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idea packet

Full STEAM Ahead: Mathematics & Photography

Full "STEAM" Ahead: Mathematics & Photography

Sandra Argüelles Daire
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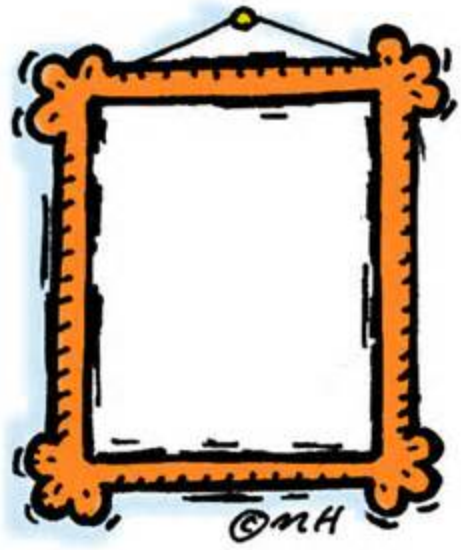
Miami, FL 33130



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THE EDUCATION FUND
FOR EXCELLENCE IN MIAMI-DADE PUBLIC SCHOOLS

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e-mail: IMPACT@educationfund.org
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Table of Contents

Goals and Objectives

Mathematics Florida Standards

MAFS.7.G.1.1: Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

MAFS.7.G.1.2: Draw geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.

MAFS.7.G.1.3: Describe the two-dimensional figures that result from slicing three-dimentional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.

MAFS.8.G.1.4: Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.

MAFS.912.G-CO.1.2: Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

NOTE:

In writing Mathematical questions based on the photographs taken, and/or describing the Mathematics represented in the photographs, students also meet several Language Arts objectives that entail the use of media .

Outline/Overview

PHOTOGRAPHY + MATH = MATHEMATICAL SUCCESS

Middle school students snap photographs of their school and community that show either straight forward or "hidden" mathematics in them. Once the images are captured, students write mathematics questions that relate to their photos. In class, students discuss possible themes for their photos and word problems, they form questions and pose solutions, and review them with each other. The entire group engages in peer review where they present their final photographs with the questions, obtaining constructive feedback.

The project also includes the help of the visual arts teacher, who gives the students pointers in taking and editing their digital photos. She is also instrumental in mounting the photos and helping the math teacher decide which meet the criteria to represent our school in the *Miami-Dade County Youth Fair and Exposition* Photography Division.

"FULL STEAM AHEAD" illustrates the interconnection between two seemingly unrelated subjects – mathematics and photography. It was inspired by the MATHEMATICAL LENS department of *The Mathematics Teacher* journal,

Guide for Implementing

If pictures will be printed and selected to enter the *Youth Fair*, then sufficient time needs to be given to complete the project PRIOR to the fair registration and entry dates. Also, if a visual arts teacher will be helping, then a preliminary planning meeting must be held prior to commencing the collaborative work.

Because students will be taking digital pictures, it is important to review copyright and plagiarism guidelines before assigning the project. (There are MANY photos available online!) If the selected subject matter is the school and immediate community, then these problems can be prevented. In addition, going to the school courtyard and PE field during class time, accompanied by the cameras, phones, tablets, etc. can give the kids great ideas that are their own! In addition, school fieldtrips and events are a GREAT source of photographs.

After sample photos are taken, students need to practice writing related math questions. If no useful pictures are available, then the teacher should go photographing!!!!! Magazines like the National Geographic can also give kids ideas, but their creativity should not be affected by too many samples. There will be students, however, that might need more help than others in the different parts of the project, including planning and implementing. Sending home a calendar will inform parents and even encourage them to engage in the activity with their kids.

DECEMBER 2014

www.12printablecalendar.com

SUN	MON	TUES	WEDS	THURS	FRI	SAT
	1	2 Meet with Visual Arts teacher	3	Classwork 4 using photographs and questions	5	6
7	8 Project Assigned	9	Visiting 10 school courtyard	11	Sample 12 Photos & Questions	13
14	15	16 Visual Arts class on photographs	17	18 Time allowed for questions	19	20
21	22	23	24	25	26	27
28	29	30	31		Project due after Holiday Break! Some students may want to use vacation photos	

Resource List:

www.thefairexhibits.com

Photography - Division 38

Registration Deadline: January 21, 2014

Includes:

Photographs demonstrating both artistic and technical accomplishments in addition to providing visual pleasure.

http://mathcounts.org/programs/math-club/

The 2013 – 14 Math Club GOLD LEVEL entailed submitting a series of questions inspired by Math-themed photographs. Attached is the copy of the slides in the Power Point submission of the Ada Merritt Mathematics Club.

http://www.nctm.org/publications/article.aspx?id=43173

Mathematical Lens

Mathematical Lens: 8

Edited by Ron Lancaster and Brigitte Bentele /October 2014, Volume 108, Issue 3, Page 172

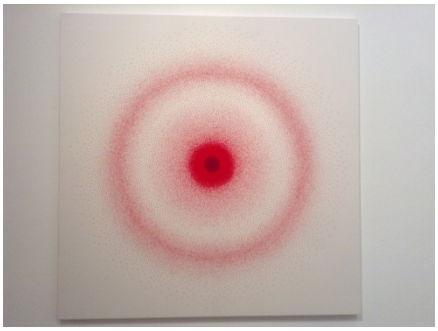
Abstract:

Students analyze a photograph to solve mathematical questions related to the images captured in the photograph.

Mathematical Lens - October 2014 - Photo 1
Mathematical Lens - October 2014 - Photo 2
Mathematical Lens - October 2014 - Photo 3
Mathematical Lens - October 2014 - Photo 4

Work Samples

Photos taken during a school fieldtrip to an Art Museum.



2015
STUDENT
EXHIBITS HANDBOOK

with Official Rules and Regulations for
students (4-18) entering agricultural exhibits in:

10901 Coral Way (SW 24th Street)
Miami, Florida 33165
Office: 305-223-7060
Fax: 305-207-8424

Visit us at our website:
www.fairexpo.com

Fair Dates:
March 12 - April 5, 2015
(Open Daily Except March 16-17 & 30-31)

Entrance Gate Open:
Monday - Friday, 3:00 PM - 10:00 PM
Saturday and Sunday, Noon - 10:00 PM

Buildings Open:
Monday - Thursday, 3:00 PM - 11:30 PM
Friday, 3:00 pm - Midnight and Saturday, Noon - Midnight
Sunday, Noon - 11:30 PM

World of Agriculture Open:
Monday - Thursday, 3:00 PM - 11:00 PM
Friday, 3:00 PM - 11:00 PM and Saturday, Noon - 11:00 PM
Sunday, Noon - 11:00 PM

Exhibits Office

The office hours are Monday through Friday 9:00 AM - 5:00 PM. All information, rules, show dates and times subject to change without notice. For the most up-to-date information please visit us on the web at www.thefairexhibits.com.

