# CONTENT

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PREPARING FOR AN OPEN BOOK EXAM

Open Book

Most applicants agree this is the most difficult part of an electrical exam. Time becomes such an important factor. 100 questions in four hours on the Master exam.

Open book is a test of your knowledge and use of the National Electrical Code. 86% of the open book Master questions are from the Code book.

Your score on the open book exam depends on how familiar you are with the Code book. Most exam applicants run out of time and are not able to find all the answers to the questions within the limited time.

**Master Exam
100 Questions
4 Hour Time Limit**
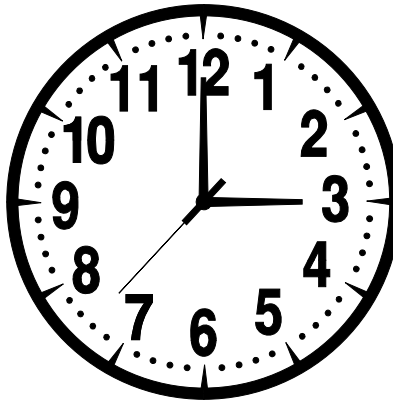
**That averages to
2.4 minutes
per question**

The key to an open book exam is not to spend too much time on one question. If the question does not contain a key word that you can find in the index, **skip this question**, and continue to the next question. If you spend 3 minutes, 5 minutes, 6 minutes on a question and never find the answer you are eating into the time that should be used for the answers you can find.

In general, there are usually 8 to 10 really difficult questions on an exam. The remaining questions after proper preparation, you will be able to find within the alotted time. Skip these 8 or 10 as you recognize them and move on finding the other answers. If you answer 40 questions correctly out of a total of 50 questions your score would be 80%! That's better than in some cases where the applicant hasn't even answered 20 questions and time has run out. You **can't** spend 5 or 6 minutes on a question. Never leave a question unanswered, unanswered is counted wrong. Always select a multiple choice answer before time runs out.

Proper preparation is so important in passing an open book exam. Don't be guilty of reading a question and feeling, "I know the answer so I won't bother looking in the Code book." The following pages will prove how this can be a big mistake. I teach by being properly prepared with how to find your way around in the Code book. You'll be able to look up all the answers within the time limit.

The difficulty occurs when you say Code book.
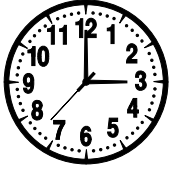
Your score on the open book exam depends on how familiar you are with the **Code book**. Most exam applicants **run out of time** and are not able to find all the questions and select a choice of answer within the limited time.

Test question writers hope the question is never copied.

Their score is instantaneous but they **never know what questions were wrong** or where their weaknesses are.

The elusive license, is still unattainable at this point. How would the applicant ever find out what the **correct answer** is? They are not permitted to ever knowing the **correct answer**. How are you to be educated if you **never** know the correct answer?

The only time you will ever know the "**correct answer**" is when you read *Tom Henry Books* where from all the years of studying the intent of the NEC from the TCD, TCR giving the substantiation for each of the new safety rules or deletions from the NEC each three years.

At my age 84, I've been through 21 code cycles and written over 100 electrical books which will give you the **correct answer** in full detail.

National Electrical Code

•The Code is Truly a "National" Code. - The men who freely contribute their time and study to the writing of the Code come from all over the United States and thus the final document represents a nationwide cross-section of opinion.

•The Code is an "American Standard." - The fact that the writers of the Code are organized under the procedure of the American Standards Association makes this possible. This simply means that the Code is officially recognized as representing standard American practice. It is a simple standard; there is no need for necessity for anyone to develop another code; the National Electrical Code is sufficient. Proof of this is the fact that cities and other governmental bodies all over the United States have adopted it as the *safety standard for electrical installations*, in spite of the fact that the Code itself, being written by a technical association, has no legal or mandatory status whatsoever.

The National Electrical Code is based on the fact that **to do less would be a hazard**. Many of the sections of the NEC are a result of known fire; incorporating corrections into the NEC each three years is an attempt to prevent similar occurrences.

Every rule in your safety manual is written in somebody's blood. The freedom and safety that you and I enjoy in our communities in large part is due to the sacrifice of others.

THE OPEN BOOK EXAM
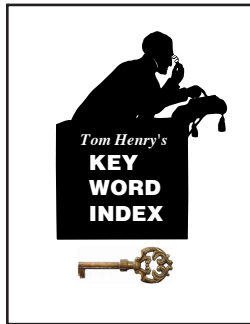
The best reference book for locating words in the Code book is "The Key Word Index". This book contains every word in the Code book with section number and page number. **Now you can find what you're looking for in seconds!** Now you'll be able to show them out on the job where it says that in the Code book. Try it once and you'll never be without it.

The "*ULTIMATE*" Code package includes the *2023* NEC, *Tom Henry* 68 TABS (installed), KEY WORD INDEX, REMINDER BOOK, 14 pages of FORMULA INSERTS, plus over 3,600 *KEY* Code references **HI-LITED**!

Will Rogers once said, "You can't come back from someplace you've never been." This book will take you there.

•If you focus first on figuring out what the answer is, **before looking at the options given**, it will force you to think back to the text or the lecture where you first heard this information.
This process helps to improve your concentration, and will exercise your memory.

•If you are really stuck on a question, make your best guess and put a question mark next to it. If you finish the test with time to spare, go back and reconsider the ones you marked.
If you do not want to guess, skip the question and put a mark beside it, so you can return to it if you have time at the end of the test.

•Skip answers when you are stuck, but try to get back to them if you can – **it's best to answer every question you can**, within the allotted time frame.

•Forget about always sticking to your first choice. Many people say that your first guess on a test question is usually right, so you should never change your answer. However, recent studies have shown that isn't the case – you're just as likely, or even more likely, to get it right if you change an answer you aren't sure about. So don't stress over whether to change an answer because it wasn't your first choice. **If you change your mind, change your answer**.

•Data collected from takers shows that test-takers who changed some of their answers tended to score higher than those who always stuck with their first choice.
Test takers in the study most often changed answers from wrong to right, which resulted in a higher score.

To pass the exam is very simple, it takes work! Like with anything in life, you get out of it what you put into it. The more time you spend preparing for the exam, the easier it will become. As you work these exams and grade yourself, hi-lite the answers with a marking pen in your Code book, or better yet purchase the "Ultimate Code Book" which has the complete package for taking an electrical exam.

The key to the exam is that the student must first **understand** the question, which requires **careful reading of each word.**

Read this sentence:

> FINISHED FILES ARE THE RE-
> SULT OF YEARS OF SCIENTIF-
> IC STUDY COMBINED WITH THE
> EXPERIENCE OF YEARS.

Now read it once more, and count the **F's** in the sentence. How many did you find?

(a) 3 (b) 4 (c) 5 (d) 6

If you are a careful reader, you will find all **6** F's.

Most applicants taking an exam are not familiar enough with the Code book and it's easy to understand why only 30 out of 100 pass an electrical exam. Many are *unsuccessful* because they failed to *read* the question correctly.
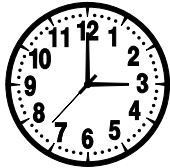
Your score on the open book exam depends on how familiar you are with the **Code book**. Most exam applicants run out of time and are not able to find all the answers to the questions within the limited time.

Number skills can be tested with math problems or interpreting plans, charts and graphs. You may wonder whether to concentrate on improving your strong areas or on building some background in your fields of *weakness*. Working more practice exams, broader coverage, would be included for those subjects which are more important in your work. Now weigh your strengths and weaknesses against the job requirements and prepare accordingly.

This book contains 20 General Knowledge exams, 21 Code book exams with two 4 hour 100 question final exams. This will aid you in better understanding the time involved with answering correctly.

25 questions at 2.4 minutes per question = 60 minutes.

Spend an hour a day working a practice exam and see your scoring increase!

NEC Code consists of **9 chapters** each dividing into four groupings: General Requirements; Specific Requirements; Communications Systems and Tables

Chapter 1: General
Chapter 2: Wiring and Protection
Chapter 3: Wiring Methods and Materials
Chapter 4: Equipment for General Use
Chapter 5: Special Occupancies
Chapter 6: Special Equipment
Chapter 7: Special Conditions
Chapter 8: Communications Systems
Chapter 9: Tables – Conductor and Raceway Specifications

I agree with questions from theory-Ohm's law, voltage drop, ampacity, tools, plan reading.

