Dear Educator,

Thank you for booking a tour with the Museum of Glass. We look forward to your visit!

We're sending you this curriculum to help enhance the visit for you and your students. These activities have been carefully prepared to go with the exhibit you will visit. You can use them as pre-visit materials or post-visit, but we strongly encourage that you spend some time with the packet before your visit. We've found that students understand and learn so much more if they're prepared before they come.

Along with this packet, we have extensive curriculum and interactive activities on our website about glassblowing and working with hot glass as an art form. Please visit ***www.museumofglass.org*** and click "**Learn**" on our home page. From there, visit the **Virtual Hot Shop**, where your students will get a chance to experience glassblowing by creating a ***macchia***. Participants walk through the process step-by-step until they get a finished work of art! Along the way they can also choose to learn more about glass. You and your students can even watch the Hot Shop Live, by clicking "**Watch**" on our home page and selecting the "**Live Web Streaming of the Hot Shop**" link.

We sincerely hope you enjoy these materials and your visit to the Museum of Glass.

Contrasts: A Glass Primer

November 2006 18 – October 12, 2009

EALRs & GLEs

Arts:

1. The student understands and applies art knowledge and skills.

   To meet this standard, the student will:

   1.1 Understand arts concepts and vocabulary
   1.2 Develop art skills and techniques
   1.3 Understand and apply arts styled from various artists, cultures and times.

2. The student demonstrates thinking skills using artistic process.

   To meet this standard, the student will:

   2.1 Apply a creative process in the arts.
   2.3 Apply a responding process to an arts presentation.

3. The student communicates through the arts.

   To meet the standard, the student will:

   3.1 Use the arts to express and present idea and feelings.
   3.2 Use the arts to communicate for a specific purpose.
   3.3 Develop personal aesthetic criteria to communicate artistic choices.

Communications:

1. The student uses listening and observation skills to gain understanding.

   To meet this standard, the student will:

   1.1 Focus Attention
   1.2 Listen and observe to gain and interpret information.
   1.3 Check for understanding by asking questions and paraphrasing.

2. The students communicate ideas clearly and effectively.

To meet this standard the student will:

2.1 Communicate clearing to a range of audiences for different purposes.
2.2 Use effective delivery. Adjust speaking strategies for a variety of audiences and purposes by varying tone, pitch, and pace of speech to create effect and aid communication.
2.3 Use effective language and style. Use language that is grammatically correct, precise engaging and well suited to topic, audience and purpose.
2.4 Effectively use action, sound, and/or images to support presentations.

3. The student uses communication strategies and skills to work effectively with others.

To meet this standard, the student will:

3.1 Use language to interact effectively and respond with others.
3.2 Work cooperatively as a group.

Writing:

2. The student writes in a variety of forms for audiences and purposes.

To meet this standard, the student will:

2.1 The student writes in a variety of forms for different audiences and purposes.
2.2 Write for different purposes, such as telling stories, presenting analytical responses to literature, persuading, conveying technical information, completing a team project, and explaining concepts and procedures.
2.3 Write in a variety of forms, including narrative, journals, poems, essays, stories, research reports, and technical writing.

3. The student writes clearly and effectively.

To meet this standard, the student will:

3.1 Develops ideas and organizes writing.
3.2 Uses appropriate style.
3.3 Knows and applies appropriate grade level writing conventions.

Science:

1. The student understands and uses scientific concepts and principles.

To meet this standard, the student will:

1.1 Understand how properties are used to identify, describe, and categorize substances, materials, and objects; and how characteristics are used to categorize living things.
1.2 Recognizes the components, structure, and organization of systems and the interconnections within and among them.
1.3 Understands that interactions within and among systems cause changes in matter and energy.

2. The students knows and applies the skills and processes of science and technology.

To meet this standard, the student will:

2.1 Develops abilities necessary to do scientific inquiry.
2.2 Applies science knowledge and skills to solve problems or meet challenges.

3. The student understands the nature and contexts of science and technology.

To meet this standard, the student will:

3.1 Apply knowledge and skills of science and technology to design solutions to human problems.
3.2 Analyze how science and technology are human endeavors, interrelated to each other, society, the workplace, and the environment.

