

Module 1: Glass Casting & Mathematics

Art in Mathematics (AiM)

GLASS CASTING AND MATHEMATICS

TIME FRAME: 6 days

ENDURING UNDERSTANDINGS:

The process of creating a small clay sculpture that will be open-face cast into glass involves the understanding and utilization of geometric formulas for perimeter, area and volume. The casting process involves work with algebraic formulas, graphs of linear functions and understanding and interpreting graphs of two variables.

MATH KEY CONCEPTS/GOALS:

- Geometric Formulas: Volume, Area, Perimeter, Surface Area
- Graphing: interpretation of graphs, relation between two variables, and creation of graphs
- Graphing Geometric Figures: reflections, translations, symmetry
- WASL (Washington Assessment of Student Learning) Practice
- Linear Functions: relationship between graphical, tabular and symbolic form

WASHINGTON MATH STANDARDS:

A 1.4, 1.6
G .5, .6
M 1.0, 1.0 B, 1.3, 1.4

CRMS:

Number sense: 4.3
Geometry: 5.2, 5.3
Algebra: 7.3
Functions: 8.2, 8.4

AT THE END OF THIS UNIT STUDENTS WILL KNOW AND BE ABLE TO:

1. Calculate volume and surface area of molds and determine the amount of material needed to create sculpture.
2. Create linear equations from tables.

PRE-REQUISITE KNOWLEDGE/SKILLS:

1. Knowledge of graphing in two dimension

ACTIVITIES*:

Transformations Worksheet
Kaleidoscope Name Activity
Pond Problem Activity
2-D Sketch and 3-D Clay Model Activity
Painter's Problem Warm-up
Geometry Gift Warm-up
Ice Cream Dilemma Warm-up
Volume and Surface Area Application Problems Worksheet1
Volume and Surface Area Application Problems Worksheet2
Graph Interpretation Problems Worksheet
Firing Graph Worksheet
Hot Tub Problem Worksheet
400 Meter Race News Story & Worksheet
Bus Trip Worksheet

*Several activities adapted from previously released math WASL test questions

POST-ASSESSMENT:

Student Reflection Survey

RESOURCES:

- Quicktime video clips illustrating use of Symmetry and Math in Art
- Quicktime video examples of casting: lenses, headlights, bronze sculpture
- Accessible from Project TIME website:
www.instruction.greenriver.edu/projecttime (AiM Link)
- www.bullseyeglass.com

DAILY PLAN

Day 1

Art

- Video clips showing the use of symmetry and math in art, chunk casting
- Art warm-up to review art/math vocabulary

Math

- **Transformations** Worksheet (translations, rotations, slides, reflections, etc)
- **Kaleidoscope Name** Activity

Day 2

Art

- Video clips of artist's bias-relief work
- Sketch of bias-relief plan

Math

- **Pond Problem** Activity
- **Painter's Problem** Worksheet

Day 3

Art

- Create clay model for glass bias-relief

Math

- **Geometry Gift** Worksheet
- **Ice Cream Dilemma** Worksheet

Day 4

Art

- Feedback and revision of clay model for bias-relief

Math

- **Volume and Surface Area Applications** Worksheet 1

Day 5

Art & Math

- Determine Mixing Investment
- Determine Volume of flask to hold investment
- Determine amount of glass needed to charge mold for chuck casting
- Video clips of casting: lenses, headlights, bronze sculptures

Math

- **Volume and Surface Area Applications** Worksheet 2

Day 6

Art

- Firing of glass casting
- Writing Assignment: self-reflection about what they learned about the math and art involved in this process

Math

- **Firing Graph** Worksheet
- **Graph Interpretation** Worksheet
- **Hot Tub Problem** Worksheet (interpreting the meaning of slope)
- **400 Meter Race** Worksheet (describing change over time)
- **Tour Bus** Worksheet

INTRODUCTION TO THE ART OF CHUNK CASTING

The art process of creating works of art most often follows steps or sequences that are in a progression that results in the final object. Some steps seem meaningless at the time; however in the final work the step or steps missing become very evident. If one looks at a building from the foundation to the roof, it is a given that all of the building sequences need to be present to complete the structure and make it stable. Nevertheless, these steps of process do not inhibit the creative genius of being an artist. The art sequence is like the wire that a tight-wire walker uses to create his performance at the circus. He must remain on the wire and needs to keep his balance and yet his grace entertains us during his performance.

The Chunk Casting process follows a step by step procedure that students will need to follow to produce a glass casting.

Students will begin this process by viewing video clips of Chunk Casting and symmetry. This will be followed by a discussion of the relevant art and math vocabulary. See the Teacher Resource page, Chunk Casting: Art and Math Vocabulary.

