Residential Wiring According to the 2011 NEC (Homestudy)

Wisconsin 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 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 and Wiring Methods.

Course# 12832 8 J, M, UDC, BER, RJE, RME Credit Hours $85.00

This course is currently approved by the Wisconsin Department of Safety and Professional Services under course number 12832.

Completion of this continuing education course will satisfy 8.000 credit hours of course credit type 'J, M, UDC, BER, RJE, RME' for Electrical license renewal in the state of Wisconsin. Course credit type 'J, M, UDC, BER, RJE, RME'. Board issued approval date: 8/2/2011. Board issued expiration date: 8/2/2016.

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Residential Wiring According to the 2011 NEC (Homestudy) - WI

Service and Subpanels

Question 1: 110.12 Protecting Equipment During Construction. Busbars.

Question ID#: 2102

Panelboard interior must be protected during construction.

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 keep out unauthorized personnel.
C: To provide a neat and workmanlike job.
D: To protect the internal parts of the panelboard from damage.

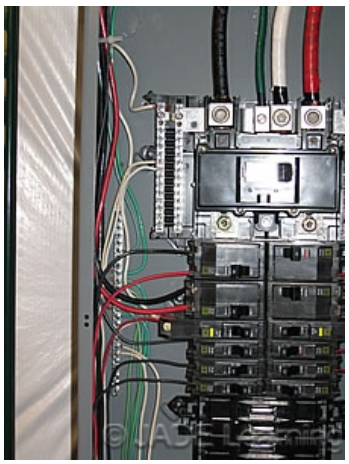
Question 2: 200.2(B) Continuity.

Question ID#: 2103

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: 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 3: 230.24 Clearance of Overhead Conductors.

Question ID#: 2104

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 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 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 4: 230.70(A)(1) Readily Accessible Location of Service Disconnects.

Question ID#: 2105

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.

Service disconnects must be located nearest the point of entrance.

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.

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: No more than 10 ft. inside the dwelling.
D: At a readily accessible location nearest the point of entrance of the service conductors.

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

Question ID#: 2106

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 5: 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 6: 250.32(B) Ex. Buildings Supplied by Feeders or Branch Circuits. Grounded Systems.

Question ID#: 2107

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 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: 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 7: 250.52 Grounding Electrodes.

Question ID#: 2108

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 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 electrically connected to form a grounding electrode system.
C: They must be copper.
D: They must be either copper or aluminum.

Question 8: 250.66 Sizing Grounding Electrodes.

Question ID#: 2109

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.

Grounding electrode conductors are sized according to table 250.66.

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.

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 8: 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 9: 250.92 Bonding Services.

Question ID#: 2110

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 9: 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 10: 250.104(B) Bonding Gas Piping.

Question ID#: 2111

Gas pipe bonding has been a very controversial electrical issue. In the past, gas piping was thought to be sufficiently bonded if a gas appliance was connected to a 15 ampere circuit with a 14 gauge equipment grounding conductor. This is no longer the case because of a lawsuit that claimed lightning caused holes in corrugated stainless steel tubing, and the leaking gas resulted in a house fire.

Everyone then began to rethink gas pipe bonding, referring back to the gas pipe manufacturers' instructions. The problem is that there are several brands of this type of gas tubing and the manufacturers have different ideas about gas pipe bonding. There has yet to be a consistent industry-wide consensus of what should be done about gas pipe bonding. Section 250.104(B) refers us to use Table 250.122 to select the size of the bonding jumper for gas piping.

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

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: #6 copper.
B: #6 aluminum.
C: #8 copper.
D: #8 aluminum.

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

Question ID#: 2112

Table 310.15(B)(7) allows smaller conductors for dwelling unit service and main power feeder conductors than 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, Table 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 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" and Table 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 #4 CU THW feeder selected from Table 310.15 (B)(7)?

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

Question 12: 408.36 Panelboards. Overcurrent Protection.

Question ID#: 2113

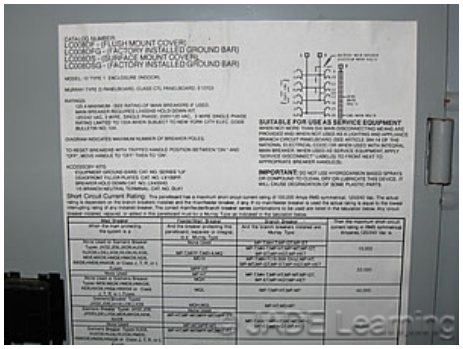
Panelboards are not limited to 42 overcurrent devices.

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 12: 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 13: 408.4 Circuit Directory or Circuit Identification.

Question ID#: 2114

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 occupancy.

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.

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

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

Question 14: 408.54 Maximum Number of Overcurrent Devices.

Question ID#: 2115

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 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 15: 210.52(B) Small Appliance Circuits.

Question ID#: 2117

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.

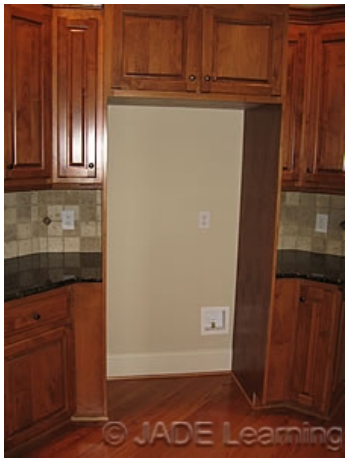
Minimum of two small appliance circuits are required in dwellings.

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

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

Question 16: 210.52(B)(1) Refrigerator Circuit. Exception No. 2.

