Students often request hand-outs while in lessons, which helps to remind them as they work out the process later on when an instructor is not with them. We understand that while you try your very best to listen, understand, watch and learn during instructional time, there is a great deal of information that can be easily forgotten later, when you are trying to remember at home.

If you feel there is something missing from these notes, please let us know and we can work on placing the information into this document.

Onward and upward, my friends, you are on a path that will challenge and test you, but it will be something you look forward to doing as you create beautiful pieces!

Contents

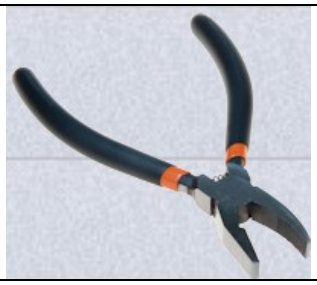
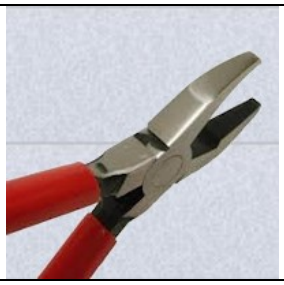
Safety Precautions

1. Safety glasses are required for all facets of doing stained glass. While in the studio, please remember to wear your glasses. If another staff or student does not have their glasses on, please remind them to do so.
2. Glass is not the only source of danger within the studio. There are many chemicals, and soldering will splatter on occasion. We do have tweezers on hand for any pesky shards of glass that may embed themselves in your fingers; however there are some precautions you can take to prevent this from happening on most occasions.
    a. When finished cutting, use the hand broom and dust pan to remove shards from your cutting area. This keeps you safer, and also helps for larger sections of glass to have less chance breaking.
    b. Use the hand broom or a small paint brush to flick glass dust off your hands when you are finished grinding. This will help keep the glass debris in the relative area, rather than track it about the room.
    c. Never wipe glass dust from a piece of glass, or from the grinder. At the ground state, the glass dust can release small shards of glass that quickly become embedded into your skin, but the dust state is where any chemicals used to create the glass are now at risk of being ingested into your system. Wash your hands after grinding glass.
    d. When soldering:
        i. Keep other cords away from your soldering area
        ii. Work in a well ventilated room
        iii. Do not eat, drink or smoke
        iv. Use small pliers to hold small sections of glass when tinning. Glass will hold the heat and become very hot.
        v. Never touch the barrel of the soldering iron. It is an immediate 3rd degree burn.
        vi. Apply flux in small quantities, with a small cheap paint brush.
        vii. Flux can irritate your fingers, hands, arms. It is best to avoid contact with skin if at all possible. Wearing disposable gloves is recommended, but regular washing is generally all that is needed.
        viii. Our studio uses a spray bottle with a mixture of 50% water / 50% plain water, to spray on a rag and rub your fingers against when flux comes into contact with skin.
        ix. Soldering irons must be placed in a proper stand when turned on, but not in use. Placing the iron on the table will cause burns to the table. Left unattended, this can result in a fire.
        x. Our studio uses a power bar to control the soldering iron and the bench light. One click of the switch turns off both … and if the lights are on, so are the irons.
        xi. Soldering needs to have your full attention. Pets, children and being tired can result in dangerous results … as well as undesirable looks ☺ If you are tired, go for a walk, wash your hands and have a beverage, or take a break for a bit.
    e. Small cuts can become irritated with flux, hold grinder dust, and sting nasty when using patina. Clean the area, and cover it with a Band-Aid to help keep it clean.
        i. Our studio keeps a "*Boo-Baid*" Box under the light table with all the soothing and covering applications you will need.

f. NEVER hold a piece of g lass over your head, or from the sides to look through. It can have an unseen fault line and break, shattering in your face.
g. Hold larger sheets of glass from the top while walking. If it cracks, stop moving & close your eyes! Do not try to save the glass!
h. Always wear long pants and closed toe shoes (leather if possible) when in the studio. Splattering soldering, tipped over chemicals, can cause burns.
    i. NOTE: *I personally had a large sheet of glass stress crack while I was walking with it. Although I did stop moving, stand still and close my eyes, a section of glass fell hard enough and at the right angle to actually cut the leather on my shoe to the point that I had to buy new shoes*.
i. Wear form fitting clothing, refrain from loose sleeves which can get caught and collect things you wouldn't want transported into your living space or car.
j. If you accidentally spill a chemical, look after yourself FIRST, then clean up the mess. Our studio has *Material Safety Data Sheets* (MSDS) on hand for every chemical. You will find them in a red binder under the cabinet on the wall where all the chemicals are kept.

