Putting the “A” in STEAM

Eric P. Olson

Pingree Math at the Intersection of Art and STEM

Artistic Sensibilities Celebrated in “regular” Mathematical Work:

Examples:

Linear Programming Poster Design

Statistics Posters

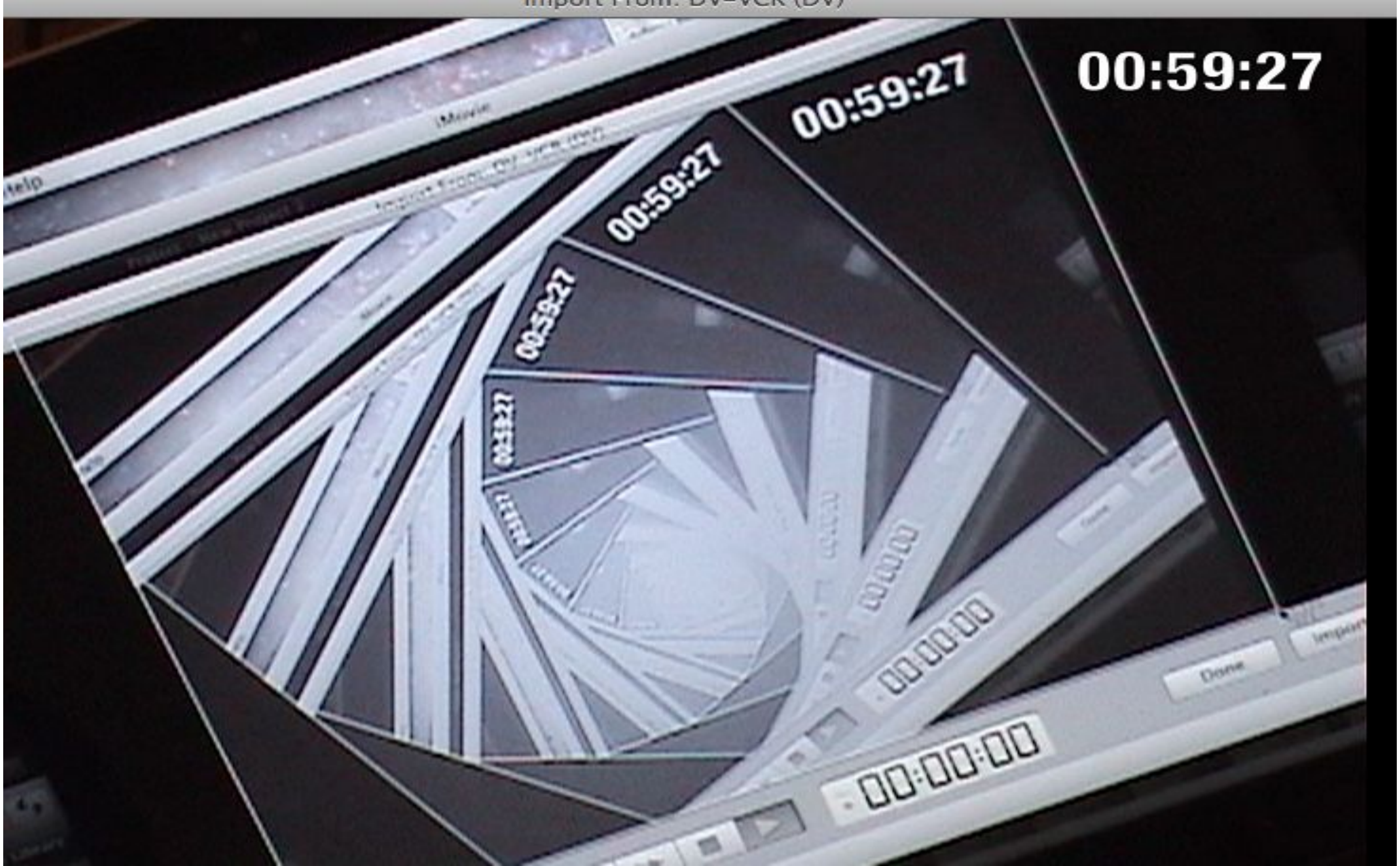
GeoGebra Geometric Portfolios

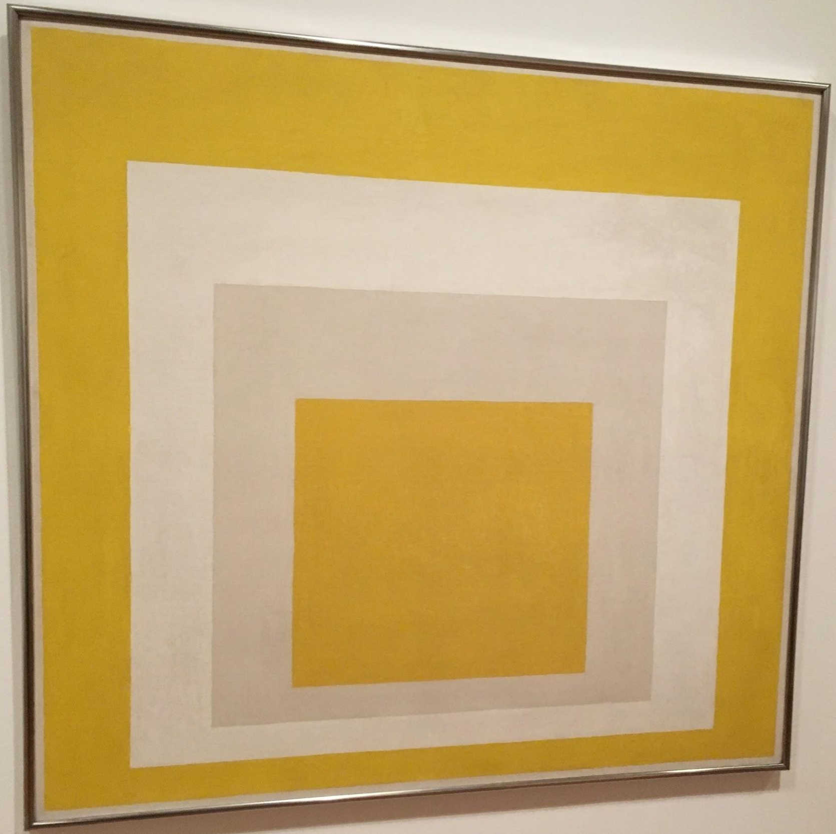
Theoretical and Experimental Geometric Probability “Target Poster Project”

