**Electrical House Wiring**

**Package A**

 

**Information Booklet** **Table of Contents**

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Electrical Site Safety

#### Why is it so important to work safely with or near electricity?

The electrical [current](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#current) in regular businesses and homes has enough power to cause death by electrocution. Even changing a light bulb without unplugging the lamp can be hazardous because coming in contact with the "hot" or live part of the socket could kill a person.

#### What kinds of injuries result from electrical currents?

There are four main types of injuries: electrocution (fatal), electric shock, burns, and falls. These injuries can happen in various ways:

* direct contact with the electrical energy.
* when the electricity arcs (jumps) through a gas (such as air) to a person who is [grounded](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#ground) (that would provide an alternative route to the ground for the electricity).
* thermal burns including flash burns from heat generated by an electric arc, and flame burns from materials that catch on fire from heating or ignition by electrical currents.
* High voltage contact burns can burn internal tissues while leaving only very small injuries on the outside of the skin.
* muscle contractions, or a startle reaction, can cause a person to fall from a ladder, scaffold or aerial bucket. The fall can cause serious injuries.

#### What are some general safety tips for working with or near electricity?

* Inspect tools, power cords, and electrical fittings for damage or wear prior to each use. Repair or replace damaged equipment immediately.
* Always tape cords to walls or floors when necessary. Nails and [staples](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#staple) can damage cords causing fire and shock hazards.
* Use cords or equipment that is rated for the level of amperage or wattage that you are using.
* Always use the correct size fuse. Replacing a fuse with one of a larger size can cause excessive currents in the wiring and possibly start a fire.
* Be aware that unusually warm or hot outlets may be a sign that unsafe wiring conditions exists. Unplug any cords to these outlets and do not use until a qualified electrician has checked the wiring.
* Always use ladders made of wood or other non-conductive materials when working with or near electricity or power lines.
* Place halogen lights away from combustible materials such as cloths or curtains. Halogen lamps can become very hot and may be a fire hazard.
* Risk of electric shock is greater in areas that are wet or damp. Install Ground Fault Circuit Interrupters (GFCIs) as they will interrupt the electrical circuit before a current sufficient to cause death or serious injury occurs.
* Make sure that exposed [receptacle](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle) boxes are made of non-conductive materials.
* Know where the [breakers](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#circuitbreaker) and boxes are located in case of an emergency.
* Label all circuit [breakers](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#circuitbreaker) and fuse boxes clearly. Each [switch](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#switch) should be positively identified as to which outlet or appliance it is for.
* Do not use outlets or cords that have exposed wiring.
* Do not use power tools with the guards removed.
* Do not block access to circuit [breakers](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#circuitbreaker) or fuse boxes.
* Do not touch a person or electrical apparatus in the event of an electrical accident. Always disconnect the [current](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#current) first.

**What are some tips for working with power tools?**

* Switch tools OFF before connecting them to a power supply.
* Disconnect power supply before making adjustments.
* Ensure tools are properly [grounded](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#ground) or double-insulated. The grounded tool must have an approved 3-wire cord with a 3-prong plug. This plug should be plugged in a properly grounded 3-pole outlet.
* Test all tools for effective grounding with a [continuity](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#continuity) tester or a ground fault circuit interrupter (GFCI) before use.
* Do not bypass the switch and operate the tools by connecting and disconnecting the power cord.
* Do not use electrical tools in wet conditions or damp locations unless tool is connected to a GFCI.
* Do not clean tools with flammable or toxic solvents.
* Do not operate tools in an area containing explosive vapors or gases.

#### What are some tips for working with power cords?

* Keep power cords clear of tools during use.
* Suspend power cords over aisles or work areas to eliminate stumbling or tripping hazards.
* Replace open front plugs with dead front plugs. Dead front plugs are sealed and present less danger of shock or [short circuit](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#shortcircuit).
* Do not use light duty power cords.
* Do not carry electrical tools by the power cord.
* Do not tie power cords in tight knots. Knots can cause [short circuits](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#shortcircuit) and shocks. Loop the cords or use a twist lock plug.

#### What is a Ground Fault Circuit Interrupter (GFCI)?

A Ground Fault Circuit Interrupter (GFCI) works by detecting any loss of electrical current in a circuit. When a loss is detected, the GFCI turns the electricity off before severe injuries or electrocution can occur. A painful shock may occur during the time that it takes for the GFCI to cut off the electricity so it is important to use the GFCI as an extra protective measure rather than a replacement for safe work practices.

GFCI wall outlets can be installed in place of standard outlets to protect against electrocution for just that outlet, or a series of outlets in the same branch. A GFCI Circuit Breaker can be installed on some circuit breaker electrical panels to protect an entire branch circuit. Plug-in GFCIs can be plugged into wall outlets where appliances will be used.

#### When and how do I test the Ground Fault Circuit Interrupter (GFCI)?

Test the GFCI monthly. First plug a "night light" or lamp into the GFCI-protected wall outlet (the light should be turned on), then press the "TEST" button on the GFCI. If the GFCI is working properly, the light should go out. If not, have the GFCI repaired or replaced. Reset the GFCI to restore power.