Photography - Division 38

Superintendents: Tim Crowther • Cecelia Davis
Assistant Superintendents: Juan Carlos Boué • Deborah Gormley • Carmela Popiel

Registration Deadline:	January 20, 2015
Arrival Date:	February 26, 2015, 4:00 PM to 8:00 PM in Arnold Hall.
	February 28, 2015, 10:00 AM to 4:00 PM in Arnold Hall.
Release Date:	April 9, 2015, 4:00 PM to 8:00 PM in Arnold Hall.
Group Entries:	Not Accepted

Includes:
Photographs demonstrating both artistic and technical accomplishments in addition to providing visual pleasure. Techniques may include selective focus, developing and printing options, color, tonal balance, light sources, filters, focal length of lenses, continuous tone, orthochromatic tone, hand tinting, solarization, and photograms. Artistic techniques may include formal or informal composition, viewpoint, elements of thirds, perspective, framing, plane separation, and chiaroscuro.

Not Accepted:
Collages, multi-images or non-paper entries will not be accepted.

Rules:
1. Grade Levels: K – 12
2. Number of Entries: Students may enter a total of 2 entries comprised of 1 conventionally developed black & white photograph **AND/OR** 1 conventionally developed color photograph or 1 digital black & white and 1 color photograph.
3. Size and Mounting Specifications: All photographs shall not be less than 8" X 10", and not more than 11" X 14".
    - All photographs must be dry mounted (no tape, rubber cement or glue) on thin (one-sixteenth, fourteen ply) mount board OR dry mounted or taped inside a combined mount/mat whose thickness does not exceed 1/8 inch. Photo spray adhesive is acceptable.
    - The border of the mount or mat should NOT BE LESS than 1 inch or MORE than 3 inches on all sides.
    - Mounting/matting may be done commercially but must follow the above specifications. No thick (1/4 inch) foam board.
    - Miami-Dade County Public School teachers may purchase inexpensive 14-ply mount board mount/mat combinations through stores and distribution (S & D). Black or white railroad board is an even less expensive alternative.
4. Entry Tag(s) must be securely attached in the lower right front corner of the photograph.
5. Acceptable Entries: All camera operations must be the original work of the students.
    - Students are encouraged to explore the many creative options

presented by in-camera and computer programs but emphasis should be placed on focus, exposure, cropping, color correction and print resolution over special effects.
- Students in K through 6th grade, may have the conventional photographic process of developing and printing done commercially.
- 7th, 8th, and 9th grade students may have conventional color processing done commercially but must do their own conventional black & white developing and printing.
- 10th graders and above must do their own conventional color and black & white developing and printing.
- Digital photographs may not be processed commercially by students in any grade. Printing must be done on personal or school computers.
- Entered prints must be printed on heavyweight gloss or matte white photo print paper.

6. NOT ACCEPTABLE: Digital photographs may not be processed commercially by students in any grade. Copyright or non-copyright images from stock libraries must not be used. Electronically duplicated copier images will not be accepted. No thick (1/4 inch) foam board mounting will be accepted.
7. Due to space limitations entries awarded Blue and Red ribbons will be displayed.
8. ANY ENTRY NOT CONFORMING TO THE ABOVE RULES OR THE OFFICIAL FAIR RULES WILL BE DISQUALIFIED.
9. This Division will accept only those entries made expressly for the 2015 fair.
10. All decisions of the judges are final. The Fair management has jurisdiction over interpretation of these rules. Items entered in the wrong division will not be judged nor shown. The Miami-Dade County Fair & Exposition® will not be responsible for loss or damage to prints due to improper mounting. This Division is not responsible for lost/damaged items.

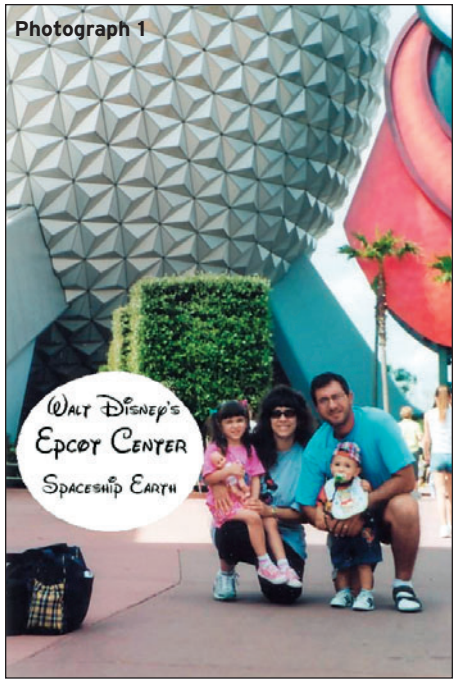
Class Number and Title:
Class 3801 - Conventional Black & White Photograph
Class 3802 - Conventional Color Photograph
Class 3803 - Digital Photograph, Black & White and/or Color

Premiums, Plaques and Trophies:
Outstanding Photograph - Elementary School ..... Trophy
Outstanding Photograph - Middle School ..... Trophy
Outstanding Photograph - High School ..... Trophy

Purple Ribbon ..... $5.00 and Rosette
Blue Ribbon 4.00
Red Ribbon 3.00
White Ribbon 2.00
Yellow Ribbon ..... Ribbon Only

If there are no entries meeting the quality standards for any special awards, no award will be given.

MATHEMATICAL lens



PHOTOGRAPHS BY SANDRA ARGÜELLES DAIRE; ALL RIGHTS RESERVED

Spaceship Earth, Epcot Center, Orlando, Florida

Editors' note: Spaceship Earth is a geosphere and opened as a ride on October 1, 1982, at the Epcot Center in Walt Disney World, Orlando, Florida. Visitors on the slow-moving ride are taken up into the geosphere and get a look at the history of worldwide communication. Sandra Argüelles Daire, Felix Varela Senior High School, Miami, Florida, took these photographs and submitted the questions.

1. Spaceship Earth is 180 feet tall. If it were a smooth sphere, what would be its volume and its surface area?

2. The diameter of Spaceship Earth's inner sphere, which houses the ride, is 165 feet. What is the volume that describes the space between the outer sphere described in question 1 and the inner sphere?

3. Spaceship Earth weighs 15,520,000 pounds and is supported by six legs. Two of the legs are partially visible in **photograph 1**. If the weight is distributed equally among the legs, how much does each leg support?

4. The surface of Spaceship Earth is covered by 11,324 individual triangles (see **photograph 2**). Groups of three triangles join to form tetrahedrons, which are the basic structures of this geosphere. How many tetrahedrons are formed?

5. From a distance, this Disney exhibit looks like a giant golf ball. Imagine a golf ball the size of the geosphere.

   (*a*) How long would the corresponding driver have to be to hit Spaceship Earth? A standard golf ball is 1.75 inches in diameter, and the length of a standard driver is usually 42.5 inches.
   (*b*) How wide would the hole need to be to accommodate Spaceship Earth? The diameter of a standard cup is 4.25 inches.
   (*c*) What would be the Spaceship Earth equivalent of a 200-yard drive?

"Mathematical Lens" uses photographs as a springboard for mathematical inquiry. The goal of this department is to encourage readers to see patterns and relationships that they can think about and extend in a mathematically playful way.

Edited by ***Ron Lancaster***
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Washington, DC 20057

11 S. A. Daire

MATHEMATICAL LENS solutions

Answers to questions 1–4 have been rounded to the nearest integer.