Introduction

As children, how do we begin to recognize the distinguishing differences in the world around us? We develop our vocabulary for describing our environment through observing variations. Pairing art objects with contrasting characteristics functions much in the same way that a children's book of opposites does. Juxtapositions provide a valuable tool for viewing glass art and allowing the viewer to better understand how an artist might approach this medium. The categories in *Contrasts: A Glass Primer* reveal a solid foundation for comprehending the medium of glass, while providing the skills for forming an educated opinion. Some pairings in *Contrasts: A Glass Primer* focus on how the glass looks and is made, while other contrasts represent differences due to development through history and iconography.

The contrasts featured in this exhibition are: Natural/Fabricated, Hot/Warm/Cold, Transparent/Translucent/Opaque, Rigid/Fluid, Heavy/Light, Thick/Thin, Handmade/Machine Made, Factory/Studio, Designer/Creator, Painted/Engraved, Form/Surface, Vessel/Sculpture, Useful/Fanciful, Figurative/Abstract, Sacred/Secular, Beautiful/Brutal, Fact/Fiction, Art/Craft.

Contrast Examples:
Designer/Creator:

Goblets from Steuben's Counterpoint 2002.

Yellow and Blue, Dante Marioni, *Collection,* Dante Marioni, c. 2003.

Roughly thirty years ago, American artists wrested the medium of glass from the grasp of industry and brought it into the private studio. About a decade after the inception of the studio glass movement, Dante Marioni began his glass blowing career at the age fifteen. Marioni studied at the Pilchuck Glass School, started by Dale Chihuly and a few of his fellow artists, during the mid 1980's. As a student, Chihuly visited the island of Murano in Italy and the work he saw there profoundly influenced him, thus he invited the Murano master Lino Tagliapietra to the Pilchuck Glass School.

In 1998, the American Glass manufacturer Steuben Glass brought the studio artist back to factory with its new “artist-in residence” program. Tagliapietra collaborated with the century year old commercial producer in order to create his first pieces in crystal, the very glass for which Steuben is internationally renowned. Five years after this breakthrough, Marioni designed a series of goblets for Steuben Glass that were then sold through Steuben’s showrooms and catalogue.

Contrasting the clear uniform pieces that he did not physically make himself, Marioni also boasts a series of bright blue goblets on yellow shelves. The series finds harmony in color and size, but each individual goblet is unique. Marioni’s talent as an artist is evident whether he is designing and creating glass art.

Useful/Fanciful:

Glass Teapot, Wilhelm Wagenfeld.

Teapots, Richard Marquis, 1990.

Wilhelm Wagenfeld participated in the Bauhaus movement in Germany during the 1930s. The Bauhaus school found beauty in function and Wagenfeld rose to the challenge of this ideal in the creation of his famous teapot. Wagenfeld used a heat-resistant glass and left it perfectly clear, so that the level of water is always visible. He gave his teapot a sieve-like basket in which the tea leaves could steep. The basket can be easily removed before the tea becomes too bitter, allowing any avid tea drinker to create the perfect cup of tea. After the tea has been perfectly brewed, the combination of the teapot’s lightness and the precision of the spout make pouring easy.

Richard Marquis takes the opposite approach of Wagenfeld in his interpretation of the same object. Marquis emphasizes that his teapot is too precious for common use by purposefully using glass that is not heat-resistant and by creating a lid that does not come off. The viewer is invited to admire the piece as an object by concentrating solely on the form and skill required to produce what essentially becomes a sculpture that only resembles a teapot. A domestic object is elevated to art through the intentional absence of function.

Fact/Fiction:

Leopold and Rudolph Blaschka, *Blaschka Invertebrate, red squid.*

Antonio Salviati, *Lettuce-Leaf Compote with Winged Griffins,* 1880-1890.

Leopold Blaschka (1822-1895) and his son Rudolph (1857-1930) perfected the art of creating models of living plants and creatures that were difficult to preserve. In the 19th century, a fascination with the natural world blossomed and the Blaschkas painstakingly provided detailed specimens for scientific study. Museums and universities, such as Cornell and Harvard, bought the Blaschka models. The duo specialized in marine invertebrates, but also made over 3,000 models of plants in their studio near Dresden. Leopold and Rudolph applied paint to lampworked clear glass, using glass working techniques developed by their family since the 15th century.