If the "RESET" button pops out but the light does not go out, the GFCI has been improperly wired and does not offer shock protection at that wall outlet. Contact a qualified electrician to correct any wiring errors.

#### What is a sample checklist for basic electrical safety?

* Inspect Cords and Plugs
* Check power cords and plugs daily. Discard if worn or damaged. Have any cord that feels more than comfortably warm checked by an electrician.
* Eliminate Octopus Connections
* Do not plug several power cords into one outlet.
* Pull the plug, not the cord.
* Do not disconnect power supply by pulling or jerking the cord from the outlet. Pulling the cord causes wear and may cause a shock.
* Never Break OFF the Third Prong on a Plug
* Replace broken 3-prong plugs and make sure the third prong is properly grounded.
* Never Use Extension Cords as Permanent Wiring
	+ Use extension cords only to temporarily supply power to an area that does not have a power outlet.
* Keep power cords away from heat, water and oil. They can damage the insulation and cause a shock.
* Do not allow vehicles to pass over unprotected power cords. Cords should be put in conduit or protected by placing planks alongside them.

Common Electrical Code Requirements by Fixture

#### Service Panel

* all circuits must be attached to the [ground](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#ground).
* close all unused [service panel](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#servicepanel) openings.

#### Electrical Boxes

* Always use boxes that are [large enough](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elec08abc/boxfill.html) to hold all of the wires safely.
* locate all electrical boxes 12" above the finished floor.
* locate all [switch](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#switch) boxes 48" above the finished floor.
* the locations of boxes may be altered if there are special circumstances, such as a child's bedroom or for wheelchair accessibility.
* leave a minimum of 8" of wire extend past the front of the electrical box.

#### Wires and Cables

* Use wires that can handle the amperage of the circuit.
* Drill holes at least 2" from the edge of joists or studs to run cables through.
* run cables at right angles to adjoining framing members.
* If you have to drill closer than 2" to the edge, use a [nail plate](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elec09a/nailprotection.html) to protect the wire.
* try to run the wire 20" above the floor.
* do not bend wires at right angles, or bend them sharply.
* make sure that wire connections or splices are placed entirely inside of electrical boxes.
* use [wire connectors (marrettes)](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elec08abc/appliances.html) to join wires.
* every wire needs to be attached with a wire [staple](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#staple) within 8" of an electrical box and every 48" along its run.
* Leave at least 1/4", but not more than 1" of sheathing where a wire enters an electrical box
* Make sure that wires are attached to electrical boxes with approved non metallic clamps
* Connect a single wire to a single screw [terminal](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#terminal). If you need to attach more wires, make sure that you use a pigtail.

#### Switches

* every room must have either a built in light fixture or a [switch](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#switch) operated [receptacle](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle) to control a lamp.
* Use three way switches at the top and bottom of stairs, and at either ends of a hallway.
* If you are using plastic boxes, use [switches](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#switch) that have a grounding screw.
* Make sure that [switches](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#switch) are within easy reach of doorways

#### Receptacles

* make sure that the [receptacle](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle) is rated for the amperage of the circuit that it is connected to.
* there should be a [receptacle](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle) on every wall that is 24" or longer.
* there should be a [receptacle](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle) at least every 12 feet although they can be as close as every 6 feet.
* You should use grounded [receptacles](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle) for every circuit.
* You should have [GFCI receptacles](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elec08abc/gfci/gfci.html) in the first [receptacle](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle) in a circuit in bathrooms, kitchens, garages, and any outdoor circuits.

#### Lighting Fixtures

* Make sure that octagonal boxes are secured to joists, etc, with straps or with blocking.
* Make sure that you follow the [installation instructions](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elec08abc/recessedlight.html) for recessed lighting.
* There must be at least one switch operated light or [receptacle](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle) in every room.

#### Grounding

* All [receptacles](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle) must have the [ground wire](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#groundingwire) attached to the box and to the [receptacle](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle).
* If you are using plastic boxes, use switches that have a grounding screw.

Common Electrical Code Requirements by Room

#### Kitchen and Dining Rooms

* use split receptacles so that you can have more than 1 item plugged into a receptacle, and they will be on separate circuits.
* You should have at least 2 circuits (preferably 4) for small appliances in a kitchen.
* Refrigerator get there own 15 [amp](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#Ampere) dedicated [circuit](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#circuit).
* there should be a dedicated 40 or 50 amp, 240 [volt](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#volt) service for a range, or 2 circuits if there are separate oven and stovetop units.
* make sure that wiring is in place if there are built ins, such as microwaves, exhaust hoods, garburators, etc.
* Every counter should have a [receptacle](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle).
* Receptacles should be 18" above the counter top, or half way between the lower and upper cupboards.
* Lighting for the kitchen and dining rooms should be on a separate circuit from the small appliance circuits.
* Add additional lighting for under cupboards and task specific lighting, such as over a sink or island.

