that affect it; includes methods for detecting proper combustion

   b) Know the purpose and operation of drum-type boilers; temperature and pressure settings and factors that affect them; safety procedures for operation of boiler; procedures for testing boiler tube integrity; factors that impact the efficient operation of the boiler (e.g., valve or drain operation)

7. **Turbine Operation** – Be familiar with the characteristics and types of turbines; includes turbine operation and components in the system

   a) Know the different sections of the turbine and their purpose (e.g., high pressure, intermediate pressure, low pressure); types of turbines and/or turbine parts (e.g., blades, rotor, valves) and their purpose; proper operating procedures (e.g., hot and
cold starts); factors that impact the efficient operation of the turbine (e.g., drains or valve operation); temperature control; methods to detect turbine problems
b) Know proper operation of turbine auxiliaries and components (e.g., valve operation)

c) Know proper procedures for turbine operations (e.g., speed control)

d) Know various lubrication or oil systems (e.g., back up oil supply, hydraulic oil supply); their operation and their purpose; includes proper pressures and results if not maintained

e) Know turbine protective devices and their proper operation (e.g., turbine trips); includes purpose for protective devices in the system

8. **Generator Operation** – Be familiar with the characteristics and types of generators; includes generator operation and components in the system

a) Know the different sections of a generator and their purpose (e.g., stator, field, exciter); types of generators (e.g., AC, DC, number of poles); proper operating procedures (e.g., speed control, temperature control); factors that impact the efficient operation of a generator (e.g., temperature, voltage); includes methods to detect turbine problems and determine proper operation

b) Know methods for regulating generator operation; includes methods to detect improper operation and results of improper operation

c) Know what it means to synchronize a generator and purpose for synchronizing

9. **Plant Electrical** – Be familiar with basic functions and electrical operations of plant equipment such as relay protection equipment, electric motors, and transformers

a) Know the types, purpose, and function of relays

b) Know components of electric motors and their purpose

c) Know methods to determine proper operation of transformers and transformer standards
**Mechanical Test**

**What do I need to know for the Mechanical Test?**

1. **Basic Hand and Power Tools** – Be familiar with types of basic hand tools, power tools, and their proper use

   a) Know the basic hand tools that a power plant mechanic uses (e.g., saws, wrenches, pliers); includes how to select the appropriate tool

   b) Know the basic power tools used in a power plant (e.g., grinders, drills); includes how to select proper tools and components (e.g., drill bits)

2. **Rigging and Hoisting** – Be familiar with materials, procedures, and safety procedures involved in lifting or transporting equipment and/or materials; includes selection of proper materials and technique based on material size and weight

   a) Know various types of knots and uses of each (e.g., square, bowline); includes how to determine proper lifting configurations based on equipment or material

   b) Know all rigging materials (e.g., shackles, eye-bolts), equipment, and configurations (e.g., choke, basket); impact different configurations have on load capacity (e.g., sling angle); safety and inspection procedures (e.g., wear detection); how to select materials (e.g., wire rope); includes knowing how to read and interpret load charts

   c) Know hand signals used in lifting and transporting materials and equipment with cranes and hoists (e.g., lift, lower, back)

   d) Know operation of chain, electric, and pneumatic hoists

   e) Know how to determine load weight based on item dimensions (e.g., height, weight, thickness)

3. **Precision Measurement** – Be familiar with precision measurement tools (e.g., inside and outside micrometers); includes their function and how to read them
a) Know all types of precision measurement tools, including micrometers, inside calipers, feeler (i.e., thickness) gauge, radius gauge, dial indicators, layout tools (e.g., dividers, squares), and torque wrench; includes knowing their uses

b) Know the definitions for different aspects of fit (e.g., tolerance, clearance)

c) Know how to properly lay out work and make calculations and measurements (e.g., hole positioning, overall size of fabricated piece, how to maximize material)

4. **Millwright Work** – Be familiar with millwright procedures for equipment repair and fabrication; includes pumps, belt drives, bearings, and couplings

   a) Know procedures for repairing pump and pump components (e.g., shafts); includes method to determine shaft run out

   b) Know bearing types and uses (e.g., journal, thrust)

   c) Know how to calculate gear turning rate based on characteristics of gear (e.g., speed, number of teeth) when a formula is provided

   d) Know different types of valves and uses for each; know valve components and valve operation (e.g., check, needle)

   e) Know different types of seals and purpose of each, how to install sealing mechanisms (e.g., pump packing), and how to determine problems with seals

   f) Know procedures involved in installing and aligning couplings (e.g., motor and pump coupling); includes how to calculate the amount of shim required

5. **Equipment Lubrication** – Be familiar with various types of lubricants (e.g., grease, oil); includes knowing uses and purposes for lubrication

   a) Know characteristics and principles of lubrication; includes troubleshooting lubrication problems; purpose for use of lubricants, factors that affect lubricants, and how to select proper lubricants

   b) Know types and characteristics of lubrication systems and how they are used

   c) Know various types and applications of filters; includes determining and selecting filter with proper micron rating and knowledge of purpose of micron rating
6. **Welding and Cutting** – Be familiar with the characteristics and types of welding and cutting tools, equipment and procedures; includes knowing proper use and safety procedures

   a) Know welding principles, processes, proper set up and equipment involved in welding and cutting (e.g., SMAW, oxyacetylene welding, brazing, soldering, air-arc cutting); includes selection of proper rods and materials based on ratings and purpose

   b) Know safety procedures and safety equipment involved in use of welding and cutting equipment; includes storage and movement of equipment (e.g., tanks)