> *"Many people think that we have some secret apparatus by which we can squeeze glass suddenly into these forms, but it is not so...The only way to become a glass modeler of skill, I have often said to people, is to get a good great-grandfather who loved glass; then he is to have a son with like tastes; he is to be your grandfather. He in turn will have a son who must, as your father, be passionately fond of glass. You, as his son, can then try your hand, and it is your own fault if you do not succeed. But, if you do not have such ancestors, it is not your fault. My grandfather was the most widely known glassworker in Bohemia, and he lived to be eighty-three years of age. My father was about as old, and Rudolf hopes my hand will be steady for many years yet. I am now between sixty and seventy and very young; am I not Rudolf?*
>
> *Leopold Blaschka, 1889*

Antonio Salviati, an Italian contemporary of the Bohemian Leopold Blaschka, saw before him the deterioration of Venetian glass art. The concerned lawyer took matters into his own hands and hired the best artists from Murano to work for his new company, *Salviati.* At a time when many glass workshops were about to close, Salviati and his business partner, Lorenzo Radi, went on to expand internationally, with shops from New York to St. Petersburg and many major cities in between. Salviati founded a school that promoted Venetian glass techniques and his development of mosaic work further established glass as a decorative medium.

The piece *Lettuce-Leaf Compote with Winged Griffins,* embodies the whimsy of fantasy. The appeal of this creation resides in its ability to carry us outside the limitations of reality. The bright colors and abstracted forms of Salviati stimulate our imaginations, while the verisimilitude of the Blaschkas' works elicit awe in the world in which we live.

Lesson One: Creating Contrasts

Objective:

Students will have a chance to creatively conceptualize the contrasts that will be presented by *The Glass Primer.* Students will collaborate in order to understand and communicate the different aspects of glass.

Materials:

Scissors, glue, tissue paper, construction paper, empty bottles of various shapes and sizes, animal images from magazines, beans, markers, clay.

Lesson:

Divide the class in half. Give each group a list of terms.

Group A:

1. Sacred
2. Thick
3. Beautiful
4. Fact
5. Factory/Designer
6. Figurative
7. Form
8. Heavy
9. Useful
10. Transparent
11. Vessel

Group B:

1.Secular
2. Thin
3. Brutal
4. Fiction
5. Creator/Studio
6. Abstract
7. Surface
8. Light
9. Fanciful
10. Opaque
11. Sculpture

Each group is in charge of using the materials to make one object that corresponds with each term. After they have finished, the group will present their objects according to their number (Group A term 1 at the same time as Group B term 1, etc.) with the intent and purpose of emphasizing the contrasts.

Example: Group A will work on creating an object with the materials provided that fits the description “factory/designer” while Group B works on the contrasting “creator/studio”. When they have finished, have a representative from each group present to the rest of the class, describing the process that they went through to arrive at their product and why it fits that description.

Hint: If students are having a hard time with “factory/designer” and “creator/studio,” reinforce the differences between a “creator,” who follows the project all the way through, verses a “designer,” who hands off their idea for someone else to make. For the “factory” element, suggest electing an individual to design for the rest of the group, who may then create at least two pieces in an assembly-line style. Group B will also elect and individual, who will not only design their piece, but also make it with the help of a few others if they choose.

Lesson Two: Journal

Objective:

The students will learn to translate the contrasts that distinguish various glass pieces into their writing. This exercise will augment the student's awareness of the utility of contrasts for understanding writing styles.

Lesson:

Students will answer one of two versions of the following prompts. When the students have finished, take volunteers to read at least one of each version.

1. Write a poem or your thoughts on a current political issue. (Collect articles from magazines and/or newspapers about current political issues for the students' use.)

2. Write a factual or fictional anecdote. (Provide images of fictional people, places and animals along with pictures of students, real places and real animals. Let the student's pick among these images to tell a factual or fictional anecdote as determined by the category in which their image falls.)