But the difficulty for the applicant comes **from asking questions from all nine chapters** of the National Electrical Code.

The preparation for the exam should educate the dangers of the **behavior of electricity**, the overload, short circuit, the explosion, the fire, the injuries, the deaths.

For some electricians, it has been twenty years or more since they have used math formulas, theory, and calculations. For most, the last time was an apprenticeship class. Now, for the exam, we are required to be an expert in the reading of the Code and in applying all of the tables and demand factors to the calculations.

Tom Henry Electrical Books
Henry Publications Since 1985
www.code-electrical.com 1-800-642-2633
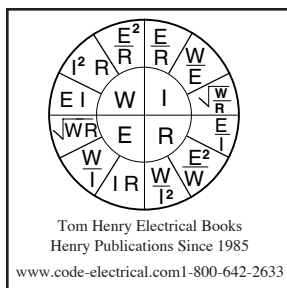
The most difficult task in preparing for the electrical exam is trying to "memorize" the formulas. You increase the strength of your memory by *overlearning the subject* and that's what our books are about. Our books will show an easier way to study. Study smarter, not harder.

Memorization is the process of committing something to memory. The act of memorization is often a deliberate mental process undertaken in order **to store in memory for later recall.** Memory is the "process of retaining information over time."

Memorization is a frontage road: It runs parallel to the best parts of learning, never intersecting. It's a detour around all the action, *a way of knowing without learning*. Only through sustained effort of **rehearsing information are we able to memorize data for longer than a short period of time**.

We tend to remember things that interest us or are made memorable to us**.**

GENERAL KNOWLEDGE CATEGORIES
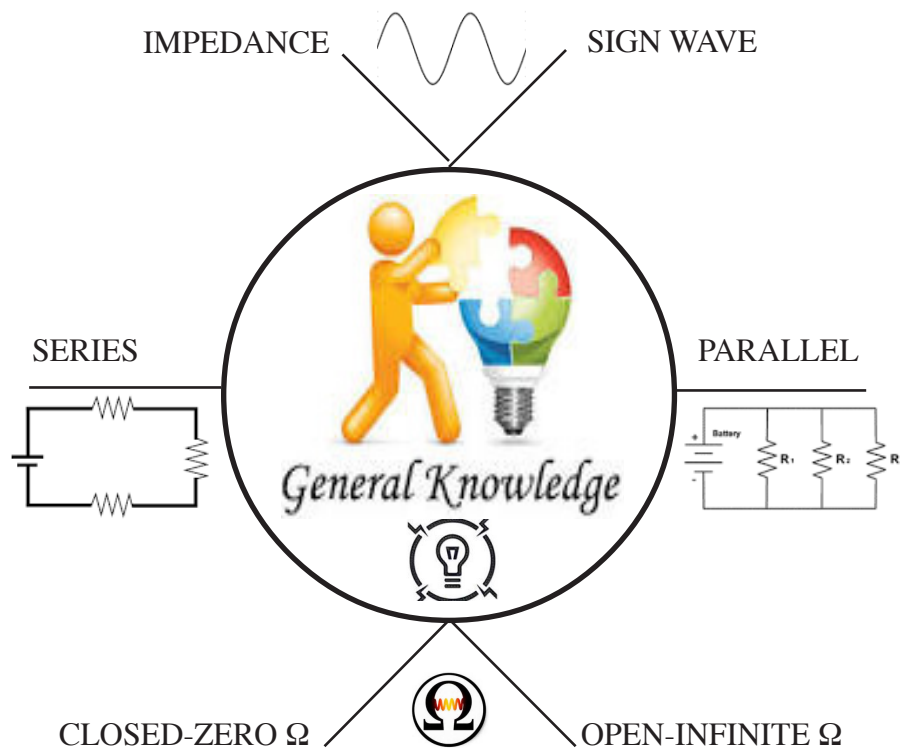
General knowledge is information that has been accumulated over time through various mediums, sources. It excludes specialized learning that can only be obtained with extensive training and information confined to a single medium.

General Knowledge or General Awareness is an important and common section in all competitive and government recruitment examinations.

The questions can be answered easily in the time limit. It's very simple, either you know the answer or you don't. It doesn't help to sit and scratch your head pondering over the correct answer. It has been proven in test taking that the longer you hesitate in selecting the choice, the more likely you are to talk yourself out of the correct answer.

Read the question and the choice of answers **carefully** and select your choice and move to the next question.

Hand-writing is a powerful tool for memorization, and it is even more effective if you do it repeatedly. **Get out a pen and paper and start hand-writing what you need to memorize**.

The **General Knowledge** exam questions your knowledge on "Other than Code questions." Some questions may seem difficult for you, but they represent every conceivable type of question encountered on previous electrical exams.

An excellent tip!
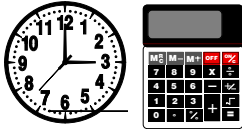
Instead of marking your choice of answer in the book, write it on a separate paper, that way you can retake the exam over until you feel you understand the question and answer.

The exams are *timed based*, so write down the time you start and finish the practice exam.

25 questions at 2.4 minutes per question = 60 minutes. **Spend an hour a day** working a practice exam and see your scoring increase!

Start now by *reading the question carefully* using your formula sheets and calculator.

To grade your exam:
**Count the number of correct answers**
and divide by the number of questions 25.
Example: 19 correct answers ÷ 25 questions = 76%

General knowledge categories such as the behavior of electricity, theory, Ohm's Law, ac-dc power, voltage drop, power factor, efficiency, cost, tools, safety, plan reading, specifications, etc.

The **general knowledge** categories test your knowledge of what you have learned from the years spent in the electrical field to **qualify** to take the exam. How much can you remember from your training?

The NEC is updated every 3 years, **general knowledge** categories remain the same over the years in most cases.
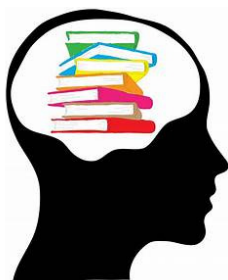
There is no NEC section to locate for **general knowledge** questions, you must select the correct answer by **memory**. These are the questions where **formulas** come into play.

The German physicist is well known today for his formulation of a law, termed Ohm's Law, describing the mathematical relationship between electrical current, resistance and voltage.

Ohm's Law. The principle is named after the German scientist Georg Simon Ohm. Ohm demonstrated that there are no "perfect" electrical conductors through a series of experiments in 1825. Every conductor he tested offered some level of resistance. These experiments led to Ohm's Law.

Georg Simon Ohm

In 1827, he discovered some laws relating to the strength of a current in a wire. Ohm found that electricity acts like *water* in a pipe. It is a simple law that states the relationship between voltage, current, and resistance in a mathematical equation.

Ohm discovered that the current in a circuit is directly proportional to the electric pressure and inversely to the resistance of the conductors.

Ohm's Law can be used to verify voltage drop. In a DC circuit, voltage equals current multiplied by resistance. $E = I R$.

Ohm's Law is one of the most important things that you will use throughout your electrical career. It is a mathematical tool which is of the greatest use in determining an *unknown* factor of voltage, current or resistance in an electrical circuit in which the other two factors are known.

Electricity was **discovered**, not invented. The dictionary defines it as "one of the fundamental entities in nature."

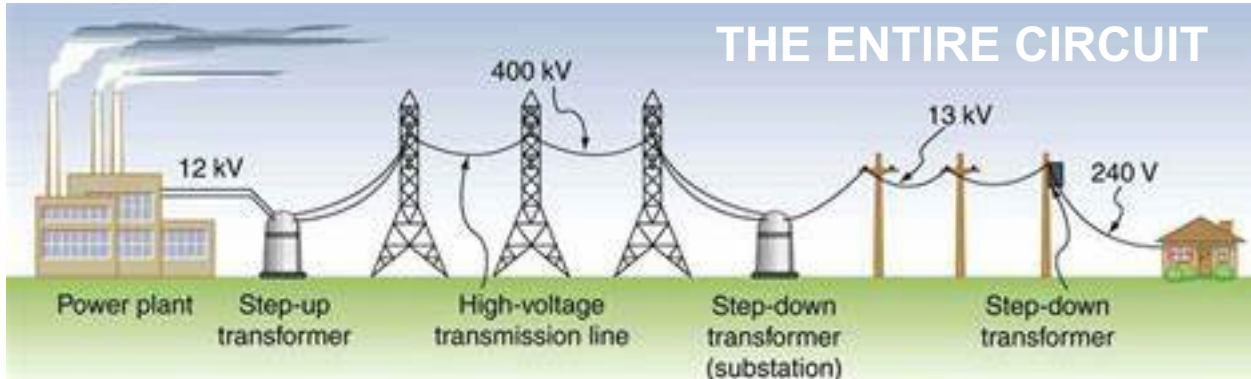Today it is generally agreed that electric current flow is comprised of moving electrons. This is called the **electron theory**. Electrons are very tiny particles of matter.