Next step is the brainstorming a shape for the bias-relief sculpture and capturing their creative ideas on paper. Video clips of artist's relief work are shown. Student art work may be assessed using the following rubric:

PLANNING SKILLS RUBRIC

| Excellent/Strong [A] | Standard/Good [B] | Approaching/Emerging [C] | Inadequate/Poor [D] |
|--|--|--|---|
| Multiple solutions/revisions or effort at exploring ideas. Multiple artworks and/or multiple ideas in planning | Plans more than one idea, or one idea that has been well thought out in multiple aspects | One idea with some effort shown in problem solving | One idea that shows little effort in problem solving, copy-work |

Once students have completed a sketch of their design, they will create a clay model for the bias-relief that will be Chunk Cast into glass. Student art work may be assessed using the following rubric:

COMPOSITIONAL AND CONCEPTUAL SKILLS RUBRIC

| Excellent/Strong [A] | Standard/Good [B] | Approaching/Emerging [C] | Inadequate/Poor [D] |
|---|---|--|---|
| Risk taking and/or addresses complex visual/conceptual ideas in composition | Has some success with ideas in concept and design. Shows some exploration | Solutions tend to be simplistic in composition | Compositions are poor or ill considered |

As students are creating their clay model, the instructor will have feedback that will help students with a critic of their bias-relief. The following rubric may be used to assess student’s revision skills.

REVISION SKILLS RUBRIC

| Excellent/Strong [A] | Standard/Good [B] | Approaching/Emerging [C] | Inadequate/Poor [D] |
|---|--|---|---|
| Responds to feedback with personal insight and incorporates own ideas and suggestions in revision | Revises work incorporating feedback or develops alternatives with some success | Responds to feedback with occasional success. Lacks successful alternatives | Unable to utilize feedback to improve work or development of alternatives |

After the bias-relief has been revised, students will calculate the mixing investment and the volume of the flask that will hold the investment. Clay will also be removed from the investment and math will be used to find the amount of glass needed to charge the mold for Chunk Casting. The following rubric may be used to assess the completed cast:

TECHNICAL SKILLS IN MEDIA RUBRIC

| Excellent/Strong [A] | Standard/Good [B] | Approaching/Emerging [C] | Inadequate/Poor [D] |
|--|---|--|---|
| Consistent high quality of technical skills shown in artwork application of media. Exceed assignment objectives with intricacy in detail, expressive qualities, or extra work. Risk taking may exhibit some technical flaws. | Successful engagement with most aspects of technical skills of media. May be more successful in one area than others. Fulfills assignment objectives with personal solutions and application of skills. | Simplistic/somewhat successful techniques in technical skills of media. Missing some of assignment objectives. | Poor qualities of technical skills of media exhibited in artwork(s). Limited work, missing significant parts or all of assignment objectives. |

CHUNK CASTING: ART AND MATH VOCABULARY/FORMULAS

ART:

Investments

Face Coat Investment

1 part - #1 pottery/casting plaster

1 part – 295 Mesh silica flour

Mixing amount: 1 part water to 1.75 parts face coat investment

Jacket Coat Investment

1 part – Water

1.75 part – Face Coat Investment

1 part – Grog mix*

*Grog mix

1 part – Fine grog

3 parts – Medium grog

3 parts – Course grog

Amount of Glass for Casting (Specific Gravity Formula)

Amount of water x 2.5 = amount of glass

Conversion of Weight

1 pound = 454 grams

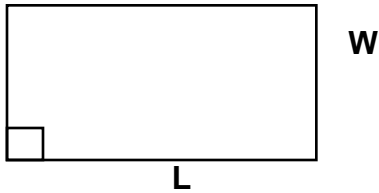
Plaster Loss of Strength

1100 degrees F/593 degrees C

Chunk Casting: Art and Math Vocabulary/Formulas

Math Geometric Formulas

Rectangle



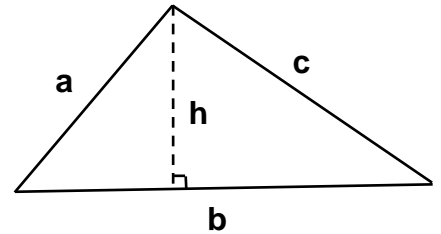
Perimeter: $P=2L+2W$
Area: $A=LW$

Square



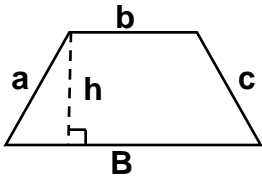
Perimeter: $P=4S$
Area: $A=S^2$

Triangle



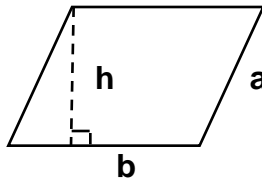
Perimeter: $P=a+b+c$
Area: $A = \frac{1}{2} b h$

Trapezoid



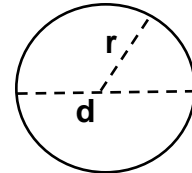
Perimeter: $P=a+b+c+B$
Area: $A = \frac{1}{2} h(B + b)$

Parallelogram



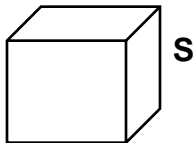
Perimeter: $P=2a+2b$
Area: $A=bh$

Circle



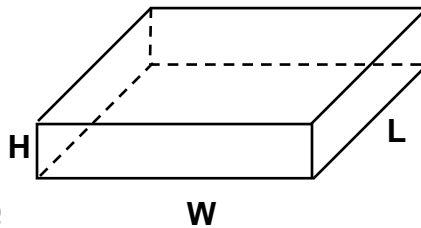
Circumference: $C = \pi d$
Area: $A = \pi r^2$

Cube



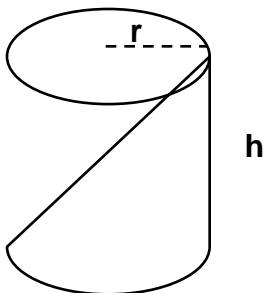
Surface Area: $SA = 6S^2$
Volume: $V = S^3$