1. The radius of the sphere would be 180 feet ÷ 2 = 90 feet. The volume is

$$V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi(90)^3 \approx 3{,}053{,}628 \text{ cubic feet},$$

and the surface area is

$$S = 4\pi r^2 = 4\pi(90)^2 \approx 101{,}788 \text{ square feet}.$$

2. The volume of the inner sphere is

$$V = \frac{4}{3}\pi\left(\frac{165}{2}\right)^3 \approx 2{,}352{,}071 \text{ cubic feet},$$

so the difference between the spheres is

$$3{,}053{,}628 - 2{,}352{,}071 = 701{,}557 \text{ cubic feet}$$

3. 15,520,000 pounds ÷ 6 = 2,586,667 pounds

4. 11,324 triangles ÷ 3 = 3,774 tetrahedrons with a remainder of 2. Where do you think Disney engineers put the remaining 2 triangular panels?

5. (*a*)

$$\frac{1.75 \text{ in.}}{42.5 \text{ in.}} = \frac{180 \text{ ft.}}{x \text{ ft.}} \rightarrow$$
$$x = \frac{(180)(42.5)}{1.75} \approx 4{,}371 \text{ ft.}$$

(*b*) Since the diameter of the cup is 1/10 the length of a driver, the hole would have to be about 437 feet wide.

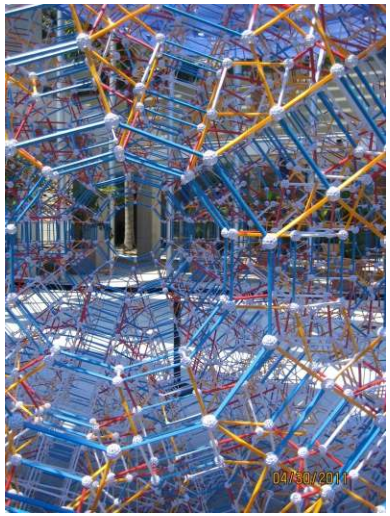
$$\frac{1.75 \text{ in.}}{4.25 \text{ in.}} = \frac{180 \text{ ft.}}{y \text{ ft.}} \rightarrow$$
$$y = \frac{(180)(4.25)}{1.75} \approx 437.1 \text{ ft.}$$

(*c*)

$$\frac{1.75 \text{ in.}}{200 \text{ yd.}} = \frac{180 \text{ ft.}}{z \text{ ft.}} \rightarrow$$
$$\frac{1.75 \text{ in.}}{7{,}200 \text{ in.}} = \frac{180 \text{ ft.}}{z \text{ ft.}}$$
$$x = \frac{(180)(7200)}{1.75} \approx 740{,}571 \text{ ft.},$$

or about 140 miles.∞

12 S. A. Daire

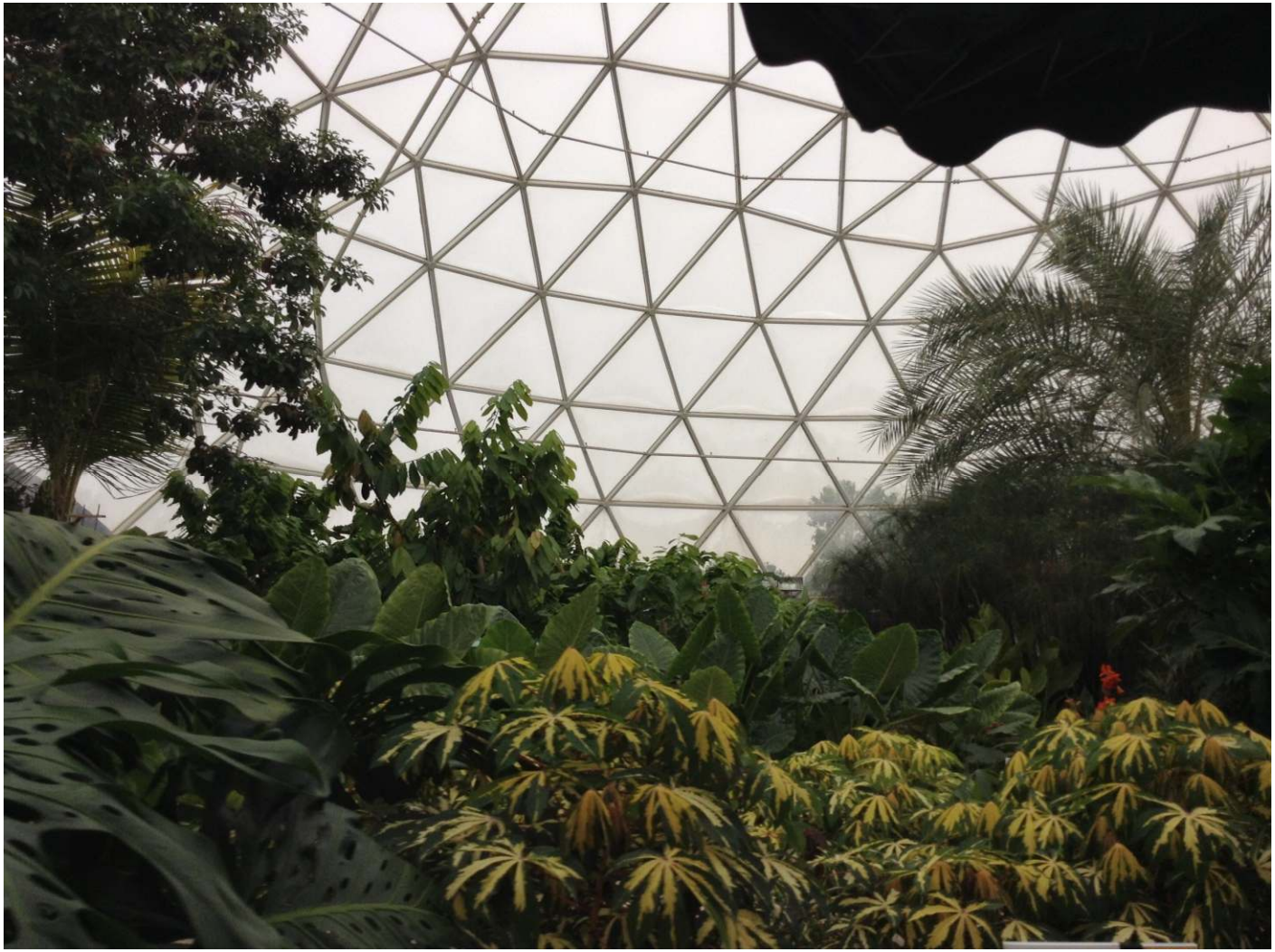


Ada Merritt K-8 Center

MATHEMATICS CLUB

2014
MATHCOUNTS
Gold-Level Submission

ACUTE ANGLE



QUESTION

The dome inside *The Land* at EPCOT in Walt Disney World is made up of equilateral triangles as shown.

1.) What is the measure of each of the angles of the triangles, &

2.) If each triangle has side length ***x***, what is the area of the highlighted hexagon?

Photo taken by S. A. Daire / 2013

SOLUTION

1.) Since the triangles are equilateral, the measure of each of the interior angles is 60°.

