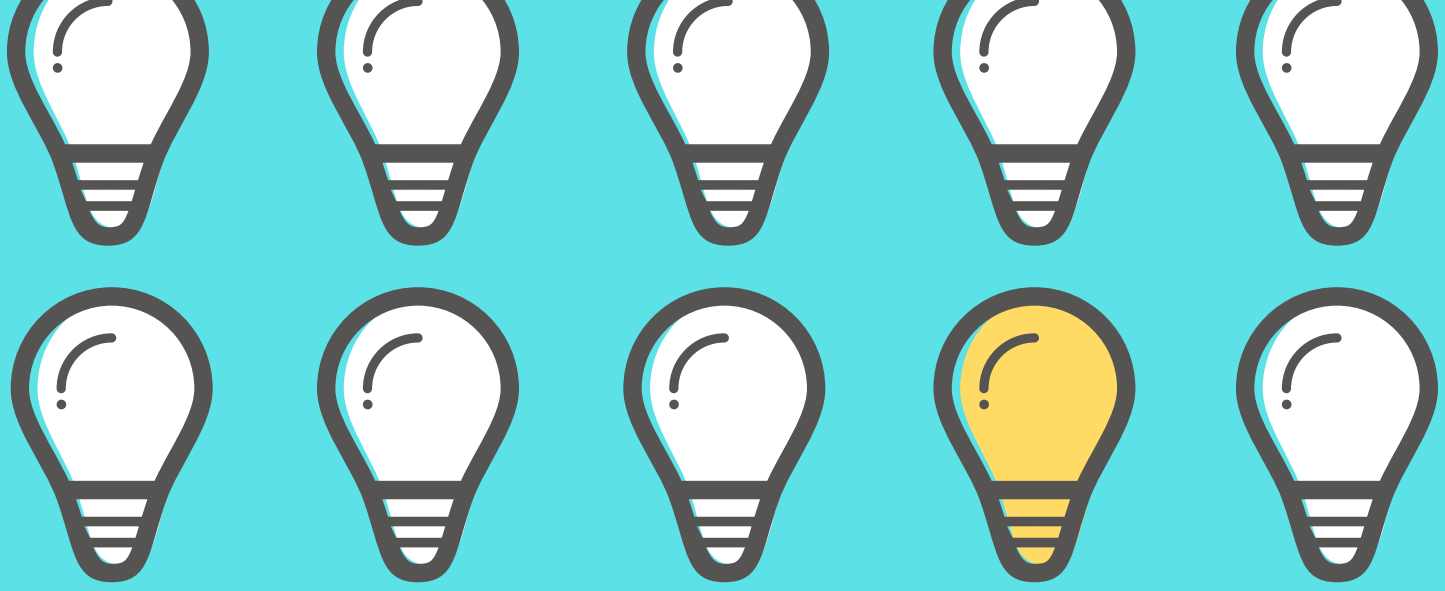
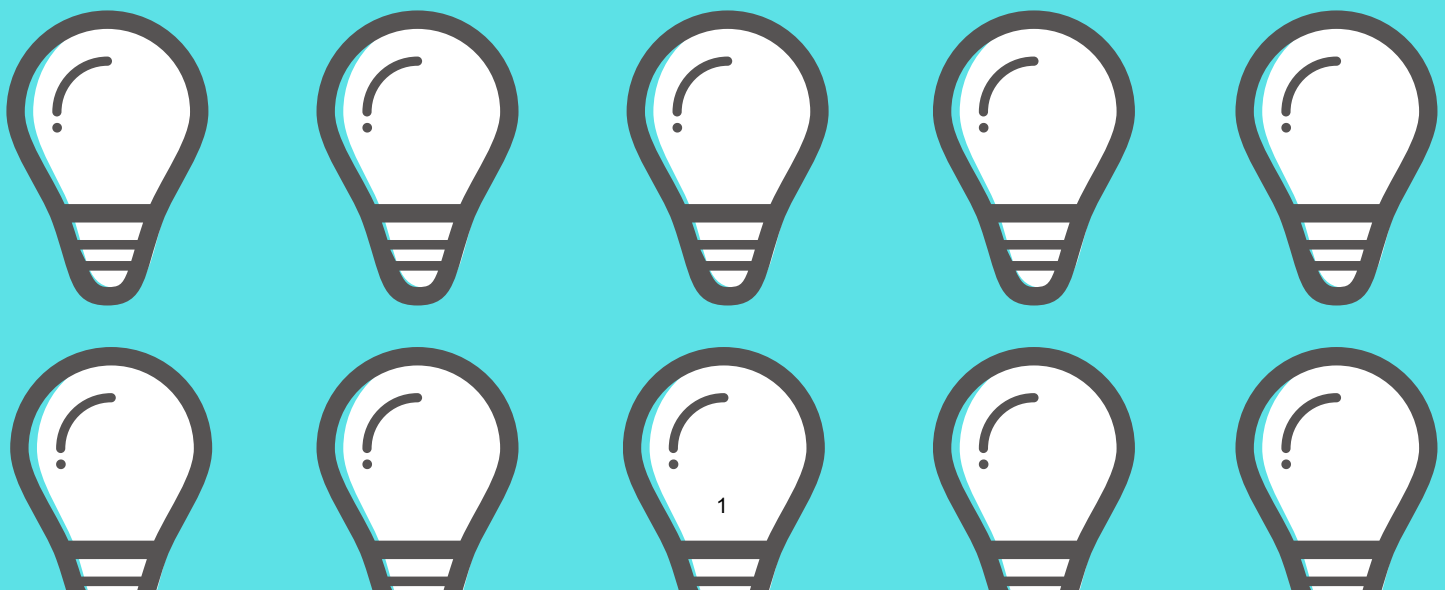