Rectangular Solid



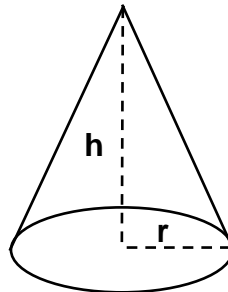
Surface Area: $SA=2LH+2LW+2WH$
Volume: $V=LWH$

Right Circular Cylinder



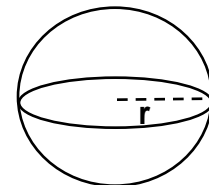
Surface Area: $SA = 2\pi r^2 + 2\pi r h$
Volume: $V = \pi r^2 h$

Cone



Volume: $V = \frac{1}{3} \pi r^2 h$

Sphere

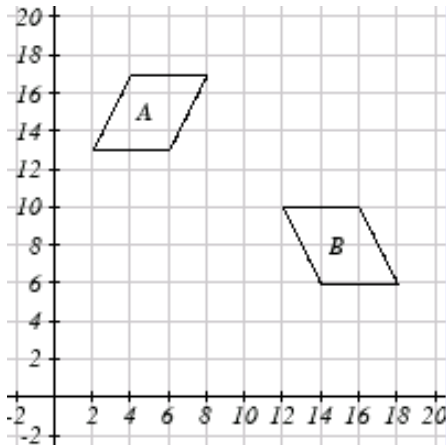


Volume: $V = \frac{4}{3} \pi r^3$

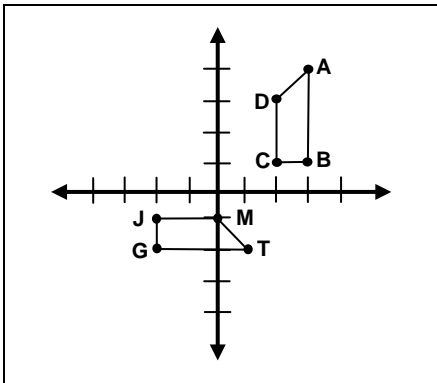
Transformations Worksheet

Name _____

1. Describe in detail how you would produce figure B, from figure A, using only verbal clues. Use the terms translate, reflect or rotate.



2. Using the words translate, reflect, and/or rotate, explain how to transform ABCD into TGJM



KALEIDOSCOPE NAME ACTIVITY

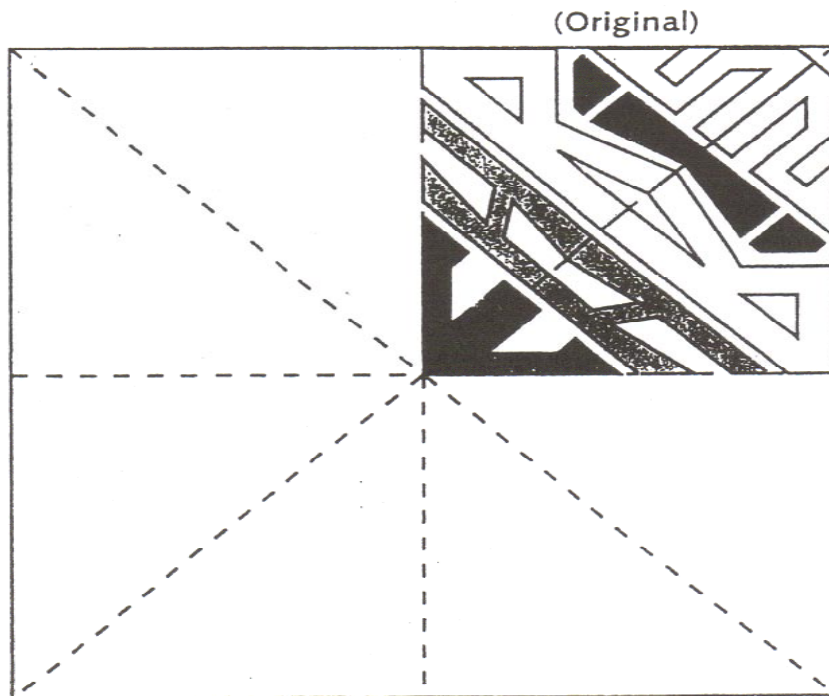
Name _____

DIRECTIONS: You will design a kaleidoscope image using your first name and its transformations.

PART 1: GEOMETRIC DESIGN

Steps:

1. Begin with a square sheet of paper. Create a fold along the paper horizontally, vertically, and along each diagonal, so that eight triangular regions are formed.
2. In one of the regions, place an artistic rendition of your first name. Your name must fill the entire region, and the borders of the letters actually touch the borders of the region.
3. Transform (reflect, rotate, translate) your letter through one of the folds to fill the next region. Continue to do this all the way around the page until all regions are full. Keep the color scheme of each letter consistent throughout the design.



KALEIDOSCOPE NAME ACTIVITY

Name _____

PART 2: WRITTEN PROJECT REFLECTION (1/2 PAGE)

- Discuss the types and number of geometric transformations that were made while completing the project using the vocabulary that was discussed (i.e., rotation, slide).
- Did things always go as anticipated? What one thing surprised you most while working on your project? (It can either be a positive or a negative thing.) Describe the surprising situation or event and discuss why you were surprised
- Describe what you learned from doing this project.
- If you did this project again, discuss how you would do this project differently?

