

Residential Wiring (2017 NEC) (Homestudy)

Idaho Electrical License

This course will cover the requirements in the 2017 NEC for installing electrical systems in dwelling units. Code sections for residential wiring installations are organized by equipment type or location in the dwelling: Service and Subpanels, Kitchen, Pantry and Dining Rooms, Bathrooms and Laundry, Living Areas (and Bedrooms), Stairways and Hallways, Luminaires, Fans and Switches, Outdoors, Garages, Basements, and Crawl Spaces, Heating and Cooling, Swimming Pools and Spas, Generators, Limited Energy, Installation.

Course# 20-581727 4 Code Related (CR) Credit Hours $55.00

This course is currently approved by the Idaho Electrical Bureau under course number 20-581727.

Completion of this continuing education course will satisfy 4.000 credit hours of course credit type 'Code Related (CR)' for Electrical license renewal in the state of Idaho. Course credit type 'Code Related (CR)'. Board issued approval date: 6/5/2017. Board issued expiration date: 6/30/2021.

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Residential Wiring (2017 NEC) (Homestudy) - ID

Service and Subpanels

Question 1: 110.12 Mechanical Execution of Work.

Question ID#: 11094.0



Panelboard interior must be protected during construction.

This course is based entirely on the National Electrical Code, 2017 edition. It does not include state specific amendments.

The integrity of electrical connections must be protected. In the past, the interiors of panelboards were regularly painted with overspray that contaminated the busbar area. If there was heavy overspray, the result would be poor or no electrical connection. This caused either overheating of the bus or voltage drop on circuits fed from the panelboard.

Trying to clean panelboard busbars doesn't work either. Steel brushes or corrosive chemicals will damage the bus finish. Other chemicals used for cleaning may not damage the bus itself, but can damage the plastic non-conductive portions of the panelboard which provide electrical insulation or circuit breaker support. Section 110.12(B) requires the internal parts of electrical equipment to be protected from the kinds of damage that can occur during construction and could prevent the safe operation of the equipment once the building is complete.

Question 1: Why was this panelboard required to be covered during the rough-in stage?

A: To protect other workers from contacting energized parts.
B: To provide a neat and workmanlike job.
C: To protect the internal parts of the panelboard from damage.
D: To keep out unauthorized personnel.

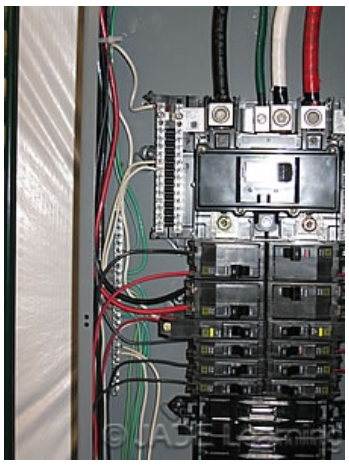
Question 2: 200.2(B) Continuity.

Question ID#: 11095.0

This section prohibits the continuity of the grounded conductor from depending on a connection to a raceway, metallic cable, or a metal enclosure. It applies to services, feeders and branch circuits. It is consistent with the effort to keep normal neutral current on grounded conductors, instead of on enclosures and raceways.

At the service, the grounded conductor is connected to the service enclosure with a wire, bus or screw. If a separate groundbar for equipment grounding conductors is installed, the service enclosure ties the equipment grounding conductor busbar to the grounded conductor busbar. Grounded, neutral conductors cannot be connected to a groundbar in such a way that the metal of the enclosure provides the pathway from a feeder or branch circuit neutral to the service neutral.

The continuity of the grounded conductor from the service equipment to the smallest branch circuit cannot depend on a connection to a metallic enclosure, raceway or cable armor.



Neutral conductor must connect to neutral terminal.

Question 2: Where is the grounded conductor of a feeder to a subpanel required to be terminated?

A: An overcurrent device.
B: The grounded conductor busbar or terminal.
C: The equipment grounding conductor busbar or terminal.
D: A bonding bushing.

Question 3: 230.24 Clearances.

Question ID#: 11096.0



Clearance must be maintained where the overhead service conductors cross over grade or roofs.

Overhead service conductors must maintain clearances above roofs and from grade. If the service mast passes through the roof, service conductors can be no closer than 18 in. from the overhanging portion of the roof, measured from the bottom of the drip loop. In order to qualify for this reduced clearance, the voltage between conductors is limited to 300 volts and not more than 6 ft. of service drop conductors can pass above the roof overhang [230.24(A) Ex. No.3].

Clearances from ground vary according to the voltage between conductors and the type of property the overhead service conductors pass over. Overhead service conductors that pass over streets and alleys that have truck traffic must always have 18 ft. clearance from ground.

If the service to a dwelling is 120/240 volts, single-phase, then the voltage to ground is less than 150 volts. Therefore the minimum clearance of 10 ft. from ground is measured from nearest approach of conductors to ground over the entire span, taking into consideration any sag in the conductors and any rise in the ground such as a knoll.

Question 3: Which of the following statements about the clearance of overhead service conductors is FALSE?

A: Clearance from ground is measured from the top of the service head.
B: The minimum clearance of overhead service conductors over the overhanging portion of a roof is 18 in.
C: The minimum clearance from ground for overhead service conductors that pass over streets that have truck traffic is 18 ft.
D: The minimum clearance from ground for 120/240 volt single-phase overhead service conductors is 10 ft.

Question 4: 230.70(A)(1) Service Equipment - Disconnecting Means. Readily Accessible Location.

Question ID#: 11097.0

Every service must have a disconnecting means, and the disconnecting means must be in a readily accessible location. From Article 100 Definitions, a readily accessible location is a location which can be reached quickly for operation and does not require a person to climb over obstacles or use a ladder.

The readily accessible location may be outside a building or structure, or inside nearest the point of entrance of the service conductors. If the service disconnect is outside the building, it can be anywhere. It can be right next to the meter or it can be on the other side of the house. There are no restrictions about how far unfused service wires can be run on the outside of a building.

Once the service conductors are run from the utility meter into the building, however, the disconnect must be located nearest the point where the conductors enter the building. The service wires from the meter are not protected by fuses or circuit breakers. If there is a problem on an unfused wire, it is much more serious than if there was overcurrent protection ahead of the wire.

To reduce the danger of having unfused wires inside the house, the Code insists they be kept as short as possible. "Nearest the point of entrance of the service conductors" means different things in different jurisdictions. In some places it means the utility meter and service panel must be back-to-back, or at most one stud bay over. In other locations the service panel can be more remote from the point of entrance.



Service disconnects must be located nearest the point of entrance.

Question 4: The location of the service disconnect must be:

A: Outside the dwelling.
B: Anywhere inside the building if the service conductors are in conduit.
C: At a readily accessible location nearest the point of entrance of the service conductors.
D: No more than 10 ft. inside the dwelling.

Question 5: 230.82 Equipment Connected to the Supply Side of Service Disconnect.

Question ID#: 11098.0



Equipment connected on the supply side of the service disconnect is limited.

For most residential services, equipment cannot be connected ahead of the service disconnect. Service conductors are not fused until they get to the service equipment, therefore the NEC limits what may be connected ahead of the service disconnect. An unlicensed person might be tempted to pull the meter and feed a new air conditioner or other load if the service panel didn't have room for additional breakers. This would be a serious violation. The installer could be cited for: (1) Breaking the seal on a utility meter, (2) Possibly overloading the service conductors, (3) Running unprotected service wires inside a building with no disconnecting means, (4) Violating the 1 wire per terminal rule, (5) Improper grounding, and a number of other important Code requirements.

Some equipment, like meter disconnects, can be connected to the supply side of the service. Also, taps ahead of the service disconnect are allowed to feed energy management and load control devices. Secondary power sources including generators, solar photovoltaic, fuel cell systems, wind electric systems and energy storage systems can be connected upstream from the service disconnect if the equipment is suitable for use as service equipment and the conductors feeding the equipment are treated as service conductors.

Question 5: Which of the following statements about equipment connected to the supply side of the service disconnect is TRUE?

A: Meter disconnects that have all of their metal housings grounded may be connected on the supply side of the service.
B: Any equipment can be connected on the supply side of the service overcurrent devices if the added load does not overload the service conductors.
C: Nothing can be connected ahead of the service overcurrent devices.
D: Any type of device that contains internal fuses or circuit breakers can be connected ahead of the service overcurrent protection.

Question 6: 250.32(B) Ex. Buildings or Structures Supplied by Feeders or Branch Circuits. Grounded Systems.

Question ID#: 11099.0

Using a grounded conductor instead of an equipment grounding conductor to ground equipment and raceways in a separate building is permitted only for existing premises wiring systems. Any new installation must include an equipment grounding conductor.

Exception No. 2 permits the grounded conductor of a feeder from an outdoor transformer to a building to ground equipment and raceways if system bonding jumpers from the transformer are connected at both the transformer and the disconnect at the building. In order to use this exception, there cannot be a parallel path for neutral current, such as metallic conduit, between the transformer and the building.

On an existing 3-wire feeder to a second building, if the existing building disconnect is damaged or another branch circuit in the separate building is added, the old 3-wire feeder is not required to be changed.



Equipment grounding conductor required with feeder conductors to separate buildings.

On all new installations, an equipment grounding conductor is required to be installed with the feeder. A grounding electrode is installed at the second building and is connected to the equipment grounding conductor. On existing 3-wire installations, the grounding electrode is connected to the grounded, neutral conductor.

Question 6: An existing feeder without an equipment grounding conductor is installed in PVC conduit to a second building. There is no ground-fault protection of equipment and no metallic paths between the two buildings. If the disconnect at the second building is replaced, which of the following statements is TRUE?

A: The grounded conductor must be isolated from the disconnect.
B: The existing grounding electrode at the second building must be removed.
C: The grounded conductor can be used to ground the new disconnect and the equipment inside the second building.
D: A new feeder with an equipment grounding conductor is required to be installed.

Question 7: 250.52 Grounding Electrodes.

Question ID#: 11100.0



Metallic water line where 10 ft. or more is in contact with the earth is a grounding electrode.

Grounding electrodes can be any of the following: metal underground water pipe, including any metal well casing bonded to the pipe, metal in-ground support structures in direct contact with the earth for 10 ft. or more, concrete-encased electrode (rebar, also called ufer) at least 20 ft. in length, a ground ring at least 20 ft. in length, rod and pipe electrodes, or other local metal underground systems or structures. A connection to the rebar is required if it is present in the foundation or footing. If more than one electrode is present at the dwelling, all the grounding electrodes must be bonded together to form the grounding electrode system.

The connection to the metal water pipe must be made within 5 ft. of where the pipe enters the building or structure. The water pipe must also be in direct contact with the earth for 10 ft. or more. Jumpers must be installed around any water meters in the water line. Plumbers often use plastic pipe to repair copper pipe so a grounding connection close to where the metal pipe enters the dwelling helps to insure the continuity of the grounding electrode.

A metal water pipe used as a grounding electrode must have at least one additional electrode, called a supplemental electrode. Probably because of the danger of losing the grounding connection if the pipe gets cut, metal water pipes cannot be the sole grounding electrode. The second grounding electrode is usually a driven ground rod, but it can be any of the electrodes listed in 250.52(A).

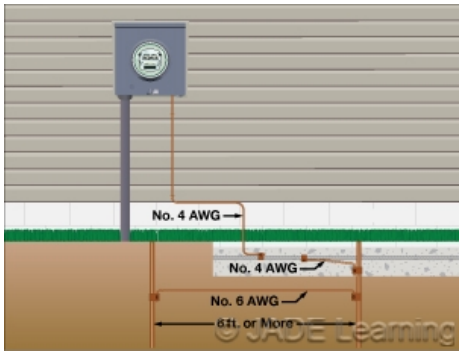
Question 7: When more than one grounding electrode is used:

A: They must be in contact with the earth for 10 ft. or more.
B: They must be either copper or aluminum.
C: They must be copper.
D: They must be electrically connected to form a grounding electrode system.

Question 8: 250.66 Size of AC Grounding Electrode Conductor.

Question ID#: 11101.0

The size of the grounding electrode conductor is selected from Table 250.66. This table is based on the size of the service conductors. Service conductors for a residential 200 amp service are 2/0 copper or 4/0 aluminum, and would require a No. 4 copper grounding electrode conductor.



Grounding electrode conductors are sized according to Table 250.66.

According to this section, if the grounding electrode conductor is connected to a single ground rod or multiple ground rods and is not connected to an additional electrode that would require a larger size grounding electrode conductor (like water pipe), the grounding electrode conductor is not required to be bigger than No. 6 copper or No. 4 aluminum. Likewise, any connection to one or more concrete-encased electrodes, such as 1/2 in. rebar, does not need to be larger than No. 4 copper, unless an additional connection to a grounding electrode is made that requires a larger grounding electrode conductor.

The reason for these limits is that the purpose of the grounding electrode conductor is not to carry fault current. The job of the grounding electrode conductor is to connect the non-current carrying parts of the electrical system to the earth and keep the potential on enclosures and conduit to 0 volts with reference to ground. The grounding electrode conductor does not have to be sized to carry large amounts of fault current if its main purpose is to establish the ground reference. The grounding electrode conductor to an 8 ft. ground rod will not see much ground fault current. The resistance to ground of a ground rod will be much higher than the resistance to ground of other grounding electrodes like copper water pipes, and the fault current will be lower.

Question 8: The purpose of a grounding electrode conductor is to:

A: Create a high resistance path for fault current.
B: Shunt the fault current to ground.
C: Keep electrical enclosures at 0 volts potential.
D: Carry fault current.

Question 9: 250.92 Bonding Services.

Question ID#: 11102.0



Service equipment enclosures are connected to the neutral by a main bonding jumper.

The noncurrent-carrying metal parts of service equipment must be bonded together. Conduits, enclosures, fittings, meters and boxes are bonded together so a fault at any point on the service equipment can be cleared.

Acceptable bonding methods include using threaded couplings or threaded bosses on enclosures made up wrenchtight; threadless couplings and connectors where made up tight for metal raceways; or bonding-type locknuts and bushings. Standard locknuts will not provide a bonding connection.

Bonding jumpers must be used around impaired connections, such as reducing washers or oversized, concentric or eccentric knockouts. Impaired connections can cause a break in the continuity between the service raceways, enclosures and equipment. Bonding around an impaired connection ensures a continuous path for fault current if there is a fault at the service.

A connection to the grounded conductor, called the main bonding jumper, ties all the noncurrent-carrying metal parts of the service equipment to the system neutral. The main bonding jumper is critical to the safety of the system because it is the key link between the neutral, service equipment and equipment grounding conductors. If there is a fault, the service neutral carries fault current and the main bonding jumper is the bridge to get fault current from anywhere in the system onto the neutral.

The main bonding jumper is sized according to Table 250.102(C)(1), just like the grounding electrode conductor, and is based on the size of the service entrance conductors. If the main bonding jumper is a screw, the head of the screw must be green and visible wherever the screw is installed.

Question 9: Why are the noncurrent-carrying metal parts of service equipment bonded together?

A: To provide a path for normal current flow on the neutral.
B: So a fault anywhere on the service will clear through the neutral.
C: To make the service stronger.
D: To connect the meter socket and the service panel.

Question 10: 250.104(B) Bonding of Piping Systems and Exposed Structural Metal.

Question ID#: 11103.0

Metal piping, including gas piping, can be bonded to any of the following: (1) Equipment grounding conductor for the circuit that is likely to energize the piping system. (2) Service equipment enclosure. (3) Grounded conductor at the service. (4) Grounding electrode conductor. (4) One or more grounding electrodes.

The bonding jumper used to bond the metal pipe is selected from Table 250.122, based on the rating of the circuit that is likely to energize the piping. The bonding jumper connection must be accessible.

Bonding Corrugated Stainless Steel Tubing (CSST) gas pipe has been controversial in the past. In all cases the manufacturers instructions must be followed.

The National Fuel Gas Code, section 7.13.2 says:

CSST gas piping systems shall be bonded to the electrical service grounding electrode system. The bonding jumper shall connect to a metallic pipe or fitting between the point of delivery and the first downstream CSST fitting. The bonding jumper shall not be smaller than 6 AWG copper wire or equivalent.



Gas pipe bonding jumper sized according to circuit likely to energize it.

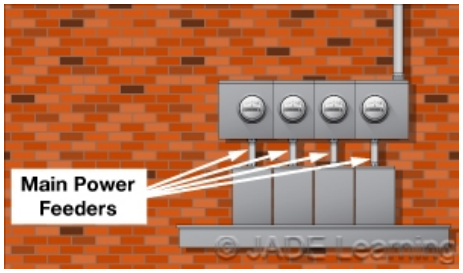
As always, the Authority Having Jurisdiction has the final say in how bonding connections are made to gas piping.

Question 10: An ungrounded conductor with a 200 amp overcurrent device is run in the same vicinity as the gas piping system. According to article 250, what is the correct size for the bonding jumper?

A: No. 4 AWG copper.
B: No. 6 AWG copper.
C: No. 8 AWG aluminum.
D: No. 6 AWG aluminum.

Question 11: 310.15(B)(7) Single-Phase Dwelling Services and Feeders.

Question ID#: 11104.0



Main Power Feeders that carry the entire load of the dwelling can be selected at 83% of their ampacity from Table 310.15(B)(16).

Dwelling units have greater load diversity than other occupancies because fewer loads are on at the same time. Because of this load diversity, section 310.15(B)(7) permits service conductors and main power feeders to panelboards supplying loads in dwellings to be smaller than would be permitted by table 310.15(B)(16). The service conductors or main power feeders can be selected based on 83% of the rating of the service or feeder. This allowed reduction applies to 120/240 single phase systems and feeders where 2 ungrounded conductors and a grounded conductor are taken from a 208Y/120 volt three phase system. Annex D, Example 7 includes a table for selecting service conductors that carry the entire load of the dwelling.

The definition of a main power feeder is: "the feeder between the main disconnect and the panelboard that supplies, either by branch circuits, or by feeders, or both, all loads that are part of or associated with the dwelling unit."

For example, if a service disconnect is mounted on the outside of a dwelling and a feeder supplies a single sub-panel inside the house, the feeder is a "main power feeder" then section 310.15(B)(7) could be used to size the feeder. If additional subpanels were supplied from the first sub-panel, the feeder from the service to the first subpanel is still the "main power feeder." If two subpanels inside the house were fed from the outside service disconnect neither one of them is a "main power feeder." A "main power feeder" must supply all the loads in the dwelling or all the loads which are associated with the dwelling. If associated loads from the dwelling are fed from the main panel, and not from a subpanel, then the feeder from the main panel to the subpanel is not the "main power feeder." The authority having jurisdiction will determine which loads are associated with the dwelling.

Question 11: Which of the following 100 amp loads is permitted to be supplied by a feeder rated for a minimum of 83 amps?

A: A 100 amp subpanel in a detached garage at a dwelling unit.
B: A 100 amp fused disconnect for an electric furnace.
C: A 100 amp service panelboard that supplies all but the heating and cooling loads in a dwelling unit.
D: A 100 amp service panelboard that supplies all of the loads in a dwelling unit.

Question 12: 408.36 Panelboards. Overcurrent Protection.

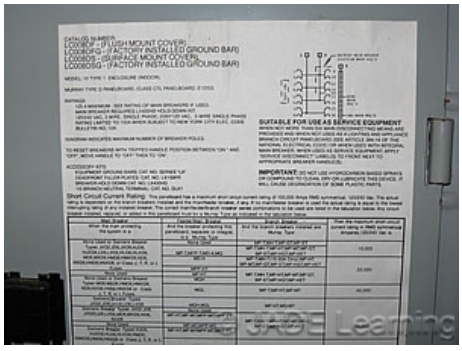
Question ID#: 11105.0

Panelboards are no longer limited to 42 overcurrent devices.

Panelboards must have a rating not less than the calculated load. The load is calculated according to Parts II, III, IV, or V of article 220. The rating of the panelboard cannot be less than the feeder capacity required to serve the load.