Electricity is **produced** when electrons are freed from their atoms. This can be done from six different ways.

MAGNETISM   CHEMICAL

LIGHT   FRICTION

PRESSURE   HEAT

1000 LBS

TH
8
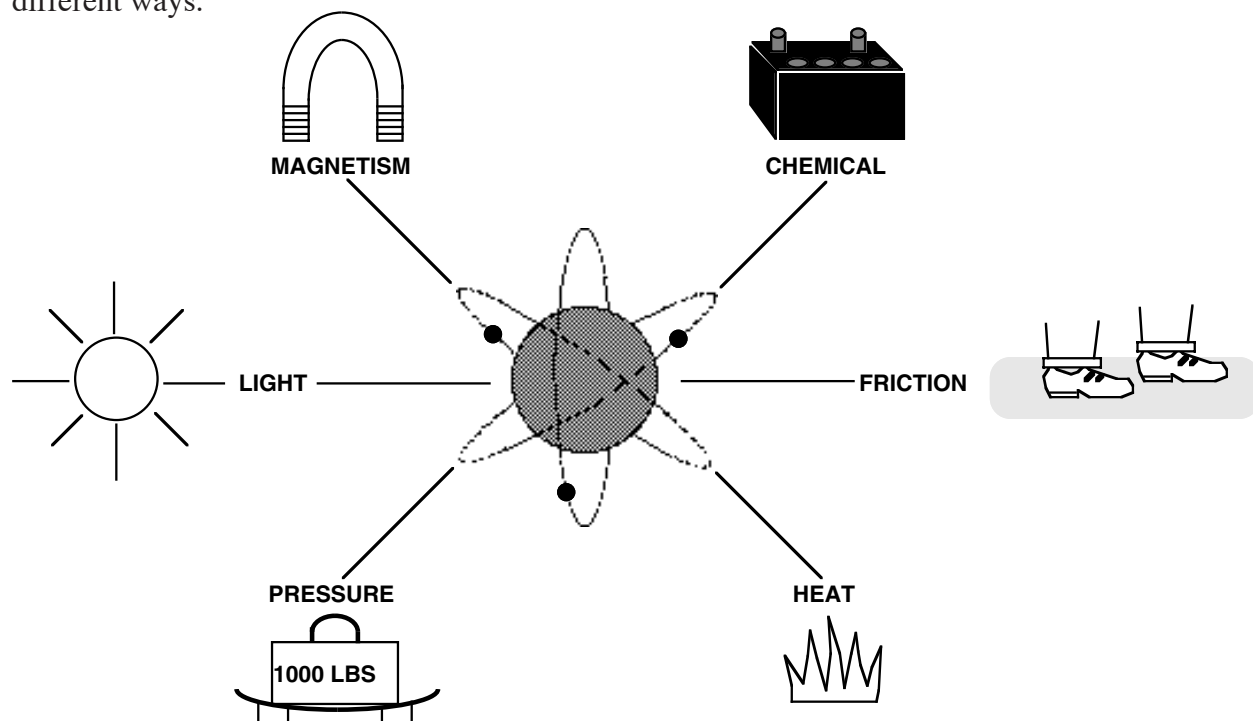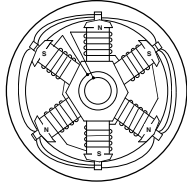
The number one producer of electrical energy is the generator which employs the principle of **electromagnetic** induction.

THE ENTIRE CIRCUIT

400 kV

13 kV

12 kV

240 V

| Power plant | Step-up transformer | High-voltage transmission line | Step-down transformer (substation) | Step-down transformer |

The key to the exam is that the student must first **understand** the question, which requires **careful reading of each word.**

Education is what you have left over when you subtract what you've forgotten from what you've learned.

It is often what we think we know already
that often prevents us from learning.

Knowledge has to be improved, challenged, and increased constantly, or it vanishes.
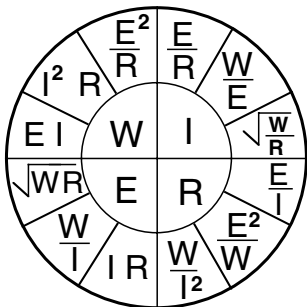
OHM'S LAW

It is a simple law that states the relationship between voltage, current and resistance in a mathematical equation.

In electrical terms, voltage is represented by the letter "E" (electromotive force), current by the letter "I" (intensity), and resistance by the letter "R".

The Ohm's Law formula cannot work properly unless all values are expressed in the **correct units** of measurement:

VOLTAGE is always expressed in VOLTS
CURRENT is always expressed in AMPERES
**RESISTANCE is always expressed in OHMS**

SERIES CIRCUIT

•*Actual exam question.* Other factors remaining the same, the effect on the current flow in the circuit would cause the current to _____ if the applied voltage was doubled.
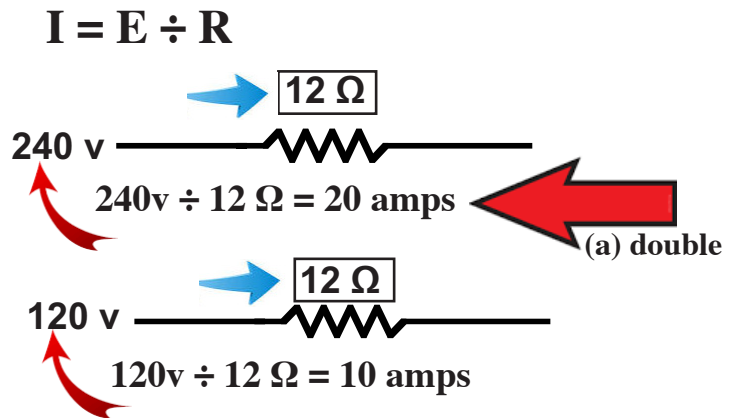
(a) double   **(b) divide by 2**   **(c) remain the same**   **(d) increase 4 times**

•Answer: To solve an unknown, you will need to know two knowns.

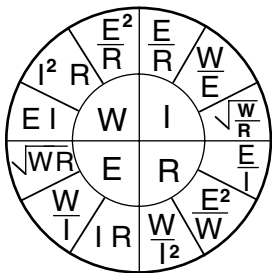$$I = E \div R$$

The Ohm's Law Triangle

$$\begin{array}{c} E \\ \hline I \;|\; R \end{array}$$
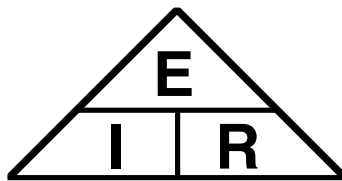
E = voltage
I = intensity of current (amps)
R = ohms of resistance

12 Ω
240 v ———\/\/\/———
240v ÷ 12 Ω = 20 amps   **(a) double**

12 Ω
120 v ———\/\/\/———
120v ÷ 12 Ω = 10 amps

Actual exam question. A 3Ω, 6Ω, 9Ω and a 12Ω resistor are connected in series @ 120 volts. The resistor that will consume the most power is the _____ .

(a) 3Ω   **(b) 6Ω**   **(c) 9Ω**   **(d) 12Ω**

Answer:

Resistance adds in series 3 Ω + 6 Ω + 9 Ω + 12 Ω = **30 ohms**
Find $I = E \div R$
$I = 120v \div 30 Ω =$ **4 amps flows through the entire circuit**

$W = I^2R$ 4a x 4a x 3 Ω = 48 watts
4a x 4a x 6 Ω = 96 watts
4a x 4a x 9 Ω = 144 watts
4a x 4a x **12 Ω = 192 watts**
Total   480 watts

Actual exam question. In the series circuit below, which resistor will consume the most power? Use 2 amps flow.