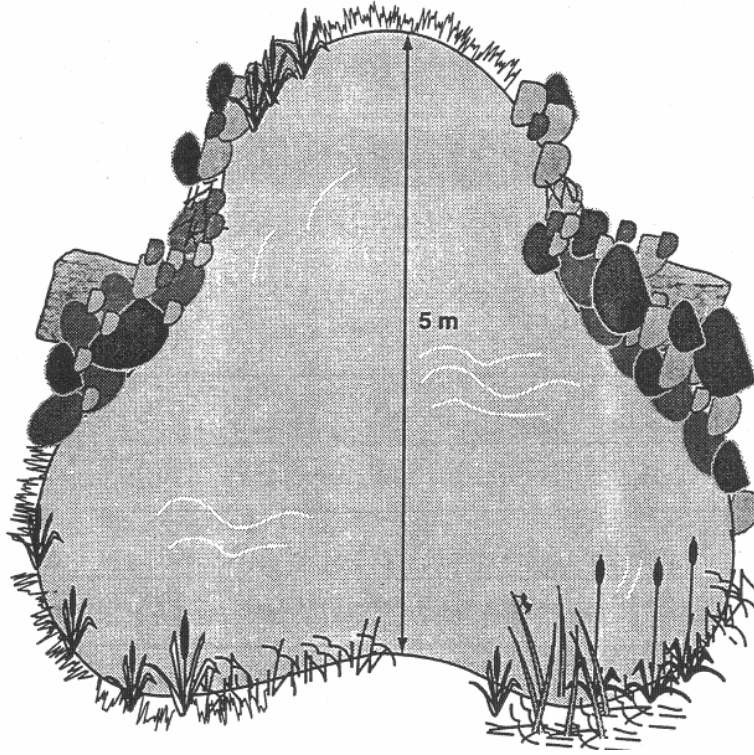
KALEIDOSCOPE NAME ACTIVITY

GRADING RUBRIC

| | Exceeds | Meets | In Progress (redo) |
|---------------------------|---|--|---|
| Required Elements | The project includes all required elements as well as additional information. | The project includes all required elements. | Several required elements are missing. |
| Attractiveness | The project is exceptionally attractive in terms of design, layout, and neatness. All transformations are accurate. | The project is attractive in terms of design, layout, and neatness. Most transformations are accurate. | The project is messy or poorly designed. Transformations are not correct. |
| Written Reflection | All questions are addressed in complete sentences. Write-up is neatly done with little to no errors in spelling and grammar. Appears to be a final draft. | Most questions are addressed in complete sentences. Write-up is neatly done but has several errors in spelling and grammar. Appears to be a rough draft. | Questions are addressed in incomplete sentences. Poor effort. |

POND PROBLEM ACTIVITY

Tran is landscaping a city park, which contains the small pond shown below.



Tran needs to estimate the pond's surface area. Describe a reasonable method for estimating this surface area.

| |
|----------------------------|
| |
| |
| |
| |
| |
| |
| |
| |
| Estimate of surface area = |

PAINTER'S PROBLEM

Name _____

A painter is going to paint a hexagonal column on a porch. One side of the column is 15" and the height of the column is 12 feet. One can of paint will cover 22 square feet, how many cans of paint will he need?



GEOMETRY GIFT PROBLEM

Name _____

Tami needs to wrap 3 packages for her mother's birthday. They are all rectangular. One is 8" x 8" x 3", one is 4" x 4" x 5" and the last one is 18" x 12" x 2". The roll of wrapping paper says it will cover 5 square feet. Will she have enough paper? Describe your answer.

ICE CREAM DILEMMA PROBLEM

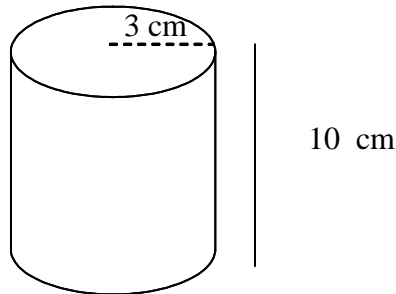
Name _____

A spherical scoop of ice cream that has a diameter of 2.5" is placed on a conical ice cream cone that also has a diameter of 2.5". If the cone is 4" deep, will it hold the ice cream as it melts? Explain your answer.

