Residential Wiring Part 2 According to 2011 NEC (Homestudy)

North Carolina Electrical License

This course will cover the requirements in the 2011 NEC for installing electrical systems in dwelling units. Code sections for residential wiring installations are organized by equipment type or location in the dwelling and include: 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, Limited Energy, Installation.

Course# 1530810 4 Homestudy Credit Hours $50.00

This course is currently approved by the North Carolina State Board of Examiners of Electrical Contractors under course number 1530810.

Completion of this continuing education course will satisfy 4.000 credit hours of course credit type 'Homestudy' for Electrical license renewal in the state of North Carolina. Course credit type 'Homestudy'. Board issued approval date: 7/1/2012. Board issued expiration date: 6/30/2015.

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Residential Wiring Part 2 According to 2011 NEC (Homestudy) - NC

Service and Subpanels

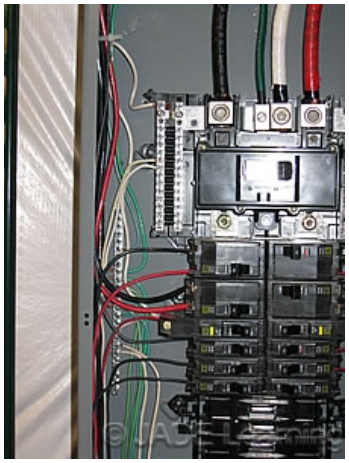
Question 1: 200.2(B) Continuity.

Question ID#: 2103.0

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 1: The grounded conductor of a 3-phase feeder is required to be terminated at the service equipment on:

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

Question 2: 230.24 Clearance of Overhead Conductors.

Question ID#: 2104.0

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

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 service conductors pass over. 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 the bottom of the drip loop to final grade.

Question 2: 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 service conductors over the overhanging portion of a roof is 18 in.
C: The minimum clearance from ground for 120/240 volt single-phase service conductors is 10 ft.
D: The minimum clearance from ground for service conductors that pass over streets that have truck traffic is 18 ft.

Question 3: 230.82 Equipment Connected to the Supply Side of Service Disconnect.

Question ID#: 2106.0

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. 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. Standby generator or secondary power sources 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 3: Which of the following statements about equipment connected to the supply side of the service disconnect is TRUE?

A: Nothing is permitted to be connected ahead of the service overcurrent devices.
B: Devices with their own internal fuses or circuit breakers are permitted to be connected ahead of the service overcurrent protection.
C: Equipment is permitted to be connected on the supply side of the service overcurrent devices if the added load does not overload the service conductors.
D: Meter disconnects that have all of their metal housings grounded are permitted to be connected on the supply side of the service.

Question 4: 250.32(B) Ex. Buildings Supplied by Feeders or Branch Circuits. Grounded Systems.

Question ID#: 2107.0

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.

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.

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.

Equipment grounding conductor required with feeder conductors to separate buildings.

Question 4: 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: A new feeder with an equipment grounding conductor is required to be installed.
B: The grounded conductor can be used to ground the new disconnect and the equipment inside the second building.
C: The existing grounding electrode at the second building must be removed.
D: The grounded conductor must be isolated from the disconnect.

Question 5: 250.52 Grounding Electrodes.

Question ID#: 2108.0

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 frame of the building, concrete-encased electrode (rebar, also called ufer), a ground ring, 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 footer. If more than one of these electrodes 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 5: 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 electrically connected to form a grounding electrode system.
C: They must be copper.
D: They must be either copper or aluminum.

Question 6: 250.66 Sizing Grounding Electrodes.

Question ID#: 2109.0

The size of the grounding electrode conductor connection to the water pipe is selected from Table 250.66. This table is based on the size of the service conductors. Service conductors for a 200 amp service are 2/0 copper or 4/0 aluminum, and would require a #4 copper grounding electrode conductor.

According to this section, if the grounding electrode conductor is the sole connection to a driven ground rod, the grounding electrode conductor is not required to be bigger than No. 6 copper or No. 4 aluminum. Likewise, any connection to a concrete-encased electrode, such as 1/2 in. rebar, does not need to be larger than No. 4 copper.

Grounding electrode conductors are sized according to table 250.66.

