Literacy and Essential Skills in Industrial Arts

STAINED GLASS COURSE
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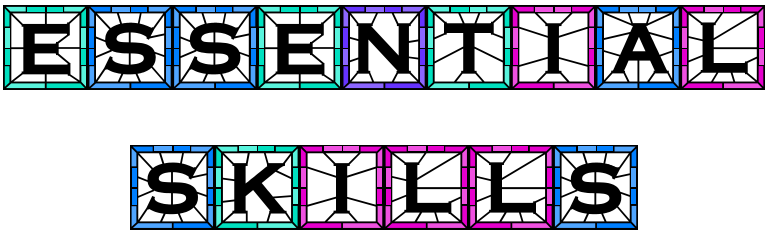

Student Notes

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Literacy Ontario Central South

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LOCS would like to extend a heartfelt thanks to David Haw, the Project Coordinator without whom this project would not have been successful. The vision that David brought to this project was the driver that made everything happen.

LOCS would like to thank the stained glass artists, Val Cowle and Steve Cowle of Hues in Glass, who worked with us to create course material. Not only did they work with the writer but they delivered a pilot course of the material created.

The following participants took part in the piloting of the material:

Bev Hafeli
Betty Patton
Joanne Stephenson
Susan Gilchrist
Jane White
James Taylor
Milly Taylor

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DISCLAIMER:

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This manual is intended to provide an opportunity for students to learn about the Essential Skills and Stained Glass in both a real life situation and an LBS environment. This manual provides basic guidelines for safe practices inside a literacy setting. Do not assume, therefore, that all necessary warnings, precautionary measures, and legal standards are contained in this document and that other or additional measures may not be required.

The opinions and interpretations in this publication are those of the author and do not necessarily reflect those of the Government of Canada.

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ORIENTATION

WELCOME

Document Use

Welcome to introduction to stained glass art.

This course was designed with four primary goals.

1. To help you develop your Essential Skills; skills that will help you in your "work, learning and life"
2. To help you develop technical skills for a hobby as well as for work
3. To help you develop your artistic and creative abilities
4. To give you the opportunity to have fun, meet new people and expand your network of contacts

Call the instructor to let them know if you are unable to attend a class.

COURSE FORMAT

Reading Text, Document Use

In addition to the information in these Student Notes, this course will be presented through a mix of group instruction, demonstration and discussion, followed by independent work.

There will be times when your instructor may ask you to stop what you are working on so that they can provide information to the entire class.

It will be important that you ask other students for help. Helping each other and sharing ideas and opinions is a great way to learn.

Before you are asked to complete any step in this stained glass course, your instructor will provide a demonstration.

Your instructor will:

- demonstrate the safe use of all of the tools and equipment and chemicals you will need in this course including: grinders, cutters, pliers, saws, flux and patina
- demonstrate all of the techniques you will be using to complete your project, including: cutting, grinding, foiling and soldering

You will then have the opportunity to try all of the tools, equipment and techniques while working independently on your project.

The instructor will be available to answer your questions and provide individual support and guidance as you work, so ask them questions anytime.

As you work on your own stained glass project you will find that there are many ways of achieving the same end result. You may find that the step-by-step instructions in your Student Notes are different than the steps your instructor demonstrates in class. You may also find the same techniques are done differently in an online stained glass video you watch. This variety will give you options to try until you find the techniques that work best for you.

STUDENT NOTES

Reading Text

Although this course will focus on oral instruction and hands-on work you will also have information and instructions to read.

In this package you will find all the Student Notes for this course. You will be asked to read a section of the notes during each class or you may read the material at home. You can also read ahead in the notes.

These Student Notes include information that will help you learn more about the topics presented and demonstrated in class. They can also be used as a reference and guide as you work on developing your stained glass skills.

There is a Table of Contents at the front of these Student Notes to help you find the information you need.

At the end of course you can take these notes home with you. They will be helpful as you work on future stained glass projects.

In your Student Notes, you will find web links. If a recommended site is no longer available, please inform your instructor.

You will be working at your own pace therefore you may find that you are ahead or behind in the notes. Talk to your instructor if you have any concerns.

Note: You can record your own notes on the pages of these Student Notes.

ICON LEGEND

Reading Text

Throughout this course you will see icons in the written material. These icons are designed to help you visually identify the content of the section you are reading.

Icons Include:

STUDENT NOTES – At the top of each page of Student Notes you will find this icon on the left side, followed by the name of the section on the top right side. This icon and the section titles will be helpful if you are looking for information listed in the Table of Contents.

ESSENTIAL SKILLS – Under each section heading you will notice this icon, bordered by two lines. The icon will be followed by a list of words. These words represent the Essential Skills you would use if you actually completed the steps outlined in the section. For example, if the text states that you need to "decide on a pattern" you would find Decision Making listed as an Essential Skill. This list will also identify the Essential Skills you are using as you read the information in the section. For example, Reading Text will be listed if you need to read more than two sentences in the section. Document Use will be listed if you need to read a bulleted list or complete a document.

ACTIVITIES – Near the end of your Student Notes you will see pages with this icon in the top left corner identifying it as the activities section of your Student Notes. This section includes step-by-step directions for completing two stained glass projects. If you leave the activities section open as you work it can serve as a guide. Alternatively, you can use this section as a reference tool that you can turn to if you get stuck on any part of your project.

TASK – If you see a "T" at the top of a page, you will find step-by-step directions for completing an Essential Skills task. These tasks are designed to help you develop your Essential Skills while at the same time providing information that will help you with your stained glass project. In most cases the tasks will be handed out during class and you will be given time to complete them before the class ends. Some tasks are designed to be completed independently and others are designed to be done in large and small groups.

When you see this image in a box on the page there will be some additional information to consider.

ESSENTIAL SKILLS

Reading Text

We consider the Essential Skills component of this course to be very important. These skills provide the foundation that makes it possible to learn all other skills. There are nine Essential Skills; Reading Text, Document Use, Numeracy, Writing, Oral Communication, Working with Others, Thinking Skills, Continuous Learning and Computer Use.

Essential Skills are used every day at work, at home and in a stained glass studio. While these skills are important in your personal life they are essential for success at work. Essential Skills will help you find and keep a job and manage change in the workplace.

Essential Skills are transferable. This means that the same skill can be used in different situations. For example, in this stained glass course you will have many opportunities to develop your problem solving skills. You may find that the next time you have a problem at home, at school or at work, your problem solving skills will be stronger.

THE NINE ESSENTIAL SKILLS

Document Use

Experts have identified the nine Essential Skills required for success in the Canadian Workforce.

For more information visit:

www.hrsdc.gc.ca/eng/workplaceskills/essential_skills/general/home.shtml

Essential Skills Include:

Reading Text

Reading materials in the form of sentences or paragraphs

Document Use

Tasks that involve a variety of information displays in which words, numbers, symbols and other visual characteristics (e.g. lines, colours or shapes) are given meaning by their spatial arrangements

Numeracy

Using numbers and thinking in quantitative terms to complete tasks

Writing

Writing text and writing in documents, such as filling in forms, and non-paper-based writing such as typing on a computer

Oral Communication

Using speech to give and exchange thoughts and information

Working with Others

Employees working with others to carry out their tasks

Thinking Skills

The process of evaluating ideas or information to reach a rational decision. They include six specific skills:

Problem Solving

Addressing problems that require solutions

Decision Making

Deciding between options

Critical Thinking

Assessing, evaluating ideas or information to reach a rational judgment of value

Job Task Planning and Organizing

Planning and organizing tasks

Significant Use of Memory

Memorization of procedures, codes, numbers, remembering information, learning from an experience

Finding Information

Using text, people, databases or systems to find information

Continuous Learning

Workers participating in an ongoing process of acquiring skills and knowledge

Computer Use

Using different kinds of computer applications and other related technical tools

ESSENTIAL SKILLS CHECKLISTS

Reading Text

As you work on your stained glass project, read your Student Notes and complete the assigned tasks, you will be developing your Essential Skills.

There will be time at the end of each class to talk with the others in your group about the Essential Skills you used in the class.

There will also be time at the end of each class to complete your own individual Essential Skills checklist. As you complete the checklist you will have the chance to identify all of the Essential Skills you used in the class.

After you have read these introductory notes, you will be able to check off Reading Text on your Essential Skills Checklist.

ESSENTIAL SKILLS IN STAINED GLASS

Reading Text, Document Use

Stained glass artists need to draw on their Essential Skills in all nine areas; however stained glass art demands a higher skill level in some areas. For example, stained glass artists need to have strong problem solving skills.

Stained glass artists:

- spot problems and solve them as they work (Thinking Skills, Problem Solving)
- talk with customers and clients (Oral Communication)
- create and/or follow patterns (Numeracy)
- work independently and/or as a member of a team (Working with Others)
- plan and organize the work involved in completing a project (Job Task Planning and Organizing)

On the other hand, writing is not an Essential Skill that would be critical to the success of a stained glass artist, even though at times they may need to record information, write notes to customers and create promotional material.

TECHNICAL SKILLS

Document Use

In addition to the Essential Skills you will develop in this class, you will also develop technical skills as you work on your stained glass project.

The technical skills you may develop in this course include:

- using tools such as pliers and cutters
- using equipment such as soldering irons and grinders
- building jigs/frames
- foiling and burnishing
- using solder, flux and patina
- reading and working with patterns
- using measurements
- completing research and creating designs

In this stained glass course you will be completing a mix of right brain and left brain activities.

Left Brain: logical - accurate measurements, detail, precision, written instructions.

Right Brain: creative - patterns, colour, images, visual demonstrations.

You will also develop:

- form perception
- motor coordination
- manual dexterity
- colour perception

CAREER EXPLORATION

Reading Text, Document Use, Oral Communication

Although this stained glass course is not designed to prepare you for a specific job, you may discover that you have the skills and interests necessary for a related career. If you enjoy this course, you may want to research careers such as:

- glazier – home and auto
- carpet, tile, linoleum, and hardwood floor installers
- plumber
- electronics assembler
- jewellery repair person
- visual artist
- painter, decorator, designer
- mechanic/small engine repair person
- woodworker/carpenter/cabinet maker
- hardware and tool salesperson
- computer repair person

Although the jobs listed above are not directly related to stained glass, they require some of the same skills.

There are many other jobs that will require the skills you will be developing throughout this course. If you think of one that is not on this list, share it with the others in the class.

SUMMARY

Reading Text

In addition to developing the skills needed to create a stained glass piece, you will also develop Essential Skills and technical skills that will help you at work, school and at home.