2Ω   4Ω   6Ω   8Ω
—\/\/\——\/\/\——\/\/\——\/\/\—
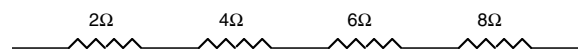
(a) 2Ω   **(b) 4Ω**   **(c) 6Ω**   **(d) 8Ω**

Answer: $W = I^2 \times R$

2a x 2a x 2Ω = 8 watts   2a x 2a x 4Ω = 16 watts
2a x 2a x 6Ω = 24 watts   2a x 2a x **8Ω = 32 watts**

Actual exam question. A 6 volt lead-acid battery has an internal resistance of 0.01Ω. How much current will flow if the battery has a short circuit?
(a) zero   (b) infinity   (c) 6 amps   (d) 600 amps

Answer: $I = E \div R$ 6 volt $\div$ .01Ω $= 600$ amps

Actual series exam questions.

• When two resistances are connected in series, ____.

(a) voltage across them must be the same | *(b) current in each resistor will be the same*
(c) there will be no current in the circuit   (d) they will become inductive

• When one resistance in a series circuit is open ____.

(a) the voltage is zero across the open resistance
(b) the current is zero in all the resistances
(c) the current is maximum in the normal resistances
(d) the current increases in the voltage source

• To increase voltage output, battery cells are connected in ____.

(a) series   **(b) parallel   (c) series-parallel   (d) parallel-series**

• In a series circuit with unequal resistances the ____.

(a) highest resistance has the highest current
(b) lowest resistance has the highest current
(c) lowest resistance has the highest voltage
(d) highest resistance has the highest voltage

SUMMARY SERIES CIRCUIT

•The same current flows through each part of a series circuit.
•The total resistance is equal to the sum of individual resistances.
•The total voltage across a series circuit is equal to the sum of individual voltage drops.
•The voltage drop across a resistor is proportional to the size of the resistor.
•The total power dissipated is equal to the sum of the individual power dissipations.

Voltage Drop in a Series Circuit

100w	69w	44w	25w	11w	3w
100w @120v	100w @120v	100w @120v	100w @120v	100w @120v	100w @120v

120v

144Ω	144Ω	144Ω	144Ω	144Ω	144Ω
R1	**R2**	**R3**	**R4**	**R5**	**R6**

100v   80v   60v   40v   20v   0v
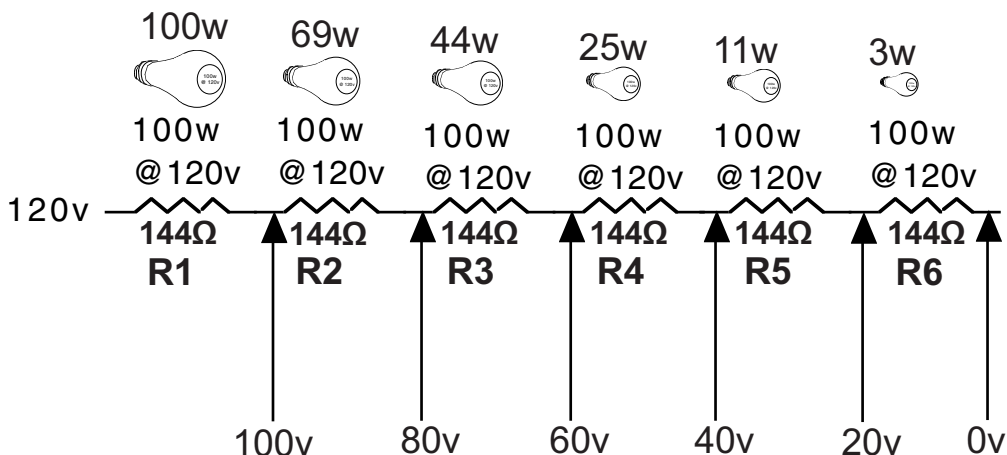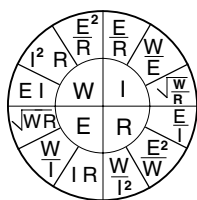
Resistance adds in series. **144 ohm** x 6 = **864** ohms total resistance series circuit.

The current flowing is I = E ÷ R   120v ÷ 864 Ω = **.1388 amp**.

VD = I x R   .13888888888 amp x 864 ohm = 120 volts dropped.

Voltage **Drop** at:
R1 = .1388 x 144Ω = 19.99 or 20v
R2 = .1388 x 288Ω = 39.97 or 40v
R3 = .1388 x 432Ω = 59.96 or 60v
R4 = .1388 x 576Ω = 79.94 or 80v
R5 = .1388 x 720Ω = 99.93 or 100v
R6 = .1388 x 863Ω = 119.92 or 120v

The Voltage at:
R1 = 120v
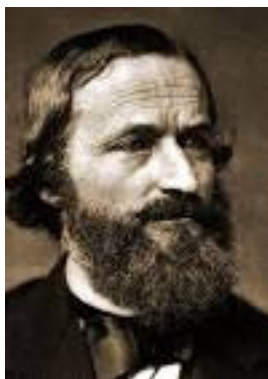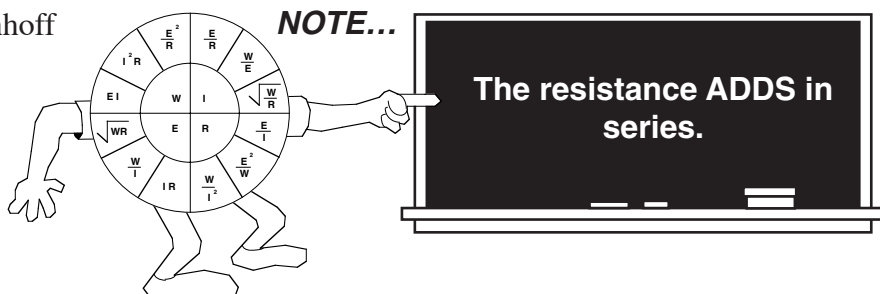R2 = 100v
R3 = 80v
R4 = 60v
R5 = 40v
R6 = 20v

Kirchhoff's Voltage Law: "The sum of the voltage drop is equal to the source voltage."

Kirchhoff's circuit laws state that in any DC circuit, the sum of the voltage drops across each component of the circuit is equal to the supply voltage.

Gustav Kirchhoff

NOTE...

The resistance ADDS in series.

Actual Ohm's Law exam questions.
• The difference of electrical potential between two conductors of a circuit is the_____.

(a) resistance   (b) amperage   (c) *voltage*   (d) wattage

• The load in an electrical circuit is used to _____.

(a) generate electrical energy   (b) transmit electrical energy
(c) utilize the electrical energy   **(d) cause a voltage drop**

• Of the six ways of producing emf, which method is used the least?

(a) pressure   (b) solar   (c) chemical action   *(d) friction*

• The continuity of a coil of winding may be determined by measuring the resistance of the coil. If the resistance measured is infinite, the coil winding is _____.

(a) partially shorted (b) totally shorted   *(c) open*   (d) in good condition

• Which of the following will **not** affect the resistance of a circuit?

(a) Length of the Conductor   (b) Diameter of the Conductor
(c) Insulation of the Conductor   **(d) Temperature**

• If you double the voltage in a circuit and cut the resistance in half, the current will become _____.

(a) the same as before   (b) twice as great   (c) half as great   *(d) four times as great*

• A wire has a resistance of 5 ohms. What will be the resistance of another wire of the same material three times as long and half the cross sectional area?

(a) 7.5Ω   (b) 15Ω   *(c) 30Ω*   (d) 50Ω

• The sum of series voltage drops _____.

(a) equals the average value of all voltage drops   *(b) equals the applied voltage*
(c) is usually more than the applied voltage   (d) is less than the smallest voltage drop

• A length of wire has a resistance of 10 ohms. What is the resistance of a wire of the same material three times as long and twice the cross-sectional area?
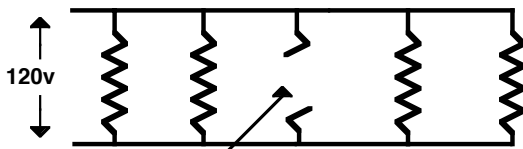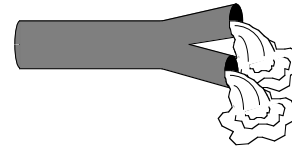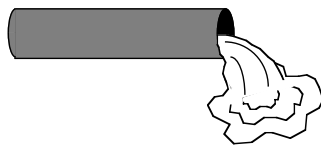
(a) 5 Ω   *(b) 15 Ω*   (c) 20 Ω   (d) 30 Ω

PARALLEL CIRCUIT

A parallel circuit is a circuit having **more than one path** for current to flow from a common voltage source.