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. The grounding electrode conductor does not have to be sized to carry large amounts of fault current to establish the ground reference. The grounding electrode conductor to an 8 ft. ground rod will not see much ground fault current anyway. The resistance of a ground rod will be much higher than the resistance of the water pipe system, and the fault current will be lower.

Question 6: The purpose of a grounding electrode conductor is to:

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

Question 7: 250.92 Bonding Services.

Question ID#: 2110.0

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.

If metal conduit is installed between the meter enclosure and the service panel, a bonding bushing is required on one end of the conduit nipple.

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 250.66, 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 7: Why are the noncurrent-carrying metal parts of service equipment bonded together?

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

Question 8: 408.36 Panelboards. Overcurrent Protection.

Question ID#: 2113.0

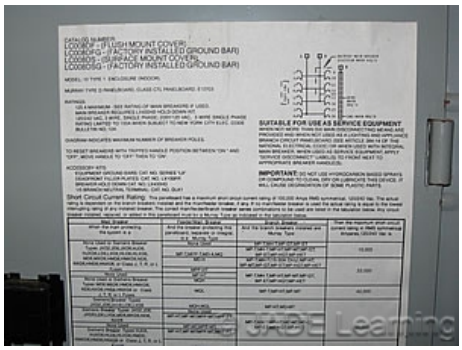
Panelboards are not limited to 42 overcurrent devices.

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.

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.



Overcurrent protection is determined by the rating of the panelboard.

Question 8: Which of the following panelboard installations are permitted?

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

Question 9: 408.54 Maximum Number of Overcurrent Devices.

Question ID#: 2115.0

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.

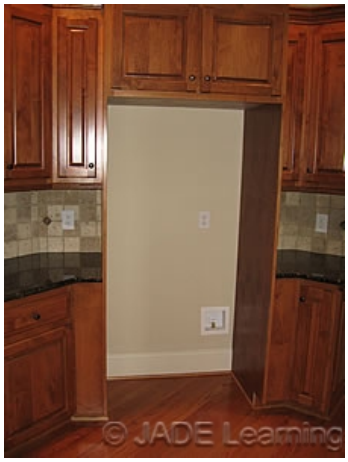
Question 9: Which of the following violates the NEC requirements for the maximum number of OCPDs that can be installed in a panelboard?

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

Kitchen, Pantry and Dining Rooms

Question 10: 210.52(B)(1) Refrigerator Circuit. Exception No. 2.

Question ID#: 2118.0



Refrigerator not required to be included on the small appliance circuit.

The refrigerator is allowed to be supplied from the 2 small appliance circuits. It may seem odd that refrigerators are permitted while outdoor outlets and other locations are not allowed on the small appliance circuits. Many large refrigerators draw more current than most equipment plugged into an outdoor outlet.

Exception No. 2 makes it clear the refrigerator is not required to be installed on the small appliance circuits. "The receptacle outlet for refrigeration equipment shall be permitted to be supplied from an individual branch circuit rated 15 amperes or greater."

How to feed the refrigerator outlet is left up to the installing electrician. The Code allows the refrigerator to be part of the small appliance circuits or connected by an individual branch circuit of 15 amps or greater. Many electrical contractors feed the refrigerator from a dedicated circuit.

Question 10: The receptacle outlet for a refrigerator:

A: May be installed on a small appliance circuit.
B: Must be installed on the small appliance circuit.
C: Must be installed as an individual branch circuit.
D: Must be connected to a 15 amp circuit.

Question 11: 250.142(B) Grounding Frames of Ranges.

Question ID#: 2124.0

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

In an existing installation, a range can be installed with a 3-wire cord and plug. In new construction, all installations of ranges and dryers must use a 4-wire system where the 4th wire is an equipment grounding conductor.

In older installations, with a 3-wire cord and plug, the neutral does double duty. It is the return conductor for 120-volt range loads (clock and timer) and a grounding conductor at the same time. If there was a ground fault on the range, the neutral would act as an equipment ground and carry ground fault current.

Allowing the neutral conductor to carry fault current and serve 120-volt loads at the same time is only permitted in existing situations, not for installations in new construction.

Question 11: Which of the following is a TRUE statement about grounding the frames of ranges?

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

Question 12: 422.16(B) Kitchen Appliances Connected by Cord and Plug.

Question ID#: 2125.0

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

The cord for a waste disposal must be at least 18 in. long and for dishwashers and trash compactors the cord must be between 3 ft. and 4 ft.