As mentioned, there are many jobs that require skills similar to the ones you will be developing. As you work through this course, think about your interests, skills and career. At the end of each day, ask yourself, "What skills did I develop that I could add to my résumé?

STUDIO SAFETY

INTRODUCTION

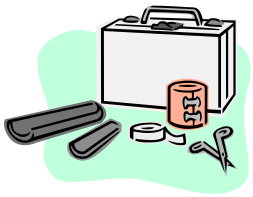
Reading Text

This section of your Student Notes will focus on working safely; this includes your own safety as well as the safety of those around you. There are risks with any hobby, sport or work environment; stained glass is no exception. The risk is moderate but it is important to be alert, stay organized and practice good housekeeping.

You will be working with glass so you will need to be aware of sharp edges, slivers and shards. You will be using sharp tools, therefore, cuts are possible. You will be working with hot soldering irons, therefore burns are possible. You may also be working with chemicals that could cause a moderate risk to you and the environment if they are not handled properly.

The following information will assist you in developing the skills you need to work safely, efficiently and in an environmentally friendly way. If you follow the safety procedures outlined, you will avoid injuries.

You must follow the instructions provided by your instructor, read this section of your Student Notes and apply all of the recommended safety tips whenever you are watching a demonstration or working on your own project.



Note: This section is only an introduction. Your instructor will provide you with a detailed safety lesson before you begin your project.

ACCIDENT REPORTING

Reading Text, Oral Communication

Minor injuries can be treated with items found in a First Aid Kit; however, we ask that you inform your instructor if you have an injury, even if your injury seems like a minor one.

We also ask that you immediately report any spills or damage to tools or equipment in the studio. Your instructor will be able to assist you with clean up and repairs.

BURN SUMMARY CHART

Reading Text, Document Use

Serious accidents are rare, but it is important that you work with caution. You will be working with soldering irons and solder that can reach temperatures of 371°-427° Celsius (700°-800° Fahrenheit). To put that into perspective, water boils at about 100° Celsius (212° Fahrenheit).

Degree	Skin Identification	Healing	Treatment
First Degree	Red and painful	Healed in 3-6 days	Soak area in cool water, apply antibiotic ointment and cover with gauze
Second Degree	Red or splotchy, painful, swollen with blisters	Healed in 2 to 3 weeks	Soak in cool water, see your doctor, apply an antibiotic cream, leave blisters, cover with new dressing daily, check your tetanus record, watch for infection, protect it from sunlight and do not scratch
Third Degree	White and charred, may not be painful because of nerve damage	Long healing process	**Seek Immediate Emergency Medical Attention**

- Never put anything oily on a burn, it will make it worse
- When in doubt seek medical attention

SAFETY TIPS

Reading Text, Document Use, Oral Communication

Thinking Skills: Critical Thinking

The safety tips in this section will focus on stained glass, although many of these tips are transferable to other situations. The tips in this section should be applied whether you are working on your project or watching a demonstration.

<u>Dress Properly:</u>

- Wear the appropriate clothing and protective gear for the job you are doing
    - Wear safety glasses and gloves when necessary
- Wear closed shoes, long pants and a long sleeved shirt
    - This will help you avoid burns from solder and/or cuts from glass

<u>Be Alert:</u>

- Work only when you are well rested
- Do not work with tools, equipment or chemicals if you have been drinking alcohol or using drugs
- Focus on the job at hand
- Inspect tools before you begin
- Be aware of the movement of others
- Keep a safe distance between yourself and others when using tools or chemicals
- Know where the fire extinguisher and First Aid Kit are located
- Never smoke or allow anyone else to smoke in your work area

Follow the Rules:

- Read manuals and follow all safety procedures
- Wear the appropriate clothing and protective gear for the job you are doing
- Listen carefully to your instructor and follow their directions
- Follow all written instructions
- Read labels and Material Safety Data Sheets (MSDS) for all chemical products

Clean and Organize Your Work Area:

- Remove any hazards from your work area before you begin
- Clean up your work area after you have completed each step
    - Pick up anything that has fallen on the floor
- Return everything to its proper place when you are finished
- Brush away any glass or tile shards in your work area
    - Keep a brush handy – never use your bare hand
- Keep all tools and materials out of the reach of children and pets
- Design your work area to be safe and efficient
- Ensure your work area is well ventilated
    - You don't need to worry about lead fumes, because the temperature of the solder will be lower than 842° Celsius (900° degrees Fahrenheit) but it is best to always have good ventilation in your work area

EQUIPMENT AND TOOL SAFETY

Document Use, Oral Communication

Thinking Skills: Critical Thinking

Handle Tools and Equipment Safely:

- Talk to your instructor before using any tools or equipment
- Read manuals and safety guidelines before you start
- Follow all manufacturers' safety guidelines
- Check that the tools are ready to use before you begin
    - For example, make sure your cutter has enough oil
- Wear all the recommended safety equipment
- Safely store or hang up tools when you are finished
- Report any tool damage

Power Cord Safety Tips:

- Check power cords for burns and report any damage to your instructor
- Inform the instructor if you burn a cord
- Switch off all tools before connecting them to a power supply
- Disconnect the power supply before making adjustments to the equipment
- Keep power cords clear of other tools
- Plug into the nearest power supply and check that the cord does not lay across the floor where other people will be walking
- Carry tools by the handle only

- Pull cords by the plug rather than the cord when unplugging equipment from an outlet
- Do not tie cords or drape them across any part of your body

Soldering Iron Safety Tips:

- Never leave a soldering iron unattended
    - Put it in a stand when it is not in use
- Unplug the soldering iron when you are finished
- Return the iron to the shelf when you are finished
- Avoid touching any area that has been recently soldered
- Avoid touching any solder that drips off the iron or your work
- Never walk around with a hot soldering iron

Grinder and Cutter Safety Tips:

- Check that all safety equipment is in place before you begin (e.g. protective grinder shield)
- Always use a cutting board to trap glass
- Wear safety glasses when cutting glass
- Push glass into grinder gently

Although you will experience noise from the grinder, it should not be loud enough to cause any damage to your hearing. However, you may want to wear hearing protection.

- Make sure there is water in the grinder's reservoir and the sponge is wet
    - If the sponge is dry there is a risk of airborne glass dust
    - You can also wear a tight fitting dust mask for protection from glass dust

WORKING WITH CHEMICALS

Reading Text, Document Use

Thinking Skills: Critical Thinking

Although the chemicals you will be using to complete your stained glass project are not dangerous, they are considered toxic and corrosive. This includes flux and patina. **Work with caution.**

Chemicals can be absorbed through your skin, eyes and mouth. Therefore you should wash your hands regularly, keep your hands away from your face, and try not to rub your eyes or mouth. You may also consider wearing gloves when you are working with chemicals.

Open cuts will absorb lead from the solder. Cover all cuts and scratches with a bandage before beginning.

Read labels and Material Safety Data Sheets (MSDS) for all chemicals. You will find MSDS sheets in any workplace that uses chemicals.

Avoid eating and smoking while you are working with stained glass. If you take a smoke or coffee break, wash your hands first.

Material Safety Data Sheets – MSDS are documents written for people who use hazardous materials. They contain information about the physical or chemical hazards associated with using the material. They outline the safe handling, storage and disposal as well as steps for dealing with emergencies, fires, spills and overexposure.

Any material covered by the Workplace Hazardous Materials Information System (WHMIS) must have an MSDS. This means that if you are working with a hazardous substance, you must have access to MSDS in your workplace and you should be trained to work with the material safely.
http://www.meridianeng.com/msds.html

SAFE LIFTING

Reading Text, Document Use, Oral Communication

Thinking Skills: Critical Thinking

Stained glass artists pick up sheets of glass and large stained glass panels. Therefore it is important that you know what you are able to lift safely and comfortably. A sheet of glass can weigh up to 18 kilograms (40 pounds) and finished panels are very heavy.

Picking up a Sheet of Glass:

- Pick up one sheet at a time
- Grip the sheet on the top edge
- Carry it so that it is vertical to the floor
- Move slowly so that the glass is not bumped
- Ask for help if it is too heavy

If a piece of glass starts to fall, move out of the way. Never try to catch falling glass.

Never use your body to balance or lift glass.

Safe Lifting Guidelines:

- Bend your knees - don't stoop
- Move to the object rather than reaching for it
- Bring your chin in to force your back to stay straight
- Tighten your stomach muscles
- Lift with your leg muscles - they are stronger than your back muscles
- Communicate with anyone helping you lift; good communication is important

http://healthandfitness101.com/wp-content/uploads/2008/05/lifting-pic.jpg

CLEAN UP

Reading Text, Document Use

You will be responsible for cleaning up your work area as you go. You will also be responsible for cleaning your work area at the end of each class.

Cleaning:

- Clean up glass shards with a brush and dust pan or a cloth
  - Never brush them away with your hand
- Keep your work area clean; including your chair or stool
- Wipe up any chemical spills
- Put away chemicals when you are finished
- Put tools and equipment away properly when you are finished
- Use the garbage and recycle bins for the appropriate items

THE ENVIRONMENT

Document Use

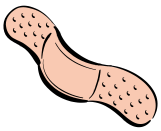
Some things can't be recycled. For example, stained glass is made with chemicals; therefore pieces that can't be used must go in the garbage.

Respecting the Environment:

- Set aside any leftover glass pieces
    - You can use them in future projects or other people in your class can use them
- Use small pieces of glass that others were not able to use
- Use newspaper or a cloth for clean up rather than paper towel
- Recycle cans and glass bottles

AVOIDING INJURIES – SUMMARY CHART

Document Use

INJURY	CAUSE	AVOIDING
Cuts 	Glass shards, slivers, broken glass, sheets of glass and Exacto knives and hacksaws	• Handle glass with caution • Wear work gloves and appropriate clothing • Wear safety glasses/use protective shields • Keep your work area clean • Ask for help moving sheets of glass • Never brush off a surface with your hand
Burns 	Soldering iron and melted solder	• Handle soldering iron with caution • Keep the iron in a stand when not in use • Wear long pants and covered shoes • Focus on the task at hand
Breathing fumes or glass dust 	Grinding and soldering	• Work in a ventilated area and use equipment properly • Don't work on stained glass if you are pregnant or are a nursing mother • Wear a mask and keep your face away from fumes
Absorbing chemicals through skin, eyes, mouth 	Chemical Exposure E.g. You will be using chemicals such as flux. Flux is not highly toxic but unpleasant if it enters your eyes or mouth. It is considered a corrosive chemical.	• Wash your hands after using chemicals • Keep your hands away from your face • Do not rub your eyes or mouth • Never eat, drink or smoke while working • Use gloves if you are using chemicals • Wash all glass with soap and water at various stages in the process

INTRODUCTION - STAINED GLASS

HISTORY OF STAINED GLASS

Reading Text

As early as the 11th century AD, stained glass was being used in church windows. These windows were often scenes from the Bible.