Tools

Many of the tools you will need for stained glass are specific to the trade. As you become more experienced, you will adapt other non-specific tools to use in your studio; however, you really do not need to get caught up in the up-sale stories you will get from online forums, groups, and glass supply shops. ***These are the basic starting tools that you DO need to be able to work with glass.***

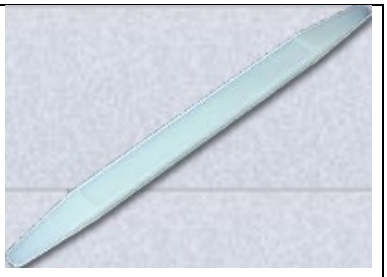
		
CUTTER: *The cutter doesn't actually cut the glass; rather it scores the glass to create a fissure, or weak line, which allows you to break the glass in an intended fashion.* • **$20.^{00}$-50.^{00}** depending if you purchase online or from a supply store.	**GROZER PLIERS**: *Not to be mistaken for a tool you can find in a hardware store, are used to grip and pull the selected section of glass away from the score line. TWO Grozer pliers are used to give support on one side & pull away from the other side of some "cuts".* • **$15.^{00}$ - $20.^{00}$** depending if you purchase online or from a supply store	**MINI GROZER PLIERS**: *Are used to pull out very small sections of glass. These are not a tool you will use often, but you will be grateful for them when you have very small areas.* • **$15.00-$20.00** depending if you purchase online or from a supply store

RUNNING PLIERS: *Running pliers are necessary to work the fissure across the score line. You NEED these, and will use them often. If possible, grab an extra set of rubber caps when you purchase these, as these caps protect the glass from too much pressure and chipping.*

- **$12.^{00}$-$20.^{00}$** depending if you purchase online or from a supply shop

GLASS GRINDER: *Used to grind the edges smooth so it will not cut you, and allow for copper foil to adhere to the glass. Check to ensue you also have a shield assembly and if not, purchase one. Grinder Coolant is also added to the water in the bed, to keep the grinder stone cool and sharp.*

- **$150.^{00}$-$500.^{00}$** depending on model, and purchase location. DO NOT purchase one online, as it will not be CSA approved, and your insurance will not cover you in the event of possible fire.



FID: Used to burnish copper foil to the glass.

- **$1.^{00}$ - $3.^{00}$**

WOODEN BURNISHING TOOL: *The wooden burnishing tool does exactly the same as the plastic fid when used to burnish copper foil; however, it fits in your hand a little better. Best for persons who struggle with hand control.*

- **$1.^{00}$-$2.^{00}$**

THERMAL SOLDERING IRON: *Remember to make sure your iron is CSA approved. Do NOT purchase just any iron, the ones used for plumbing/electrical are not the same.*

- **$125.^{00}$-$175.^{00}$**

SOLDERING IRON STAND: *Used to hold your soldering iron safe & secure. With convenient sponge area to wipe your tip & collect solder bits.*