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

In Article 100, accessible is defined as: "Capable of being removed or exposed without damaging the building structure or finish, or not permanently closed in by the structure or finish of a building." This is different than ***readily*** accessible, which means capable of being reached quickly without removing obstacles. So, a receptacle installed behind a dishwasher is OK because the dishwasher can be removed to service the cord or receptacle.

Some kitchen appliances may be cord and plug connected.

Question 12: The National Electrical Code requires dishwashers that are cord and plug connected to be installed:

A: With a cord that is a minimum of 18 in.
B: So that the receptacle is accessible.
C: On one of the kitchen small appliance circuits.
D: On a dedicated circuit.

Bathrooms and Laundry

Question 13: 210.52(D) Receptacle Below the Basin Cabinet.

Question ID#: 2129.0

At least one receptacle outlet must be installed in bathrooms within 3 ft. of the outside edge of each basin. The receptacle outlet can be installed on the wall behind or next to the basin. If space is limited, the receptacle outlet can be installed on the side of a cabinet below the countertop level, as long as it is not more than 12 in. below the 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.

Outlets in the bathroom to be installed within 3 ft. of basin.

Question 13: The receptacle shown in the wall to the left of the left-hand 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 outlet required, installed at the floor line.
B: 1 additional outlet is required within 3 ft. of the outside edge of the sink in the right of the photo.
C: 2 outlets required, installed within 3 ft. of either side of the sink.
D: 1 outlet required, installed in the bathroom vanity, not more than 18 in. below the countertop.

Living Areas (and Bedrooms)

Question 14: Fire Alarm Code: Smoke Detectors.

Question ID#: 2132.0

NFPA 72 requires smoke detectors in dwellings.

The Fire Alarm Code, NFPA 72, requires smoke detectors to be installed inside of every sleeping room, outside of each sleeping area, in the immediate vicinity of the sleeping rooms, and on each additional story of a dwelling unit, including basements.

Smoke detectors 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 14: 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 detectors are required?

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

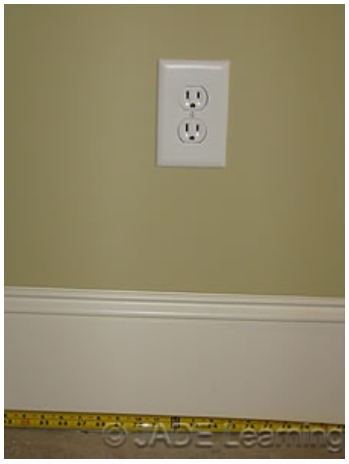
Question 15: 210.52 Dwelling Unit Receptacle Outlets.

Question ID#: 2135.0

A duplex receptacle where both receptacles are switched is not permitted to be counted as one of the required receptacle outlets in 210.52.

A switched receptacle outlet can be used instead of a lighting outlet in dwelling unit habitable rooms, except kitchens and bathrooms, according to 210.70(A)(1) Ex. No. 1. A switch controlled luminaire on an end table next to a chair or sofa is a common application for a switched receptacle.

If a duplex receptacle is a split receptacle, where one of the outlets is switched and the other is not, then the un-switched outlet can count as a required dwelling unit receptacle. Receptacles in dwelling units must be placed so that no space along the floor line is more than 6 ft. from a receptacle outlet.



A switched receptacle is not allowed as a required receptacle.

Question 15: 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: 0.
B: 1.
C: 2.
D: 3.

Question 16: 406.12 Tamper Resistant Receptacles.

Question ID#: 2137.0

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-volt, 15- and 20-ampere receptacles shall be listed tamper resistant.

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 four exceptions that will not require tamper resistant receptacles. Tamper resistant GFCI receptacles are available.

Receptacles installed in dwellings must be listed tamper resistant.

Question 16: Which location requires tamper resistant receptacles?

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

Stairways and Hallways

Question 17: 210.52(H) Receptacles in Hallways.

Question ID#: 2139.0

The spacing requirements for receptacles installed in bedrooms, living rooms, dining rooms and other spaces in a dwelling do not apply to hallways. Every hallway which is 10 ft. or longer, measured down the centerline of the hallway and not going through a doorway, needs at least one receptacle outlet.