Throughout history there have been long periods of time when stained glass was not being used; however, there was a renewed interest in both Europe and North America in the late 1800's. During this time artists started to look at how they could use stained glass in new and creative ways. For example, Louis Comfort Tiffany created the copper foil method, a technique necessary for lamp making.

Tiffany continues to be the most recognized name in stained glass.

> "A Tiffany lamp is a type of lamp with a stained glass shade. The pieces of stained glass that comprise a Tiffany shade are soldered together with copper foil….. The first Tiffany lamp was created in 1899 with a bronze base and was designed by Louis Comfort Tiffany."
> *http://en.wikipedia.org/wiki/Tiffany_lamp*

In the last 30 years, stained glass has increased in popularity. Today stained glass can be found in many homes. Entrance doors, cupboard doors, tiffany style lampshades, sun-catchers and panels are only a few examples of how stained glass is currently being used.

Much of the stained glass you see today is made using the copper foil method. This is the method you will use throughout this course.

HOW STAINED GLASS IS MADE

Reading Text, Document Use

Glass is made by combining silica sand, limestone and soda ash. This mixture is heated in a glass furnace to 1,648° Celsius (3,000° Fahrenheit). At this temperature the raw materials melt into a liquid. The liquid is then poured into a form and cooled slowly. The cooled liquid solidifies and becomes a sheet of glass.

To make stained glass, it is necessary to add metal oxides to the raw materials while they are still in liquid form. For example:

If you add the metal oxide:	The resulting colour is:
Selenium or Gold	Red or Pink
Sulphur	Amber
Cobalt	Blue

ADVANCES IN STAINED GLASS

Reading Text

Stained glass art has changed over the years. Tools have been developed that make it possible to work quicker and to be more accurate. For example, in the past, stained glass artists had to hand grind the glass. Now with equipment such as grinders, the process is more efficient, not to mention safer.

Artists today have more types of cutters to choose from than ever before. There are also tools that will help you apply copper foil.

The internet has also been a great addition to the field of stained glass. For example, there are many sites that offer free patterns. You can also use the internet to research techniques and buy tools, equipment and glass. There are many online videos available offering stained glass instruction. Finally, you can buy stained glass software that will give you more flexibility in all aspects of your stained glass work.

Note: Details about these tools can be found throughout your Student Notes.

USING COLOURS

SELECTING A COLOUR

Reading Text, Document Use

Thinking Skills: Decision Making, Critical Thinking

Deciding on colours for your piece is an important step.

You are probably already aware that some colours look better together than others. Some colours even appear to change when they are placed side-by-side. When you are deciding on colour, think critically about your choices. If you take some time selecting the colour combinations for your stained glass projects, you will be happier with your finished piece.

Before you decide on colours, ask yourself:

- What colours do I like?
- What colours fit this particular pattern?
- Where am I going to hang my finished piece?
- How many colours do I want in my piece?
    - Too many colours may detract from the overall design

UNDERSTANDING COLOUR

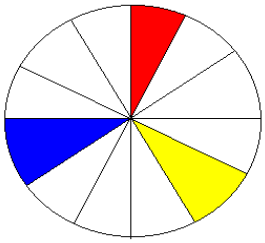
Reading Text, Document Use

Colour is important to think about when you are doing any type of art work**.** Although knowledge of colour theory is not necessary to be able to work with stained glass, a basic understanding of colour will help you make decisions about your piece.

The following is an introduction to colour. There is no need to memorize the specific details but you may want to refer back to these notes if you are having trouble deciding which colours to use for a project.

Primary Colours

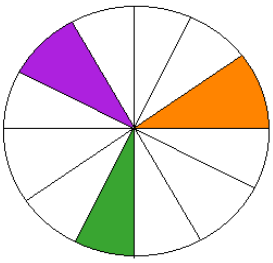
There are three primary colours: Red, Blue and Yellow



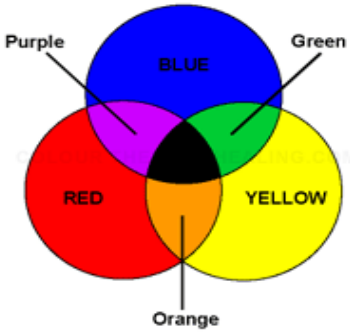
Primary colours cannot be created by combining other colours. However, if the three primary colours are combined, the resulting colour is black.

Secondary Colours

There are three secondary colours: Orange, Purple and Green



When two of the three primary colours overlap or are combined equally you will end up with one of the three secondary colours.



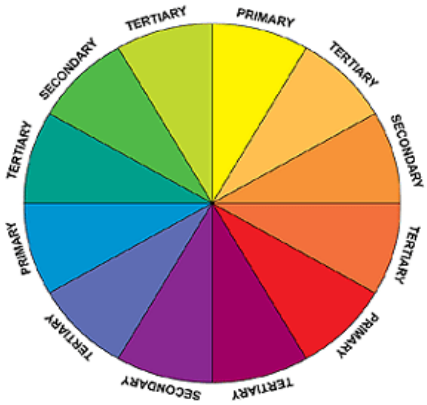
Red + Yellow = Orange

Red + Blue = Purple

Blue + Yellow = Green

Tertiary Colours

If you mix one primary colour (red, yellow or blue) with one secondary colour (orange, purple or green), you get one of the six tertiary colours: Red-Orange, Yellow-Orange, Yellow-Green, Blue-Green, Blue Violet and Red-Violet



Tertiary: means third in degree, order or place

Colour Definitions:

Complementary Colours

Complementary colours are the colours that are found opposite each other on the colour wheel. Yellow and purple are examples of complementary colours. When they are placed together they can create a very powerful effect. When you are working with stained glass, you will want to use colours that complement each other. Because they are so powerful they can be overdone, so use them with caution.

Related Colours

Related colours are the colours that you will find side-by-side on the colour wheel; for example, yellow and orange. They share a common base and work in harmony with each other.

Neutral Colours

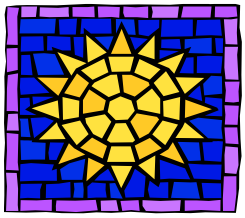
These colours are not found on the colour wheel. They include black, gray and white. These colours don't compete with each other. They are safe to combine with other colours.

Accent Colours

These are colours used to add contrast and make your piece more interesting. Accents are often small but strong, bright colours. You may have heard them referred to as a "splash of colour". For example, a red eye on a gray bird.

Colour and Mood

You can use colour to create a mood. For example, bright yellow is often considered to be a happy colour. Black is a more serious colour and red more passionate.



USING COLOUR TO SEND A MESSAGE

Reading Text

You can use colour to capture a true image, for example, yellow for the sun.

You can also use colour to send a message, create a mood or stimulate an emotion. For example, the colour red actually energizes people; therefore, it is not a good choice for a child's bedroom. Blue is calming, so it may be the perfect choice for the bedroom of a very active child.

Red can also be used to symbolize anger.

Blue is often used to create a peaceful or relaxing feeling.

Early fast food restaurants used the colours orange and brown because studies showed people did not linger when they were surrounded by these colours. It was also known that the colour orange made people feel hungry.

When you are working with colour you may also notice that you like some colours better than others. Think about why you may be drawn to a particular colour.

SUN-CATCHER

INTRODUCTION

Reading Text, Document Use

In this course your first project will be a sun-catcher. A sun-catcher is designed to hang in a window where the glass will catch the light.

As you build your sun-catcher you will learn basic stained glass skills that will help you in all of your future projects.

You will be using the copper foil method. The steps will include:

- transferring your pattern to glass
- cutting and grinding glass
- foiling and burnishing
- soldering
- finishing

In addition to developing skills in the copper foil method of stained glass, this section will cover stained glass tools, equipment and chemicals.

Detailed, step-by-step instructions for building a sun-catcher can be found at the end of these Student Notes in the Activities section.

SUN CATCHER - PATTERNS AND GLASS

DECIDING ON A PATTERN

Reading Text, Document Use, Oral Communication

Thinking Skills: Decision Making

The first step in any project is deciding on a pattern. Ask your instructor for some example sun-catcher patterns that you can choose from.

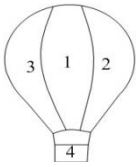
Before deciding on a pattern there are a number of things you will want to consider.

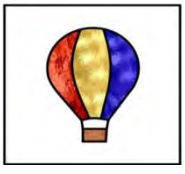
- What is your current stained glass skill level?
  - How hard are the designs you're considering?
  - Start with an easy design
- How big will the finished piece be?
  - Start with a small sun-catcher
- How small is the smallest piece of glass?
  - Small pieces are more difficult to cut
- How complicated are the shapes?
  - Will you need to make angled cuts?
- Does the design interest you?
- Where will you hang your finished sun-catcher?

It is fun to work on an image you like.

Note: As you gain skill, you can design your own pattern. You will find information later in these Student Notes about pattern design.

EXAMPLE SUN-CATCHER: By Val Cowle





DECIDING ON GLASS

Reading Text, Document Use, Oral Communication

Thinking Skills: Decision Making

Colour Decisions:

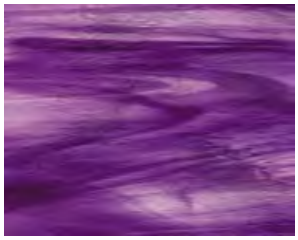
As mentioned earlier, colour will have a big impact on your finished piece. Before you begin your sun-catcher take some time to decide on the colours you will use. When you are picking the glass you will want to think critically about your colour choices.

- What colours do you like?
- What colours fit the pattern?
    - For example, if your pattern includes a sun you may want to use yellow or orange glass
- Where are you going to hang your sun-catcher?
    - What colours are already in the room?
    - How strong will the background light be? If you use dark colours you will need a stronger background light
- How many colours do you want for the image?
    - It is recommended that you pick one main colour with complementary accents
    - For variety, use different shades and textures

Before you begin, set all the glass you have selected in a window or on a light table/light box.

Seeing the colours together with some background light will make it easier for you to evaluate how the colours look together.

