

Question 1 - How many 10 AWG THHN conductors are allowed to be installed in a 3/4-inch electrical metallic tubing (EMT) conduit?**► Solution****Step 1 – Lookup**

“Electrical Metallic Tubing, Number of conductors in,” to find a reference to Section 358.22.

Step 2 – Read

Section 358.22 requires the use of Chapter 9, Table 1. Most tables in the code have notes and the notes must be addressed when using the tables, we see that Note 1: states that Annex C is to be used to determine the maximum number of conductors permitted when they are all the same size and insulation type.

Step 3 – Find

On the first page, the second column of Table C1 shows that ten (10) No. 10 AWG THHN conductors are permitted to be installed in 3/4" EMT

Note: These tables are conduit type-specific.

Question 2 - What is the allowable current-carrying capacity of thirteen #10 AWG THHN current-carrying conductors that are run in the same conduit in an area with an ambient temperature of 40°C?**► Solution****Step 1**

Find the unadjusted allowable ampacity for #10 AWG THHN copper conductors from Table 310.16 which is 40 amperes. Also, note that this is coming from the 90°C column.

Step 2

The 40°C ambient temperature requires you to apply a correction for temperature and then the adjustment for the number of current-carrying conductors.

Step 3

The temperature correction factor from Table 310.15(B)(1) found under the 90°C column is 0.91 and the adjustment factor from Table 310.15(C)(1) for thirteen current-carrying conductors in the same conduit is 0.50.

So applying these the conductors could be loaded to:

$$40 \text{ A} \times 0.91 \times 0.50 = 18.2 \text{ A}$$

Round down to 18 A.

Question 3 - When installed outdoors, dry-type transformers shall have a _____.**► Solution****Step 1 – Lookup**

“Transformers” in the index and find the sub-index listing for *“Dry-Type,”* which refers to Sections 450.21 and 450.22.

Step 2 – Read

Since the question deals with the outdoor installation of a dry-type transformer, go directly to Section 450.22.

Step 3 – Find

Here the *Code* requires Dry-type transformers installed outdoors to be equipped with a weatherproof enclosure.

Question 4 - When installed indoors, Askarel-transformers rated over 35,000 volts must be installed in a _____.

► Solution

Step 1 – Look

In the index under “*Askarels, Transformers*” to find Section 450.25.

Step 2 – Read and Find

Section 450.25 requires that, when installed indoors, Askarel-Insulated transformers rated over 35,000 volts shall be installed in a vault.

Question 5 - Given a transformer of 1000 volts or less and a primary rated at 50 amperes, it would be permissible to use an overcurrent protection device set or sized at _____.

► Solution

Step 1 – Lookup

“*Transformers*” in the index and find the sub-index listing for “*Overcurrent protection*,” which refers to Section 450.3.

Step 2 – Read

Section 450.3(B) “*Transformers 1000 Volts Nominal or Less*,” which refers to Table 450.3(B) which shows transformers with primary currents of more than 9 amperes shall have overcurrent protection not exceeding 125%.

Step 3 – Calculate the Size of OCD Permitted

Calculate the maximum permissible size overcurrent device by multiplying the given 50-ampere primary amperage by 125%.

$$50 \text{ A} \times 1.25 = 62.5 \text{ A}$$

The answer of 62.5 amperes does not correspond to a standard-size overcurrent device. Note No. 1 to Table 450.3(B), however, permits increasing the overcurrent device to the next largest standard overcurrent device from Section 240.6.

Step 4 – Read

Section 240.6 lists the next higher rating overcurrent device above 62.5 amperes as 70 amperes.

Note: The Note only permits going to the next higher rating overcurrent device, it does not require it, nor does it permit exceeding that.

Question 6 - An electrical subset of a PV system that has two conductors in the output circuit, one positive and one negative.

► Solution

Step 1 – Begin

The quickest way to find the answer is to recognize that the question deals with “*Solar Photovoltaic (PV) Systems*” and go directly to Article 690. Definitions are always found in Section .2 of an Article so look for Section 690.2.

Step 2 – Read and Find

Read through the Section for a matching definition. The matching definition you will find is “*Monopole Circuit*.”

Question 7 - A 15-ft x 20-ft square meeting room with no moveable partitions in a hotel facility must have _____ floor receptacles.

► Solution

Step 1 – Begin

Look up “*Receptacles, cord connectors ...*” in the index. Then the sub-index “*Outlets, Meeting, rooms,*” which references Section 210.65.

Step 2 – Find

In this section under subparagraph (B)(2) FloorOutlets, it requires one floor receptacle when the meeting room is more than 12 feet wide and is at least 215 square feet of floor area.

Question 8 - What is the maximum size time-delay (current-limiting) fuse permitted for a No. 1 AWG copper THWN motor feeder (sized by Section 430.24) short-circuit and ground-fault protection for the following five 480-volt, 3-phase, squirrel-cage, induction motors, marked code letter F: One 10-hp, two 15-hp, and two 20-hp.

► Solution

Step 1 – Lookup

“*Motors*” in the index and find the sub-index listing for “*Ground-fault protection,*” which refers to Part IV and V of Article 430: Part IV addresses Branch circuits, and Part V addresses feeders.

Section 430.62(A) lists the rules for sizing the protective device for a feeder where the feeder is sized according to Section 430.24. Section 430.6(A) requires the use of Table 430.250 to find the full-load current ratings of the motors. First, find the largest motor in the group then the remaining motors' full-load currents.

Step 2 – Read

Find the maximum protective device permitted. Table 430.250 lists the full-load current rating for one of the 20-hp motors as 27 amperes. Section 430.52(A) specifies the use of Table 430.52 to calculate the maximum device permitted for anyone motor in the group. Table 430.52 states that a time-delay fuse may be sized to 175% of the full-load current rating of the motor.

27 A × 1.75 = 47.25 A

According to Section 240.6, there is no standard fuse with this rating. Section 430.52(C), *Exception No. 1*, permits advancement to the next larger size, where the value of the device determined above does not correspond to the standard sizes or ratings of fuses or circuit breakers. Section 240.6 lists the next size fuse as 50 amperes.

Step 3 – Calculate and Sum the Motors' FLC

Table 430.250 lists the full-load current rating for a 10-hp motor as 14 amperes, a 15-hp motor as 21 amperes, and a 20-hp motor as 27 amperes. Total the full-load current ratings for all motors. Section 430.62(A) allows the maximum device permitted for any motor of the group, plus the sum of the full-load currents of the other motors.

Largest motor 1st 20-hp	= 50	A
2nd 20-hp motor	= 27	A
2 - 15-hp motors	= 42	A
10-hp motor	= 14	A
Total	= 133	A

The rule in 430.62(A) requires the protective device to have a rating or setting not exceeding this value. According to Section 240.6, the next smaller fuse size is 125 amperes.

Question 9 - When installing CATV cables in other spaces used for environmental air (plenums), they shall be of Type _____.

► Solution

Step 1 – Look

In the index for “*Cables, CATV*” is the only reference listed in Article 820.

Step 2 – Read

Article 820 doesn't cover the application CATV and types required for this you will have to look in Section 800.154 Application of Listed Communications Wires, Cables, and Raceways, and Listed Cable Routing Assemblies. Here browse Table 800.154a, which applies to types of cables etc. Looking down the “*Applications*” column at the left of the table, look under the “*Wire and Cable Type*” columns for a “Y,” which indicates its suitability for use in this application.

Step 3 – Find

You will find Plenum cable Type is suitable for use in other spaces used for environmental air (plenums) as described in 300.22(C). So CATVP would be suitable.

Note: Article 800 is actually a new Article for the 2020 NEC. It now contains common general requirements previously found in Articles 800, 810, 820, 830, and 840, and applies to each of these including the new Article 805. Take time to familiarize yourself with it.

Question 10 - A piece of #12 AWG solid copper conductor _____ feet long has a DC resistance at 75° C of 1.44 ohms.

► Solution

Step 1 – Lookup

“*Conductor*” in the index and find the sub-index listing for “*Properties of,*” which refers to Table 8, Chapter 9.

Step 2 – Read

Locate No. 12 AWG wire size and read under the DC resistance for solid copper wire 1.93 ohms/1000 feet.

Step 3 – Calculate Resistance

Take the given resistance for the unknown length of wire and divide that by the resistance for 1000 feet of wire.

$$1.44 \, \Omega / 1.93 \, \Omega = 0.746 \, \Omega$$

To find the length of the wire simply multiply the results calculated in step 3 by 1000.

Step 4 – Determine Wire Length

$$0.746 \, \Omega \times 1000 = 746 \, \text{ft.}$$

Question 11 - Electrical Nonmetallic Tubing (ENT) must be supported at intervals not exceeding _____ feet.

► Solution

Step 1 – Lookup

“*Electrical nonmetallic tubing,*” and then “*Securing and supporting*” in the index. This list Section 362.30.

Step 2 – Find

Here Section 362.30 states that ENT shall be securely fastened at intervals not exceeding 3 feet.

Question 12 - The grounded conductor, #10 AWG, of a two-wire branch circuit, shall be identified by a _____.

▼ Solution

Use this ID when reporting a problem. **QID: 23-00021**

Step 1

Look up *“Grounded conductors”* in the index and find the sub-index listing for *“Identification,”* which refers to Section 210.6.

Step 2 Read

Section 210.6(A) Sizes 6 AWG or Smaller states that the grounded conductor can be identified as stipulated in subparagraph (A)(1) *“...with a continuous white or natural gray outer finish.”*

Question 13 - Three NM cables each containing two current-carrying conductors are installed, without maintaining spacing between the cables, through the same opening in wood framing that is to be sealed with thermal insulation, caulk, or sealing foam, the allowable ampacity of each conductor shall be _____.

► Solution

Step – Lookup

“Nonmetallic-sheathed cable” in the index and find the sub-index listing for *“Ampacity,”* which refers to Section 334.80 Ampacity.

Step 2 – Find

Section 334.80 requires the ampacity of these NM conductors to be adjusted in accordance with Table 310.15(C)(1).

Question 14 - A flush deck box for a 12-volt underwater swimming pool light shall be located a minimum of _____ feet from the inside wall of the pool.