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 which would prohibit installing 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 has greatly reduced the use of extension cords and cut down on the number of house fires caused by faulty extension cords.

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

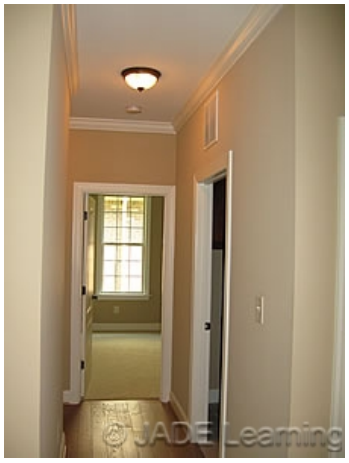
Question 17: A hallway in a single family dwelling is 15 ft. long. How many receptacle outlets are required?

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

Question 18: 210.70(A)(2)(a) Switch Controlled Lighting Outlets.

Question ID#: 2141.0

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.



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

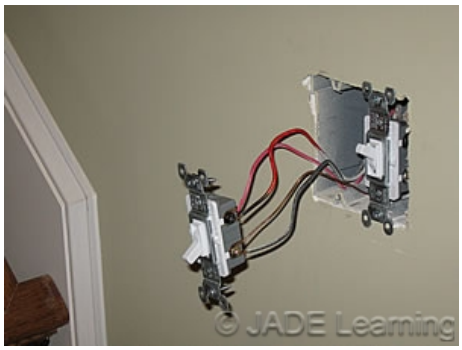
Question 18: Which of the following statements about this picture of a dwelling unit hallway is correct?

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.

Luminaires, Fans and Switches

Question 19: 200.7(C)(1) Indentifying the Ungrounded Conductor in a Switch Leg.

Question ID#: 2144.0



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 19: 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 20: 314.27(A) Maximum Weight of a Luminaire Supported by a Box. Exception.

Question ID#: 2146.0

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.

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 20: An exterior wall mounted luminaire mounted on a device box weighs 2.45 kg (5.4 lbs.). What is the minimum means of support?

A: An outlet box suitable for luminaire support and rated for 30 lbs.
B: The luminaire must be secured to the structure, not by the outlet box.
C: The luminaire or its supporting yoke must be secured to the device box by two #6 screws.
D: The luminaire shall be secured to a device box, not rated for luminaire support, by two #4 screws.

Question 21: 404.14(E) Dimmer Switches for Luminaires Only.

Question ID#: 2148.0

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 21: General use dimmer switches may be used to control:

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

Question 22: 404.9(B)(1) Grounding Snap Switches.

Question ID#: 2149.0

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

If the snap switch is mounted in a metal box or metal cover, without attaching the equipment grounding conductor to the snap switch, the metal box or cover must be connected to an equipment grounding conductor. If the box is nonmetallic, it must have an integral means for connecting an equipment grounding conductor to the screws used to mount the switch.

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

Bonding jumper is not required for a switch mounted to a grounded metal box.

Question 22: A general use snap switch is considered grounded if:

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

Question 23: 410.74 Luminaire Rating.

Question ID#: 2150.0

Luminaire name plate protected during construction.

The requirement for maximum wattage markings located where 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 23: What is the purpose of the paper in the luminaire in this photo?

A: The paper is the manufacturer's instructions and has been left for the inspector to verify the instructions have been followed.
B: It is additional insulation to prevent the lamp from overheating.
C: It must be removed prior to rough-in inspection.
D: It protects the nameplate with the marking of the maximum wattage required during relamping.

Question 24: 410.116(A) Non-IC Luminaires.

Question ID#: 2153.0

Thermal insulation cannot be installed above or within 3 in. of a non-IC luminaire. Type non-IC luminaires are usually provided with a thermal protective device and have a higher lamp wattage rating. 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 24: If this luminaire 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: 3 in. of insulation must be installed on all sides and the top of the luminaire.
C: Thermal insulation cannot be installed above or within 3 in. of the luminaire.
D: Only batt type insulation may be installed over the top of the luminaire.

Outdoors, Garages, Basements, and Crawl Spaces

Question 25: 210.52(E) Outdoor Outlets. Balconies. Exception.

Question ID#: 2156.0

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.

A balcony, deck, and porch of any dimension is required to have at least one receptacle installed if the area is accessible from inside the dwelling.