- Do you want strong colours and/or light colours?
    - A balance is always a good choice
- What flow/colour/texture do you want in a piece of glass?
    - In a piece of wood it's called grain; in glass it is called flow
    - The following two images show flow or movement in glass




Glass Decisions:

Once you have decided on colour you need to decide on the glass you will use.

- How easy is the glass to work with?
    - Some glass, such as textured glass, is much harder to work with and should be avoided for your first few projects. Your instructor will guide you through the glass selection process
- How much will you need of each colour?
- How much does the glass cost?
- Is the glass available?
    - If you are using glass leftover from another project make sure there is enough for your project
    - If the glass is not in stock you may need to place a special order

Types of Glass:

You will learn more about glass as you work on your project, but for now it's important to consider the three basic types of glass.

1. **Cathedral** – clear or coloured glass that you can see through
2. **Opal** – glass that allows light through, but cannot be seen through - some white pigment
3. **Translucent** – clear glass with opal streaks

PREPARING THE PATTERN

Reading Text, Document Use, Numeracy

Thinking Skills: Critical Thinking

Once you have selected a pattern you will need to cut out the individual pattern pieces. Rather than cutting your original pattern it is best to make a photocopy. Once you have photocopied the pattern, there are several steps you will need to follow.

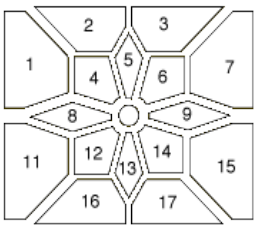
- Number each piece (section) of your pattern - both the original and the photocopy
  - Number the pieces in a way that makes sense to you
  - Numbering will make it easier to put the pieces back together once you cut out the pattern
- Photocopy your numbered pattern onto cardstock or cardboard
  - This will act as a template
- Identify and mark the direction you want the colour to flow for each piece/section
  - This will help you select the right piece of glass
- Identify and record the colour you want for each piece
- Cut out the individual pieces using scissors

Some people prefer to use a carbon copy of the pattern.

Taking time now to plan will save you time later in the project.

If you have any questions remember to ask your instructor.

EXAMPLE OF A NUMBERED AND CUT PATTERN:



http://www.thestorefinder.com/glass/library/howto.html

TRANSFERRING THE PATTERN TO THE GLASS

Reading Text, Document Use, Numeracy, Oral Communication

Thinking Skills: Decision Making, Critical Thinking

You will now need to transfer your pattern to the glass. There are a few steps that will make this process easier.

Evaluating your layout will reduce waste. This will save you money and keep the glass from becoming landfill.

You must cut from an edge so think critically about the placement of each piece.

When you are marking pieces on the glass, leave 12 mm (½ inch) between each piece.

- Work with one colour of glass at a time
- Lay the glass on a work table with the smooth side facing up
    - Always cut on the smoothest side of a piece of glass
- Select all of the cutout pattern pieces you want to have in that particular colour
- Lay the paper pieces on the glass
- Evaluate the position of each piece, based on:
    - the colour and flow of the pieces that will be side-by-side
    - the space you will need to leave between pieces so the cuts are possible
    - the best use of the glass
- Move the pieces around until they are in the right position
    - Ask you instructor to check the position of your pieces before you move on to the next step
- Trace each piece onto the glass using a marker
    - Some people glue the pattern pieces to the glass which must be followed up by soaking the glass in soap and water and scraping off the glue

- Write the number of the pattern piece on the glass
- Repeat these steps with all of the other glass colours

EXAMPLE OF TRANSFERRING A PIECE TO GLASS:

http://www.thestorefinder.com/glass/library/howto.html

CUTTING THE GLASS

Reading Text, Document Use, Numeracy

Thinking Skills: Problem Solving

Once you have the glass selected and the pattern transferred, the next step is cutting out the individual glass pieces.

To break the glass along the lines you have drawn, you will use a tool known as a glass scorer. A scorer has a wheel that you push along the surface of the glass exactly where you want it to break. The wheel creates a score line which looks like a scratch or a hair on the glass. A score line breaks the surface tension of the glass.

When you have finished scoring the glass, you will notice that it will still be in one piece. You now need to break it apart by applying pressure to the edge of the score line with pliers. The pressure causes it to run from one edge to another, breaking apart. The glass will break along the score line because the area has been weakened.

You will hear the term cutting glass; this means the same as scoring the glass.

AN EXAMPLE OF A GLASS CUTTER:

TIPS FOR CUTTING GLASS

Safety:

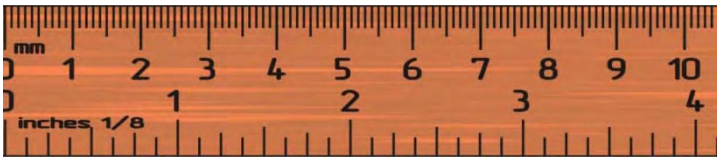
- Follow the safety procedures outlined in the safety section of your Student Notes. For example:
    - Wear safety glasses to protect your eyes
    - Use a broom to remove glass chips and shards

Preparation:

- Check that there is oil in the cutter and the head isn't clogged
    - Your cuts will be smoother with an oiled wheel
- Place your glass on a cutting board
- Clean away any dirt and glass chips from the glass with a broom or gloved hand before making your cut

Scoring:

- Work on one piece at a time
- Check that the piece you are about to cut is numbered
- Cut on the smoothest side of the glass
- Start by placing the cutter wheel on the glass about 1.5 millimetres (1/16 inch) in from the edge that is closest to you



- Make your score on the inside of the line you have drawn
- Start at one edge of the glass and travel all the way to another edge
    - Push the cutter away from you when making a score
    - Stand while you are cutting - this will help you keep equal pressure on the wheel
- Break the glass using running pliers (running pliers are covered in the next section of your Student Notes)
- Score the next line

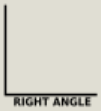
Problem Solving:

- If the glass is not breaking correctly you will need to determine the source of the problem. For example:
    - Too much pressure on the cutter = the glass will shatter
    - To little pressure on the cutter = the glass won't break evenly
- If the cut is angled, the cutter may have been held on an angle
- If the metal part of the cutter has scratched the glass, the cutter may not have been held upright

When scoring, never back up or try to go over a score line.

Once you start your cut, don't stop.

Glass likes to break in a straight line. You don't want to score glass at right angles.



It takes a while to be able to score glass and get the results you want. Before you begin cutting glass for your project, spend some time practicing on scrap glass. Don't make your first cut on the glass you need for your sun-catcher.

Practice:

- Hold the glass cutter
    - Try using different grips until you find one that feels right
- Keep an even, steady pressure through your entire cut
    - Think about the pressure coming from your shoulder rather than from your hand
    - Keep your wrist straight
- Keep your speed even as you make your cut

SUN CATCHER - TOOLS

PLIERS

Reading Text, Document Use, Numeracy

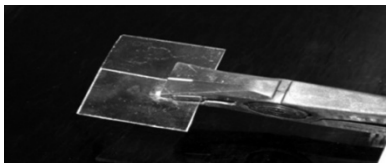
Thinking Skills: Decision Making

As mentioned, the score line only breaks the surface tension of the glass, not the glass itself. Therefore you need to apply pressure at the edge of the score line to cause the pieces to break apart. Pliers are used for this step.

RUNNING PLIERS (TOP) AND BREAKER/GROZING PLIERS (BOTTOM):

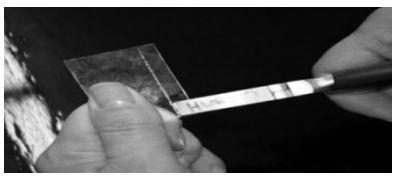
RUNNING PLIERS IN USE:

Running pliers are the most common tool used for this step. Centre the jaws of the running pliers across the score line as shown in the image below. When pressure is applied the score line will run and the pieces will break apart.



BREAKER/GROZING PLIERS IN USE:

If you decide to use breaker/grozing pliers, hold the pliers at a 90° angle to the score - as shown in the image below. This means holding the pliers at a right angle to the score line so that it looks like a T.



Images courtesy of Val Cowle - Hues in Glass

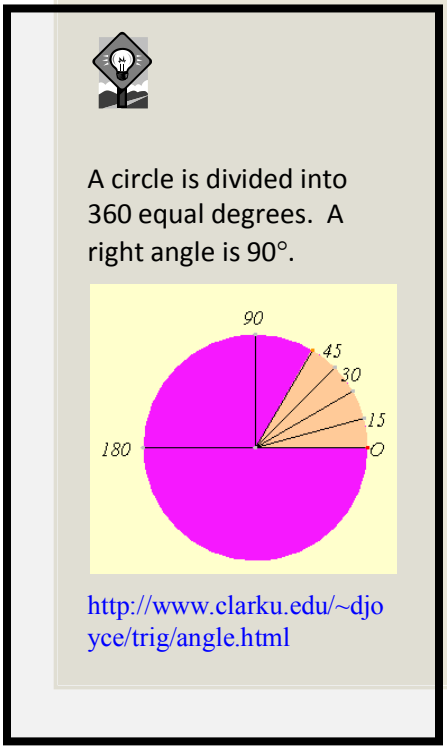
TIPS FOR BREAKING OUT THE GLASS

Safety:

- Follow the safety procedures outlined in the safety section of your Student Notes. For example:
  - Wear safety glasses and gloves
  - Handle cut glass with care

Breaking Glass:

- Hold the glass firmly between your thumb and index finger near the score line
  - Some people make a fist and put the glass between their thumb and index finger
- Apply a quick, even, light pressure with the pliers
  - If you are using running pliers – place the pliers across the score line and grip the glass firmly with the flat jaw part of the pliers
  - If you are using breaker/grozing pliers - place the pliers at a 90° angle to the score line. Have the pliers on the glass about 1.5 mm (1/16) in from the edge. Grip the glass firmly with the flat jaw part of the pliers.



A circle is divided into 360 equal degrees. A right angle is 90°.

http://www.clarku.edu/~djoyce/trig/angle.html

GRINDERS

Reading Text, Document Use

Thinking Skills: Problem Solving, Critical Thinking

It is important that you are able to fit the pieces of your sun-catcher together so that it takes the shape of the pattern. This is like assembling puzzle pieces, although the pieces will not fit together as tightly as they do in a puzzle. You only need the pieces close enough that they can be soldered together. You will need some space between the pieces of glass so there is room for the copper foil. (Foiling will be covered later in your Student Notes.)

For the pieces to fit, the edges of each piece of glass must be smooth and straight. You will need to use a tool called a grinder to remove any rough areas and straighten any crooked edges.