EDUCODE - MARCH 3, 2021

ELECTRICAL EXAM PREP CLASS - WORKSHEETS

by Christel Hunter and Randy Hunter



You will need a copy of the National Electrical Code® to complete the exercises during this class. All answers will be based on the 2020 edition of the NEC®.

If you do not have a copy of the NEC, you can sign up for a 14-day free trial of NFPA LiNK at link.nfpa.org to access the NEC and complete the exercises.

Worksheet Exercise 1

What Article contains only Definitions?

What Article has general requirements for motors?

What Article has specific requirements for hospitals?

References: Table of Contents

Worksheet Exercise 2

What Section has requirements for meeting room outlets?

What Section has requirements for dormitory unit outlets?

What Section has requirements for meters at recreational vehicle sites?

References: Index

Worksheet Exercise 3

What Table has lighting load values for various occupancies?

What Table has ampacities for THHN and XHHW insulated conductors in a raceway?

What Table has equipment grounding conductor sizes?

References: Articles 220, 310 and 250

Worksheet Exercise 4

What is the general lighting load for a continuous load of 50 amps and a noncontinuous lighting load of 50 amps?

Calculation space:

Answer:

References: 210.19(A)(1)(a)

Worksheet Exercise 5

What is the load in volt-amperes for the general purpose lighting load in a 20,000 sq. ft. office space?

Calculation space:

Answer:

References: Table 220.12

Worksheet Exercise 6

What minimum size THHN copper conductor is required for a 50 amp load?

Given: 75C terminals; 86F ambient; 3 current carrying conductors (CCC) in raceway

Answer:

References: Table 310.16 and 110.14(C)(1)

Worksheet Exercise 7

What minimum size XHHW-2 aluminum conductor is required for a 350 amp load?

Given: 75C terminals; 86F ambient; 3 current carrying conductors (CCC) in a raceway

Answer:

References: Table 310.16 and 110.14(C)(1)

Worksheet Exercise 8

Using 3 parallel runs, what is the minimum size THHN copper conductor required for a 580 amp load?

Given: 75C terminals; 86F ambient; 3 current carrying conductors (CCC) in each of three raceways

Answer:

References: Table 310.16 and 110.14(C)(1)

Worksheet Exercise 9

What minimum size USE aluminum conductor is required for a 225 amp load?

Given: 60C terminals; 86F ambient; 3 current carrying conductors (CCC) directly buried

Answer:

References: Table 310.16 and 110.14(C)(1)

Worksheet Exercise 10

What minimum size THHN copper conductors are required for a branch circuit supplying a continuous 90 amp load?

Given:
75C terminals
86F ambient
3 CCC in raceway

Calculation space:

Answer:

References: Table 310.16
110.14(C)(1), and 210.19(A)(1)(a)

Worksheet Exercise 11

What minimum size EMT is required for the conductors chosen in Worksheet Exercise 10?

Given:

There are 3 CCC

Calculation space:

Answer:

References: Chapter 9, Tables 1, 4 and 5

Worksheet Exercise 12

What minimum size circuit breaker is required for a branch circuit supplying a continuous 90 amp load?