The overcurrent device that protects the panelboard cannot have a rating greater than the panelboard. The panelboard overcurrent protection can be located in the panelboard or at any point on the supply side of the panelboard.

If the overcurrent protection is in the panelboard, the situation is straightforward. A 200 amp main breaker protects a 200 amp panelboard; a 400 amp main breaker protects a 400 amp panelboard.



Overcurrent protection is determined by the rating of the panelboard.

If the overcurrent device protecting the panelboard is on the supply side of the panelboard, the overcurrent device still cannot be greater than the rating of the panelboard. For example, a feeder protected at 200 amps could not feed two, 100 amp Main Lugs Only panelboards because the 200 amp overcurrent device protecting the feeder is greater than the rating of the 100 amp Main Lugs Only

panelboards.

Question 12: Which of the following panelboard installations are permitted?

A: A panelboard rated 150 amps with a 200 amp overcurrent device installed in the panelboard.
B: A 60 circuit panelboard rated 400 amps with a 400 amp main breaker.
C: A 400 amp fusible disconnect switch protecting two, 200 amp-rated panelboards.
D: A panelboard rated 100 amps with a 150 amp overcurrent device installed in the panelboard.

Question 13: 408.4 (A) & (B) Circuit Directory or Circuit Identification. Source of Supply.

Question ID#: 11106.0



Circuits in panelboards must be specifically marked - unused breakers must be marked spare.

In a switchboard or panelboard a spare position that contains an unused overcurrent device must be identified. Also, no circuit can be described in a manner that depends on transient conditions of occupancy (conditions that might change when the next occupant moves in).

An unused circuit breaker in a panelboard is considered a spare. On the circuit directory it should be identified as "spare." If there is no overcurrent device in an empty panelboard space, then it is not required to be identified on the circuit directory, but the space would have to be covered.

An example of an incorrect circuit label is "Billy's Bedroom" or "Joe's Sandwich Shop." Billy's family might move and another tenant might take over the sandwich shop. The new residents or tenants wouldn't know how the circuits were identified. No circuit can be described in a way that depends on knowing the occupants of the premises.

Panelboards in other than one- and two-family dwellings must be permanently marked to indicate where the feeder originates. For example, this would be required for feeders to individual apartment panelboards in multifamily dwellings. The marking must be permanent, sufficient to withstand the environment involved, and may not be handwritten.

Question 13: Which of the following circuit labels on a circuit directory is acceptable?

A: Lights.
B: Receptacles.
C: Dad's study.
D: Outdoor receptacles.

Question 14: 408.54 Maximum Number of Overcurrent Devices.

Question ID#: 11107.0

Panelboards must now be manufactured so that they physically limit the number of circuit breakers which can be installed. The number of circuit breakers installed in any panel cannot be greater than the number listed for that panelboard. A 2-pole circuit breaker is considered as 2 devices and a 3-pole circuit breaker is considered 3 devices.

Panelboards may be listed to have more than 42 overcurrent devices. A 60 circuit panelboard must be manufactured to accept no more than 60 circuit breakers. A 42 circuit panelboard must prevent more than 42 circuit breakers from being installed.

To comply with this requirement, manufacturers will have to design panels so that tandem breakers cannot be installed in a panel if their installation would exceed the number of OCPDs for which the panel was listed.



Number of breakers in a panelboard now determined by manufacturer.

Question 14: Which of the following violates the NEC requirements for the maximum number of OCPDs that can be installed in a panelboard?

A: A panelboard listed for 36 OCPDs that has 30 single pole OCPDs and 3 double pole OCPDs installed.
B: A panelboard listed for 48 OCPDs that has 24 double pole OCPDs installed.
C: A panelboard listed for 24 OCPDs that has 18 single pole OCPDs and 4 double pole OCPDs installed.
D: A panelboard listed for use with more than 42 OCPDs.

Kitchen, Pantry and Dining Rooms

Question 15: 210.52(B) Small Appliances.

Question ID#: 11109.0

At least two small appliance circuits are required in dwellings to supply receptacle outlets in the kitchen, pantry, breakfast room, or dining room. Both of the required circuits must serve the kitchen countertop outlets. All small appliance circuit outlets that serve the countertop must be GFCI protected. Additional small appliance circuits may be added if necessary.

Although the Code allows the 2 small appliance circuits to serve outlets in the areas mentioned above, many contractors limit the appliance circuits to kitchen countertop outlets. Wall outlets are required in the kitchen, just like any other area of the house. The 2 small appliance circuits cannot feed outlets in areas other than the kitchen, pantry, breakfast room or dining room. The small appliance circuits cannot feed outdoor receptacle outlets.

Two exceptions to 210.52(B)(2) will allow the small appliance circuits to feed an electric wall clock and a gas range in the kitchen that needs electricity to ignite the gas burner.

In addition to the 20 Amp circuits required by 210.52(B)(1), 210.52(B)(1) ***Exception No. 2*** allows 15 Amp or greater individual branch circuits to supply receptacle outlets for individual appliances such as refrigerators, dishwashers, and garbage disposals.



Minimum of two small appliance circuits are required in dwellings.

Question 15: Which of the following loads could NOT be served by the 2 small appliance circuits?

A: A convenience outlet on a patio.
B: A wall clock.
C: An electric frying pan plugged into an outlet in the dining room.
D: A coffee pot plugged into a kitchen countertop receptacle.

Question 16: 210.8(D) Kitchen Dishwasher Branch Circuit

Question ID#: 11110.0



In dwelling units the outlet for the dishwasher must be GFCI protected.

Kitchen dishwashers are required to be GFCI protected. Water and electricity do not mix well, and a dishwasher combines both. A dishwasher is required to be GFCI protected in dwellings only, so a dishwasher in a commercial location is not required to be GFCI protected.

The number of deaths from electrocution have dropped significantly since the introduction of GFCIs. For this reason, with each Code cycle, the types and number of outlets that require GFCI protection have increased. Ground-fault circuit-interrupter protection will de-energize an outlet when a ground-fault current of 6mA or more is detected. Low levels of electrical current can be fatal in ranges well below 1 amp.

Like in other locations, the GFCI protection for the dishwasher must be readily accessible. If GFCI protection for the dishwasher is provided by a circuit breaker it would definitely be readily accessible. If GFCI protection is provided by a GFCI receptacle, the receptacle cannot be behind the dishwasher, because it could not be inspected on a regular basis without removing the dishwasher.

Question 16: Which of the following statements about GFCI protection for dishwashers in dwellings is true?

A: A dishwasher in a dwelling kitchen must be GFCI protected.
B: The branch circuit for a dishwasher in a dwelling kitchen must be protected by a GFCI circuit breaker.
C: A GFCI receptacle used to provide protection for a dishwasher does not have to be readily accessible.
D: A dishwasher in the kitchen of a dwelling only requires GFCI protection if the dishwasher is within 6 ft. of the sink.

Question 17: 210.52(C) Countertops and Work Surfaces.

Question ID#: 11111.0

General

At least one receptacle outlet shall be installed at each island or peninsula countertop space with a long dimension of 24 in. or greater and a short dimension of 12 in. or greater.

The outlet requirements in 210.52(C) apply to countertops installed in pantries, breakfast rooms, and similar areas in dwelling units as well as in kitchens and dining rooms. Countertops that are separated by a sink, range, or cooktop (Note: a sink, range, or cooktop only separates a countertop when there is LESS THAN 12 inches that can be measured behind that sink, range, or cooktop) are to be treated as separate spaces when figuring receptacle placement and spacing from 210.52.



Receptacle spacing for countertops.

Island or Peninsula Countertop

Likewise, on an island or peninsula countertop, the space on either side of an installed cooking unit, range, or sink is to be considered a separate countertop space when it comes to receptacle spacing if the area of countertop remaining behind the cooking unit, range, or sink measures less than 12 inches. (If it measures 12 inches or greater the entire countertop is considered one piece. Receptacles then must be spaced as if it is an unbroken countertop, which can mean installing a receptacle outlet BEHIND that cooking appliance, range, or sink if the measurements work out

that way.)

To summarize, you do not consider the area behind a sink (range, cooktop, etc.) as countertop space that requires measuring for receptacle outlet spacing if that area measures less than 12 inches. But you do consider it countertop space and therefore measure the ENTIRE countertop as one unbroken countertop space if that area behind the sink, cooktop, etc., measures 12 inches or more.

Corner Mounted

If a range, counter-mounted cooking unit, or sink is mounted in the corner, and the space behind that range, counter-mounted cooking unit, or sink is less than 18 inches, that small area is exempt from the countertop and from countertop receptacle spacing. In that case, the range, counter-mounted cooking unit, or sink has divided the countertop into two separate countertop spaces and receptacles must be spaced accordingly. Refer to FIGURE 210.52(C)(1) in the NEC for these measurements.

Question 17: A kitchen island countertop is large enough to require one or more receptacles. The countertop is separated by a cooktop and the area behind the cooktop is 11 inches. The countertop space on each side of the cooktop is 24 inches, how many receptacle outlets are required in all?

A: 1
B: 2
C: 0
D: 3

Question 18: 210.52(C)(1) Spacing of Countertop Receptacles.

Question ID#: 11112.0



Receptacle spacing for countertops.

The receptacle outlets required by 210.52(C) apply to countertops and work surfaces in pantries, breakfast rooms and similar areas in dwelling units as well as in kitchens and dining rooms. Countertop and work surface spaces that are separated by a sink, range or cooktop are to be treated as separate spaces.

Likewise, on an island or peninsula countertop, the space on either side of a cooking unit, range or sink is to be considered a separate countertop space if the width of the countertop behind the cooking unit, range, or sink is less than 12 inches. A receptacle outlet behind the sink is not required if the space behind the sink is less than 12 inches. If a range, counter-mounted cooking unit, or sink is mounted in the corner, and the space behind it is less than 18 inches, a receptacle outlet behind the range, cooktop, or sink is not required, but the spaces on either side are considered separate spaces.

At least one receptacle outlet shall be installed at each island or peninsula countertop space with a long dimension of 24 in. or greater and a short dimension of 12 in. or greater.

Question 18: A kitchen island countertop is separated by a cooktop and the area behind the cooktop is 11 inches wide. If there is a countertop space on each side of the cooktop that is 24 inches, how many receptacle outlets are required?

A: 2.
B: 3.
C: 0.
D: 1.

Question 19: 210.52(C)(1) Wall Countertop and Work Surface.

Question ID#: 11113.0

210.52(C) of the NEC lays out the requirements for kitchen countertops and the receptacles that are required to serve them. The countertop space directly behind a range, counter-mounted cooking unit (such as a cooktop), or sink may ***or may not*** be counted as part of this measurable countertop, whenever you are determining required receptacle spacing for the countertop. It all depends on the depth of countertop behind that component.



When the depth behind a corner-mounted sink is 18" or greater, you MUST include this area in your measurement of the countertop, when determining receptacle spacing along the countertop.

When NOT to count the area as countertop space

When a range, cooktop, or sink is installed within a straight piece of countertop, and the depth of countertop surface behind that range, cooktop, sink, etc. measures LESS than 12 inches (from the back edge of the equipment to the backsplash behind it), then that equipment is considered to have broken that countertop into two separate pieces of countertop, and each section of countertop must be treated separately when spacing out receptacles.

When to count the area as countertop space

However, when the depth of countertop surface measured behind that equipment (from the back edge of the equipment to the backsplash behind it) is 12 INCHES OR MORE, then the countertop remains one-piece (one section) of countertop and has not been broken in two pieces, even though a range, cooktop or sink now rests in the middle. When this is the case, when spacing receptacles for the counter, your tape measurement goes right across the countertop area behind the range, cooktop, sink, etc. and you continue to measure the countertop as if there was nothing there interrupting it. It may be that your measurements end up with a receptacle installed behind that range, cooktop, or sink - or perhaps not, it just depends on how it lays out when marking off the location for outlet boxes. But either way, the point is this, if you can measure 12 or more inches (deep) from the back edge of that range, cooktop, or sink, to the backsplash behind it, then you have to treat the whole countertop as one piece, and your 48" distance between receptacles carries on across the back-side of that equipment like it isn't there.

What about corner countertops?

Now, the measurement is somewhat different if that range, cooktop, or sink is mounted in a ***corner*** countertop (see image). Your measurement of countertop surface (depth) behind corner-mounted equipment is still measured from the rear edge of the equipment to the farthest point where the two corners of backsplash (or wall) meet, but the deciding number is 18 inches - ***not 12 inches.*** If the depth of countertop is ***LESS than 18 inches***, then the equipment is considered to have broken that countertop into two pieces, and you must treat each piece of countertop as a separate countertop. That means spacing their receptacles accordingly by following the measurement guide found in the NEC illustration 210.52(C)(1). If the measurement behind the component is ***18 inches or more***, then the corner-mounted component has ***not*** broken the countertop in two, and your measurement carries on as if the equipment was not even there.

You may or may not end up with a receptacle behind your corner-mounted range, cooktop, or sink, it will just depend on how your measurements fall when you are spacing receptacle boxes 48" apart (48" is the max distance allowed between kitchen countertop receptacles when installing them to comply with NEC 210.52: ***A receptacle located within 24" of every countertop break, and then located so that no point along the countertop surface measures more than 24" from a receptacle***)

Using Figure 210.52(C)(1) of the NEC as your guide

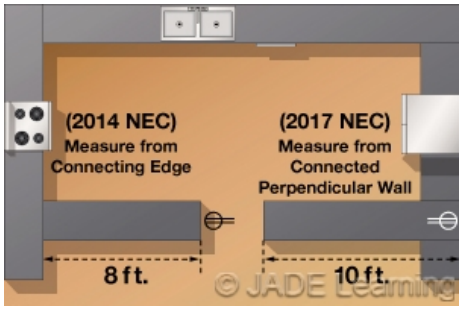
Refer to Figure 210.52(C)(1) in your NEC for guidance as it provides two illustrations for the proper way to measure countertop surface area. One illustration shows equipment (cooktop or sink) mounted within a straight countertop space. The other shows the equipment mounted in the corner of a countertop where two countertops meet like the corner of a picture frame. These illustrations make it clear just how to perform the measurements discussed.

Question 19: In the photo, a receptacle outlet has been installed behind the sink because:

A: The depth of countertop surface measured from the backsplash to the rear edge of the sink is less than 12".
B: Receptacle outlets are always required behind sinks.
C: The depth of measurable countertop behind the sink was less than 18".
D: The depth of measurable countertop surface behind this sink, to the wall measured 18" or more, and therefore had to be included when measuring the entire countertop, and spacing receptacles accordingly.

Question 20: 210.52(C)(2)&(3) Island and Peninsular Counter Spaces.

Question ID#: 11114.0



Island and peninsular counter tops require only one outlet.

Island counter spaces have different requirements than wall counter spaces. A single outlet must be installed if the island counter is at least 24 in. long and 12 in. or greater wide. But the 24 in. spacing that is required for wall counter spaces does not apply to island countertops. In other words, if the island counter was 48 in. x 48 in., only 1 receptacle outlet would be necessary, as long as the countertop was considered a single space.

The same is true for peninsular counters. A peninsular counter is a counter with access to both sides, like a breakfast bar. If the peninsular counter has a long dimension of 24 in. and a short dimension of 12 in. or greater, a receptacle outlet is required. The measurement is made from the connecting perpendicular wall or other counter space and a wall receptacle can be counted as the required receptacle for the peninsular. Additional outlets can be installed if desired.

Question 20: Receptacles installed for island and peninsular counters:

A: Require 2 receptacles if the counter is longer than 12 in.
B: Have the same requirement as wall counter spaces.
C: Require 1 receptacle if the counter is at least 24 in. long x 12 in. wide.
D: Must be spaced no more than 24 in. apart.

Question 21: 210.52(C)(5) Exception. Receptacle Outlet Location..

Question ID#: 11115.0

Outlets installed below a countertop can be dangerous. They are permitted in special circumstances, but a cord hanging over the edge of a counter and plugged into a receptacle below the counter is a hazard, especially for small children who could pull on the cord and be injured by falling appliances or boiling liquids.

Receptacles can be installed below a countertop only in construction being performed for the physically impaired, or where the countertop space is flat across its entire surface with no backsplash or dividers.

Receptacles installed below a countertop must meet the following conditions:

- They must be mounted no more than 12 in. below the countertop
- The countertop cannot have more than a 6 in. overhang from the support base
- There is no other place on the countertop, like a backsplash or underneath a hanging cabinet, to install a receptacle

Receptacle outlet assemblies that are listed for installation directly in the countertop are another option, when the cabinet construction does not provide an acceptable location for a receptacle. Listed countertop receptacle assemblies can be mounted directly in the countertop and eliminate the hazard of overhanging cords plugged into receptacles below the countertop.



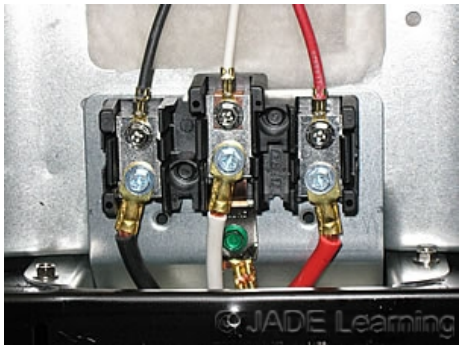
Required outlets installed in base-cabinets shall be mounted not more than 12 in. below the countertop.

Question 21: Which location would NOT be acceptable for installing a required kitchen wall-counter top, island, peninsula, or breakfast bar receptacle?

A: 6 in. below a countertop that has a backsplash.
B: Along the backsplash, within 18 in. of the sink.
C: 8 in. below the flat counter top of an island.
D: In the backsplash of a peninsula.

Question 22: 250.142(B) Load-Side Equipment.

Question ID#: 11116.0



Frames of Ranges and Dryers are allowed to be grounded to the neutral in existing installations.

In an existing installation (such as an older home built in the 1950s), it is considered Code-compliant for the kitchen range or the clothes dryer to be installed using a 3-wire cord and plug. However, in new construction the installation of kitchen ranges and clothes dryers requires a 4-wire cord and plug. The 4th wire in that cord and plug configuration is an equipment grounding conductor. This equipment grounding conductor is the missing wire in the older 3-wire configurations.

In these older appliance installations where 3-wire cords were legally installed, the wiring consisted of two hot wires and a neutral wire. The two hot wires provided both phases, which were 180 degrees out of phase from one another, to handle the big electrical load of the range or the dryer, and then the neutral wire which acted as a return path for any 120 Volt loads incorporated into that 240 Volt range or dryer, such as the built-in light or timer. (Note: These small loads that are a part of kitchen ranges or clothes dryers, such as clocks, timers, lights, LED displays and similar are usually 120 Volts, even on ranges and dryers that are 240 Volt. As such, they require a return path for that 120 Volt current in the form of a neutral.)

In the older style 3-wire cord and plug setup, the neutral did two jobs: (1) it carried the return current back to the source for the aforementioned 120 Volt appliance loads, and, (2) it was connected to the metal frame and metal housing of that same appliance, so that in the case of a short to ground condition, the circuit-breaker at

the panel would trip. If the Neutral in that 3-wire configuration wasn't connected to the metal frame and housing of the appliance, the circuit-breaker protecting the appliance would not trip during a short to ground condition. For example: if a hot wire within a clothes dryer broke loose from the heater element, due to vibration, and then made contact with the metal housing of the dryer, that metal housing would become energized and would remain energized indefinitely, as long as there was no path for that shorted current to travel, to get back to its source. This energized metal would then no doubt shock someone who touched it, if they were grounded, such as a person with bare feet on a basement floor. The takeaway from this is that without a return path for current, connected to the exposed metal of any appliance, applied voltage to that metal during any kind of fault condition, would just remain on that metal. That is why even in the 3-wire cord configuration, a return path in the form of the neutral wire was attached to the exposed metal.