7. **Pipe Fitting** – Be familiar with the pipe fitting tools and equipment; includes ability to make calculations (e.g., piping systems)

   a) Know how to identify piping systems and determine characteristics (e.g., take out, travel)

   b) Know various types of pipe fitting tools (e.g., pipe cutting tools) and their proper use

   c) Know pipe hanger types (e.g., snubbers, constant tension) and their proper installation procedures

8. **Fire Prevention** – Be familiar with the different classes of fires, how they differ, and what type of extinguisher is used for each class (e.g., water, carbon dioxide); includes proper procedures for use of extinguishers and knowledge of different extinguishing systems

9. **General Plant Safety** – Be familiar with aspects of general plant safety; includes use of tools, equipment, and ladders

   a) Know safety procedures for using power tools (e.g., grinders, cutters, drills); know how to select proper tool or equipment for purpose

   b) Know safety or proper procedures for using ladders; know how to set up safely (e.g., distance of base from wall)

   c) Know personal protective equipment (e.g., types of eye protection to protect against various hazards)

   d) Know procedures for working in confined spaces and use of respirators; includes safe oxygen levels for entry into confined space

10. **Machine Shop Operations** – Be familiar with machine shop tools and equipment; includes knowledge of machine shop procedures and techniques
a) Know proper procedures and tools for threading, reaming, and sharpening; how to operate presses and saws; how to remove and install pins, keys, taps, and fasteners

b) Know how to select equipment from charts and using formulas (e.g., grinding wheels, drill bits); how to maintain grinding wheels

c) Know types of presses and their use; includes proper operation of presses

11. **Mechanical Prints and Drawings** – Be familiar with types of prints and drawings (e.g., schematics, diagrams, mechanical drawings); includes ability to read and interpret specifications and calculate dimensions
**Electrical Formulas**

While you may have memorized basic resistance, Ohm’s Law, and Kirchoff’s Law formulas, here are these formulas, as well as some others, which may not be as familiar but would be available on the job in a reference book or manual. Some of these will apply to some of the items on the test. Wherever required, you are expected to determine which formula to use for a given application. Note: Formulas are not labeled on the actual test.

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
<th>Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohm’s Law</td>
<td>$I = E/R$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacitance-Parallel</td>
<td>$C_T = C_1 + C_2 + C_3 + ...$</td>
<td>Capacitance-Series</td>
<td>$C_T = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$</td>
</tr>
<tr>
<td>Resistance</td>
<td>$R = E/I$</td>
<td>Voltage</td>
<td>$E = IR$</td>
</tr>
<tr>
<td>Power</td>
<td>$P = IE$</td>
<td>Power</td>
<td>$P = RI^2$</td>
</tr>
<tr>
<td>Current</td>
<td>$I = P/E$</td>
<td>Average Voltage</td>
<td>$V_{avg} = V_{peak} \times 0.637$</td>
</tr>
<tr>
<td>RMS Voltage</td>
<td>$V_{rms} = V_{peak} \times 0.707$</td>
<td>Resistance-Series</td>
<td>$R_T = R_1 + R_2 + R_3 + ...$</td>
</tr>
<tr>
<td>Resonance</td>
<td>$f = \frac{1}{2\pi \sqrt{LC}}$</td>
<td>Resistance-Parallel</td>
<td>$R_T = R_1 + R_2 + R_3 + ...$</td>
</tr>
<tr>
<td>Capacitive Reactance</td>
<td>$X_C = \frac{1}{2\pi f C}$</td>
<td>Resistance-Parallel (all resistors same value)</td>
<td>$R_T = R/N$</td>
</tr>
<tr>
<td>Resistance-Parallel (2 resistors, different values)</td>
<td>$R_T = R_1 \times R_2 \div (R_1 + R_2)$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Inductive Reactance**  \[ X_L = 2\pi f L \]

**Current-Series**  \[ I_T = I_1 = I_2 = I_3 = \ldots \]

**Total Impedance**  \[ Z = \sqrt{R^2 + (X_L - X_C)^2} \]

**Current-Parallel**  \[ I_T = I_1 + I_2 + I_3 + \ldots \]

**Pi**  \[ \pi = 3.1426 \]

**NOTE:** Because there are different methods or sequences of operations for calculating some problems, answers may vary slightly because of rounding. In those cases, you will have to choose the answer closest to your calculations.
Section 3: Sample Test Items
Sample Test Items

*Electrical*

1. In the diagram below, the equivalent resistance of the circuit is:

![Circuit Diagram](image)

A. 66.67 ohms  
B. 120 ohms  
C. 650 ohms  
D. 666.7 ohms

2. If capacitors of 8 µf, 2 µf, and 12 µf are connected in series, the total capacitance is:

![Capacitor Diagram](image)

A. 1.41 µf  
B. 7.33 µf  
C. 11.00 µf  
D. 22.00 µf
3. If inductors of 4, 8 and 6 millihenrys are connected in parallel with no magnetic coupling between them, the total inductance is:

A. 18 mh  
B. 9 mh  
C. 3.7 mh  
D. 1.85 mh

4. For the diagram below, compute:

a) total resistance \( (R_T) \)  
b) total voltage \( (V_T) \)  
c) total current \( (I_T) \)