- **$35.^{00}$-$50.^{00}$**

Selecting Glass for your Project

1. There are many styles of stained glass, such as; opaque, translucent, opalescent, iridized, dichroic. As well, there are several types of glass, depending on the manufacturer. You will hear/see terms such as Cathedral, ripple, baroque, ice crystal, glue chip, streaky, water glass, etc.
    a. Typically, the texture side of glass has been known as the reverse side of your project. This was first done to help avoid dust and grease from collecting on the "front" of the project. Textured glass can be difficult to clean.
    b. There is no "right" way for the glass to become part of your project. If you like the way it looks, if it gives you the right feel for your project, if the colors are better on one side rather than the other, then this is the correct way for you to use it in your project.
    c. Heavy textures, iridized, opalescent, and dark colors will refract the way light shows through the glass.
2. Try to choose all the glass you think you might want to use in one project, at the same time. If possible, use a light table to help show how the glass will look when placed next to each other.
3. Don't worry about blemishes and flaws in the glass, not only is some glass designed this way, but those blemishes can add an unintended character to your glass.
4. Tap your fingers against the glass, and listen for a hollow ping type noise. This will alert you to the potential of a stress point in the glass that may cause it to break unintentionally.
    a. The stress crack may not be visible without a black light, but look closely through the glass at various angles.
    b. IF you find the crack, carefully lay the piece down, and draw a line with a permanent marker to indicate where the crack is. Score a line adjacent to the fracture. Use the running pliers to break the good section away from the fracture.
5. Allow for cutting mistakes, and undetected stress points. By rule of thumb, an experienced glass worker will purchase between 10% and 20% more glass than what is necessary for each project. On the plus side, this will enhance your on-hand glass stock if you don't use it all. On the side of erroring with caution, this will be a great stress reliever if the glass you have your heart set on for the project is no longer in stock, or worse … out of circulation!
6. *NOTE: Glass is glass, and by the very nature of being made mostly by hand, the exact color patterns may never been found again! If you love the look of any glass you see and intend to use in your project, purchase what you can while you can.* ☺
7. Some glass companies, such as Spectrum, don't change very much or very often, if at all. Their stock is readily available, usually in a close format to what you are currently using at home, and usually available in a close enough match if you need more.
    a. Other companies, like Oceana (now very difficult to find), Kokimo, Youghiogheny and Uroboros, are known for their very beautiful color combinations. However, the pattern in their glass changes very frequently, and may never be found in a close enough match to finish or repair a project in the future.
    b. Keep your eyes peeled for the very hard to find, flash glass, and for old antique windows that other people have deemed "garbage" because they are broken. Older windows have some wonderfully textured glass in them!

Glass: Cutting, Breaking & Grinding

Our studio prefers to use Toyo brand cutters, but there are many styles of cutters on the market. There are several types of cutters in the studio for you to try.

1. Determine the side of glass you wish to have as your top side in your panel.
    a. You cannot cut rough texture with your scoring tool, and will damage it if you try.
    b. If you want the rough side of texture glass for the top of your panel, you will need to reverse your pattern. Draw the pattern on the back side of the paper, and trace that onto the smooth side of the glass.
    c. Some glass will be hard to tell which side is smooth, opt for the side that you deem the smoothest.
    d. Water glass has the same texture on both sides, and will cut equally from both sides.
2. Draw the shape of your pattern piece on your glass.
    a. If you have a light table, put the pattern under the glass and use a Sharpie Fine line permanent marker to trace the pattern piece. Alternately, and to keep your lines from smudging off later, our shop likes to use Pilot Gold or Silver Metallic Paint Markers.
    b. You can also use pattern shears to cut your pattern out and a UHU glue stick to temporarily glue your pattern piece to the glass.
    c. Ensure you have the pattern piece that you want to glue down lined up for the area, color, and grain that you want to show in your panel.
    d. Ensure you have larger concave areas towards the edges of the glass.
    e. Ensure you place your pattern pieces in a manner that you can successfully score between them, and logically expect to get a clean separation.
3. Make sure your cutting area is clean of all debris at all times! A tiny bit of glass shard can cause an entire sheet of glass to crack where you don't want it to. Not only does this cause waste, but it can cause you to not have enough glass to finish your project.
4. Dip the cutter in a jar that you have a small rag or sponge in, and have wet with cutting oil. Some cutters will leak oil when you put the oil in the handle chamber.

5. Hold the cutter at a 70^{O} angle, about 2mm from the edge, using not more than 9 lbs. of pressure (*yes, you can test this by using a scale*). Guiding the cutter with your opposite hand and keep the pressure even, score the glass from one side to the other.
6. NEVER score the g lass more than once on the same line. You will ruin your cutter, but you may possible cause the glass to completely smash.
7. You are listening for a sound of ripping paper, adjust your pressure accordingly. If it sounds like you are scratching a chalk board, lighten your pressure.