Question ID#: 2118



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 16: 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 17: 210.52(C) Countertops.

Question ID#: 2119

The outlets required by 210.52(C) apply to countertops in pantries, breakfast rooms and similar areas in dwelling units as well as in kitchens and dining rooms. The same rules for countertop receptacles that apply to ranges and sinks apply to countertop cooking units as well.

Also, 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 if the width of the countertop behind the cooking unit, range, or sink is less than 12 inches.

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.

Receptacle spacing for countertops.

Question 17: Assume the cooktop in the photo is 36 inches long and 24 inches wide. In the photo, if the countertop width behind the cooktop is less than 12 inches wide and the countertop on each side of the cooktop is more than 12 inches wide and 36 inches long, how many receptacle outlets are required on this island countertop?

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

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

Question ID#: 2120

No point along the wall line can exceed 24 in. measured horizontally from a receptacle outlet.

The photograph of the kitchen countertop receptacle shows a Code violation. To avoid this mistake in the future, the installer needs to: (1) know the Code requirement to install a receptacle outlet so that an appliance sitting on the countertop with a 2 ft. cord will reach the outlet; (2) have the ability to properly scale drawings; and (3) communicate with the cabinet builders for any changes in the drawings.

It is best to have the cabinet builder draw out the actual cabinet design on the kitchen floor because the typical 1/4 in. per foot scale on the drawing is too tight a tolerance for the close kitchen layout. It is better to add an extra receptacle than to guess at the scale minimum. The location of framing members also affects receptacle layout; and, installing receptacles on studs regardless of their location relative to cutouts in the countertop may cause the receptacles to be spaced too far apart. In such cases, you may have to add studs or framing members to allow correct placement of receptacles.

Question 18: If the ceramic tile measures 4 X 8-inches; the installation is a violation because the receptacle is

A: Mounted too high above the countertop cabinet.
B: Too far from the edge where the countertop is cut out for the range.
C: Not a GFCI receptacle.
D: Is flush mounted in ceramic tile.

Question 19: 210.52(C)(1) Receptacles Behind Sink.

Question ID#: 2121

The countertop space directly behind a range, counter-mounted cooking unit or sink may require a receptacle. Whether or not a receptacle outlet is necessary depends on the distance from the sink, range or cooktop to the wall above the countertop.

Outlet is not required behind a sink where the space is less than 18 in.

If a sink is mounted in a corner, then no outlet is required if the space from the back edge of the sink to the wall is less than 18 in. If a sink, range, or cooktop is mounted parallel to the countertop wall, then no receptacle outlet is required if the distance to the wall is less than 12 in.

Figure 210.52(C)(1) shows these dimensions, and a receptacle outlet is required if the space behind the sink, range or cooktop is greater than what is shown in the drawing.

If a countertop appliance was placed behind the sink and there was not an outlet, then the appliance cord could possibly stretch across the sink or stove.

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

A: The space from the backsplash to the edge of the sink is greater than 18 in.
B: Receptacle outlets are required within 24 in. of a sink.
C: The space from the backsplash to the edge of the sink is less than 18 in.
D: Receptacle outlets are required within 18 in. of the sink.

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

Question ID#: 2122

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 edge with the wall or other counter space. Of course, more outlets can be installed if desired.

Question 20: Receptacles installed for island and peninsular counters:

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

Question 21: 210.52(C)(5) Receptacles Below the Countertop. Exception.

Question ID#: 2123

Outlets installed below a countertop are dangerous. They are permitted under 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 if:

- They are mounted no more than 12 in. below the counter
- 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
- The kitchen will be used by physically impaired individuals

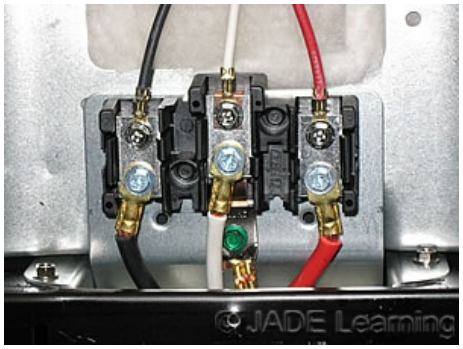
Required outlets shall be mounted not more than 12 in. below the countertop.

Question 21: Without applying the exception, which location would NOT be acceptable for a required kitchen counter, island, peninsular, or breakfast bar receptacle?

A: 8 in. below a flat island.
B: 6 in. below a breakfast bar that has a backsplash.
C: In the backsplash of a peninsula.
D: Within 18 in. of the sink.

Question 22: 250.142(B) Grounding Frames of Ranges.

Question ID#: 2124



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 22: 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 23: 422.16(B) Kitchen Appliances Connected by Cord and Plug.

Question ID#: 2125

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 23: 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 24: 210.11(C)(2) Laundry Branch Circuit.

Question ID#: 2127

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 is for the laundry receptacle outlet(s).

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

If there is a sink in the laundry area, any receptacle outlet within 6 ft. of the sink, including the outlet for the washing machine, must be GFCI protected.

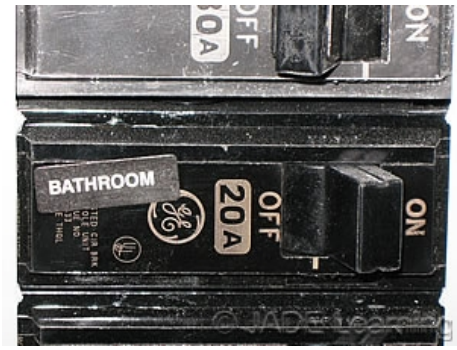
The 20 amp laundry circuit can have more than one outlet.