In the 4-wire cord and plug configuration, the equipment grounding conductor now serves to do one of the jobs that the neutral was doing previously in the old 3-wire setup. The equipment grounding conductor is now the conductor that is attached to the metal frame and housing of the appliance. It has the sole responsibility of carrying back any fault current on that metal during a short to ground condition. The neutral in that cord is no longer connected to the metal frame and housing, and indeed cannot be, as it is prohibited by the NEC, during new construction.

The reason the neutral wire of an appliance is no longer permitted to carry fault current back to the source, which means it is no longer allowed to be attached to the metal frame and housing of an appliance, is because it was determined long ago that attaching the exposed metal of an appliance to a neutral conductor that is carrying current, is a bad idea. That moving current is always looking for the path of least resistance back to its source, and under the right circumstances, such as a homeowner standing barefoot on a wet basement floor, that current on the exposed metal of that appliance, may just briefly decide that a human being in contact with that exposed metal, is that path of least resistance.

Question 22: Which of the following is a TRUE statement about grounding the frames of ranges?

A: In new construction, if the manufacturer has installed a bonding jumper that connects the frame of the range to the grounded neutral conductor, then the bonding jumper must be removed.
B: In new construction, new appliances are permitted to use the neutral as a grounding conductor.
C: In new construction, the neutral conductor is allowed to ground the frame of a range during a new installation.
D: In an existing dwelling, if a homeowner replaces an older range that was equipped with a 3-wire cord with a new range that has a 4-wire cord, you must replace the 3-wire receptacle with a 4-wire receptacle, to match the new appliance cord.

Question 23: 422.16(B) Flexible Cords. Specific Appliances.

Question ID#: 11117.0

Kitchen appliances, like trash compactors, range hoods, waste disposers and dishwashers, may be cord-and-plug connected. The plug must be the grounding type, unless the appliance is listed as having double insulation.



Some kitchen appliances may be cord and plug connected.

The cord for a waste disposal must be at least 18 in. long and not over 36 in. long. The cord for a range hood must be at least 18 in. long but not over 4 ft. long. For dishwashers the cord must be at least 3 ft. long and not over 6 1/2 ft. long. The receptacle outlet for the dishwasher must be located in the space adjacent to the space occupied by the dishwasher. Trash compactor cords must be between 3 ft. and 4 ft. long.

The receptacle for the appliances has to be located so the cord will not be damaged when the appliance is fully installed.

Section 210.8(A)(7) requires receptacle outlets that are installed within 6 ft. of the outside edge of the sink to be GFCI protected. This applies in dwelling unit kitchens as well as any other location in dwellings, like a laundry or utility room.

A receptacle outlet supplying a trash compactor or waste disposer might be located within 6 ft. of the sink, but would not necessarily require GFCI protection. Section 210.8 says the 6 ft. distance is measured as the shortest path the cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window. Since the trash compactor or disposer is underneath the sink, and the measurement to the sink would pierce a barrier, trash compactors and disposers do not require GFCI protection.

If the receptacle outlets for trash compactors, waste disposers and dishwashers are GFCI protected, the receptacle outlets must be readily accessible. This means they must be easily reached so they can be tested to be sure they are still providing GFCI protection.

Question 23: A receptacle outlet for an in-sink waste disposer is installed directly below a kitchen sink in a dwelling. Which of the following statements is true?

A: The receptacle outlets must be on one of the 2 small appliance circuits.
B: The receptacle outlets must be listed as weather resistant.
C: The receptacle outlets must be on a GFCI circuit that is protected at the panelboard by a GFCI circuit breaker.
D: The receptacle outlet does not need to be GFCI protected if the measurement taken to the top inside edge of the sink must go through a door.

Bathrooms and Laundry

Question 24: 210.11(C)(2) Laundry Branch Circuits.

Question ID#: 11119.0

The dedicated laundry circuit is for loads in the laundry area. The required 20 ampere branch circuit is not just for the washing machine. It includes all of the receptacle outlets installed in the laundry.

The 20 ampere branch circuit for the laundry can provide power to the washer outlet and to general purpose outlets in the laundry room and still meet the requirements of the code. The additional outlets are often used for ironing and other household tasks .

All the outlets in the laundry area must be GFCI protected [per 210.8(A)(10)] and AFCI protected [per 210.12(A)].



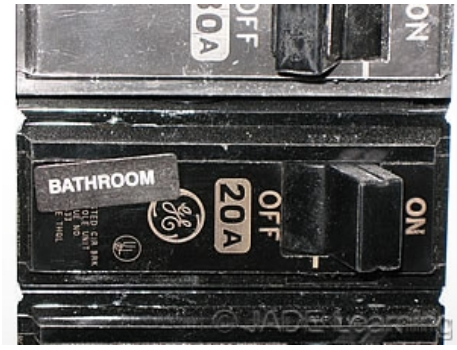
The 20 amp laundry circuit can have more than one outlet.

Question 24: In the photo above, there are two No. 12 AWG NM cables installed in the one washing machine receptacle box. There are two receptacle outlets (total) located in this laundry room. Which of the following statements about this laundry branch circuit is correct?

A: One cable is the homerun to the panelboard and the other cable may feed only another receptacle(s) located in the laundry area.
B: One cable is the homerun to the panelboard and the other may feed 20 amp receptacles in the bathroom.
C: A 15 ampere branch circuit is allowed to feed the receptacles located in the laundry area.
D: The washer must be on a 20 ampere dedicated branch circuit and the other cable must be removed.

Question 25: 210.11(C)(3) Bathroom Branch Circuits.

Question ID#: 11120.0



A dedicated 20 amp branch circuit required for bathroom outlet(s).

A 120-volt, 20 amp circuit is required to supply the bathroom receptacle outlets in a dwelling unit. If other outlets, such as lighting outlets or exhaust fans in the same bathroom are connected to the 20 amp circuit, the circuit cannot leave the bathroom. However, if only receptacle outlets are served, then the 20 amp circuit can be run to additional bathrooms in the house.

For example, if a 20 amp circuit feeds the receptacles in the master bathroom and also supplies a light fixture and fan in that bathroom, the circuitÂ is not permitted to supply receptacles or other outlets in another bathroom. However, ifÂ only the receptacle outlets in the master bathroom are connected to the 20 amp circuit , the circuit can be extended to other bathrooms throughout the house provided it only supplies receptacles outlets in the other bathrooms.

Appliances used in the bathroom like hair dryers and curling irons can draw a lot of current. A 1500 watt hair dryer operating at 120 volts will draw 12.5 amps. If two of them are being used at the same time in different bathrooms and are wired on the same circuit, a 20 amp breaker should trip.

Per 210.8(A)(1), all single phase, 125 volt, 15 or 20 ampere receptacle outlets within a dwelling unit bathroomÂ must be GFCI protected. The protection may be provided by a GFCI circuit breaker or by a GFCI-type receptacle.

Question 25: The required 20 amp bathroom branch-circuit that always supplies a GFCI protected receptacle within the bathroom, is also permitted to:

A: Supply one bathroom as well as the laundry loads.
B: Supply all loads in multiple bathrooms within a home.
C: Supply a light fixture and fan if the circuit remains in that one bathroom.
D: Supply bathroom and bedroom loads, if that bedroom and bathroom share at least one common wall.
Â

Question 26: 210.52(D) Dwelling Unit Receptacle Outlets. Bathrooms.

Question ID#: 11121.0

At least one receptacle outlet must be installed in bathrooms within 3 ft. of the outside edge of each basin (sink bowl). If there are two basins in the bathroom it may be possible to install one receptacle outlet between the two basins such that the receptacle outlet is within 3 ft. of the outside edge of either basin, and it would be Code compliant. In this case, only one receptacle outlet is required. If a mirror or other decorative finish is to be applied to the wall behind the basins it may be necessary to install two receptacles, or the mirror can be cut to allow a receptacle outlet to be installed through the mirror and into the wall behind that mirror.



Receptacle outlets in the bathroom must be installed within 3 ft. of each basin. Often, one receptacle outlet can serve two basins.

Generally speaking, the Code allows the required receptacle outlet(s) to be installed on the wall behind or next to the basin(s). If space is limited, the receptacle outlet can be installed on the side of a base cabinet below the top of the basin or basin countertop, as long as that outlet is no more than 12 in. below the top of the basin or basin countertop.

Mounting receptacles in small bathrooms with limited space can be challenging. Being able to mount a receptacle in the side of the basin cabinet adds flexibility when no other options are available because of the placement of the bathroom mirror or tub.

Question 26: The receptacle shown in the wall to the left of the sink complies with code requirements.If the distance between the outside edge of the two sink basins in the photo is 4-feet, how many additional receptacle outlets are required for the bathroom?

A: 1 additional outlet is required within 3 ft. of the outside edge of the sink in the right of the photo.
B: 1 additional outlet required, installed at the floor line.
C: 1 additional outlet is required, installed in the bathroom vanity, not more than 18 in. below the countertop.
D: 2 additional outlets are required, installed within 3 ft. of either side of the sink.

Question 27: 410.10(D) Bathtub and Shower Areas.

Question ID#: 11122.0



The space up to 8 ft. above a bathtub or shower is either a damp or wet location.

"Luminaires located within the actual outside dimensions of the bathtub or shower to a height of 8 ft." above the bathtub rim or shower threshold shall be marked for damp locations, or if subject to shower spray, they are required to be marked for wet locations. If they are more than 8 ft. above the bathtub rim or shower threshold then these requirements do not apply. It would be unusual for a luminaire recessed in the ceiling over a shower to be subject to shower spray; if it is not subject to spray, it is only required to be marked for a damp location. However, if it were wall mounted in ceramic tile where it was likely to be subject to shower spray, it has to be marked for a wet location.

No cord-connected luminaires, lighting track, pendants or ceiling-suspended paddle fans can be located within a zone which includes the space inside the tub or shower and extends 3 ft. horizontally from the rim of the tub or shower threshold and 8 ft. vertically above it.

Question 27: If a recessed luminaire is installed in the ceiling of a bathroom which has a tub with a shower, it is:

A: Always required to be marked as suitable for a wet location.
B: Required to be marked for a wet location if it is within the actual outside dimensions of the tub, not subject to shower spray, and 8 ft. or less from the top of the tub or shower threshold.
C: Always required to be marked as suitable for a damp location.
D: Required to be marked for a damp location if it is within the actual outside dimensions of the tub, not subject to shower spray, and 8 ft. or less from the top of the tub or shower threshold.

Living Areas (and Bedrooms).

Question 28: Fire Alarm Code: Smoke Alarms.

Question ID#: 11124.0



NFPA 72 requires smoke detectors in dwellings.

The Fire Alarm Code, NFPA 72, requires one smoke alarm to be installed inside of every sleeping room, and then one smoke alarm to be installed outside of each sleeping room in the immediate vicinity of the sleeping room(s), such as in a hallway. One smoke alarm in a hallway can serve multiple bedrooms, if the bedrooms are in close proximity, and the distance from each bedroom to the one hallway mounted smoke alarm does not exceed the distance permitted in the smoke alarm installation instructions provided by the manufacturer. NFPA 72 also requires one smoke alarm on each additional story of a dwelling unit(where bedrooms are not contained), and this includes a smoke alarm in the basement(when applicable) .

Smoke alarms must be powered by the building wiring and interconnected so that if one alarm goes off, all alarms will sound. Smoke alarms must be battery-backed in case the normal source of power fails. In general, arc fault protection is required for smoke or fire alarm outlets in bedrooms.

However, according to 210.12(A) Ex. 3 in the NEC, if the individual branch circuit to a fire alarm system is installed in rigid or intermediate metal conduit, electrical metalllic tubing, Type AC or Type MC cable, then the branch circuit to the fire alarm system does not require AFCI protection.

Question 28: A two-story dwelling unit without a basement has a master bedroom on the first floor and 3 bedrooms located closely together on the second floor. How many smoke alarms are required?

A: 6.
B: 5.
C: 4.
D: 7.

Question 29: 210.12(A) AFCI Protection.

Question ID#: 11125.0

Arc-fault circuit interruption protection is required for all 120-volt, single phase, 15- and 20 ampere branch circuits installed in most areas of dwelling units. A combination AFCI device, which provides protection from series and parallel arcs, must be installed.

Arc-fault circuit interrupter protection is required in dwelling unit kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sun rooms, recreation rooms, closets, hallways, laundry areas, or similar rooms or areas.

AFCIs are not required in bathrooms, unfinished basements, garages, attics or outdoors.

More than 20,000,000 arc-fault circuit interrupter devices have been installed to protect branch circuits in residential bedrooms since they were first required in 2005. The electrical loads in the other areas of a house where AFCIs are now required are similar to the electrical loads in a bedroom. Bathrooms, garages and outdoor receptacle outlets supply different types of electrical loads and do not require AFCI protection.

If a branch circuit in an area of the dwelling that requires AFCI protection is modified or extended greater than 6 feet, AFCI protection must be provided with either an AFCI circuit breaker or an AFCI receptacle as the first outlet on the circuit.

According to 406.4(D)(4), when a receptacle outlet is replaced in an area of a dwelling unit that requires AFCI protection, AFCI protection for the outlet must be provided.



Combination type AFCI required in most rooms in a dwelling.

Question 29: Which of the following dwelling unit outlets requires AFCI protection?

A: A 120-volt, 15 ampere receptacle installed outdoors on a balcony.
B: A 120-volt, 15 ampere receptacle installed in an unfinished basement.
C: A 120-volt, 20 ampere convenience receptacle installed in a kitchen.
D: A 120-volt 15 ampere receptacle installed for a garage door opener.

Question 30: 210.12(A) AFCI Protection. Exception No. 1.

Question ID#: 11126.0



AFCI device can be installed at first outlet.

There are six ways to provide AFCI protection in a dwelling.

- Install a listed combination-type AFCI circuit breaker.
- Install an outlet branch circuit type AFCI receptacle as the first outlet on the branch circuit. The wiring between the circuit breaker and the first outlet is required to be installed in RMC, IMC, EMT, Type MC, or steel armored Type AC cable, and the outlet and junction boxes have to be metal.
- Install an outlet branch circuit type AFCI receptacle as the first outlet on the branch circuit with the conduit or tubing between the circuit breaker and the first outlet encased in not less than 2 inches of concrete.

Additional ways to provide arc-fault circuit-interrupter protection that are new and not as widely used are:

- Install a listed branch/feeder type AFCI circuit breaker ***and*** a listed outlet type branch circuit AFCI receptacle as the first outlet on the circuit. The first outlet box must be marked to show it is the first outlet on the circuit.
- Install a listed supplemental arc protection circuit breaker with a listed outlet branch circuit type AFCI receptacle as the first outlet on the circuit if all of the following conditions are met:
- The branch circuit must be continuous from the circuit breaker to the outlet branch circuit arc-fault circuit interrupter.
- The maximum length of the branch circuit wiring from the circuit breaker to the outlet branch circuit arc-fault receptacle is not greater than 50 ft. for a No. 14 AWG or 70 ft. for a No. 12 AWG conductor.
- The first outlet box in the branch circuit shall be marked to indicate that it is the first outlet of the circuit.

- Install a listed outlet branch circuit type arc-fault circuit interrupter as the first outlet on the branch circuit in combination with a listed circuit breaker if all the following conditions are met:
- The branch circuit must be continuous from the circuit breaker to the outlet branch circuit arc-fault circuit interrupter.
- The maximum length of the branch circuit wiring from the circuit breaker to the outlet branch circuit arc-fault receptacle is not greater than 50 ft. for a No. 14 AWG or 70 ft. for a No. 12 AWG conductor.
- The first outlet box in the branch circuit shall be marked to indicate that it is the first outlet of the circuit.
- The combination of the branch circuit overcurrent device and the outlet branch circuit AFCI is identified as meeting the requirements for a "System Combination" type AFCI and is listed as such.

Question 30: When installed in a new dwelling, an AFCI device can be installed as the first outlet in the branch circuit, rather than as a circuit breaker in the panelboard, if:

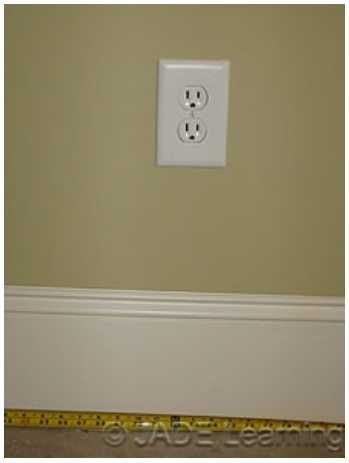
A: The AFCI device is located within 10 ft. of the panelboard.
B: The homerun is installed in EMT and the AFCI receptacle outlet device is installed in a metal box.
C: The entire branch circuit is installed in a metallic raceway.
D: The homerun is installed in flexible metal conduit.

Question 31: 210.52 Dwelling Unit Receptacle Outlets.

Question ID#: 11127.0

A "duplex" receptacle contains two receptacles, one above the other, on one single yoke. A switched-receptacle outlet is typically a duplex receptacle containing one receptacle that is switched off and on by way of a wall mounted switch, in conjunction with another receptacle that stays energized all of the time- this is often referred to as a "split-receptacle." If both receptacles on that single yoke are switched, that duplex receptacle is ***NOT*** permitted to be counted as one of the required receptacle outlets, as outlined in 210.52. However, if only one of the receptacles on the yoke is switched, then the receptacle outlet ***IS PERMITTED*** to serve as one of the required receptacle outlets for a wallspace, as outlined in 210.52...since the one receptacle on the yoke that remains energized all of the time will meet the Code requirement,

A switched duplex receptacle can be used instead of a switched lighting outlet (such as a lighting fixture found on the ceiling) in all dwelling unit habitable rooms, ***except*** in kitchens and bathrooms, according to 210.70(A)(1) Ex. No. 1.



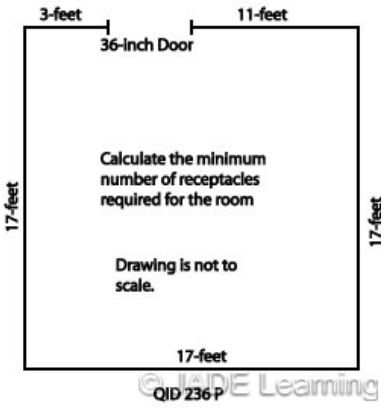
A switched receptacle is not allowed as a required receptacle.

Question 31: How many additional receptacle outlets are required in a wall space that measures 8 ft. at the floor line and has a duplex receptacle in the middle of the space if both halves of the duplex receptacle are controlled by a wall switch?

A: 2.
B: 1.
C: 0.
D: 3.

Question 32: 210.52(A)(1) Spacing of Receptacles.

Question ID#: 11128.0



No point along the floor line in any wall space can be more than 6 feet from a receptacle.

Section 210.52(A)(1) states:

Receptacles shall be installed such that no point measured horizontally along the floor line in any wall space is more than 6 ft. from a receptacle outlet.

If you stand between two receptacle outlets measuring 12 feet apart, you are 6 feet from a receptacle outlet. This is why electricians generally space receptacles 12 feet apart ***maximum*** along an unbroken wall.

Most appliances and standing light fixtures (NOTE: The definition for appliances includes fans, TVs, and similar devices) have 6-foot cords. By spacing receptacles no more than 12 feet apart these appliances can be located anywhere along the wall while still reaching an outlet - without the need for an extension cord. Extension cords are a tripping hazard and they cause electrical fires in the home due to overheating.

Wall Spaces

Section 210.52(A)(2) goes on to tell us that a wall space is defined as any section of unbroken wall measuring 2 feet or greater in width (including space measured around corners). This means the wall space is unbroken at the floor line by doorways, fireplaces, fixed cabinets ***that do not have countertops***, and similar openings that are considered to break a wall. (NOTE: Beginning in the 2017 NEC, fixed cabinets in bedrooms, dens, living rooms, libraries, etc. that DO have countertops affixed ***are*** considered wall space, therefore the measurement from 210.52(A)(1) continues uninterrupted across these wall spaces above the affixed countertop, with receptacles required accordingly. It is important to note - these countertops that are considered wall space are NOT the same as kitchen countertops and their special receptacle requirements found in Section 210.52(C).