► Solution

Step 1 – Lookup

“Swimming pools” and then *“Junction boxes and enclosures”* to find the reference to Section 680.24.

Step 2 – Read and Find

Section 680.24(A)(2)(c)(2) contains the answer and requires a flush deck box to be a minimum of 4 feet (1.2m) from the inside wall of the pool.

Question 15 - An 800-ampere, high-impedance grounded neutral, 480-volt electrical system is installed in an industrial plant. The grounding impedance will limit the current flow to 8 amperes. The minimum size of the neutral conductor from the neutral connection to the grounding impedance shall not be less than _____.

► Solution

Step 1

Look up *“High-impedance grounded neutral systems”* in the index refers to Section 250.20(D), 250.36, and 250.186.

Step 2

Section 250.36(B) requires that the grounded system conductor (neutral) *“... have an ampacity of not less than the maximum current rating of grounding impedance ...”* and *“... in no case smaller than No. 8 AWG copper or No. 6 AWG aluminum or copper-clad aluminum.”*

Question 16 - A 3/4-hp, 240-volt, single-phase, no code letter motor is to be protected with an inverse-time circuit breaker. The branch-circuit conductors are No. 14 AWG copper as permitted by Section 430.22(A). What is the maximum size inverse-time circuit breaker permitted to protect this motor?

► Solution

Step 1 – Lookup

“Motors” in the index and find the sub-index listing for “Short circuit protection,” which refers to Section 430, Part IV. Scan Part IV to find “Rating or Setting for Individual Motor Circuit,” Section 430.52.

Step 2 – Read

Section 430.52(C)(1) states: “... a protective device having a rating or setting not exceeding the value calculated according to Table 430.52 shall be used to determine the branch-circuit, short-circuit, and ground-fault device rating.”

Table 430.248 lists the full-load current rating for a 3/4-hp as 6.9 amperes. Table 430.52 permits this type of motor to have an inverse time circuit breaker sized at 250% of the full-load current rating.

Step 3 – Calculate the Motor's FLC

3. Calculate the full load current by multiplying the rating of the motor found in Table 430.248 by 250%.

$$6.9 \text{ A} \times 2.50 = 17.25 \text{ A}$$

Step 4 – Find OCD Size

Exception No. 1 permits the next higher standard size overcurrent device where the calculation does not correspond to a standard overcurrent device from Table 240.6. In this instance 20 amperes.

Question 17 - Use this ID when reporting a problem. QID: 23-00043

► Solution

Step – Begin

Look in the index for “Outlets” and then “Receptacle, Dwellings, where required” to find Section 210.52.

Note: Think receptacle outlet when reading receptacle.

Step 2 – Find

In Section 210.52 look for “General Provisions” in bold print, next “Wall Space” or subparagraph (A)(2). and then in (A)(2)(1) find “Any space 2 feet (600mm) or more in width (including space measured around corners) and unbroken along the floor line by doorways and similar openings ...”

Question 18 - Any switchboard which is not fully enclosed requires a space of _____ or more between it and any combustible ceiling.

► Solution

Step 1 – Lookup

“Switchboards” in the index and look for the sub-index listing “clearances,” which refers, among others, to Section 408.18.

Step 2 – Read and Find

Section 408.18(A) states: “A space of 3 feet (900mm) or more shall be provided between the top of any switchboard and any combustible ceiling unless a non-combustible shield is provided.”

Question 19 - What is the maximum size time-delay fuse permitted to protect a 40-hp, 480-volt, three-phase, Code letter F motor with a nameplate current rating of 50 amperes?

► Solution

Step 1 – Lookup

“Motors” in the index and find the sub-index listing for “Rating or setting of branch-circuit short-circuit and ground-fault devices,” which refers to Table 430.52.

Step 2 – Read

Table 430.52 limits the time-delay fuse for this motor to 175% of the full-load current rating.

Step 3 – Calculate Motor's FLC Rating

Section 430.6(A)(1) requires the use of Table 430.250 to determine the full-load current rating for this motor instead of using the nameplate value. From the table, the full-load current rating is 52 amperes.

$$52 \text{ A} \times 1.75 = 91 \text{ A}$$

Step 4 – Determine OCD Rating

Exception No. 1 to Section 430.52 permits moving up to the next standard overcurrent device when the value in the calculation is not a standard device. The next higher standard in Section 240.6 is 100 amperes.

Question 20 - Indoor antennas and indoor lead-ins shall not be installed nearer than _____ inches to conductors of other wiring systems in the premises.

► Solution

Step 1 – Lookup

“Radio and television equipment,” and then “receiving equipment -- antenna systems” in the index you will see the reference to Part II of Article 810

Step 2 – Read and Find

Browsing through Part II of Article 810 you'll find Section 810.18 Clearances -- Receiving Stations, where it states in Section 810.18(B) that wires must be separated 2 inches from other wiring systems in the premises.

Question 21 - The maximum overcurrent device permitted to protect a 208-volt single-phase, 5.0 kW water heater connected with No. 8 AWG copper is?

► Solution

Step 1 – Lookup

“Overcurrent protection” in the index and look for the sub-index listing for “appliances,” which refers to Section 422.11.

Step 2 – Read

This section covers overcurrent protection for all appliances. Paragraph (E), “Single Non-motor-Operated Appliance,” says that, where the appliance exceeds 13.3 amperes, the overcurrent device shall not exceed 150% of the appliance marked rating.

Step 3 – Calculate Full-Load Current

The full-load current of this water heater is given as 5.0 kW. Calculate the full-load current for the water heater using the power formula.

$$\begin{aligned} I &= P \div E \\ I &= 5.0 \text{ kW} \times 1000 / 208 \text{ V} \\ I &= 24.04 \text{ A} \end{aligned}$$

Step 4 – Calculate OCD Size

Then, using the calculated full-load current, determine the size of the overcurrent device allowed.

$$24.04 \text{ A} \times 150\% = 36.06 \text{ A}$$

Step 5 – Find

Finally, look up the calculated overcurrent device size in Section 240.6 to find a match for the maximum overcurrent device allowed. Section 240-6 does not list a standard overcurrent device of 36 amperes. Subparagraph (E)(3) does permit using the next higher overcurrent device, which in this case is 40 amperes.

Question 22 - Which receptacles are not required to be tamper-resistant receptacles in a dwelling unit?

► Solution

Step 1 – Look

In the index under “Receptacles, cord connectors, and attachment plugs (caps),” and “Tamper-resistant” for Section 406.12

Step 2 – Read

Section 406.12 states: “**All 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles in areas specified in 406.12(1) through (8) shall be listed tamper-resistant receptacles.**”

Step 3 – Find

This means all 15- and 20-ampere receptacles installed in a dwelling must be tamper-resistant, but according to *Exception (3)* those receptacles within a dedicated appliance space need not be tamper-resistant.

Question 23 - A feeder supplies a continuous lighting load of 41 amperes, a noncontinuous load of 50 amperes, and a 7½ hp, 3-phase, 230-volt motor. What is the calculated minimum ampere rating required for the feeder?

► Solution

Begin

By looking up “*Feeders*” in the index and find the sub-index listing for “*Calculation of loads*” which refers to Section 215.2(A) and 220.40. These sections require that the feeder have sufficient ampacity to supply the load. The solution can be accomplished in three steps:

Step 1 – Total Continuous & Noncontinuous Loads

Compute the ampacity of the continuous and noncontinuous loads.

Section 215.2(A) requires that a feeder have an allowable ampacity equal to or greater than the noncontinuous load plus 125% of the continuous load.

Continuous load:

$$41 \text{ A} \times 1.25 = 51.25 \text{ A}$$

Noncontinuous load:

$$50 \text{ A}$$

Total continuous and noncontinuous ampacity:

$$51.25 \text{ A} + 50 \text{ A} = 101.25 \text{ A}$$

Step 2 – Motor Loads

Compute the ampacity of the motor loads.

Section 220.14(C) covers the motor loads and refers to Sections 430.22 and 430.24. Section 430.24 requires that, where a feeder supplies motor load and lighting loads, the feeder be sized by Article 220 for the lighting load and Article 430 for the motor load.

Using Table 430.250 find that a 7½ hp, 3-phase, 230-volt motor has a full-load current of 22 amperes.

Section 430.22 requires that the conductors for a single motor be 125% of the full load.

$$22 \text{ A} \times 1.25 = 27.5 \text{ A}$$

Step 3 – Total of All Loads

To compute the ampacity of the feeder, add the ampacities calculated in steps 1 and 2 above.

Total of the continuous, noncontinuous, and motor loads:

$$101.25 \text{ A} + 27.5 \text{ A} = 128.75 \text{ A}$$

This is rounded to 129 A

Question 24 - Fixture wires shall not be smaller than _____.

► Solution

Step 1 – Lookup

“*Fixture wires*” in the index, then look for the sub-index “*Minimum size*.” This refers to Section 402.6 Minimum Size.

Step 2 – Read

Section 402.6 states that fixture wires cannot be smaller than No. 18 AWG.

Question 25 - The minimum ampere rating for an overcurrent device permitted to supply a central electric heating unit rated at 18 kVA in a dwelling unit is _____.

► Solution

Step 1 – Lookup

“Branch circuits, Fixed electric space heating equipment” in the index, which refers to Section 424.4 Branch Circuits.

Step 2 – Read

Subparagraph (A) states: “An individual branch circuit shall be permitted to supply any volt-ampere or wattage rating of fixed electric space-heating equipment ...” Then in subparagraph (B), which states: “The branch-circuit conductors for fixed electric space-heating equipment and any associated motors shall be sized not smaller than 125 percent of the load.”

Step 3 – Calculate Full-Load Current

To find the full-load current use the power formula.

$$\begin{aligned} I &= P / E \\ I &= 18,000 \text{ VA} / 240 \text{ V} \\ I &= 75 \text{ A} \end{aligned}$$

Calculate the branch-circuit total load requirement by applying the 125 percent

$$75 \text{ A} \times 1.25 = 93.75 \text{ A}$$

Step 4 – Find OCD Size

To determine the overcurrent device size, use Section 240.4(B). There is no standard overcurrent device listed at 94 amperes but Section 240.4(B) permits using the next larger size overcurrent device while Section 424.4 does not prohibit it. Section 240.6 lists the next larger device above 94 amperes as 100 amperes.

