GEOMETRY AND ART

Clay Cylinder (Mug)

Main Ideas

Unit of Instruction

Introduction to nets, surface area, and volume by having students build their own cylinder out of clay.

Geometry Concepts

- Geometric constructions of rectangles for nets, geometric design on cylinder, surface area calculations, volume calculations, circle terminology

Rationale

This project provides a hands-on approach to measurement.
Students create a three-dimensional object (a mug) and calculate its varying dimensions while wet, dry, and fired.

NCTM 9-12 Standards

- Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Apply appropriate techniques, tools, and formulas to determine measurements.
- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.
- Build new mathematical knowledge through problem solving.
- Solve problems that arise in mathematics and in other contexts.
- Recognize and use connections among mathematical ideas.
- Recognize and apply mathematics in contexts outside of mathematics.
- Use representations to model and interpret physical, social, and mathematical phenomena.

Idaho Content Standards

- G.2.1. Understand measureable attributes of objects and the units, systems, and processes of measurement.
- G.2.1.1. Make decisions about units that are appropriate for problems involving measurement.
- G.2.2.1 Understand and use formulas to calculate the perimeter, circumference, area, surface area, and volume of geometric figures.
- G.4.1.3 Establish the validity of geometric conjectures.
- 9-12.VA.3.1.1 Select and apply media, techniques, and processes effectively and with artistic intention.
- 9-12.VA.3.1.2. Demonstrate safe and proper use, care, and storage of media, materials, and equipment.

Background

Vocabulary

Base	Kiln
Bisqueware	Net
Circumference	Pi
Clay	Radius
Cubic Units	Score and Slip
Diameter	Shrinkage
Firing	Slab
Glaze	Square Units
Greenware	Surface Area
Height	Volume

Math Instruction (pre- or post-project)

- Identify the parts of a circle (radius, diameter, circumference)
- Calculate the areas of circle and rectangle
- Calculate the volume and surface area of a cylinder
- Perform basic compass constructions
- Determine the net of a cylinder

Driving Question

Project Objective

- Students will make net of a cylinder.
- Students will construct a cylinder out of clay.
- Students will calculate surface area and volume of student-made cylinder.

Questions to be Answered

- How does change in diameter and height affect volume and surface area?
- How much volume was lost due to firing?
- How does the volume inside the shape differ from the volume of the overall shape?

Materials

Materials Required

- Approximately 3 lbs of clay per person
- 5 rolling pins or slab rollers (for approximately 30 person class)
- 7-10 dinner knives or fettling knives
- 7-10 dinner forks
- 1 sheet of drawing paper (12 X18) per student for construction of net
- Rulers
- Compasses
- Clay glaze
- Kiln (if not available –possible substitutes—self hardening clay or play dough)
- Scissors
- Stamps (pressable die cast objects)
- Copy of attached worksheets for each student

Lesson Outline

Description of Activity

- Construct net using compass
- Review sample calculations of volume, surface area, circumference and area
- Use student-made net to construct and decorate clay cylinder (mug)
- Measure finish unfired mug
- Fire mug
- Measure fired mug
- Compare various measurements

Day One 50-55 minutes

- Introduce project and finished example(s)
- Review compass constructions of right angles and parallel lines
- Use compass to construct nets for cylinder (suggested parameters: minimum diameter of 2 ½" and sum of diameter and height equal to 10")
- Complete "Net Measurement" worksheet
- Discuss next day's clay activity - general rules and procedures in art room

Day Two 50-55 minutes

In art room

- Assign art buddies, working spaces, and clay process
- Get clay
- Roll slabs
- Use net to cut pieces of clay
- Decorate rectangle with pressed designs
- Roll rectangle into a cylinder
- Slip and score side seam
- Attach bottom and put name on bottom
- Measure and record wet mug (height, diameter, wall thickness, base thickness) using "Mug Measurement Worksheet"
- Discuss glazing with art buddy, who will glaze the mug
- Set to dry

Day Three - **may be 5-7 days after Day Two (day before mug pickup) 15-20 minutes**

- Review formulas for area, surface, and volume of cylinders, circles, and rectangles
- Calculate the surface area and volume of the student's net and wet mug using "Mug Measurement Worksheet"