VOLUME AND SURFACE AREA APPLICATIONS WORKSHEET 1

Name _____

1. The sketch of a cylindrical storage tank is shown below. The outside surface of the top and side must be painted.

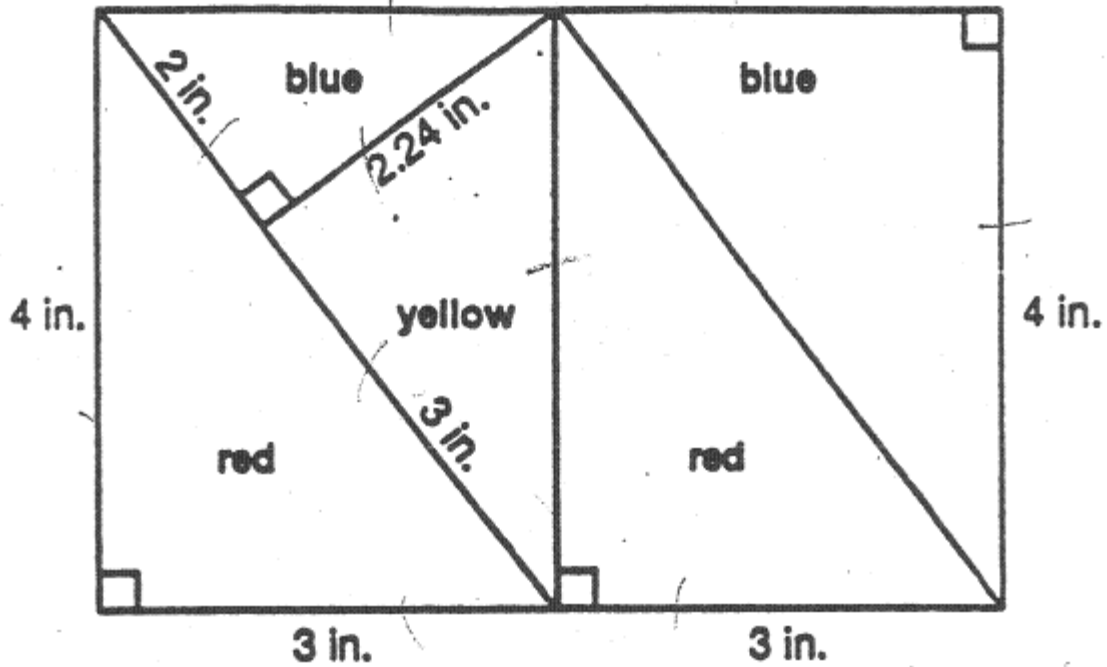


The painter remembers that the area of a circle is equal to π times the square of the radius, and that the circumference of a circle is equal to π times the diameter.

1a. Write an equation that the painter could use to find the surface area (SA) to be painted

1b. Determine the surface area that will be painted.

2. In art class, Becky is designing cut glass patterns. She has sketched out the design below.



- 2a. After Becky cuts the glass into shapes and positions them according to her drawing, she uses a bead of lead solder along each seam and the outer edges to hold the pieces together. How many inches of glass were soldered? Show detailed work and justify your solution by including the formulas needed to solve the problem.

3. A high school has to resurface the soccer field. The field measures 110 yards by 80 yards and must first be covered with 6 inches of gravel. A gravel truck holds 12 cubic yards of gravel and each cubic yard of gravel costs \$9.50.

You have been asked to present a committee with a basic cost analysis. How much do they need to budget for the resurfacing? Support your analysis with logical, clear diagrams and formulas.

4. Mary built a sandbox for her daughter. Her husband has offered to pick up the sand. Mary gave him the following information:
- The dimensions of the sandbox are **4 ft. 10 in. by 6 ft. 3 in.**
 - They want the sand to be 5 inches deep
 - The sand comes in 60 pound bags
 - The sand weighs about 95 pounds per cubic foot

Sketch and label the dimensions of the sand box

How many bags of sand should he buy? What information do you need to solve the problem? Show all of your work.

5. Jeff is setting up the fish tank in the reception area of a posh office building. When he added a large, decorative rock, the water level changed from 5'9" to 6'3". This made Jeff wonder...What is the **volume** of that beautiful rock?

If you know that the tank is 8' long and 4' wide, how could you help Jeff find the volume of the rock? Use diagrams and be sure to show enough work that Jeff is able to follow your thought process.

VOLUME AND SURFACE AREA APPLICATIONS WORKSHEET 2

Name _____

1. Small cans of frozen juice are 9.5 cm tall and have a diameter of 5.5 cm. The tops and bottoms are made of metal; the rest is cardboard.
 - a. How much metal is needed to make one can?
 - b. How much cardboard is needed to make one can?
2. A fuel storage tank has a diameter of 50 meters and a height of 75 meters. If a gallon of paint can cover 45 square meters and 2 coats of paint are required, how many gallons are needed to paint the exterior sides and top of the tank?
3. Two solids have the same surface area. Do the two solids also have the same volume? Why or why not.
4. What is the volume of a paper bag with base 12" by 7" and a height of 17"?
5. A top is put on the paper bag: how much has the surface area increased? How much is the bag's volume?

6. A water trough is half of a circular cylinder with a radius of 6 ft and a height of 3 ft. If one gallon of water has a volume of about 230 cubic inches, how many gallons of water will the trough hold?

7. A rectangular room is 12.5 ft long by 8 ft high by 10 ft wide. How much wallpaper is needed to cover the walls, not taking into account any doorways or windows?