Question 26 - A 2-inch Rigid Polyvinyl Chloride Conduit (PVC), Schedule 40, nipple 24 inches long installed between panels has a permitted fill of _____.

► Solution

Step 1 – Lookup

“Conduit nipples” in the index refers to Note 4, Chapter 9, Table 1, and Note (4) permits a conduit nipple, 24 inches or less, to be filled to 60 percent of its cross-sectional area.

Step 2 – Find

Table 4, Rigid Polyvinyl Chloride Conduit (PVC), Schedule 40, section lists the total cross-sectional area of the 2-inch conduit as 3.291 in².

Step 3 – Calculate the Fill

3. Calculate the permitted fill by multiplying the value found in Table 4 by 60%:

$$3.291 \times 0.60 = 1.9746 \text{ in}^2.$$

Note: This can also be found in the table under the 60% column, 1.975 in².

Question 27 - The distance between supports on a horizontal run of nonmetallic wireways shall not exceed _____.

► Solution

Step 1 – Lookup

“Wireways, nonmetallic” in the index and find the sub-index listing for “Securing and supporting,” which refers to Section 378.30.

Step 2 – Find

Section 378.30(A) states: “In no case shall the distance between supports exceed 10 feet (3.m).”

Question 28 - What volume device box would be required to adequately contain two switches, a duplex receptacle, four 14 AWG NM cables for the light switches, and two 12 AWG NM cables for the receptacle?

► Solution

Step 1

In the index lookup “Boxes (outlet, device, pull, and junction)” then “Volume calculations,” which will reference Section 314.16 Number of Conductors in Outlet, Device, and Junction Boxes, and Conduit Bodies.

Step 2

Read the complete Section 314.16(A) to find the necessary volume allowances that must be used to calculate the required box volume.

Step 3

Now calculate the volume necessary to contain the devices (switches & receptacles), wires, and clamps. Remember, that since the number of EGCs exceeds four additional volumes must be added for each EGC that exceeds this.

Items	Volume Allowances	Unit	Fill
8 conductors	1 based on 14 AWG	2.00	= 16.00 in ³
4 conductors	1 based on 12 AWG	2.25	= 9.00 in ³
2 devices(sw)	2 based on 14 AWG	2.00	= 8.00 in ³
1 device(rcpt)	2 based on 12 AWG	2.25	= 4.50 in ³
1 clamp	1 based on 12 AWG	2.25	= 2.25 in ³
EGCs (1st 4)	1 based on 12 AWG	2.25	= 2.25 in ³
EGCs (¼ vol for >4)	2 based on 12 AWG	0.5625	= 1.125 in ³
Total volume required			= 43.125 in ³

Step 4

The box must have a volume that equals or exceeds 43.125 in³

Question 29 - What is the minimum general lighting load of a 10,240-square-foot Auditorium?

► Solution

Begin

Look up "*Lighting*" in the index then look for the sub-index listing "*Branch circuits, calculation of loads,*" which refers to Section 220.12 Lighting Load for Non-Dwelling Occupancies.

Step 1 – Read

Section 220.12 requires the use of Table 220.12 when computing the lighting load for a listed occupancy. Read the notes at the bottom of the table and notice that here it states:

"Armories and auditoriums are considered gymnasium-type occupancies".

Going to the listing for Gymnasiums in the Table you will find that it requires a unit load of 1.7 volt-amperes per square foot. Also, notice the values given now include the 125 percent multiplier for the continuous load as specified in 210.20(A)

Step 2 – Calculate Lighting Load

Multiply the square footage of the auditorium times the 1.7 volt-amperes.

$$10,240 \text{ ft}^2 \times 1.7 \text{ VA /ft}^2 = 17,408 \text{ VA}$$

Question 30 - The non-heating leads of factory-assembled heating cables, if any, shall be at least _____ in length.

► Solution

Step 1 – Lookup

"Heating, Cables" in the index. This only gets you to the Article where the topic is covered, Article 424. So now, scan this article looking first for *"Heating Cable Construction,"* which is 424.34.

Step 2 – Read and Find

It states that factory-assembled heating cables which have the non-heating leads supplied, are to be 7-feet in length.

Question 31 - The insulated grounded conductor of a #4 AWG multiconductor cable shall be identified by a _____.

► Solution

Step 1 — Begin

Look up "*Grounded conductors*" in the index and find the sub-index listing for "*Identification,*" which refers to Section 210.6.

Step 2 — Read

Section 210.6 Means of Identifying Grounded Conductors, first of all, requires that the grounded conductor be identified(according to the size of the wire: #6 AWG and smaller in Section 200.6(A) and #4 AWG and larger in Section 200.6(B). Reading further you will also find multiconductor cable requirements in subparagraph (E) Grounded Conductors of Multiconductor Cables which requires that the grounded conductor be identified according to subparagraph (B).

Step 3 — Find

Section 200.6(B) applies to #4AWG and larger conductors and it states that the grounded conductor can be identified *"At the time of installation, by distinctive white or gray marking at its terminations. This marking shall encircle the conductor or insulation."*

Question 32 - The frame of an electric range is permitted to be grounded through the grounded circuit conductor when using a Type SE service-entrance cable with an uninsulated grounded conductor when the circuit is existing and originates at _____.

► Solution

Step 1

Look in the index under "*Ranges, grounding*" to find Section 250.140.

Step 2

In the Exception, it states that this section shall apply to existing branch-circuit installations, and (3) only allows the range to be grounded through the grounded circuit conductor with Type SE cable when the circuit originates at the service equipment.

Note: The Code does not permit grounding through the neutral conductor in new installations.

Question 33 - On a transformer installation, how many secondary overcurrent protection devices shall be permitted _____?

► Solution

Step 1 – Look

In the index look first for "*Transformers*" and then under "*Overcurrent protection*" find Section 450.3.

Step 2 – Read

Section 450.3 requires that we use Table 450.3(B). In the Table, find on the right side, "*Secondary Protection (see Note 2).*" This Note clearly states that the maximum number of overcurrent protection devices permitted on the secondary side of a transformer is not to exceed six.

Note: This section also states: "*Where multiple overcurrent devices are utilized, the total of all the device ratings shall not exceed the allowed value of a single overcurrent device.*"

Question 34 - When using a surface metal raceway that has a cross-sectional area of _____ or greater; containing fewer than 30 current-carrying conductors, and they do not exceed 20% of the interior cross-sectional area, the ampacity adjustment factors do not need to be applied to the conductors contained in the raceway.

► Solution

Step 1 – Lookup

"*Surface metal raceways*" in the index to find in Article 386.

Step 2 – Read

The index doesn't help narrow down where you might find the section of the code governing conductor adjustment factors and their application. Fortunately, the article is short. So scan until you come to Section 386.22, "*Number of Conductors or Cables.*" Here it states: "*– the adjustment factors of 310.15(C)(1) shall not apply to conductors installed in surface metal raceways where all of the following conditions are met:*"

Step 3 – Find

Section 386.22 subparagraph (1), states the first of these requirements: "*The cross-sectional area of the raceway exceeds 2500 mm² (4 in²).*"

Question 35 - Ride devices, entertainment devices, or a combination thereof, that are installed so that portability or relocation is impracticable is a(n) _____.

► Solution

Step 1 – Look

In the index for “*Amusement attractions*,” which references Section 522.2 “*Definitions*.”

Step 2 – Read and Find

Search the definitions for the same wording to find that it is the definition of a Permanent Amusement Attraction.

Question 36 - The conductors supplying outlets for arc and xenon projectors of the professional type shall not be smaller than _____ AWG.

► Solution

Step 1 – Lookup

In the index under “*Projector rooms, motion picture, Projectors, professional type*,” and then “*Conductors, size*,” which will reference Section 540.13 “*Conductor Size*.”

Step 2 – Read and Find

Section 540.13 requires the conductors supplying outlets to be no smaller than 8 AWG.

Question 37 - The computed receptacle load for a Bank, which has 4,000 square feet of floor space, but an unknown receptacle load is _____ volt-amperes.

► Solution

Step 1 – Lookup

“Receptacles” and then the sub-listing “Outlets, load” in the index refers to Section 220.14 Other Loads -- All Occupancies.

Step 2 – Read

Section 220.14 states:

“In all occupancies, the minimum load for each outlet for general-use receptacles and outlets not used for general illumination shall not be less than that calculated in 220.14(A) through (M), the loads shown being based on nominal branch-circuit voltages.”

Continue reading through these sub-paragraphs until you find Section 220.14(I) Receptacle Outlets, which it states:

“Except as covered in 220.14(J) and (K), receptacle outlets shall be calculated at not less than 180 volt-amperes for each single or each multiple receptacles on one yoke...”

Step 3 – Find

Subparagraph (J) deals with Dwelling Units and (K) deals with Office Buildings. It states:

“In Office Buildings, the receptacle loads shall be calculated to be the larger of (1) or (2). (1) The calculated load from 220.14(I) after all demand factors have been applied.” or “(2) 11 volt-amperes/m² or 1 volt-ampere/ft².”

$$4,000 \text{ ft}^2 \times 1 \text{ VA} = 4,000 \text{ VA}$$

Question 38 - A raceway contains 9 #12 AWG THHN conductors from a 120/240 volt, single-phase panelboard. The conductors supply three 120/240 volt, three-wire circuits made up of phases A and B and a grounded conductor (neutral). What is the allowable ampacity for each of the No. 12 AWG conductors?

► Solution

Step 1

Look up *“Conductors”* in the index, next look for the sub-index listing *“Ampacity of”* which refers to Sections 310.14 through 310.21.

Step 2

Section 310.14 permits the ampacities of conductors to be determined by tables as provided in Section 310.15.

Step 3

Section 310.15 states that the *“Ampacities of conductors rated 0 to 2000 volts shall be as specified in the Ampacity Tables 310.16 through 310.21 ...”* Note 2 at the bottom of Table 310.16 requires the derating of the conductors according to Section 310.15(C)(1) if more than three current-carrying conductors are present.