Small balconies and porches are commonly used to display holiday lighting, or as a place to put radios, fans or other appliances. If an outlet is not installed on the balcony or porch, extension cords are often run through doorways and plugged into outlets that do not have GFCI protection.

Requiring balconies and porches that can be accessed from inside the dwelling to have a GFCI protected receptacle outlet, regardless of the size of the porch, will eliminate the double hazard of running extension cords through doorways and plugging appliances into outlets without GFCI protection.

Question 25: Which of the following dwelling unit locations requires a GFCI protected receptacle outlet?

A: A balcony that measures 6 ft. x 3 ft. with a door into the inside of the dwelling.
B: A balcony that measures 8 ft. x 6 ft. without a door leading into the dwelling.
C: A space that is accessible while standing on a fire escape.
D: A landing on steps used for access to a 2nd floor apartment.

Question 26: 210.52(G) Basements and Garages.

Question ID#: 2157.0

At least one general use receptacle outlet must be installed in garages and unfinished basements in one-family dwellings. This convenience outlet cannot be dedicated to specific equipment. Sump pumps, fans, stationary tools, exercise equipment, washing machines, water filters or other types of fixed equipment can be cord and plug connected to a receptacle. If a receptacle is dedicated to a piece of equipment, it cannot be used for general purposes, like running hand tools, vacuums or battery chargers.

Receptacle required in garages and unfinished basements.

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

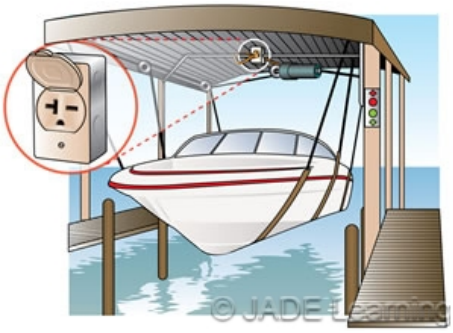
All locations except industrial establishments, 125-volt, single-phase, 15 and 20 ampere outdoor receptacle outlets require GFCI protection.

Question 26: In a large basement there is a finished entertainment room and two unfinished areas on either side. Excluding the entertainment room, how many receptacles are required that are not dedicated to specific equipment?

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

Question 27: 210.8(C) Boat Hoists.

Question ID#: 2160.0



Boat hoist outlets must be GFCI protected.

"GFCI protection shall be provided for outlets not exceeding 240 volts that supply boat hoists installed in dwelling unit locations."

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

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

Question 28: 225.26 Outside Wiring Cannot be Supported by Vegetation.

Question ID#: 2161.0

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

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

Question 29: 340.10(1) UF Cable. Uses Permitted.

Question ID#: 2163.0

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

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

Question 30: Article 411 Landscape Lighting.

Question ID#: 2165.0

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. 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.

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

- The lighting transformer for the low voltage landscape lighting cannot be supplied by a branch circuit greater than 20 amps
- The maximum rating of the secondary of the transformer is 25 amps
- The lighting system must be listed for the purpose
- 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
- The lighting transformer must be an isolating type which insulates the secondary low voltage side from the primary branch circuit.

Question 30: Which of the following statements about limited energy landscape lighting is TRUE?

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

Heating and Cooling

Question 31: Article 424 Electric Heating Equipment.

Question ID#: 2170.0

All equipment must be installed according to manufacture's 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. Even if 90Â° C conductors are used, many times the 60Â° C column from Table 310.15(B)(16) must be used to select the proper conductor if the ampacity is 100 amperes or less. If the ampacity is over 100 amperes, then you are permitted to use the 75Â° C column in table 310.15(B)(16).

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.

Question 31: The nameplate amperage on 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: 45 amps, maximum fuse size: 45 amps.
B: Minimum circuit ampacity: 50 amps, maximum fuse size: 50 amps.
C: Minimum circuit ampacity: 56 amps, maximum fuse size: 60 amps.
D: Minimum circuit ampacity: 60 amps, maximum fuse size: 80 amps.

Question 32: 440.14 Disconnect for HVAC Equipment.

Question ID#: 2171.0

A disconnecting means is required 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 it.

The disconnect must be readily accessible. This means it can't be located more than 50 ft. away from the equipment. If the disconnecting means is attached to the equipment itself, it cannot cover the data tag. With the data tag covered, it is impossible to read important information such as operating voltage, maximum size overcurrent protection allowed, and minimum circuit size.