SERIES CIRCUIT HAS ONLY ONE PATH

PARALLEL CIRCUIT HAS MORE THAN ONE PATH

120v

Bulb burnt out but the current still flows through the other bulbs.

In parallel the lights are connected **side-by-side** instead of end-to-end so that there exists more than one path through which current can flow.

In a parallel circuit, the **total** resistance is **less** than the size of the smallest load. And, everytime you **add** another load to the circuit, the **total** resistance will be **less**.
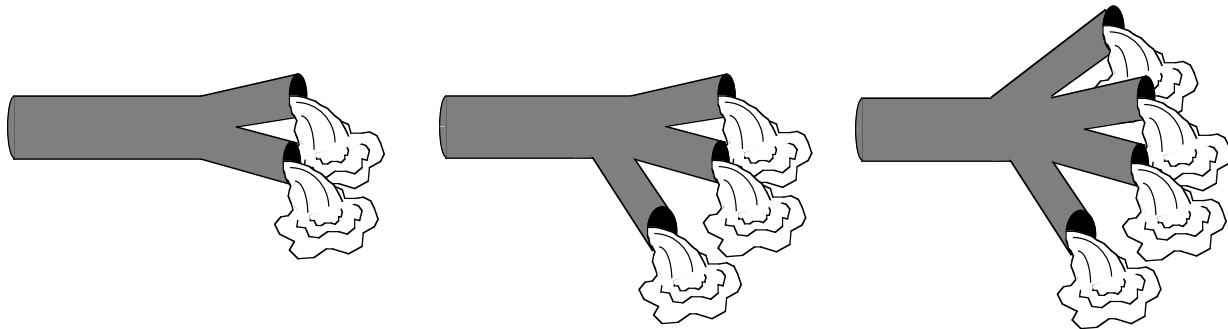
Each time a pipe (load) is **added,** the total restriction (resistance) is **less**. By adding another pipe, you create another path for the flow. With the addition of a another pipe, you have more flow (amperage), the only way you can have more flow (amperage), is to have less restriction (resistance).

EQUAL PARALLEL RESISTANCES

The simplest calculation for total resistance in a parallel circuit is when all of the loads are **equal** in resistance.

120 volts   **R 1**   **6 ohms**   **R 2**   **6 ohms**
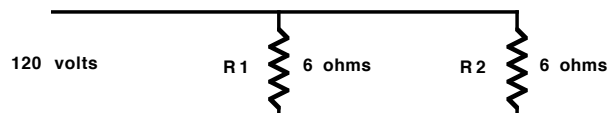
• Checkpoint: Apply the formula for total resistance in parallel for **equal** resistors.

$$\frac{\text{Resistance of one}}{\text{Number of resistors}} = 6\ \Omega \div 2 \text{ resistors} = \textbf{3 } \boldsymbol{\Omega} \textbf{ total resistance in parallel}.$$
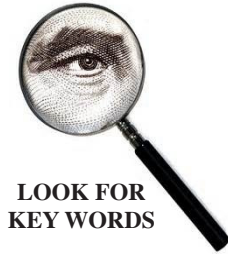
INTRODUCTION SUMMARY

CAREFUL READING OF EACH QUESTION

Reading is a process of sensory reception, involving skilled eye movements and a brain process, in which the meaning of the printed symbols are elaborated. The eye is like a camera relaying the picture to the brain. So we read not only with our eyes, but also with our brains. Reading is a very complex process, as it is obvious if you remember how long it took you to learn to read.

You cannot excel in a subject if you don't understand it. The key is learning and understanding a subject. We can understand almost anything, but we can't understand how we understand.

Memory comes from overlearning. You don't forget how to walk or ride a bicycle. Learning is experience. Everything else is just information.

The mathematics of high achievement can be stated in a simple formula. Begin with a dream. *Divide* the problems and conquer them one by one. *Multiply* the exciting possibilities in your mind. *Substract* all negative thoughts to get started. *Add* enthusiasm. Your answer will be the attainment of your goal.

• *Continuous Load*. A load where the **maximum** load current in a circuit flows without interruption for three hours or more. When reading a question be sure it is asking for continuous "load" and not "duty."

• There are five definitions for *duty*. Continuous, Intermittent, Periodic, Short-Time and Varying.

This is **not** amperage

↓

• If the voltage is doubled the **ampacity** of a conductor ____.

(a) increases   (b) decreases   (c) doubles   (d) remains the same

Dusttight. Constructed so that dust *will not enter* the enclosing case under specified test conditions.

The same definition for *raintight*. Constructed or protected so that exposure to a beating rain *will not result in the entrance* of water under specified test conditions.

The same for *watertight*. Constructed so that moisture *will not enter* the enclosure under specified test conditions.

When you read the "word" *tight*, it means will not enter.

When you read *rainproof*, constructed, protected, or treated so as to prevent rain *from interfering* with the successful operation of the apparatus under specified test conditions.

Weatherproof, constructed or protected so that exposure to the weather *will not interfere* with successful operation.

The word "tight" means will not enter. The word "proof" means will not interfere.

•Divide 30 by 1/2 and add 10. What is the answer?

    (a) 12 (b) 25 (c) 70 (d) 90

    The answer is **70**. $30 \div .5 = 60 + 10 = 70$

*1/2 is a fraction and changed to a decimal is $1 \div 2 = .5$.

There is a big difference between "one half" and 1/2!

If you divided 30 by 15 (15 is one half) = 2 + 10 = 12.

•This must be done in your head only.Do **NOT** use paper and pencil or a calculator. Try it.

    Take 1000 and add 40 to it. Now add another 1000. Now add 30. Add another 1000. Now add 20. Now add another 1000 Now add 10. The total is _____.

    The answer: Did you get 5000? The correct answer is actually 4100. Don't believe it? Check with your calculator!

• 60% is equivalent to _____.

    (a) 5/8 (b) 3/5 (c) 2/5 (d) 5/16

Answer. *3 ÷ 5* = 0.6 or 60%

• If the plans drawing has a scale of 1/4" = 1', a dimension of 3 1/2" on the drawing would be equal to _____.

    (a) 12' (b) 13' (c) 14' (d) 15'

Answer: (c) 14 feet $3.5 \div .25 = **14**$

• With switches 1 and 2 closed, the combined resistance of the circuit is _____ ohms.

    (a) 30 (b) 25 (c) 10 (d) 3
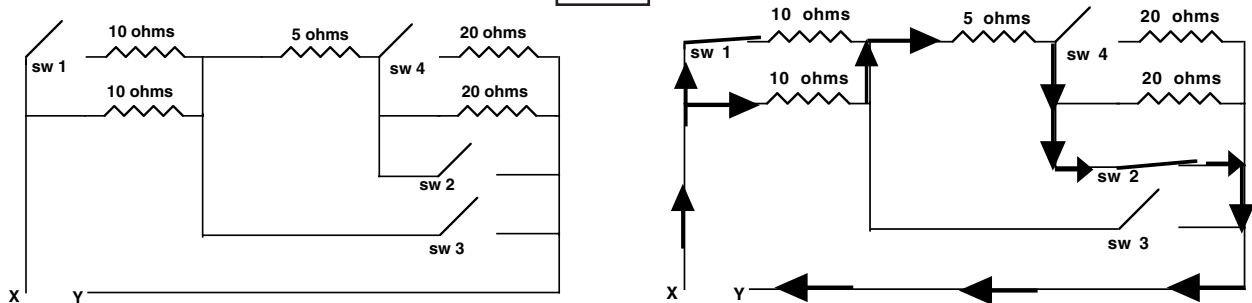
(c) 10 ohms   •In **SW1** $10\Omega + 10\Omega$ in **parallel** $= 5\Omega + 5\Omega = 10\Omega$ out **SW2**

    Will Rogers once said "*you can't come back from someplace you've never been.*" I believe in this. If you have never been there (seen or learned the meaning of a word or question) how do you expect to understand the question and answer it correctly? You can't come from someplace you've never been. The books I have written will take you there.
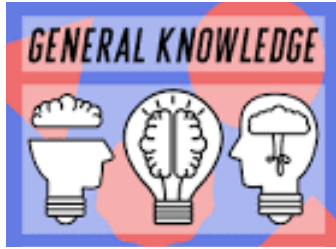
GENERAL KNOWLEDGE EXAM #1
25 Questions
30 minute Time Limit

1. An autotransformer is generally used rather than an isolation transformer _____.

(a) when cost is a factor
(b) where the ratio of transformation is low
(c) when you have several branch-circuits
(d) when safety is a factor