8. Do NOT lift the wheel of the cutter once you start cutting! You may stop movement, but keep the wheel on the glass where you stopped, reposition your body, begin scoring again and exhale … relax. ☺ The pressure should be coming from your shoulder, not your forearm.
9. There are ways to separate the two sections of glass when the sheet of glass is larger, but for smaller more manageable pieces, use the center point of your running pliers directly on the score line, make sure the tension knob is on the top, and apply gentle pressure.
    a. IF the line is longer, work end to end until the fissure joins and the glass separates.
10. Smaller sections can be removed by placing the flat side of the grozer pliers at the top, near the score line, and gentle pressure downward and out at the same time.
11. Next, work on any concave areas, by cutting rainbows (*smaller sections scored and removed, until you get the entire area removed*)
12. Finally, work on any convex areas. These are easy to separate, usually being done with one or two scores. *NOTE: Remember that the closer you get to your score lines, the more accurate your scores are, and meaning less grinding you will have to do. Less grinding means the life of your grinding head will be much longer!*
13. Place your cut out piece on your pattern, and work on a few more.
14. Take a break, if you need to; relax the muscles in your neck, arm, back, and legs.
15. Grinding is where you will shape the pieces of your panel "puzzle". This is where you will look after tiny irregular bits of glass that didn't break off cleanly, and ensure the edges are smooth.
    a. Proper grinding will give you a nice clean edge, one that looks like sea glass, and will allow your foil to adhere properly.
    b. The grinder head will NOT hurt you! ☺ You may jump at first, but it feels smooth on the skin … and makes for a really quick way to file your nails back into shape.
16. Begin grinding by going around each piece with almost no pressure at all. This takes off the small razor type edges that some glass will leave, and also remove small daggers. ☺ Sounds horrible, but they are tiny and give you paper cuts or make you think you are testing your blood; it's more annoying than it is painful.
17. The 2nd pass around the glass piece will be where you shape your piece. Do this with just enough pressure to cause shaping, but not enough pressure to push the grinder head backwards in the grinder. It won't take long to get the hang of this at all.
    a. Wash your piece off in a bowl of water, dry with a rag, and test on your pattern.
    b. It is better to make several passes on the grinder, than it is to have to cut another piece.

Copper Foiling

1. Copper foil comes in 3 main types: Back back (stickiest), Silver back (midly tacky), and Copper back (medium tack). There are several decorative foils, but you won't use them much, and they are expensive.
    a. **Black back foil**: Used for all glass that you cannot see through, and/or if you are using black patina after the panel is complete. It is best to use if you will have outside edges exposed on your finished project.
    b. **Silver back foil**: Used when you are foiling mirror, so the reflection of the mirror shows only a mirrored effect.

   c. **Copper back foil**: Typically used by cheaper, line assembly manufacturing companies, is used when you will not have any outside edge exposed. You may use this on clear or translucent glass, if you will be applying a copper patina later.
2. Copper foil also comes in a variety of sizes. Our studio uses 3 widths, depending on what type of project we are working on.
   a. **7/32"** foil is the most commonly used foil. It can be used on almost any glass.
   b. **1'4"** foil is the widest foil (in this studio), and is used for thicker glass, double layers of thin plate glass, and some heavy textured glass.
   c. **3/16"** foil is used for very small pieces of glass. This allows you to have small details, without losing the piece of glass when it is wrapped in solder.
3. Before foiling, ensure you have all your grinding complete, and all the pieces fit in your panel, leaving just a small amount of wiggle room. The foil will take up some space between glass pieces, but it will not fill in large gaps.
4. Ensure your glass piece is clean of all debris, and dry.
5. Do not cut lengths of foil prior to applying to the glass. This will not only save you time, but will allow you to have enough foil to work all the way around the piece.
   a. You cannot add a length of foil to your piece.
   b. Foil needs to be in one continuous length around each separate piece.
6. Take note of where the pattern piece touches each other. This will become very important later, if you have a piece of your panel that is exposed to the outside view. Try to begin securing the foil to the edges that will touch each other.
7. Wrap the foil around the entire piece, ensuring the foil is flat against all concave areas.
   a. You can gentle coax the foil into place by rubbing it with your fingers. Foil will flex and stretch a very small bit.
8. Ensure the foil is centered on your glass. This gives you even coverage on both sides of the glass, and is very important as this is the only thing that is holding your piece into the panel.
9. Once the piece is completely foiled, overlap the beginning by a ¼", and cut off straight with scissors.
10. Beginning on a flatter edge, roll the foil over onto the top/bottom of the glass. Do your best not to rip the foil, as this will show later when you try to solder.
11. Once the foil has been folded over on both sides, use your burnishing tool and flatten the foil to the glass until it is smooth. Considerable pressure can be used, although you need to take care when working on long thin pieces.
   a. We teach that if you close your eyes and feel the piece of glass, you should not be able to tell where the foil is … or barely tell where the foil is.
12. If you notice any uneven areas where the overlap of foil is, remove the excess with an X-acto knife. Take care not to scratch the glass.

Soldering

1. The iron is typically 700^{O} and will cause an immediate 3^{rd} degree burn! Have the utmost respect for it, and treat it with care.