2.) The hexagon is regular since the triangles are equilateral. Thus the area of the hexagon can be found by the following formula: $A = \frac{1}{2} \cdot a \cdot P$ where a is the *apothem* and P is the *perimeter* of the hexagon. $P = 6x$, and $a = 3\sqrt{3}x$, so $A = \frac{1}{2}(3\sqrt{3}x)(6x)$ And $A = 9\sqrt{3}x^2$ square units.

CIRCUMFERENCE

QUESTION

The below picture was taken at a museum in Miami Beach, Florida. The canvas was filled with the shavings left after different color pencils were sharpened.
Sharpen a standard color pencil.

Photo taken by J. Gurbuz / 2014

Estimate the radius of the shaving to the nearest centimeter and find the circumference of the shaving.

SOLUTION

The radius of the shaving of a standard color pencil is approximately 2 cm.

$$\text{Circumference} = 2 \cdot \pi \cdot r$$

where r is the radius of the shaving and $\pi \approx 3.14$

$$\text{Circumference} = (2)(3.14)(2) = 12.56 \text{ cm}^2$$

DIAMETER

QUESTION

Photo taken by L. Daire / 2013

The original Ferris Wheel was approximately 80 meters in height. What is the distance traveled by each car in one revolution of the wheel?

SOLUTION

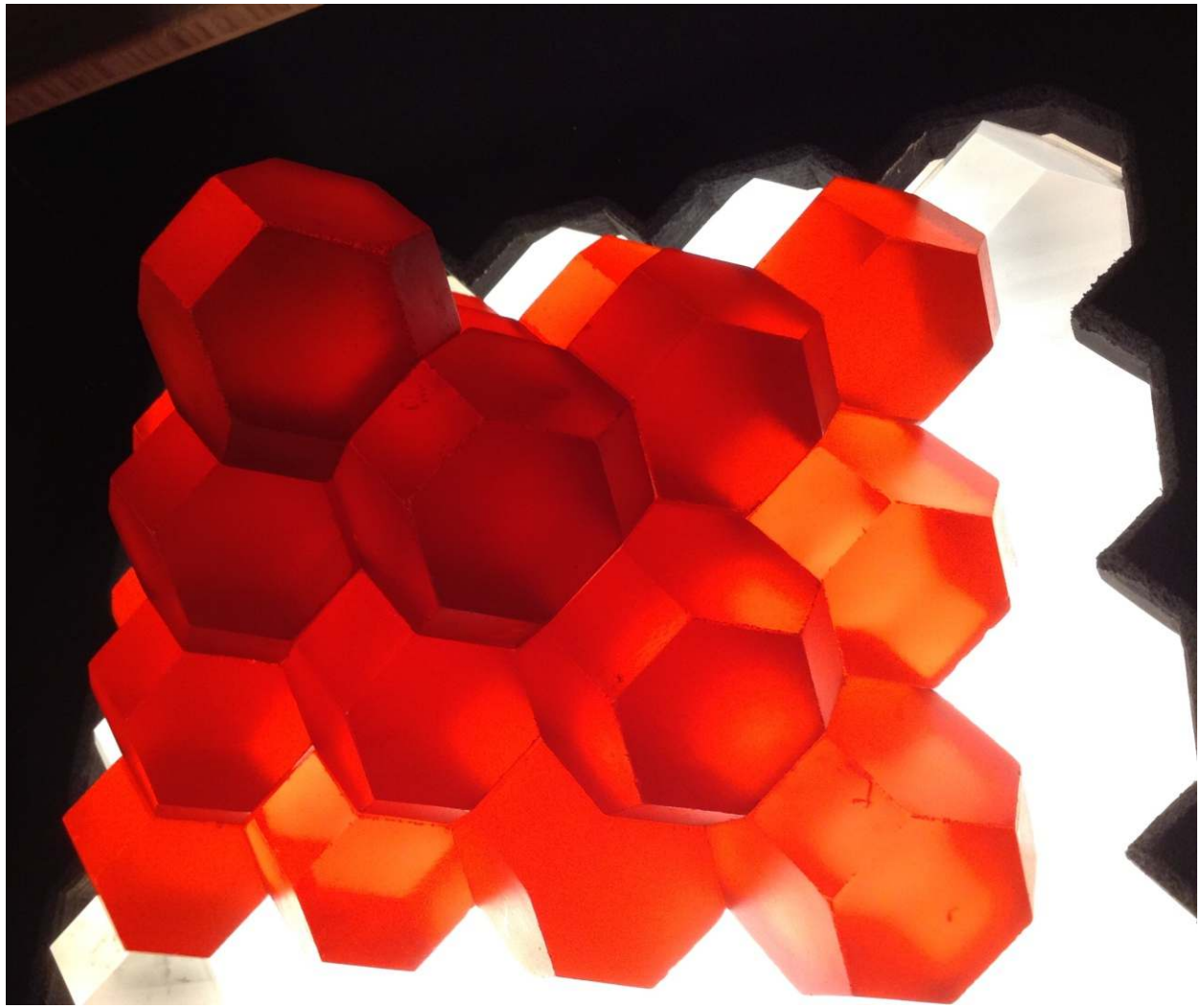
Assuming that the height of the Ferris Wheel is its diameter, then the distance traveled by each car in one complete revolution is the circumference of the wheel.

$$\text{Circumference} = \pi \cdot d$$

where d is the diameter of the wheel and $\pi \approx 3.14$

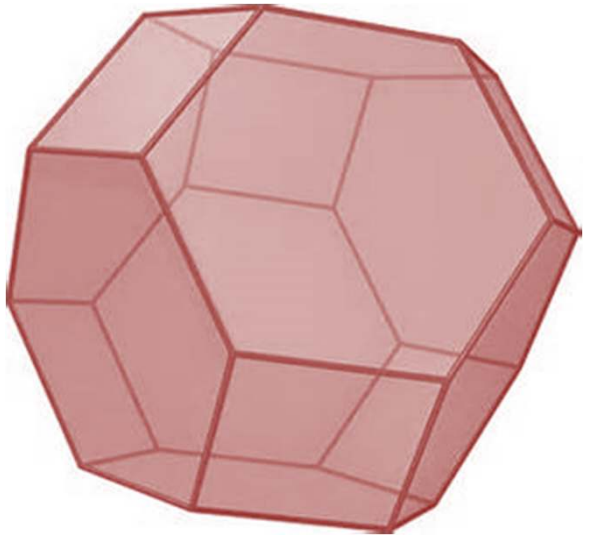
$$\text{Circumference} = (3.14)(80) = 251.2 \text{ meters}$$

HEXAGON



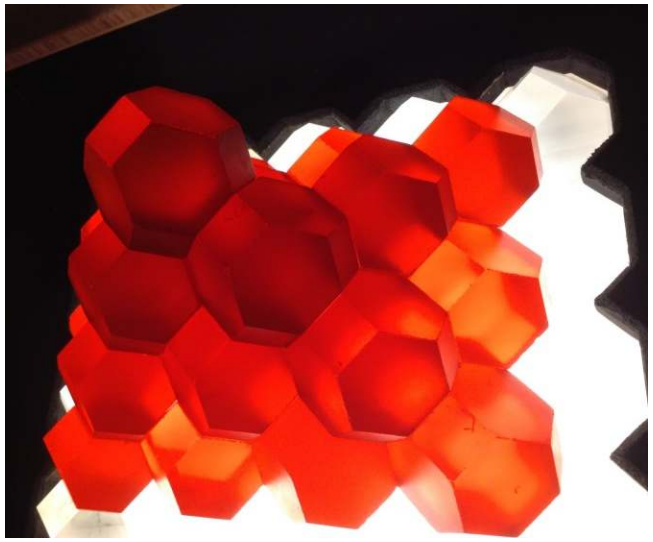
QUESTION

The Miami Museum of Science has an exhibit where children can play with truncated octahedra.



http://ts4.mm.bing.net/th?&id=HN.608052148146210364&w=300&h=300&c=0&pid=1.9&rs=0&p=0&url=http%3A%2F%2Fen.wikipedia.org%2Fwiki%2FTruncated_octahedron

Photo taken by L. Daire / 2014



Each truncated octahedron has 24 vertices and 35 edges. Use Euler's Formula to find out how many faces each has.