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

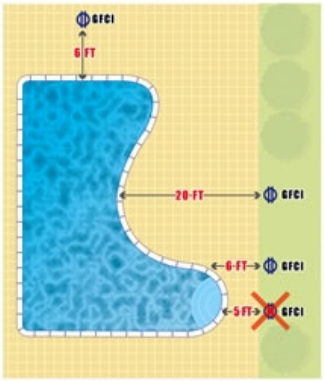
Question 32: Which of the following statements concerning heating or air conditioning equipment is correct?

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

Swimming Pools and Spas

Question 33: 680.22(A) Receptacles.

Question ID#: 2174.0



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

The required distances from the inside walls of the pool to several different types of receptacles are as follows:

Type of Receptacle	***Distance***
Circulation and Sanitation (non-GFCI, non-locking) receptacle outlets	10 ft.
Circulation and Sanitation (GFCI, locking, single receptacle)	6 ft.
Other Receptacles	6 ft.
At dwelling units, at least one 125-volt, 15-or 20-amp receptacle outlet is required	between 6 ft. and 20 ft.
All receptacle outlets required to be GFCI protected	between 6 ft. and 20 ft.

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

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

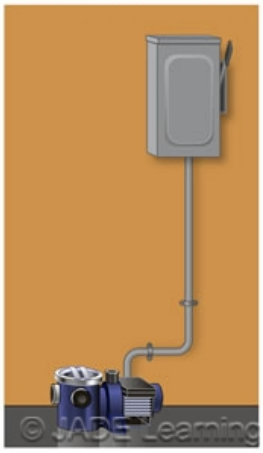
Question 34: 680.21(C) GFCI Protection.

Question ID#: 2175.0

Pool pump motors rated 15 or 20 amperes, 120 volt through 240 volt, single phase must be provided with ground-fault circuit-interrupter protection for personnel, whether by receptacle or 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 like a 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 34: GFCI protection for pool pump motors is required:

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

Question 35: 680.43(A)&(B) Receptacles and Luminaires Near Indoor Spas.

Question ID#: 2176.0

Fixtures and paddle fans located between 7 ft. 6 in. and 12 ft. must be GFCI protected.

One GFCI protected receptacle, 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.

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. Luminaires may be mounted closer than 7 ft. 6 in. to the hot tub or spa if they are GFCI protected and are recessed with a glass or plastic lens, with electrically isolated trim and suitable for a damp location. 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 a damp location.

Question 35: If a recessed luminaire that is suitable for a damp location and has a glass or plastic lens is mounted 7 ft. above a spa, it must:

A: Be identified for use above a spa.
B: Have GFCI protection.
C: Be suitable for a wet location.
D: Be relocated.

Question 36: 680.71 Hydromassage Bathtubs. Protection.

Question ID#: 2177.0

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 accesible. 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.

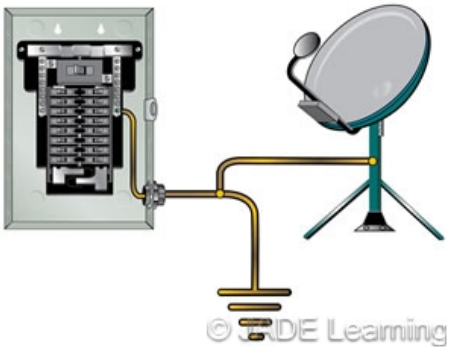
Question 36: Which of the following hydromassage bathtub installations is a Code violation?

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

Limited Energy

Question 37: 250.94 Bonding for Other Systems. Exception.

Question ID#: 2184.0



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.

Referring to item number (3) an informational note 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."

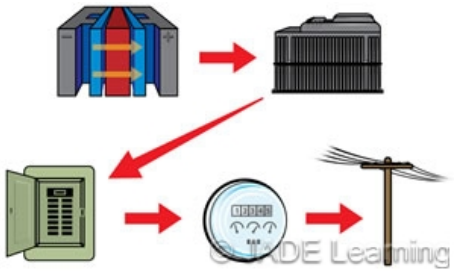
Question 37: A satellite dish is installed at a mobile home in a rural area. The existing service is run in PVC conduit. Which of the following is a TRUE statement?