2. The vector sum of the phase currents is equal to what in a balanced, resistive three-phase system?

(a) Phase current x power factor   **(b) Zero**
(c) 1.732 x phase current   **(d) Three x phase current**

3. When referring to an "8-32" machine bolt, the "32" refers to the _____.

(a) threads per inch   **(b) length of the bolt**   **(c) diameter**   **(d) strength**

4. A motor works in the principles of _____.

(a) magnetism   **(b) mechanical force**   **(c) residual force**   **(d) chemical action**

5. The current used for charging storage batteries is _____.

(a) direct   **(b) positive**   **(c) alternating**   **(d) negative**

6. Lubrication would never be applied to a _____.

(a) bearing   **(b) knife switch**   **(c) controller drum**   **(d) commutator**

7. When the power factor in a given circuit is unity, the reactive power is _____.

(a) at maximum   **(b) 1.1414**   **(c) zero**   **(d) a negative quantity**

8. Materials containing numerous free electrons are _____.

(a) good insulators   **(b) ferrous alloys**   **(c) good conductors**   **(d) carbons**

9. If frequency is constant, the inductive reactance of a circuit will _____.

(a) remain constant regardless of voltage or current change
(b) vary with voltage
(c) vary directly with current
(d) not affect the impedance

10. An isolating switch is one that is _____.

(a) intended for cutting off an electrical circuit from its source of power
(b) required to have a padlock
(c) primarily used with an isolation transformer
(d) used only for heavy motor overloads

11. If the maximum current on a circuit is 70 amperes, the ammeter will read _____.

(a) 70 amps   (b) 60.4 amperes   (c) 49.49 amperes   (d) 40.62 amperes

12. Two 500 watt lamps connected in series across a 120 volt, the total wattage consumed is _____.

(a) 1000 watts   (b) 500 watts   (c) 250 watts   (d) 200 watts

13. A substance that would be good as an electrical insulation is which of the following?

(a) carbon   (b) oil   (c) lead   (d) iron

14. High AC voltages are usually measured using a _____.

(a) potential transformer and voltmeter   (b) current transformer and a voltmeter
(c) galvanometer in parallel   (d) manometer in series with a voltmeter

15. The decimal equivalent of 5/8" is _____.

(a) 0.652   (b) 0.500   (c) 0.875   (d) 0.625

16. If a 10Ω, a 20Ω and a 30Ω resistor are connected in series across a 120 volt source, the voltage across the 20Ω resistor will be _____ volts.

(a) 20   (b) 40   (c) 60   (d) none of these

17. A one-eighth bend in a conduit is equivalent to an angle of _____ degrees.

(a) 33   (b) 45   (c) 18   (d) 22

18. Which one of the following is known as an actuating control?

(a) thermostat   (b) relay   (c) manometer   (d) galvanometer

19. A cycle counter would be used in testing _____.

(a) motors   (b) transformers   (c) ammeters   (d) relays

20. The electrolyte of a storage battery is formed by the dissolving of _____ in water.

(a) sulphuric acid   (b) hydrochloric acid   (c) lye   (d) soda

21. Orangeburg pipe is _____.

(a) nonmetallic of fiber   (b) cast iron   (c) galvanized steel   (d) lead coated

22. Which of the following will have the **least** effect on the voltage drop of a branch circuit?

(a) the size of the conductors   (b) the amount of the load
(c) whether the source is 50 hz or 60 hz   (d) the length of the conductors

23. A low value of reactive voltamperes in an AC circuit compared with the wattage would indicate _____.

(a) unity power factor   (b) high power factor
(c) maximum current for the load   (d) very low efficiency

24. If a light bulb rated 100 watts @ 120 volts is connected across a 240 volt source, the wattage would be _____.

(a) 100 watts   (b) 200 watts   (c) 300 watts   (d) 400 watts

25. With only switch 4 closed and a line voltage of 225 volts, the drop across one of the 10 ohm resistors is _____ volts.

(a) 225   (b) 90   (c) 64.3   (d) 56.3
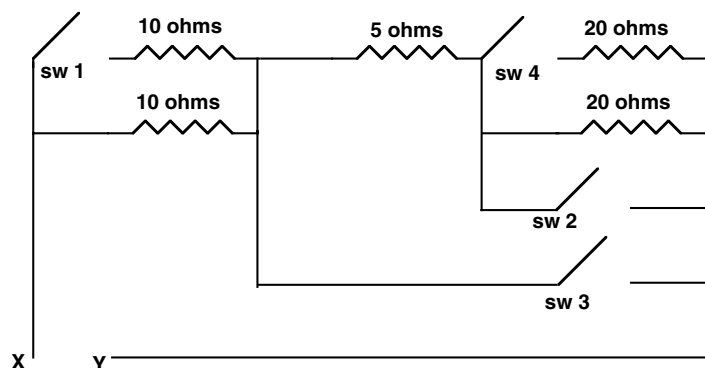
MASTER OPEN BOOK EXAM #1   25 Questions   One Hour Time Limit

1. If an exit enclosure (stair tower) is required to be separated from the building, only electrical wiring methods serving equipment permitted by the _____ is permitted within the exit enclosure.

(a) electrical inspector   (b) building inspector   (c) fire marshal   (d) AHJ

2. For large-scale PV installations (5,000 kW or more), buildings whose sole purpose is to house supply station equipment shall _____ comply with 690.12 for rapid shutdown systems.

(a) never   (b) be required to   (c) not be required to   (d) always

3. The emergency shutoff device for a fuel dispenser must simultaneously disconnect all conductors of the circuit(s), including the _____ conductor if any.

(a) grounded   (b) grounding electrode   (c) equipment grounding   (d) all of these

4. Unless otherwise permitted, wiring for _____ loads shall be kept independent from all other wiring and equipment.

(a) emergency   (b) legally-required standby   (c) optional standby   (d) all of these

5. A building may have more than one service if the capacity requirement exceeds _____ amperes at 1,000 volts or less.

(a) 1,000   (b) 1,200   (c) 2,000   (d) 2,400

6. Equipment intended to interrupt current at fault levels shall have a/an _____ rating, at normal voltage, that is at least equal to the available fault current at the line terminals of the equipment.

(a) time delay   (b) interrupting   (c) short-time   (d) long-time

7. Microgrid systems shall be permitted to disconnect from other sources and operate in _____ mode.

(a) series   (b) parallel   (c) island   (d) automatic

8. Openings around electrical penetrations into or through fire-resistance rated _____ shall be firestopped using approved methods.

(a) walls   (b) floors   (c) ceilings   (d) all of these

9. The dc conductors of a PV system shall not occupy the same _____ as PV system ac conductors unless separated by a barrier or partition.

(a) raceway   (b) cable   (c) enclosure   (d) all of these

10. On a 4-wire, delta-connected system where the midpoint of one phase winding is grounded, the conductor having the higher voltage to ground shall be marked by an outer finish that is orange or _____.

(a) gray   (b) yellow   (c) brown   (d) other effective means

11. The voltage at the load terminals of a fire pump controller shall not drop more than _____ percent below the voltage rating of the connected motor when operating at 115% of the full-load current of the motor.

(a) 1.2   (b) 3   (c) 5   (d) 7.5

12. Vegetation such as trees shall not be used for support of _____.

(a) luminaires   (b) boxes   (c) overhead conductor spans   (d) any of these

13. A/an listed _____ shall be installed between a wind-electric system and any loads served by the premises wiring system.

(a) surge protective device   (b) GFCI   (c) AFCI   (d) arrester

14. A luminaire in a commercial cooking hood must, among other requirements, exclude grease, oil, and _____ from the lamp and wiring compartment.

(a) solids   (b) moisture   (c) oxygen   (d) exhaust vapors

15. A device that uses power electronics to convert one form of electrical power into another form of electrical power is known as a/an _____.

(a) solar cell   (b) wind turbine   (c) inverter   (d) electronic power converter

16. Stainless steel rigid metal conduit may use galvanized steel boxes and enclosures if those enclosures are not subject to _____.

(a) severe corrosive influences   (b) unauthorized contact
(c) corrosive influences   (d) physical damage

17. For a PV system, the rapid shutdown for conductors inside the array boundry must limit the voltage to not more than _____ volts within 30 seconds of the shutdown initiation.

(a) 10   (b) 15   (c) 24   (d) 30

18. The sum of the multiconductor cable fill area as a percentage of the allowable fill area for the tray calculated in accordance with 392.22(A), and the single-conductor cable fill area as a percentage of the allowable fill area for the tray calculated in accordance with 392.22(B), totals not more than _____%.