Question 24: In the photo above, there are two No.12 AWG NM cables installed in the washing machine receptacle box. Which of the following statements about the laundry branch circuit is correct?

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

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

Question ID#: 2128



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

A 20 amp circuit is required to supply the bathroom receptacle outlets. If other outlets 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 circuit is not permitted to supply receptacles or other outlets in another bathroom. However, if 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.

Question 25: The required 20 amp bathroom circuit which supplies a GFCI protected receptacle is permitted to:

A: Also supply a light fixture and fan in a single bathroom.
B: Supply all the loads in more than 1 bathroom.
C: Supply bathroom and laundry loads.
D: Supply bathroom and bedroom loads.

Question 26: 210.52(D) Receptacle Below the Basin Cabinet.

Question ID#: 2129

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 26: 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.

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

Question ID#: 2130

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. It would be unusual for a luminary 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 a bathroom which has a tub with a shower, it is:

A: Always required to be marked as suitable for a damp location.
B: Always required to be marked as suitable for a wet location.
C: Only required to be marked for a damp or wet location if it is within the actual outside measurements of the tub.
D: Unless it is subject to shower spray, a recessed luminaire that is installed 8 ft. or less vertically from the top of the tub rim and horizontally within the actual outside dimensions of the tub is only required to be marked for a damp location. However, if it is subject to shower spray, it must be marked for a wet location.

Living Areas (and Bedrooms)

Question 28: Fire Alarm Code: Smoke Detectors.

Question ID#: 2132

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 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 detectors are required?

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

Question 29: 210.12(B) AFCI. Dwelling Units.

Question ID#: 2133

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 family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sun rooms, recreation rooms, closets, hallways, or similar rooms or areas.

AFCIs are not required in bathrooms, kitchens, laundry rooms, 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. Bathroom, kitchen, garage and outdoor receptacle outlets supply different types of electrical loads. AFCI protection is not required in areas of a home where electrical loads may have different characteristics than bedroom loads. AFCI protection is only required in those areas of a dwelling with the types of loads that have a proven track record of being compatible with AFCI protection.

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, 20 ampere convenience receptacle installed in a finished basement.
C: A 120-volt, 15 ampere receptacle installed for a garbage disposal in the 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#: 2134

AFCI device can be installed at first outlet.

In locations where arc-fault protection is required in dwelling units, the entire branch circuit must be protected. That means all the branch circuit wiring from the panelboard to the last outlet on the circuit must be protected because any of that wiring is subject to arcing faults.

Exception No. 1 permits a combination type AFCI device to be installed as the first outlet in the branch circuit, which provides protection for the remaining portion of the branch circuit. This leaves the home run wiring between the panelboard and the first outlet without AFCI protection. If Exception No. 1 is used the home run wiring must be installed in RMC, IMC, EMT, Type MC, or steel armored Type AC cables meeting the requirements of 250.118. Metal boxes are also required.

A combination AFCI device can be installed as the first outlet on the branch circuit at any distance from the panelboard as long as the homerun is installed in one of the metallic wiring methods described in the exception.

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 homerun is installed in EMT and the AFCI receptacle is installed in a metal box.
B: The homerun is installed in flexible metal conduit.
C: The AFCI device is located within 6 ft. of the panelboard.
D: The entire branch circuit is installed in a metallic raceway.

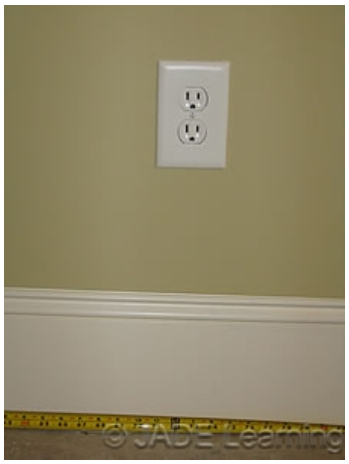
Question 31: 210.52 Dwelling Unit Receptacle Outlets.

Question ID#: 2135

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.



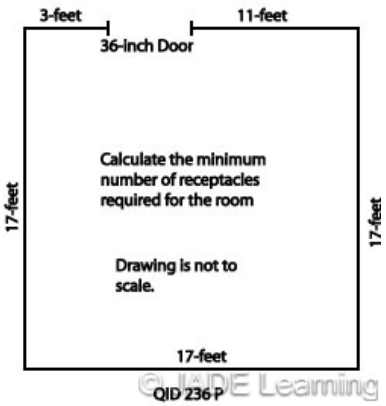
A switched receptacle is not allowed as a required receptacle.

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

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

Question ID#: 2136



No point in any wall space can be more than 6 ft from a receptacle.

"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."

Most electrical appliances and standing light fixtures have 6 ft. cords. The reason for the 6 ft. receptacle spacing requirement is to allow them to reach an outlet without using an extension cord. Extension cords are a tripping hazard and the cause of many electrical home fires. Receptacle outlets are placed 12 ft. apart so that no space between the receptacles is more than 6 ft. from an outlet.

Receptacle outlets are required in any wall space which is 2 ft. or more in width and unbroken at the floor line by doorways or other openings. Fixed room dividers, like bar-type counters, are considered wall space and require receptacle outlets just like walls.

Question 32: A living room is square and measures 17 ft. on each side with one 36 in. wide door located 3 ft. from one corner of the room. What is the minimum number of receptacles required for the room?

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

Question 33: 406.12 Tamper Resistant Receptacles.