The grinder you will be using will have a grinding wheel (also called a bit). You push the edges of each glass piece into the grinding wheel as it spins, moving it from right to left. Do not move the glass back and forth. Continue this motion until all of the edges are smooth and straight.

Note: If you are left-handed, you may prefer to move the piece from left to right.

EXAMPLE OF A GRINDER:

Grinders have a safety shield to protect you as you work. Grinders also have a water reservoir and a sponge located behind the grinding wheel. The sponge absorbs the water which keeps glass dust from going into the air. The water also helps to cool the bit and the glass.

GLASS BEING GROUND:

TIPS FOR GRINDING GLASS

Safety:

- Follow the safety procedures outlined in the safety section of your Student Notes. For example:
    - Wear your safety glasses and a mask

Preparation:

- Check the sponge to make sure it is clean and wet
- Check the grinder to make sure there is water in the reservoir
- Make sure the protective shield on the grinder is in place before you begin

Using the Grinder:

- Hold the glass firmly against the bit and push gently
    - Work carefully so you don't cut your fingers or damage the grinder
    - You can also use a tool to help you push the glass into the grinder
    - Move the glass from right to left, not back and forth
- Assess the edges of the glass
    - Continue until the edges are smooth and straight
- Line each piece up beside the other pieces it will be touching in the finished sun-catcher
    - Check the fit and continue grinding if necessary
- Wash and dry each piece of glass to remove any glass dust

Problem Solving:

- If the sponge is dry, add water to the reservoir
- If the glass is bumpy, the edge is crooked or the pieces don't fit close together, continue grinding
    - Be careful not to over grind or you will end up with a piece of glass that is the wrong shape

SUN CATCHER - COPPER FOIL

INTRODUCTION

Reading Text

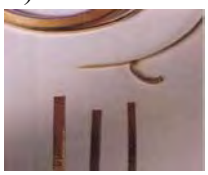
Once you have your glass pieces ground so that they fit close together you will need to connect them permanently. This is done using solder. (Soldering will be covered in detail later in your Student Notes.)

Unfortunately solder does not stick to glass. This means you will need to add something to the glass that will hold the solder. Copper foil is the ideal choice because solder sticks to copper. It is the copper foil that gives this method its name. The projects in this course use the copper foil method.

Copper foil comes on rolls. The foil unrolls in a long continuous thin strip. The copper strip has a paper backing on one side. The paper covers the glue. When you peel back the paper covering you will expose the sticky side of the foil. This is the side that you will stick to the edges of the glass pieces.

In the past you could only buy copper foil that was a copper colour. This meant that when you used silver coloured solder with transparent or beveled glass, the seams would show. Today, you have more colour options. You can buy silver backed foil to match the solder. Black backed foil is also available if you want to tint the solder black. (Tinting is done using patina, which will be covered later in your Student Notes.)

EXAMPLE OF COPPER FOIL:



For this course we assume you will be applying foil by hand. However if you have access to a foiler, this step can be done much quicker. A foiling machine holds the foil roll and dispenses it as you apply it to your piece. This means you have two hands free rather than one.

APPLYING COPPER FOIL

Reading Text, Document Use, Numeracy

Thinking Skills: Problem Solving, Decision Making

To apply the copper foil, peel off a small piece of the backing, hold the glass vertically, centre the foil over the edge and then press the foil to the edge of the glass piece. Work your way around the entire piece. Next, fold the foil over the front and back of the glass (the large surface area of the glass) ensuring that there is an equal amount overlapping both sides. When you are done you should have enough foil on the flat surface of the glass to hold the solder and create a strong seam.

The width of foil you choose will depend on the size of the glass you are using. Beginners usually start with glass that is 3 millimetres (1/8 inch) thick. As mentioned, the foil needs to be wide enough to cover the edges of the piece and an area on the front and back of the glass; therefore you would need foil that is at least 5.5 millimetres (7/32 inch) wide.

EXAMPLE OF COPPER FOIL APPLIED TO GLASS:

TRIMMED:

Before foiling, check that the glass edges are smooth and straight. If not, return to the grinder.

If your foil is 5.5 mm wide, and your edge is 3 mm wide, you should have about 2.5 mm of foil to fold over onto the front and back of the glass.

If you are having trouble assessing whether your foil is even, try working above your piece so that you are looking down as you work.

http://www.thestorefinder.com/glass/library/foiling.htm

BURNISHING

Reading Text, Document Use, Numeracy

Thinking Skills: Problem Solving, Critical Thinking, Decision Making

Solder will follow the foil, so crooked foil will result in crooked solder. Take a moment to assess the foil, making sure it's straight. If it is not straight you will need to make adjustments or reapply the foil.

Once the foil is attached to the edges and the front and back of a glass piece, you will need to smooth the foil using a burnisher. By rubbing the burnisher over the foil, it ensures that the foil is stuck tight to the glass and the wrinkles and air bubbles are removed. Burnishing will make the foil shiny and smooth.

Start by burnishing the edges first and then work on the front and back of your piece.

AN EXAMPLE OF A BURNISHER:

Once you have finished burnishing the pieces, assemble them again. You want to make sure they still fit now that the foil has been added. Don't worry about small spaces between the pieces; the solder will fill in the gaps.

Burnishing: to polish metal until it shines.

You can purchase a commercial burnisher or use something you have handy such as a pencil, pen, or even an old toothbrush.

Burnishing is critical to the final look. It will also strengthen your finished sun-catcher. Taking time to do a good job at this stage will mean you will have a better end product.

TIPS FOR FOILING AND BURNISHING

Safety:

- Follow the safety procedures outlined in the safety section of your Student Notes

Preparation:

- Ensure each piece of glass has been washed and dried
- Wash your hands
    - Do not use hand lotion while foiling

Foiling and Burnishing – By Hand

- Remove the paper backing on the foil, 25 millimetres (1 inch) at a time
- Start foiling at least 6 millimetres (¼ inch) in from a corner
- Line up the foil with the edge of the glass so it is centred
    - Your goal is to have an equal amount of foil overlapping the front and the back of the glass
- Press the foil down onto the edges using your fingers
    - You will press the foil onto the flat surface of the glass at a later stage
- Continue taking off the backing and sticking the foil to the glass, rotating the piece until all the edges of the piece are covered
    - Overlap the foil by 5.5 millimetres (7/32 inch) where the ends meet
- Cut the foil with scissors before pressing the end piece down
- Check to make sure the foil is straight and even

Tips for Foiling and Burnishing Continued:

- Press the foil down on the flat surfaces (the back and front of your sun-catcher)
    - Start on the surface that will be the back of your finished sun-catcher
    - Try to keep the foil smooth and flat in the corners
- Burnish the foil on the edges first then burnish the front and the back of the glass
    - Continue until the foil is smooth

Problem Solving:

- Avoid over burnishing, it can stretch the foil
- If the foil is crooked or uneven you can use an Exacto knife to trim the excess foil or you can remove the foil and start again
- If there is not enough foil on the glass to hold the solder you will need to remove the foil and start again

SUN CATCHER - SOLDERING

SOLDER

Reading Text

Solder is a metal alloy with a melting point between 371° and 427° Celsius (700° and 800° Fahrenheit).

Soldering is a technique used to permanently join metal. Solder is heated until it melts and runs across the seams and down between two metals that have been placed side-by-side. When it cools it hardens, joining the two metals. Solder has a lower melting point than the metal being joined which means that the solder melts but the base metals remain solid.

In stained glass the metal is the copper foil. You will be joining the copper foil on one piece of glass to the copper foil on another. The copper foil will have a higher melting point than the solder so it will remain solid.

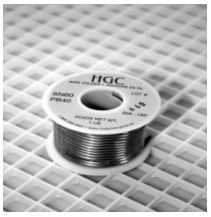
Note: If you are buying solder in places other than stores specializing in stained glass, please read the labels carefully.

Alloy: The end result of mixing metals and/or non-metallic substances together.

Ratio: A proportional relationship between two different numbers or quantities.

Solder is usually a mix of tin and lead. The solder you will be using for your copper foil sun-catcher will be a 60/40 ratio of tin and lead. This solder ratio is easy to work with so it is ideal for beginners.

AN EXAMPLE OF A SPOOL OF SOLDER:



SOLDERING IRON

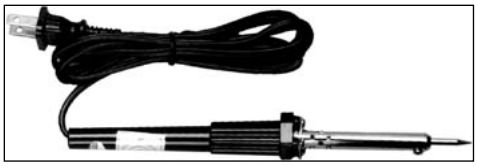
Reading Text

To apply solder you need to use a soldering iron. The soldering iron is used to melt the solder onto the copper foiled area between the two pieces of glass you want to join.

The soldering iron will be very hot so you will need to put it in a stand when it's not being used.

Note: Solder can reach temperatures of 371°-427° Celsius (700°-800° Fahrenheit).

AN EXAMPLE OF A SOLDERING IRON AND STAND:



Note: Because of the lead content, solder used in stained glass cannot be used in plumbing and should not be used to assemble and repair jewellery. You can buy lead free solder.

There are many jobs that require the use of a soldering iron. For example, soldering irons are used in the assembly of electronic components and circuit boards. They are also used to make joints in sheet metal and to join pipes in plumbing. They are also used for making jewellery.

It is important to note that soldering irons come in many styles. Make sure you are using the correct one for the job.

FLUX

Reading Text

Flux is a chemical that is used to deoxidize (remove oxidization) and clean the copper foil. Flux makes solder flow onto the copper smoothly and it helps it to stick. You will use liquid flux in this course. Flux is applied sparingly to the copper foil using a brush, just before it's soldered.

When you are working with flux you need to work quickly. Flux left on glass too long will make it hazy. Flux left on copper too long will cause it to tarnish and oxidize (a chemical reaction to oxygen). If this happens your solder won't stick. Wash your pieces with soap and water as soon as you are finished soldering.

Please read the MSDS sheets for flux that your instructor provides.

SOLDERING

Document Use, Oral Communication, Numeracy

Thinking Skills: Problem Solving, Decision Making, Critical Thinking

Once you have your sun-catcher pieces cut, ground, foiled, burnished and assembled, you can use solder to attach the pieces.

Steps:

- Assemble your sun-catcher face up on a flat surface
- Brush flux onto the copper foil
- Tack solder the pieces to hold them together temporarily. This involves placing a small drop of solder on all of the seams of your sun-catcher. Tack soldering will hold the pieces in place while you add the final bead of solder.
- Decide where you want to begin soldering
    - If you are right handed, you will want to work down and to the right
- Touch the tip of the soldering iron to the copper
- Touch the end of the spool of solder to the top of the tip
    - The solder will melt down over the tip and flow onto the foil
- Move the soldering iron and solder along the foil

Safety glasses will protect your eyes while you solder.