Pencil Code

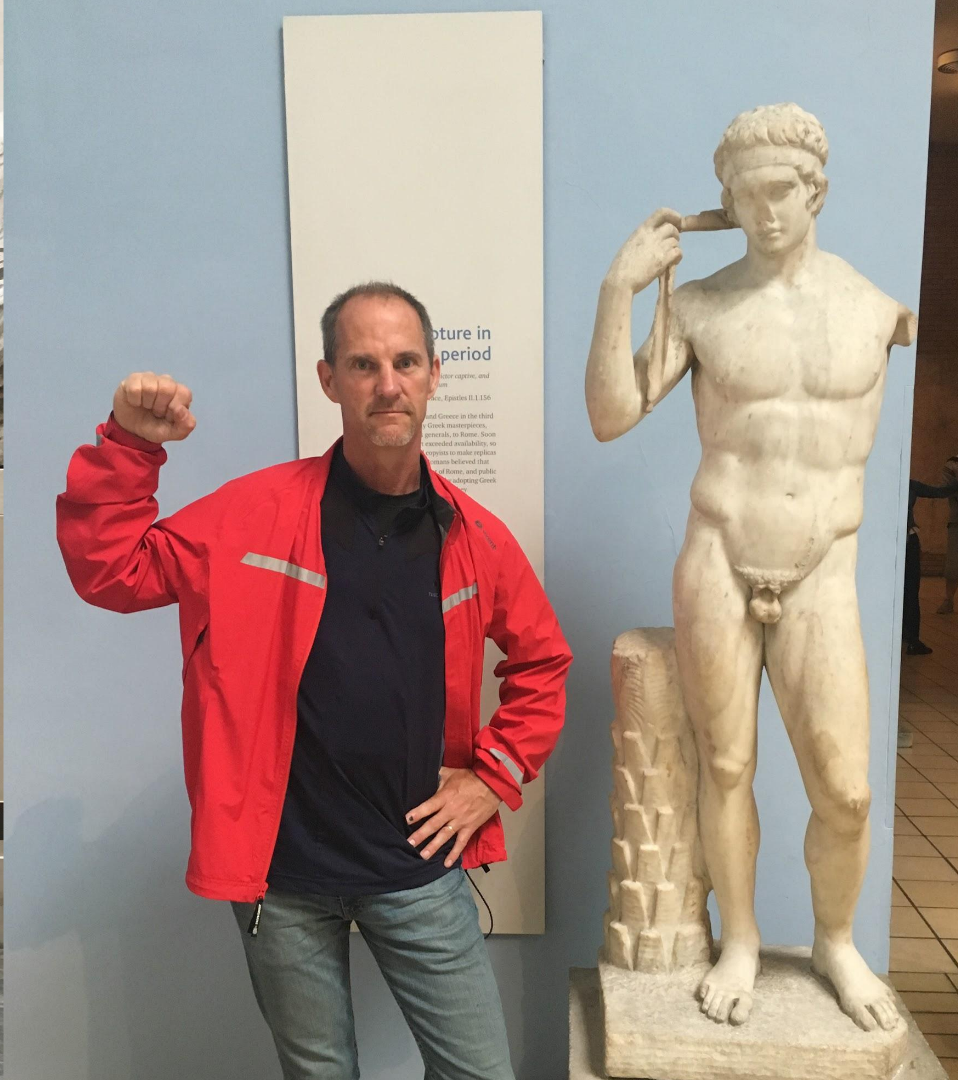



HOLDEN



00:59:27
00:59:27
00:59:27
00:00:00
00:00:00
Done

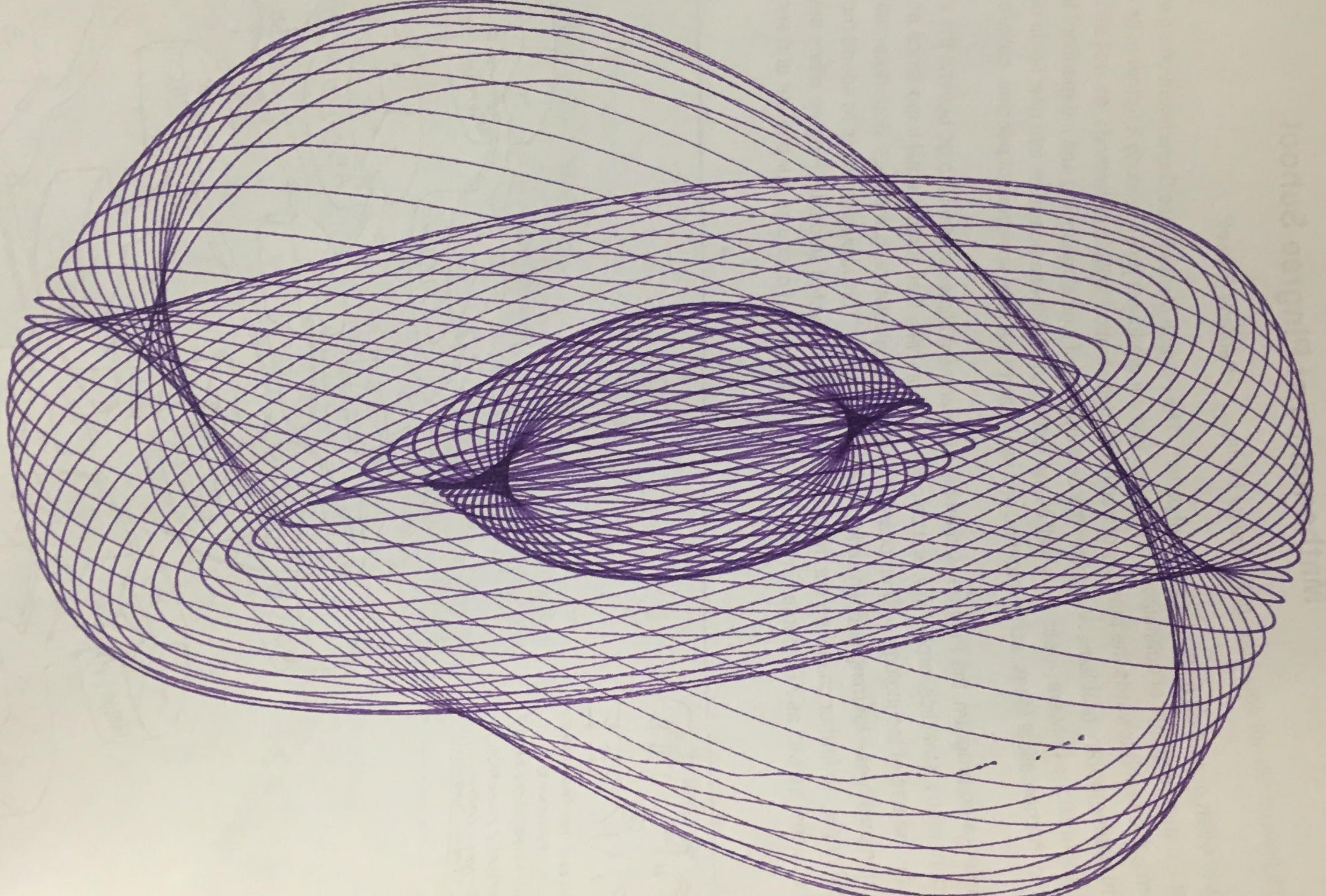

4
DIAGRAM OF THE CAUSES OF MORTALITY
IN THE ARMY IN THE EAST
2
APRIL 1855 TO MARCH 1856
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
1856
FEBRUARY
MARCH
APRIL 1855
MAY
1
APRIL 1854 TO MARCH 1855
JULY
AUGUST
SEPTEMBER
CRIMEA
OCTOBER
NOVEMBER
DECEMBER
JANUARY 1855
FEBRUARY
MARCH 1855
APRIL 1854
MAY
JUNE
BULGARIA
The Areas of the blue, red, & black wedges are each measured from the centre as the common vertex.
The blue wedges measured from the centre of the circle represent area for area the deaths from Preventible or Mitigable Zymotic diseases, the red wedges measured from the centre the deaths from wounds, & the black wedges measured from the centre the deaths from all other causes.
The black line across the red triangle in Nov. 1854 marks the boundary of the deaths from all other causes during the month.
In October 1854, & April 1855, the black area coincides with the red, in January & February 1855, the blue coincides with the black.
The entire areas may be compared by following the blue, the red & the black lines enclosing them.

Three-pendulum Rotary Harmonograph

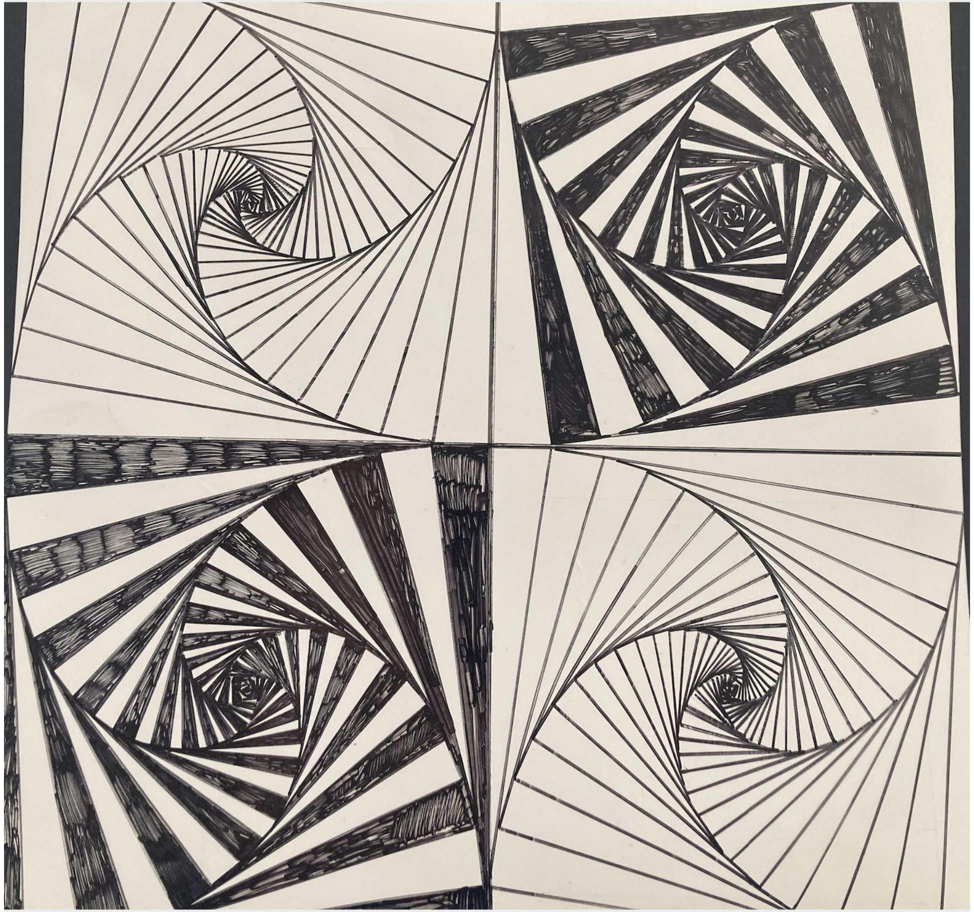
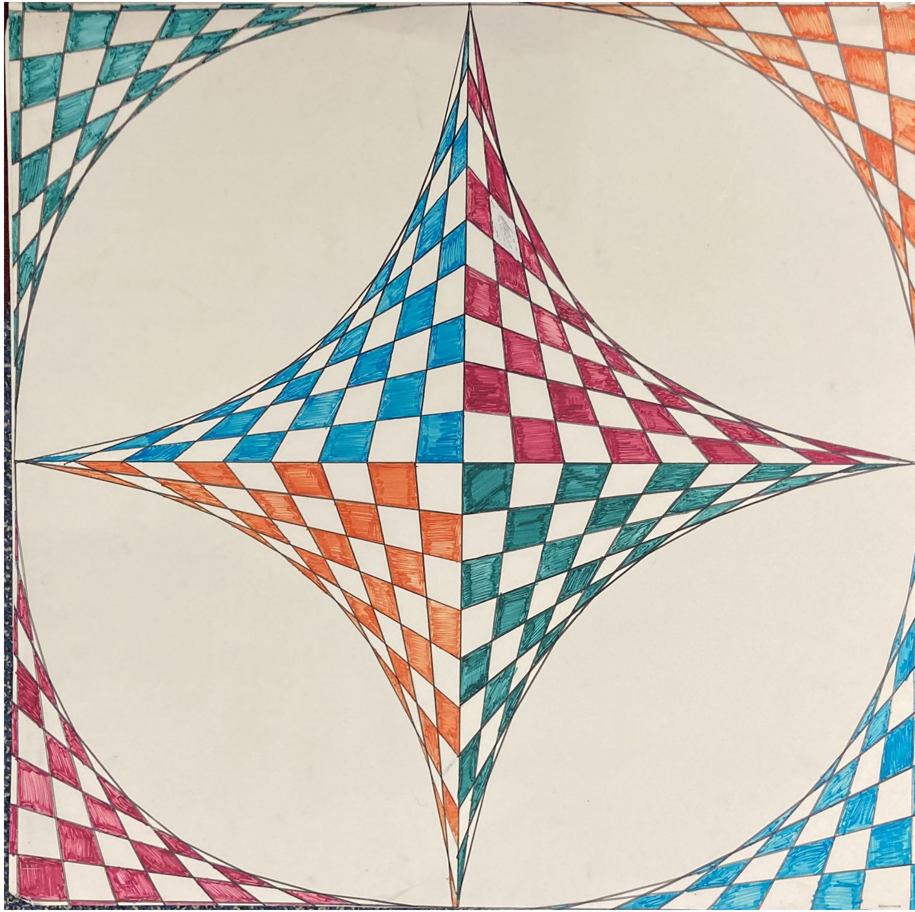
Designed by a Scottish Mathematician, the Three-pendulum Rotary Harmonograph is a mesmerizing combination of physics, math, and art. It is thought by some to be a visual representation of musical harmonies. Different lengths and motions of the three pendulums creates a variety of designs that are like fingerprints: each is unique, but similar in the patterns of swirls and loops.