![Diagram of electrical circuit with resistors and voltages](image)

\[
\begin{align*}
a) R_T &= \quad & b) V_T &= \quad & c) I_T &= \\
A. \ 4.5 \ ohms & \quad & A. \ 4.5 \ volts & \quad & A. \ 0.5 \ amps \\
B. \ 9 \ ohms & \quad & B. \ 5 \ volts & \quad & B. \ 1.5 \ amps \\
C. \ 12.5 \ ohms & \quad & C. \ 7.5 \ volts & \quad & C. \ 3.0 \ amps \\
D. \ 25 \ ohms & \quad & D. \ 15 \ volts & \quad & D. \ 6.0 \ amps
\end{align*}
\]
5. In the circuit diagram below, the voltage indicated by voltmeter M1 is:

A. 9.4 volts  
B. 20 volts  
C. 47 volts  
D. 80 volts

6. The ammeter in the circuit diagram below will indicate:

A. 1.9 milliamps  
B. 2.6 milliamps  
C. 3.5 milliamps  
D. 7.0 milliamps
7. If the effective AC voltage is 140 volts, the peak AC voltage is:

A. 70 volts  
B. 198 volts  
C. 280 volts  
D. 396 volts

8. The RMS current flow in the circuit diagram below is:

A. 1.8 milliamps  
B. 3.5 milliamps  
C. 7.1 milliamps  
D. 10.0 milliamps

9. A 6 k-ohm, an 8 k-ohm, a 12 k-ohm, and a 16 k-ohm resistor are connected in parallel to a 120 volt power source. The resistor which dissipates the highest watts is the:

A. 6 k-ohm  
B. 8 k-ohm  
C. 12 k-ohm  
D. 16 k-ohm
10. A 5:1 potential transformer is used to monitor a high voltage line. If a voltmeter on the secondary of the transformer indicates 120 volts, the line voltage is:

A. 120 volts  
B. 240 volts  
C. 600 volts  
D. 1200 volts

11. In the circuit diagram below, the voltage measured across the load resistor (RL) with a DC voltmeter is:

![Circuit Diagram](image)

A. 120 volts  
B. 150 volts  
C. 300 volts  
D. 600 volts

12. To measure voltage across $R_1$ and $R_2$ in the diagram below, a voltmeter could be connected between points:

![Circuit Diagram](image)

A. A and B  
B. F and A  
C. H and C  
D. H and F
13. Using the information given below, the pressure at the bottom of a 300 ft. tank that is ½ full of water is calculated to be:

\[ P = 0.43 \times H \]

Where:
- \( P \) = Pressure
- \( H \) = Height of water in the tank

A. 32.25 psi  
B. 64.5 psi  
C. 129 psi  
D. 150 psi

14. The fuse size needed to safely handle the running current in the circuit diagram below would be (Refer to Full-load Currents Chart – 3-Phase A-C Induction Motors on the following page):

A. 150 volts, 5 amps  
B. 150 volts, 10 amps  
C. 150 volts, 20 amps  
D. 150 volts, 30 amps
### FULL-LOAD CURRENTS CHART
#### 3-PHASE A–C INDUCTION MOTORS

<table>
<thead>
<tr>
<th>HP</th>
<th>115V</th>
<th>200V</th>
<th>230V</th>
<th>460V</th>
<th>575V</th>
<th>2300V</th>
<th>4000V</th>
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<td>4</td>
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<td>0.8</td>
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<td>¾</td>
<td>5.6</td>
<td>3.2</td>
<td>2.8</td>
<td>1.4</td>
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<td>1</td>
<td>7.2</td>
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<td>1 ½</td>
<td>10.4</td>
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<td>5.2</td>
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<td>2</td>
<td>13.6</td>
<td>7.8</td>
<td>6.8</td>
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<td>3</td>
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<td>7 ½</td>
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<td>75</td>
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<td>415</td>
<td>360</td>
<td>180</td>
<td>144</td>
<td>36</td>
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<td>550</td>
<td>480</td>
<td>240</td>
<td>192</td>
<td>48</td>
<td>27.6</td>
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<td>Over 200HP</td>
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<tr>
<td>Approx. A/HP</td>
<td>2.75</td>
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<td>1.2</td>
<td>0.96</td>
<td>0.24</td>
<td>0.14</td>
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</tr>
</tbody>
</table>
1. Which of the following represents a “Class A” fire?

A. Paper fire  
B. Metal fire  
C. Oil fire  
D. Electrical fire

2. If the oil temperature on a boiler feed pump is excessively high, which of the following could be the cause?

A. Vibration  
B. No or low cooling water flow  
C. High surge tank water level  
D. Low drum level

3. To ensure that it is safe to work on a piece of electrical equipment, the equipment must be___________?

A. Disconnected and tagged from its electrical source  
B. Tagged on its control switch  
C. Isolated from its electrical source  
D. Tagged in control room

4. Which of the following is a major safety concern when working with superheated steam?

A. It’s invisible  
B. It’s noisy  
C. It’s combustible  
D. It’s moisture level is high

5. What type of valve rotates on a pin and is used with low flow pressure?

A. Stem valve  
B. Stop valve  
C. Solenoid valve  
D. Butterfly valve
6. The purity of hydrogen used in generators is critical to ______?  
   A. Minimize risk of explosion  
   B. Maintain generator stator winding temperature  
   C. Keep oxygen level high  
   D. Keep moisture out of the generator