When soldering, ensure the surface you are working on is flat.

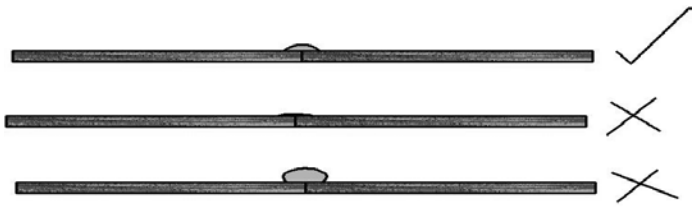
Always hold the insulated handle of the soldering iron.

All exposed copper foil must be covered with solder, including the edges of the outside pieces.

- Continue applying solder until it forms a rounded bead along the seam (this will be your final bead)
    - As you move the iron and the solder along the seam it will fill in any gaps between the glass pieces
    - You will need to work slow enough that the solder melts and flows between the seams, but quick enough that the glass doesn't crack
- Finish by tinning the edges of your sun-catcher
    - Tinning is a technique of applying a thick layer of solder over an entire seam

Creating a Bead:

The bead of solder should not be too flat or too round. Getting the solder just right will take practice. Anytime you finish soldering, take time to assess your beads.



Images courtesy of Val Cowle - Hues in Glass

TIPS FOR SOLDERING

Safety:

- Follow the safety procedures outlined in the safety section of your Student Notes. For example:
    - Use the solder and the soldering iron correctly, avoiding burns
    - When you're not using your soldering iron, keep it in the stand
    - Do not breath in flux fumes
    - Be aware of the people around you

Preparation:

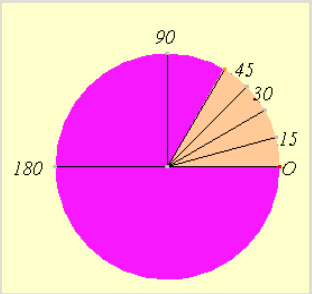
- Plug in the soldering iron 5 minutes before you need it
- Ensure each piece of glass has been washed and dried
- Wash your hands
- Clean your work area
- Assemble your sun-catcher on a flat surface, face up
    - Check that the pieces fit together well
- Brush flux onto the sides and edges of the glass, covering all of the copper foil
    - Remember to use flux sparingly
    - Avoid dragging your hands through the flux

Be careful that you don't overwork the solder or the glass may crack.

Wipe the tip of the iron on the sponge once you finish a seam.

To get an even bead – use one unbroken motion.

This chart shows a 45° angle:



http://www.clarku.edu/~djoyce/trig/angle.html

Tack Solder:

- Clean the tip of the soldering iron on a damp sponge
- Tack solder the front of your sun-catcher everywhere two pieces meet
    - Place solder along each seam
    - Keep the soldering iron at a 45° angle
    - Touch the copper foil
    - Feed the solder to the tip of the iron
    - Don't drag your hand or the cord through the hot solder

- Work down and to the right if you are right handed

Soldering:

- Continue working on the front of your piece
- Brush more flux onto the seams after tack soldering
- Touch the tip of the iron to the foil
- Hold the solder over the tip of the iron until it melts and flows over the foil
- Continue to feed the solder onto the tip until you build up a rounded bead over all of the seams
  - Add extra solder at the joints
  - Keep the iron at a 45°
  - angle
  - Pull the iron toward you as you feed the solder along the seam
  - Maintain a steady motion
  - Apply a consistent amount of solder
  - Solder anywhere you see copper foil
- Let the solder cool – it will cool quickly
- Flip the sun-catcher over carefully
  - Don't let it bend or the soldered seam will act like a hinge and the foil may pull away
- Repeat the steps - flux and solder all the seams on the back of the sun-catcher

Note: Always wait until the solder has cooled before moving your piece.

Tinning/Soldering the Edges:

- Apply flux to the edges of your sun-catcher once the solder has cooled
- Tin all the edges of your piece while it is still laying flat
    - Flip and repeat
- Pick up your sun-catcher and hold it vertically, so the edge is horizontal
- Tin the edges, rotating the sun-catcher as you work
- Bead the entire outside edge of your sun-catcher
    - This will create a frame and make your piece stable

Your instructor will demonstrate all of these techniques.

You can reheat the solder, but add more flux first. Be careful you don't overwork the solder.

Don't let the glass get too hot – it will crack.

Remember when in doubt ask your instructor or other group members for help.

Finishing the Solder:

- Assess the solder on the front, back and edges of your piece
- Smooth out the solder by reheating it, if necessary
    - Solder will level itself so you only need to apply heat
- Add more solder if the beads are too thin
- Reheat and remove extra solder if the beads are too large or hang over the edges of the glass

Problem Solving:

- If the solder does not flow smoothly you may need to apply more flux
- Wipe off excess flux if the solder hisses or bubbles

- If the glass cracks, it may have overheated
- If the solder splatters, air may be escaping from a seam
    - If you have worked too fast, you may get air in a seam where the solder didn't fill the gap between the pieces
- If the solder splatters, lower the temperature of the iron
- If the solder falls through a seam to the other side, the solder or the foil was too hot
- Clean the tip on the sponge if you find soot on your sun-catcher
- If your seams are too flat, add more solder
- If your seams are uneven or too large – reheat and remove excess solder
- If solder forms peaks and ridges or looks lumpy, it may be that the solder was not the right temperature or you have not used enough flux – reapply heat
- If the solder won't stick, you may need more flux or a neutralizer (neutralizer makes a substance neither acid nor alkaline)

SUN CATCHER - FINISHING

HOOKS, PATINA, POLISHING

Reading Text, Document Use, Numeracy

Thinking Skills: Decision Making

Hooks

Hooks are attached to sun-catchers so they can be hung in a window. Soldering a loop of copper onto the top of a sun-catcher is the most common method.

Solder the hook so that it is attached to an existing soldered seam. This will give it enough strength to hold the weight of the sun-catcher. Run the two tails of the loop down into the seam and solder it in place.

When you are hanging your sun-catcher; use a chain or fishing line strong enough to hold the weight.

Patina

Patina is a chemical that is used to change the colour of metal. If you want your silver soldered seams to be brass, black or copper in colour you will need to use patina. Patina is applied to your finished piece. It is best to apply patina very soon after you have finished soldering. Patina is corrosive so work carefully and remember to wash your hands thoroughly when you're done.

Polishing

If you want to keep the solder on your sun-catcher shiny you can add a finishing compound. Cover all the seams with the compound, let it dry and then buff it with a soft cloth.

TIPS FOR FINISHING

Safety:

- Follow the safety procedures outlined in the safety section of your Student Notes
    - Wear gloves and safety glasses
    - Read the MSDS for the patina

Soldering the Loop:

- Wash your sun-catcher in warm soapy water to remove any flux, dirt or dust
- Decide on the best spot for a loop so that your sun-catcher hangs correctly
- Hold the loop in place with pliers - the copper loop heats up quickly
- Solder the loop onto an existing soldered seam

Patina:

- Clean your sun-catcher and lay it on newspaper
- Rub patina into the soldered seams using a small brush or a cotton rag
    - Continue until it is the colour you want
- Dab off excess patina from the glass immediately and let it sit for 10 - 12 minutes
- Repeat until all the solder on your sun-catcher has been covered, including the edges

Finishing:

- Apply neutralizer (even if you are not using patina)
- Wash your sun-catcher with soap and water and dry it
- Apply a finishing compound, let it dry and then buff it with a cloth

PANELS

INTRODUCTION

Reading Text

Once you have completed a sun-catcher you will want to try your hand at building a stained glass panel.

As you build your panel you will have a chance to develop all of the skills you learned completing your sun-catcher. For example, you will be using the same copper foil method. You will also select a pattern and glass, cut and grind the glass, foil and burnish the edges and solder the pieces together. You will also complete some of the same finishing steps. Use your Table of Contents and refer back in your Student Notes for information about each of these steps.

Although many of the techniques used in building a panel will be similar to the techniques you used to build your sun-catcher, there are a few extra steps you will need to complete. For example, when you build a panel you will need to build a jig to hold your pieces in place as you work. You will also need to build a frame around your final piece.

As you build your stained glass panel you will be developing your technical skills. As you work you will also continue to develop your Essential Skills.

PANELS – BUILDING A JIG

JIG ASSEMBLY

Reading Text, Document Use, Numeracy

Thinking Skills: Decision Making

For your first panel it is best to select either a square or a rectangle pattern.

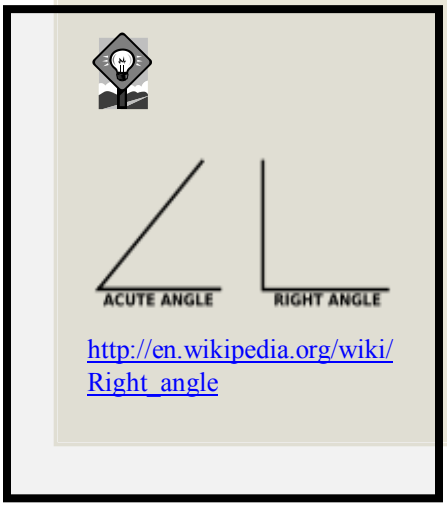
When you are building a stained glass panel you need to start by building a jig. The term jig is used in woodworking and metalworking. It means something that holds a piece of work in place.

In stained glass, the jig is used to keep the corners of your panel square. It will also provide you with a guide and it will hold your glass pieces in place as you solder.

The term square means that the corners are at perfect right angles. If your panel is not square your solder lines will be uneven, your pieces will not fit together well and your finished panel will look crooked.

It is not possible to assess the angle of your corners visually. You will need a tool called a Square to determine if your corners are at perfect right angles. A Square has two straights arms forming either an "L" or "T" shape. For this project you will use an L shaped square.