Question ID#: 2137

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 33: 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 34: 210.52(H) Receptacles in Hallways.

Question ID#: 2139

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.

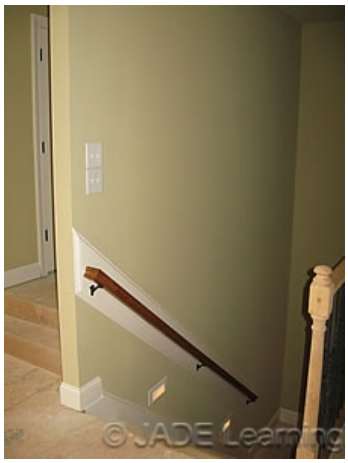
Hallways 10 ft. or more in length must have a receptacle.

Question 34: 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 35: 210.70(A)(2) Switches on Stairways.

Question ID#: 2140



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.

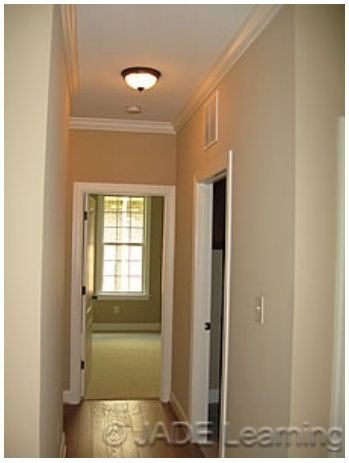
Question 35: The switches installed at the top and bottom of this set of stairs, in a dwelling, are required in which of the following situations?

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

Question 36: 210.70(A)(2)(a) Switch Controlled Lighting Outlets.

Question ID#: 2141

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 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#: 2142

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 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.

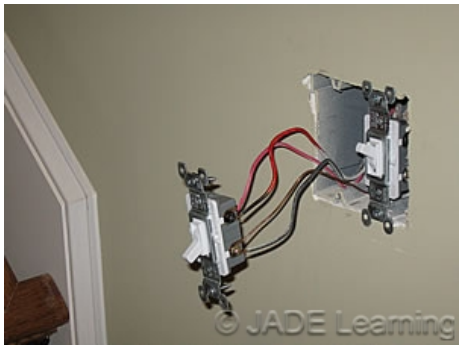
Question 37: Overcurrent devices are permitted to be installed in:

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

Luminaires, Fans and Switches

Question 38: 200.7(C)(1) Indentifying the Ungrounded Conductor in a Switch Leg.

Question ID#: 2144



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) Storage and Equipment Space Lighting.

Question ID#: 2145

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

Question 40: 314.27(A) Maximum Weight of a Luminaire Supported by a Box. Exception.

Question ID#: 2146

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 40: 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 41: 314.27(C) Boxes at Ceiling-Suspended Fan Outlets.

Question ID#: 2147

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. If a ceiling fan weighs more than the Code will allow, it must be supported independently of the box.

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

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

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

Question 42: 404.14(E) Dimmer Switches for Luminaires Only.

Question ID#: 2148

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

Question 43: 404.9(B)(1) Grounding Snap Switches.

Question ID#: 2149

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 43: 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 44: 410.74 Luminaire Rating.

Question ID#: 2150

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 44: 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 45: 410.16 Luminaires in Clothes Closets.

Question ID#: 2151

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 surface mounted completely enclosed LED luminaire installed within 6 in. of clearance from the Closet Storage Area.
D: A recessed completely enclosed LED luminaire installed with at least 6 in. of clearance from the Closet Storage Area.

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

Question ID#: 2152

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

Type IC (Insulation Contact) luminaires 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: 0 in.
B: 3 in.
C: 1/2 in.
D: 2 in.

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

Question ID#: 2153

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 47: 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 48: 210.52(E)(3) Outdoor Outlets.

Question ID#: 2155

Outdoor Outlets covers (1) One-Family and Two-Family Dwellings; (2) Multi-Family Dwellings and (3) Balconies, Decks, and Porches. The required outdoor outlets must be accessible while standing at grade level. _

A receptacle must be installed within the perimeter of the balcony, deck or porch if the balcony, deck or porch 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.

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.

Receptacle required on decks, porches and balconies.

Question 48: An outdoor outlet is required on a balcony:

A: Only if a person can reach the outlet while standing at grade level.
B: Only if the balcony measures at least 6 ft. by 3 ft.
C: If the balcony is accessible from inside the dwelling.
D: Only if the balcony is more than 20 sq. ft. and is accessible from an inside room.

Question 49: 210.52(E) Outdoor Outlets. Balconies. Exception.

Question ID#: 2156

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 49: 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 50: 210.52(G) Basements and Garages.

Question ID#: 2157

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.

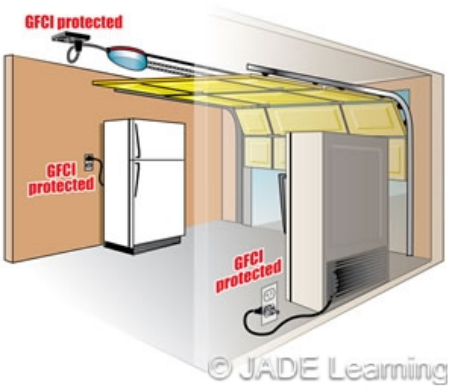
All locations except industrial establishments, 125-volt, single-phase, 15 and 20 ampere outdoor receptacle outlets require GFCI protection.

Question 50: 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 51: 210.8(A)(2) GFCI Protection.

Question ID#: 2158



Receptacles in garages and accessory buildings must be GFCI protected.