7. Two factors involved in turning water into steam are temperature and______?  
   A. Flow  
   B. Pressure  
   C. Water chemistry  
   D. Water level

8. The purpose of a condensate pump is to pump water to the ________?  
   A. Deaerator  
   B. Boiler feed pump  
   C. Hotwell  
   D. Coldwell

9. Which of the following is a reason to maintain proper drum level?  
   A. To prevent water hammer in the deaerator  
   B. To prevent water carryover into superheater  
   C. To reduce hotwell makeup  
   D. To reduce flow to the reheat

10. Which part of the turbine receives steam first from the boiler?  
    A. HP turbine  
    B. IP turbine  
    C. Stop valve  
    D. Steam seal regulator

11. Turbine speed is controlled by which of the following?  
    A. Line voltage  
    B. Generator voltage  
    C. Stop valve  
    D. Control valves
12. The purpose of the exciter in a generator is to __________?

A. Convert DC voltage to AC voltage
B. Convert AC voltage to DC voltage
C. Maintain field voltage
D. Maintain stator winding temperature
Mechanical

1. The estimated weight of steel is 500-lb/cu ft. The weight of the box (including the four sides and the bottom) in the figure below is:

   - Plate thickness = 3 inch
   - Width = 2 ft.
   - Height = 1 ft.
   - Length = 3 ft.

   A. 1000 lb.
   B. 1500 lb.
   C. 2000 lb.
   D. 3000 lb.

2. The weight of the piece of metal described below is approximately:

   - METAL PLATE 3’ X 6’ X 3” WITH A 9” SQUARE HOLE CUT IN THE CENTER
   - WEIGHT OF THE METAL = 490 LBS/FT³

   A. 1163 lb.
   B. 1838 lb.
   C. 2136 lb.
   D. 2205 lb.

3. To fabricate the base plate shown below from a ½” plate, the overall size would be:

   A. ½” x 6 ½” x 16 ¾”
   B. ½” x 8 ½” x 16 ¾”
   C. ½” x 6 ½” x 17 ¾”
   D. ½” x 8 ½” x 17 ¾”
4. Using the information below, determine the turning rate of gear B.

Speed of gear A = 110 rpm
Number of teeth on gear A = 24
Number of teeth on gear B = 64
Number of teeth on gear C = 16

To determine turning rate of gear B, use

\[
S_B = \frac{N_A \times S_A}{N_B}
\]

- S_A = Speed of gear A
- S_B = Speed of gear B
- S_C = Speed of gear C
- N_A = Number of teeth on gear A
- N_B = Number of teeth on gear B
- N_C = Number of teeth on gear C

A. 22.6 rpm
B. 41.25 rpm
C. 57.5 rpm
D. 110.0 rpm
5. Using the information provided below, the amount of shim to be added to the inboard “I” and the outboard “O” feet of the motor are:

\[ I = \frac{X(b - a)}{D} \quad O = \frac{Y(b - a)}{D} \]

\[ a = 0.003'', \ b = 0.010'', \ D = 2'', \ X = 2'', \ Y = 10'' \]

A. .007 for the inboard .035 for the outboard  
B. .007 for the inboard .045 for the outboard  
C. .009 for the inboard .035 for the outboard  
D. .009 for the inboard .045 for the outboard
6. Refer to the Yoke Plate drawing. Dimension "A" is:

A. 1/2
B. 1
C. 1 ½
D. 2 ¾

7. What type of valve would be used to regulate flow?

A. Globe valve
B. Check valve
C. Diaphragm valve
D. Relief valve

8. Which of the following rod types would be used to make an "out-of-position" weld?

A. E7002
B. E7018
C. E7024
D. E7085
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### Answer Key

<table>
<thead>
<tr>
<th></th>
<th>Electrical</th>
<th>Operations</th>
<th>Mechanical</th>
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<tbody>
<tr>
<td>1.</td>
<td>A</td>
<td>A</td>
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<td>D</td>
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<td>4. a)</td>
<td>C</td>
<td>A</td>
<td>B</td>
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<td></td>
<td>b) D</td>
<td>D</td>
<td>A</td>
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<td></td>
<td>c) B</td>
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<td>12.</td>
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<td>13.</td>
<td>B</td>
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<td>14.</td>
<td>B</td>
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</table>
Explanation of Correct Answers

Electrical

Note: For some questions, there may be alternative ways to arrive at the correct answer.

1. A

Total resistance for a circuit connected in parallel ($R_1 = 150$, $R_2 = 200$, $R_3 = 300$):

$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

$$R_T = \frac{1}{\frac{1}{150} + \frac{1}{200} + \frac{1}{300}}$$

$$R_T = 66.67 \text{ ohms}$$

2. A

Total capacitance in a circuit connected in a series ($C_1 = 8$, $C_2 = 2$, $C_3 = 12$):

$$C_T = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

$$C_T = \frac{1}{\frac{1}{8} + \frac{1}{2} + \frac{1}{12}}$$

$$C_T = 1.41 \mu\text{f}$$
3. D

Total inductance for inductors connected in parallel (L₁ = 4, L₂ = 8, L₃ = 6):

\[
L_T = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}}
\]

\[
L_T = \frac{1}{\frac{1}{4} + \frac{1}{8} + \frac{1}{6}}
\]

\[L_T = 1.85 \text{ mh}\]

4a. C

Break down the problem into steps:

- First, add the first 2 resistors (R₁ = 2, R₂ = 5) (connected in series) using \(R_T = R_1 + R_2\):

\[R_T = 2 + 5 = 7\]

- Then, use the resulting value as \(R_1\) in the formula for 2 resistors of different values connected in parallel (R₁ = 7; R₂ = 10):

\[
R_T = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{7 \times 10}{7 + 10} = 4.12
\]

- Finally, use the above value as \(R_1\) in the formula for resistors connected in series (R₁ = 4.12, R₂ = 8):

\[R_T = R_1 + R_2 \quad R_T = 4.12 + 8 \quad R_T = 12.12 \text{ ohms}\]

4b. D

Total Voltage (V₁ = 10, V₂ = 5): \(V_T = V_1 + V_2\)

\[V_T = 10 + 5\]

\[V_T = 15 \text{ volts}\]
4c. B

Ohm’s Law for calculating current where \((E = 15, R = 12.5)\):
\[
I = \frac{E}{R} \text{ where } E = \text{voltage}, R = \text{resistance}
\]

\[
I = \frac{15}{12.5} = 1.2 \text{ amps}
\]

5. A

Ohm’s Law for calculating voltage: \(E = IR\) where \(I = \text{current}, R = \text{resistance}\)

- First, calculate total resistance for resistors connected in series \((R_1 = 5, R_2 = 10, R_3 = 2)\):
  \[
  R_T = R_1 + R_2 + R_3 \quad R_T = 5 + 10 + 2 = 17k
  \]

- Then, determine the current using Ohm’s Law \((E = 80; R = 17k)\):
  \[
  I = \frac{E}{R} \text{ where } E = \text{voltage}, R = \text{resistance}
  \]
  \[
  I = \frac{80}{17} = 4.7
  \]

- Finally, calculate voltage for M1 (note that M1 is only related to the \(2 \text{k}\Omega\) resistor):
  \[
  E = IR \quad E = 4.7 \times 2000 \quad E = 9.4 \text{ volts}
  \]

6. C

The first step is to simplify the circuitry by calculating intermediate values (total resistance) when possible \((R_1 = 2, R_2 = 3.5, R_3 = 3.5, R_4 = 5, R_5 = 5, R_6 = 15, R_7 = 15)\):

- Add \(R_2 + R_3 = 3.5 + 3.5 = 7\)

- Next, calculate the total resistance for the circuits connected in parallel with \(R_2\) and \(R_3\):

\[
R_T = \frac{1}{\frac{1}{R_2} + \frac{1}{R_4} + \frac{1}{R_5}} \quad \frac{1}{\frac{1}{R_7} + \frac{1}{5} + \frac{1}{5}} = 1.84
\]
Then, calculate the total resistance for $R_6$ and $R_7$ connected in parallel ($N = \#\text{ resistors}$):

\[ R_T = \frac{R}{N} \quad R_T = \frac{15}{2} \quad R_T = 7.5 \]

Now calculate the total resistance for circuits connected in series using the $R_T$ values from the 2 parallel circuits ($R_2$ includes $R_2, R_3, R_4, R_5$; $R_3$ includes $R_6, R_7$):

\[ R_T = R_1 + R_2 + R_3 \quad R_T = 2 + 1.84 + 7.5 \quad R_T = 11.34 \]

Finally, calculate the current using Ohm’s Law:

\[ I = \frac{E}{R} \quad I = \frac{40}{11.34} \quad I = 3.5 \]

7. B

Modify formula for $V_{\text{rms}}$ to calculate peak voltage:

\[ V_{\text{rms}} = V_{\text{peak}} \times 0.707 \]

\[ V_{\text{peak}} = V_{\text{rms}} / 0.707 \]

\[ V_{\text{peak}} = 140/0.707 \]

\[ V_{\text{peak}} = 198 \text{ volts} \]

8. C

This problem can be solved in three steps:

- First, calculate the RMS current flow:

\[ V_{\text{rms}} = V_{\text{peak}} \times 0.707 \quad V_{\text{rms}} = 200 \times 0.707 \quad V_{\text{rms}} = 141.4 \text{ volts} \]

- Then, calculate total resistance for currents connected in series ($R_1 = 5, R_2 = 15$):

\[ R_T = R_1 + R_2 \quad R_T = 5 + 15 \quad R_T = 20 \text{ K} \]

- Finally, divide RMS voltage by the total resistance:

\[ V_{\text{rms}} / R_T = 141.4/20\text{K} = 7.1 \text{ milliams} \]
9. A

Calculate the watts for each resistor and compare results:

Ohm’s Law  \[ \text{Watts} = \frac{\text{Volts}^2}{\text{Ohms}} \]

\[ W_1 = \frac{120^2}{6} = 2400 \]
\[ W_2 = \frac{120^2}{8} = 1800 \]
\[ W_3 = \frac{120^2}{10} = 1440 \]
\[ W_4 = \frac{120^2}{16} = 900 \]

10. C

A 5:1 potential transformer indicates a 5:1 turn ratio. Line voltage can be calculated by multiplying voltage from the secondary on the transformer by the value indicated by the transformer. Here, the line voltage will be 5 times the voltage from the secondary on the transformer:

\[ 5 \times 120 = 600 \text{ volts} \]

11. C

The circuit in the diagram is center tapped. Therefore, only half of the voltage will be measured across the load resistor. The 1:5 transformer indicates that the secondary of the transformer will be 5 times the line voltage:

\[ 120 \times 5 = 600 \quad 600/2 = 300 \]