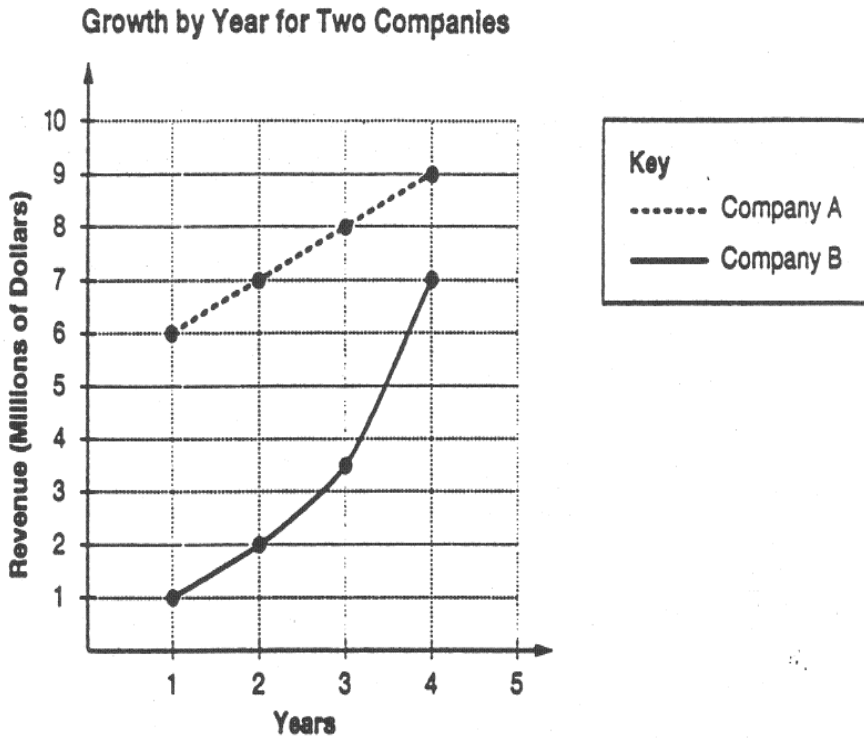
8. A water storage tank has a cylindrical shape. If the radius of the base is 20 feet and the tank is 60 feet high, what is the surface area of the tank?

9. The ABC company has been hired to paint the tank described above. How many gallons of paint would be needed to apply one coat of paint to the tank if one gallon of paint covers 450 square feet?
 - a. How much will the paint cost if one coat is applied to the tank and one gallon of paint costs \$15. How much will the paint cost if two coats are applied?

10. At the grocery store, there are two bags of rice. The bag on the left is 1.4 times as high as the bag to its right, 1.2 times as wide and 1.2 times as deep. How do the capacities of the two bags compare?

GRAPH WORKSHEET

Name _____



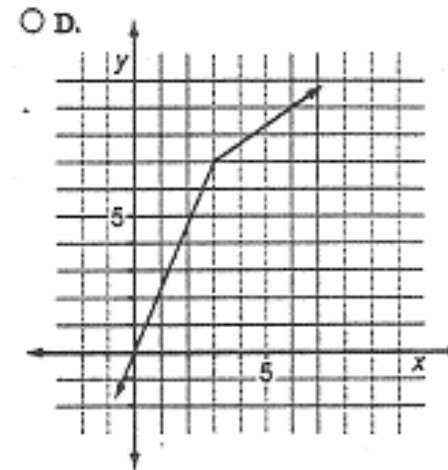
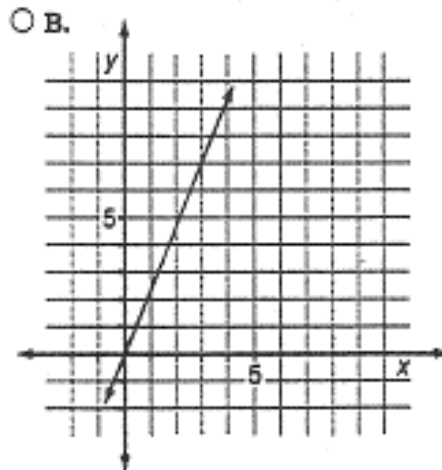
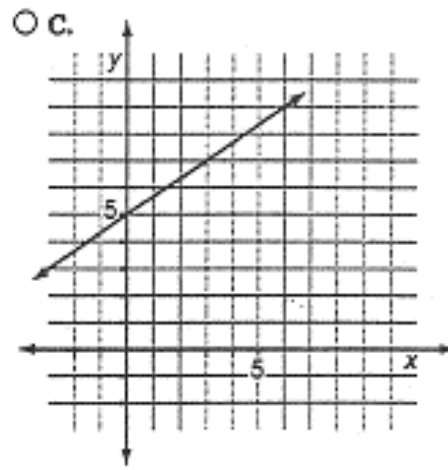
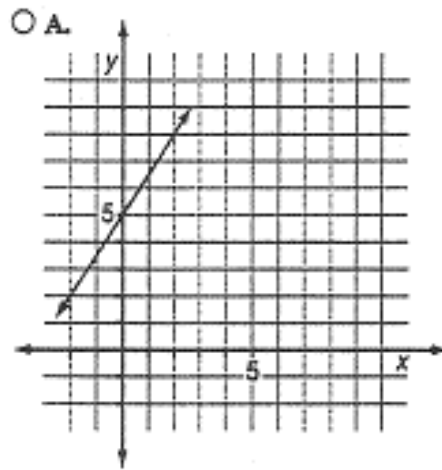
1. Using the graph above, determine the statement(s) below that best describe the trends shown by the data in the graph.

- A. Company A is growing at a faster rate than Company B.
- B. Company A is growing at the same rate as Company B.
- C. Company A will always have more revenue than Company B if the current trend continues.
- D. Company A will have less revenue than Company B if the current trend continues.