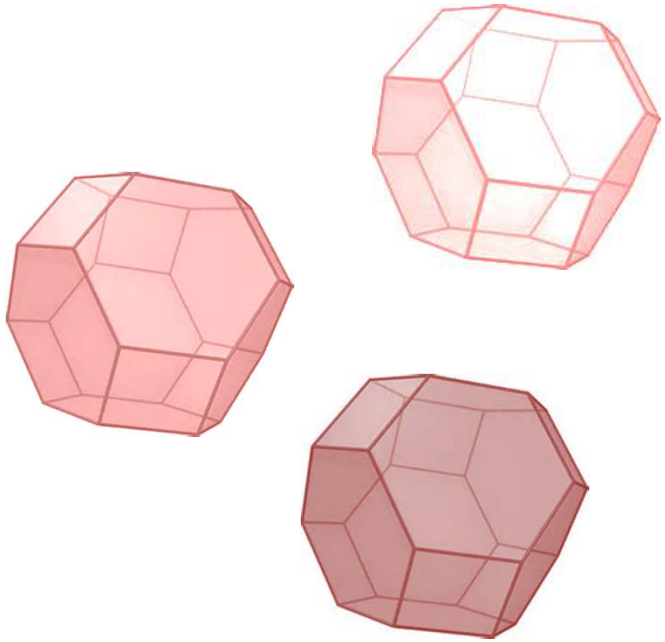
SOLUTION

Euler's Formula states that

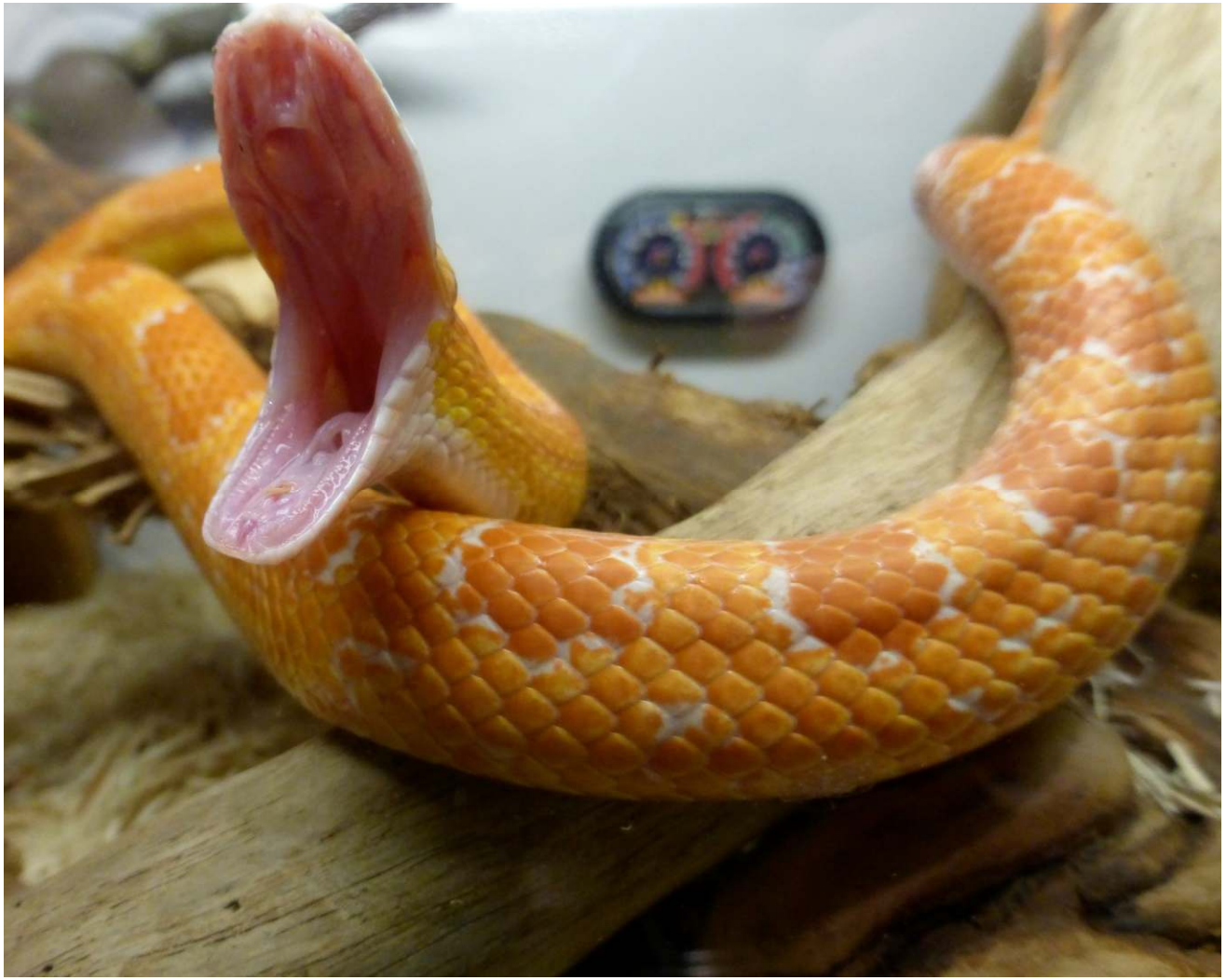
faces + vertices = edges + 2, so

f + 24 = 35 + 2, &

f = 13

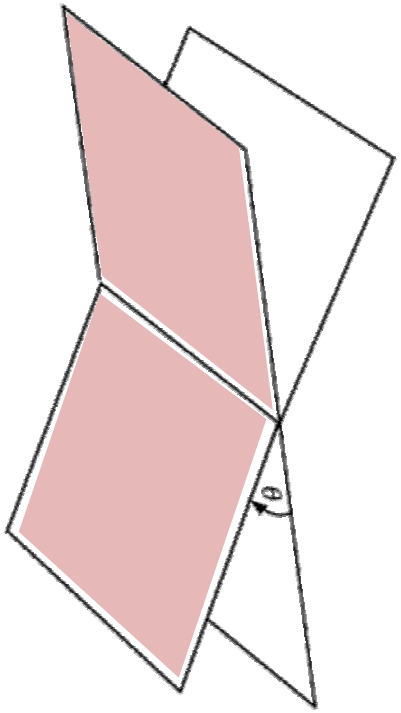


OBTUSE ANGLE



QUESTION

The angle formed by two intersecting planes is called the *dihedral angle*. Let each jaw of this snake be represented by intersecting planes as shown. If the snake's jaws are forming a dihedral angle of approximately 110°, what is the measure of angle θ ?



http://mathworld.wolfram.com/images/eps-gif/DihedralAngle_800.gif

Photo taken by A. Sherer / 2013

SOLUTION

$\theta = 180^\circ - 110^\circ = 70^\circ$

Wadjet is a female corn snake. She is about 1½ years old and likes to eat mice! She is 3 feet long and is also *amelanistic.* She will probably grow to be about 6 feet long!