12. C

Look for common points in the circuit:

A voltmeter connected between A and B does not include any resistors.
A voltmeter connected between F and A includes \( R_2 \) and \( R_3 \) only.
A voltmeter connected between H and F includes \( R_1 \) only.
A voltmeter connected between H and C includes both \( R_1 \) and \( R_2 \).
13. B

Calculate pressure using the formula provided:

\[ P = 0.43 \times H \] where \( P = \) pressure, \( H = \) height of water in tank

The height of water in a 300 ft tank that is \( \frac{1}{2} \) full = 150 ft.

\[ P = 0.43 \times 150 \quad P = 64.5 \text{ psi} \]

14. A

The chart indicates the amperage pulled by the motor. At 115 volts and 1 HP, the running current in the circuit is 7.2 amps. Although a 150 volt fuse would require slightly less amps, it is necessary to consider factors that may increase the current (e.g., start-up). Therefore, the fuse size needed to safely handle the running current is 150 volts, 10 amps.
Operations

1. A

Paper fires are class A.
Oil fires are class B.
Electrical fires are class C.
Metal fires are class D.

2. B

Water is the cooling medium. If no water is getting in or through the pump coolers, oil temperature will be high due to lack of a cooling mechanism.

3. A

Without disconnecting equipment from its electrical source, it could be energized and operated.

4. A

Superheated steam is above the saturation point, so it has no moisture to create a visible indication.

5. D

The use of a butterfly valve allows the valve to be opened and is usually not used for throttling or controlling flow.

6. A

When hydrogen mixes with oxygen, it becomes highly explosive.

7. B

In order to turn water into steam, the molecules must spread out. While temperature influences the velocity of molecules (higher temperatures cause an increase in velocity), pressure influences the ability of the molecules to spread out (high pressure keeps molecules compact, low pressure allows molecules to spread freely). Therefore, as pressure increases, so does the temperature required to turn water into steam.

8. A

The condensate pump supplies the water to the deaerator, where condensable gases are removed and water is preheated for use in the boiler.
9. B
An improper drum level can cause water to carry over into the superheater, which may cause damage to the steam turbine and cracking in the superheated tubes.

10. A
The HP turbine is the first point of exit from the superheater and is designed to handle the highest pressure and lowest moisture content.

11. D
Control valves allow for fine-tuning or control of the steam required to maintain constant or proper turbine speed.

12. C
The exciter system generates electricity for the main generator field winding.


**Mechanical**

1. **C**

   Calculate the weight of each plate (4 sides and a bottom), then add them together:

   3 inches = .25 ft

   L x W x H for each plate

   \[2(3 \times 1 \times .25) = 1.5 \text{ (2 long sides)} \quad 1.5 \times 500 = 750 \text{ lbs.}\]

   \[2(3 \times 1 \times .25) = 1.0 \text{ (2 short sides)} \quad 1.0 \times 500 = 500 \text{ lbs.}\]

   \[2 \times 3 \times .25 = 1.5 \text{ (bottom)} \quad 1.5 \times 500 = 750 \text{ lbs.}\]

   \[2000 \text{ lbs.}\]

2. **C**

   This problem requires 3 steps:

   - Calculate the total weight of the metal plate:

     3 inches = .25 ft; 9 inches = .75 ft

     \[L \times W \times H\]

     \[3 \times 6 \times .25 = 4.5 \text{ ft}^3\]

     \[4.5 \times 490 = 2205 \text{ lbs.}\]

   - Calculate the weight of the 9” square of metal:

     \[L \times W \times H\]

     \[.75 \times .75 \times .25 = .141 \text{ ft}^3\]

     \[.141 \times 490 = 69 \text{ lbs.}\]

   - Subtract the weight of the 9” square from the total weight of the metal:

     \[2205 \text{ lbs.}\]

     \[\phantom{2205} - 69 \text{ lbs.}\]

     \[2136 \text{ lbs.}\]
3. D

The diagram indicates a 1” square at each corner of the plate. Therefore, the length of each side of the plate is 2” (1” on each corner) longer than the values provided in the diagram:

15.75” + 1” + 1” = 17.75

6.5” + 1” + 1” = 8.5

The dimensions of the plate are ½ ” x 8 ½ ” x 17 ¾ ”

4. B

Using the formula provided: \( S_B = \frac{N_A \times S_A}{N_B} \)

\( S_B = \frac{24 \times 110}{64} \)

\( S_B = 41.25 \text{ rpm} \)

5. A

Using the formulas provided:

\( I = \frac{x \times (b-a)}{D} \)

\( I = \frac{.010 - .003}{2} \)

\( I = .007 \)

\( O = \frac{y \times (b-a)}{D} \)

\( O = \frac{10 \times (.010 - .003)}{2} \)

\( O = .035 \)

6. B

Based on the drawing, we know that Dimension A + 5/8 + 7/8 will equal 2 ½.

- Convert 2 ½ to eighths:
  
  \( A + 5/8 + 7/8 = 20/8 \)

  \( A + 12/8 = 20/8 \)

  \( A = 20/8 - 12/8 \)

  \( A = 8/8 = 1 \)
7. A
A check valve is either open or shut.
A diaphragm valve is used to stop flow.
A relief valve opens under pressure.
Of the options listed, a globe valve is the only one that is used to regulate flow.