#### Utility and Laundry Rooms

* install a separate 20 amp circuit for washing machines.
* there should also be a separate 30 amp 110/220 circuit for the dryer.
* Use [GFCI receptacles](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elec08abc/gfci/gfci.html) for all receptacles, except for freezers or dryers.
* There should be a separate 110/220 circuit for a furnace, depending if it us gas or electric.
* there should be a separate 110/220 circuit for a water heater, depending if it us gas or electric

#### Living Rooms and Bead Rooms

* There should be at least two 15 amp circuits.
* there should be at least 1 [duplex](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#duplex) receptacle every 12 feet although they can be as close as every 6 feet.
* Install a dedicated circuit for permanent appliances, such as window air conditioners, base board heaters, computers, etc.
* Make sure that there are [cable TV](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elec08abc/extra/coax/coax.html) and [telephone jacks](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elec08abc/extra/phone/phone.html) on all walls, so that you won't have cords on the floor in front of door ways, etc.

#### Outdoors

* always dial before you dig, checking for telephones, cable TV, natural gas, water and sewer lines.
* make sure that you use cable that is rated for out doors.
* All receptacles should be protected by [GFCI circuits](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elec08abc/gfci/gfci.html).

#### Stairs and Hallways

* use three way switches in hallways or stairwells.
* Make sure that you have [receptacles](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle) in hallways, for vacuum cleaners, etc.
* make sure that there is sufficient lighting in stairwells, and that the lighting comes from more than one [source](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#source).

Wire Color Chart

|  |  |
| --- | --- |
| **Wire Color** | **Purpose** |
| White | neutral wire carrying [current](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#current) at zero [voltage](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#voltage) |
| Black | [hot](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#hotwire) wire carrying [current](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#current) at full [voltage](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#voltage) |
| Red | [hot](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#hotwire) wire carrying [current](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#current) at full [voltage](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#voltage) |
| White with black markings | [hot](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#hotwire) wire carrying [current](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#current) at full [voltage](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#voltage) |
| Green | serves as a pathway to [ground](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#ground) |
| Bare copper | serves as a pathway to [ground](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#ground) |

Wire Gauge and Uses

Wire is measured by units of the American Wire Gauge system. The larger the number, the smaller the AWG number.

|  |  |
| --- | --- |
| **Wire****Gauge** | Purpose |
| *#6* | * 60 [amps](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#Ampere)
* 240 [volts](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#volt)
* central air conditioner or Electric Furnace
 |
| *#8* | * 40 [amps](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#Ampere)
* 240 [volts](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#volt)
* electric range, central air conditioner
 |
| *#10* | * 30 [amps](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#Ampere)
* 240 [volts](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#volt)
* window air conditioner, clothes dryer
 |
| *#12* | * 20 [amps](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#Ampere)
* 120 [volts](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#volt)
* light fixtures, [receptacles](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle), microwave oven
 |
| *#14* | * 15 [amps](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#Ampere)
* 120 [volts](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#volt)
* light fixtures, [receptacles](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle)
 |
| *#16* | * light duty extension cords
 |
| *#18-#22* | * Thermostats, doorbells, security systems
 |

Outlet boxes

There are numerous types of electrical boxes that are used in residential wiring. Here are some common boxes and their uses:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|

|  |  |
| --- | --- |
| [*octboxsm*](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elec08abc/images/octbox.jpg)Octagon Box  | * Used for light fixtures
* can also be used with a cover plate, as a [junction box](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#junction)
 |
| *handysm2Handy Box* | * used for masonry and surface mounting
* used for [switches](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#switch) and [duplex](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#duplex) [receptacle.](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#receptacle)
 |
| *ganged2smStud Box* | * Gangable, meaning they can be attached together, making a box for more than 1 outlet or [switch.](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#switch)
* Notice the tabs that stick out, for positioning the box for 1/2" from the face of the stud. This will make the box flush with
* In this instance there are two boxes that are already joined, or ganged, together.
 |
| *extboxsmSealed Box* | * used where the box and outlet may be exposed to weather.
 |
| *coverplatesmCover Plate* | * used to cover [junction boxes](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#junction), or boxes with live wires, but without an outlet or [switch](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#switch).
* All [junction boxes](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#junction) require a cover to protect from something being jammed into a live box.
 |
| *Extension Ring* | * used to make the box deeper, allowing for more wires to be used inside the box, and not go over the box fill limits.
 |
| [*saucerboxsm*](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elec08abc/images/81pics/saucerbox.GIF)*Saucer Box* | * essentially a shallow box used at the end of a run.
* Be sure to never use the center knock out on a saucer box.
 |
| *vapour2smPre-formed Tray* | Each type of electrical box must have a [vapor barrier](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#vapourbarrier) around the outlet box, wherever it penetrates the [vapor barrier](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#vapourbarrier). This can be as simple as a piece of plastic, or a pre-formed plastic tray. The purpose of the [vapor barrier](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#vapourbarrier) around the boxes is two fold: * It prevents air movement from outside flowing through your outlet, creating a cool breeze near from every outlet.
* It prevents warm air from condensing in the outlet box when it contacts the cool air, thus preventing moisture in the outlet box.
 |

 |

The correct type of box must be used for each application. Municipal, Provincial and Federal codes need to be used to determine the correct type of box.