Video clip Here

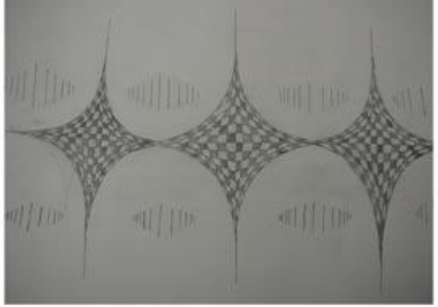
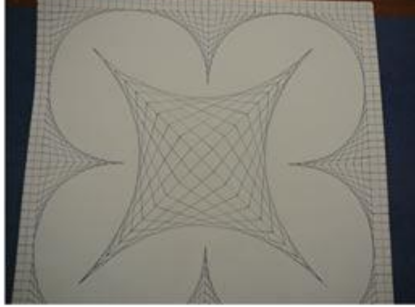
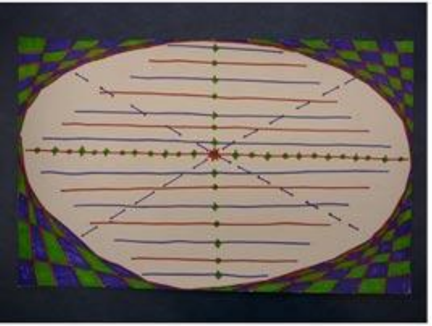
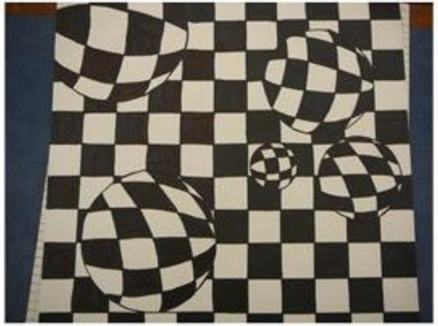


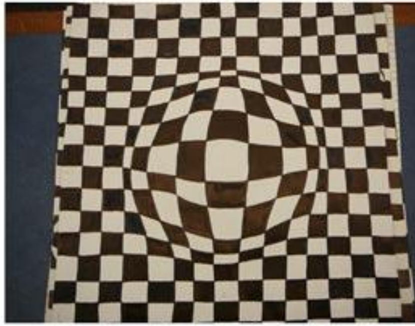
“The Art of Mathematics” (30 hrs) An Elective Course (0.5 cr)

- Elective course--open to all grades
- Pass/no credit--narrative evaluation
- Good mix of students across grades and interests
- Some come from a “math” perspective, others from an “art” perspective
- TOPICS: Line Designs, Op Art, Mandalas, 1 and 2 Point Perspective, Islamic Art, Knot Designs, MC Escher Tessellations, Origami...
- Survey of techniques for the first half of the course
- Final Poster Project for the second half of the course

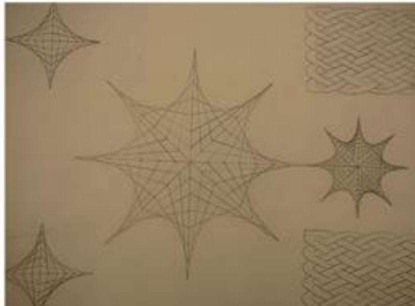



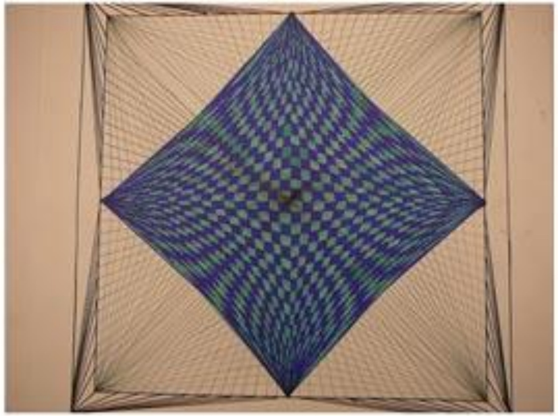


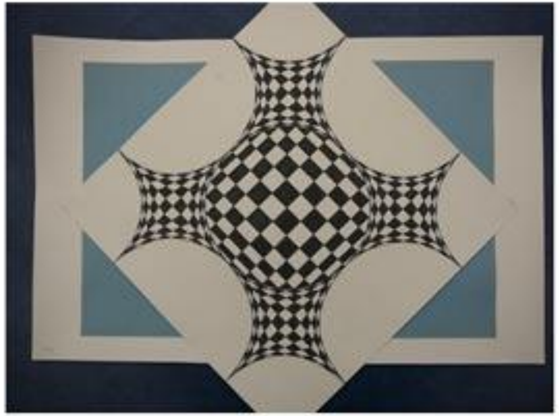





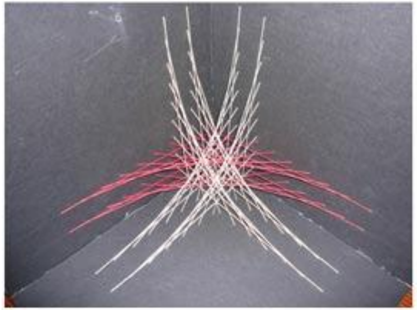
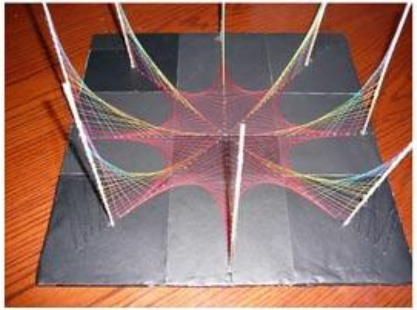


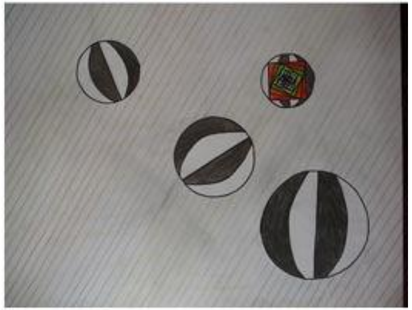
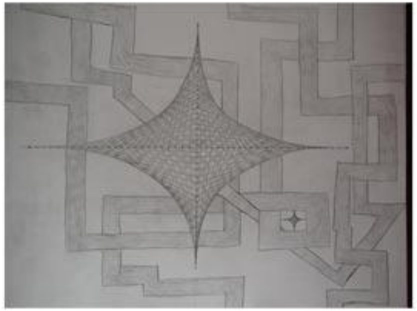