PARALLEL

QUESTION

Given that *m || n, find the value of x and the measure of the angles.*

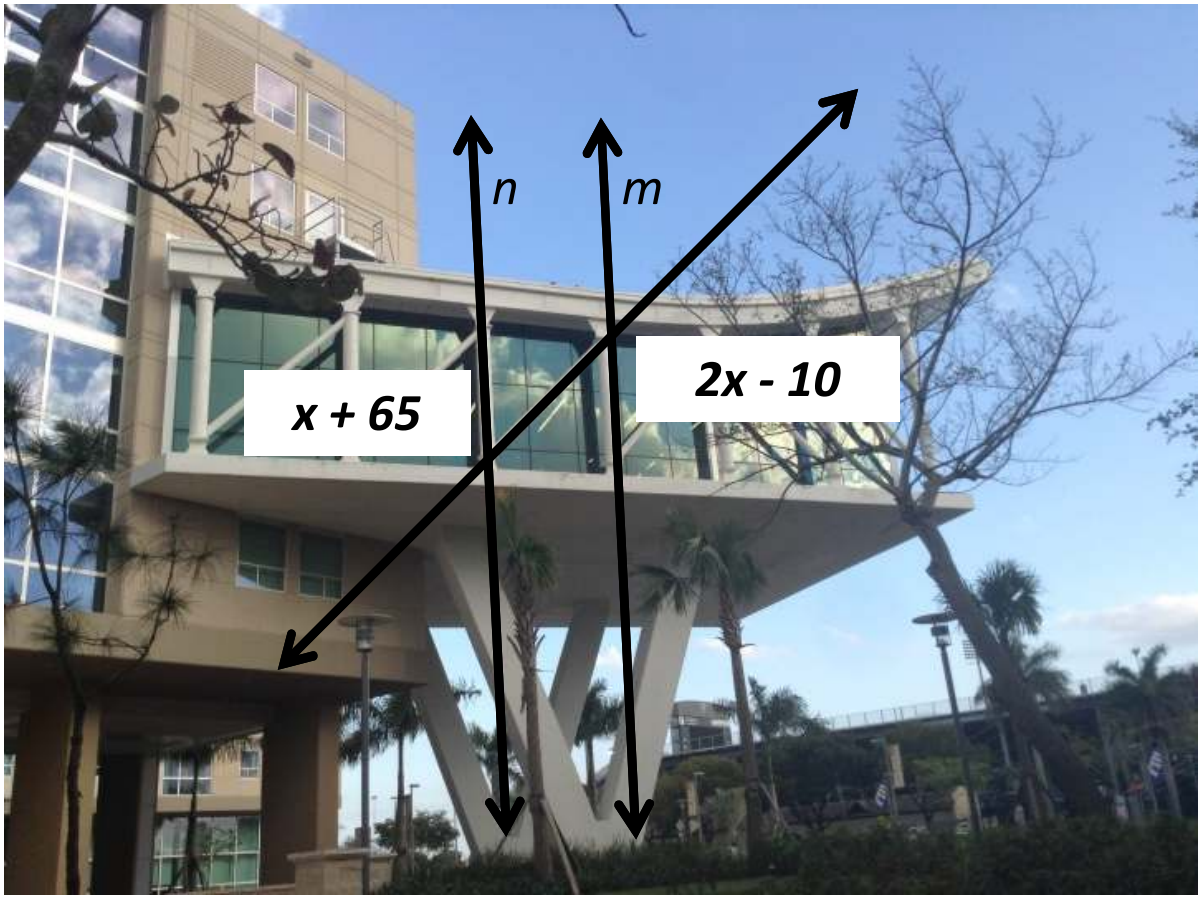
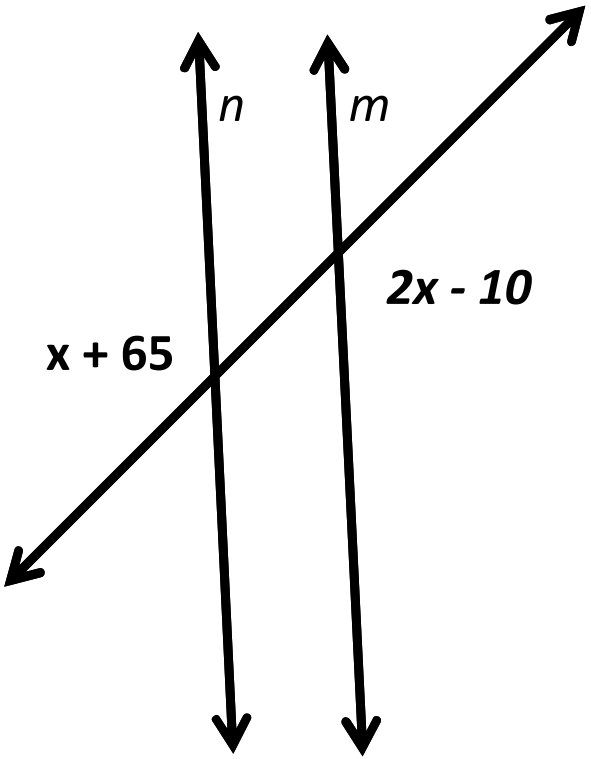


Photo taken by M. A. Daire / 2014

SOLUTION



x + 65 = 2x – 10 because these angles are congruent (lines n || m & alternate exterior angles formed when parallel lines are cut by a transversal are congruent).