All receptacle outlets installed in dwelling unit garages, accessory buildings having floors at or below grade level that are used for storage and work areas, and receptacle outlets in unfinished basements must have GFCI protection for personnel.

All 125-volt, single-phase, 15- and 20-ampere receptacles installed in garages, accessory buildings and unfinished basements must be GFCI protected. The only exception is for a receptacle supplying a fire alarm or burglar alarm system in an unfinished basement.

It doesn't matter if the receptacle outlet is behind dedicated equipment which is not easily moved, like a freezer. It doesn't matter if the receptacle outlet is not readily accessible, like an outlet for a garage door opener. Both types of outlets, because they are located in the garage, must be GFCI protected.

Question 51: Which of the following 125-volt, single-phase, 15- and 20-ampere receptacle outlets in a garage building is NOT required to have GFCI protection for personnel?

A: A receptacle outlet mounted 7 ft. above the floor.
B: A single receptacle outlet used to supply a freezer.
C: A duplex receptacle outlet used for two appliances in dedicated space.
D: A receptacle located in a habitable room above the garage on the second floor.

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

Question ID#: 2159

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.

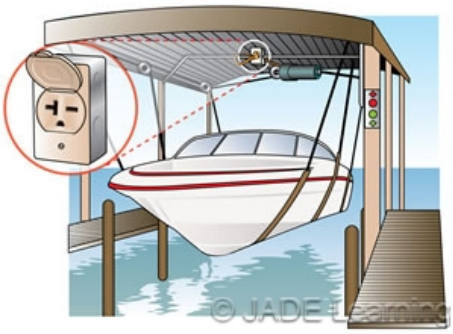
Receptacles located outdoors must be GFCI protected.

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: Only 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed in public spaces 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: A 125-volt, single-phase, 15- and 20-ampere receptacle outlet installed outdoors with a weatherproof cover does not require GFCI protection.

Question 53: 210.8(C) Boat Hoists.

Question ID#: 2160



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 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: 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 54: 225.26 Outside Wiring Cannot be Supported by Vegetation.

Question ID#: 2161

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.

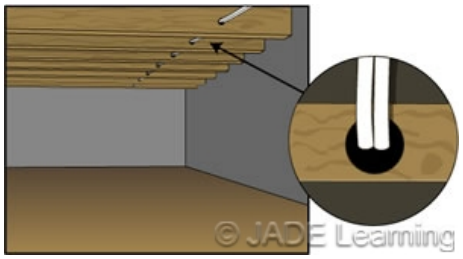
Trees shall not be used to support overhead conductors.

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

A: 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 55: 334.15(C) Exposed Work in Unfinished Basements and Crawl Spaces.

Question ID#: 2162



NM cables through bored holes in crawl spaces.

In unfinished basements and crawl spaces, NM cable in sizes #14, #12, and #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 #8 AWG conductors must also be installed through bored holes or protected by running boards, but cables having more than two #8 conductors can be secured directly to the bottom of the joists. If the conductors in a cable are larger than #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 two conductor #6 NM cable.
B: A two conductor #10 NM-B cable.
C: A three conductor # 4 NM cable.
D: A three conductor #8 NMS cable.

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

Question ID#: 2163

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

Question ID#: 2164

Outlets installed in wet or damp locations must be listed weather-resistant.

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.

Currently, 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 2008 NEC no longer permits standard receptacles in damp or wet locations.

The NEC now requires 15- and 20-ampere non-locking receptacles, rated 125 and 250 volts installed in damp and wet locations to be weather resistant. These receptacles are coated with a conformal weather resistant coating that is not used on standard non-weather resistant receptacles. In damp and wet location weather resistant receptacles are still required to be installed in weatherproof enclosures or using weatherproof covers for recessed boxes.

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

A: Receptacles installed outdoors in a wet location must have an enclosure that is weatherproof when the attachment plug cap is not inserted and the receptacle covers are closed.
B: Twist-lock receptacles must be weather-resistant when installed in damp or wet locations.
C: Receptacles installed outdoors in a damp location must have an enclosure that is weatherproof whether or not a plug cap is installed.

D: A 125 volt, 20 amp receptacle non-locking receptacle must be weather-resistant when installed in a wet location.

Question 58: Article 411 Landscape Lighting.

Question ID#: 2165

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 58: 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 59: Table 110.26(A)(1) Working Space.

Question ID#: 2167

Table 110.26(A)(1) requires clear working space in front of equipment such as the heat pump in the photo. Some jurisdictions allow the disconnect to be located behind the equipment as long as there is ready access and the doors will open to 90Â°.

Often it is difficult to maintain the working space. The vegetation located in this area does not allow ready access and as the plant grows it will impede access altogether and affect appliance operation. The installation shown in the photo is a Code violation.

Shrubbery cannot interfere with working space.

Question 59: The voltage to ground on a certain piece of equipment is 120 volts. According to Table 110.26(A)(1), what is the required depth of the working space?

A: 3 ft.
B: 3 ft. 6 in.
C: 4 ft.
D: 4 ft. 6 in.

Question 60: 210.63 HVAC Equipment Outlet.

Question ID#: 2168

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

Question 61: 338.10(B)(4) Ampacity of SE Aluminum Cable.

Question ID#: 2169

SE aluminum cable is one of the most commonly used wiring methods for wiring up to the HVAC disconnecting means. Most brands of heating equipment require the connection to their equipment to be copper so the whip to the equipment is typically copper. The high cost of copper has made the use of aluminum more attractive.