Step 4

Section 310.15(C)(1) requires the use of Table 310.15(C)(1) to determine the ampacity. The note at the bottom of the table tells which sections apply to determine the count.

Step 5

Section 310.15(E)(1) states that a neutral that carries the unbalanced current from other conductors of the same circuit shall not be required to be counted as a current-carrying conductor when applying the provisions of Section 310.15(C)(1).

Step 6

Since the three neutrals are not considered current-carrying, we then have 6 current-carrying conductors to derate. In the Table, read down the column headed *“Number of Conductors”* until reaching 4-6 then across to the percent column to find that when a raceway contains 6 current carrying conductors they must all be derated to 80 percent of their values as first determined in Table 310.16.

Step 7

Therefore, No. 12 AWG THHN:

$$30 \text{ A} \times 0.8 = 24 \text{ A}$$

Question 39 - Equipment that regulates the output of a wind generator by diverting power from the generator to dc or ac loads or to an interconnected utility service is called a(n) _____.

► Solution

Step 1 – Lookup

“Wind electric systems” in the index and the *“Definitions”* which of course is Section 694.2.

Step 2 – Read and Find

Look through Section 694.2 for a matching definition. Here the matching definition is for a *“Diversion Load Controller.”*

Question 40 - Which one of the following systems and materials shall not be used as grounding electrodes?

▼ Solution

Use this ID when reporting a problem. **QID: 23-00026**

Step 1

Look up "*Grounding electrode system*" in the index. There it lists only the reference Part 250-III.

Step 2

So in going there and scanning you will find that the second section under this part is Section 250.52 Grounding Electrodes

Step 3

This section contains a specific subparagraph (B) "*Not Permitted for Use as Grounding Electrodes,*" and in the sub-paragraph (3) it states: "*The structures and structural reinforcing steel described in Sections 680.26(B)(1) and (B)(2).*" These are not permitted to be used for grounding electrodes.

Question 41 - A branch-circuit panelboard is to be installed in a dwelling unit. The owner would like it installed on the stairway going up to the bedrooms. Which of the following best describes Code requirements concerning the location of this panelboard?

► Solution

Step 1

There is no easy way to find this. Look up "*Overcurrent protection*" in the index and find the sub-index listing for "*Location,*" which, after eliminating the other references, refers to Article 240, Part II.

Step 2

Scan through the bold print section headings to find "*Not Located over Steps,*" Section 240.24(F). Here it forbids locating the overcurrent devices over steps.

Question 42 - An apartment building has 12 dwelling units each with 1,640 square feet of space plus the following equipment: 12.0 kW range, 5.0 kW water heater, 5.0 kW dryer, and 10.5 kW of heat supplied from 5 pieces of baseboard heat. Using the optional calculation, what is the minimum size service entrance permitted for this building at 120/240 volts?

► Solution

Start by Looking Up

“Dwellings” in the index and find the sub-index listing for “Feeder load calculations,” which refers to Sections 220.82 through 220.85. In this case, multifamily dwelling, which is Section 220.84.

The solution to this problem involves 6 steps:

- 1. Total all the General Lighting Loads
- 2. Total all the Small Appliance & Laundry Loads
- 3. Total all the Fixed Appliance Loads
- 4. Total of the Larger of Heating or A/C Loads
- 5. Apply the demand factor
- 6. Calculate the service size.

Step 1 – General Lighting Load

Total all the General Lighting Loads. Section 220.84(C)(1) requires 3 volt-amperes per square foot for general lighting and general-use receptacles.

1640 ft² × 3 VA = 4,920 VA

Total all apartments:

4,920 VA × 12 units = 59,040 VA

Note: This includes all receptacle loads in a dwelling unit, except for the small appliance loads from Section 220.84(C)(2).

Step 2 – Small Appliance & Laundry Loads.

Section 220.82(B)(1) requires a minimum of 1500 volt-amperes for each 2-wire, 20-ampere small appliance circuit, and each laundry circuit specified in Section 220.52.

Small Appliance & Laundry Loads			
Small Appliance Load	=	3,000	VA
Laundry Load	=	1,500	VA
Total Load	=	4,500	VA

Step 3 – Fixed Appliance Loads

Total all the Fixed Appliance Loads Section 220.84(C)(3) requires using the nameplate rating of all appliances fastened in place, etc. Each apartment has:

Fixed Appliance Loads			
Range	12,000	VA × 12 =	144,000 VA
Water Heater	5,000	VA × 12 =	60,000 VA
Dryer	5,000	VA × 12 =	60,000 VA
Total Load		=	264,000 VA

Note: The dryer must be calculated using its nameplate rating according to Section 220.84(C)(3).

Step 4 – Heating or A/C Load

Section 220.84(C)(5) requires using the largest of either the heating or the air-conditioning load.

10,500 VA × 12 units = 126,000 VA

Step 5 – Apply Demand Factor

Apply the demand factor for the 12 apartments.

Total the values computed in steps 1 through 4:

Demand Factors		
General Lighting	= 59,040	VA
Small Appliance	= 54,000	VA
Fixed Appliance	= 264,000	VA
Larger Heating or A/C	= 126,000	VA
Total Load	= 503,040	VA

Table 220-84 specifies the demand factor for 12 apartments as 41%.

$$503,040\text{ VA} \times 0.41 = 206,246\text{ VA}$$

Step 6 – Calculate Service Size

Calculate the service size by dividing the computed service load by the service voltage. This will be used to determine the minimum size feeders required.

$$206,246\text{ VA} / 240\text{ V} = 859.36\text{ A}$$

This is rounded to 859 A in accordance with Section 220.5(B).

Question 43 - Fire alarm circuits shall _____ to prevent unintentional signals on the fire alarm system circuits.

► Solution

Step 1 – Lookup

In the index “*Fire alarm systems*” and then “*Identification,*” which will reference Section 760.30.

Step 2 – Read and Find

Section 760.30 requires that the fire alarm system wires be “*identified at the terminal and junction locations in a manner that helps to prevent unintentional signals on fire alarm system circuits(s) during testing and servicing of other systems*”

Question 44 - When using the optional calculation for a dwelling unit, a 3-ton heat pump drawing 24 amperes and provided with 20 kW of supplemental heat would be calculated at _____ when both units could be operated at the same time. The service will be 120/240 volts.

▼ Solution

Use this ID when reporting a problem. **QID: 23-00076**

Step 1 – Lookup

"Dwellings" in the index and find the sub-index listing for "Feeder load, calculations for" this refers to Sections 220.14(J); 220.16(A), 220.82 through 220.85, and Annex D. You should become familiar enough with these references so that you can immediately turn to Section 220.82 Dwelling Unit, which is in Part IV of Article 220, and deals with Optional Feeder and Service Load Calculations.

Step 2 – Read

Section 220.82(C)(3) Heating and Air-Conditioning Load requires that we use *"100% of the nameplate rating(s) of the heat pump compressor and 65% of the supplemental heating..."* unless the controller prevents both from being on at the same time. (See also Example No. D2(c) in Appendix D).

Step 3 – Calculate the Heating Load

Since both units can be on at the same time in this question, we must do the calculation as follows:

Convert the heat pump load to volt-amperes

$$24 \text{ A} \times 240 = 5,760 \text{ VA}$$

Now add 65% of the 20 kW integral supplemental heat (Note: kVA is considered equivalent to kW).

$$5,760 \text{ VA} + (20,000 \text{ kW} \times 0.65) = 18,760 \text{ VA}$$

Step 4 – Convert to Amperes

Finally convert 18,760 VA to amperes.

$$18,760 / 240 = 78.17 \text{ A}$$

Round this according to Section 220.5(B).

Question 45 - What size standard device box would be adequate to contain a switch and 2 #14 NM cables?

► Solution

Step 1

In the index lookup "*Boxes (outlet, device, pull, and junction)*" then "*Volume calculations,*" which will reference Section 314.16 Number of Conductors in Outlet, Device, and Junction Boxes, and Conduit Bodies.

Step 2

Begin by calculating the volume necessary to contain the devices (two switches), wires, and clamps.

Items	Volume Allowance Unit	Fill
4 conductors	based on 14 AWG	2.00 = 8.00 in ³
2 clamps	1 based on 14 AWG	2.00 = 2.00 in ³
1 device(sw)	2 based on 14 AWG	2.00 = 4.00 in ³
EGCs (all)	1 based on 14 AWG	2.00 = 2.00 in ³
Total volume required		= 16.00 in ³

Step 3

Now go to Table 314.16(A), scan down the Box Trade Size column looking for "*device*" then across to the Minimum Volume column and down until you find a volume that equals or exceeds the necessary 16.00 in³. This will be a 3 × 2 × 3½ device box (wall case), which exceeds the necessary calculated volume.

Question 46 - The basic PV device that generates electricity when exposed to light is the definition of a(n) _____.

► Solution

Step 1 – Lookup

"*Solar photovoltaic systems*" in the index and the "*Definition*" which of course is Section 690.2.

Step 2 – Read and Find

Look through Section 690.2 for a matching definition. Here the matching definition is for a "*Solar Cell.*"

Question 47 - Mandatory rules of the NEC are characterized by the use of the word "shall" or "shall not." Explanatory materials are in the form of _____.

► Solution

In the Index lookup "Explanatory Material". Section 90.5(C) states: "*Explanatory material, such as references to other standards, references to related sections of this Code, or information related to a Code rule, is included in this Code in the form of informational notes or an informative annex. Unless the standard reference includes a date, the reference is to be considered as the latest edition of the standard. Such notes are informational only and are not enforceable as requirements of this Code*"

Question 48 - An existing exterior rooftop receptacle at a department store building must be replaced due to damage. Which of the following best describes the Code requirements for this replacement?

► Solution

Step 1 – Look

In the index for “*Receptacles replacement*,” which refers to Section 406.4(D) Replacements.

Step 2 – Read

Section 406.4(D)(3) Ground-Fault Circuit-Interrupter Protection states that “*Ground-fault circuit-interrupter-protected receptacles shall be provided where replacements are made at receptacle outlets that are required to be so protected elsewhere in this Code.*” This means that if you are replacing a receptacle outlet that is required to be protected by a ground-fault circuit interrupter (GFCI) elsewhere in the *Code*, you must install a GFCI-protected receptacle outlet.