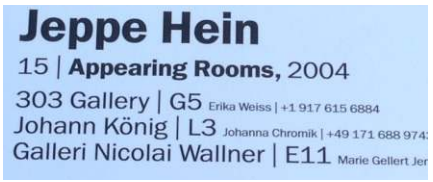
x + 65 = 2x – 10

x = 75

The angles each measure 140°

QUADRANT

QUESTION



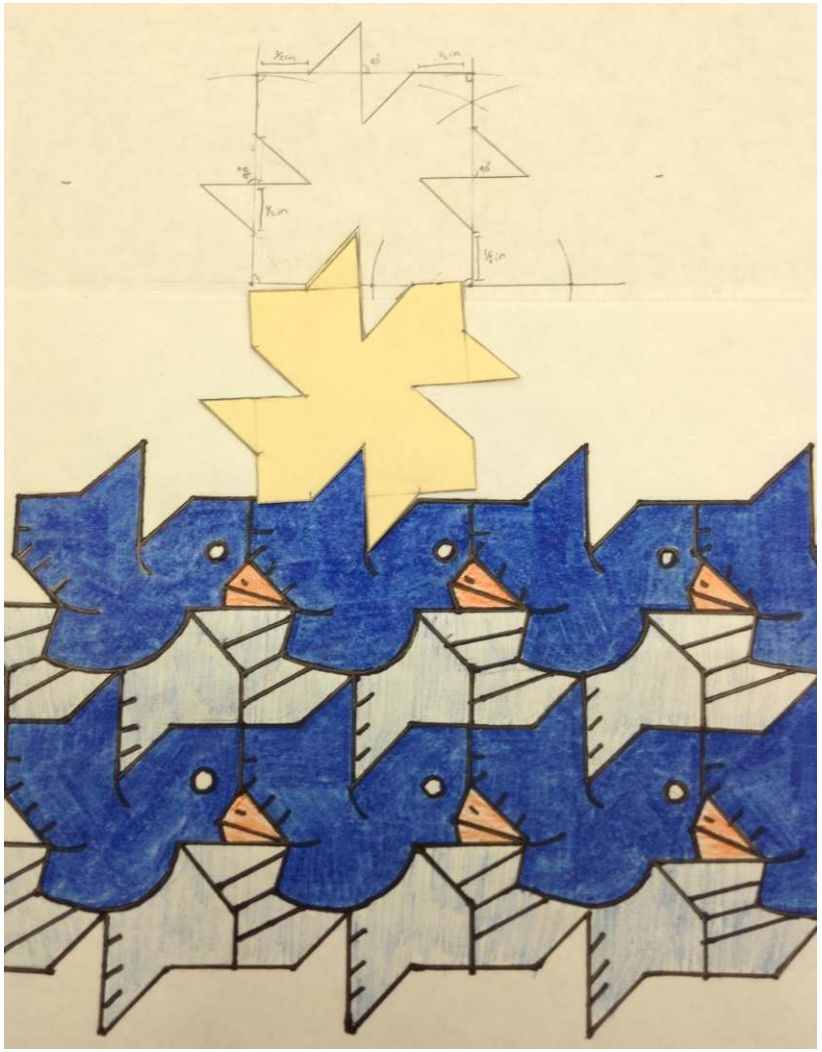
The student marked “A” is currently in location (1,-6) on the “live” coordinate plane. He moves to a new position determined by the transformation $(x, y) \rightarrow (x - 3, y + 2)$. What quadrant does student “A” end up at?

SOLUTION

The student is currently at (1,-6), so $(x,y) = (1,-6)$.

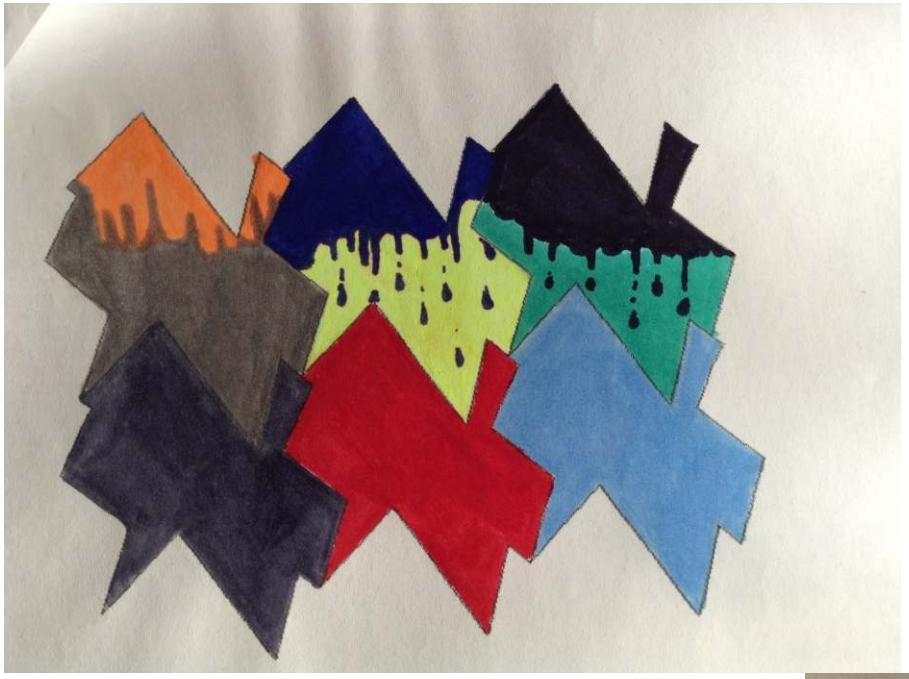
$(x, y) \rightarrow (x - 3, y + 2)$ means $(1,-6) \rightarrow (1 - 3,-6 + 2)$ which is location (-2,-4). The student ends up in quadrant III (approximately at point marked A')

TESSELLATION



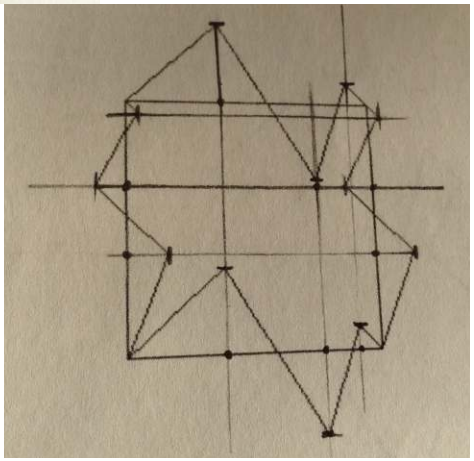
Completed by Z. Grand / 2013

QUESTION



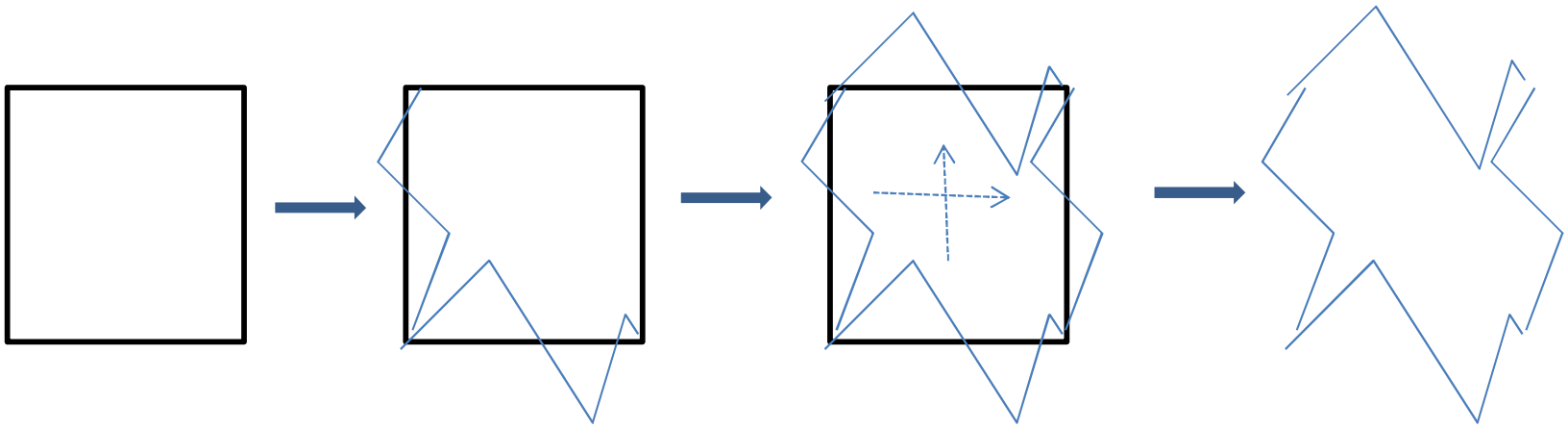
Completed by C. Amastha

Study the work that this student completed to draw the tessellation. Describe, using math terms, the process he followed.