For many years, SE cable was sized using the 75Âº C column. Now the feeder and branch circuit size for SE cable installed in thermal insulation must be selected from the 60Âº C column. This means that larger sizes of SE cable will be necessary. For example, a cooling unit with a minimum circuit ampacity of 38 amps requires a #6 SE Aluminum cable. If using the 75Âº C column of Table 310.15(B)(16) was permitted, a #8 SE Aluminum cable would have been big enough.

For interior wiring the ampacity of SE cable installed in thermal insullation shall be figured at 60Â° C.

Question 61: The branch circuit from the panelboard to a heating unit disconnect is type SE aluminum and must be sized for a minimum circuit ampacity of 59 amps. What is the correct size conductors when installed in thermal insulation?

A: #6 AWG.
B: #4 AWG.
C: #3 AWG.
D: #1 AWG.

Question 62: Article 424 Electric Heating Equipment.

Question ID#: 2170

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 62: 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 63: 440.14 Disconnect for HVAC Equipment.

Question ID#: 2171

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 63: 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.

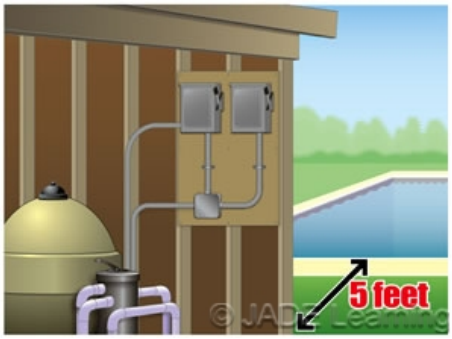
Swimming Pools and Spas

Question 64: 680.12 Maintenance Disconnecting Means.

Question ID#: 2173

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.

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

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 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

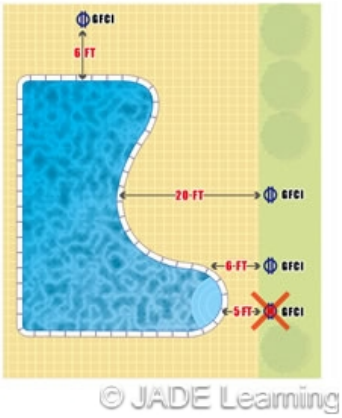
of the pool. Luminaires and paddle fans cannot be installed overhead within 5 ft. of the edge of the pool. Switching devices must be located at least 5 ft. horizontally from the inside walls of a pool, unless a barrier is installed.

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

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

Question 65: 680.22(A) Receptacles.

Question ID#: 2174



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 65: 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.

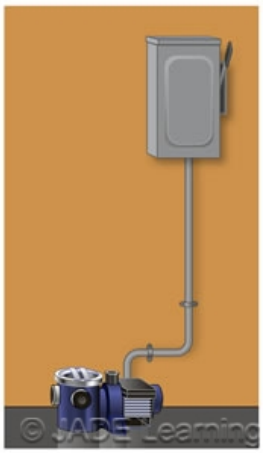
Question 66: 680.21(C) GFCI Protection.

Question ID#: 2175

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 66: 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 67: 680.43(A)&(B) Receptacles and Luminaires Near Indoor Spas.

Question ID#: 2176

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 67: 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 68: 680.71 Hydromassage Bathtubs. Protection.

Question ID#: 2177

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 68: 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.

Generators

Question 69: 702.4 Optional Standby Systems. System Capacity.

Question ID#: 2179

Calculating the load supplied by a generator is the same as calculating the load for a building supplied by a utility service. Use Article 220.

However, the size and capacity of the generator for an Optional Standby System depends on the type of transfer equipment 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. The user of the Optional Standby System is permitted to select the loads connected to the generator.

For Optional Standby Systems using automatic transfer switches, the generator must be rated to carry the full load that is transferred by the automatic transfer equipment. If there is a load management system which can determine which loads are supplied at any one time, the generator must be rated to supply the maximum load which will be supplied simultaneously.

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

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

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

Question 70: 702.7 Signs.

Question ID#: 2180

A sign must be located at the service to indicate the location of the generator.

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.

Question 70: Which of the following statements about Optional Standby Systems is true?

A: Power is required to be restored within 60 seconds of failure of the normal power system.
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.
D: Signs indicating the location of the second power source shall be placed at the service-entrance location and the Optional Standby Location.

Question 71: 250.35 Grounding Permanently Installed Generators.

Question ID#: 2181

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.

For nonseparately derived systems an equipment bonding jumper is required to be installed from the generator overcurrent device to the first disconnect. Usually this equipment bonding jumper is on the load side of the generator overcurrent device and is sized according to Table 250.122, based on the size of the generator overcurrent device.

Grounding depends on whether the generator is a separately derived system.

Question 71: A 10 KW standby generator is installed at a single family dwelling. The generator overcurrent device is rated 50 amperes. What size copper conductor is required for the equipment bonding jumper?

A: #12 AWG.
B: #10 AWG.
C: #8 AWG.

D: #6 AWG.

Limited Energy

Question 72: 250.94 Bonding for Other Systems.

Question ID#: 2183

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

An intersystem bonding termination is required to be installed at the service equipment and at the disconnecting means for any additional buildings. The purpose of the intersystem bonding termination is to provide a means to connect bonding and grounding conductors from other 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.

The intersystem bonding termination must be one of the following:

"(1) A set of terminals securely mounted to the meter socket enclosure and electrically connected to the meter socket enclosure. The terminals and the enclosure shall be listed for grounding.