3. Describe the most beautiful or the most brutal/ugliest landscape you have ever seen (or can imagine).

4. What invention/consumer product do you think is the most useful (or useless) and why?

5. Imagine that you are going to make a glass piece that represents you. Would it be a vessel or a sculpture? Why? Things to think about: How do you receive and transmit information? Do you let others influence you? Are you more interactive or more self-sufficient? Continue the glass metaphor, using other properties of glass art to describe yourself.

Lesson Three: Natural verses Fabricated

Natural Glass

Fulgurite – Glass resulting from a strike in a mass of sand that has the right combination of minerals. This forms brittle, glassy tubes that preserve the shape of the lightening as it travels through sand.

Quartz – This glass-like rock crystal has the transparency of glass, but its crystalline structure prevents it from fully fitting the definition of glass. [1]

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[1] A simplified definition of glass describes it as a material that solidifies from a molten state without forming crystals.

Obsidian – Glass formed due to the intense heat of a volcano.
Tektite – Glass that forms as molten blobs of earth are tossed into the air when a meteorite hits the earth.
Euplectella – A glass sponge found in the western Pacific Ocean near the Phillipines with a hollow-cylindrical skeleton made from silica.

Glass occurs in nature when sand or stone endures extreme heat and then cools rapidly. Man used natural glass to create tools and jewelry, but was not able to fully take advantage of the beneficial properties of glass till he could make it himself. After witnessing how glass formed in nature, man began to modify glass recipes that create the many glass objects we depend on everyday.

Fabricating Glass
The glass that surrounds us in our every day lives, from bottles to windows, is commonly made from silica (silicon dioxide, SiO_2), also known as sand. When silica is cooled from a molten state it begins to behave like a solid, though it technically retains its status as a liquid. The structure of the molecules of glass does not change as it goes from a hot liquid state to a cold rigid one. The temperature at which silica begins to act like a solid, known as the *transition temperature*, is relatively high. Pure silica creates a very strong glass with great chemical durability, but the cost of manufacturing a glass that requires such a high melting temperature prevents its commercial use. The solution for this problem can be found in the addition of modifiers known as *flux.* Fluxing agents, such as alkali or alkaline earth oxides, lower the temperature at which the pure silica melts by disrupting the network connectivity. As modifiers lower the transition temperature, they also decrease the chemical durability and make the formation of glass more difficult. This requires a glass engineer to balance cost and quality when creating a recipe that best fits the needs of the glass manufacturer.

Understanding Fabrication through Candy Making
The methods used for making candy demonstrate many of the same principles as in the formation of glass. Sugar replaces silica as the glass former and the use of water mimics alkali as a modifier. Sugar (sucrose) has a melting temperature of 186 ^oC while water has a melting temperature of 0^oC. Comparably, silicon dioxide has a melting temperature of 1723^oC while alkali has a melting temperature of 1275^oC. The experiments below use a) sugar alone, b) sugar and water, c) sugar, corn syrup and water.

Vocabulary
Transition temperature
Flux
Fiber draw
Viscosity

Objective

After this experiment, the student should be able to understand these basic principles of glass science and technology:

1. If a pure melt is cooled slowly enough, it forms a single crystal, while cooling quickly produces a polycrystalline solid. Crystal formation can be completely suppressed if the cooling rate is sufficiently increased, thus creating glass.
2. Impurities, mechanical agitation, bubbles and other factors can create crystals. The addition of a modifier decreases the ability of the melt to form glass.
3. The number of ingredients may improve the ability of a melt to form glass.
4. Modifiers overall weaken the glass.
5. The *viscosity* of a melt can be controlled by varying the temperature, which makes it possible to control the drawing of glass fibers.

Materials

Hotplate or electric stovetop
1 one-quart stainless steel pan
12 metal tablespoons
1 laboratory balance
1 metal tray to hold hot candies (up to ~ 175^{o}C/350^{o}F)
1 laboratory of good quality thermometer that reads up to ~ 205^{o}C or 400^{o}F
5 pounds of granulated cane sugar
16 oz. bottle of corn syrup
Drinking water
20 molds for casting. (The metal containers from *Tea Light* candles work well or small cookie cutters)
4 eight oz. glasses
Crystal candy, available in clumps of large, colorless crystals

Experiment A- Pure sugar.