In this course, you will build your jig with wood or metal. You will be attaching the jig to a flat board using pins or nails.



http://en.wikipedia.org/wiki/Right_angle

TIPS FOR BUILDING A JIG

Safety:

- Follow the safety procedures outlined in the safety section of your Student Notes

Preparation:

- Buy or find a flat piece of wood (board) large enough to lay your entire pattern on and still have at least 5 centimetres (2 inches) around the outside edge
    - The space you leave around the outside of your pattern will depend on the size of your jig. In most cases, 5 centimetres will be enough
- Place a photocopy of your pattern on the centre of your board
    - Make sure that you have numbered your pattern first
    - You can tape your pattern to the board, but it is not necessary

Building a Jig:

- Decide on the type of jig you would like to use (wood or metal)
- Buy or find two or three pieces of trim
    - Cedar strips, lath, or metal strips will work
- Lay one piece of trim across the top edge of your pattern
    - Line up the inside edge of the trim with the outside edge of the pattern
- Secure the trim to the board
    - You can use finishing nails or metal pins
    - You will need a hammer if you are using nails

Tips for Building a Jig Continued:

- Lay the second piece of trim along either the right or left side of your pattern forming a right angle with the top piece
- Measure the angle of the jig using a Square
    - Remember you want a 90° angle
- Nail or pin this second piece of trim onto the board once you have a 90° angle
- Use your square again to check that the jig has not shifted
- Repeat the steps to add a third piece of trim
- Decide if you need or want a fourth side to your jig
    - If yes, repeat the steps

Building your Panel:

Once you have your jig built you can build your panel. Follow the same steps you followed to build your sun-catcher. You will need to transfer your pattern to glass, cut and grind the glass, foil and burnish the pieces, solder the pieces and finish the panel

- Start with a corner piece, using the jig as a guide
- Cut and grind three or four pieces at a time, fitting them into the jig as you go
- Check each piece against the jig, the pattern and the other pieces before you foil the edges

Removing the Jig:

- Remove your panel from the jig once you have completed soldering the front of the panel
- Turn the panel over and solder the back
    - Follow all of the techniques you learned while building your sun-catcher
- Tin the front and back edges of your panel
    - Use the same techniques you used to build your sun-catcher
    - You won't need to solder the edges of your panel because you will be building a frame

Problem Solving:

- If your pattern does not fit the board or you don't have room around your pattern for your jig, you will need to find a larger board
- If the corners of your jig are not at right angles you will need to remove the nails or pins and rebuild the jig

PANELS – BUILDING A FRAME

INTRODUCTION

Reading Text Document Use, Numeracy

Thinking Skills: Critical Thinking

Once you have finished building your panel, you will need to build a frame. For this project you will be using a single channel zinc frame. These metal frames come in strips that fit over the edges of your panel. You will need to measure the panel and the framing material. You will then need to use a hacksaw to cut the frame to fit.

TIPS FOR BUILDING A FRAME

Safety:

- Follow all safety procedures outlined in the safety section of your Student Notes
- You will be using a hacksaw, so work with caution

Preparation:

- Slide a strip of the framing material over each side of your panel
- Assess the fit and identify any area where the solder prevents the frame from sliding over the edge
    - You will need to remove any excess solder until the frame fits
    - You may find that you need to flatten the solder where the seams of your panel reach the edges
- Flatten the beads of solder, if necessary
    - You can remove solder by reheating it with the soldering iron

Building the Frame:

- Measure the longest side of your panel from edge to edge
- Measure and mark the same length on the framing material
    - This will mark your cut line
- Use a hacksaw to cut a strip of framing material along the cut line
- Fit the frame onto the panel
- Measure the opposite side of the panel
- Measure, mark, cut and fit a second piece of framing material
- Measure from the inside edge of the frame on one side, to the inside edge of the frame on the other side
- Measure, mark, cut and fit a third piece of framing material
- Repeat for the remaining side of the panel
- Fit the frame onto your panel

Soldering the Frame:

- Tack solder the frame at each of the seams
    - This will hold it in place
- Solder the frame to the seams
- Use solder to fill in the space where the frame meets at the edges

Detailed, step-by-step instructions for building a panel and frame can be found at the end of your Student Notes in the Activities section.

PATTERN DESIGN

SELECTING AN IMAGE

Reading Text, Document Use

Thinking Skills: Critical Thinking, Decision Making

Once you have completed a sun-catcher and panel using an existing pattern, you may want to consider designing your own pattern.

The first step in designing your own pattern is to decide on a theme and then research images you can use as a guide for your design. For example, if you enjoy boxing and want to use it as your theme, you would begin searching for boxing images.

In your first two projects you used a stained glass pattern. You can draw on that experience to help guide your image selection. You will want to think back to:

- how the existing stained glass patterns looked
- the impact colour, texture and flow had on the design
- the size of pieces you had to cut
- the angles you had to cut

It is important that you use copyright free images.

Next, you need to select an image. Let's say that through your research you find an image of a boxer. After assessing the image you realize that it may be too detailed for your current skill level. You may also see that you would need to cut small pieces and make tricky angle cuts.

However, you don't want to give up on your boxing theme, so you consider another image; a stained glass boxing glove. This would be an easier image to use as a guide for your pattern design. By selecting the image of the glove you could be confident in your ability to make all the cuts with your current stained glass skills.

DESIGNING A PATTERN

Reading Text, Document Use, Oral Communication, Numeracy, Computer Use

Thinking Skills: Decision Making

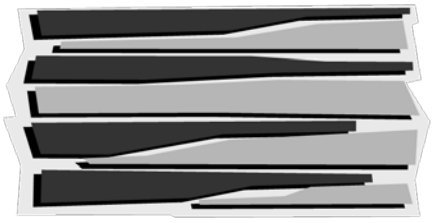
You can use computer software such as Glass Eye to create a pattern from a picture. However, before you use a computer to assist you, it is best to have experience creating a pattern by hand.

In most cases, the image you select will be of a person, place or thing (realism). This will require that you draw much of your image freehand. However, you may need a drawing tool such as a ruler to draw a border for your pattern.

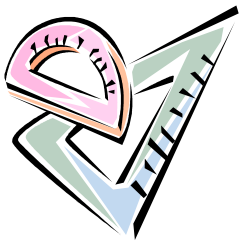
For more information about drawing tools use a search engine to search "Drawing Tools" on the internet.

Note: If you decide on an abstract image for this project or for a future project, you will need drawing aids such as a ruler, compass or square.

AN EXAMPLE OF AN ABSTRACT IMAGE:



If you don't feel confident about your artistic abilities, there is no need to worry. You can still successfully design your own stained glass pattern. The key is to keep your design simple. Also keep in mind your current stained glass skills. You don't want to design something you will not be able to create. When in doubt, ask your instructor for assistance.



TIPS FOR DESIGNING A PATTERN

Decisions:

- Select a theme and image
- Decide on the size and shape of your panel
- Decide if you want a border
- Decide where you want your central image
- Decide what you want in the background

Preparation:

- Make a copy of your image
- Enlarge or shrink the image to the size you need
    - You can photocopy or you can scan and print the image
    - Some people like to use black and white so that it is easier to see the lines; however it depends on the picture. If you have an image with the same intensity of green, blue, and yellow, you will lose the contrast

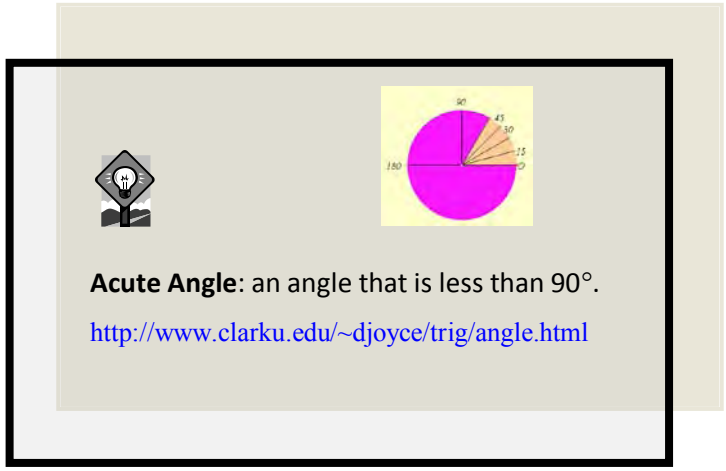
The Pattern:

- Transfer the pattern to blank paper
    - It can help to put the image on a light table or in a window

- Use a pencil to outline the major lines
    - Start with the main image
- Outline the background after the main image is complete
- Add detail and relief lines freehand or you can use a drawing tool (e.g. ruler)

Finishing Touches:

- Tape your finished pattern to the wall
    - You could also have someone hold it up for you
- Step back and look at the pattern
- Assess the pattern lines
- Make any necessary changes
    - Change any acute angles
    - Change any lines that result in pieces that are too small to cut
    - Erase any unnecessary lines
    - Add lines that would make the cuts easier



- Draw a border, using a ruler
- Enlarge or shrink the image to the size you need (if necessary)
- Make a copy of your pattern
- Trim the final pattern leaving a 1 centimetre (.4 inches) white paper border

BUILDING YOUR PANEL

Document Use

Once you have designed your pattern you can begin building your panel. You will follow the same steps you followed when you built your first panel.

- Build your jig
- Transfer your pattern
- Cut and grind the glass
- Foil and burnish the foil
- Solder
- Finish
- Frame

Detailed, step-by-step instructions for building a panel can be found at the end of your Student Notes in the Activities section.

ACTIVITIES

INTRODUCTION

Reading Text, Document Use

The following pages will provide you with step-by-step guidelines for building a stained glass sun-catcher and a stained glass panel. You may want to keep these notes open as you work so that you can quickly check your progress and identify your next steps.

The combination of all of these steps is a good example of the Essential Skill called Job Task Planning and Organizing.

If you have questions as you work, refer back in your Student Notes to find the answers.

Use the Table of Contents to help you find information in your notes.

Follow all safety procedures when completing the steps in this Activities section.

For example:

- Use caution when applying flux and solder
- Handle soldering irons, hacksaws, Exacto knives, grinders and glass cutters safely
- Wear safety gear such as gloves and masks whenever they are needed

BUILDING A SUN-CATCHER

STEP ONE: PICKING A PATTERN AND GLASS

Document Use, Numeracy

Thinking Skills: Decision Making, Critical Thinking

YOU WILL NEED:

- ✓ a pattern
- ✓ scissors
- ✓ glass
- ✓ a cardstock or cardboard copy of the pattern
- ✓ a pen/marker

- ☐ Review your pattern options and decide on a sun-catcher pattern
- ☐ Decide on the colour and type of glass you want for your project
- ☐ Make a cardboard/cardstock replica or carbon copy of the pattern
- ☐ Number all of the pieces, including the background
- ☐ Record the colour you want for each piece
- ☐ Cut out each piece of the pattern
- ☐ Lay the cardboard/cardstock pieces onto the glass
- ☐ Assess the position of the pieces and make adjustments
- ☐ Trace each pattern piece onto the glass
- ☐ Transfer the number from each pattern piece to the glass
- ☐ Mark the flow of the pattern on the glass

Start with an easy pattern for your first project.