SOLUTION

The student first drew a square. He then proceeded to change two consecutive sides and translate the changes to their opposite sides. Once the tessellating tile was completed, the student duplicated it several times, and decorated them.



VOLUME

QUESTION

The pictured paper weight is in the shape of a cube (with a truncated corner!) In order to determine its volume, the Geometry class decided to use displacement. The students dropped the cube into a cylinder with radius 5 cm. The water level in the cylinder was measured to rise 1.4 cm. What is the approximate volume of the cube ? Use $\pi \approx \frac{22}{7}$.

SOLUTION

Volume of the cube equals the volume of the displaced water inside the cylinder.

$V = \pi \cdot r^2 \cdot h$ where h is the displaced height.

$V \approx (\frac{22}{7})\ (25)(1.4)$

$V \approx 110$ cubic centimeters

RATIO

RATIO

RATIO

QUESTION

The ratio of the heights of the two SIMILAR queens is 2:7

1.) If the giant queen is 56 cm, how tall is the smaller queen?

2.) What is the ratio of the volumes of the queens?

SOLUTION

1.) $\frac{2}{7} = \frac{x}{56}$ where x is the height of the smaller queen.

$7x = 2(56)$

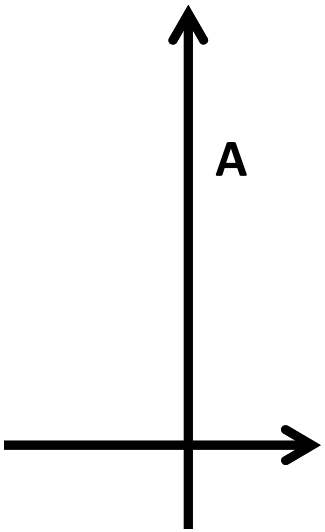
$7x = 112$

$x = 16$ cm

2.) The ratio of the volumes is $\frac{2^3}{7^3} = \frac{8}{343}$

REFLECTION

QUESTION



Point **A** is located at (*x,y*). What are the coordinates of **A'**, the image of **A** after each completed reflection.

1.) **A** is reflected over the x-axis
2.) **A** is reflected over the y-axis.
3.) **A** is reflected over the line y = x.
4.) **A** is reflected over y = -1 and then over x = -2

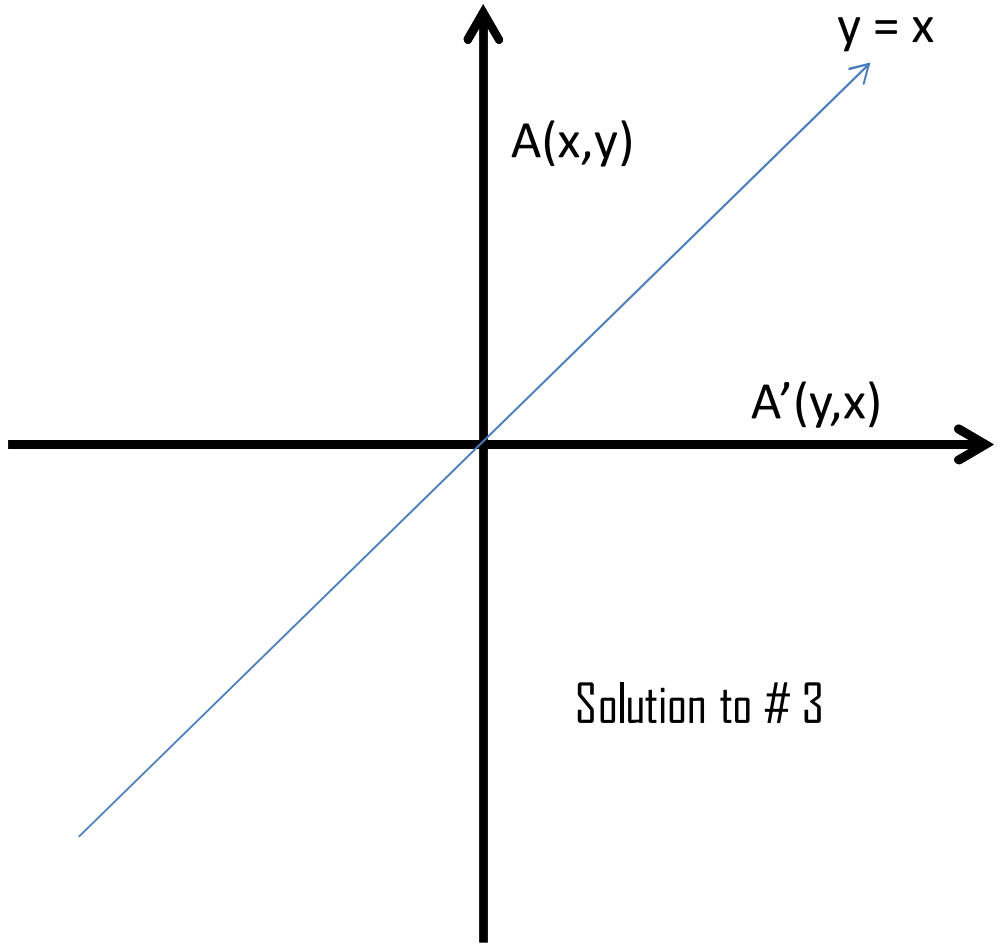
SOLUTION

1.) A’ (x,-y)

2.) A’ (-x,y)

3.) A’ (y,x)

4.) A’ (-x - 4,-2 - y)



DILATION

QUESTION

Did you see the movie “Honey, I blew up the kid”? Well, a certain Math teacher “blew up” her daughter Leia during their recent visit to San Francisco (see picture below!) Leia was so tall she was actually able to tap the top of one of the Golden Gate Bridge!

Leia’s height is normally 5’3”. In San Francisco she was 777 feet tall!

1.) How much was the dilation? Express your answer as a ratio in simplest form.

2.) If Leia normally uses 2 ml of suntan lotion on her face, how much did “tall” Leia use?

Photo taken by S. A. Daire / 2013

SOLUTION

The ratio $\frac{Regular\ Leia}{Tall\ Leia} = \frac{5.25}{777} = \frac{1}{148}$

Suntan lotion covers the face area in the ratio of $\left(\frac{1^2}{148^2}\right)$ so the amount of sunscreen that Tall Leia needs for her face is $\frac{1^2}{148^2} = \frac{2\ ml}{x}$; x = 43,808 ml

THE END

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