Step 3 – Find

Also, Section 406.4(D)(6) Weather-Resistant Receptacles states: “*Weather-resistant receptacles shall be provided where replacements are made at receptacle outlets that are required to be protected elsewhere in this Code.*”

Note: Code requirements for GFCI receptacle locations can be found in Section 210.8.

Question 49 - What is the maximum number of 4/0 AWG THW copper conductors that can be installed in a 2-1/2-inch EMT Conduit nipple six inches long installed between a panel and wireway?

► Solution

Step 1 – Lookup

“*Conduit nipples*” in the index refers to Chapter 9, Note 4 of Notes to the Tables.

Step 2 – Read

Note 4 allows a conduit nipple, which has a maximum length of 24 inches and is installed between cabinets, etc., to be filled to a capacity of 60% of its cross-sectional area with no adjustment factors needed for this condition.

Step 3 – Find Allowable Fill

Refer to “*Electrical Metallic Tubing (EMT)*” within Table 4 to determine the 60% cross-sectional area of a 2-1/2-inch conduit in square inches. This is 3.515 in².

Step 4 – Calculate the Fill

Refer to Table 5 to find the square inch area of a 4/0 AWG THW conductor, which is 0.3718 in². Now divide the capacity of the 2-1/2-inch conduit by the area of one 4/0 AWG conductor to calculate the number of conductors that can be installed in a 2-1/2-inch nipple.

$$3.515 \text{ in}^2 / .3718 \text{ in}^2 = 9.454$$

Note 7 to Tables, Chapter 9 only allows rounding to the next higher whole number where the decimal is 0.8 or larger. So a maximum of 9 4/0 AWG THW conductors can be installed in this nipple.

Question 50 - What is the calculated maximum system voltage using a PV module with a rated open-circuit voltage (Voc) = 37.3 volts, installed in a location where the lowest expected ambient temperature is 20°F? The array design uses 14 series-connected PV modules.

► Solution

Step 1 – Look

In the index for “*Solar photovoltaic systems*” and then “*Voltage*” which refers to Section 690.7.

Step 2 – Read

Section 690.7(A) states: “*PV system dc circuits on or in one- and two-family dwellings shall be permitted to have a maximum voltage no greater than 600 volts.*” Then in subparagraph (A)(1), it states: “*The sum of the PV module rated open-circuit voltage of the series-connected modules corrected for the lowest expected ambient temperature using the open-circuit voltage temperature coefficients in accordance with the instructions included in the listing or labeling of the module.*”

Step 3 – Find

In Table 690.7(A) from the row for ambient temperature equal to 22°F to 14°F, we see that a correction factor of 1.14 must be applied.

Step 4 – Apply Correction Factor

Now calculate this:

$$V_{\max} = 37.3 \text{ V} \times 14 \times 1.14$$

$$V_{\max} = 595.31 \text{ V}$$

This is less than the maximum 600 V allowable by the Code.

Question 51 - Power-limited fire protective signaling circuit conductors are to be installed within an enclosure containing electric light and power conductors. Which of the following best describes Code requirements for these conductors?

► Solution

Step 1 – Lookup

“*Fire alarm systems*” in the index and find the sub-index listing for “*Power-limited, circuits, Conductors, Separation of,*” which refers to Section 760.136.

Step 2 – Read

Section 760.136 covers the separation of power-limited circuit conductors from other non-power-limited conductors. Subsection (B) covers separation by barriers etc.

The basic rule is that power-limited conductors shall not be installed within enclosures with non-power-limited conductors.

Step 3 – Find

Subsection (D)(1) recognizes that connections must be made between systems and requires a separation of at least 0.25 inches (6mm) to be maintained between the systems' conductors.

Question 52 - A delicatessen kitchen has two 12 kW electric ranges, three 20 kW pizza ovens, and one 10 kW water heater. What is the feeder demand factor percentage?

► Solution

Begin

Look up “*Feeders*” in the index and find the sub-index listing for “*Kitchen equipment, commercial,*” which refers to Section 220.56.

Step 2 – Read

Section 220.56 states “*It shall be permissible to calculate the load for commercial electric cooking equipment, dishwasher booster heaters, water heaters, and other kitchen equipment in accordance with Table 220.56.*”

Step 3 – Find

Using Table 220.56 simply count the number of pieces of equipment, then look down the left-hand column for the appropriate number and read across to find the demand factor percentage to be applied. In this case, there are six pieces of equipment, which according to the table are allowed to be derated to 65% of their maximum load.

Question 53 - What is the calculated maximum system voltage using a PV module with a rated open-circuit voltage (Voc) = 39.7 volts, installed at a one-family dwelling in a location where the lowest expected ambient temperature is 5°F? The array design uses 13 series-connected PV modules.

► Solution

Step 1 – Look

In the index for “*Solar photovoltaic systems*” and then “*Voltage*” which refers to Section 690.7.

Step 2 – Read

Section 690.7(A) states: “*PV system dc circuits on or in one- and two-family dwellings shall be permitted to have a maximum voltage no greater than 600 volts.*” Then in subparagraph (A)(1), it states: “*The sum of the PV module rated open-circuit voltage of the series-connected modules corrected for the lowest expected ambient temperature using the open-circuit voltage temperature coefficients in accordance with the instructions included in the listing or labeling of the module.*”

Step 3 – Find

In Table 690.7(A) from the row for ambient temperature equal to 13°F to 5°F, that a correction factor of 1.16 must be applied.

Step 4 – Apply Correction Factor

Calculate this:

$$V_{\max} = 39.7 \text{ V} \times 13 \times 1.16$$

$$V_{\max} = 598.68 \text{ V}$$

This is less than the maximum 600 V allowed by the *Code*.

Question 54 - A receptacle is installed outdoors on the porch of a dwelling unit. The receptacle is located such that it is near the open railing of the porch, but is at a height of 7 feet above grade level. Which of the following best describes Code requirements for the installation of this receptacle?

► Solution

Step 1 – Begin

Look up *“Ground-fault circuit-interrupters”* in the index and find the sub-index listing for *“Receptacles,”* which refers to Section 210.8 Ground-Fault Circuit-Interrupter Protection for Personnel.

Step 2 – Read

Section 210.8(A) states: *“All 125-volt through 250-volt receptacles installed in locations specified in 210.8(A)(1) through (11) and supplied by single-phase branch circuits rated 150 volts or less to ground shall have ground-fault circuit-protection for personnel.”*

Step 3 – Find

Section 210.8(A) lists those applications that require receptacles to have ground-fault circuit-interrupter for personnel protection. Subparagraph (3) Outdoors is one of those applications.

Question 55 - Use this ID when reporting a problem. QID: 23-00557

► Solution

Step 1 – Look

In the index under *“Boxes”* then *“Depth.”* This references Section 314.24.

Step 2 – Read

Section 314.24 paragraph (B)(4) Conductors 12 or 10 AWG states that the internal depth of a box used to enclose devices or utilization equipment while being supplied by 12 or 10 AWG conductors and where the equipment projects rearward from the mounting plane of the box by more than 1 inch *“... shall have a depth not less than that of the equipment plus 1/4 inch.”*

Question 56 - Outdoor self-supporting radio and television receiving antennas, such as vertical rods, dishes, etc., shall be located well away from overhead conductors of electric light and power circuits of over _____ to ground.

► Solution

Step 1 – Lookup

“Radio and television equipment” in the index and find the sub-index listing for *“Receiving equipment--antenna systems,”* which refers to Article 810, Part II.

Step 2 – Read and Find

The bold print section headings for *“Self-Supporting Antennas”* to find Section 810.16(B) covering self-supporting antennas. Section 810.16(B) requires clearance from power circuits of over 150 volts to ground.

Question 57 - If a building is provided with two sets of service drop conductors from the utility pole, and one service drop is 120/240 volts for lighting and receptacle loads, and the other service is 480 volts to supply motor loads. How many disconnecting means are permitted for this building?

► Solution

Begin

1. Look up "Service equipment" in the index and find the sub-index listing for "Six switch rule," which refers to Section 230.71.

Step 2 – Read

Section 230.71(B) refers to Section 230.2 to determine permitted services. The first sentence of Section 230.2 requires that a building or structure have only one service unless permitted in subparagraphs (A) through (D). In subparagraph (D) it permits another service for different voltages, etc., or different uses, etc.

Step 3 – Read Find

Being it is permitted for there to be more than one service, the next question is, how many disconnects are permitted?

Section 230.71(B) states: *"Two to six service disconnects shall be permitted for each set of service-entrance conductors permitted by Section 230.40, Exception No. 1, 3, 4, or 5."*

This then means the two services permitted by Section 230.2(D) are permitted to have 6 disconnects each for a total of 12 disconnects.

Question 58 - A single-phase 5-hp pump motor has a nameplate full-load ampere rating of 26.8 at 230 volts and will be utilized in a continuous-duty application. What is the minimum conductor ampacity of the branch circuit permitted to supply this motor?

► Solution

Step 1 – Lookup

"Motors, Conductors" in the index and find the sub-index listing for *"Single motor"* which refers to Section 430.22.

Step 2 – Read

Section 430.22 requires branch-circuit conductors that supply a single motor must have an ampacity of not less than 125% of the motor full-load current rating as determined by Section 430.6(A)(1).

Section 430.6(A)(1) tells us that we must use the ampacity values given in the motor ampacity tables, not the nameplate value to determine the wire size.

Step 3 – Find the Motor's FLC in Amperes

Table 430.248 provides information on single-phase AC motors. The table requires 28 amperes to be used for a 5-hp motor at 230 volts.

Step 4 – Calculate the Required Conductor Ampacity

Now calculate the required conductor ampacity:

$$28 \text{ A} \times 1.25 = 35 \text{ A}$$

Question 59 - Which of the following is not true concerning overload protection for a motor?

► Solution

Step 1 – Lookup

“Motors” in the index then look for the sub-index listing “Overload protection” this, in turn, refers to Article 430, Part III.