1. Place molds on metal tray.
2. Put 410 g sugar in the pan and gradually heat on hotplate or electric stovetop at low-medium temperature. Insert thermometer and monitor the temperature of sugar.

Stir sugar with spoon in order to maintain uniform temperature throughout. **Note**: keep thermometer bulb in the middle of sugar, but away from the bottom of the pan.

3. Continue to stir at a rate that best mixes solid and molten parts. Continue heating and stirring until all the sugar has melted. The stirring speed should be such that solid and molten parts mix together. Record the temperature at which the sugar melts.
4. At this point, stop stirring and prevent the temperature from increasing. Temperature increase would cause excessive browning and the formation of bubbles, symptoms of the decomposition of sugar.
5. Put one tablespoon of molten sugar in mold (sample #A1) and three tablespoons in a different mold (sample #A2). Note: molds can be easily marked and kept track of with permanent marker.

6. Record the physical appearance of the samples as they cool to room temperature. Make observations regarding transparency, presence of small white crystals and/or bubbles, and solid or liquid state.
7. A *fiber draw* can be created by slowly pull a spoon out of the melted sugar. Record a prediction for which temperature the fiber draw will be at the height of its ability.
8. Turn the hotplate off. Make several fiber draws, all the while noting the temperature. Continue this process, as the temperature decreases and the sugar becomes more solid, until a fiber draw is no longer possible. Note the temperature at which the fiber draw reached its maximum ability.
9. Compare the appearance of samples #A1 and #A2 with that of crystal candy that is also made of pure sugar.

Experiment B- Sugar and water modifier.
1. Put 410 g sugar and 100 g water in the pan and begin heating while stirring the melt. Monitor increasing temperature as sugar dissolves. Record the temperature at which all the sugar dissolves.
2. Continue to heat and stir. Record the temperature at which the syrup begins to boil.
3. Cast candy from the syrup (sample #B1). Record the physical appearance of the samples as they cool to room temperature. Make observations regarding transparency, presence of small white crystals and/or bubbles, solid or liquid state. If the sample remains fluid once it has reached room temperature, note its relative viscosity.
4. Continue to stir and boil the remaining syrup until the temperature increases by
5. °C (or 10 °F) If solid sugar deposits on sides, scrape and stir it into the liquid. Cast candy from this more concentrated syrup (sample #B2). Make a note of the physical appearance as in step three of experiment B.
5. Repeat step 4, casting a new candy for each 5 °C (or 10 °F) increment in temperature (sample #B3, #B4, … etc.). Continue until the temperature reaches 170 °C (338 °F).
Be sure to use a clean spoon to cast each new sample.

Experiment B(a)- Sugar and water; without stirring.
1. Repeat all the steps of Experiment B, except this time **do not stir** the solution after the sugar has settled at the bottom of the pan (at 200 F). Try to cast the samples (#B1(a), #B2(a), #B3(a),… etc.) when the melt is at the same temperature as in Experiment B.
2. Record the changes in samples as they cool to room temperature, making special note of any differences compared to the corresponding B samples.

Experiment C- Sugar, corn syrup and water.

1. Repeat Experiment B(a) using 240 g corn syrup, 410 g sugar and 100 g water in a clean pan.

Testing: Effect of processing conditions on the properties of candies.
Hardness or Chewy character. The samples should have a wide range of hardness from brittle solid to a watery liquid. To make a comparison of this property, use a paper clip. Open up a paper clip to have one sharp end and keep the rest bent. For the solid samples, insert the sharp end with consistent force into each sample and compare the size of the dents created. For liquid samples, use the bent end of the paper clip. Dip it into the liquid and take it out, noting the relative force needed.
Durability in water. For one temperature, select a sample from each of the A, B, B(a) and C experiments (i.e. the cast from the melt at 150 °C or 302 °F). Weigh (still in mold) on laboratory balance and place them in separate 8-oz. glasses with 200 g tap water. (Note: all the water should be at the same temperature). Drain the water out after 1 hour. During this time, avoid disturbing the sample and water. Take the samples out, dry and weigh them again. Calculate the respective weight loss due to the water dissolving the sample. Each sample has equal surface area exposure to the water, thus making the weight loss inversely proportional to the durability; the greater the weight loss, the lower the sample's durability.