A: A bonding bar is required to be installed next to the service disconnect.
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: The grounding conductor from the satellite system can be connected to the service grounding electrode conductor.

Question 38: 692.65 Utility-Interactive Point of Connection.

Question ID#: 2185.0

Utility-interactive inverters used with fuel cells (or solar photovoltaic panels) 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 38: Utility-interactive inverters supplying premises distribution panels are:

A: Required to be connected to the load side of service disconnects.
B: Required to be connected to the supply side of the service disconnects.
C: 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.
D: Are not permitted to be connected to the supply side of the service disconnect.

Installation and Wiring Methods

Question 39: Table 110.28 Enclosure Selection Table.

Question ID#: 2188.0

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 and switchboards, 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 39: 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: 3R.
C: 5.

D: 12.

Question 40: 110.(3)(B) Installation Instructions.

Question ID#: 2189.0

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's listing and labeling.

Question 40: 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 disconnect is not required because the appliance is less than 300 VA.
B: The disconnecting means shall be rated at least 20 amperes.
C: A disconnecting means is required at the unit because listed or labeled equipment shall be installed according to instructions.
D: No disconnect is necessary with motors rated 1/8 horsepower or less.

Question 41: 210.24 Branch Circuit Requirements – Summary & 210.21(B)(1) Outlet Devices.

Question ID#: 2190.0

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 41: 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: 15 amps.
B: 15 or 20 amps.
C: 20 amps.
D: 30 amps.

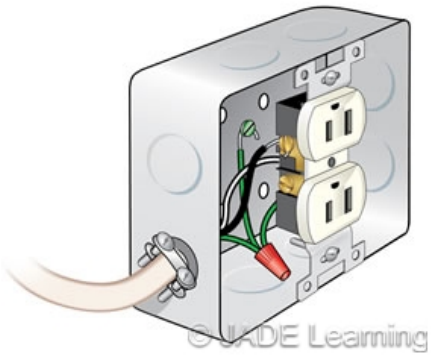
Question 42: 250.8 Connection of Grounding and Bonding Equipment.

Question ID#: 2191.0

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.

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 have been added as a permitted 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."***



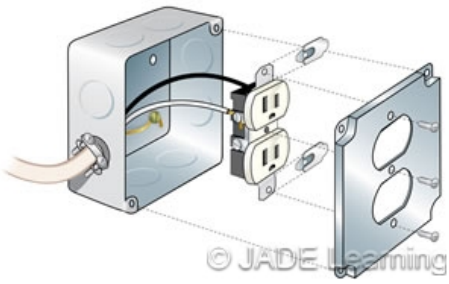
Grounding screws are used to ground metal boxes.

Question 42: Which of the following devices is permitted as a method of connecting grounding and bonding equipment?

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

Question 43: 250.146(A) Surface Mounted Box.

Question ID#: 2192.0



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*** 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 43: A surface mounted receptacle:

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

Question 44: 300.4(A)(1) Cables and Raceways Through Wood Studs.

Question ID#: 2193.0

The photo shows the use of type UF cable run through bored holes in wood members with the use of protective plates because the holes are drilled less than 11/4 in. from the edge.

Metal plates protect the conductor from being damaged by sheet rock nails or nails used to hang objects on the wall after construction is complete.

An exception to 300.4(A)(1) permits steel plates to be omitted if rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing are used through bored holes in wood studs. UF cable is not mentioned in the exception.

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

Question 44: 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 not required because of the type of cable.
B: The protective plates are required to be 1/8 in. thick minimum.
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 required when the edge of the hole is less than 11/4 in. from the edge of the wood member.

Question 45: Table 300.5 Burial Depth of Conductors and Raceways.

Question ID#: 2194.0

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

Residential circuits which have GFCI protection, rated 120 volts or less, and 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.

Landscape lighting operating at 30 volts or less and installed with UF or other outdoor cable must be buried 6 in. below the surface. 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 ampere rating can be installed in rigid nonmetallic conduit on residential property if buried 18 in. If 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 goes to 24 in.

Question 45: An 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: 24 in.
B: 18 in.
C: 12 in.
D: 6 in.

Question 46: 314.16(B)(4) Device or Equipment Fill.