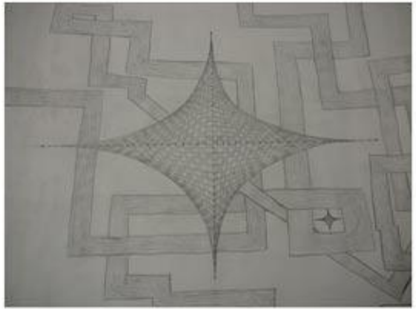


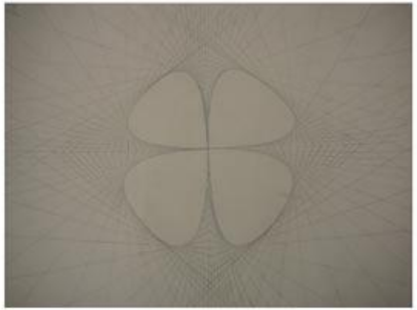
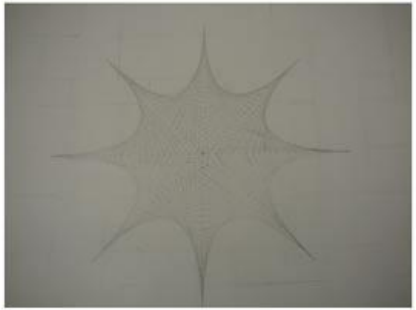
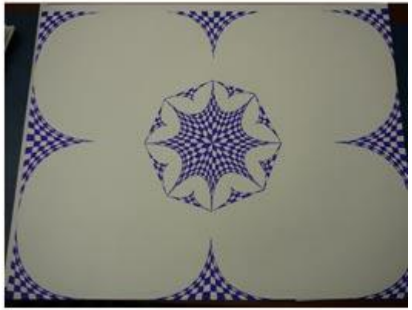