2. Apply flux with a small flux brush that has been dipped into a small pot of flux just barely. A small amount will go much farther than you can imagine. "Paint" the copper foil lines with the brush (*do not worry about getting any on the glass*).
    a. Our studio prefers to use Gel Flux, as it stays where you put it, doesn't burn off, and doesn't smoke (unless you use too much).
3. Your soldering iron solder will have a small area for a sponge. Dampen the sponge with plain water, and gently wipe the soldering iron tip on the sponge before you begin soldering.
4. Tack a small amount of solder onto each area where two pieces touch each other. This will stop pieces from moving around and potentially causing large gaps between the pieces.
5. If you accidentally touch the length of solder to the copper, and it becomes "stuck" do not try to pull it off. Simply touch the area with the soldering iron to "melt" the solder again, and lift the length of solder off the panel.
6. Once all pieces have been tacked together, you can remove the pattern from under smaller panels/sun catchers.
7. You will ensure you have flux on all copper seams, and begin to lay down a flat solder line to cover the copper foil.
    a. Use the flat part of your tip, at a 45^{O} angel, moving quickly enough to pull the molten solder pool with you.
    b. Do NOT attempt to make a raised bead of solder. You are intentionally laying a flat line simply to cover the foil and fill the gaps between the seams.
8. Once all seams and gaps are flat soldered, you may need to apply more flux.
    a. You will notice the solder isn't flowing smoothly, which indicates not enough flux.
    b. Make sure to wipe your tip every so often to remove build up.
    c. If you get sputtering, a burning smell, or smoke, you have too much flux. If this is the case, use a rag with a small spray of 50% water/50% white vinegar and wipe off the flux.
9. Your panel is not strong enough to stand up yet, but you need to turn the panel over to flat solder the other side. Be careful, move slowly, and turn the panel over. Apply your flux and flat solder the second side.
10. If working on a sun catcher, you can apply a flat solder to the outside edges of the panel now.
    a. If working on a panel that will require zinc edge, you do not need to solder the outer edge.
11. If you have too much solder on your tip at any point, you can move the iron off the glass and simply flick your wrist so the solder will drop onto your work surface. This is essentially the same as wiping the tip on a sponge.
12. Once all the copper foil has been flat soldered, you will need to make a smooth finish solder bead. This will get better with time and practice. The trick is to be slow and do NOT paint the solder. ☺
    a. If you are planning to attach a zinc frame, you can attach it now. Otherwise, you will need to leave ¼" of flat solder area so the zinc will slide over and seat the glass properly inside. You will solder the zinc frame to the panel after all 4 edges are in place.
13. To get a nice rounded bead, remember that less is more. Begin by melting a small pool of solder near the edge of the panel, and drawing the iron towards you, using the corner of the tip, allow the solder to flow and add a bit more as the flow becomes thinner.
    a. It can be difficult to see if the solder is still molten, but the general rule of thumb is that molten solder is intensely shinier looking, and slightly more matte looking when cooled.

   b. When reaching a cross roads in the seams, run about an inch of solder onto the seam you are not working with, and come back through the molten solder to continue down the seam you were working on. This will give you a clean, seamless joint area.
14. Take caution not to stay in one area too long, as the copper and lead together will hold heat, which can cause your glass to break … especially smaller, thinner pieces.
15. If you get a blob of solder on your glass, do not worry. Leave it there until it is cooled, and pick it off later.
   a. Do NOT attempt to melt the solder blob with the iron while it is on the glass. This may result in a spider crack that you will end up needing to repair.
16. Once both sides are top soldered, wash with warm water and a mild soap.
   a. Our studio uses a mix in a spray bottle of 50% Head & Shoulders / 50% water. Shake well, spray on panel. Yupper, it smells great, cleans very well, and once the panel is dried off, there are no streaks.
   b. Do NOT use anything that will scratch the glass. You might choose to purchase the round scratch-less scrubbies from the dollar store, as these do really well at making sure to get any left-over paint from the markers off the glass.