Calculation space:

Answer:

References: Table 310.16, 240.4(B), Table 240.6(A), and 210.20(A)

Worksheet Exercise 13

What minimum size XHHW-2 aluminum conductors are required for a feeder circuit supplying a noncontinuous 850 amp load?

Given:
75C terminals
94F ambient
4 CCC/raceway

Calculation space:

Answer:

References: Table 310.16, Table 310.15(B)(1), Table 310.15(C)(1), 110.14(C)(1), and 215.2(A)(1)

Worksheet Exercise 14

What minimum size PVC Schedule 40 is required for the conductors chosen in Worksheet Exercise 13?

Given:
-Use 3 separate raceways
-Install a 250 kcmil XHHW-2 EGC/raceway

Calculation space:

Answer:

References: Chapter 9, Tables 1, 4 and 5

Worksheet Exercise 15

What minimum size circuit breaker is required for a feeder circuit supplying a noncontinuous 850 amp load?

Given:
-For this exercise, use 86F ambient and three CCC

Calculation space:

Answer:

References: 215.3, 240.4(C), Table 240.6(A)

Answer Key

The information below tells you how to solve the problem or find the answer to a question. The answer to each question/problem is in **bold**.

Worksheet Exercise 1

I. What Article contains only Definitions?
   A. Review the Table of Contents and look for an Article with the keyword "definitions." **Article 100** is titled "Definitions."
II. What Article has general requirements for motors?
   A. Review the Table of Contents and look for an Article with the keyword "motors." **Article 430** is titled "Motors, Motor Circuits, and Controllers."
III. What Article has specific requirements for hospitals?
   A. Review the Table of Contents and look for an Article with the keyword "hospital." The word hospital does not appear, but **Article 517** is titled "Health Care Facilities" and a quick review of the scope (517.1) lets you know that this article has requirements for hospitals.

Worksheet Exercise 2

I. What Section has requirements for meeting room outlets?
   A. Review the Index and look for keywords. For this question, the keywords are "meeting room" and "outlets." Under "Meeting rooms", there is a reference for "Outlets" that directs you to **210.65**.
II. What Section has requirements for dormitory unit outlets?
   A. Review the Index and look for keywords. For this question, the keywords are "dormitory unit" and "outlets." Under "Dormitory units", there is a reference for "Outlets" that directs you to **210.60**.
III. What Section has requirements for meters at recreational vehicle sites?
   A. Review the Index and look for keywords. For this question, the keywords are "meters" and "recreational vehicle sites." Under "Meters", there is a reference for "Recreational vehicle site" that directs you to **551.78(B)**.

Worksheet Exercise 3

I. What Table has lighting load values for various occupancies?
   A. In the Table of Contents, we find that Article 220 is titled "Branch-Circuit, Feeder, and Service Load Calculations." In the Index, we find under "Lighting" a reference to Branch circuits, calculation of load" that directs us to 220.12. Section 220.12(A) directs us to **Table 220.12** for general lighting loads by non-dwelling occupancy.
II. What Table has ampacities for THHN and XHHW insulated conductors in a raceway?
   A. Reviewing the Table of Contents, we find Article 310 is titled "Conductors for General Wiring." In the Index, under the keyword "Ampacities," we find references to multiple sections in Articles 310 and 311. Reviewing Article 310, we find **Table 310.16** that indicates it is for conductors in raceways and includes conductor types THHN and XHHW.
III. What Table has equipment grounding conductor sizes?
   A. Reviewing the Table of Contents, we find Article 250 is titled "Grounding and Bonding." In the Index, under the keyword "Equipment grounding conductors" we find the term "Sizing" that directs us to 250.122, which leads us to **Table 250.122**.

Answer Key

Worksheet Exercise 4

I. What is the general lighting load for a continuous load of 50 amps and a noncontinuous lighting load of 50 amps?
   A. This question is asking us to calculate the total load for a circuit with both continuous and noncontinuous loads. Section 210.19(A)(1)(a) tells us that a continuous load must be multiplied by 125%. Therefore:
   (50 amps * 100%) + (50 amps * 125%) = 50 amps + 62.5 amps = **112.5 amps**

Worksheet Exercise 5

I. What is the load in volt-amperes for the general purpose lighting load in a 20,000 sq. ft. office space?
   A. This question is asking us to calculate the lighting load based on the occupancy type and floor area. Table 220.12 tells us that the unit value for office occupancies is 1.3 volt-amperes/sq. ft. Therefore:
   20,000 sq. ft. * 1.3 volt-amperes/sq. ft. = **26,000 volt-amperes**
   B. Pay attention to the changes in Table 220.12 for the 2020 NEC. Many of the unit values are much lower than in previous editions of the NEC. The new values are based on industry usage data from ASHRAE 90.1. Also, pay attention to the new note under the table, which tells us that the 125% multiplier for a continuous load is included in the unit values and does not have to be separately applied.