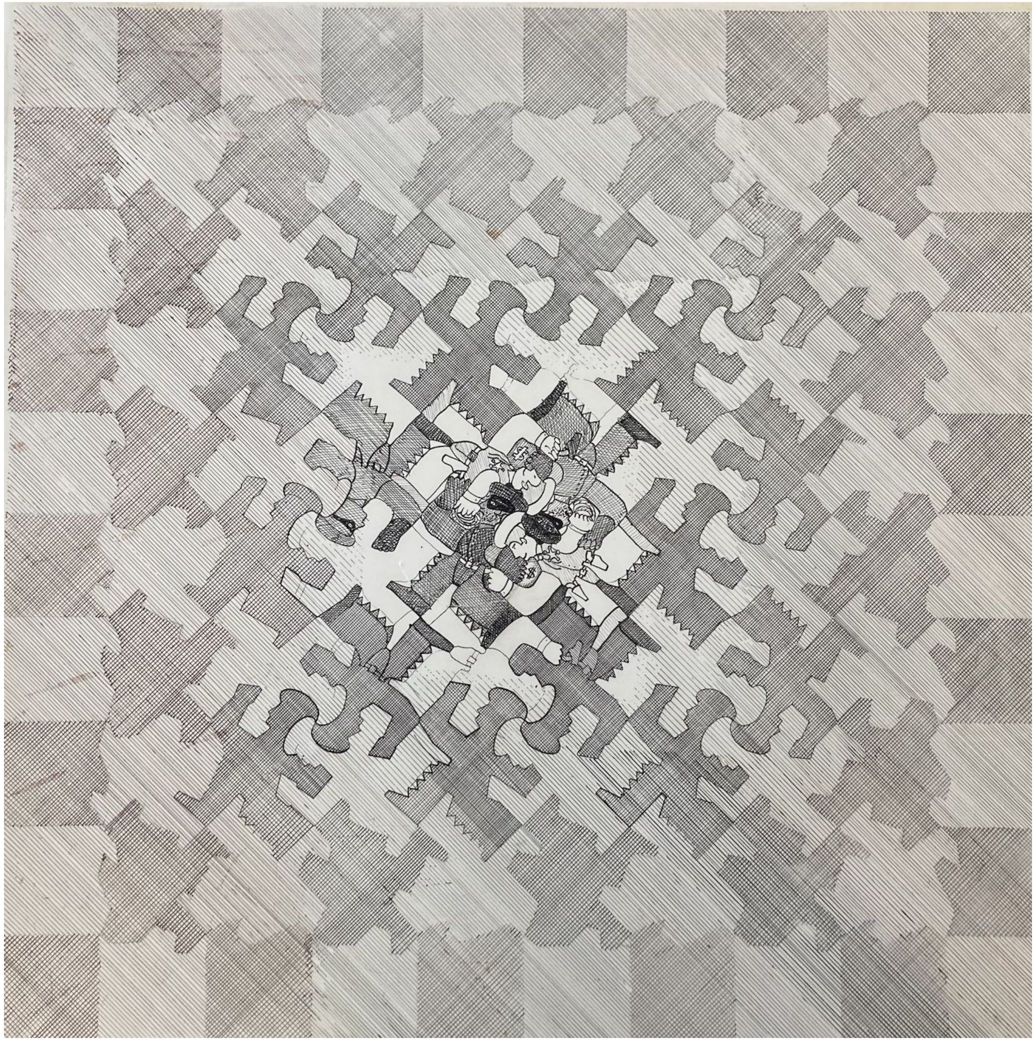



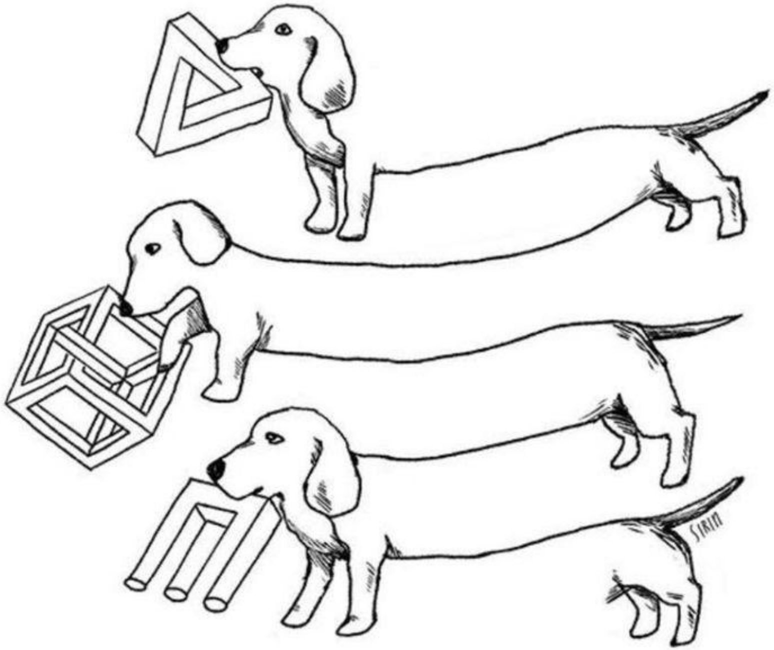


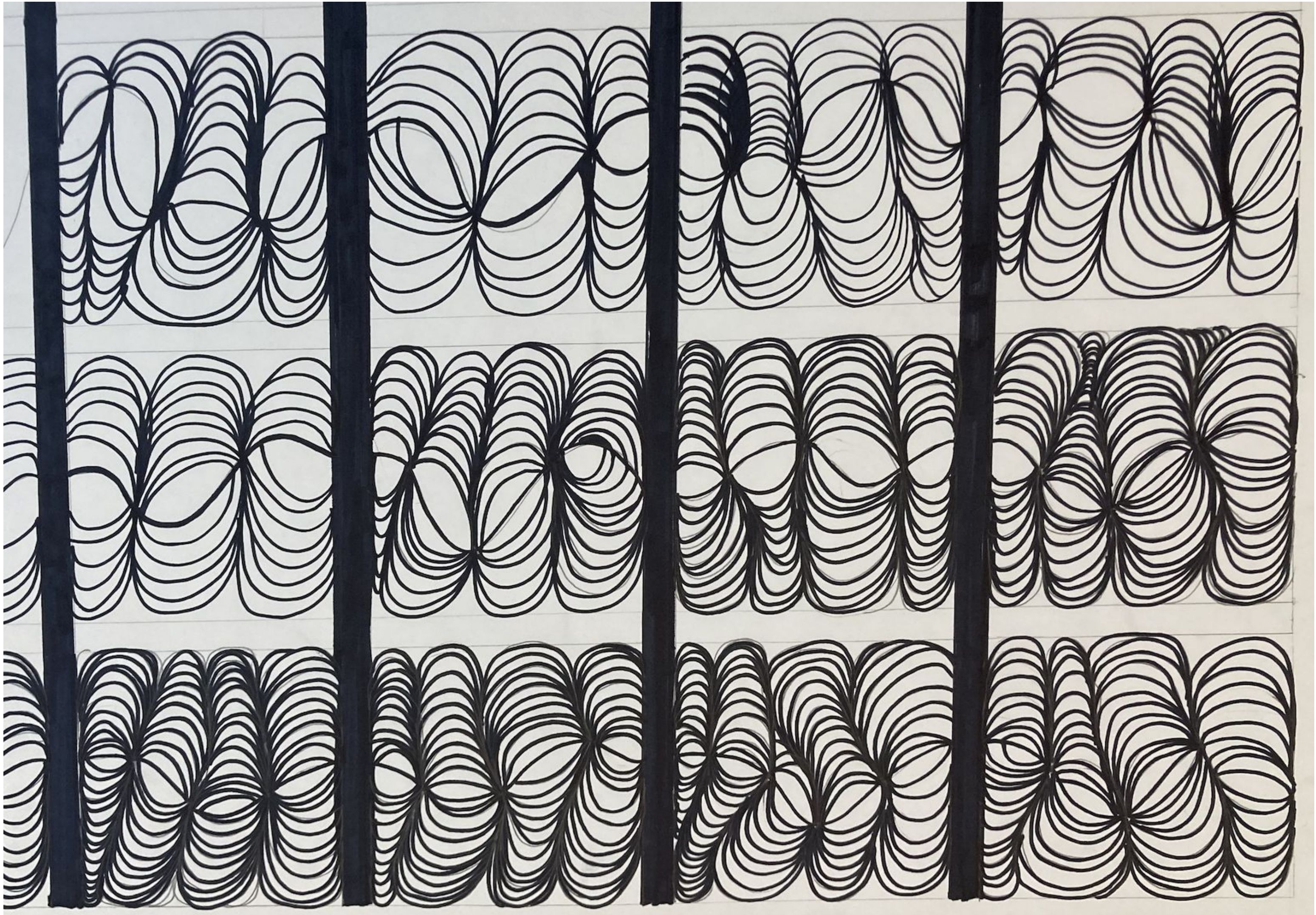