There are also a maximum number of wires that can be contained inside of each box. Again, this is dictated by the Municipal, Provincial and Federal codes. Here is a sample of some. Be sure the consult your local government codes before beginning any project.

Box Fill

In the tables below, there are a maximum number of wires or wires and [marrettes](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#marrette) that can be used, by code, in that size of electrical box. For example, in the top table, you can use 3 pieces of 14 gauge wire, 3 wires and 1 cap, or 2 wires and 2 caps in the single gang box. This includes any [grounding wires](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#groundingwire), or other wires.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Each section is 3x2x1 1/2**Single Gang* |

|  |
| --- |
| **One switch or one outlet plus:** |
| Wires | 3 | 3 | 2 |
| Caps | 0 | 1 | 2 |

 |
| *Each section is 3x2x1 1/2**Double Gang* |

|  |
| --- |
| **Two switches or two outlets plus:** |
| Wires | 6 | 6 | 5 | 5 | 4 |
| Caps | 0 | 1 | 2 | 3 | 4 |

 |
| *each section is 3x2x1 1/2**3-gang* |

|  |
| --- |
| **Three switches or three outlets plus:** |
| Wires | 10 | 10 | 9 | 9 | 8 |
| Caps | 0 | 1 | 2 | 3 | 4 |

 |
| *each section is 3x2x2or3x2x2.25 Single Gang* |

|  |
| --- |
| **One switch or one outlet plus:** |
| Wires | 4 | 4 | 3 | 3 | 2 |
| Caps | 0 | 1 | 2 | 3 | 4 |

 |
| *each section is 3x2x2or3x2x2.25 Double Gang* |

|  |
| --- |
| **Two switches or two outlets plus:** |
| Wires | 9 | 9 | 8 | 8 | 7 | 7 |
| Caps | 0 | 1 | 2 | 3 | 4 | 5 |

 |
| *each section is 3x2x2or3x2x2.25 3-Gang* |

|  |
| --- |
| **Three switches or three outlets:** |
| Wires | 14 | 14 | 13 | 13 | 12 | 12 |
| Caps | 0 | 1 | 2 | 3 | 4 | 5 |

 |
| *3x2x2 1/2Single Gang* |

|  |
| --- |
| **Three switches or three outlets plus:** |
| Wires | 6 | 6 | 5 | 5 | 4 | 4 |
| Caps | 0 | 1 | 2 | 3 | 4 | 5 |

 |
| *3x2x2 1/2Double Gang* |

|  |
| --- |
| **Two switches or two outlets plus:** |
| **Wires** | 12 | 12 | 11 | 11 | 10 | 10 |
| **Caps** | 0 | 1 | 2 | 3 | 4 | 5 |

 |
| *3x2x2 1/23-Gang* |

|  |
| --- |
| **Three switches or three outlets plus:** |
| **Wires** | 19 | 19 | 18 | 18 | 17 | 17 |
| **Caps** | 0 | 1 | 2 | 3 | 4 | 5 |

 |
| *3x2x3Single Gang* |

|  |
| --- |
| **One switch or one outlet plus:** |
| **Wires** | 8 | 8 | 7 | 7 | 6 | 6 |
| **Caps** | 0 | 1 | 2 | 3 | 4 | 5 |

 |
| *3x2x3Double Gang* |

|  |
| --- |
| **Two Switches or two outlets plus:** |
| **Wires** | 16 | 16 | 15 | 15 | 14 | 14 |
| **Caps** | 0 | 1 | 2 | 3 | 4 | 5 |

 |
| *3x2x33-Gang* |

|  |
| --- |
| **Three switches or three outlets** |
| **Wires** | 24 | 24 | 23 | 23 | 22 | 22 |
| **Caps** | 0 | 1 | 2 | 3 | 4 | 5 |

 |
| *4x1/1 1/2Octagon Box* |

|  |
| --- |
| **Light outlet boxes maximum fill** |
| **Wires** | 10 | 10 | 9 | 9 | 8 | 8 |
| **Caps** | 0 | 1 | 2 | 3 | 4 | 5 |

 |
| *4x2 1/8Octagon Box* |

|  |
| --- |
| **Light outlet boxes maximum fill** |
| **Wires** | 14 | 14 | 13 | 13 | 12 | 12 |
| **Caps** | 0 | 1 | 2 | 3 | 4 | 5 |

 |
| *Shallow Saucer Box* |

|  |
| --- |
| **Light outlet boxes maximum fill** |
| **Wires** | 3 | 3 | 2 |
| **Caps** | 0 | 1 | 2 |

 |

Electrical Appliances

Here are some common items that you use in residential wiring.