In most cases you will make your cuts on the non-textured side of the glass.

STEP TWO: CUTTING AND GRINDING GLASS

Document Use

Thinking Skills: Critical Thinking

YOU WILL NEED:

- ✓ safety glasses
- ✓ glass cutter
- ✓ breaker/grozing pliers
- ✓ running pliers
- ✓ a grinder
- ✓ sink and towel

☐ Use a glass cutter to score the glass along the lines of the first piece (cut inside the lines)

☐ Use pliers to break the glass along the score line

☐ Continue until all the pieces are cut

☐ Use a grinder to grind your first piece

☐ Examine the edges and continue grinding until they are smooth and straight

- o Be careful not to over grind the piece

☐ Cut and grind your second piece

☐ Examine the edges on the second piece

- o Continue grinding if necessary

☐ Test that your first two pieces fit together well

- o Continue grinding if necessary

☐ Grind the rest of the pieces until they all fit together to form your sun-catcher

STEP THREE: FOILING AND BURNISHING GLASS

Document Use

Thinking Skills: Critical Thinking

YOU WILL NEED:

- ✓ foil (use a foiler if available)
- ✓ a burnisher
- ✓ scissors
- ✓ an Exacto knife

☐ Peel the paper backing off the foil and press it onto the edges of the piece

- o Assess the foil as you work to make sure it is centered

☐ Fold the foil onto the back and front of the glass

☐ Burnish the edges and then burnish the back and front of the piece

☐ Assess the foil

- o Look for wrinkles or air bubbles
- o Check that the foil line is straight

☐ If necessary:

- o continue burnishing
- o re-foil or use an Exacto knife to trim the foiled edges

☐ Foil and burnish each piece until the pattern is complete

☐ Wash and dry each piece

STEP FOUR: SOLDERING

Document Use

Thinking Skills: Problem Solving, Critical Thinking

YOU WILL NEED:

- ✓ gloves
- ✓ flux
- ✓ a soldering iron and wet sponge
- ✓ brush
- ✓ solder

☐ Lay your pieces on a flat surface

- Start working on the front of your piece

☐ Use a brush to apply flux to the foil seams anywhere the glass pieces will meet

☐ Tack-solder the pieces together

☐ Solder all of the seams making sure you cover all of the copper foil

☐ Flip the piece carefully

☐ Apply flux and then solder the back of your sun-catcher

☐ Apply flux and then tin all of the edges of your sun-catcher, on both the front and back

☐ Tin the edge of your sun-catcher with the piece upright

☐ Solder the edges - work carefully, the solder may drip

☐ Assess the solder and fix any problems

Note: Always allow the solder to cool before trying to move your piece.

STEP FIVE: FINISHING

Document Use, Numeracy

YOU WILL NEED:

- ✓ wax or polish
- ✓ pliers
- ✓ cloth
- ✓ gloves
- ✓ mild dish detergent
- ✓ brush
- ✓ safety glasses
- ✓ sink and towel
- ✓ patina

☐ Make a loop of copper wire with two tails

☐ Solder the loop onto an existing soldered seam of the sun-catcher

☐ Wash your panel with soap and water and dry it with a towel

☐ Apply neutralizer

☐ Add patina to all soldered areas and dab off excess

- o Dab off excess from the glass
- o Let sit for 10-15 minutes
- o Repeat on the other side and on edges

☐ Wash your finished piece with soap and water

☐ Polish the soldered seams with finishing compound

Congratulations! You have finished your Sun-Catcher!

BUILDING A PANEL

STEP ONE: PICKING A PATTERN AND GLASS

Document Use, Numeracy

Thinking Skills: Decision Making

YOU WILL NEED:

- ✓ a pattern
- ✓ scissors
- ✓ glass
- ✓ 1 cardboard or cardstock copy and 1 paper copy of the pattern
- ✓ a pen/marker

☐ Review your options and select a panel pattern

☐ Check that you have two copies of the pattern

- o One copy to cut out and transfer to glass (paper or cardstock) and one whole pattern for the jig (paper)

☐ Number all of the pieces, including the background

- o Remember to mark the colour and flow on the pattern

☐ Cut out each piece of the pattern (cardstock)

☐ Decide on the glass for your project

☐ Lay the cardboard/cardstock pieces onto the glass

- o Line up the flow of the pattern with the flow of the glass

☐ Trace each pattern piece onto the glass

☐ Number each piece of glass and mark the flow

STEP TWO: JIG ASSEMBLY

Document Use, Numeracy

Thinking Skills: Decision Making

YOU WILL NEED:

- ✓ a flat wooden board
- ✓ a Square
- ✓ nails or pins
- ✓ wood or metal strips
- ✓ a hammer

☐ Place your uncut pattern on the centre of a flat board

☐ Measure and cut a piece of trim to fit across the top edge of your pattern

- o This is the first piece of your jig

☐ Nail or pin the trim to the board

☐ Measure, cut and place a second strip of trim down one side of your pattern

☐ Use a Square to measure the corner where the two pieces of trim meet

☐ Assess the corner and adjust the side piece until you have a perfect 90° angle

☐ Nail or pin the side piece of trim to the board

☐ Repeat the steps to add the third strip

☐ Decide if you want to use a fourth strip, if yes, repeat the steps

STEP THREE: CUTTING AND GRINDING GLASS

Document Use, Numeracy

Thinking Skills: Critical Thinking

YOU WILL NEED:

- ✓ safety glasses
- ✓ breaker/grozing pliers
- ✓ a grinder
- ✓ glass cutter
- ✓ running pliers
- ✓ sink and towel

☐ Score and break out the pieces of glass you need for your pattern

- o Start with a corner piece so you are working against the jig

☐ Grind the pieces until they fit together inside the jig

- o Work with three or four pieces at a time

☐ Assess the edges of each piece

- o Continue grinding until they are smooth and straight

When fitting pieces, remember you will need to leave room for the foil.

Only foil a piece of glass when you know that there will be no need to grind it (or an ajoining piece) any further.

STEP FOUR: FOILING AND BURNISHING GLASS

Document Use

Thinking Skills: Decision Making

YOU WILL NEED:

- ✓ foil (use a foiler if available)
- ✓ scissors
- ✓ a burnisher
- ✓ an Exacto knife

☐ Stick the foil to the edges of each piece

- o Assess the foil to make sure it is centered

☐ Fold the foil onto the back and front of the glass

☐ Burnish the edges and then the back and front of the piece

☐ Assess the foil

- o Look for wrinkles or air bubbles
- o Assess that the foil line is straight

☐ If necessary:

- o continue burnishing
- o re-foil or use an Exacto knife to trim the foil edges

☐ Foil and burnish each piece until the pattern is complete

☐ Wash and dry each piece

STEP FIVE: SOLDERING

Document Use

Thinking Skills: Decision Making

YOU WILL NEED:

- ✓ gloves
- ✓ flux
- ✓ a soldering iron
- ✓ brush
- ✓ solder
- ✓ wet sponge

☐ Apply flux to the foil on the front of your piece

☐ Tack-solder the pieces together

☐ Flux again

☐ Solder all of the seams

- o Cover all of the copper foil

☐ Remove the piece from the jig carefully once the solder has cooled

☐ Flip the piece and flux and solder the other side

☐ Apply flux and tin around all of the edges of your panel, on both the front and back

☐ Assess the solder

☐ Fix any problems

You do not need to tin the vertical edge of a panel if you will be using a frame; however you still need to tin the front and back edge.

STEP SIX: FRAMING

Document Use, Numeracy

YOU WILL NEED:

- ✓ metal channel
- ✓ pins or nails
- ✓ tape measure
- ✓ framing material
- ✓ soldering iron
- ✓ a hacksaw

- ☐ Test the fit of the frame on each side of your panel
- ☐ Flatten any solder beads that prevent the frame from fitting snuggly - retest the fit
- ☐ Continue soldering until the frame slides over all of the panel edges
- ☐ Measure the longest side of your panel
- ☐ Measure the framing material and cut it with a hacksaw
- ☐ Repeat for the opposite side of the panel
- ☐ Measure the length from inside the first frame to the inside of the second frame
- ☐ Measure the framing material and cut it with a hacksaw
- ☐ Repeat until all 4 sides of your panel are framed
- ☐ Tack-solder the frame to the seams
- ☐ Solder the joints at the seams
- ☐ Fill in the spaces in the frame with solder

STEP SEVEN: FINISHING

Document Use, Numeracy

YOU WILL NEED:

✓ gloves	✓ safety glasses	✓ brush
✓ mild dish detergent	✓ sink and towel	✓ wax or polish
✓ patina	✓ pliers	✓ cloth

☐ Make a loop of copper wire with 2 *-+tails

☐ Solder the loop onto the panel frame

☐ Wash your panel with soap and water and dry it with a towel

☐ Apply neutralizer

☐ Add patina to all soldered areas and dab off excess

- o Dab off excess from the glass
- o Let it sit for 10-15 minutes
- o Repeat on the other side and on edges

☐ Wash your finished piece with soap and water

☐ Polish the soldered seams with finishing compound

Congratulations! You Finished your Panel

Stained Glass Resources Used Throughout Student Notes

www.hrsdc.gc.ca/eng/workplaceskills/essential_skills/general/home.shtml

http://www.meridianeng.com/msds.html

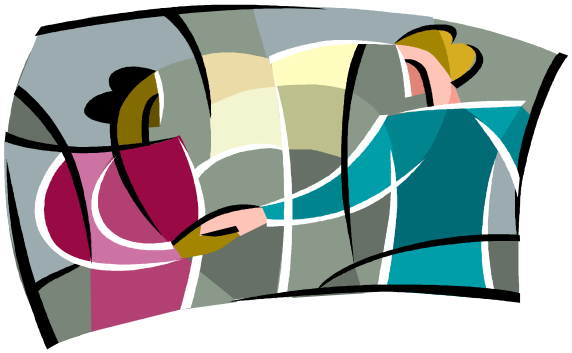
http://healthandfitness101.com/wp-content/uploads/2008/05/lifting-pic.jpg

http://en.wikipedia.org/wiki/Tiffany_lamp

store@thestorefinder.com

http://www.clarku.edu/~djoyce/trig/angle.html

http://en.wikipedia.org/wiki/Right_angle



We hope you have enjoyed this stained glass course.

On behalf of Literacy Ontario Central South, Literacy and Essential Skills in Industrial Arts (L.E.S.I.A.) project, we would like to thank you for your participation.

Best of luck with your future endeavours