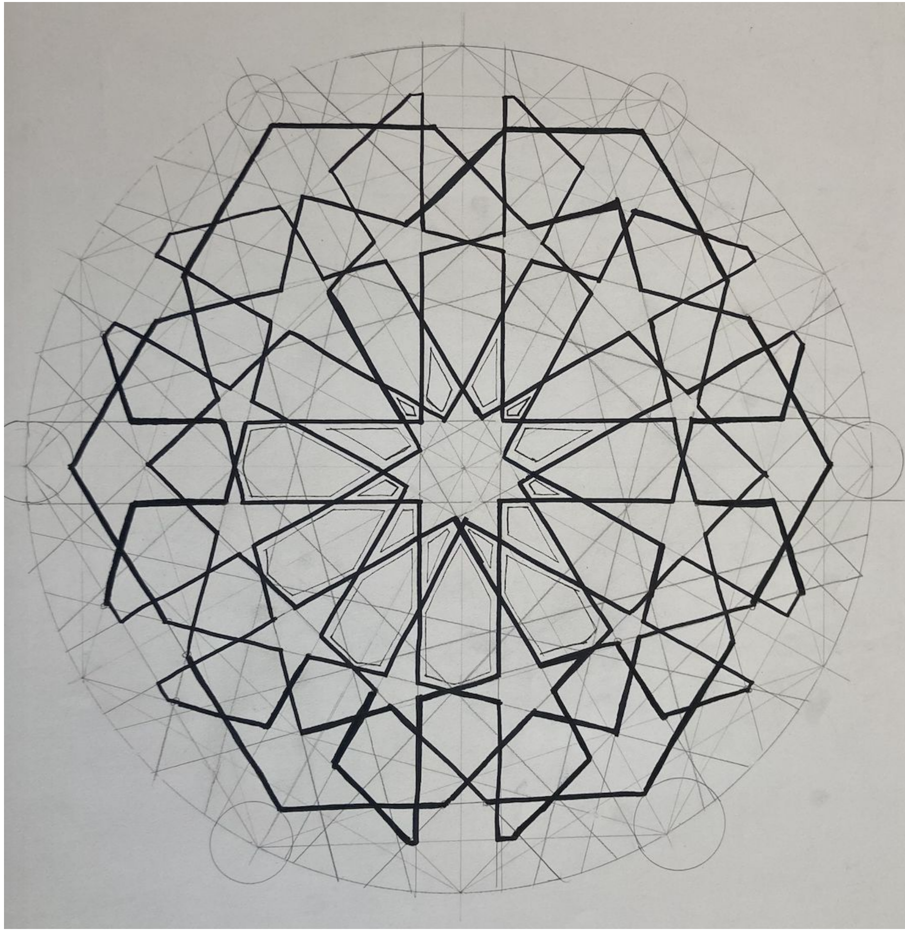

1
2
3
4
5
6
7
8
9
10
11
12

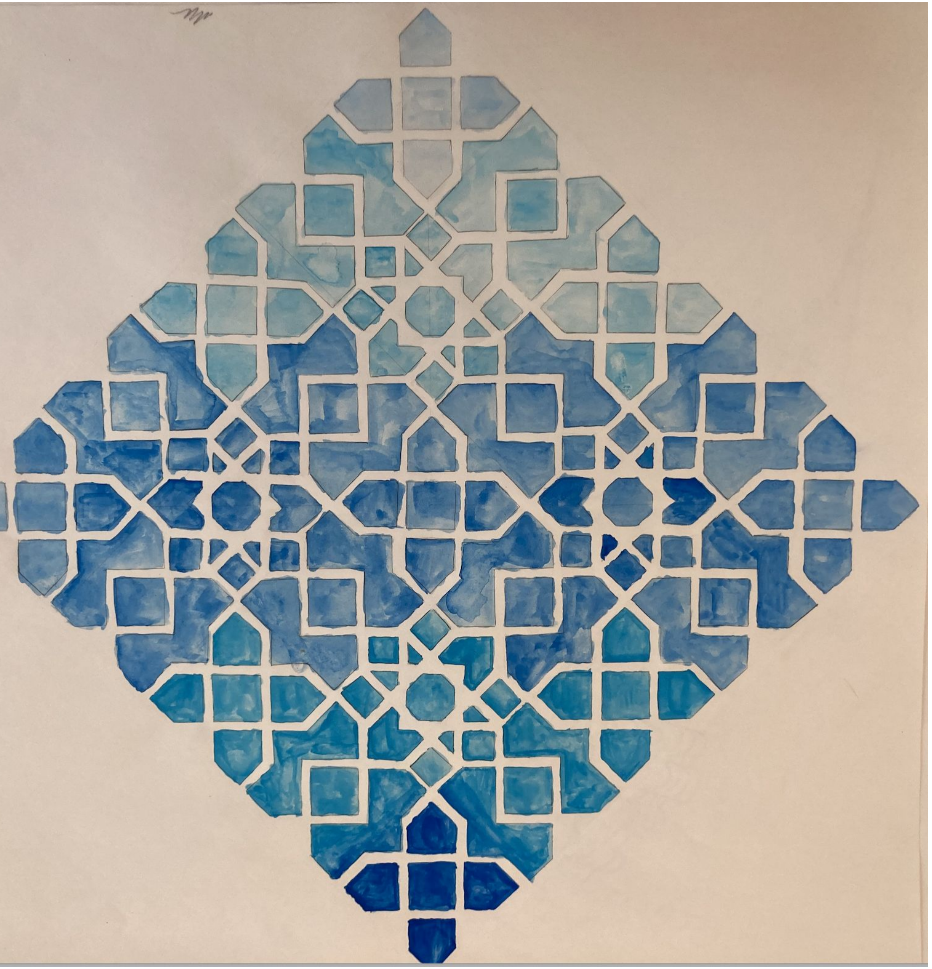
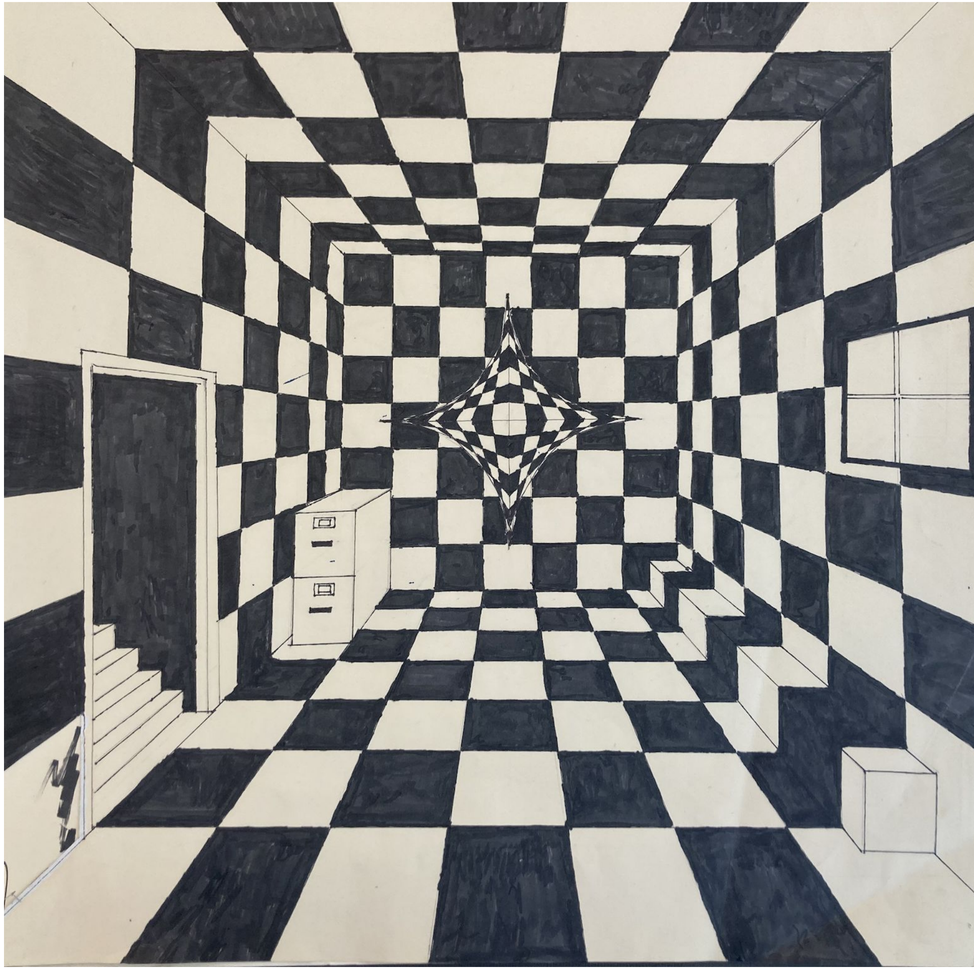