Fixed room dividers, fixed panes of glass as part of sliding glass doors, and even railings (such as the railing along the edge of a second-floor loft), are all considered wall space and require receptacle outlets just like other walls - even if the outlets must be placed in the floor, as in the case of fixed glass panes or railings made of iron bars where receptacles cannot possibly be installed.

Hallways and Foyers

A receptacle outlet is required in a hallway measuring 10 ft. or greater in length [210.52(H)]. A receptacle is also required in a foyer having an area greater than 60 sq. ft. [210.52(I)]- ***(NOTE: in a foyer where receptacles are required, the Code requires one receptacle to be installed in each foyer wall space measuring 3 ft. or greater in width).***

Question 32: A square-shaped living room in a home measures 17 ft. on every side except for one where a 3-foot wide doorway breaks the wall. What is the minimum number of receptacles required for this room?

A: 4.
B: 6.
C: 5.
D: 7.

Question 33: 406.12 Tamper Resistant Receptacles.

Question ID#: 11129.0

In dwelling units, every kitchen, family room, dining room, living room, parlor, library, den, sunroom, bedroom, recreation room, bathroom, garage, basement, laundry and outdoor area, all 125- and 250 volt non-locking type, 15- and 20-ampere receptacles shall be listed tamper resistant.



Receptacles installed in dwellings must be listed tamper resistant.

Tamper-resistant receptacles are also required in the following locations:

- Guest rooms and guest suites of hotels and motels
- Child care facilities
- Preschools and elementary education facilities
- Business offices, corridors, waiting rooms and the like in clinics, medical and dental offices and outpatient facilities
- Certain assembly occupancies including places of waiting transportation, gymnasiums, skating rinks, and auditoriums
- Dormitories

Tamper resistant receptacles are designed to prevent a child from being injured by inserting a foreign object into the receptacle. Manufacturers use several different techniques to make their receptacles tamperproof. Many children have been shocked and badly burned by sticking keys, hair pins and other objects into receptacles.

There are exceptions that will permit tamper resistant receptacles to be omitted.

- When receptacles are located more than 5 1/2 ft. above the floor.
- When receptacles are part of a luminaire or appliance.
- When a single receptacle for one appliance or a duplex receptacle for two appliances is located in dedicated space and the appliances are cord-and-plug connected and not easily moved from one place to another.
- When nongrounding receptacles are used as replacement receptacles.

Question 33: Which location requires tamper resistant receptacles?

A: A hotel lobby.
B: A bathroom in a public library.
C: A commercial garage.
D: A bedroom in an apartment.

Stairways and Hallways

Question 34: 210.52(H) Dwelling Unit Receptacle Outlets. Hallways.

Question ID#: 11131.0

The spacing requirements for receptacles installed in bedrooms, living rooms, dining rooms and other spaces in a dwelling unit do not apply to hallways. Every dwelling unit hallway measuring 10 feet or longer, measured down the centerline of the hallway and not going through a doorway, needs at least one receptacle outlet. One receptacle outlet is all that is required in a hallway, and only then if the hallway measures 10 feet in length. A hallway that is less than 10 feet in length does not require a receptacle. Doorways are considered starting and stopping points for a hallway and the electrician must take that into consideration when measuring the hallway.

Generally, the only type of electrical equipment used in a hallway is a vacuum cleaner, and they have long cords. Most residential hallways can be cleaned with the vacuum cleaner plugged into a single outlet. Of course, there is nothing in the Code prohibiting the installation of more than one receptacle outlet in a hallway.

Receptacle spacing requirements are designed so extension cords will not be used. Many house fires have been caused by the careless use of extension cords. The Code requirements for installing receptacles throughout a dwelling have greatly reduced the use of extension cords and cut down on the number of house fires reportedly caused by faulty extension cords.



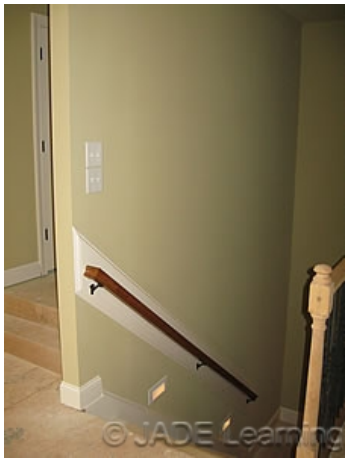
Hallways 10 feet or more in length must have a receptacle.

Question 34: A hallway in a single family dwelling is 15 ft. long. How many receptacle outlets are required?

A: 2.
B: 3.
C: 0.
D: 1.

Question 35: 210.70(A)(2) Dwelling Units. Additional Locations.

Question ID#: 11132.0



Interior stairways with six or more risers must have a switch at top and bottom.

In interior stairways between floor levels with six or more stair risers, a switch is required at the top and bottom of the stairs. A switch is also required on any stairway landing that has an entry where someone can walk out onto the landing.

The 3-way switch required at each end of an interior stairway is in the Code to prevent travel up or down an unlit set of stairs. Climbing up or down stairs in the dark is an obvious tripping hazard. In multi-level, cut-up home designs, modern stairways have become more complex. A set of stairs may go up to a landing and have two entryways on the same landing before proceeding to the next floor level. Therefore, it is important to note that landings with a doorway are required to have a switch for the lighting outlet.

Dimmer switches may not be used for stairway lighting unless the full range of dimming is provided at all switch locations for that stairway.

Question 35: The switches installed at the top and bottom of this set of stairs, in a dwelling, are required in which of the following situations?

A: On interior stairways with 6 or more risers.
B: On exterior stairways with 6 or more risers.
C: When there are 5 risers.
D: When automatic control of lighting is provided.

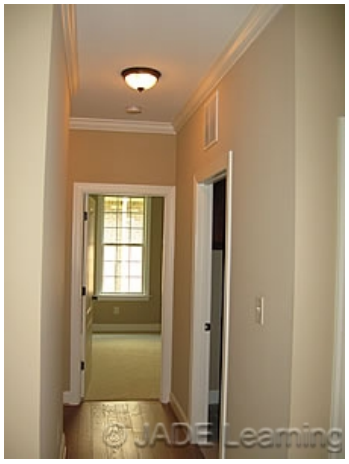
Question 36: 210.70(A)(2) Dwelling Units. Additional Locations.

Question ID#: 11133.0

Section 210.70 gives details to provide enough lighting outlets in rooms for general occupancy and safe passage from one living area to another. Without lighting outlets for passageways such as hallways, stairways, etc., lighting would only be in rooms and would not provide enough illumination to travel safely throughout the dwelling.

Regardless of how long the hallway is or how many turns a staircase takes, only one lighting outlet is required. Sometimes it may be more practical to install several lighting outlets along a long hallway but this is not required by the NEC.

There is nothing in the NEC requiring 3-way or 4-way switches at each end of a hallway or at each floor level and intermediate landing of a staircase, but installing 3-way and 4-way switches at these locations has been an industry standard for years.



Hallways, stairways and attached garages must have a switched light.

Question 36: Which of the following statements about this picture of a dwelling unit hallway is correct?

A: 3-way switches are required for lighting outlets located in hallways.
B: Hallway lighting outlets are required to be GFCI protected.
C: There must be a lighting outlet at each end of the hallway.
D: One wall switch-controlled lighting outlet is required in hallways.

Question 37: 240.24(F) Not Located Over Steps.

Question ID#: 11134.0



Overcurrent devices cannot be located over steps. Overcurrent devices in panelboards located over steps create a hazard for the installer and the building occupant. Standing on a stairway tread, or two treads on different levels, puts the installer at risk for losing his balance and falling. Trying to reset a circuit breaker located in a stairway, when the circuit which has tripped could be a lighting circuit for the stairway, is very dangerous.

Stairways are sometimes used as routes of egress from buildings. NFPA 101, The Life Safety Code, requires routes of egress to be kept clear and open. A panelboard with overcurrent devices installed on a stairway could interfere with exit paths out of a building.

Section 110.26(B), Clear Spaces, requires a guard or barrier to be set up if the work space is in a passageway or general open space. It is clearly not practical to set up guards on stairways and would be a violation of The Life Safety Code.

For all these reasons, overcurrent devices will no longer be permitted over steps.

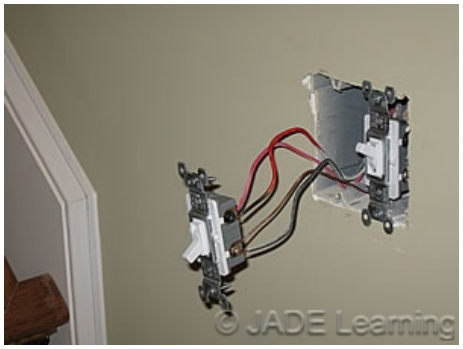
Question 37: Overcurrent devices are permitted to be installed in:

A: Clothes closets.
B: Stairways.
C: Kitchen cabinets.
D: Bedrooms.

Luminaires, Fans and Switches

Question 38: 200.7(C)(1) Circuits of 50 Volts or More.

Question ID#: 11136.0



The white wire in cable assemblies used as a switch leg must be reidentified.

A switch leg, or switch loop, supplies a single-pole switch with a hot conductor and returns a switched hot conductor back to the lighting outlet. A switch loop for a 3-way switch supplies a hot conductor and returns 2 switched traveler conductors to the lighting outlet.

The white wire must be used as the supply to the switch in a cable assembly (NM, UF, AC, MC, etc) and not as a return conductor to the switched outlet.

This Code section requires the white wire in a 2-conductor or 3-conductor cable to be permanently re-identified by painting or taping to make it clear it is being used as part of a switch leg, and is not a neutral conductor.

This requirement has been in the NEC since 1999. It was added because many homeowners or "handymen" were replacing light fixtures with ceiling fans and got into trouble by mistaking the white wire in a switch leg for a neutral.

Question 38: When NM cable is used in a switch leg, the white wire:

A: Must be the return wire to the switched outlet.
B: Must be re-identified so it is clearly not a grounded conductor.
C: Can supply the switch and remain white in color.
D: Can be used as an equipment ground.

Question 39: 210.70(A)(3) Dwelling Units. Storage or Equipment

Question ID#: 11137.0

Equipment that requires servicing, like heat pumps or fixed electric space heating, must have a lighting outlet and receptacle installed near the equipment. The lighting outlet is installed at the equipment, with the wall switch located at the usual point of entry to the equipment space. For basements, utility rooms, attics and crawl spaces, the light fixture can contain the switch (pull chain) if the equipment is close to the entrance to the space.

Storage areas in attics and utility rooms, as well as basements and crawl spaces, also require a lighting outlet. An attic without a floor is not considered storage space and would not require a light. But if flooring is installed at any point in the attic, then a lighting outlet is required. A crawl space is also not storage space and would not need a lighting outlet if there was no equipment there which required servicing.



Spaces used for storage or equipment must have a light.

Question 39: An attic with a pull down ladder has a 5 ft. x 10 ft. area which is floored. Which of the following statements is TRUE?

A: A lighting outlet is required.
B: There is no storage space in this attic.
C: A lighting outlet is not required.
D: There is not enough storage space in the attic to require a lighting outlet.

Question 40: 314.27(A)(1) Vertical Surface Outlets.

Question ID#: 11138.0



Wall mounted device boxes can be used to support luminaires up to six pounds.

Device boxes are commonly used in masonry construction for wall hung luminaires with brick veneers because the shape and size of these boxes make installation practical. Even though the boxes are not listed for luminaire support, the Code allows luminaires weighing not more than 6 lbs. to be supported by device boxes that are mounted on walls, columns or other vertical surfaces.

Device boxes usually come designed for use with #6 screws. Luminaire boxes most commonly are designed for use with #8 screws. The wording of the 314.27 exception lets us know that as long as the support is provided with #6 screws, no additional tapping for larger screws is required.

Question 40: An exterior wall mounted luminaire that weighs 2.45 kg (5.4 lbs.) is mounted on a device box. Including the exception, what is the minimum means of support?

A: The luminaire shall be secured to a device box, not rated for luminaire support, by two No. 8 screws.
B: The luminaire must be secured to the structure, not by the outlet box.
C: An outlet box suitable for luminaire support and rated for 30 lbs.
D: The luminaire or its supporting yoke must be secured to the device box by two No. 6 screws.

Question 41: 314.27(C) Boxes at Ceiling-Suspended Fan Outlets.

Question ID#: 11139.0

Two products became increasingly popular in the early 1980's. One was the use of plastic and fiber boxes for fixture support, the other was ceiling fans. These two products seemed to be working against each other. Prior to the 80's, most ceiling fixture support boxes were octagonal metal boxes which had no problems supporting standard paddle fans. The plastic and fiber boxes had difficulty supporting paddle fans, especially if the fans were not properly balanced. The screws would gradually work loose from these boxes until they fell out, usually damaging the box threads and making reattachment of the fan difficult. These issues, coupled with the fact that heavier custom paddle fans came onto the market, resulted in the requirement for paddle fan boxes to be listed for the purpose.



Boxes used to support ceiling fans must be listed for ceiling fan support.

An outlet box or outlet box system that is used as the sole support of a ceiling suspended (paddle) fan is required to be listed and marked by the manufacturer as suitable for the purpose; such boxes are not permitted to support ceiling-suspended (paddle) fans weighing more than 70 pounds. If a ceiling fan weighs more than the Code will allow, it must be supported independently of the box.

If ungrounded, separately switched conductors are installed in a ceiling box in a single-family or two-family dwelling, which would provide the option to install a ceiling fan at a later date, then the ceiling box must be listed for the sole support of a paddle fan.

Question 41: Outlet boxes used as the sole support for paddle fans shall be _____.

A: Approved, labeled suitable for the purpose, and support no more than 35 kg.
B: Listed, steel boxes, approved for lighting fixture support of at least 35 lbs.
C: Listed, marked suitable for the purpose, and support no more than 70 lbs.
D: Listed, marked suitable for the purpose, and support no more than 70 kg.

Question 42: 404.14(E) Rating and Use of Switches. Dimmer Switches.

Question ID#: 11140.0



General-use dimmer switches can be used for permanent incandescent luminaires only.

"General-use dimmer switches shall be used only to control permanently installed incandescent luminaires (lighting fixtures) unless listed for the control of other loads and installed accordingly."

A general use dimmer switch cannot be used to control a ceiling paddle fan or a wall receptacle. Motor loads, like ceiling fans, need special control which is not available in a general use dimmer switch.

If a dimmer switch is used to control a receptacle and if an appliance is plugged into the receptacle, it could be damaged if the dimmer switch was set at less than full scale. Dimmer switches reduce the voltage to the load. Appliances like TVs, stereos, vacuum cleaners or computers are designed to work at full voltage. At reduced voltages the internal wiring of the appliance would overheat and the appliance could be seriously damaged.

Question 42: General use dimmer switches may be used to control:

A: Incandescent luminaires.
B: Ceiling Fans.
C: Cord and plug connected appliances.
D: Receptacles.

Question 43: 404.9(B)(1) Provisions for General-Use Snap Switches. Grounding.

Question ID#: 11141.0

A general-use snap switch can be grounded using metal screws to mount the snap switch to a metal box or metal cover.

If the snap switch is mounted to a metal box or metal cover without attaching the equipment grounding conductor to that snap switch, the metal box or cover must be connected to an equipment grounding conductor so that continuity to ground is transferred to the attached switch. If the box is nonmetallic (plastic or similar) and you wish to use the metal screws instead of an equipment grounding conductor to ground the snap switch, the box must have an integral means for making contact between those screws and the wire-type equipment grounding conductor in the box.



A bonding jumper to the switch is not required for a switch that is mounted to a grounded metal box.

The Most Common Methods

The most common way to ground a general-use snap switch to a box is to simply connect an equipment grounding conductor or equipment bonding jumper directly to the green equipment grounding screw on the snap switch.

Older Installations

When installing replacement switches, such as at older homes and commercial buildings, if the wiring method such as a cable or conductors in a raceway does not provide an equipment grounding conductor, the switch can be installed without an equipment grounding conductor present. But in this case, the switchplate must be a nonmetallic type and it must be fastened with non-metallic screws. Otherwise, the switch can be installed if it is protected by a ground-fault circuit-interrupter (GFCI) device.

Question 43: A general use snap switch is considered grounded if:

A: The metal box is not grounded.
B: A nonmetallic outlet box is installed.
C: A nonmetallic switch cover is used.
D: The switch is attached to a grounded metal box with metal screws.

Question 44: 410.74 Luminaire Rating.

Question ID#: 11142.0



Luminaire name plate protected during construction.

The requirement for "maximum wattage" markings to be located so they are visible during relamping helps to minimize the age old problem of installing lamps with wattages higher than the fixture rating. Code section 110.12(B) also requires protection of electrical equipment from paint or foreign materials. The lampholders generally come with some type of device to prevent entry of paint, but they often fall out during the construction process. It is also not good practice to allow paint to cover the thermal protector.

Question 44: What is the purpose of the paper in the luminaire in this photo?

A: It protects the nameplate with the marking of the maximum wattage required during trimout or relamping.
B: It is additional insulation to prevent the lamp from overheating.
C: The paper is the manufacturer's instructions and has been left for the inspector to verify the instructions have been followed.

D: It must be removed prior to rough-in inspection.

Question 45: 410.16 Luminaires in Clothes Closets.

Question ID#: 11143.0

Electricians who find this section of the Code confusing usually have difficulty:

- determining what part of a closet is defined by the Code as Clothes Storage Space.
- determining what clearances are required for different types of luminaires.

Section 410.16(A) lists the types of luminaires permitted in clothes closets.

Section 410.16(C) specifies the minimum distance between the Clothes Storage Space and various types of luminaires.

- Surface mounted LED or incandescent luminaries having a completely enclosed light source require a 12 in. clearance from the storage space (not from the wall).
- Surface mounted fluorescent luminaries on the ceiling or on a wall above a door require a 6 in. clearance from the storage space (not from the wall).
- Recessed LED or incandescent luminaries having a completely enclosed light source require a 6 in. clearance from the storage space (not from the wall).
- Recessed fluorescent luminaries installed in a ceiling or wall require a 6 in. clearance from the storage space (not from the wall).



Luminaires in clothes closets must have proper clearance to storage area.

Question 45: Which of the following is permitted to be installed in a closet?

A: An open incandescent lamp.
B: A pendant luminaire.
C: A recessed completely enclosed LED luminaire installed with at least 6 in. of clearance from the Closet Storage Area.
D: A surface mounted completely enclosed LED luminaire installed within 6 in. of clearance from the Closet Storage Area.

Question 46: 410.116(A)(2) Clearance. Type IC Luminaires.

Question ID#: 11144.0



Recessed luminaires in contact with thermal insulation to be marked type IC.

Type IC (Insulation Contact) luminaires are suitable for direct contact with thermal insulation and combustible materials. They are tested to release less heat to the surrounding building materials when covered by thermal insulation. The IC rating is achieved by thermal protectors that disconnect power to the lamp when excessive heat builds up in the luminaire. In some models, there is also a heat shield that creates a separation between the lamp section and the top of the can. There are also some type IC rated luminaires that are dual rated: IC and NON IC, and this is based solely on the lamp wattage.

Due to the ever growing need to conserve energy, codes such as the model energy code and the international building code are requiring airtight recessed cans. In order to meet this requirement, manufacturers are enclosing the entire housing to prevent air movement across the luminaire. The luminaire trims are gasketed to further seal the luminaire. When these energy codes are in force, only type IC luminaries can be installed to ensure protection of the thermal envelope.

Question 46: For the IC recessed luminaire shown here, what is the minimum clearance to thermal insulation?

A: 3 in.
B: 1/2 in.
C: 2 in.
D: 0 in.

Question 47: 410.116(A)(1) Clearance. Non-Type IC Luminaires.

Question ID#: 11145.0

Recessed luminaires that are Non-Type IC cannot be installed within 1/2 in. of combustible materials and must be kept at least 3 in. from thermal insulation.