Hint for recording information onto a table: When possible, assign relative grades of 1 through 5 to non-quantative information. For example, in a column for transparency, write 1 for an opaque and 5 for a completely transparent sample.

Example Table:

Sample #	Casting Temp.	Transparency	Crystal Formation	Relative hardness (H) or viscosity (V)	Comments
#A1					
#A2					
#B1					
#B2					
#B3					
Etc.					

Image Credits:

Designer-Creator

Dante Marioni (designer, American, born 1964)
Fifteen Goblets from the *Counterpoint Collection*, Steuben Glass, 2003
Glass and lead crystal, press-molded stems and feet, mold-blown bowls
Courtesy of Steuben Glass
Photo courtesy of Steuben Glass

Dante Marioni (American, born 1964)
Y*ellow and Blue*, 2002
Blown glass and wood
Courtesy of the artist
Photo by Roger Shcreiber, courtesy of the artist

Useful-Fanciful

Wilhelm Wagenfeld (designer, German, 1900–1990)
Glass Teapot, Jenaer Glas, 1932 design
Free-blown glass spout and handle; mold-blown glass body; pressed glass strainer and lid
Museum of Glass
Photo courtesy of Museum of Glass

Richard Marquis (American, born 1945)
Crazy Quilt Coffee Pot, 1990
Heart Teapot, 1988
Crazy Quilt Teapot, 1990
Blown murrine glass
Collection of Johanna Nitzke Marquis
Photo courtesy of the artist

Fact-Fiction

Leopold Blashka (German, 1822–1895) and
Rudolph Blaschka (German, 1857–1929)
Invertebrates, about 1880–1885
Flameworked and painted glass
Collection of Museum of Science, Boston
Photo courtesy of Museum of Science, Boston (red squid)

Antonio Salviati (designer, Italian, 1816–1890)
Lettuce-Leaf Compote with Winged Griffins, Murano, about 1880–1900
Blown and hot-worked glass and gold foil
Collection of The Corning Museum of Glass, gift of Barry Friedman Ltd., New York, 2005.3.36
Photo courtesy of The Corning Museum of Glass

Transparency Image Credits:

Heavy/Light-
Robbie Miller (Canadian-American, born 1960)
Block, 2000
Kiln cast lead crystal
15.5 inches
Courtesy of Robbie Miller

Susan Plum (American, born
Metamorphasis Series: Tejidos XIII, 1997
Lampworked Glass
35 ½ x 51 ½ x 14 inches
Courtesy of Anne Gould Hauberg

Sacred/Secular-
Louis Comfort Tiffany (American, born 1848-1933)
Young Joseph, stained glass panel, United States, Corona, Long Island, New York
Tiffany Studios, about 1900
Multi-colored, cut and lead glass; assembled
69.49 (framed) x 39 (framed) inches
Courtesy of Corning Museum of Glass

Frank Lloyd Wright (American, born 1867-1959)
Sample Window for Susan Lawrence Dana House, Springfield, Illinois, c. 1904
Leaded glass
46 ½ x 31 ½ inches
Courtesy of Greenville College

Form/Surface-
Flora C. Mace and Joey Kirkpatrick (American born 1849/1952)
Water Catcher, United States, Stanwood, Washington, Pilchuck Glass School, 1984
Blown and enameled glass, wood, and wire
37.2 (base) x 6.02 (base) inches
Courtesy of Corning Museum of Glass

Flora C. Mace and Joey Kirkpatrick (American born 1849/1952)
Doll Drawing, 1981
Blown glass, wire, and glass frit
17 ½ x 15 x 15 inches
Courtesy of Anne Gould Hauberg

Museum of Glass Educational Curriculum is supported in part by generous donations from:

The Florence B. Kilworth Foundation
The William W. Kilworth Foundation
The Dan & Pat Nelson Family Foundation
The Gary E. Milgard Family Foundation
The Ben B. Cheney Foundation
Macy's
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and

THE FRED MEYER FOUNDATION