8. B
Each digit in the code/label for rod types is meaningful:

E7018 – Electrode
E7018 – 70,000 lbs. tensile strength
E7018 – Position rod can be used in
E7018 – Manufacturer’s code

A rod with a “position” value of “1” would be used to make an out-of-position weld.
Section 4: Additional Resources
Additional Resources

Classes
An additional option for training is a classroom-based course at a local technical school or college. Compare the course curriculum to the list of skills and knowledge areas outlined in Section 2 of this study guide to determine if a course covers what you need. It may also be helpful to review the list with the instructor.

How do I Register?
Call your local technical school or college and ask about their registration requirements. This information should also be available at the institution’s website.

Reference Books
The following books may be found at your public library, your local bookstore, or on the Internet. Reference books may cost between $20 and $50. However, some websites may sell them used, and they can usually be checked out of the library at no charge.

Lists of Books
Below is a list of books, including title, author(s), publisher, and date. Recommended books are marked with an asterisk (*). Keep in mind that this list is not exhaustive; you may find useful books that are not included in this list.

Electrical

1993 National Electrical Code: Interpretive Diagrams
Building News
NECA/WEST
1993

Basic Electricity
Van Valkenburgh
Prompt Publications
1995

Basic Electricity: A Self-Teaching Guide
Charles W. Ryan
John Wiley & Sons, Inc.
1986
**Electrical** (continued)

*Basic Electricity/Electronics: How AC & DC Circuits Work*
Robert R. Manville
H.W. Sams
1985

*Basic Electricity/Electronics: Motors & Generators*
Robert R. Manville
H.W. Sams
1985

*Basic Electricity/Electronics: Understanding Electronic Circuits*
Robert R. Manville
H.W. Sams
1985

*Basic Electricity/Electronics: Understanding & Using Test Equipment*
Robert R. Manville
H.W. Sams
1985

*Basic Electronics*
Gene McWhorter, Alvis J.Evans
Master Publishing
1994

**Combined Instructor’s Guide, Electricity 1 - Electricity 4**
Walter N. Alerich, Jeff Keljik, Thomas S. Kubala
Delmar Publishers
1996

**Electrical Power - Motors, Controls, Generators**
Joe Kaiser
Goodheart-Wilcox Co.
1991

**Electricity: Principles and Application**
Richard J. Fowler
Glencoe McGraw-Hill
1999
**Electrical** (continued)

**Electronic Instrumentation and Measurement Techniques**  
William David Cooper, Albert D. Helfrick  
Prentice-Hall  
1985

**Introduction to Electricity and Electronics - Conventional Current Version**  
Allen Mottershead  
Prentice-Hall  
1985

**National Electrical Safety Code Handbook**  
Allen L. Clapp  
IEEE Standards Press  
1992

**Pneumatics and Hydraulics**  
Harry L. Stewart, Tom Philbin  
Macmillan  
1987

**Schaum’s Outline of Basic Electricity**  
Milton Gussow  
McGraw-Hill  
1987

**TAB Electronics Guide to Understanding Electricity and Electronics**  
Randy G. Slone  
McGraw-Hill  
2000

**Teach Yourself Electricity & Electronics**  
Stan Gibilisco  
McGraw-Hill  
1997

***Ugly’s Electrical References**  
George V. Hart  
Burleson Distributing Corp.  
1999
Operations

Boiler Operator’s Guide
Harry M. Spring, Jr., Anthony Lawrence Kohan
McGraw-Hill
1981

Mechanical

Handbook of Rigging
W. E. Rossengel, Lindley R. Higgins, Joseph A. MacDonald
McGraw-Hill
1990

*Millwrights & Mechanics Guide
Carl A. Nelson
Macmillan
1989

Pipefitters and Welders Pocket Manual
Charles N. McConnell
Audel
1997

Rigging Handbook: The Complete Illustrated Field Reference
Jerry Kline
Acra Enterprises
1995

The TAB Handbook of Hand and Power Tools
Rudolf F. Graf, George J. Whalen
TAB Books
1984

Welding Handbook
American Welding Society
1987

Welding: Principles and Applications
Larry F. Jeffus
Delmar Publishers
1999
Mathematics

Basic Mathematics for Electricity and Electronics
Bertrand B. Singer, Mitchell E. Schultz, Harry Forster
Glencoe McGraw-Hill
1999

Mathematics for Electricity/Electronics
Fred W. Culpepper, Jr., Rex Miller
Glencoe Publishing Co.
1980

Correspondence Courses

The following vendors offer self-study courses with reference books.

Harcourt Learning Direct
P. O. Box 1900
Scranton, PA 18505-1900
800.275.4409
Fax 570.343.3620
www.harcourt-learning.com

Heathkit Educational Systems
455 Riverview Dr.
Benton Harbor, MI 49022
800.253.0570
Fax 616.925.2898
www.heathkit.com

Cleveland Institute of Electronics
1776 East 17th St.
Cleveland, OH 44114-3679
800.243.6446
Fax 216.781.0331
www.cie-wc.edu

On the web

The following websites may also provide useful information and/or resources.

www.sweethaven.com/acee

www.electronictech.com/resources/olics/meade.html

www.free-ed.net/catalog/eremain.asp?nC=2&nD=3&nO=0
Section 5: General Testing Tips
**General Testing Tips**

**Introduction**

This section will introduce a number of tips and strategies for taking tests. It will remind you of important behaviors prior to the test as well as certain strategies you may use during the test session. As you read these strategies, try to determine which suggestions would be most helpful to you. Different people may find some of the suggestions more helpful than others.