(2) A bonding bar near the service equipment enclosure, meter socket enclosure or raceway for service conductors. The bonding bar shall be connected with a minimum 6 AWG copper conductor to an equipment grounding conductor(s) in the service equipment enclosure, meter socket enclosure or exposed nonflexible metallic raceway.

(3) A bonding bar near the grounding electrode conductor. The bonding bar shall be connected to the grounding electrode conductor with a minimum 6 AWG copper conductor."

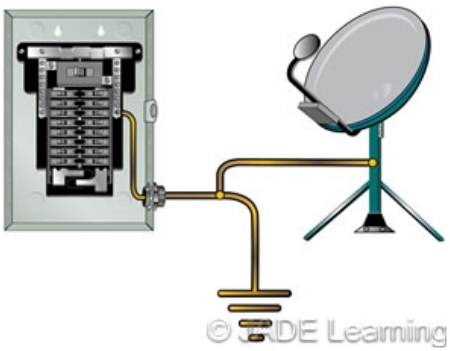
Low voltage systems like Cable TV, Satellite TV, and telephone are bonded to the power grounding electrode system to prevent differences of potential from developing between them and the electrical system. If a high voltage is impressed on one of the systems because of a lightning strike or contact with 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 system.

Question 72: The intersystem bonding termination is required to be installed:

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

Question 73: 250.94 Bonding for Other Systems. Exception.

Question ID#: 2184



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."

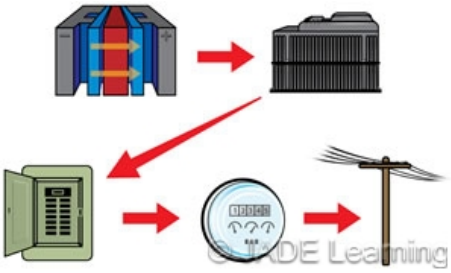
Question 73: A satellite dish is installed at a mobile home in a rural area. The existing service is run in PVC conduit. Which of the following is a TRUE statement?

A: 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 74: 692.65 Utility-Interactive Point of Connection.

Question ID#: 2185

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 74: 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.

Question 75: 800.156 Dwelling Unit Communications Outlet.

Question ID#: 2186

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 reliable way to contact emergency personnel or the fire department. 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 single family dwelling.
B: A new multifamily dwelling unit.
C: A college dormitory room without cooking facilities.
D: A new two-family dwelling unit.

Installation and Wiring Methods

Question 76: Table 110.28 Enclosure Selection Table.

Question ID#: 2188

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 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: 3R.
C: 5.
D: 12.

Question 77: 110.(3)(B) Installation Instructions.

Question ID#: 2189

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 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 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 78: 210.24 Branch Circuit Requirements – Summary & 210.21(B)(1) Outlet Devices.

Question ID#: 2190

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

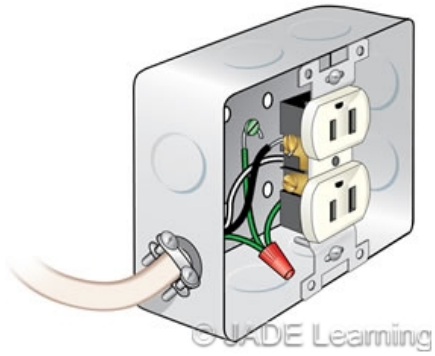
Question 79: 250.8 Connection of Grounding and Bonding Equipment.

Question ID#: 2191

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."***



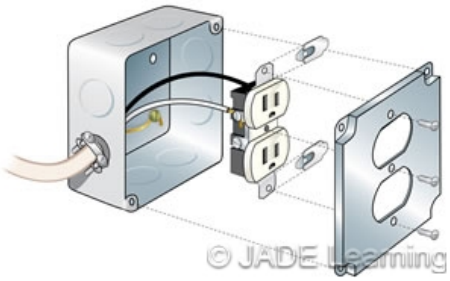
Grounding screws are used to ground metal boxes.

Question 79: 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 80: 250.146(A) Surface Mounted Box.

Question ID#: 2192



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 80: 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 81: 300.4(A)(1) Cables and Raceways Through Wood Studs.

Question ID#: 2193

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 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 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 82: Table 300.5 Burial Depth of Conductors and Raceways.

Question ID#: 2194

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 82: 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 83: 314.16(B)(4) Device or Equipment Fill.

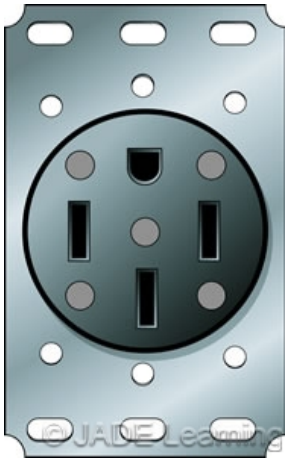
Question ID#: 2195

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 83: 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 84: 314.20 Boxes in Wall or Ceiling.

Question ID#: 2196

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 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 85: 314.20 Listed Box Extender.

Question ID#: 2197

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

Question 86: 314.24 Minimum Depth of Boxes.

Question ID#: 2198

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 86: 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 87: 334.12(A)(9) NM Cable Installation.

Question ID#: 2199

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

Question 88: 334.12(B)(4) NM Cable Not Permitted in Damp Locations.

Question ID#: 2200

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

Question 89: 334.23 & 320.23 NM Cable in Accessible Attics.

Question ID#: 2201

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: 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 90: 334.30 Securing and Supporting NM Cable.

Question ID#: 2202

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 90: 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?