Type non- IC luminaires are usually provided with a thermal protective device and have a higher lamp wattage rating than a type IC luminaire. They are generally constructed in a manner that does not allow heat to escape. If a non-IC luminaire is covered with thermal insulation, nuisance tripping and moisture condensation can occur in the short term. Conductor breakdown and ground faults can occur in the long term, possibly causing a fire hazard.



Recessed luminaires must maintain 3 in. clearance to thermal insulation.

Question 47: If the luminaire in the image were a non IC luminaire, what would the insulation requirements be?

A: The luminaire must be covered with 6 in. of insulation to meet the energy code.
B: Thermal insulation cannot be installed on top of or within 3 in. of the luminaire.
C: 3 in. of insulation must be installed on all sides and the top of the luminaire.
D: Only batt type insulation may be installed over the top of the luminaire.

Outdoors, Garages, Basements, and Crawl Spaces

Question 48: 210.52(E) Outdoor Outlets.

Question ID#: 11147.0

This section on Outdoor Outlets covers (1) One-Family and Two-Family Dwellings; (2) Multi-Family Dwellings and (3) Balconies, Decks, and Porches. The required outdoor outlets at the front and back of the dwelling must be accessible while standing at grade level and not more than 6 1/2 ft. above grade level.



Receptacle required on decks, porches and balconies.

A receptacle must be installed accessible from the balcony, deck or porch if the balcony, deck or porch is attached to the dwelling and is accessible from inside the dwelling unit. The receptacle outlet must be installed no more than 6 1/2 ft. above the balcony, deck or porch. If the balcony deck or porch has steps from grade, or the receptacle is accessible from the balcony, deck, or porch it is considered accessible and can be counted as one of the required outdoor outlets if it is not more than 6 1/2 ft. above grade.

Installing a receptacle outlet on a porch or balcony will eliminate residents running extension cords into the house to play radios, run lights or power appliances. Indoor outlets are not GFCI protected, and an extension cord run through a doorway can easily be damaged when the door is closed.

The receptacle outlet must be rated Weather Resistant and GFCI protected. Per

406.9(A)(1) the receptacle must have an "extra duty" cover.

Question 48: According to Section 210.52(E), when is an outdoor outlet required to be installed accessible from a balcony?

A: If the balcony is attached to the building and accessible from inside the dwelling.
B: If the balcony measures at least 6 ft. by 3 ft.
C: If the balcony is within 6^{1/2} ft. of grade.
D: Only if the balcony is more than 20 sq. ft. and is accessible from an inside room.

Question 49: 210.52(E)(3) Outdoor Outlets. Balconies, Decks, and Porches.

Question ID#: 11148.0



If a deck, porch, or balcony is accessible from inside a dwelling unit, a receptacle outlet is required regardless of the size of the balcony, deck, or porch.

All balconies, decks and porches that are attached to a one-family, two-family, or multi-family dwelling, and can be reached from inside the dwelling, are required to have a GFCI protected receptacle outlet installed. The receptacle outlet must be accessible from the balcony, deck, or porch. The receptacle outlet cannot be more than 61/2 ft. above the walking surface.

The receptacle outlet is not required to be inside the footprint of the balcony, deck, or porch, but a person must be able to reach the outlet while standing on the balcony, deck, or porch. If there are two separate areas, for example on a deck where part of the deck is screened-in and the other part is open, there must be receptacle outlets on both parts.

If there are steps that are accessible from grade leading up to the deck or porch, then the receptacle outlet can count as one of the required outdoor outlets. In this case a single outlet can serve two purposes. In order to count as the required outlet for the balcony, deck, or porch, the outlet must be accesible while standing on the walking surface, and cannot be more than 6 1/2 ft. above the walking surface. In order to count as one of the required outdoor outlets, there must be steps that connect the deck to grade level.

Question 49: Which of the following installations will satisfy the requirement for a receptacle outlet on a deck?

A: A receptacle installed 8 ft. above the walking surface of the deck.
B: A receptacle installed 5 ft. outside the perimeter of the deck.
C: No receptacle is required if the deck has steps from grade level.
D: A receptacle that is accessible from the deck.

Question 50: 210.52(G) Basements, Garages, and Accessory Buildings.

Question ID#: 11149.0

At least one general use receptacle outlet must be installed within the garage (all attached or detached garages with electric power) and the unfinished basement of all one- and two-family dwellings. This convenience receptacle outlet cannot be dedicated to specific equipment, such as sump pumps, fans, stationary tools, exercise equipment, washing machines, water filters, or other types of fixed equipment that can be cord- and plug-connected to a receptacle.



A receptacle is required in unfinished garage and basement areas.

In basements and garages where a portion of the area is finished for living space, and one or more areas are left unfinished, a minimum of one receptacle outlet (which is not intended for a specific appliance or piece of equipment) must be installed in each unfinished area.

In addition to these basic requirements, in attached garages and detached garages with electric power, there must be at least one receptacle outlet installed in each

individual vehicle bay and not more than 5 1/2 ft. above the garage floor. The garage receptacle outlets must be supplied by at least one 20 amp, 120 volt circuit. The branch circuit that supplies the garage receptacle(s) cannot serve any other outlets (in the garage or otherwise) except readily accessible outdoor receptacle outlets.

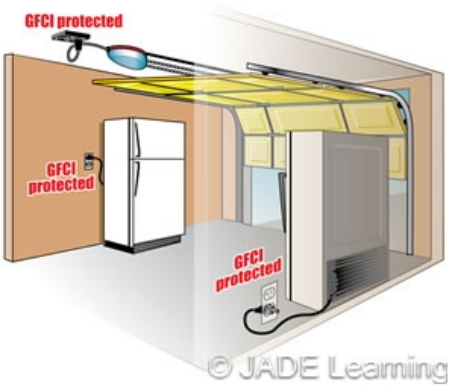
At dwelling units, all 125-volt, single-phase, 15 and 20 ampere outdoor receptacle outlets require GFCI protection.

Question 50: In a large basement, there is a finished entertainment room along with two separate unfinished areas that contain no dedicated equipment. To satisfy minimum Code, how many receptacle outlets are required to serve this basement?

A: Zero
B: Zero receptacle outlets in the unfinished areas of the basement as long outlets are spaced to meet Code for habitable space in the finished entertainment room.
C: One receptacle outlet in each of the unfinished areas of the basement, and then outlets spaced to meet Code for habitable space, in the finished entertainment room.
D: One receptacle outlet in just one of the unfinished areas of the basement, and then outlets spaced to meet Code for habitable space, in the finished entertainment room.

Question 51: 210.8(A)(2) GFCI Protection.

Question ID#: 11150.0



Receptacles in garages and accessory buildings must be GFCI protected.

All GFCI receptacle outlets must be readily accessible. This means they cannot be blocked by appliances like washing machines that cannot be easily moved. The purpose is to have the GFCI device available for testing, as required by the manufacturer.

All single phase, 125-volt, 15 and 20- ampere receptacle outlets, installed in dwelling unit garages, unfinished basements, bathrooms and accessory buildings having floors at or below grade level that are used for storage and work areas,Â must have GFCI protection for personnel.

There is an exception for a receptacle supplying a fire alarm or burglar alarm system in an unfinished basement.

At a dwelling unit GFCI protection must also be provided for single phase, 125-volt, 15- and 20-ampere receptacle outlets in crawl spaces, outdoors, serving kitchen countertops, or where installed within 6 ft. a sink, in boathouses, and in laundry areas. Receptacle outlets within 6 ft. of the outside edge of a bathtub or shower stall must also have GFCI protection even if the bathtub or shower is not located within a bathroom. Dishwashers are required to be GFCI protected by 210.8(D) whether cord-and-plug connected or hard-wired
The measurement from a receptacle outlet to a sink is taken from the top inside edge of the bowl of the sink. For the purposes of 210.8 the measurement to a receptacle is taken as the shortest distance the cord of an appliance connected to the receptacle would follow without piercing a floor, wall ceiling, or fixed barrier, or passing through a door, doorway, or window.

Question 51: Which of the following 125-volt, single-phase, 15- and 20-ampere receptacle outlets is required to have GFCI protection for personnel?

A: A receptacle outlet installed to supply a permanently installed fire alarm system.
B: A receptacle outlet in a bedroom, located 8 ft. from a garden-type bathtub.
C: A general purpose receptacle outlet in a finished basement.
D: A receptacle outlet for a kitchen waste disposer installed in an open front cabinet underneath a sink, if within 6 ft. of the top insided edge of the sink bowl.

Question 52: 210.8(A)(3) Outdoors.

Question ID#: 11151.0

The general rule for dwellings requires that all 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed outdoors must have GFCI protection. The only exception to this general rule exempts receptacles that are not readily accessible and which are supplied by a branch circuit dedicated to electric snow melting, deicing, or heat tracing tape for pipes and vessel heating equipment.

At dwelling units, other than receptacles covered by this exception, 125-volt, single-phase, 15- and 20-ampere outdoor receptacle outlets require GFCI protection.



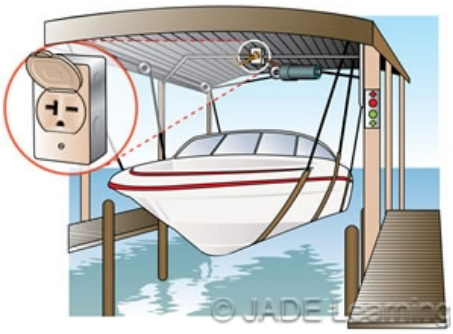
Receptacles located outdoors must be GFCI protected.

Question 52: Which of the following statements about GFCI protection for outdoor receptacle outlets installed at a dwelling is TRUE?

A: A WR type receptacle installed outdoors does not require GFCI protection.
B: A 125-volt, single-phase, 15- and 20-ampere receptacle outlet installed outdoors with a weatherproof cover does not require GFCI protection.
C: GFCI protection is not required for 125-volt, single-phase, 20-amp receptacles that are not readily accessible if they are used for electric snow-melting equipment.
D: Only 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed in public spaces require GFCI protection.

Question 53: 210.8(C) Boat Hoists.

Question ID#: 11152.0



Boat hoist outlets must be GFCI protected.

Both 120-volt and 240-volt receptacles that supply boat hoists at residential locations must have GFCI protection.

The Consumer Product Safety Commission reported four fatalities between 1994 and 2003 from electrocutions that were caused by faulty residential boat hoists.

Boat hoists are often subject to rough use and are located in naturally wet areas. The cord supplying the boat hoist or the pendant controller can easily get tangled with the boat hoist chain or sling and be damaged. Boat hoists rated at 240-volts are common and present an even greater danger to boat owners than 120-volt boat hoists.

Question 53: At a residential location which of the following statements about boat hoists is TRUE?

A: Boat hoists must have built in GFCI protection.
B: A boat hoist that is double insulated does not need GFCI protection.
C: A 240-volt receptacle supplying a boat hoist is required to be GFCI protected.
D: Receptacles supplying boat hoists do not need GFCI protection if the receptacle is a single contact device.

Question 54: 225.26 Vegetation as Support.

Question ID#: 11153.0

Vegetation such as trees cannot be used for the support of overhead outside wiring. Also, service wires cannot be supported by trees, per section 230.10. Branch circuits and feeders used as temporary wiring, in section 590.4(J), cannot be supported by trees either.

Outdoor luminaires can be supported by trees, however. Section 410.36(G): "Outdoor luminaires and associated equipment shall be permitted to be supported by trees." Temporary wiring for holiday lighting is also exempted from the general rule by an exception in 590.4 (J). It is permissible to install the conduit or cable underground, attach it to the tree trunk and feed a light fixture fastened to the tree. What is not permitted is overhead spans run from one tree to another. If cable was installed between trees, the movement of the trees during storms could damage the cable.



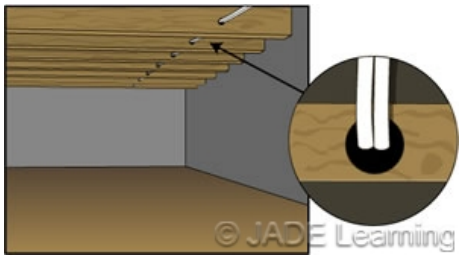
Trees shall not be used to support overhead conductors.

Question 54: Which of the following overhead spans may be supported by trees?

A: Branch circuits for lighting a used car lot.
B: Feeders used to supply branch circuits for lighting ski slopes.
C: Temporary wiring used for holiday lighting.
D: Service conductors.

Question 55: 334.15(C) In Unfinished Basements and Crawl Spaces.

Question ID#: 11154.0



NM cables through bored holes in crawl spaces.

In unfinished basements and crawl spaces, NM cable in sizes No.14, No.12, and No. 10 AWG is required to be installed on running boards or through bored holes when run at angles to the joists in crawl spaces.

Cables with two No. 8 AWG conductors must also be installed through bored holes or protected by running boards, but cables having more than two No. 8 conductors can be secured directly to the bottom of the joists. If the conductors in a cable are larger than No. 8 AWG, they are permitted to be secured directly to the bottom of floor joists without any protection.

Although the location is quite different, cable installed in crawl spaces and unfinished basements cannot be fastened to the bottom of the floor joists. In unfinished basements there is a danger of the homeowner damaging exposed NM cable by using it to support clothing or yard and garden tools. The same danger does not exist in crawl spaces. Although crawl space is not defined, its name suggests not being able to stand up. The types of activities common to an unfinished basement are not done in a crawl space. Wiring in a crawl space is not exposed to the same physical damage as in an unfinished basement.

However, the requirements for protecting NM cable in a crawl space are identical to protecting NM cable in an unfinished basement. Many jurisdictions have not adopted this requirement. Check with the Authority Having Jurisdiction about enforcement of this section.

Question 55: When unprotected by a raceway, if it is run at angles to the joists in a crawl space, which of the following is required to be run through bored holes or installed on running boards?

A: A three conductor #8 NMS cable.
B: A three conductor # 4 NM cable.
C: A two conductor #10 NM-B cable.
D: A two conductor #6 NM cable.

Question 56: 340.10(1) UF Cable. Uses Permitted.

Question ID#: 11155.0

Underground Feeder (UF) cable provides an option to installing wire in conduit for underground wiring. Type UF cable can be directly buried in the ground. Typical installations include well pumps, landscape lighting, branch circuits and feeders.

UF cable cannot be used as service entrance cable, overhead cable or embedded in poured cement or concrete. Type UF cable cannot be installed where exposed to the direct rays of the sun or exposed to physical damage, unless listed for use in direct sunlight.

Table 300.5 lists the cover requirements for UF cable and other underground wiring methods. In residential locations the cables and raceways may not need to be buried as deeply as in other locations. If the underground circuit is limited to 120-volts, 20 amperes and is GFCI protected, the burial depth is reduced even further.



UF cable must be buried 24 in. deep.

Question 56: Which of the following underground installations would be an acceptable wiring method?

A: Type UF cable buried 24 in. and powering a 240-volt, 20 ampere branch circuit.
B: Rigid non-metallic conduit buried 12 in. under a residential parking lot, with wires providing power to a 120-volt, 20 ampere lighting circuit.
C: Type SE cable on a residential branch circuit rated 120-volts with GFCI protection and buried 12 in. below grade.
D: Non-metallic sheathed cable buried 18 in. in residential parking areas.

Question 57: 406.9(A)&(B) Receptacles in Wet Locations.

Question ID#: 11156.0



All 15- and 20-ampere non-locking receptacles, rated 125 and 250 volts, installed in damp and wet locations must be a listed weather-resistant type.

Standard 15- and -20 ampere receptacles installed in damp and wet locations are protected from the weather by weatherproof enclosures or weatherproof covers. Unfortunately, poor installation or assembly practices have often allowed water into the enclosure and damaged the receptacle. For a number of reasons, outdoor receptacles are subject to harsher conditions than indoor receptacles. A NEMA/UL study found the failure rate of GFCI receptacles installed outdoors was more than double the failure rate in other locations. Because of this high failure rate, the NEC no longer permits standard receptacles in damp or wet locations.

Weather resistant receptacles are coated with a weather resistant coating that is not used on standard non-weather resistant receptacles.

In wet locations weather-resistant receptacles are still required to be installed in weatherproof enclosures. If an outlet box hood is used with a weatherproof enclosure it must be marked "extra-duty". Other listed products that provide weatherproof protection but do not utilize an outlet box hood need not be marked "extra-duty."

Damp locations: When receptacles are installed outdoors in ***damp*** locations, they are required to be installed in an enclosure that is weatherproof when a plug is not inserted in the receptacle and the cover is not open.

Wet locations: For residential applications, 15- and 20-amp, 125 and 250 volt receptacles in wet locations must be installed in enclosures that are weatherproof whether or not a plug is inserted in the receptacle.

Question 57: Which of the following statements about 125- and 250-volt, 15- and -20 ampere receptacles installed outdoors is TRUE?

A: A 125 volt, 20 amp non-locking receptacle must be weather-resistant when installed in a damp or wet location.
B: Receptacles installed in damp locations are not required to be identified as weather-resistant.
C: Twist-lock receptacles must be weather-resistant when installed in damp or wet locations.
D: Receptacles installed outdoors in a damp location must have an enclosure that is weatherproof whether or not a plug cap is installed.

Question 58: Article 411 Low-Voltage Lighting.

Question ID#: 11157.0



Landscape lighting operating at less than 30 volts is covered in article 411.

Article 411 covers lighting systems that are operated at no more than 30 volts ac or 60 volts dc. Where wet contact is likely to occur, the limits are 15 volts ac or 30 volts dc. Low voltage lighting systems covered by this article are required to include the following components: an isolating power supply, low-voltage luminaires, and associated equipment that are all identified for the use. All components are required to be listed and identified for use in low voltage lighting systems, either as a listed system or an assembly of listed parts.

Low voltage landscape wiring is very popular for a number of reasons. The burial depths in Table 300.5 are only 6 in. if the system is limited to 30 volts and does not go underneath a driveway. Depths of less than 6 in. are allowed if specified in the installation instructions of listed low voltage lighting systems. Normal 120 volt wiring, protected by GFCI, must be buried at least 12 in. Also, the fixtures themselves are usually mounted on stakes which can be easily pushed into the ground, avoiding support and conductor protection issues.

- Â·The lighting transformer for the low voltage landscape lighting cannot be supplied by a branch circuit greater than 20 amps
- Â·The maximum rating of the secondary of the transformer is 25 amps
- Â·The lighting system must be listed for the purpose
- Â·Low voltage lighting systems cannot be installed through the wall of a dwelling, unless protected by a raceway, and cannot be installed within 10 ft. of swimming pools, spas or fountains unless permitted by article 680.
- Â·The lighting transformer must be an isolating type which insulates the secondary low voltage side from the primary branch circuit.

Question 58: Which of the following statements about limited energy landscape lighting is TRUE?

A: The supply circuit to the low voltage transformer must be GFCI protected.
B: Low voltage landscape wiring must be buried at least 12 in. in the ground.
C: Low voltage landscape wiring must be installed in conduit.
D: The supply circuit to the low voltage transformer cannot have a rating greater than 20 amps.

Heating and Cooling

Question 59: Table 110.26(A)(1) Working Space.

Question ID#: 11159.0

The basic requirement in 110.26(A) is that there must be access and working space about electrical equipment, â€œto permit ready and safe operation and maintenance,â€• of the equipment. This applies to all electrical equipment, but is especially important where the electrical equipment may be examined or serviced while energized.



Shrubbery cannot interfere with working space.

Where electrical equipment operating at 1000-volts or less is likely to require â€œexamination, adjustment, servicing, or maintenance while energized,â€• Table 110.26(A)(1) applies. The table now includes three voltage-to-ground categories, 0-150-volts to ground, 151-600-volts to ground, and 601-1000 volts-to-ground. A typical residential single-phase, 120/240-volt service falls under the 0-150 volts-to ground category.

The minimum depth of working space in the 2017 NEC for electrical equipment operating at no more than 150-volts to ground is 900 mm which is approximately 3 ft. This is a change from the 914 mm required in the 2014 NEC which was an exact conversion. The change was made to conform with the conversion methods outlined in 90.9 which are used when converting mm to inches. The difference amounts to about 0.5 of an inch.