**Advance Preparation for the Testing Session**

There are some things you may do in advance in order to best prepare for the testing session. Reading and studying this guide is part of a good preparation strategy. Studies have shown that memory works best when a subject or topic is studied over multiple occasions during a long period of time. Utilizing this strategy, it may be best to start studying the material contained in this guide and other resources well ahead of attending the testing session.

Become familiar with the nature of the questions that will be asked in the test session by completing the sample questions in this guide. You will feel more comfortable during the testing session if you are familiar with the types of questions you will see prior to the session.

Take care of your well-being before the test session. For about a week prior to the test session, be sure to get enough sleep. You should also take steps to increase your quality of sleep. Your body repairs itself primarily during sleep. Disrupted sleep affects memory, mood and general well being. Alcohol inhibits the body’s natural rhythm, which in turn will interrupt sleep. You should avoid alcohol near the test date. Caffeine in the evening, or excessive caffeine at any time, will make it more difficult to fall asleep and will also affect the quality of sleep.

A good diet may also affect problem solving and your ability to perform well in the testing session. Make sure that you get enough nutritional foods in the weeks before the testing session.
General Testing Tips (continued)

On the Day of the Test

Below are the specific actions that you can take to start the testing session relaxed and ready to do your best:

- Eat enough to not be hungry, but not so much that you are stuffed.
- Do not drink a lot of liquids prior to the testing session.
- Avoid any medication that may make you drowsy.
- Arrive early.
- Settle in and try to relax.
- Realize that even if you prepared well, you may be nervous or stressed.

Below is a list of items that will not be allowed into the testing session:

- Laptop computers
- Study guides
- Notes
- Beepers
- Cellular phones
- Walkmans/portable CD players

Relax, if you've prepared well by utilizing this guide and using good study skills, you are more likely to perform well.

The test administrator has the authority to not allow any items he or she feels are unnecessary or violate test guidelines.
**General Testing Tips** (continued)

**During the Test Session**

During the test session, it is important to stay relaxed and focused on the test. To perform your best, you need to be positive and confident. Work quickly but accurately. You may find it helpful to wear a watch to the testing session. This will help you monitor the time. You should try to complete all the questions in the test, but if you find yourself working a little slowly, do not sacrifice accuracy for speed.

**Listen to and Read the Instructions Carefully**

The test administrator will read the instructions aloud. Be sure to follow along in the test booklet. Each test may have different instructions. If so, the instructions will clarify any items that are specific to the test you are taking. Be sure that you understand what to do for each test. If you have any questions be sure to ask them at this time. Once the test begins, the test administrator will not be able to answer any questions.

**Know the Time Limits**

If the test is timed, the test administrator will read aloud the time limit for each test during the instructions. Make a note of the start time. **Do NOT set your watch alarm.** It is important to use the time limits to pace yourself. Occasionally, check your testing progress against the time limit.

**Do not Spend too Much Time on any One Question**

If you are having difficulty answering a question, go on to the next question. If you have time left when you get to the end, you may go back and answer any skipped questions. If you do skip a question, be sure to skip the corresponding answer space on the answer sheet.
General Testing Tips (continued)

Answering Questions

During the test, it is important to stay relaxed and focused. Your score is determined by the number of questions answered correctly. It is important to try to answer all the questions. Next, we will discuss some strategies that will assist you when you encounter a question that you have a hard time answering.

Eliminating Incorrect Responses

If you are unsure of the correct response, try to eliminate the responses that you know are wrong. It is generally better to eliminate the responses and take an educated guess than to leave an item blank. Below is a sample:

Which of the following would most likely be found in a bedroom?

A. Pillow
B. Spoon
C. Book
D. Refrigerator

“Refrigerator” would obviously be found in a kitchen. You now have “Pillow”, “Spoon”, and “Book” remaining. You know that spoons and books may be found in a bedroom if someone was eating or reading in bed. However, the question asks which one would “most likely” be found in a bedroom; You know that generally a bed with pillows is found in a bedroom, so the best answer is “A”. Pillow.” In this question, the key words “most likely” helped you eliminate some choices.

All of the Above

In a question that contains an “All of the Above” response, if you can eliminate one response; you can also eliminate the “All of the Above” response.
General Testing Tips (continued)

None of the Above

In a question that contains a “None of the Above” response, if you can reasonably say that one response is a possible answer, you can eliminate the “None of the Above” response.

Difficult Questions

Were there any other questions in the test that are similar in subject matter? It is possible that other questions in the test may contain a clue to the correct response to a difficult question.

Matching Response to Question

There may be a phrase in the question that matches, or closely resembles, a portion of the response. An example is provided below:

Which magazine would you consult first to locate articles on the use of yeast in baking?

A. Restaurant Today  
B. Home Baking  
C. Home Improvements  
D. Psychology Today

The correct response is “B”. The word “baking” appears in the question and in the correct response.

Additional Resources on Test Taking Strategies

It is up to you to be well prepared for the testing session. This guide introduced some basic steps which will help you feel more positive and confident about test taking. We have also provided some training on answering difficult questions. There are numerous books that have been written on test taking and strategies for test taking. If this is a subject that interests you, check your library or the internet for additional resources.