Framing

1. Any panel that has any amount of bend or flex to it will need some sort of framing to help support it. Square panels can be framed with zinc edging. Round panels can also be framed with zinc edging, but you will need a zinc bender to do this. As a result, use U channel lead caming.
   a. Square panels with zinc edging will need miter corners. To do this without putting out much cost, use a miter box and hack saw or a Dremmel with a cutoff blade.
2. At the top of the panel, you will need jump rings strong enough to hold the weight of the panel. These should be attached at opposite ends, and on the vertical sides.
   a. Our studio makes strong jump rings that attach both under the edge of zinc frame, as well as on the top of the frame, by using curtain hangers.
3. Solder the front and back of all miter corners. Solder the top and bottom of the miter corners on the panel to close them; working about ¼" out onto joins.
4. Join the frame edges to all solder lines that connect to the frame. This will secure your framing to your panel, and help create reinforcement against any flex within the panel.
   a. A second pair of eyes is often helpful now, as you may be tired and "seam-blind", causing you to not be able to notice unsoldered seams after you complete the top solder. Rest assured, you will notice them once you get to the final step of patina and wax … it is inevitable!
5. If you are using U channel caming to frame a round panel, you need to stretch the lead first. This takes the elasticity out of the lead, causing the lead to become firmer. When the lead is attached, as you would in step 4, the lead will relax a little bit over time, but will be held firmly in place, giving your panel strength.
6. Again, wash your panel thoroughly … twice is not out of line … you need to ensure every single bit of grease from your fingers, and flux has been removed. Dry thoroughly with cotton rags (cotton T-shirts make the best rags, as they leave little to no lint.)

a. You will want to tip your panel left and right to get any water out of the zinc framing or U channel caming.

Finishing

1. Congratulations! You are almost there, and you should be more than proud of yourself!
2. Here is where you get to decide if you want to leave the solder silver, or apply patina.
    a. **Black Patina**: turns the solder black, and hides a world of faults in soldering. It is also the most commonly used application for finishing, as it gives the most traditional look to any stained glass panel. Over time, every panel will naturally darken to a muted charcoal grey state, but this can be avoided with a good wash and wax every few years.
    b. **Copper Patina**: turns the solder to a dark brass look, and will show every fault in soldering. Once you wax the panel, the brass will take on a new penny shine of copper. Again, over time, the copper will naturally darken to a brass look, and can be avoided by a good wash and waxing every few years.
    c. **Green Patina**: this is not available in Canada; however you may find recipes for it online. This gives the panel a look as if it has been outside and exposed to the elements or in a garden for some time. This is not something our studio has every experimented with.
    d. **No patina**: some people enjoy the look of silver on their work. There is nothing wrong with this at all. Simply wax the solder to a shine.
3. When applying patina, our studio likes to use old toothbrushes. Mark the ends of the toothbrush so it doesn't get used for the wrong patina.
    a. Pour a small amount of patina into a shot glass that will be specifically used for patina. Dip your brush into the patina and paint it onto the solder lines, making sure to always go in one direction. You can move quicker, but make sure to get the patina on all edges.
    b. Patina dries to a very matte, almost chalky look. Do not go over the patina at this point unless you notice an area you have missed, and making sure to follow the same direction for application.
    c. Allow the patina to dry for about 10 minutes at least, but not more than 12 hours. If you leave patina on the glass, it will etch the glass.
    d. Once the patina is dry, you need to wash the panel again, this time with just water and your fingers. Do not use a rag, as this may cause you to remove too much patina.
4. Waxing your panel causes some controversy within several forums. It is a practice in our studio to wax every single panel we do. We generally use the waxing polish purchased from a glass supply shop, but on occasion, you will run out and can use a paste wax. Mother's Caranuba Car Wax smells great!
    a. Apply a small amount of wax to the glass, and gently wipe around with a clean, dry rag.
    b. Allow the wax to dry to a matte finish.
    c. Buff the dried wax from your panel, creating a shine to your lead lines.
    d. Smaller areas that are hard to get a corner of the rag into may be coaxed out with a clean, dry, old toothbrush. Refrain from the idea of using old spin brushes.
5. Select a length of chain that has a weight tolerance suitable for your panel.
6. There is little doubt that you have crafted your panel for a specific location, and you may have already thought about how to hang the panel.

a. A smaller panel, no more than 12” square, can be safely hung from a single cup hook center to your location.
b. A larger panel will need two equal lengths of chain, each secured to its own hook on either side of your window. Ensure the hooks you use are sufficient for the weight of your panel, and are seated into wood.
c. By attaching equal lengths of chain, you are protecting the panel from possibly ever falling out of the window completely. If one of your panel hooks were ever to fail, the 2nd length of chain will at least hold the panel from falling to the floor.