|  |  |
| --- | --- |
| *duplex4sm* | A common [duplex](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#duplex) outlet. |
| *switch3sm* | A common switch, used to turning off and on lights or outlets, or both. |
| *3waysm*  | A 3 way [switch](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#switch), used by code at the top and bottom of all stairwells. |
| *lampsm*  | A simple lamp holder. |
| *staplessm* | Some examples of wire staples.Staples come in many forms for varied uses. Most commonly in electrical wiring, they are used to attach wire to the center of a stud. They can be insulated for smaller gauge electrical wires.  |
| *platesm* |   |
| *redmarsmyelmarsmblmarsmmaroransm* | An example of 4 different twist on connectors. These are commonly called [marrette](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#marrette) connectors. These are designed to hold a different number of wires. * Black marrettes hold 6 14 gauge wires
* Red marrettes hold 5 14 gauge wires
* Yellow marrettes hold 3 14 gauge wires
* Orange marrettes hold 2 14 gauge wires
 |

Nonmetallic Sheathed Cable

A cable consists of two or more wires contained in the same protective outer sheathing.

* Available in sizes from No. 14 to No. 2 for copper wire.
* Available in sizes from No. 12 to No. 2 for aluminum wire.
* Each wire will have an uninsulated copper wire to act as a [ground wire](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#groundingwire).
* Can have 2 or 3 wires that will carry [current](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#current) and they are colored as follows:

|  |  |
| --- | --- |
| **2 wire** | **3 Wire** |
| * black is [hot](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#hotwire)
* white is [return](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#return)
* bare is [ground](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#ground)
 | * Black is hot
* Red is hot
* White is [return](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#return)
* bare is [ground](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#ground)
 |

There are 2 classifications of nonmetallic sheathed cable.

1. Type NM cable is used for exposed and concealed work in mostly dry areas. There is a flame and moisture resistant covering around all of the wires. It cannot be used inside of concrete or cindercrete walls or where there are corrosive vapors of fumes.
2. Type NMC can be used in all locations. It has a covering that is resistant to vapors, fungus, corrosion, dampness and flames.



Connectors and Fasteners

|  |  |
| --- | --- |
| securedyes | * This is a picture of an Electrical box with the NMD wire properly attached to the box. The clamp should secure the wire without crimping or bending it.
* Please note that the side of the box has been removed for visual clarity.
 |
| secureno | * In this picture, the wire is not properly secured. The wire is touching the sharp edge of the box, and is being bent at an unnatural angle. You should never do something like this.
* Please note that the side of the box has been removed for visual clarity.
 |
| stripped | * The wire should project at least 6", preferably 8" beyond the face of the box.
* Please note that the side of the box has been removed for visual clarity
 |
| bonded | * In this picture, the bare [ground wire](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#groundingwire) has been [bonded](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#bond), or attached to the electrical box. Notice that the wire is on the left of the screw, so that the wire is pulled into the connection, and not pulled away from it.
* When making a connection inside a box, you must use pig tails for attaching the [ground](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#ground) wire to you device.
* Please note that the side of the box has been removed for visual clarity.
 |

Residential Electrical Symbols

|  |
| --- |
| **Electrical Symbols** |
| Lighting Outlets | Convenience Outlets |

|  |  |  |  |
| --- | --- | --- | --- |
| Outlet Box and [Incandescent](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#incandescent) Light Fixture | outletbox | Single Receptacle Outlet | singleout |
| [Incandescent](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#incandescent) Track Lighting | tracklight | [Duplex](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#duplex) Receptacle Outlet | doubleout |
| Junction Box | junction | Split Wired [Duplex](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#duplex) Receptacle Outlet  | splitout |
| Lamp holder and Pull Switch | lampholder | Range Outlet | range |
|   | GFCI Receptacle | gfci |

|  |
| --- |
| **Electrical Symbols** |
| Switch Outlets | Signaling System Outlets  |

|  |  |  |  |
| --- | --- | --- | --- |
| Single Pole Switch | singleswitch | Computer Data Outlet | data |
| Double Pole Switch | doubleswitch | Phone Outlet  | phone |
| Three-Way Switch  | threeswitch | Chime | chime |
| Four-Way Switch  | fourswitch | Stereo | stereo |
| Dimmer | dimmer | Television Outlet | tv |
| Switch and Receptacle | switchrecept | Thermostat | thermostat |

Instillation

General Insulation guidelines

* Attach the wire to the stud within 12" (300mm) of the outlet box. Be sure that the wire is flat against the stud. DO NOT overdrive the [staple.](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#staple)



* Wires that pass through a hole drilled in a stud must be at least 1.25" (31mm) from either face. If they are closer than 1.25", then you must install a metal plate over the stud. This will prevent the drywall screws from coming in contact with the wire.



* When running wires through metal studs or plates, you must use plastic grommets.
* The grommet protects the jacket and insulation from becoming nicked on the sharp edges.