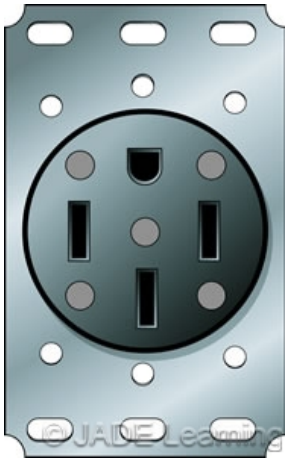
Question ID#: 2195.0

A device like a range or dryer receptacle, which will not fit into a single gang box, is counted as four conductors, rather than two conductors, if a 2-gang box is used.

"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 indicates that if two single-gang spaces are required to install a device, it should not be counted the same as a device that can be installed in a single gang space. Now, 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 of the largest conductors connected to it.

The volume requirements of the conductors are added to the volume requirement of the device to get the total volume of the box.



If a device requires a two gang box conductor fill is counted as four conductors.

Question 46: If a double gang box is used and two single gang spaces are required to mount the device, what is the minimum volume required for a 4-wire range receptacle supplied by #8 AWG conductors?

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

Question 47: 314.20 Boxes in Wall or Ceiling.

Question ID#: 2196.0

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 47: 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 never necessary because the wall's finished surface is non-combustible.
B: Listed box extenders are required if the box is set back of the finished surface more than 1/4 of an inch.
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 48: 314.24 Minimum Depth of Boxes.

Question ID#: 2198.0

Boxes must be deep enough to contain devices or equipment installed in them without damaging the device or its conductors.

Outlet and device boxes shall have sufficient depth to allow equipment installed within them to be mounted properly and without likelihood of damage to conductors within the box.

Outlet boxes that do not enclose devices or utilization equipment shall have a minimum internal depth of 1/2 inch.

Outlet and device boxes that enclose devices or utilization equipment must be large enough to accomodate the device, utilization equipment and the conductors that supply the device or equipment.

If equipment projects into the box more than 1 7/8 in. box depth shall be 1/4 in. deeper than the equipment.

Boxes containing #4 AWG and larger conductors shall be identified for their function.

Boxes containing #4, #6, or #8 AWG conductors shall have a minimum depth of 2 1/16 inches.

Boxes containing #12 or #10 AWG conductors shall have a minimum depth of 1 3/16 inches.

Boxes containing #14 or smaller AWG conductors shall have a minimum depth of 15/16 inches.

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

Question 48: What is the minimum depth for a box containing utilization equipment supplied by #10 AWG conductors?

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

Question 49: 334.23 & 320.23 NM Cable in Accessible Attics.

Question ID#: 2201.0

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 49: NM cable installed in an accessible attic:

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

Question 50: 334.30 Securing and Supporting NM Cable.

Question ID#: 2202.0

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 light luminairea in an accessible ceiling are no more than 4 1/2 ft. apart, NM cable can be installed from fixture to fixture without support, and junction boxes will not be necessary.

Question 50: If high-hat luminaires are installed on 4 ft. centers in an accessible ceiling in a residence and are fed with nonmetallic sheathed cable, excluding the support required within 12 in. of each luminaire which can be provided by a fitting on the luminaire, how many supports for the cable are required between luminaires?

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

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

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1.) A B C D	**18.) A B C D**	**35.) A B C D**
2.) A B C D	**19.) A B C D**	**36.) A B C D**
3.) A B C D	**20.) A B C D**	**37.) A B C D**
4.) A B C D	**21.) A B C D**	**38.) A B C D**
5.) A B C D	**22.) A B C D**	**39.) A B C D**
6.) A B C D	**23.) A B C D**	**40.) A B C D**
7.) A B C D	**24.) A B C D**	**41.) A B C D**
8.) A B C D	**25.) A B C D**	**42.) A B C D**
9.) A B C D	**26.) A B C D**	**43.) A B C D**
10.) A B C D	**27.) A B C D**	**44.) A B C D**
11.) A B C D	**28.) A B C D**	**45.) A B C D**
12.) A B C D	**29.) A B C D**	**46.) A B C D**
13.) A B C D	**30.) A B C D**	**47.) A B C D**
14.) A B C D	**31.) A B C D**	**48.) A B C D**
15.) A B C D	**32.) A B C D**	**49.) A B C D**
16.) A B C D	**33.) A B C D**	**50.) A B C D**
17.) A B C D	**34.) A B C D**	

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