The depth of working space in front of residential services, panelboards, or other equipment that are likely to be worked on while energized must not be less than the 900 mm (3 ft) required by Table 110.26(A)(1). For example, trouble-shooting heating or air-conditioning equipment, checking volts/amps and similar activities will likely require the circuit to be energized. The clear distance is measured in the direction of access to the live parts and is measured from the front of the enclosure. The width of the working space must not be less than 762 mm (30 in.) or the width of the equipment whichever is greater. Equipment doors or hinged panels must be able to open at least 90 degrees.

Care should be taken when locating any electrical equipment on the exterior of the home to avoid landscape plants that over time will grow to a size that will prevent ready and safe access to the electric equipment. For example, some AHJâ€™s permit an air-conditioning disconnect to be mounted with less than the working space given in the table, but a hedge or shrub planted in front of the disconnect may eventually block the basic access requirement in 110.26 for safe operation and maintenance of the disconnect. Click on the illustration to see an example of a plant blocking access to both the AC disconnect and the electrical connection at the air conditioner. If there is an opportunity the homeowner should be advised not to plant shrubs too close to electrical equipment.

Where service equipment, panelboards, or other equipment that is likely to require â€œexamination, adjustment, servicing, or maintenance while energized,â€• is mounted on the exterior of a home, the 900 mm (3 ft.) minimum clear distance in front of the equipment must always be provided.

Question 59: The voltage to ground on an outdoor 120/240-volt service panelboard is 120 volts. According to Table 110.26(A)(1), what is the required depth of the working space in front of the service?

A: 1.2 m (4 ft.)
B: 900 mm (3 ft.)
C: 1.5 m (5 ft.)
D: 1.0 m (3 ft. 6 in.)

Question 60: 210.63 HVAC Equipment Outlet.

Question ID#: 11160.0



Need a receptacle located within 25 ft. of HVAC equipment.

A 125-volt, single-phase, 15- or 20 ampere receptacle outlet is required to be provided near air conditioning equipment because tools needed for servicing HVAC equipment do not work well with high voltage drop.

The outlet must be on the same level as the HVAC equipment and cannot be connected to the load side of the equipment disconnecting means.

Locating the outlet near the equipment also helps prevent service personnel from opening a window and running an extension cord to the nearest outlet (which may not provide GFCI protection).

Question 60: In the photo, what is the maximum distance the receptacle can be from both pieces of heating and air conditioning equipment?

A: 75 ft.
B: 26.5 ft.
C: 50 ft.
D: 25 ft.

Question 61: 338.10(B)(4) Installation Methods for Branch Circuits and Feeders.

Question ID#: 11161.0

SE aluminum cable is one of the most commonly used wiring methods for wiring between a panelboard and the HVAC disconnecting means or from a panelboard to a range or dryer.

In previous codes if any size SE cable was installed in thermal insulation, the ampacity of the conductors had to be taken from the 60 degree column of Table 310.15(B)(16). This is no longer the case.

The ampacity of SE cable depends on the type of insulation used on the conductors themselves. For example the ampacity of SE cable marked with XHHW conductors is taken from the 90Âº C column if used in a dry location and the 75Âº C column if used in a wet location. In practice, the ampacity is virtually always taken from the 75Âº C column since the terminals they are used with are only rated for 75Âº C. However, the 90Âº C column ampacity can be used as a starting point for derating due to high ambient or more than three current carrying conductors that are in a raceway or bundled. This is allowed as long as the final derated ampacity is not more than what the 75Âº C column allows. For Type SE cable with ungrounded conductors sized No. 10 AWG or smaller installed in thermal insulation the 60Âº C column must be used for ampacity.



For interior wiring the ampacity of SE cable installed in thermal insullation shall be figured at 75Â° C.

Question 61: The branch circuit from the panelboard to a heating unit disconnect is type SE aluminum and is installed in thermal insulation. Conductors are type THWN. The minimum circuit ampacity (per the heating unit nameplate, so upsizing wires for continuous duty is already factored in) is 59 amps. Terminals on the equipment are 75 degrees C. What are the minimum correct size conductors when installed in thermal insulation?

A: No. 1 AWG.
B: No. 6 AWG.
C: No. 4 AWG.
D: No. 3 AWG.

Question 62: Article 424 Fixed Electric Space-Heating Equipment.

Question ID#: 11162.0



All equipment must be installed according to the manufacture listing and labeling.

Because all fixed electric heating equipment is considered to be a continuous load, the supply conductors are sized to carry 125% of the rated ampacity of the unit. When wiring electric heating equipment, such as electric furnaces or heat pumps, the nameplate rating for the appliance is the best way to select the branch circuit conductor size, overcurrent protection and disconnect size. The values on the equipment nameplate must be followed. If the nameplate says the maximum fuse size is 100 amps then the maximum size allowed is 100 amps and a circuit breaker cannot be used instead of fuses.

If the nameplate on a furnace or heat-pump specifies a minimum conductor size then that is the minimum size we use. The minimum conductor size listed on the nameplate is the conductor size we use because the manufacturer has already included the 25% increase for continuous loading in the data on the nameplate.

Similarly, if the nameplate specifies the maximum amperage rating of an overcurrent protective device (OCPD) such as a fuse or circuit breaker, that is the maximum size OCPD permitted for the unit; and, it is not necessary to increase the OCPD to carry 125% of the units rated ampacity.

If, however, the nameplate does not specify either the minimum conductor size or maximum rating for an OCPD, we have to calculate the values for each of these based on 125% of the rated ampacity of the unit given on the nameplate.

Example #1: If the nameplate specifies a maximum OCPD rating of 30 amps, and a minimum conductor size of No. 10 AWG. The smallest conductor we are permitted to use is a No. 10 AWG; however, we can use a larger wire if needed to compensate for voltage drop for lengthy circuits. Regardless of the conductor size, the largest OCPD we are permitted to install is a fuse or circuit breaker rated at 30 amps.

Example #2: If the nameplate specifies the unit amperage at 40 amps; but, does not specify the minimum conductor size or maximum OCPD, we have to calculate the size for each based on the amperage rating of the unit as follows: Circuit ampacity= 40-A X 125% = 50 amps, Smallest AL conductor is No. 4 AWG SE cable or No. 6 CU cable.

Maximum OCPD = 40-A X 125% = 50 amps; Largest OCPD is a 50 amp fuse or circuit breaker. We are required to use either a fuse or circuit breaker if the type device is specified on the nameplate.

The branch circuit conductors are sized at 125% of the rated current of the electric heating equipment. The overcurrent protection is also sized at 125% of the rated current of the electric heating appliance. If the size of the required overcurrent device does not match a standard size fuse or circuit breaker, the next higher size from 240.6(A) may be used.

The disconnecting means for electric heating equipment must be located within sight of the equipment. The disconnecting means is required to be capable of being locked in the open position; and, the means for locking are required to remain in place with or without the lock being present. Fixed electric heating equipment is permitted to be supplied by more than one branch-circuit or feeder. When supplied by more than one source, the disconnects for all sources are required to be grouped and identified.

Question 62: The nameplate amperage on a single-phase 240 volt electric furnace is 45 amps. The nameplate does not specify either the minimum branch circuit conductor size or amperage or the maximum rating of the overcurrent protective device (OCPD) for the furnace. What is the minimum ampacity for the supply conductors and what is the maximum rating of the OCPD for the furnace?

A: Minimum circuit ampacity: 50 amps, maximum fuse size: 50 amps.
B: Minimum circuit ampacity: 56 amps, maximum fuse size: 60 amps.
C: Minimum circuit ampacity: 45 amps, maximum fuse size: 45 amps.
D: Minimum circuit ampacity: 60 amps, maximum fuse size: 80 amps.

Question 63: 440.14 HVAC Equipment. Location.

Question ID#: 11163.0

The general rule requires a disconnecting means to be located within sight of the equipment, for the safety of service personnel working on the equipment. If you can see the disconnect, you can prevent someone from turning it back on while you are working on the equipment it serves. The 2017 NEC defines "***In Sight From, (Within Sight From, Within Sight)***" in Article 100, as being: in view and no more than 50' away from the equipment.



HVAC equipment requires a disconnect to be located within sight of equipment.

The disconnect must be readily accessible. If the disconnecting means is attached to the equipment itself, it cannot cover the nameplate data tag. With the nameplate data tag covered, it is impossible to read important information such as operating voltage, maximum size overcurrent protection allowed, and minimum circuit size.

Exception No. 2 permits the use of a cord-and-plug as a disconnecting means. In such cases, the disconnect is required to be within sight of the equipment and accessible, but not readily accessible.

Question 63: Which of the following statements concerning heating or air conditioning equipment is correct?

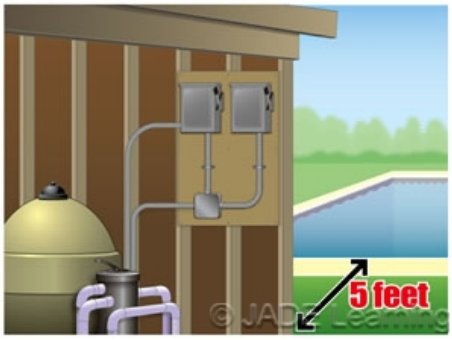
A: The disconnecting means may be installed on equipment panels but cannot cover the equipment nameplate.
B: The disconnecting means must be attached to the equipment and be locked in the open position at all times.
C: The disconnecting means must be within 25 ft. of the equipment and securely attached to the structure.
D: The disconnecting means must be within 30 ft of the equipment and be readily accessible.

Swimming Pools and Spas

Question 64: 680.13 Maintenance Disconnecting Means.

Question ID#: 11165.0

A maintenance disconnecting means is required for all utilization equipment except lighting. The disconnect must simultaneously disconnect all ungrounded conductors, and it must be accessible and within sight of the equipment.



The maintance disconnect must be located at least 5 ft. from inside wall of a pool.

If a barrier is not installed between the maintenance disconnect and the edge of the pool, each disconnecting means must be located no closer than 5 ft. horizontally from the inside walls of the pool, spa or hot tub. The purpose of the barrier is to ensure that the minimum travel distance between the edge of the pool and the maintenance disconnects is at least 5-feet. For example, if a barrier such as a wall, fence or other partition is installed between the edge of the pool and the disconnect, as long as the distance it takes to walk around the barrier is 5-feet or more, the installation complies with the requirements in 680.12.

The disconnect can be closer than 5 ft. to the inside walls of the pool, spa or hot tub if there is a barrier installed that would require 5 ft. of travel to reach the disconnect.

Other electrical equipment around swimming pools, spas, fountains, and hot tubs are

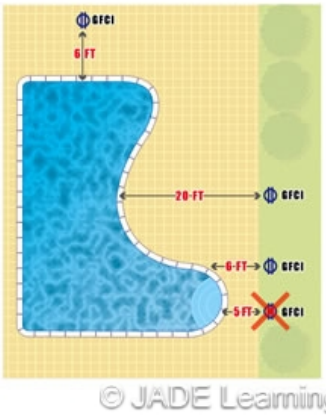
required to maintain horizontal distances from the edge of the water. Receptacles for pool-pump motors and general use receptacles must be no closer than 6 ft. from the inside wall of the pool. Luminaires and paddle fans cannot be installed overhead within 5 ft. of the edge of the pool. Switching devices must be located at least 5 ft. horizontally from the inside walls of a pool, unless a barrier is installed.

Question 64: Which of the following statements about maintenance disconnects for swimming pools is correct?

A: The maintenance disconnects are not required to be within sight of the utilization equipment.
B: All utilization equipment, including lighting, for swimming pools, spas, and hot tubs require maintenance disconnects.
C: Maintenance disconnects are permitted to be located less than 5 ft. from the edge of the pool without a barrier being installed.
D: If a barrier is not installed between the pool edge and a maintenance disconnect, maintenance disconnects are required to be 5 or more feet from the edge of the pool.

Question 65: 680.22(A) Receptacles.

Question ID#: 11166.0



Receptacles must be located a minimum of 6 ft. from the inside wall of the pool.

At least one 125-volt, 15- or 20- amp GFCI protected receptacle must be installed within 20 ft. of the inside edge of a permanently installed pool and must be on a general purpose branch circuit. This receptacle may not be any closer than 6 ft. from the pool. A receptacle installed for a water circulation pump must have GFCI protection and may not be installed any closer than 6 ft. from the pool. No other receptacle may be installed closer than 6 ft. from the pool.

Section 680.22(D) says that ***other*** outlets cannot be less than 10 ft. from the inside walls of the pool. An informational note gives examples of ***other outlets*** as communication circuits (telephone), remote-control, signaling (computer), and fire alarm. CATV outlets also qualify as ***other outlets***.

Question 65: A GFCI protected receptacle at a dwelling unit cannot be closer to the inside walls of the pool than:

A: 20 ft.
B: 6 ft.
C: 10 ft.
D: 5 ft.

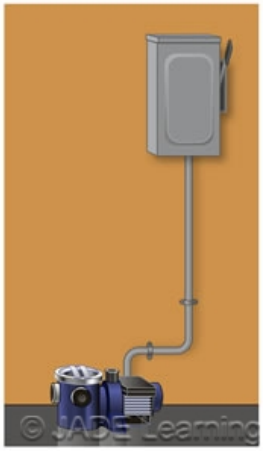
Question 66: 680.21(C) Motors: GFCI Protection.

Question ID#: 11167.0

Regardless of their ampacity, all circuits supplying single-phase pool pump motors rated 120-240 volts are required to be provided with ground-fault circuit-interrupter protection for personnel. This applies to motors that are cord-and-plug connected and to those that are hardwired.

There is just as much of a shock hazard if a pool pump is hard wired as when it is connected to a receptacle. The environment is wet and corrosive, and motor leads which are directly connected to a branch circuit can deteriorate, just as they can if they are connected by cord-and-plug. Even though a pool pump motor which is hardwired is not as likely to be moved as a pump connected to a receptacle, problems in the wiring can develop.

This requirement applies to permanently installed pools at all locations, not just dwelling units. If a pool pump motor is cord-connected to a receptacle or the branch circuit is hardwired directly to the pump, GFCI protection for personnel must be provided for the pump.



Most pool pump motors must be GFCI protected.

Question 66: GFCI protection for pool pump motors is required:

A: Only if it is cord-and-plug connected.
B: Only if it is hardwired.
C: If it is cord and plug connected or hardwired.
D: Only if it is installed at a dwelling unit.

Question 67: 680.43(A)&(B) Indoor Installations. Receptacles & Installation of Luminaires, Lighting Outlets, and Ceiling-Suspended (Paddle) Fans.

Question ID#: 11168.0



Fixtures and paddle fans located between 7 ft. 6 in. and 12 ft. above a spa or hot tub must be GFCI protected.

In indoor locations, for single-family, two-family, or multifamily dwelling units, one GFCI protected receptacle supplied by a general purpose branch-circuit rated for 125-volt, 15- or -20 amp, must be located between 6 ft. and 10 ft. from the inside wall of the spa or hot tub. Receptacles that provide power for a spa or hot tub must be ground-fault circuit-interrupter protected.

Fans and Lights

If a luminaire or paddle fan does not have GFCI protection, it must be hung at least 12 ft. above the spa or hot tub. If it does have GFCI protection, it may be mounted no lower than 7 ft. 6 in over the spa or hot tub. Luminaires may be mounted closer than 7 ft. 6 in. to the top of the hot tub or spa if they are GFCI protected and are recessed with a glass or plastic lens, with electrically isolated trim, and are suitable for damp locations. Surface-mounted luminaires may also be mounted closer than 7 ft. 6 in. if they have a glass or plastic globe, a nonmetallic or electrically isolated body, and are suitable for damp locations.

Question 67: What is the minimum mounting height above a spa for a non-metallic, recessed fixture with a plastic lens and that is suitable for a damp location, but is not GFCI protected?

A: 10 ft.
B: 12 ft.
C: Can be less than 7 ft. 6 inches

D: 7 ft. 6 inches

Question 68: 680.71 Hydromassage Bathtubs. Protection.

Question ID#: 11169.0

Hydromassage bathtubs must be on an individual branch circuit and protected by a readily accessible ground-fault circuit-interrupter.

The tub heaters and hydromassage pump are a large enough load that they need to be on an individual branch circuit. An individual branch circuit is one that supplies a single piece of utilization equipment. Luminaires, convenience receptacles or other loads cannot be connected to the dedicated hydromassage circuit. The rating of the required circuit is not specified.

A GFCI receptacle outlet for the circuit cannot be located in the pump enclosure or cavity if it is not considered readily accessible. Readily accessible means it must be reached quickly, and a receptacle outlet behind a panel may not be reached quickly.

Also, the distance from the inside edge of the tub to receptacles requiring GFCI protection must be 6 ft. to make it consistent with the distance requirements for GFCI protected receptacles from a pool.



Hydromassage bathtub must be on an individual branch circuit.

Question 68: Which of the following hydromassage bathtub installations is a Code violation?

A: A 15 amp GFCI protected device on an individual branch circuit.
B: A 20 amp branch circuit that supplies the hydromassage tub and an overhead luminaire above the tub.
C: An individual 20-ampere branch circuit that supplies a GFCI receptacle for the hydromassage tub.
D: A GFCI protected outlet located 6 ft. from the inside edge of the hydromassage tub.

Generators

Question 69: 702.4 Optional Standby Systems. Capacity and Rating.

Question ID#: 11171.0

Calculating the maximum load permitted to be supplied by a generator, is the same as calculating the load of a building supplied by a electrical utility provider. Use Article 220.

However, the size and capacity of the generator you need when installing what is considered an ***Optional Standby System*** is dependent upon the type of transfer equipment(switching device) used: manual or automatic.

For Optional Standby Systems using ***manual transfer switches***, the generator must have enough capacity to supply all of the equipment intended to be operated at one time. More loads than those intended to operate, can be connected to the generator, but the loads that are expected to run, must be covered. With a manual transfer switch, the operator can select all loads to power up, before manually transferring to this back-up generator, thus eliminating the need to ever overload and trip the generator overcurrent devices.

For Optional Standby Systems using ***automatic transfer switches***, the generator must be rated to carry the full load that is transferred to the generator (or in other words, the full load that is ***CONNECTED*** to the generator) by the automatic transfer equipment.

In this case, the auto-transfer system will transfer the building loads without warning, during a grid outage, that is why all connected loads, regardless if you plan to run them, must be calculated into the size of the generator. The generator must be able



The load a generator can supply is based on the generator KW rating and whether the transfer switch is manual or automatic.

to handle whatever is imposed, when this automatic transfer occurs. Unlike the aforementioned manual transfer switch, there is no time with the automatic transfer, to power down unneeded loads that would trip the generator's overcurrent devices.

If the automatically transferred generator is equipped with a load management system, which can determine which loads are to be supplied at any one time, then the generator must be rated to supply the maximum load that could possibly be supplied at any one time, based on that management system's output.

Question 69: Which of the following generators is sized correctly for an Optional Standby System?

A: Manual transfer; 80 amps calculated load at 240 volts; 40 amps supplied by the generator; Generator is rated 7.5 KW at 240 volts.
B: Manual transfer; 100 amps total calculated load at 240 volts; 50 amps at 240 volts to be supplied by the generator; Generator is rated 15 KW at 240 volts.
C: Automatic transfer switch; 150 amps calculated load at 240 volts; Generator rated 30KW at 240 volts.
D: Automatic transfer with load management; 400 amp calculated load at 240 volts; 225 amps to be supplied simultaneously; Generator rated 50 KW at 240 volts.

Question 70: 702.7 Signs.

Question ID#: 11172.0



Signs are required when standby generators are installed.

Brutal storms and a weakening utility power-grid have made generators more popular.

Generators at residential dwellings are classified as Optional Standby Systems. They are installed mostly as a convenience when the normal power goes out. The life safety of the occupants does not depend on the generator.