Step 2 – Read

Look through Part III, “Motor and Branch-circuit Protection,” to find Section 430.31, “Motor Circuit Overcurrent Protection.”

Step 3 – Read

Section 430.31 General. “Specifies overload devices intended to protect motors, motor-control apparatus, and motor branch-circuit conductors against excessive heating due to motor overloads and failure to start.” It does not make any reference to the short circuit and ground fault protection.

Note: The *Code Handbook* states in the explanatory material for this Section that ““Overload protection is not designed or may not be capable of breaking short-circuit current or ground-fault current.””

Question 60 - Branch-circuit conductors within 3 inches of a ballast in the ballast compartment shall have an insulation temperature rating of not less than _____.

► Solution

Step 1 – Lookup

“Branch circuits” in the index then find the sub-index listing for “Through luminaires,” which refers to Section 410.64(C). This is another case where no direct link can be made to the section with the information necessary to answer the question.

Step 2 – Find

Beginning with Section 410.64 scan the bold print for “Feeder and Branch-circuit Conductors and Ballasts,” which should bring you to Section 410.68. Here it requires “Feeder and branch-circuit conductors within 3 inches (75mm) of a ballast, LED driver, power supply, or transformer shall have an insulation temperature rating not lower than 90° C (194° F) ...”

Question 61 - When are electric baseboard heaters permitted to be installed below a required receptacle outlet?

► Solution

Step 1 – Begin

The index does not cover this question at all. The only help is in the “Informational Note” in Section 210.52 Dwelling unit receptacle outlets. The Informational notes are advisory information only and are not enforceable. But this information can be very helpful since the *Code* in Section 110.3(B) requires that listed or labeled equipment be installed to comply with any instructions included in the listing or labeling. This makes this Informational Note important because it points to the location of enforceable information.

Step 2 – Find

Informational note in Section 210.52 states: “Listed baseboard heaters include instructions that may not permit their installation below receptacle outlets.”

Question 62 - On a high leg 240 / 120-volt, 3-phase, 4-wire, delta system, the conductor having the higher phase voltage to ground shall be durably and permanently marked by an outer finish that is _____ in color.

▼ Solution

Use this ID when reporting a problem. **QID: 23-00674**

Begin

By looking up "*Identification*" in the index and then the sub-index listing for "*High leg*," which refers to Section 110.15.

See the Requirement

Section 110.15 requires: "*On a 4-wire delta-connected system where the midpoint of one phase is grounded, only the conductor or busbar having the higher phase voltage to ground shall be durably and permanently marked by an outer finish that is orange in color or by other effective means.*"

Note: Always test each phase to ground with the correct testing equipment to identify where the high leg actually is in the system.

Question 63 - What size inverse time circuit breaker is permitted by code to be used first for the branch-circuit, short-circuit, and ground-fault protection to protect a 25-hp three-phase, 480-volt, squirrel-cage induction motor, code letter F?

► Solution

Step 1 – Lookup

"*Motors*" in the index and find the sub-index listing for "*Short circuit protection*," which refers to Section 430, Part IV. Scan Part IV to find "*Rating or Setting for Individual Motor Circuit*," Section 430.52.

Step 2 – Read

Section 430.52(C)(1) states: "... a protective device having a rating or setting not exceeding the value calculated according to Table 430.52 shall be used."

Step 3 – Calculate Motor's FLC Rating

Table 430.250 lists the full-load current rating for a 25-hp as 34 amperes. Table 430.52 permits this type of motor to have an inverse time circuit breaker sized at 250% of the full-load current rating.

$$34 \text{ A} \times 2.50 = 85 \text{ A}$$

Step 4 – Find OCD Size

Exception No. 1 permits the next higher standard size overcurrent device where the calculation does not correspond to a standard overcurrent device from Table 240.6. In this instance 90 amperes.

Question 64 - What is the maximum demand load for four ranges rated at 1¾ kW, 2.0 kW, 2.5 kW, and 3.0 kW?

► Solution

Step 1 – Begin

Looking up “*Ranges*” in the index and finding the sub-index listing for “*Branch circuits, Calculation of load,*” which refers to Table 220.55.

Step 2 – Read

According to Note 3 for those ranges with ratings 1¾ kW through 8¾ kW, the ratings are permitted to be added together. Find the total of the range ratings.

$$1.75 \text{ kW} + 2.0 \text{ kW} + 2.5 \text{ kW} + 3.0 \text{ kW} = 9.25 \text{ kW}$$

Step 3 – Find the Adjustment Value and Apply

Now using Column A (1¾ kW through 3½ kW Rating) find that the demand factor percentage for four ranges is 66%. This needs to be applied to the sum of the ratings found in the preceding step to give the maximum demand.

$$9.25 \text{ kW} \times 66\% = 6.11 \text{ kW}$$

Question 65 - Single conductor portable supply cable sets to portable stage switchboards shall be permitted to have the grounded and grounding conductors identified by marking at least the first _____ from both ends with appropriate colored marking.

► Solution

Step 1 – Lookup

“*Switchboards*” in the index and find the sub-index listing for “*Portable, theater stages,*” which refers to Part IV of Article 520.

Step 2 – Read and Find

Since there is no direct section reference, scan the bold print titles of Part IV, which covers “*Portable Switchboards on Stage*” to find “*Supply Conductors,*” Section 520.54. Read through this section until you find “*Single-Conductor Cables,*” which is subparagraph (C) and requires that the identification be made by marking at least the first 6 inches (150mm) from both ends.

Question 66 - What size standard device box would be adequate to contain a receptacle and 2 #12 NM cables?

► Solution

Step 1

In the index lookup "*Boxes (outlet, device, pull, and junction)*" then "*Volume calculations,*" which will reference Section 314.16 Number of Conductors in Outlet, Device, and Junction Boxes, and Conduit Bodies.

Step 2

Begin by calculating the volume necessary to contain the devices (two switches), wires, and clamps.

Items	Volume Allowance Unit	Fill
4 conductors	based on 12 AWG	2.25 = 9.00 in ³
2 clamps	1 based on 12 AWG	2.25 = 2.25 in ³
1 device(sw)	2 based on 12 AWG	2.25 = 4.50 in ³
EGCs (all)	1 based on 12 AWG	2.25 = 2.25 in ³
	Total volume required	= 18.00 in ³

Step 3

Now go to Table 314.16(A), scan down the Box Trade Size column looking for "*device*" then across to the Minimum Volume column and down until you find a volume that equals or exceeds the necessary 18.00 in³. This will be a 3 × 2 × 3½ device box (wall case), which exceeds the necessary calculated volume.

Question 67 - In a solar photovoltaic system, the system disconnecting means is required to _____.

► Solution

Step 1 – Lookup

"*Solar photovoltaic systems*" in the index and find the sub-index listing for "*Disconnecting means,*" which refers to Article 690 Part III.

Step 2 – Read and Find

Browse Part III to find "*Type of Disconnect,*" Section 690.13(E). it states: "*The PV system disconnecting means shall simultaneously disconnect PV system conductors that are not solidly grounded from all conductors of other wiring systems.*"

Question 68 - A unit of an electrical system other than a conductor, that carries or controls electric energy as its principal function is the definition of a _____.

► Solution

Begin

Since the question appears to be a definition, go to Article 100 Part I and search through it until you find the match.

Article 100 Definition

You will find that this matches the definition of a Device: "*A Unit of an electrical system, other than a conductor, that carries or controls electric energy as its principal function.*"

You should know this.

Question 69 - A 1200-ampere service is installed to a switchboard by using 3 sets of 500 kcmil THWN copper conductors in parallel. A 3/0 AWG copper conductor is connected from the neutral to building steel, and a No. 6 AWG copper conductor is connected from the neutral to a 10-foot ground rod. What size copper main bonding jumper is required from the neutral to the enclosure?

▼ Solution

Use this ID when reporting a problem. **QID: 23-00398**

Begin

Look up “*Jumpers, bonding*” then “*Main*” in the index this refers to Sections 250.24(B) and 250.28.

Step 1 – Read

Section 250.24(B) states that the main bonding jumper is to be installed in accordance with Section 250.28.

Section 250.28(D) Size, requires that the size is determined in accordance with Sections 250.28(D)(1) thru (D)(3), where the size of the main bonding jumper is based on the equivalent size of the ungrounded conductors.

Step 2 – Find

The equivalent ungrounded conductor size:

$500 \text{ kcmil} \times 3 \text{ sets} = 1500 \text{ kcmil}$

Step 3 – Calculate Size of Main Bonding Jumper

Section 250.28(D)(1) covers the size of the Main Bonding Jumper. The rule is that Table 250.102(C)(1) must be used, except when the phase conductors exceed 1100 kcmil. Then according to the Notes to the table, the main bonding jumper must be sized at no less than 12.5% of the area of the largest phase conductor.

$1500 \text{ kcmil} \times 0.125 = 187.5 \text{ kcmil}$

Step 4 – Find Bonding Jumper Size Required

Since Table 8, “*Conductor Properties*” in Chapter 9, lists no conductor sized at 187.5 kcmil, the next larger size must be used as the main bonding jumper. The next larger size listed is 211,600 circular mils. This is 4/0 AWG.

Question 70 - A decorative fountain is installed in a shopping mall. Which of the following best describes code requirements for the lighting fixtures which are installed in this fountain?

► Solution

Step 1 – Lookup

“*Swimming pools, Fountains*” in the index and find the reference to 680-V. If you looked under “*Fountains*,” you found a reference to Swimming pools, fountains, and similar installations.

Step 2 – Read

In Part V of Article 680 use the bold print to find section 680.51(E), “*Wiring*.” In this section you will find cords cannot exceed 10 feet; in subparagraph (B) you see that the operating voltage cannot be more than 150 volts; in subparagraph (F) find that the fixtures must be removable.

Step 2 – Find

Since all the choices are correct, the correct choice to the question is “*all of these*.”

Question 71 - The lower (basement) level of a dwelling unit is completely finished off into habitable rooms except for an 8-foot by 8-foot area which contains the heater and water heater. A duplex receptacle is to be installed in this area. Which of the following best describes Code requirements for the installation of this receptacle?