(a) 75   (b) 80   (c) 100   (d) 125

19. The requirements for overcurrent protection of circuits rated greater than 1,000 volts ac or 1,500 volts dc are found in Article _____.

(a) 230   (b) 245   (c) 320   (d) 344

20. There shall be no voltage marking on a Type TC cable employing _____ wire.

(a) covered   (b) fixture   (c) rubber insulated   (d) thermocouple extension

21. The maximum size FMT permitted is _____.

(a) 1/2"   (b) 3/4"   (c) 1"   (d) 1 1/4"

22. Fastening of unbroken lengths of EMT conduit can be increased to a distance of _____ from the termination point where the structural members do not readily permit fastening within 3 feet.

(a) 4'   (b) 5'   (c) 6'   (d) 10'

23. The minimum size copper equipment grounding conductor required on a motor branch circuit with a 30 amp circuit breaker and #12 copper conductor is _____.
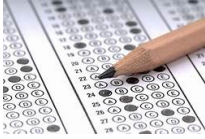
(a) #10   (b) #8   (c) #12   (d) #14

24. What is the maximum length of an unprotected feeder tap conductor?

(a) 10 feet   (b) 25 feet   (c) 50 feet   (d) 100 feet

25. Individual open conductors and cables other than service entrance cables shall not be installed less than _____ feet from grade level.

(a) 8   (b) 10   (c) 15   (d) 18

MASTER OPEN BOOK FINAL EXAM #2

100 Questions - 4 Hours

1. An AC sine wave has an RMS value of 100 V. What is the average of the waveform?

(a) 80 V   (b) 90 V   (c) 92.6 V   (d) 102 V

2. Where raceways or cables enter above the level of uninsulated live parts of an enclosure in a wet location, a/an ____ shall be used.

(a) fitting listed for damp locations   (b) insulated bushing
(c) fitting listed for wet locations   (d) dielectric type fitting

3. The term "cabled" refers to a manufacturing process of twisting single conductors together and may also be referred to as ____.

(a) connected   (b) grouped   (c) plexed   (d) having continuity

4. Circuit breakers used to switch high-intensity discharge lighting circuits shall be listed and marked as ____.

(a) †Approved   (b) HID   (c) SWD   (d) Ω Tested

5. The ampacity of a single insulated #1/0 THHN copper conductor in free air is ____ amps.

(a) 165   (b) 185   (c) 260   (d) 310

6. For grounded systems, the electrical equipment wiring, and other electrically conductive material likely to become energized, are installed in a manner that creates a permanent low-impedance circuit capable of safely carrying the maximum ground-fault current likely to be imposed on it from where a ground fault may occur to the ____.

(a) earth   (b) ground   (c) electrode   (d) electrical supply source

7. Luminaires located in bathtub and shower zones shall be listed for damp locations, or listed for wet locations where ____.

(a) not GFCI protected   (b) below 7' in height
(c) below 6'6" in height   (d) subject to shower spray

8. For listed explosion-proof equipment, factory threaded entries shall be made up with at least ____ threads fully engaged.

(a) 5   (b) 5 1/2   (c) 4   (d) 4 1/2

9. Agricultural buildings where a corrosive atmosphere exists include areas with conditions such as ____.

(a) corrosive particles which may combine with water
(b) an area that is damp and wet by reason of periodic washing
(c) poultry and animal excrement which may cause corrosive vapors
(d) all of these

10. Where one side of the motor control circuit is grounded, the motor control circuit shall be so arranged that a/an ____ ground in the remote-control devices will not start the motor.

(a) intentional   (b) accidental   (c) isolated   (d) low-voltage

11. Power-supply and Class 1 circuit conductors are permitted to occupy the same cable, enclosure, or raceway ____.

(a) under no circumstances
(b) only where the circuits are not AC and DC mixed
(c) only where the equipment powered is functionally associated
(d) none of these

12. An effective electrical safety program ____.

(a) contains a procedure covering all electrically hazardous work tasks
(b) contains a lockout/tagout procedure
(c) outlines effective safety training
(d) all of the above

13. A circuit contains three resistors connected in parallel. The value of R1 is 100Ω, the value of R2 is 400Ω, and the value of R3 is 330Ω. If this circuit is supplied with 40 VDC, what is the circuit current?

(a) 0.048 A   (b) 0.096 A   (c) 0.38 A   (d) 0.62 A

14. Enclosures not over 100 cubic inch that have threaded entries that support luminaires or contain devices are considered adequately supported where two or more conduits are threaded wrenchtight into the enclosure where each conduit is supported within ____ inches.

(a) 6   (b) 12   (c) 18   (d) 24

15. Each service disconnecting means shall be suitable for ____.

(a) the prevailing conditions   (b) hazardous locations
(c) wet locations   (d) dry locations

16. 4160v feeder, in no case shall the fuse rating in continuous amperes exceed three times, or the long-time trip element setting of a breaker _____ times, the ampacity of the conductor.

(a) 3   (b) 4   (c) 6   (d) 8

17. A vertical run of #4/0 copper conductor must be supported at intervals not exceeding _____ feet.

(a) 40   (b) 60   (c) 80   (d) 100

18. The grounding electrode system of each building or structure served shall be comprised of all of the following **EXCEPT** _____.

(a) a concrete encased electrode   (b) an 8' long aluminum pipe electrode
(c) a metal frame of the building   (d) a metal underground water pipe

19. Each resistance welder shall have overcurrent primary protection set at not more than _____ percent.

(a) 200   (b) 300   (c) 250   (d) 125

20. In a hospital electrical system, the Critical Branch of the Emergency System shall supply power for _____.

(a) coronary care units   (b) human physiology labs
(c) angiographic labs   (d) all of these

21. Where are conduit seals **NOT** required in a Class I Division 1 installation?

(a) Where the conduit exits the Class I Division 1 area.
(b) Where the conduit enters an explosion-proof motor.
(c) Where a conduit less than 36" in length connects two enclosures.
(d) Where metal conduit passes completely through the Class I Division 1 area with no fittings less than 12" outside any classified area.

22. What is the **MINIMUM** size copper grounding conductor required to serve a multisection motor control center equipped with a 300 amp overcurrent device?

(a) #6   (b) #4   (c) #3   (d) #2

23. A Class 1 power limited circuit shall be supplied by a source having a rated output not more than ____ volts.

(a) 12   (b) 15   (c) 24   (d) 30

24. A circuit is supplied with 30 VDC and contains three resistors connected in series. The value of R1 is 80 Ω, the value of R2 is 1,000 Ω, and the value of R3 is 4,200 Ω. What is the voltage drop across R2?

(a) 2.14 V   (b) 4.61 V   (c) 5.68 V   (d) 6.82 V

25. The maximum number of #14 THHN conductors permitted in a 3/8" LFMC with outside fittings is _____.

(a) 2   (b) 3   (c) 4   (d) 6

26. For installations consisting of not more than two 2-wire branch circuits, the service disconnecting means must have a rating of not less than _____ amps.

(a) 15   (b) 20   (c) 30   (d) 60

27. Plug fuses of the Edison-base type shall be used _____.

(a) where overfusing is necessary
(b) only as replacement items in existing installations
(c) as a replacement for type S fuses
(d) only for 50 amps and above

28. Flat cable assemblies shall have conductors of _____ special stranded copper wires.

(a) #14   (b) #12   (c) #10   (d) #8

29. Aluminum service entrance phase conductors are larger than #1750 kcmil. The bonding jumper shall have an area of not less than what percentage of the area of the largest phase conductor?

(a) 12.5%   (b) 70%   (c) 80%   (d) 125%

30. Conductors to the hoistway door interlocks from the hoistway riser shall be _____.

(a) flame retardant   (b) type SF or equivalent
(c) rated 200 degrees C   (d) all of these

31. Type P conductors shall be of tinned copper. Conductors shall employ flexible stranding. The minimum conductor size shall be _____.

(a) 18 AWG   (b) 16 AWG   (c) 14 AWG   (d) 12 AWG

32. In industrial establishments, where conditions of maintenance and supervision ensure that only qualified persons service the installed cable, nonshielded single-conductor cables with insulation types up to _____ that are listed for direct burial shall be permitted to be directly buried.