Generators are a second power source to a dwelling and signs must be installed at the service-entrance equipment location identifying the type and location of the optional standby system. Generators with automatic transfer switches will start automatically when utility power is lost. This can pose a real hazard to someone who is unaware of the generator as a second source of power. If the standby generator is cord-and-plug connected, a second sign is required at the power inlet receptacle that indicates whether the generator is a separately derived system with a bonded neutral or not a separately derived system with a floating neutral.

Question 70: Which of the following statements about a cord-and-plug connected generator is true?

A: Signs indicating the location of the generator shall be placed at the service-entrance location and at the generator.
B: A sign shall be placed at the generator indicating the location of the power source from the local utility.
C: A sign shall be placed at the service-entrance equipment indicating the location of the alternate power source and at the generator indicating if the generator is a separately derived system.
D: Power is required to be restored within 60 seconds of failure of the normal power system.

Question 71: 250.35 Permanently Installed Generators.

Question ID#: 11173.0

Standby generators can be Separately Derived Systems or Nonseparately Derived Systems. Most standby generators are nonseparately derived systems. A standby generator used as a nonseparately derived system does not switch the neutral. It is directly connected to the utility neutral. Nonseparately derived systems never switch the neutral in the transfer switch.

Generators can be equipped with a factory installed main overcurrent device, or the overcurrent device can be field installed in another enclosure elsewhere on the premises.

Selecting the correct size of an equipment bonding jumper or supply side bonding jumper depends on where the overcurrent protection is located.

If the main overcurrent device for the generator is factory installed inside the generator, and the generator is being installed as a nonseparately derived system, then only an equipment bonding jumper is needed and it must be sized from table 250.122 (see 250.102(D).

If the generator does not have a main overcurrent device, and is being installed as a nonseparately derived system, then a supply-side bonding jumper must be installed to connect the grounding terminal on the generator to the grounding terminal where the overcurrent protection is located. This must be sized from Table 250.102(C)(1).



Choose a supply-side bonding jumper if the generator is not equipped with overcurrent protection.

Question 71: A standby generator is installed as a nonseparately derived system at a single family dwelling. The generator is not equipped with an integral overcurrent device. The conductors between the generator and the first disconnecting means are 2/0 cu. AWG.
What is the minimum size copper supply-side bonding jumper required?

A: No. 8 AWG.
B: No. 6 AWG.
C: No. 4 AWG.
D: No. 12 AWG.

Limited Energy

Question 72: 250.94 Bonding for Communication Systems.

Question ID#: 11175.0

An intersystem bonding termination is required to be installed at the service equipment and at the disconnecting means for any additional buildings. As an exception, the intersystem bonding termination is not required at an additional building where communication systems are not likely to be used. The purpose of the intersystem bonding termination is to provide a means to connect bonding and grounding conductors from communication systems, like Cable TV and telephone. The intersystem bonding termination must be installed external to any enclosure and be accessible for connection and inspection. It must have the capacity to connect not less than three intersystem bonding conductors.

At the service the intersystem bonding termination must be electrically connected to the grounding electrode conductor or the service equipment, the meter enclosure or an exposed nonflexible metal raceway with a minimum No. 6 AWG copper conductor.

At the disconnecting means for a building or structure the intersystem bonding termination must be electrically connected to the building disconnecting means or the grounding electrode conductor with a minimum No. 6 AWG copper conductor.



Means to bond three other systems must be provided at the service.

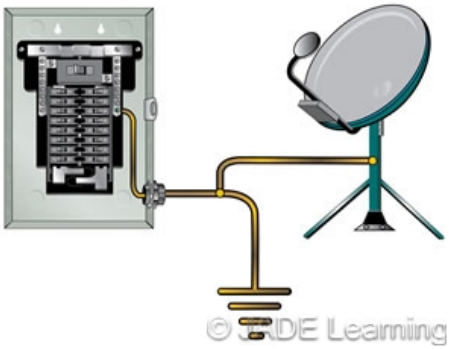
Communication systems like Cable TV, Satellite TV, and telephone are bonded to the power grounding electrode system to prevent differences of potential from developing between them and the electrical system. If a high voltage is impressed on one of the systems because of a lightning strike or contact with outside electrical distribution wires, and it is not bonded to the premises wiring system, a shock hazard exists and arcing can occur between the normal premises wiring system and the low voltage communication system.

Question 72: Where is the intersystem bonding termination required to be installed?

A: Inside the meter socket enclosure.
B: Within 6 ft. of the service disconnecting means.
C: External to service equipment enclosures.
D: Next to the telephone primary protector.

Question 73: 250.94 Exception. Bonding for Communication Systems.

Question ID#: 11176.0



Intersystem bonding not required for existing buildings.

In existing buildings, installation of the Intersystem Bonding Termination is not required. An accessible means outside of the service equipment enclosures must be provided to allow for the connection of bonding and grounding conductors for optical fiber cables, telephone, TV, CATV, and Network Powered Broadband Communications Systems.

Grounding and bonding conductors from the low voltage systems can be connected by: (1) Exposed nonflexible metallic raceways; (2) Exposed grounding electrode conductor; (3) Approved means for external connection of a copper conductor to the grounded raceway or equipment.

Informational note No. 1 says: "A 6 AWG copper conductor with one end bonded to the grounded nonflexible metallic raceway or equipment and with 6 inches or more of the other end made accessible on the outside wall is an example of the approved means."

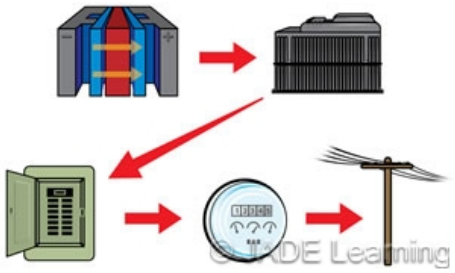
Question 73: A satellite dish is installed at a mobile home in a rural area. The existing service is run in PVC conduit. Which of the following is a TRUE statement?

A: The grounding conductor from the satellite system can be connected to the service grounding electrode conductor.
B: A set of terminals must be mounted to the meter socket enclosure.
C: A bonding jumper must be attached to the service conduit.
D: A bonding bar is required to be installed next to the service disconnect.

Question 74: 692.65 Utility-Interactive Point of Connection.

Question ID#: 11177.0

Utility-interactive inverters used with solar photovoltaic panels or wind generators supply alternate power to connected loads and feed any excess power back to the electric utility. The utility uses net metering to credit the building owner with power which is generated by the fuel cell and subtracts it from the monthly bill. No transfer switch is required for utility-interactive systems and the fuel cell is disabled if the utility loses power.



Fuel cells supply alternate power to loads and feed excess load back to utility.

The point of connection between the alternate energy source (fuel cell, photovoltaic system, wind generator) is installed according to section 705.12. Article 705 is ***Interconnected Electric Power Production Sources.***

The utility-interactive inverter can be connected to the supply side or the load side of the service disconnect. In a typical installation, the output from the inverter ***backfeeds*** a circuit breaker in the premises distribution system. The rating of the circuit breaker cannot be more than 120% of the rating of the busbar in the panel. The distribution equipment must be marked to indicate there are multiple sources of supply to the panel. Circuit breakers, when backfed, must be suitable for backfeeding. The backfed circuit breaker is not required to have additional fastening means. A permanent warning label must be installed in the distribution equipment with the wording: WARNING INVERTER OUTPUT CONNECTION DO NOT RELOCATE THIS OVERCURRENT DEVICE.

Question 74: Utility-interactive inverters supplying premises distribution panels are:

A: Required to be connected to the supply side of the service disconnects.
B: Permitted to be connected to the load side of the service disconnecting means of the other source(s) at any distribution equipment on the premises.
C: Required to be connected to the load side of service disconnects.
D: Are not permitted to be connected to the supply side of the service disconnect.

Question 75: 800.156 Dwelling Unit Communications Outlet.

Question ID#: 11178.0



A minimum of one communications outlet shall be installed in new construction.

New construction must include at least one communications outlet in dwellings. Section 800.156 requires the following: "For new construction, a minimum of one communications outlet shall be installed within the dwelling in a readily accessible area and cabled to the service provider demarcation point."

Because the definition of ***communications circuits*** in 800.2 includes a wide variety of communications systems, the outlet required by section 800.156 is not required to be a phone outlet, but that will be the most commonly installed type of outlet.

Having a hardwired telephone outlet in every dwelling unit will give the occupants a way to contact emergency personnel or the fire department if cell service is interrupted. A telephone outlet is necessary for fire alarm and security systems that use auto-dialers. Having a communications outlet installed in the rough-in stage will reduce the need to fish communications wire inside walls and along unseen pathways used for electrical conductors.

Question 75: Which of the following is NOT required to have a communications outlet installed in it?

A: A new multifamily dwelling unit.
B: A new two-family dwelling unit.
C: A college dormitory room without cooking facilities.
D: A new single family dwelling.

Installation and Wiring Methods

Question 76: Table 110.28 Enclosure Selection.

Question ID#: 11180.0



Table for enclosure selection no longer just for motor installations.

When selecting an enclosure type, it is important to pay attention to the enclosure type number. Without the correct number selection, it is possible to select enclosures that are not at all suitable for the specific installation.

Enclosures that are most commonly used outdoors, like panelboards, switchboards and switchgear, for example, are rarely installed with the wrong type of enclosure. However, other equipment that can be installed outdoors, like wireways, gutters, and transformer enclosures is sometimes installed in a way which is not suitable for outdoor use.

Table 110.28 applies to all enclosures, not just motor enclosures.

Question 76: The combo panel, shown here, is located outdoors and is subject to rain, sleet, and snow. Which of the following is the correct enclosure type number?

A: 1.
B: 5.
C: 12.
D: 3R.

Question 77: 110.(3)(B) Installation and Use.

Question ID#: 11181.0

Instantaneous water heaters are being used more and more in replacement and new construction installations because of savings on utility bills. As with any new product, questions come up about the proper installation and wiring.

The electrical consumption for this gas appliance is only for the ignition circuit and the exhaust blower. The motor is variable and uses more electricity to move the exhaust as the demand for more hot water is increased.



All equipment must installed according to manufacture listing and labeling.

Question 77: The tankless water heater shown here is listed and labeled. The instructions require a disconnecting means at the unit. The amp rating is .7 amps at 120 volts and the horsepower is less than 1/8. Which of the following statements is TRUE?

A: A disconnecting means is required at the unit because listed or labeled equipment shall be installed according to instructions.
B: No disconnect is necessary with motors rated 1/8 horsepower or less.
C: A disconnect is not required because the appliance is less than 300 VA.
D: The disconnecting means shall be rated at least 20 amperes.

Question 78: 210.24 Branch Circuit Requirements â€“ Summary.

Question ID#: 11182.0



Branch circuit requirements are based on single and multiple outlet circuits.

Most of the wiring in a dwelling is branch circuit wiring. A branch circuit can have a single outlet device or multiple outlets. For multi-outlet circuits, the NEC does not say how many outlets are permitted on a single circuit. In commercial wiring, each outlet is figured at 180 volt-amps (watts), but there is no such requirement for residential wiring. Most electricians do not put more than 12 outlets on a 15 amp circuit or 15 outlets on a 20 amp circuit.

If a branch circuit has two or more receptacle outlets for cord and plug connected loads, no single receptacle can supply more than 80% of the branch circuit rating. If a branch circuit supplies lighting outlets and equipment which is fastened in place (not cord and plug connected), no single piece of equipment can be rated more than 50% of the branch circuit rating. However, if a branch circuit has only one receptacle on it, the assumption is that the circuit was installed for a specific load and that it needs to be rated to carry that load; so, the receptacle is required to have the same rating as the circuit.

The receptacle rating for 20 amp circuits can be 15 or 20 amps. The receptacle rating for 40 amp circuits can be 40 amps or 50 amps. But if a branch circuit is a dedicated circuit and supplies a single outlet, section 210.21(B)(1) requires that the receptacle have a rating not less than the rating of the branch circuit.

The NEC says branch circuit wiring and overcurrent protection for continuous loads must be calculated at 125% of the actual load. This is because devices (See Article 100) are not rated continuously, but the wires are rated for continuous loading. Exactly which loads in a dwelling unit are continuous and which ones are not continuous is not spelled out. Most electricians use an 80% rule and don't load a 15 amp circuit to more than 12 amps and a 20 amp circuit to more than 16 amps in order to account for continuous loading.

How circuits are laid out in a residence is mostly left up to the installing electrician.

Question 78: A single window air conditioner is connected by cord and plug on an individual 20 amp branch circuit which has a single receptacle. The rating of the receptacle is required to be:

A: 30 amps.
B: 20 amps.
C: 15 or 20 amps.
D: 15 amps.

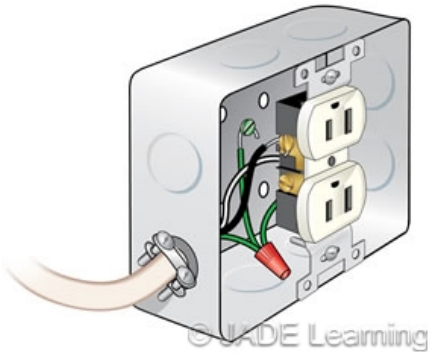
Question 79: 250.8 Connection of Grounding and Bonding Equipment.

Question ID#: 11183.0

There are two parts to this section: (A) Permitted Methods and (B) Not Permitted Methods. Not Permitted is any device that depends solely on solder for a connection. Equipment groundng conductors, grounding electrode conductors, and bonding jumpers are required to be connected by one or more of the 8 means listed in 250.8.

Listed pressure connectors (any color wire nut) and exothermic welding are permitted. Pressure connectors listed as grounding and bonding equipment (green wire nuts) are also permitted. Terminal bars are permitted as a way to connect grounding conductors and bonding jumpers. Connections which are part of a listed assembly and other listed means are permitted.

Section 250.8(A)(5) & (6) includes two methods to connect grounding and bonding conductors: ***"machine screw-type fasteners that engage not less than two threads or are secured with a nut; and thread-forming machine screws that engage not less than two threads in the enclosure."***



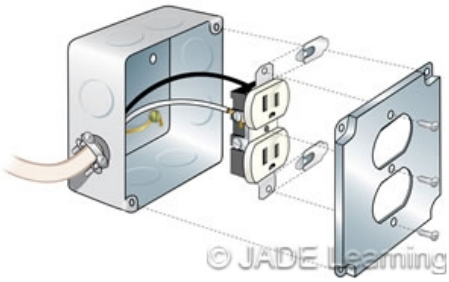
Grounding screws are used to ground metal boxes.

Question 79: Which of the following devices is permitted as a method of connecting grounding and bonding equipment?

A: A wood screw.
B: A sheet metal screw.
C: A listed red wire nut.
D: A solid wire wrapped around a metal post and soldered.

Question 80: 250.146(A) Surface Mounted Box.

Question ID#: 11184.0



Metal to metal contact approved for grounding receptacle in surface mounted metal box.

When a metal box is surface mounted, the direct metal to metal contact between the box and the contact yoke of the receptacle is an acceptable way to ground the receptacle to the box. A bonding jumper from the receptacle to the box is not required.

If two conditions are met, a cover mounted receptacle can also be grounded to a box without a bonding jumper. The two conditions are***: "(1)The device is attached to the cover with at least two fasteners that are permanent (such as a rivet) or have a thread locking or screw or nut*** locking ***means; (2) When the cover mounting holes are located on a flat non-raised portion of the cover. "***

Exposed work metal covers must have two ***permanent*** fasteners to attach the receptacle to the cover in order to be listed. The ***flat, non-raised portion of*** crushed corner design of a listed exposed work metal cover provides good metal to metal contact between the cover and the box.

Question 80: When a receptacle is installed using a surface-mounted metal box:

A: It is considered grounded if installed with a mud-ring attached to a listed metal box extension.
B: It is considered grounded if it is installed in a listed exposed metal work cover.
C: There must be a bonding jumper installed between the receptacle and the box.
D: There must be a bonding jumper installed between the receptacle and the cover.

Question 81: 300.4(A)(1) Cables and Raceways Through Wood Members. Bored Holes.

Question ID#: 11185.0

The photo illustrates a typical installation of NM-Cable pulled through bored holes of wooden framing members. The NEC requires that all types of NM-Cable pulled through bored holes in framing members be protected from nails and screws, whenever the edge of the bored hole is less than 1.25" from the face of the framing member. This nail guard shall be no less than 1/16" thick.

There are two exceptions to this rule.

Exception #1 does not require a nail guard when NM-Cable is installed in rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing. Note: Nail guards are required for all other raceways, including Electrical Nonmetallic Conduit (ENT), Liquidtight Flexible Metal Conduit (LFMC).

Exception #2 allows for a nail guard to be less than 1/16" thick, when listed and marked by the manufacturer for use as a nail guard.



Nail plates required when cables are less than 11/4 in. from edge of framing member.

Question 81: The cables shown in this photo are run through bored holes in wood members. Which of the following is correct?

A: The protective plates are required to be 1/8 in. thick minimum.
B: The protective plates are required when the edge of the hole is less than 1Â¼ in. from the edge of the wood member.
C: The protective plates are required when the edge of the hole is 1 3/8 in. from the edge of the wood member.
D: The protective plates are not required because of the type of cable.

Question 82: Table 300.5 Minimum Cover Requirements.

Question ID#: 11186.0



PVC conduit must be buried at least 18 in. when under a residential driveway.

Table 300.5 covers underground installations for circuits rated 0 to 1000 volts. Cables or conductors that are installed underneath a building must be in a raceway.

Residential circuits which have GFCI protection, rated 120 volts or less, with maximum overcurrent protection of 20 amps must be buried at least 12 inches below the surface. If the installation is underneath a residential driveway or residential parking area, the required depth is still 12 in. If the circuit goes underneath a street or alleyway, the distance increases to 24 in.

Generally, landscape lighting operating at 30 volts or less and installed with UF or other outdoor cable must be buried 6 in. below the surface. Lesser depths than 6 in. are permitted if specified in the installation instructions of a listed low-voltage lighting system. If passing underneath a residential driveway or residential parking area, the depth is 18 in. The required burial depth is 24 in. if installed below a street or alleyway.

Circuits of any voltage or current rating can be installed in rigid nonmetallic conduit on residential property if buried 18 in. If the circuit goes under a one- or two-family driveway or parking area, the raceway must also be buried 18 in. If passing underneath a street, the burial depth increases to 24 in.

Question 82: A 60 ampere underground feeder from a single family dwelling to the garage cuts across the backyard and is installed in rigid nonmetallic conduit. What is the required burial depth?

A: 18 in.
B: 24 in.
C: 12 in.
D: 6 in.

Question 83: 314.16(B)(4) Device or Equipment Fill.

Question ID#: 11187.0

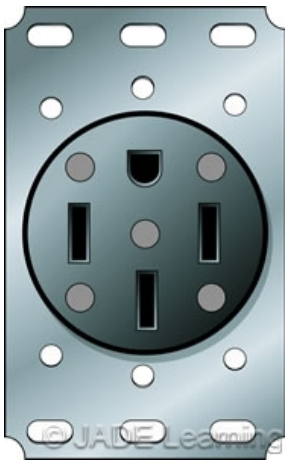
Larger Devices (Volume Allowance)

The Code tells us that a device, such as a receptacle that serves a 240-volt electric range or clothes dryer which typically will not fit into a single gang box, is counted as ***four conductors*** instead of two conductors, if a 2-gang box is used to house that device.

"A device or utilization equipment wider than a single 50 mm (2 in.) device box as described in Table 314.16(A) shall have double volume allowances provided for each gang required for mounting."

Common Sense

Common sense indicates that if two single-gang spaces are needed to house one device, that device should not be counted the same as a device that can be installed in a single-gang space. Therefore, the Code makes it clear that if a device requires TWO single-gang spaces and is ***"wider than a single 50 mm (2 in.) device box,"*** the device is counted as four times the largest conductor terminated onto that device. ***(Example: A No. 10 AWG has a volume allowance of 2.50 cu. inches for EACH conductor in the box. If a 240-volt double-wide receptacle is also in that box and the largest wire landed on that receptacle is that No. 10 AWG, that receptacle volume allowance is 4 x 2.50 or 10.00 cu. inches.)***



If a device requires a two-gang box, conductor fill for that device is counted as four conductors.