► Solution

Step 1 – Begin

Look up “*Ground-fault circuit interrupters*” in the index and find the sub-index listing for “*Receptacles, required,*” which refers to Section 210.8.

Step 2 – Read

Scan this section and look to see if basements require GFCI-protected receptacles.

Step 3 – Find

Section 210.8(A)(5) Basements now requires that all receptacles installed in basements of dwellings have GFCI protection whether or not the area is finished or unfinished.

Question 72 - Use this ID when reporting a problem. QID: 23-00269

► Solution

Step 1 – Look

In the index under “*Transformer vaults*” to find Article 450, Part III, since the question deals with transformer vault construction.

Step 2 – Read and Find

Scan Part III to find Section 450.42, Walls, Roof, and Floor where Informational Note No. 2 explains that 6-inch (150mm) reinforced concrete is a typical 3-hour construction.

Question 73 - All conductors of a multiwire branch circuit are required to _____.

► Solution

Step 1 – Begin

Look in the Code index for “*Multiwire branch circuit,*” which references Section 210.4.

Step 2 – Find

Section 210.4(D) requires a multiwire branch circuit to be grouped in accordance with Section 200.4(B), using wire markers, cable ties, or similar means in at least one location within the enclosure.

Question 74 - What size Intermediate Metal Conduit (IMC) would be required to install a single 1.5-inch diameter cable?

► Solution

Step 1 – Lookup

“Intermediate metal conduit” and then *“Number of conductors”* in the index, which refers to Chapter 9, Table 1. (Section 342.22 reference also refers you to Table 1 in Chapter 9.)

Step 2 – Read

Table 1, Chapter 9 specifies that the maximum percentage permitted for 1 cable or conductor is 53%.

Step 3 – Calculate the Area

Next, determine the area required by the 1.5-inch cable. To do this use the formula for the area of a circle:

$$A = r^2 \times \pi.$$

$$A = 0.75^2 \times 3.1416$$

$$A = 0.5625 \times 3.1416$$

$$A = 1.7671 \text{ in.}^2$$

Step 4 – Find

Now go to the Table in Chapter 9 to determine the proper trade size conduit to be used. The tables are in the order of the conduit sections as they occur in Chapter 3. Look for Table Article 342 — Intermediate Metal Conduit (IMC).

Step 5 – Read

The column headed "1 Wire 53%." Reading down this column under the in.² portion find a value that exceeds 1.7671. This turns out to be 1.924. You can now read across to the left to find the Trade Size conduit. It is **2 inch IMC**.

Question 75 - Temporary electric power and lighting installations shall be permitted not to exceed _____ days for holiday decorative lighting.

► Solution

Step 1 – Lookup

In the index *“Temporary installations”* then *“Time constraints,”* which will reference Section 590.3 Time Constraints.

Step 2 – Read and Find

Section 590.3(B) 90 Days states: *“Temporary power and lighting installations shall be permitted for a period not to exceed 90 days for holiday decorative lighting and similar purposes.”*

Question 76 - Type AC cable shall not be permitted to be unsupported or unsecured in which one of the following conditions?

► Solution

Step 1 – Look

In the index under *“Armored cable, Support”* to find Section 320.30 Through or parallel to framing members.

Step 2 – Read

The lettered paragraphs to find Unsupported Cables, which will be paragraph (D).

Step 3 – Find

Paragraph (D) Unsupported Cables allows the cables as stated in sub-paragraphs (1) through (3) to be unsupported as described in each of the choices.

Question 77 - A vertical run of a 4-inch rigid conduit is installed to a height of 230 feet. The conduit contains four pieces of 500 kcmil THHN copper conductor. How many conductor supports are required?

► Solution

Step 1 – Lookup

“Raceways” in the index and find the sub-index listing for “*Supporting conductors, vertical,*” which refers to Section 300.19.

Step 2 – Read

Section 300.19, Table 300.19(A) requires 500 kcmil copper to have supports spaced no greater than 50 feet apart. This would mean 4 supports are required in the run.

Step 3 – Find

Also, Section 300.19(A) requires that one support be placed at the top of the run and thus bringing the total number of supports required to 5.

Question 78 - The maximum size of the overcurrent device permitted to protect a 4.5 kW, 240-volt, electric water heater that is connected with No. 8 AWG copper NM cable is _____.

► Solution

Step 1 – Look

In the index under “*Appliances, Overcurrent protection*” find Section 422.11.

Step 2 – Read

Section 422.11 in paragraph (E) Single Non-Motor-Operated Appliance subparagraph (3) it states: “*Not to exceed 150 percent of the appliance rated current if the overcurrent protection rating is not marked and the appliance is rated over 13.3 amperes.*”

Step 3 – Rated Current

To find the rated current, use the Power formula dividing 4500 watts by 240 volts.

$$\begin{aligned} I &= P \div E \\ I &= 4.5 \text{ kW} \times 1000 / 240 \text{ V} \\ I &= 18.75 \text{ A} \end{aligned}$$

Step 4 – Calculate OCD Size

3. As indicated in Step 2, the overcurrent device cannot exceed 150% of FLA. (Full-load amperes).

$$18.75 \text{ A} \times 1.50 = 28.13 \text{ A}$$

Step 5 – Find

Since there is no overcurrent device with this rating, the rule also allows advancing to the next standard overcurrent device, which according to Section 240.6, is 30 amperes.

Question 79 - Which of the following is not an acceptable use for flexible cords?

► Solution

Step 1 – Lookup

“Cords” in the index and find the sub-index listing for “*Uses not permitted,*” which refers to Section 400.12.

Step 2 – Read

Section 400.12 does not permit flexible cords to be fastened permanently to building surfaces.

Question 80 - A 30-hp, induction type, Code letter D, 230-volts, three-phase motor used in a continuous duty application has a nameplate current rating of 73.2 amperes. The minimum branch-circuit ampacity permitted to supply this motor is?

► Solution

Step 1 – Lookup

“Motors” in the index and find the sub-index listing for “Conductors, Single motor,” which refers to Section 430.22.

Step 2 – Read

Section 430.22 requires the branch-circuit conductors to be sized to 125% of the full-load current rating as determined by Section 430.6(A)(1).

Section 430.6(A)(1) requires that where the full-load current rating is to be used for sizing of conductors, overcurrent protection, etc., the values given in Tables 430.248 through 430.250 must be used – **NOT** the nameplate current rating.

Table 430.250 lists a 30-hp, 230-volt motor as having a full-load current rating of 80.0 amperes.

Step 3 – Calculate the Branch-Circuit Ampacity

The **minimum** ampacity of the conductors required by Code would be calculated as follows:

$$80 \text{ A} \times 1.25 = 100 \text{ A}$$

Question 81 - What minimum distance (labeled "D" in the drawing) is required for an angle pull, if the wire is 3 3/0 THW in a 2-inch EMT conduit that enters and leaves from adjacent sides of the pull box?

► Solution

Step 1

Look in the index for “Pull boxes” then “Sizes” here you will need to know what the wire size is. Is it greater than or less than 4 AWG? Since 3/0 is greater than 4 AWG we will need to go to Section 314.28(A).

Step 2

Reading through this section we find that paragraph (A)(2) deals with Angles, U pulls, and Splices.

It requires the conduits that enclose the same conductor(s) to have a distance between them of at least six times the size of the largest raceway.

This can be calculated as:

$$6 \text{ inches} \times 2 = 12 \text{ inches}$$

The minimum separation distance of conduits is 12 inches.

Question 82 - Which of the following is considered by Code to be adequate for the bonding together of metal parts on spas and hot tubs located indoors?

► Solution

Step 1 – Lookup

“Spas and hot tubs, Indoor installations” in the index to find the reference to 680.43.

Step 2 – Read

Use the bold print in Section 680.43 to find subsection 680.43(E), “Methods of Bonding”.

Step 3 – Find

In this subsection, all these choices are accepted as methods of bonding of the metal parts making the correct answer “any of these.”

Question 83 - What is the maximum demand load for four residential ranges each rated at 14-kW?

► Solution

Begin

Look up “*Ranges*” in the index and find the sub-index listing for “*Branch circuits, Calculation of load,*” which refers to Table 220.55.

Step 1 – Calculate Load Adjustment

Column C of Table 220.55 applies to ranges, not over 12 kW. Note 1 applies to ranges over 12 kW but less than 27 kW when they are all the same rating.

Note 1 requires that the maximum demand in Column C be increased by 5% for each additional kW or major fraction that each individual range exceeds 12 kW.

14 kW exceeds 12 kW by 2 kW.

$$2 \times 5\% = 10\%$$

Step 2 – Apply Load Adjustment

Using Column C the maximum demand for four ranges is 17 kW. This value must now be increased by 10% per Note 1 (as calculated above).

$$17 \text{ kW} \times 1.10 = 18.7 \text{ kW}$$

Question 84 - A new recreational vehicle park is designed with 16 sites. Each site is equipped with a 50-ampere receptacle. What basis, in volt-amperes, is used for the individual sites when calculating the service load?

► Solution

Begin

By looking up “*Recreational vehicle parks*” in the index; then find the sub-index listing for “*Calculated load.*” This refers to Section 551.73.

Find

Section 551.73(A) requires that the calculation be based on 12,000 volt-amperes per site where the site is equipped with a 50-ampere receptacle.

Question 85 - All switching devices not separated from a swimming pool by a solid permanent barrier shall be located at least how far from the inside of the pool.

► Solution

Step 1 – Lookup

“*Swimming pools, fountains, and similar installations,*” and the sub-listing “*Switches and switching devices*” to find the reference to Section 680.22(C).

Step 2 – Read and Find

Section 680.22(C) requires that all switching devices be located at least 5 feet (1.5m) from the inside walls of the pool, unless separated by a solid permanent barrier that provides at least a 5 ft reach distance.

Question 86 - Service conductors not over 300 volts between conductors that terminate in a through-the-roof-raceway, and pass over horizontally a roof with a slope of 5 in. in 12 in. shall be permitted to have a minimum clearance of _____ above the roof.

▼ Solution

Use this ID when reporting a problem. **QID: 23-00622**

Step 1

Check the index under “*Service drops, Clearances*” to find Section 230.24.