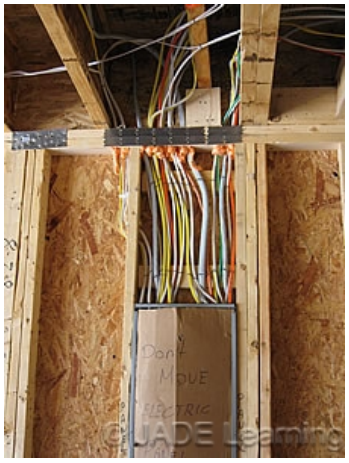
A: 0.
B: 1.
C: 2.
D: 3.

Question 91: 334.80 Ampacity.

Question ID#: 2203

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 derated.

Derating is done by applying the same table used to derate conductors in conduit, Table 310.15(B)(3)(a). The Table requires 4 to 6 conductors to be derated to 80% of their rating from Table 310.15(B)(16) and 7 to 9 conductors derated to 70% of their value in Table 310.15(B)(16). Higher derates apply to a larger number of conductors. According to 334.80, the ampacity of NM cable is 60Â° C, but the 90Â° C rating is permitted to be used for derating purposes.



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

Question 91: What is the ampacity of each conductor in a 12/3 with ground NM cable if it passes through a 1 in. fire-stopped hole in wood framing with 2 other 12/2 with ground NM cables? Assume all conductors except grounds are current carrying and rated for 30 amps (90Â° C rating from Table 310.15(B)(16)).

A: 30 amps.
B: 24 amps.
C: 21 amps.
D: 12 amps.

Question 92: 338.10(B)(4) Ampacity of SE Cable.

Question ID#: 2204

Ampacity of SE cable used for interior wiring to be calculated at 60Â° C.

Service Entrance (SE) cable must be sized from the 60Â°C column of Table 310.15(B)(16) when installed in thermal insulation. In a previous example above, the size of SE cable run to an HVAC disconnect had to be increased a whole size because the 60Â°C column was used instead of the 75Â°C column.

SE cable is often used to feed subpanels in single family and multi-family dwellings. Sizing the SE cable feeder from the 60Â°C column of Table 310.16 will result in larger feeders for subpanels and other types of equipment.

Question 92: An aluminum SE cable feeder is used to supply a 100 amp load. What is the minimum size feeder when installed in thermal insulation?

A: 2/0 AWG.
B: 1/0 AWG.
C: #1 AWG.
D: #2 AWG.

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

Question ID#: 2205

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: Receptacles mounted in boxes that are set back from the finished surface as allowed in 314.20 _____.

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

Practical Exercises

Question 94: Garage GFCI Receptacles.

Question ID#: 2207

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

Use the blueprint to answer the question.

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

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

Question 95: AFCI Protected Outlets.

Question ID#: 2208

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

Use the blueprint to answer the question.

Question 95: Which locations require AFCI protected outlets?

A: Kitchen.
B: Great Room.
C: Master Bath.
D: Garage.

Question 96: Tamper Resistant Outlets.

Question ID#: 2209

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

Use the blueprint to answer the question.

Question 96: The space above the dishwasher is not a countertop; it is a built-in bookcase for cookbooks. A single receptacle is installed for the dishwasher and another single receptacle is installed for the refrigerator. The receptacle on the right side of the sink is in a dedicated space for the dishwasher which is located in the cabinet under the bookshelf. There is not a receptacle in the bookcase.According to the 2011 NEC, how many receptacle outlets in the kitchen must be tamper resistant?

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

Question 97: Ampacity Rating of SE Cable.

Question ID#: 2210

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

Use the blueprint to answer the question.

Question 97: The range in the kitchen is rated for 40 amperes. What is the minimum size aluminum SE cable that can be installed to the range when installed in thermal insulation?

A: #6 AWG.
B: #8 AWG.
C: #4 AWG.
D: 1/0 AWG.

Question 98: Weather Resistant Receptacles.

Question ID#: 2211

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

Use the blueprint to answer the question.

Question 98: Weather resistant receptacle outlets are required to be installed:

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

Question 99: Bonding Jumper for Gas Pipe.

Question ID#: 2212

Use the blueprint to answer the question.

Question 99: A gas log assembly is equipped with a fan and remote control system which is supplied by a 120-V, 20-A circuit. The gas logs are connected with CSST gas pipe.
Some states, including New Mexico, have state codes that have modified the NEC requirements for bonding CSST. However, the NEC requirements for bonding CSST are the same as for bonding other types of metal piping.
According to the NEC, what size copper bonding jumper is required to bond the gas pipe?

A: #12 AWG.
B: #8 AWG.
C: #6 AWG.
D: #4 AWG.

Question 100: Indoor Switch for Outdoor Lights.

Question ID#: 2213

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

Use the blueprint to answer the question.

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 floodlights must be IC rated.
D: The switch and floodlight must be GFCI protected.

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
2.) A B C D	22.) A B C D	42.) A B C D	62.) A B C D	82.) A B C D
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
5.) A B C D	25.) A B C D	45.) A B C D	65.) A B C D	85.) A B C D
6.) A B C D	26.) A B C D	46.) A B C D	66.) A B C D	86.) A B C D
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
8.) A B C D	28.) A B C D	48.) A B C D	68.) A B C D	88.) A B C D
9.) A B C D	29.) A B C D	49.) A B C D	69.) A B C D	89.) A B C D
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
19.) A B C D	39.) A B C D	59.) A B C D	79.) A B C D	99.) A B C D
20.) A B C D	40.) A B C D	60.) A B C D	80.) A B C D	100.) A B C D

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