Summary

Each conductor takes up space. Each device takes up space based on the largest size conductor landed on the device screw (4 x the largest conductor on the device when the device is a 240-volt receptacle or similar device that takes up two spaces in a box).

The volume allowance of the conductors in the box, as well as any clamps, studs, or hickeys (where applicable) must be added to the volume allowance of the device(s) to get the total volume that will be occupied in any box.

Question 83: If a two-gang box is being used and two single-gang spaces are needed to mount a 240-volt receptacle in that box, what is the total volume being occupied in the box if the device is a 4-wire range receptacle, and each screw of the device has a No. 8 AWG conductor terminated to it? (Assume 3.00 cubic inches for each No. 8 AWG conductor). Remember, you must calculate all of the conductors and the device.

A: 15 cubic in.
B: 24 cubic in.
C: 20 cubic in.
D: 12 cubic in.

Question 84: 314.20 Flush-Mounted Installations.

Question ID#: 11188.0



Boxes in noncombustible walls or ceilings can be set back 1/4 in.

Boxes in noncombustible walls such as tile or drywall can be set back in the wall up to 1/4 in. and have receptacles or switches installed without any alterations. However, once the box is recessed more than a 1/4 in. a box extender must be used.

The most common extenders are the plastic fire rings shown in the picture. Prior to the plastic fire rings, similar metal rings were used in many cases, but because they were metal, they could create ground faults and short circuits.

Question 84: If the box for a receptacle is installed in a wall with a 3/8-inch ceramic tile wall covering, which of the following statements is correct?

A: Listed box extenders are required if the box is set back of the finished surface more than 1/4 of an inch.
B: Listed box extenders are never necessary because the wall's finished surface is non-combustible.
C: Listed box extenders are not allowed and the box has to be relocated flush with the wall's finished surface.
D: Listed box extenders are only required in wall with a combustible finished surface.

Question 85: 314.20 Flush-Mounted Installations. Extender.

Question ID#: 11189.0

Recently more has been done to dress up dining areas such as adding columns, tray ceilings and installing receptacles in the baseboards instead of at the standard wall height.

The rules for installing boxes in combustible walls and ceilings are different than when installing boxes in noncombustible walls and ceilings. Section 314.20 permits boxes, plaster rings, extension rings, or listed extenders installed in combustible surface material such as wood to be either flush with the finished surface or project from the finished surface. In no case are they permitted to be recessed in the combustible material.

If the box is not flush with a combustible surface, a listed extender is required to be installed so that it is flush with or extends beyond the finished surface.



In combustible walls and ceilings listed box extenders can be used.

Question 85: The receptacle outlets shown here are mounted in the wooden baseboard; if the box is set back 1/8 in. from being flush with the surface, which of the following statements is TRUE?

A: Isolated ground receptacles must be installed.
B: Listed extenders shall be flush with the finished surface or project out from it.
C: Listed extenders shall not be required unless the front edge of the box is recessed more than 1/4 in.
D: Metal faceplates are required.

Question 86: 314.24 Depth of Boxes.

Question ID#: 11190.0

Boxes must be deep enough to contain devices or equipment installed in them without damaging the device or its conductors. Boxes that do not enclose devices or utilization equipment shall have a minimum depth of 1/2 in (12.7mm).

Boxes containing devices or utilization equipment supplied by No. 4 AWG and larger conductors must be identified for their specific function.

Where the device or utilization equipment projects more than 1-7/8 in. (48 mm) into the box, the depth of the box must not be less than 1/4 in.(6 mm) greater than the depth of the equipment.

The minimum depth of a box that contains devices or equipment supplied by No. 8, No. 6, or No.4 AWG conductors is 2-1/16 in.

Boxes containing devices or utilization equipment supplied by No. 12 or No. 10 AWG conductors shall have a minimum depth of 1-3/16 inches.

The minimum depth of boxes containing devices or equipment supplied by No. 14 or smaller AWG conductors is 15/16 inches.



Boxes must be deep enough to protect the device and conductors being installed.

Question 86: What is the minimum depth for a box containing utilization equipment supplied by #10 AWG conductors?

A: 1 ^{3/16} in.
B: 1 ^{7/8} in.
C: 1 ^{1/2} in.
D: 15/16 in.

Question 87: 334.12(A)(9) Nonmetallic-Sheathed Cable. Uses Not Permitted.

Question ID#: 11191.0



NM cable not allowed to be embedded in masonry.

The photo shows two examples of NM cable used per Article 334.

The NM cable installed to the masonry box shown in the right corner of the photo will pass through the air gap between the brick and sheathing and will not be embedded in the masonry. Therefore the cable is not required to be sleeved.

The two orange cables in the left-center of the photo will be embedded in the masonry and must be sleeved.

Question 87: What is the purpose of the conduit sleeve on the two NM cables on this house with masonry veneer?

A: To make sure the cable comes out in the proper location.
B: To protect the NM cable and prevent it from being embedded in the masonry.
C: To prevent moisture from going into the structure.
D: To keep the mason from covering the wire.

Question 88: 334.12(B)(4) Nonmetallic-Sheathed Cable. Uses Not Permitted.

Question ID#: 11192.0



NM cable not allowed to be installed in wet or damp locations.

NM cable is not permitted in damp or wet locations. Even if it is installed in a raceway, if the installation is outdoors or in another wet location, NM cable cannot be used.

Section 300.9 says that when raceways are installed in wet locations (outdoors), the interior of the raceways are considered a wet location and only conductors suitable for a wet location can be used. Since NM cable is not permitted in a damp or wet location, it cannot be used outdoors, even if installed in a raceway. See Table 310.104(A) for conductors which are suitable for a wet location.

Many existing installations use NM cable for air conditioning whips from the disconnecting means to the equipment. This is a Code violation in any new installation.

Question 88: What type of wiring is acceptable for use in an air conditioning whip outdoors?

A: NMS cable.
B: TFE.
C: NM cable.
D: THWN-2.

Question 89: 334.23 & 320.23 Nonmetallic-Sheathed Cable in Accessible Attics.

Question ID#: 11193.0

Nonmetallic sheathed cable is installed in accessible attics the same way as armored cable is installed in attics. Section 320.23 describes the procedure.

If NM cable is run parallel with the rafters or floor joists, it does not require further protection as long as the cable is installed no closer than 1.25 in. from the leading edge of the framing member. If the cable is installed closer than 1.25 in. to the face of the rafter or floor joist, then a steel plate or sleeve must be installed to protect the cable.

When run across the top of floor joists, or across the face of rafters within 7 ft. of the floor joists, then NM cable must be protected by guard strips which are at least as high as the cable. If the attic does not have permanent stairs or ladders, then the guard strips are not required, except for an area within 6 ft. of the scuttle hole or attic entrance.



NM cable must be protected in accessible attics.

Question 89: NM cable installed in an accessible attic:

A: Needs to be protected by guard strips if the NM cable is within 10 ft. of the scuttle hole.
B: Must be protected by guard strips if run across the top of floor joists in an attic that is accessible by permanent stairs.
C: Must be protected by guard strips in all attic locations if installed across the top of floor joists.
D: Does not require guard strips in any attic location if installed across the face of rafters.

Question 90: 334.30 Nonmetallic-Sheathed Cable, Securing and Supporting.

Question ID#: 11194.0



NM cable must be supported every 4 1/2 ft. and within 12 in. of a box or cabinet.

Nonmetallic-sheathed cable must be supported every 4 1/2 ft. and within 12 in. of every cabinet, box or fitting. NM cable may be secured with staples, cable ties, straps or hangers.

Nonmetallic-sheathed cable is considered supported when fished in concealed spaces and when run through bored holes in studs. When installed in bored holes in studs, the studs cannot be spaced further than 4 1/2 ft. apart and the cable must be supported within 12 in. of a box. The hole in the stud cannot be closer than 1 1/4 in. from the face of the stud, or a 1/16 in. steel plate must be installed to protect the cable from sheet rock nails or other wall penetrations.

In one- and two-family dwellings and multi-family dwellings, nonmetallic sheathed cable can be installed in dropped or suspended ceilings. NM cable is permitted to be run 4 1/2 ft. from the last point of support in an accessible ceiling. This means if luminaires in an accessible ceiling are interconnected with no more than 4 1/2 ft. of NM cable, the cable can be installed from fixture to fixture without additional support, and junction boxes will not be necessary.

Question 90: If two recessed luminaires are installed in an accessible ceiling in a residence and are interconnected with 4 ft. of nonmetallic sheathed cable, excluding the support required within 12 in. of each luminaire, how many supports for the cable are required between luminaires?

A: 0.
B: 1.
C: 2.
D: 3.

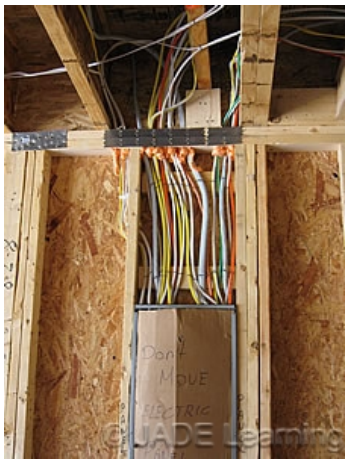
Question 91: 334.80 Ampacity.

Question ID#: 11195.0

When more than 2 NM cables are installed through a bored hole in wood framing that is required to be fire-stopped with insulation or other identified material, the current carrying capacity of each conductor must be adjusted in accordance with Table 310.15(B)(3)(a)

Since the insulation on the individual conductors in an NM-B cable is rated 900C the ampacity adjustment factors in the table can be applied to the ampacity of a 900C conductor in Table 310.15(B)(16). However, the final adjusted ampacity of the conductor cannot exceed the ampacity of a 60C rated conductor.

For example, the ampacity of a 900C rated No. 12 AWG copper conductor in Table 310.15(B)(16) is 30 amps. If five 12/2 NM cables (Type NM-B) are installed through the same bored hole, the ampacity of the conductors must be adjusted based on the number of current-carrying conductors. In a two-wire (120-volt) circuit each conductor is considered current-carrying so the ampacity of the five 12/2 cables must be adjusted based on 10 current-carrying conductors.



Ampacity of NM cable to be calculated at 60Â° C.

The adjustment factor for 10 conductors in Table 310.15(B)(3)(A) is 50%. Multiply the 900C cable ampacity by 50% (30A X 0.50 = 15A). The adjusted ampacity of the conductors is now only 15 amps. The conductors must be protected by a 15-amp fuse or circuit breaker. This would be a problem if the circuits were small-appliance branch circuits or other circuits where a 20-amp rating is required.

When applying the adjustment factors in Table 310.15(B)(3)(a) remember that it is the number of current-carrying conductors that is counted, not just the number of cables. A rule of thumb for use with NM cable is to keep the number of current-carrying conductors in the cables to less than ten.

For example, if four 12/2 NM cables are installed through the same bored hole, the number of current-carrying conductors is 8 (4 X 2 = 8 conductors). The adjustment factor in Table 310.15(B)(3)(a) for 7-9 conductors is 70%. Multiply the 900C ampacity of the No. 12 AWG conductor by 70% (30A X 70% = 21A). The adjusted ampacity of the cable is not permitted to exceed the 600C ampacity of 20 amps, so in effect the ampacity of the conductors remains 20-amps.

It must be noted that the insulation on the conductors in Type NM cables manufactured before 1984 is only 600C. The 900C ampacity cannot be used for adjusting the ampacity of conductors in pre-1984 installations.

Question 91: What is the ampacity of each conductor when a total of five, 12/2 with ground NM cables pass through a 1 in. fire-stopped hole in wood framing? Assume all conductors, except the ground within each cable, is considered current-carrying, and each is rated for 30 amps (90Â° C rating from Table 310.15(B)(16)).

A: 24 amps.
B: 30 amps.
C: 15 amps.
D: 21 amps.

Question 92: 338.10(B)(4) Installation Methods for Branch Circuits and Feeders.

Question ID#: 11196.0



The ampacity of SE cable larger than 10 AWG, installed indoors, is not subject to the 60Â° C column.

In the previous Code-cycle, SE cable that was installed within wall, floor or ceiling insulation (such as R15 batt or blown insulation), had to have its conductor ampacity determined from the 60'C column. But the 2017 NEC now permits Service Entrance (SE) cable with ungrounded (Hot) conductors ***larger than size 10 AWG***, that are installed in "interior installations" including insulation, to have its ampacity determined by the terminal ratings of the circuit (such as the conductor terminations where the conductors attach to the circuit-breaker, and the terminations where the SE cable attaches to the load it is feeding.) In other words, an SE cable larger than 10 AWG, with a jacket marking corresponding to a temperature rating found in the 90'C column, CAN BE INSTALLED utilizing the ampacity found in that 90'C column, if every terminal rating that the SE cable attaches to is ***also*** rated for no less than 90'C. ***However***, if even one terminal rating is below 90'C, the entire circuit must be calculated based on that lower terminal rating. The cable or conductor is no better than the lugs it is attached to, and it must be treated accordingly.

An example where this can benefit the electrician and customer: In the 2014 NEC, the size of SE cable run to an HVAC disconnect, or an electrical subpanel often had to be increased a whole size because the 60Â°C column was required to be used instead of the terminal ratings.

Be aware, you will typically find the terminal ratings of equipment, such as panelboards, load centers, disconnects, etc to be 75'C. While this isn't as good as 90'C, it is a marked improvement about the previous 60'C limitation that was imposed on SE cable installed within insulation

Lastly, keep in mind, this new Code provision ONLY applies to conductors larger than 10 AWG. 10 AWG conductors and smaller still have their ampacity determined from the 60'C column.

Question 92: An aluminum SE cable with Type THW conductors is used as a feeder to supply a 100 amp panelboard (This feeder does not carry 100% of the load so the 83% rule from 310.15(B)(7) does not apply here). What is the minimum size of the feeder, if the feeder is installed in thermal insulation?

A: No. 1 AWG.
B: No. 2 AWG.
C: 1/0 AWG.
D: 2/0 AWG.

Question 93: 406.5(A) Receptacle Mounting. Boxes That Are Set Back.

Question ID#: 11197.0

Section 406.5 now requires that screws used to attach receptacles to a box or assembly be the same type that is provided by manufacturers of listed receptacles. Listed receptacles are provided with No. 6 machine screws that have 32 threads per inch.

When a receptacle is mounted in a plastic box in a sheetrock wall, the receptacle must be firmly supported to the box. If the box is recessed 1/4 in. into the wall, the receptacle may not seat firmly into the box. The rigid support for receptacles is necessary in order to prevent damage to the receptacle cover or the receptacle itself. Movement of receptacles that are not rigidly attached may allow the equipment grounding conductor to come into contact with the ungrounded conductor.

A common way to prevent this is to install an adapter that holds the receptacle against the finished surface, as in the photo.



Receptacles set back in the wall 1/4 in. must be held rigidly in place.

Question 93: Which of the following statements about receptacles that are mounted in boxes that are set back from the finished surface is true?

A: They shall be rigidly held in place at the wall opening.
B: They need no further work as long as the receptacle can be installed.
C: They may not be installed if the box is not flush with the finished surface.
D: They shall have the box relocated to a flush position.

Practical Exercises

Question 94: Garage GFCI Receptacles.

Question ID#: 11199.0

Use the blueprint to answer the question.



Use this blueprint to answer the question.Number of receptacles in the garage to be GFCI protected.

Question 94: How many receptacle outlets in the garage must be GFCI protected?

A: 4
B: 8.
C: 5
D: 6

Question 95: AFCI Protected Outlets.

Question ID#: 11200.0

Use the blueprint to answer the question.



Use this blueprint to answer the question.Number of AFCI required.

Question 95: Which one of the following areas require AFCI protected outlets?

A: Both bathrooms.
B: Kitchen
C: Garage.
D: Sceen Porch.

Question 96: Tamper Resistant Outlets.

Question ID#: 11201.0

Use the blueprint to answer the question.



Use this blueprint to answer the question.Number of tamper resistant receptacles in the kitchen.

Question 96: In the 3 bedrooms, how many receptacles are required to be tamper-resistant?

A: 13
B: 15
C: 18
D: 10

Question 97: Ampacity Rating of SE Cable.

Question ID#: 11202.0

Use the blueprint to answer the question.



Use this blueprint to answer the question.Size the SE cable to the range.

Question 97: The range in the kitchen is rated for 40 amps. The circuit breaker as well as the range termination screws are rated for 75C. What is the minimum size aluminum SE cable that can be installed to the range if the cable is installed in thermal insulation?

A: No. 8 AWG.
B: No. 6 AWG.
C: 1/0 AWG.
D: No. 4 AWG.

Question 98: Weather Resistant Receptacles.

Question ID#: 11203.0

Use the blueprint to answer the question.



Use this blueprint to answer the question.Location of weather resistant receptacles.

Question 98: Where are weather resistant receptacle outlets required to be installed?

A: Within 6 ft. of a sink.
B: In wet and damp locations.
C: In garages.
D: In basements and crawl spaces.

Question 99: Bonding Jumper for Gas Pipe.

Question ID#: 11204.0

Use the blueprint to answer the question.



Use this blueprint to answer the question.

Question 99: In the Great Room of the home, the gas-log fireplace assembly is equipped with a fan and a remote control system which are supplied by a 120-volt, 20-amp branch-circuit. The gas-logs are piped in with CSST gas pipe. What size conductor should be used to ground the CSST pipe?NOTE: Some states such as New Mexico have their own state codes that amend the NEC requirements for bonding CSST type pipe. However, this question is based on the NEC and the NEC requirements for bonding CSST are the same as for bonding other types of metal piping according to Table 250.122.

A: No. 4 AWG cu.
B: No. 8 AWG cu.
C: No. 6 AWG cu.
D: No. 12 AWG cu.

Question 100: Indoor Switch for Outdoor Lights.

Question ID#: 11205.0

Use the blueprint to answer the question.



Use this blueprint to answer the question.Switch on bedroom circuit and located in bedroom feeding outside flood light.

Question 100: The switch for the rear outdoor floodlights is supplied by the bedroom circuit & is located in the master bedroom (not shown on blueprints). Which of the following statements about the switch and floodlights is TRUE?

A: The floodlights must be cord-and-plug connected to a weather-resistant receptacle outlet.
B: The switch and floodlight must be AFCI protected.
C: The switch and floodlight must be GFCI protected.
D: The floodlights must be IC rated.

Answer Sheet **Darken the correct answer. Sample: A ● C D**

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1.) A B C D	21.) A B C D	41.) A B C D	61.) A B C D	81.) A B C D
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3.) A B C D	23.) A B C D	43.) A B C D	63.) A B C D	83.) A B C D
4.) A B C D	24.) A B C D	44.) A B C D	64.) A B C D	84.) A B C D
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7.) A B C D	27.) A B C D	47.) A B C D	67.) A B C D	87.) A B C D
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10.) A B C D	30.) A B C D	50.) A B C D	70.) A B C D	90.) A B C D
11.) A B C D	31.) A B C D	51.) A B C D	71.) A B C D	91.) A B C D
12.) A B C D	32.) A B C D	52.) A B C D	72.) A B C D	92.) A B C D
13.) A B C D	33.) A B C D	53.) A B C D	73.) A B C D	93.) A B C D
14.) A B C D	34.) A B C D	54.) A B C D	74.) A B C D	94.) A B C D
15.) A B C D	35.) A B C D	55.) A B C D	75.) A B C D	95.) A B C D
16.) A B C D	36.) A B C D	56.) A B C D	76.) A B C D	96.) A B C D
17.) A B C D	37.) A B C D	57.) A B C D	77.) A B C D	97.) A B C D
18.) A B C D	38.) A B C D	58.) A B C D	78.) A B C D	98.) A B C D
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