## General Rules

* Try not to penetrate, or put holes in, the [vapor barrier](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#vapourbarrier).
* When you do put holes in the [vapor barrier](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/elecgloss.html#vapourbarrier), tape them shut or use expanding foam to seal the holes.
* Try to run all the wires together through a central chase. This will help to keep everything in order.

Residential Branch Circuits

There are some common rules that apply for wiring most residential homes. Here are some of the most basic. While all of these may not be required in the Canadian Electrical code, they are some good examples to follow.

* Most residential houses can get by with a 100 [amp](http://www.saskschools.ca/curr_content/paasurveyb/elecmod/elecgloss.html#Ampere) service, but the difference in cost to go to a 200 amp service is well worth the money.
* Try to keep each room on a separate circuit. This will help if you need to turn the power off to work in a bedroom, because you can still plug a light into an adjoining room
* Remember that there can be no more than 15 switches, receptacles, or fixtures on any one circuit
* Label the [feed](http://www.saskschools.ca/curr_content/paasurveyb/elecmod/elecgloss.html#feedwire) wires inside each electrical box.
* Make sure that the panel is clearly labeled.
* Your panel box should have extra spots in it after you are done, for future expansion
* Outdoor plug ins should be on separate circuits
* Each outdoor receptacle should be on a separate circuit. This will allow you to plug more than 1 vehicle in without popping the breaker
* Deep freezes and fridges should each be on their own separate circuit. In this way, if something else makes the breaker pop, you will not loose all of your food.

Residential Circuit Layout

Residential Circuit layout is fairly simple. Here are some basic rules for house circuits:

* Each room should have at least one circuit.
* There are special requirements for bathrooms, kitchens, and laundry rooms
* Every wall 2' or more needs a plug in
* if it is near water, you need to have a GFCI
* switches should be within easy reach of doorways and stairwells, and at a comfortable height
* receptacles are located 12 inches from the floor
* light switches are located 48 inches from the floor
* each room should be on a separate circuit

## Kitchen Layout

******

* *The refrigerator should be on its own circuit*
* *Outlets that are on the counters should be split receptacle, and should alternate circuits*
* *There should be a separate circuit for the range hood and microwave*
* *Circuits on counters should be protected by either GFCI breakers or a GFCI outlet that protects the rest of the circuit.*
* *The telephone should have an outlet next to it, as many modern phones require electricity.*
* *Remember to bring a wire for the range hood, even if you are not installing one immediately.*
* *You should have a 3 way switch in your kitchen if there is more than one entrance or exit.*
* *Islands should have at least one outlet on them.*

## Hallway

**

* *note the 3 way switches at either end of the hallway*
* *If it was a longer hallway, you may want to use 4 way switches, and place another switch on the south wall by the 2 doors*
* *there are 4 receptacles in this example. They can be on their own circuit, or tied into a circuit from a bedroom*

## Bedroom

**

* *note that there is only 1 circuit in the bedroom*
* *although there are multiple TV outlets, these can be looped, with only one line running to the service.*
* *make sure that you install telephone lines, for either telephone or internet connection for a computer in the future.*
* *notice that there is an outlet on the wall behind the door. This wall is more than 2', and so requires an outlet.*

****All You Ever Wanted to Know About Fire Extinguishers . . .****

There are basically four different types or classes of fire extinguishers, each of which extinguishes specific types of fire. Newer fire extinguishers use a picture/labeling system to designate which types of fires they are to be used on. Older fire extinguishers are labeled with colored geometrical shapes with letter designations. Both of these types of labels are shown below with the description of the different classes of extinguishers.

Additionally, Class A and Class B fire extinguishers have a numerical rating which is based on tests conducted by Underwriter’s Laboratories that are designed to determine the extinguishing potential for each size and type of extinguisher. Click on any of the topics listed below for additional information that may be helpful to know.
**Fire Extinguisher Ratings**

|  |  |  |
| --- | --- | --- |
| A-2 | **Class A Extinguishers** will put out fires in ordinary combustibles, such as wood and paper. The numerical rating for this class of fire extinguisher refers to the amount of water the fire extinguisher holds and the amount of fire it will extinguish. | A-1 |
|  |  |  |
| B-2 | **Class B Extinguishers** should be used on fires involving flammable liquids, such as grease, gasoline, oil, etc. The numerical rating for this class of fire extinguisher states the approximate number of square feet of a flammable liquid fire that a non-expert person can expect to extinguish. | B-1 |
|  |  |  |
| C-2 | **Class C Extinguishers** are suitable for use on electrically energized fires. This class of fire extinguishers does not have a numerical rating. The presence of the letter “C” indicates that the extinguishing agent is non-conductive. | C-1 |
|  |  |  |
|  | **Class D Extinguishers** are designed for use on flammable metals and are often specific for the type of metal in question. There is no picture designator for Class D extinguishers. These extinguishers generally have no rating nor are they given a multi-purpose rating for use on other types of fires. | d-1 |