Step 2

Section 230.24(A), *Exception No. 2*, permits the clearance to be reduced to 3 feet, where the roof has a slope of 4 inches in 12 inches or greater. The slope in the question is steeper or greater.

Note: The Code Handbook states in a note following the Exception: “*The conductor's length over the roof is not restricted.*”

Question 87 - What is the minimum length (labeled "A" in the drawing) pull box required for a straight pull, if the wire is 4 4/0 THW conductors in a 2½-inch EMT conduit?

► Solution

Step 1

Look in the index for “*Pull boxes*” then “*Sizes*” here you will need to know what the wire size is. Is it greater than or less than 4 AWG? Since a 4/0 conductor is greater than a 4 AWG conductor we will need to go to Section 314.28(A).

Step 2

Reading through the section we find that paragraph (A)(1) deals with Straight Pulls.

Then Section 314.28(A)(1), requires the length of the box or conduit body to be not less than eight times the metric designator (trade size) of the largest raceway.

We can calculate this:

8 inches × 2.5 = 20 inches

The minimum required length of the box would be 20 inches.

Question 88 - A bathroom lighting outlet shall not be permitted to be controlled by _____.

► Solution

Step 1 – Begin

Look in the index under “*Lighting, Outlets*” to find Section 210.70.

Step 2 – Read

Section 210.70(A)(1) requires that at least one wall switch-controlled lighting outlet be installed in every habitable room and bathroom. Exception No. 2 permits lighting outlets to be controlled by occupancy sensors that are (1) in addition to wall switches or (2) located at a customary wall switch location and equipped with a manual override that will allow the sensor to function as a wall switch.

Step 3 – Find

The choice “*remote located occupancy sensor*” did not provide for manual override operation, therefore, it is not permitted to control the lighting outlets by itself.

Question 89 - All bends in armored cable Type AC must be made so that the radius of the inner edge of any bend is not less than _____ the diameter of the cable.

► Solution

Step 1 – Lookup

In the index under "Armored cable, Bends" find Section 320.24 Bending Radius.

Step 2 – Find

This section states: *"The radius of the curve of the inner edge of any bend shall not be less than five times the diameter of the Type AC cable."*

Question 90 - A 2-inch Electrical Metallic Tubing (EMT) nipple 24 inches long installed between panels has a permitted fill of _____.

► Solution

Step 1 – Lookup

"Conduit nipples" in the index refers to Note 4, Chapter 9, Table 1, and Note (4) permits a conduit nipple, 24 inches or less, to be filled to 60 percent of its cross-sectional area.

Step 2 – Read

Table 4, Electrical Metallic Tubing section lists the total cross-sectional area of the 2-inch conduit as 3.356 in².

Step 3 – Calculate the Fill Permitted

Calculate the permitted fill by multiplying the value found in Table 4 by 60%:

$$3.356 \text{ in}^2 \times 0.60 = 2.0136 \text{ in}^2$$

Note: This can also be found in the table under the 60% column, which also gives the area as 2.013 in²

Question 91 - What is the minimum length (labeled "A" in the drawing) pull box required for a straight pull, if the wire is 3/0 THW conductors in a 2-inch EMT conduit?

► Solution

Step 1

Look in the index for "Pull boxes" then "Sizes" here you will need to know what the wire size is. Is it greater than or less than 4 AWG? Since 3/0 AWG is greater than 4 AWG we will need to go to Section 314.28(A).

Step 2

Reading through the section we find that paragraph (A)(1) deals with Straight Pulls.

Then Section 314.28(A)(1), requires the length of the box or conduit body to be not less than eight times the metric designator (trade size) of the largest raceway.

We can calculate this:

$$8 \text{ inches} \times 2.0 = 16 \text{ inches}$$

The minimum required length of the box would be 16 inches.

Question 92 - The calculated unit lighting load of a 1,200-square-foot barbershop is _____.

► Solution

Step 1 – Lookup

“*Lighting*” and then “*Branch circuits, calculation of load*” in the index, and find Section 220.12 Lighting Load for Non-Dwelling Occupancies.

Step 2 – Calculate Minimum Lighting Load

Section 220.12 requires that the minimum unit load per square foot be as listed in Table 220.12, but there is no listing for barbershops (change for 2020). Read the notes at the bottom of the table, and there it is explained that barbershops are to use the retail occupancies unit loads when figuring the lighting loads. These occupancies are now required to use a unit load for the lighting of 1.9 volt-amperes per square foot. Also, notice that the 125 percent multiplier for a continuous load as specified in 210.20(A) is now included in these unit loads, and is no longer required to be applied separately.

$$1,200 \text{ ft}^2 \times 1.9 \text{ VA /ft}^2 = 2,280 \text{ VA}$$

Question 93 - When optional standby power is employed, a sign at the service entrance shall indicate _____.

► Solution

Step 1 – Begom

Go to the index and find “*Optional standby systems*,” and then “*Signs*.” This will reference Section 702.7 Signs.

Step 2 – Read and Find

Section 702.7(A) states: “*A sign shall be placed at the service-entrance equipment for commercial and industrial installations that indicates the type and location of each on-site optional standby power source.*”

Question 94 - Liquidtight Flexible Metal Conduit must be supported at intervals not exceeding _____.

► Solution

Step – Lookup

“*Liquidtight flexible metal conduit*” in the index, then “*Securing and supporting*,” this references Section 350.30.

Step 2 – Find

Section 350.30(A) requires that LFMC be “... *supported and secured at intervals not exceeding 4-1/2 feet.*”

Question 95 - A lubrication service and repair pit in a commercial garage is classified as Class I, Division 2 if it is equipped with ventilation of at least _____ per square foot of floor area, with suction taken from a point with 12 inches of floor level.

► Solution

Begin

By looking up “*Garages, commercial*” in the index and find the sub-index listing for “*Classification of locations*,” which refers to Sections 511.3.

Step 1 – Requirements

Section 511.3(C) “*Repair Garages, Major, and Minor*” states: Table 511.3(C) is to be used for classification guidance.

Step 2 – Find the Classification

In Table 511.3(C) you find that the entire space within the pit, below-grade work area, or subfloor work area that is ventilated at 1 cubic foot/minute per square foot of floor space is Class I, Division 2 location.

Question 96 - A 1-inch Rigid PVC Conduit (PVC), Schedule 80 nipple 18 inches long installed between a panel and a pull box has a permitted fill of _____.

► Solution

Step 1 – Lookup

“Conduit nipples” in the index refers to Note 4, Chapter 9, Table 1, and Note (4) permits a conduit nipple, 24 inches or less, to be filled to 60 percent of its cross-sectional area.

Step 2 – Read

Table 4, Article 352, A 1-inch Rigid PVC Conduit (PVC), Schedule 80 lists the total cross-sectional area of the 1-inch conduit as 0.688 in².

Step 3 – Calculate the Fill

Calculate the permitted fill by multiplying the value found in Table 4 by 60%:

$$0.688 \times 0.60 = 0.4128 \text{ in}^2$$

Note: This can also be found in the table under the 60% column, which this instance gives the area as 0.413 in².

Question 97 - Type CMUC communications cable is listed as suitable for use _____.

► Solution

Step 1 – Look

In the index under “Communications, circuits,” look for “Cable marking,” which references Section 805.179 and Table 805.179.

Step 2 – Read and Find

Table 805.179 Cable Markings lists CMUC as “Under-carpet communications wire and cable.”

Question 98 - How many outdoor receptacles are required at a two-family dwelling?

► Solution

Step 1 – Begin

Look in the index under “Outlets” and then “Receptacles, Dwellings where required” to find Section 210.52.

Step 2 – Find

Section 210.52(E) requires a minimum of two outlets outdoors for each dwelling unit. One is to be installed on the front and the other on the rear with both being accessible at grade level.

Note: Recognize that Section 210.52 covers the required receptacles in a dwelling unit. **Memorize it**

Question 99 - What volume device box would be required to adequately contain one switch, two duplex receptacles, two 14 AWG NM cables for the light switch, and four 12 AWG NM cables for the receptacles?

► Solution

Step 1

In the index lookup “Boxes (outlet, device, pull, and junction)” then “Volume calculations,” which will reference Section 314.16 Number of Conductors in Outlet, Device, and Junction Boxes, and Conduit Bodies.

Step 2

Read the complete Section 314.16(A) to find the necessary volume allowances that must be used to calculate the required box volume.

Step 3

Now calculate the volume necessary to contain the devices (switch & receptacles), wires, and clamps. Remember, that since the number of EGCs exceeds four, additional volumes must be added for each EGC that exceeds this.

Items	Volume Allowances	Unit	Fill	
4 conductors	1 based on 14 AWG	2.00	= 8.00	in ³
8 conductors	1 based on 12 AWG	2.25	= 18.00	in ³
1 device(sw)	2 based on 14 AWG	2.00	= 4.00	in ³
2 devices(rcpt)	2 based on 12 AWG	2.25	= 9.00	in ³
1 clamp	1 based on 12 AWG	2.25	= 2.25	in ³
EGCs (1st 4)	1 based on 12 AWG	2.25	= 2.25	in ³
EGCs (¼ vol for >4)	2 based on 12 AWG	0.5625	= 1.125	in ³
Total volume required			= 44.625 in ³	

Step 4

The box must have a volume that equals or exceeds 44.625 in³

Question 100 - An electric clothes dryer circuit is to be installed in an apartment building where the circuit originates in a subpanel in the apartment. Which of the following best describes Code requirements for this connection?

► Solution

Step 1

Look in the index under "*Clothes dryers, grounding*" to find Sections 250.114 and 250.140.

Step 2

Section 250.114(3) requires clothes dryers to have "... *exposed normally non-current carrying metal parts ... shall be connected to the equipment grounding conductor ...*"

Step 3

Section 250.140 requires the clothes dryer frame "... *shall be connected to the equipment grounding conductor in the manner specified by 250.134 or 250.138.*"

Step 4

Finally, Section 250.138(A) requires that this be accomplished "*By means of an equipment grounding conductor run with the power supply conductors in a cable assembly or flexible cord properly terminated in a grounding-type attachment plug with one fixed grounding contact.*"