2.

| | | | | | |
|-----|---|---|----|----|----|
| x | 3 | 6 | 9 | 12 | 15 |
| y | 7 | 9 | 11 | 13 | 15 |

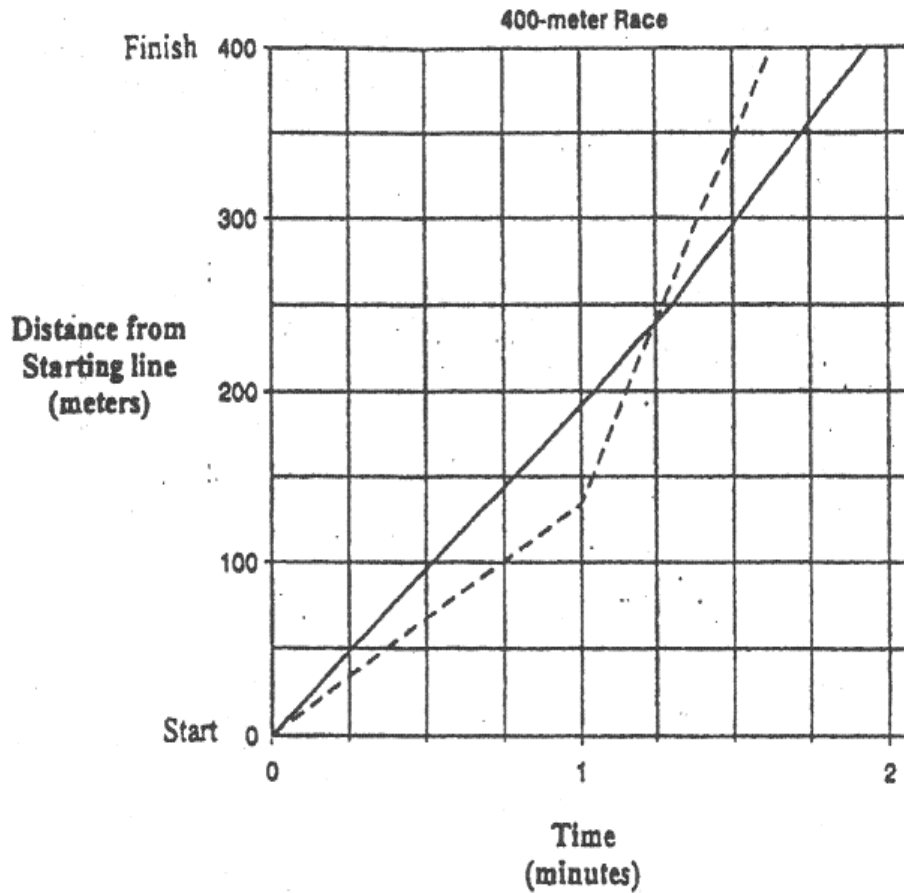
Assume that the relationship between x and y shown in the chart is true for all real number values of x . Which of the following graphs represents the relationship shown in the chart?



400 METER RACE WORKSHEET

Name _____

The following graph shows what happened in a 400 meter race between Kelsey (-----) and Shelby (solid line).



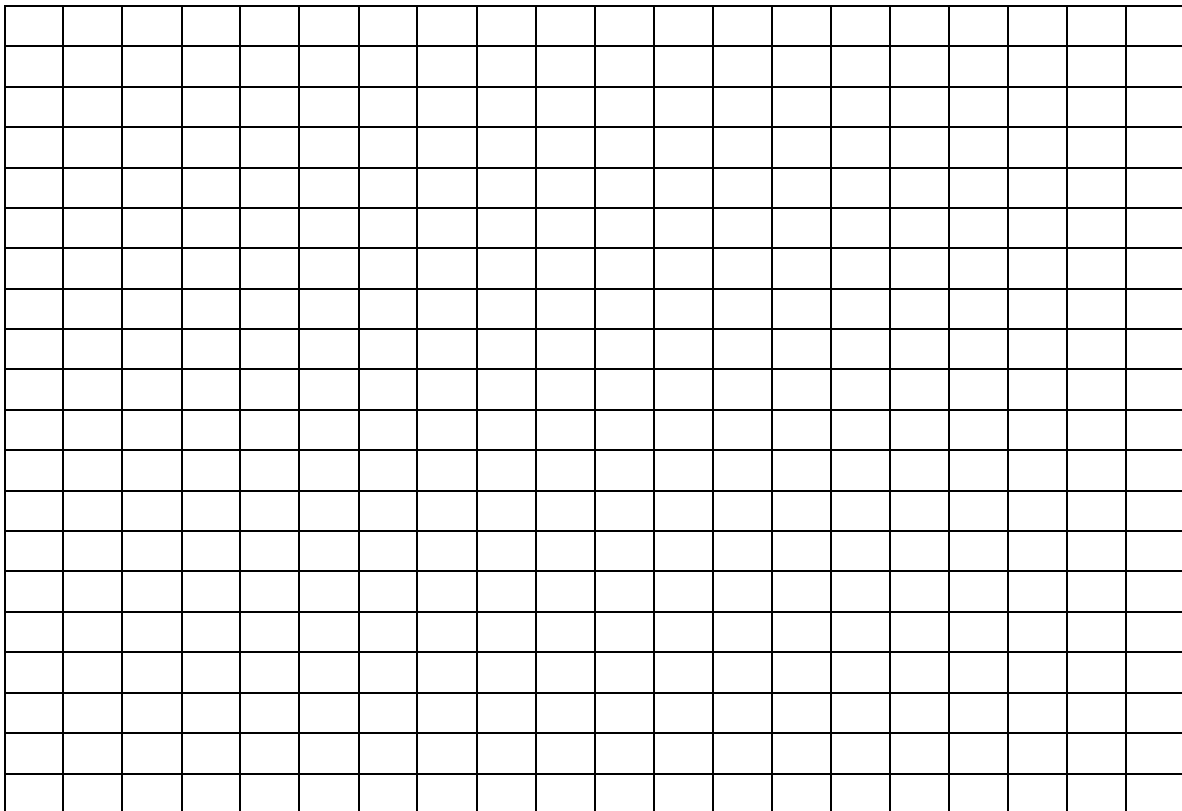
Your assignment for the school newspaper is to write an article describing the race between these two runners. Be sure the article is of high enough quality that the editor will approve it for the paper. Be sure to include the following information:

- When one runner was ahead of the other
- When the runners got further apart or closer together
- Who won the race

GRAPHING CHUNK CASTING

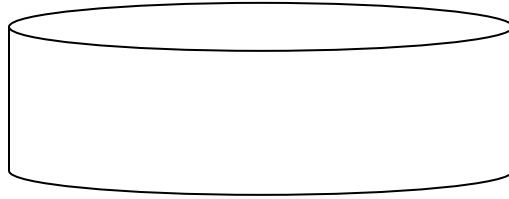
NAME _____

| Rate per hr | Temperature | Hold hrs for heat work |
|-------------|--------------|------------------------|
| 20 degrees | 200 degrees | 4:00 |
| 200 degrees | 1000 degrees | 1:00 |
| 500 degrees | 1650 degrees | 2:00 |
| AFAP * | 900 degrees | 4:00 |
| 50 degrees | 700 degrees | 0:30 |
| 75 degrees | 70 degrees | 0:00 |

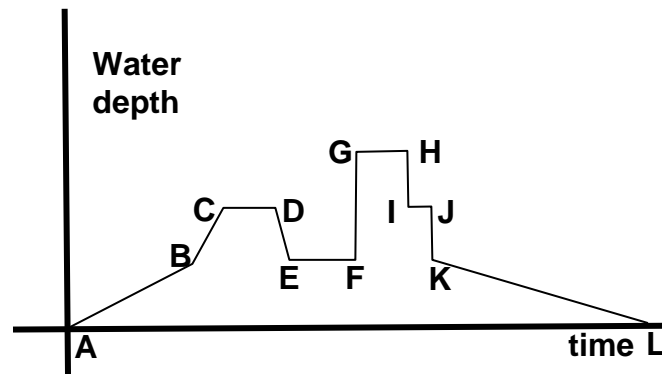


HOT TUB WORKSHEET

Name _____



Based on the graph below, answer the following questions:



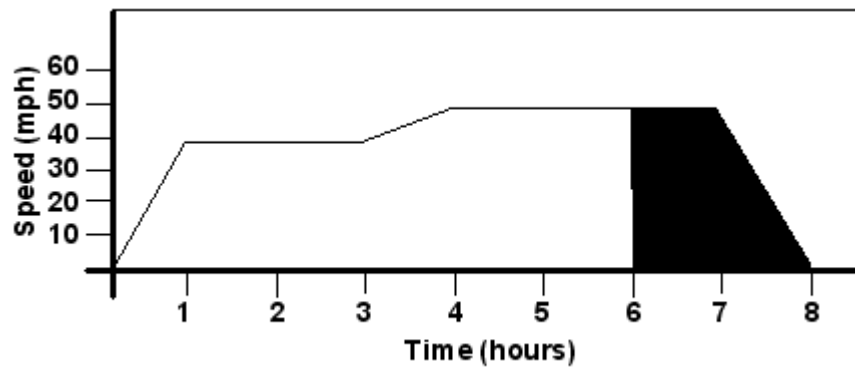
1. If the tub is filled during the time between A and B, describe what is happening in the rest of the segments (BC, CD etc.)
2. Notice the connections between the slope of the lines and the rate of change of the water depth. On what segments is the slope positive and the water depth is increasing?
3. On what segments is the slope negative, and the water depth decreasing?

4. On what segments is the slope 0, and the water depth constant?
5. On what segment is the water depth increasing at the fastest rate?
6. On what segment is the water depth decreasing at the slowest rate?
7. Does this graph represent a function? Explain why or why not. (Hint: Can the water ever be two different heights at the same time?)
8. Could this be the graph of someone's bank balance over time? If so, tell the story. If not, explain why not.
9. What other behaviors could this graph model?

BUS TRIP WORKSHEET

Name _____

The graph below shows the average speed of a bus which carries your favorite band as they travel from Seattle to Sand Point Idaho. The trip takes 8 hours. You follow their every move and know that the distance the bus travels can be found by computing the area under the graph. For example, the distance traveled in the last two hours can be found from calculating the area of the shaded portion of the shaded portion of the graph.



- 1) What is the distance traveled in the first four hours?
- 2) How far did they travel to their gig in Sand Point? Justify your answer.