Day Four **(day of mug pickup-several days later…after drying, firing, glazing, firing) 30 minutes**

- Pick up mugs
- Measure finished products
- Complete calculations of surface area, volume ("Mug Measurement Worksheet")
- Compare and contrast surface area and volume at different stages (net, wet, and fired)

Day Five **(mugs on parade) 15 minutes**

- Give mug awards: students nominate mugs for various categories (least volume, most volume, most functional, least like a mug, best seasonal mug, best surface design, etc.)
- Determine actual capacity of each award winning category mug
- Write thank you notes to art class and buddies

Assessment

Calculation worksheets and reflection

Net Measurement Worksheet - see attached
Mug Measurement Worksheet - see attached
Mug Project Reflection - see attached

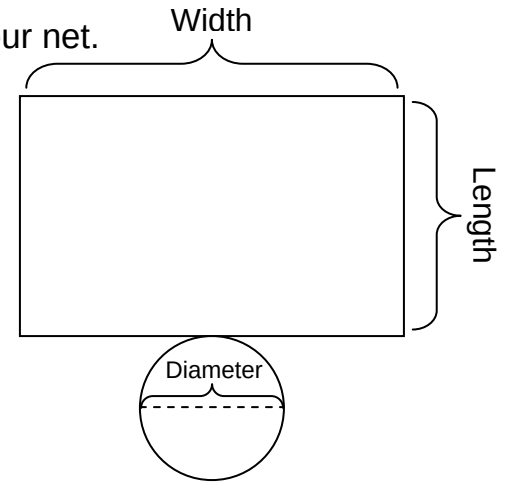
Ideas for Further Independent Student Project

- Use mug project for percent change
- Use percent of change in volume to construct a distribution and determine its shape
- Calculate standard deviations
- Test Inferences
- Write hypotheses

Name: _____ Period: _____

Net Measurement Worksheet

Use a ruler to find the following measurements of your net.



Rectangle Length: _____

Rectangle Width: _____

Base Diameter: _____

Use the measurements you arrived at to calculate the following values. Show your work.

Base Circumference _____

Base Area _____

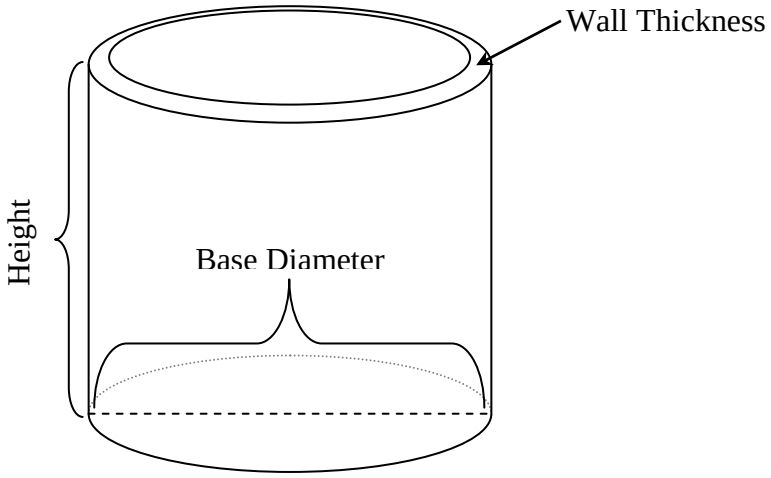
Rectangle Area _____

Surface Area of Cylinder _____

Volume of Cylinder _____

Name: _____ Period: _____

Mug Measurement Worksheet



Measurements/Calculations	Wet	Fired
Wall Thickness		
Exterior Height		
Interior Height		
Exterior Base Diameter		
Interior Base Diameter		
Exterior Base Area		
Interior Base Area		
Exterior Surface Area		
Interior Surface Area		
Total Surface Area		
Volume		

Name: _____ Period: _____

Mug Project Reflection

1. What did you like about the project?

2. What did you <u>not</u> like about the project?

3. What are five new things that you learned over the course of this project? Include at least one specific to geometry and one specific to working with clay.

4. Which of the items from question three did you find the most surprising and why?