## Multi-Class Ratings

|  |  |
| --- | --- |
| ABC-2 | Many extinguishers available today can be used on different types of fires and will be labeled with more than one designator, e.g. A-B, B-C, or A-B-C. Make sure that if you have a multi-purpose extinguisher it is properly labeled.  |

|  |  |
| --- | --- |
| This is the old style of labeling indicating suitability for use on Class A, B, and C fires.  | ABC-1 |

|  |  |
| --- | --- |
| AB-3 | This is the new style of labeling that shows this extinguisher may be used on Ordinary Combustibles, Flammable Liquids, or Electrical Equipment fires. This is the new labeling style with a diagonal red line drawn through the picture to indicate what type of fire this extinguisher is **NOT** suitable for. In this example, the fire extinguisher could be used on Ordinary Combustibles and Flammable Liquids fires, but not for Electrical Equipment fires.  |

## Types of Fire Extinguishers

|  |  |
| --- | --- |
| ABC-THM | **Dry Chemical** extinguishers are usually rated for multiple purpose use. They contain an extinguishing agent and use a compressed, non-flammable gas as a propellant. |

|  |  |
| --- | --- |
| HAL-THM | **Halon** extinguishers contain a gas that interrupts the chemical reaction that takes place when fuels burn. These types of extinguishers are often used to protect valuable electrical equipment since them leave no residue to clean up. Halon extinguishers have a limited range, usually 4 to 6 feet. The initial application of Halon should be made at the base of the fire, even after the flames have been extinguished. |

|  |  |
| --- | --- |
| H2O-THM | **Water**  These extinguishers contain water and compressed gas and should only be used on Class A (ordinary combustibles) fires. |

|  |  |
| --- | --- |
| CO2-THM | **Carbon Dioxide** (CO2) extinguishers are most effective on Class B and C (liquids and electrical) fires. Since the gas disperses quickly, these extinguishers are only effective from 3 to 8 feet. The carbon dioxide is stored as a compressed liquid in the extinguisher; as it expands, it cools the surrounding air. The cooling will often cause ice to form around the “horn” where the gas is expelled from the extinguisher. Since the fire could re-ignite, continue to apply the agent even after the fire appears to be out.  |

**How to Use a Fire Extinguisher**

Even though extinguishers come in a number of shapes and sizes, they all operate in a similar manner.  Here's an easy acronym for fire extinguisher use:

**P  A  S   S**  --  **P**ull, **A**im, **S**queeze, and **S**weep

|  |  |
| --- | --- |
| PULL-THM | **Pull** the pin at the top of the extinguisher that keeps the handle from being accidentally pressed.  |
| [AIM-THM  AIM1-THM](http://www.hanford.gov/fire/safety/extinguse.htm) | **Aim** the nozzle toward the base of the fire.  |
| [SQZ-THM  SQ2-THM](http://www.hanford.gov/fire/safety/extinguse.htm) | Stand approximately 8 feet away from the fire and **squeeze** the handle to discharge the extinguisher. If you release the handle, the discharge will stop.  |
| [SW3-THM SW4-THM](http://www.hanford.gov/fire/safety/extinguse.htm) | **Sweep** the nozzle back and forth at the base of the fire. After the fire appears to be out, watch it carefully since it may re-ignite! |
| OT5-THM | **Congratulations** -- you did it!!! |

First Aid For Electrical Accidents

**First Aid for Electric Shock Victims**

1. Don’t touch them!

2. Unplug the appliance or turn off the power at the control panel.

3. If you can’t turn off the power, use a piece of wood, like a broom handle, dry rope or dry clothing, to separate the victim from the power source.

4. Do not try to move a victim touching a high voltage wire. Call for emergency help.

5. Keep the victim lying down. Unconscious victims should be placed on their side to allow drainage of fluids. Do not move the victim if there is a suspicion of neck or spine injuries unless absolutely necessary.

6. If the victim is not breathing, apply mouth-to-mouth resuscitation. If the victim has no pulse, begin cardiopulmonary resuscitation (CPR). Then cover the victim with a blanket to maintain body heat, keep the victim’s head low and get medical attention.



**First Aid for Electrical Burn Victims**

Electrical burns vary in severity depending upon:

1. how long the body is in contact with the electric current;
2. the strength of the current;
3. the type of current; and
4. the direction the current takes though the body. Often these burns are deep. There may be more than one area burned. One area may be where the current entered the body and another may be where it left. Electrical burn wounds may look minor on the outside, but could be severe on the inside.