Worksheet Exercise 6

I. What minimum size THHN copper conductor is required for a 50 amp load?
   A. We are given information that the terminals are 75C, the ambient temperature is 86F, and there are three current-carrying conductors in a raceway. Using the ampacity table we identified earlier, Table 310.16, we find the column for copper at 75C and identify the first conductor in that column with sufficient ampacity for 50 amps. That conductor size is **8 AWG**. No adjustment factors or temperature correction factors need to be applied since the conditions of use match the table conditions listed in Section 310.16.

Worksheet Exercise 7

I. What minimum size XHHW-2 aluminum conductor is required for a 350 amp load?
   A. We are given information that the terminals are 75C, the ambient temperature is 86F, and there are three current-carrying conductors in a raceway. Using the ampacity table we identified earlier, Table 310.16, we find the column for aluminum at 75C and identify the first conductor in that column with sufficient ampacity for 350 amps. That conductor size is **700 kcmil**. No adjustment factors or temperature correction factors need to be applied since the conditions of use match the table conditions listed in Section 310.16.

Worksheet Exercise 8

I. Using 3 parallel runs, what is the minimum size THHN copper conductor required for 580 amp load?
   A. We are given information that the terminals are 75C, the ambient temperature is 86F, and there are three current-carrying conductors in each of three separate raceways. We must first calculate the required ampacity for each of the parallel runs:
   580 amps/3 = 193 amps
   B. Using the ampacity table we identified earlier, Table 310.16, we find the column for copper at 75C and identify the first conductor in that column with sufficient ampacity

for 193 amps. That conductor size is **3/0 AWG**. No adjustment factors or temperature correction factors need to be applied since the conditions of use match the table conditions listed in Section 310.16.

Worksheet Exercise 9

I. What minimum size USE aluminum conductor is required for a 225 amp load?
   A. We are given information that the terminals are 60C, the ambient temperature is 86F, and there are three current-carrying conductors directly buried in earth. Using the ampacity table we identified earlier, Table 310.16, we find the column for aluminum at 60C and identify the first conductor in that column with sufficient ampacity for 225 amps. That conductor size is **400 kcmil**. No adjustment factors or temperature correction factors need to be applied since the conditions of use match the table conditions listed in Section 310.16.

Worksheet Exercise 10 (corrected)

I. What minimum size THHN copper conductors are required for a branch circuit supplying a continuous 90 amp load?
   A. We are given information that the terminals are 75C, the ambient temperature is 86F, and there are three current-carrying conductors in a raceway. Since this is a continuous load, we must first multiply the given load by 125% to comply with 210.19(A)(1)(a):
   90 amps * 1.25 = 112.5 amps
   B. Using the ampacity table we identified earlier, Table 310.16, we find the column for copper at 75C and identify the first conductor in that column with sufficient ampacity for 112.5 amps. That conductor size is **2 AWG**. No adjustment factors or temperature correction factors need to be applied since the conditions of use match the table conditions listed in Section 310.16.

Worksheet Exercise 11 (corrected)

I. What minimum size EMT is required for the conductors chosen in Worksheet Exercise 10?
   A. In the previous exercise, we identified a 2 AWG THHN copper conductor would be sufficient for the continuous load. We are given that there are three current carrying conductors. Using Chapter 9, Table 5, we find that the approximate area of a 2 AWG THHN conductor is 0.1158 sq. in. We multiply that by three to find the total equivalent area:
   0.1158 sq. in. * 3 = 0.3474 sq. in.
   B. Since Chapter 9, Table 1 tells us that 3 conductors in a raceway must be limited to 40% fill, we use Table 4 for EMT to find the minimum size raceway that can be used is: **Trade size 1 1/4** with a permissible 40% fill of 0.598 sq. in.