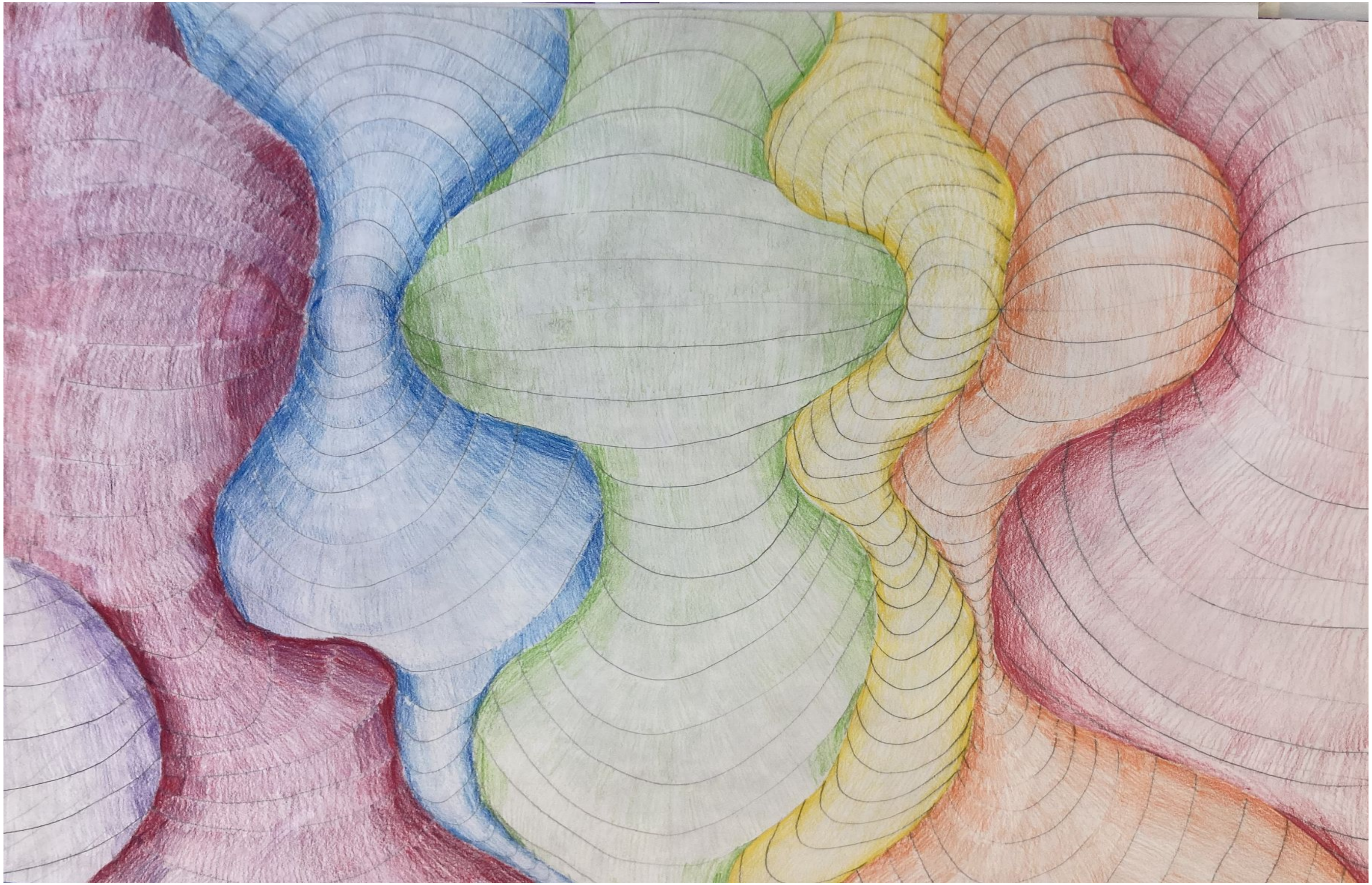
Escher’s Dogs

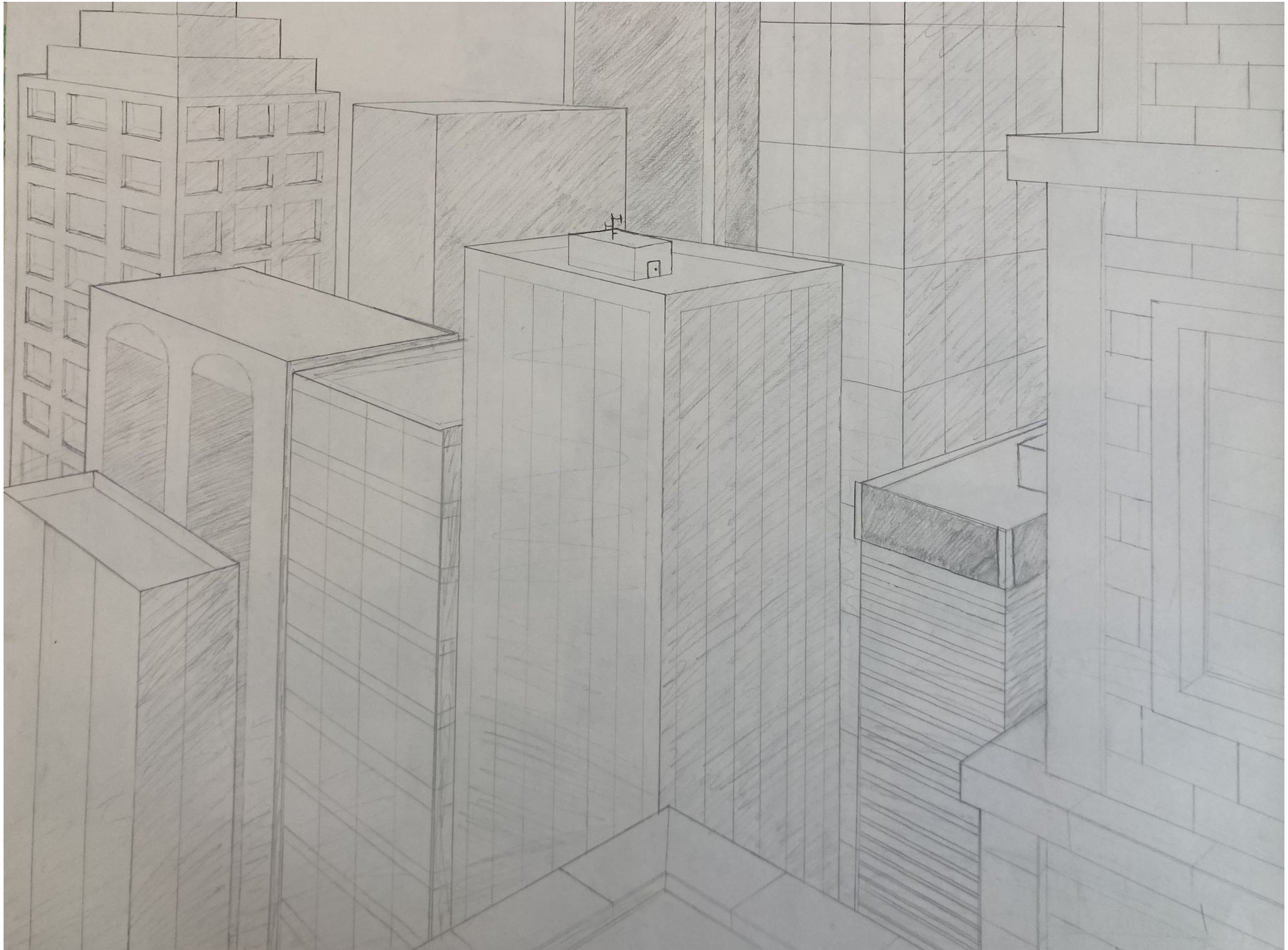






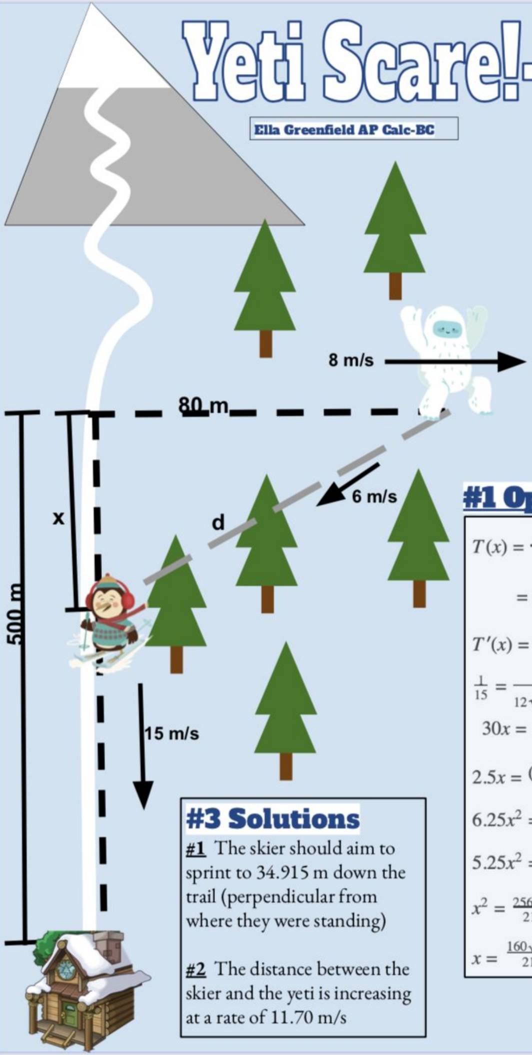







Yeti Scare!-Optimizing an Escape!

Ella Greenfield AP Calc-BC



The Situation

A skier wanders 80 m off the trail and runs into a yeti! The ski lodge is 500 m down the trail measured from the spot perpendicular to the skier. The skier can run back to the trail at a speed of 6 m/s, and once they reach the trail they can ski away at 15 m/s.

#1-How far down the trail should the skier sprint to so they can get back to the safety of the lodge the fastest?

#2-Turns out the yeti is just as scared of the skier as the skier is of them and runs away from the trail at 8 m/s. At the moment the skier starts skiing down the trail what is the rate of the change of the distance between the skier and the yeti?

#1 Optimization

$$T(x) = \frac{\sqrt{80^2+x^2}}{6} + \frac{500-x}{15}$$

$$= \frac{1}{6}(80^2+x^2)^{\frac{1}{2}} + \frac{100}{3} - \frac{1}{15}x$$

$$T'(x) = \frac{1}{12}(80^2+x^2)^{-\frac{1}{2}} \times 2x - \frac{1}{15} = 0$$

$$\frac{1}{15} = \frac{2x}{12\sqrt{80^2+x^2}}$$

$$30x = 12(80^2+x^2)^{\frac{1}{2}}$$

$$2.5x = (80^2+x^2)^{\frac{1}{2}}$$

$$6.25x^2 = 6400 + x^2$$

$$5.25x^2 = 6400$$

$$x^2 = \frac{25600}{21}$$

$$x = \frac{160\sqrt{21}}{21} = 34.915\ m$$

#2 Related Rates

$$34.915 \times \frac{1}{6} = 5.819s \rightarrow 5.819 \times 8 = 46.55m$$

$$46.55 + 80 = 126.6$$

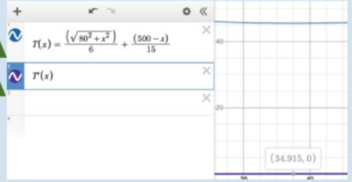
$$(d(t))^2 = 126.6^2 + 34.92^2 \rightarrow d(t) = 131.3m$$

$$d^2 = x^2 + y^2$$

$$2dd' = 2xx' + 2yy'$$

$$2(131.3)d' = 2(34.915)(15) + 2(126.6)(8)$$

$$d' = 11.70\ m/s$$



#3 Solutions

#1 The skier should aim to sprint to 34.915 m down the trail (perpendicular from where they were standing)

#2 The distance between the skier and the yeti is increasing at a rate of 11.70 m/s

Pingree Math Curriculum

Math 1-2-3

Precalculus

Calculus-Stats- (AP’s)

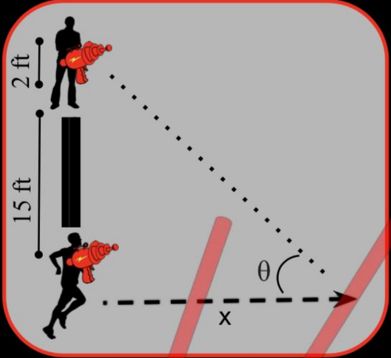
“Student-Centered”

Inquiry Based

Project Oriented

21st Century Skills: Collaboration, Quantitative Evidence-based Decisions

LASERTAG OPTIMIZATION



Challenge

You and a friend are playing lasertag on opposite teams. You each start standing on either side of a 15 foot wall that is between you both. With his equipment, your opponent takes up 2 feet of space. You make a run perpendicular to the wall, hoping to get an optimal shot at your stationary opponent. You run at a rate of 5mph.

1. **How far do you need to run to have an optimal shot at your opponent?**
2. **At what rate are you moving away from your opponent?**

Optimization

Finding x (optimal distance from wall)

$$\theta_{(x)} = tan^{-1}(\tfrac{17}{x}) - tan^{-1}(\tfrac{15}{x})$$

$$0 = \tfrac{d}{dx}\,[\ tan^{-1}(\tfrac{17}{x}) - tan^{-1}(\tfrac{15}{x})\ ]$$

$$0 = (\tfrac{1}{1+\frac{17^2}{x^2}} * \tfrac{-17}{x^2}) - (\tfrac{1}{1+\frac{15^2}{x^2}} * \tfrac{-15}{x^2})$$

$$0 = \tfrac{-17}{(x^2+289)} + \tfrac{15}{(x^2+225)}$$

$$\tfrac{17}{(x^2+289)} = \tfrac{15}{(x^2+225)}$$

$$17(x^2+225) = 15(x^2+289)$$

$$17x^2 + 4335 = 15x^2 + 3825$$

$$510 = 2x^2$$

$$x = \sqrt{255} \approx 16 \text{ feet}$$

Related Rate

Find the rate at which you are running away from your opponent

Pythagorean Theorem: $x^2 - y^2 = c^2$

$255 - 15^2 = c^2$

$c = \sqrt{480} \approx 4\sqrt{30} \approx 21.91$ feet

Derivation with respect to t: $2x\frac{dx}{dt} - 2y\frac{dy}{dt} = 2c\frac{dc}{dt}$

Snapshot data:

$x = \sqrt{255}$; $y = 15$; $c = 21.91$; $\frac{dx}{dt} = 5mph$; $\frac{dy}{dt} = 0mph$

Subbing and Solving:

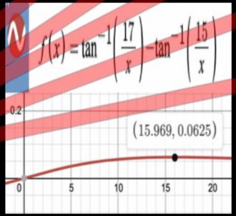
$2(\sqrt{255})5 - 2(15)0 = 2(\sqrt{480})\frac{dc}{dt}$

$159.69 - 0 = 43.82(\frac{dc}{dt})$

$\frac{159.69}{43.82} = \frac{dc}{dt}$

$\frac{dc}{dt} \approx 3.64\ mph$

The rate at which you are moving away from your opponent is about 3.64 mph.



3V3

Hockey tournament

Overview

You've created a 3V3 hockey league and you want to make as much money as possible. There will be teams of kids and teams of teens. Each kid team has to pay \$20 and each teen team has to pay \$40. (x= kids teams y= teen teams)

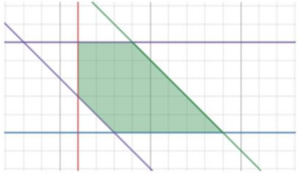
constraints

1)There has to be at least 6 kid teams.
2)There has to be at least 10 teen teams
3) There has to be at least 18 overall teams
4) There can't be more than 24 overall teams
5) There will be no more than 15 weeks of games.