Glossary

|  |  |  |
| --- | --- | --- |
| *Ampere(amp)*  |  | Refers to the rate at which electrical power flows through a circuit. Think of this as the force that moves electrons through the wire. |
| *Armored Cable* |  | two or more wires, plus a bare [ground wire](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/#groundingwire), that are sheathed inside a flexible metal coating. |
| *Bond* |  | To develop a physical connection to an electrical box or appliance. Most often this term relates to the attachment of the ground wire to the electrical box.  |
| *Box* |  | A box holds the wiring and connectors, and provides for a safe place to make connections that will be protected. |
| *Breaker Panel* |  | See [Service Panel.](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/#servicepanel) |
| *Circuit* |  | A continuous loop of electrical current flowing along wires. The loop starts and stops at the same place, making a "circle". |
| *circuit breaker* |  | The breaker is the connection from the panel to the circuit. The breaker will interrupt or break a circuit if there is an overload or short circuit. |
| *Conductor* |  | the conductor is any material that allows the electricity to flow through it. Many materials are good conductors. The most commonly used conductor for electricity is copper wire. |
| *Conduit* |  | A metal or plastic tube that protects wires. The wires in most conduits have a plastic coating on the wire, but no sheathing. |
| *Continuity* |  | If there is continuity, then the circle or the circuit is unbroken. Continuity essentially means that electricity can flow through the entire circuit An uninterrupted electrical pathway through a circuit or electrical fixture. |
| *Current* |  | The movement of the electrons along a wire.The flow of electricity. |
| *Duplex Receptacle* |  | A common plug-in on a wall in your house. There are places for 2 plugins, hence the word duplex. |
| *Feed wire*  |  | this is the wire that comes directly from the service panel to a device, such as a receptacle or a switch. |
| *GFCI* |  | Ground Fault Circuit Interrupter.[(Go to GFCI page)](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/#screwterminal) |
| *ground* |  | see [neutral](http://www.saskschools.ca//curr_content/paasurveyb/elecmod/#neutral) wire. |
| *Grounding Wire* |  | This wire is for safety. If there is a short circuit, this wire will conduct the electricity to the earth (i.e. ground.) In most house wiring, this is a bare copper wire. In an extension cord, this is the green wire. |
| *Hot Wire*  |  | Any wire that carries voltage is a hot wire. In house wiring, this wire is usually colored black or red. There may be more than 1 hot wire in a circuit, such as for a stove or other 220 volt plug. There may also be more that one hot wire in a box if there is a split receptacle.  |
| *Incandescent Light* |  | A light where power heats up the filament causing it to glow, and give off light. |
| *Insulator* |  | Any material that keeps the electrical current from going where you don't want it to go. This is often plastic or rubber. The insulation protects the wires from short circuiting against each other.  |
| *Junction Box* |  | A type of electrical box which only house wires or cables, no devices. |
| *Marrette* |  | See wire connector. |
| *Neutral Wire*  |  | This is also known as the Return Wire. This wire returns the voltage from the device to the service panel. This wire is usually covered with white plastic.  |
| *Ohm* |  | Measurement of resistance. |
| *Overload* |  | An overload occurs when there is more demand for electricity than the wire can carry. Most circuits in a house can carry a load of 15 amps. If you demand more than this, such as plugging in a kettle, toaster, hair dryer, the circuit breaker will trip.  |
| *Pigtail* |  | A short wire that is used to connect two or more wires to a single terminal on a device. |
| *Polarized Receptacle*  |  | In this type of receptacle, there is a wider prong and a narrow prong. The hot wire is always connected to the narrow prong. This keeps the hot wires running along a specific wire, and the neutral along a different wire. The polarized plug will dictate that the hot will always run along the same wire. |
| *Power* |  | Power makes something work. Power makes heat, light or motion.  |
| *Receptacle* |  | A device that allows you to plug something in. |
| *Resistance* |  | Is what impedes or slows down the movement of the electrons through a conductor. |
| *Return* |  | Normally the white wire in a common circuit. This is how the electricity returns to the circuit breaker from the appliance. |
| *Screw Terminal*  |  | See terminal post. |
| *Service Panel*  |  | Also known as a breaker panel. This metal box contains the circuit breakers that splits the electrical current from the power company into individual circuits. The service panel is grounded to a ground rod that is driven into the earth.  |
| *Short Circuit*  |  | When the current that is meant to go one place gets diverted to another. For example, a nick in the insulation may allow 2 wires to touch, or for a wire to touch an electrical box. When this happens, the current is taking a short cut to get back home. |
| *Source* |  | The place where the electricity originates in the circuit. |
| *Staple* |  | Staples come in many forms for varied uses. Most commonly in electrical wiring, they are used to attach wire to the center of a stud. They can be insulated for smaller gauge electrical wires.  |
| *Switch* |  | A switch allows the user to control the flow of current. A switch is always placed on the hot wire of a circuit.  |
| *Terminal Post*  |  | A place where the wire is attached to a receptacle, switch or fixture. |
| *Transformer* |  | An electrical device which changes the amount of current flowing through a wire. A transformer will reduce or increase the current. |
| *Traveler* |  | In a three way switch configuration, two traveler wires run between the pairs of travel screw terminals on the three-way switches. It conducts electricity while bypassing the switch. |
| *Vapor Barrier* |  | A plastic barrier that is placed on the warm side of any insulation. Electrical boxes are wrapped in plastic or have a custom cover that does not allow water vapor or moisture to enter the box. This is important as the wires and fixtures can rust if they are in contact with moisture. |
| *Voltage* |  | Voltage is the pressure that moves electrons in a conductor. |
| *Volt* |  | Unit of measurement for voltage. |