Worksheet Exercise 12

I. What minimum size circuit breaker is required for a branch circuit supplying a continuous 90 amp load?
   A. Section 210.20(A) states that the overcurrent protective device shall not be less than the noncontinuous load plus 125% of the continuous load. Therefore, to size a branch circuit overcurrent protective device, we multiply the continuous load by 125%:
   90 * 1.25 = 112.5 amps
   B. Section 240.4(B) permits us to use the next higher standard ampere rating since we are under 800 amps, so we choose the smallest standard ampere rated overcurrent device

in Table 240.6(A) that is sufficient for our load:
125 amperes

Worksheet Exercise 13 (corrected)

I. What minimum size XHHW-2 aluminum conductors are required for a feeder circuit supplying a noncontinuous 850 amp load?
   A. We are given information that the terminals are 75C, the ambient temperature is 94F, and there are four current-carrying conductors per raceway. This means the ambient temperature is higher than permitted by the table, and there are more current carrying conductors than permitted by the table. To determine the conductor ampacity we need, we must first apply temperature correction factors and an adjustment factor for the number of current carrying conductors.
   B. Using Table 310.15(B)(1), we find a temperature correction factor of 0.96 in the 90C column. Using Table 310.15(C)(1), we find an adjustment factor of 80% (0.80) for 4 current carrying conductors. Therefore:
   850 amps/(0.96 * 0.80) = 1107 amps
   C. Reviewing Table 310.16 reveals that there is no conductor large enough to carry 1107 amps. Therefore, we must run parallel conductors.
   D. While we could have 2 runs, that would require 1500 kcmil conductors (at least 554 amps in the 90C column), which would be very difficult to pull through conduit. If we choose to use 3 runs, we need conductors with an ampacity of at least 369 amps in the 90C column, so we choose **3 runs of 600 kcmil aluminum.**

Worksheet Exercise 14 (corrected)

I. What minimum size PVC is required for the conductors chosen in Worksheet Exercise 13?
   A. In the previous exercise, we identified that using 3 runs of 600 kcmil XHHW-2 aluminum conductor would be sufficient for the load. We are given that there are four current carrying conductors per raceway, and a 250 kcmil XHHW-2 aluminum equipment grounding conductor is installed in each raceway. Using Chapter 9, Table 5, we find that the approximate area of a 600 kcmil XHHW-2 conductor is 0.8709 sq. in. and the approximate area of a 250 kcmil XHHW-2 conductor is 0.3904 sq. in. We multiply and then add to find the total equivalent area:
   0.8709 sq. in. * 4 = 3.4836 sq. in.
   0.3904 sq. in. * 1 = 0.3904 sq. in.
   3.4836 sq. in. + 0.3904 sq. in. = 3.8740 sq. in.
   B. Since Chapter 9, Table 1 tells us that 5 conductors in a raceway must be limited to 40% fill, we use Table 4 for Schedule 40 PVC to find the minimum size raceway that can be used is:
   Trade size 3 1/2 with a permissible 40% fill of 3.895 sq. in.

Worksheet Exercise 15 (corrected)

I. What minimum size circuit breaker is required for a feeder circuit supplying a noncontinuous 850 amp load? (Notice the modified conditions of use in the problem: 86F and three current-carrying conductors.)
   A. Section 215.3 states that the overcurrent protective device shall not be less than the noncontinuous load plus 125% of the continuous load. Since our load is noncontinuous, we take the 850 amp value to size our circuit breaker.
   B. However, Section 240.4(C) states that since we are over 800 amps, the ampacity of the conductors must be equal to or greater than the rating of the overcurrent protective device. We chose to use 3 runs of 600 kcmil XHHW-2 aluminum for our conductors.

Each conductor has an ampacity of 340 amps at the specified 75C terminals, therefore the total ampacity of our conductors is:
340 amps * 3 = 1,020 amps

C. Using the standard ampere ratings in Table 240.6(A) and the termination limitations, we find that we are limited to a **1000 amp circuit breaker**, which is also large enough for our 850 amps of noncontinuous load.

NOTES

NOTES

NOTES

NOTES

Break time...

SUDOKU

FIll out the blocks so that the numbers one to nine will only appear once in each row, colum and 3x3 grid.

		9	7	3		5	2	6
		5		2		8		
6		8					4	7
					9		6	2
	4		6		3		8	
8	9		5					
2	6					1		8
		7		1		6		
9	5	1		6	4	2		

Page left intentionally blank