(a) 480 volts   (b) 600 volts   (c) 1000 volts   (d) 2000 volts

33. Several motors, each not exceeding one horsepower in rating, shall be permitted on a nominal 120 volt branch circuit protected at not over 20 amperes or a branch circuit of 600 volts, nominal, or less, protected at not over 15 amperes, if _____.

(a) individual overload protection confirms to 430.32
(b) the full-load rating of each motor does not exceed 6 amperes
(c) the rating of the branch-circuit short-circuit and ground fault protective device marked on any of the controllers is not exceeded
(d) all of the above

34. Insulated conductors shall be a thermoset type identified for use in Type P cable. All conductors shall be suitable for wet conditions. The minimum wall thickness shall be _____ mils.

(a) 26   (b) 30   (c) 35   (d) 37

35. What is the very first thing to do when an electrical accident occurs?

(a) Turn off the source of power.
(b) Call 911.
(c) Check to see if the victim is breathing.
(d) Begin CPR.

36. Which of the following instruments can detect the presence of a voltage, but not the voltage level?

(a) Clamp-type meter   (b) Wattmeter   (c) Multi-tester   (d) Neon circuit tester

37. Short sections of raceways used for _____ are not required to be installed complete between outlet, junction, or splicing points.

(a) offsets   (b) meter hubs   (c) nipples   (d) protection of conductors from physical damage

38. If a 20 amp branch circuit supplies multiple 125 volt receptacles, the receptacles must have an ampere rating of no less than _____ amps.

(a) 15   (b) 20   (c) 25   (d) 30

39. Conductor overload protection is not required if ____.

(a) conductors are oversized by 125%
(b) conductors are part of a limited-energy circuit
(c) interruption of the circuit can create a hazard
(d) none of the above

40. Optical fiber cables are not required to be listed and marked where the length of the cable within the building, measured from its point of entrance, does not exceed ____ and the cable enters the building from the outside and is terminated in an enclosure.

(a) 25'   (b) 50'   (c) 75'   (d) 100'

41. If one ground rod is installed and the resistance to ground is measured to be 50 ohms, the National Electrical Code requires ____.

(a) installation of one additional ground rod
(b) relocation of the ground rod to meet the 25 ohm maximum requirement
(c) increasing the diameter and/or length of the rod to meet the 25 ohm maximum requirement
(d) installation of one or more additional ground rods until the 25 ohm maximum requirement is met

42. Wind turbines might use the electric grid to ____ energy from short-term wind gusts.

(a) restore   (b) parallel   (c) store   (d) dump

43. GFCI protection is not permitted at carnivals, circuses, and fairs for ____.

(a) sign lighting   (b) equipment that is not readily accessible to the general public
(c) egress lighting   (d) circuits serving spot lights

44. NM and NMC cables can be used for temporary wiring as branch circuits in structures of a height of ____.

(a) 2 stories   (b) 3 stories   (c) 6 stories   (d) no limit

45. A motor controller enclosure with incidental contact with the enclosed equipment installed indoors where atmospheric conditions are normal is ____.

(a) NEMA type 1   (b) NEMA type 3R   (c) NEMA type 6   (d) NEMA type 13

46. Power to a premises wiring system fed by a stand-alone system shall be permitted to have less capacity than the _____ load.

(a) smallest   (b) largest   (c) calculated   (d) inductive

47. Which of the following statements is/are true?

(a) Electrical hazards remain the same, regardless of the location or type of government or the ability of the electrical workers.
(b) Electricity *always* follows the laws of physics.
(c) Methods and degrees of exposure to a hazard never vary from one location to another.
(d) All of the above.

48. The AC ohms-to-neutral impedance per 1,000 feet of #4/0 aluminum in a steel raceway is _____.

(a) 0.05Ω   (b) 0.010Ω   (c) 0.101Ω   (d) 0.10Ω

49. Which of the following areas of an aircraft hangar are **not** classified as a Class I, Division 1 or 2 location?

(a) Areas within the vicinity of the aircraft.
(b) Any pit or depression below the level of the hangar floor.
(c) Areas adjacent to and not suitably cut off from the hangar.
(d) Adjacent areas where adequately ventilated and where effectively separated from the classified area of the hangar.

50. "Equipment that controls dc voltage or dc current, or both, and that is used to charge a battery or other energy storage device" is the definition of a/an _____.

(a) inverter   (b) rectifier   (c) charge controller   (d) exciter

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You are half way through the final exam, you have 50 questions to go.

GENERAL KNOWLEDGE ANSWERS EXAM #1

1. **(b) where the ratio of transformation is low**
2. **(b) Zero**
3. **(a) threads per inch**
4. **(a) magnetism**
5. **(a) direct**
6. **(d) commutator**
7. **(c) zero**
8. **(c) good conductors**
9. **(a) remain constant regardless of voltage or current change**
10. **(a) intended for cutting off an electrical circuit from its source of power**
11. **(c) 49.49 amperes** • 70 amp x .707 = 49.49
12. **(c) 250 watts** •See example below
13. **(b) oil**
14. **(a) potential transformer and voltmeter**
15. **(d) 0.625** • 5/8 = 5 ÷ 8 = .625
16. **(b) 40** •Solve $I = E \div R$ 120v ÷ 60Ω = 2 amps flow in series $E = I \times R$ 2amp x 20Ω = **40v**
17. **(b) 45**   • 360º ÷ 8 = 45º
18. **(b) relay**
19. **(d) relays**
20. **(a) sulphuric acid**
21. **(a) nonmetallic of fiber**
22. **(c) whether the source is 50 hz or 60 hz**
23. **(b) high power factor**
24. **(d) 400 watts** •See example below
25. **(b) 90** •See example below

•12. Two 500 watt lamps connected in series across a 120 volt, the total wattage consumed is _____.
Solve $R = E^2 \div W$ 120v x 120v = 14400÷500w =28.8Ω + 28.8Ω = 57.6Ω resistance
$W = E^2 \div R$ 120v x 120v = 14400 ÷ 57.6 ohms resistance = **250 watts**

•24. Solve $R = E^2 \div W$ 120v x 120v = 144Ω $W = E^2 \div R$ 240v x 240 v = 57600 ÷ 144Ω = **400 W**

•25. With only switch 4 closed and a line voltage of 225 volts, the drop across one of the 10 ohm resistors is _____ volts.


(a) 225   (b) 90   (c) 64.3   (d) 56.3

Solve $I = E \div R$ 225v ÷ 25Ω = 9 amps flow
$E = I \times R$ 9 amps x 10 ohms = **90 volts**

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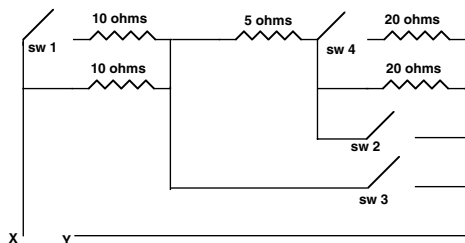
ANSWERS

2023 MASTER OPEN BOOK EXAM #1 - ANSWERS

1. **(d) AHJ** 300.25
2. **(c) not be required to** 691.9
3. **(a) grounded** 514.11(A)
4. **(a) emergency** 700.10(B)
5. **(c) 2,000** 230.2(C)(1)
6. **(b) interrupting** 110.9
7. **(c) island mode** 705.50
8. **(d) all of these** 300.21
9. **(d) all of these** 690.31(B)(1)
10. **(d) other effective means** 110.15
11. **(c) 5%** 695.7(D)
12. **(c) overhead conductor spans** 225.26
13. **(a) surge protective device** 694.7(D)
14. **(d) exhaust vapors** 410.10(C)
15. **(d) electronic power converter** DEF 100
16. **(a) severe corrosive influences** 344.14
17. **(d) 30** 690.12(B)(1)
18. **(c) 100** 392.80(A)(3)(1)
19. **(b) 245** Article 245
20. **(d) thermocouple extension** 336.120
21. **(b) 3/4"** 360.20(B)
22. **(b) 5'** 358.30(A) ex.1
23. **(c) #12** Table 250.122
24. **(d) 100 feet** 240.21(B)(4)(2)
25. **(b) 10** 225.18(1)
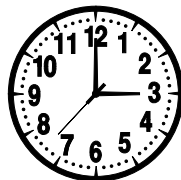
After completing the exam, grade yourself by counting the correct number of questions and divide by the number of questions answered.
Example: 19 correct answers ÷ 25 questions = 76%.

Hi Lite each answer in your Code Book

Time limit 60 minutes ÷ 25 questions = 2.4 minutes per question!