1. $x \geq 6$
2. $y \geq 10$
3. $x + y \geq 18$
4. $x + y \leq 24$
5. $y \leq 15$

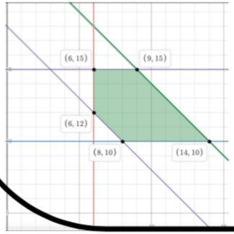
The Feasible Region sentence

$x + y \leq 24 \{x + y \geq 18\} \{y \geq 10\} \{x \geq 6\} \{y \leq 15\}$



The Maximum profit you could make

(The objective Function)



$9 \cdot 20 + 15 \cdot 40 = 780$

$6 \cdot 20 + 15 \cdot 40 = 720$

$14 \cdot 20 + 10 \cdot 40 = 680$

$6 \cdot 20 + 12 \cdot 40 = 600$

$8 \cdot 20 + 10 \cdot 40 = 560$

\$780

The Cookie Co.

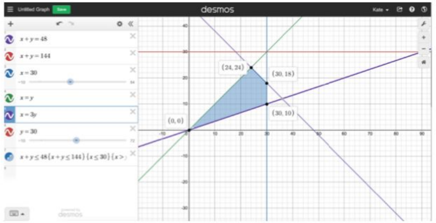
Kate Littlehale

X- Chocolate chip
Y- Oatmeal butterscotch
Objective- make the most profit

A cookie company makes 2 types of cookies, chocolate chip, and oatmeal butterscotch. 6 chocolate chip cookies (x) costs \$14, and 6 oatmeal butterscotch cookies costs \$18. The objective is for the company to make the most profit.
Objective function: cost= 14x+ 18y

1. The oven cant hold more than 48 cookies
2. The shelf space can't more than 144 cookies
3. They cant make more than 30 chocolate chip cookies because they don't have enough staff
4. Chocolate chip cookies always sell more but never more than 3 times as popular
5. They cant make more than 30 oatmeal butterscotch cookies

Objective function: maximum profit = 14x+ 18y
(0,0)- 14(0)+18(0)=\$0
(30,10)- 14(30)+18(10)=\$600
(30,18)- 14(30)+18(18)=\$744
(24, 24)- 14(24)+18(24)= \$786



Pizza shack

Objective:
You are running a pizza shack and can only make two types of pizzas, cheese and deluxe. You will sell a slice of cheese pizza for $5 and deluxe for $10. The objective is for you to earn the most money in the least amount of time.

Variables:
X- Slice of cheese pizza = $5
Y- Slice of deluxe pizza(cheese, pepperoni, peppers, and mushrooms) =$10

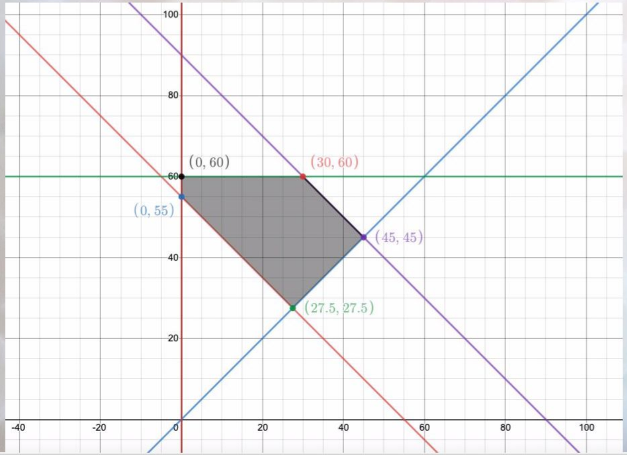
Constraints:

1. You have to sell at least 55 slices of pizza of cheese and deluxe combined
2. Cannot sell more than 90 slices all together because they don't have enough dough
3. The deluxe pizza is always more popular than the cheese
4. Can't sell more than 60 deluxe pizzas
5. You can't sell negative pizzas

Points in feasible region:
(0,60)
(30,60)
(0,55)
(27.5,27.5)
(45,45)

Calculations:
1. 5(0) +10(60)=$600
2. 5(30) +10(60)=$750
3. 5(0)+10(60)=$550
4. 5(45)+10(45)=$675
5. 5(27.5)+10(27.5)=$412.5

Objective function:
5x+10y=p



The best point outcome to sell the pizzas, is (30,60) 30 cheese pizzas and 60 deluxe pizzas.

Constraint equations:
1.x+y ≥55
2.x+y≤90
3.y>x
4.y≤60
5.x>0

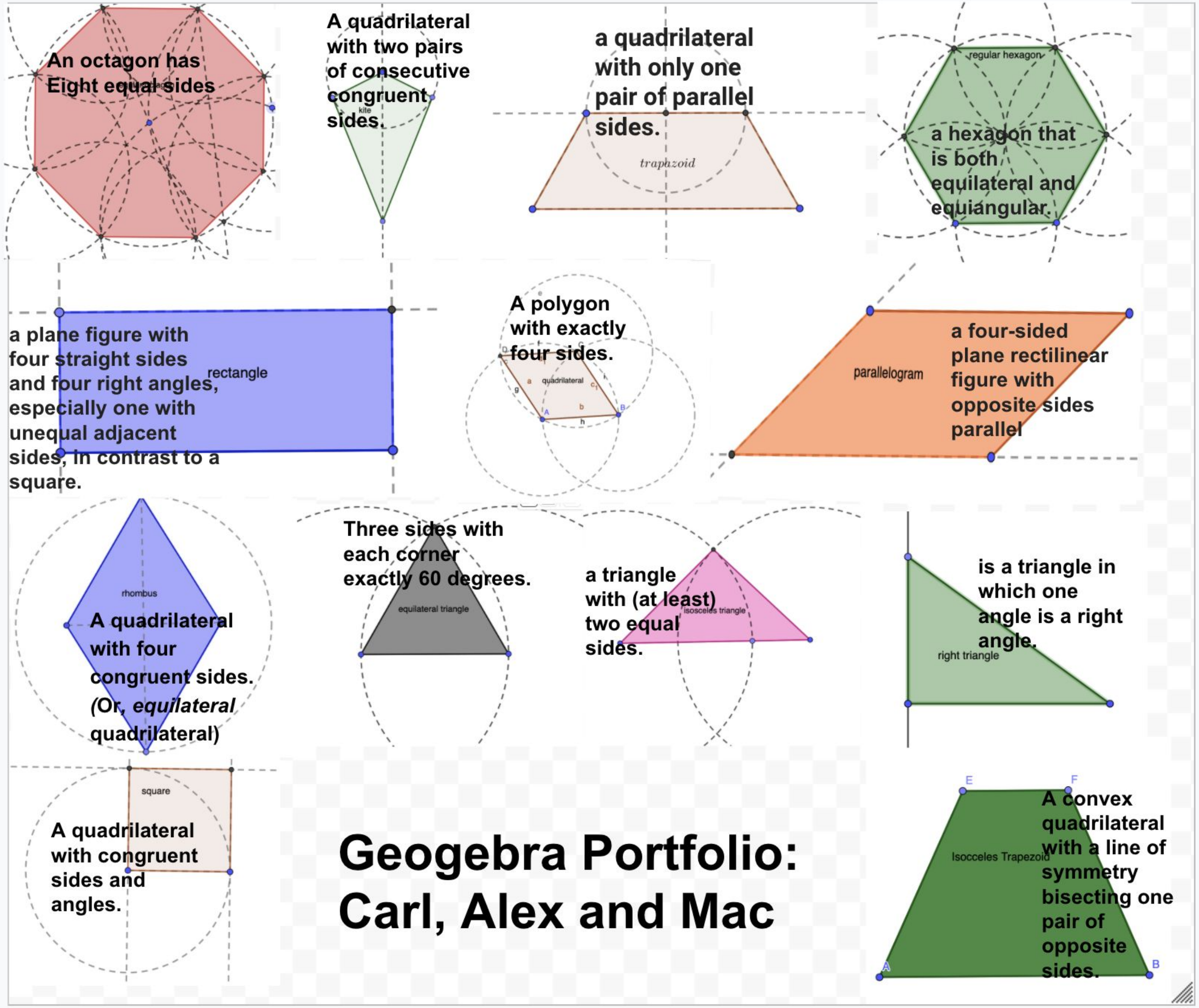
Graph key:
Red line= constraint 1
Purple line= constraint 2
Blue line= constraint 3
Green line= constraint 4
Dark red=constraint 5

Math-1 Theoretical v. Experimental Geometric Probability

Projects:

Student Work

Tutorial Video


An octagon has
Eight equal sides
A quadrilateral
with two pairs
of consecutive
congruent
sides.
kite
a quadrilateral
with only one
pair of parallel
sides.
trapezoid
regular hexagon
a hexagon that
is both
equilateral and
equiangular.
a plane figure with
four straight sides
and four right angles,
especially one with
unequal adjacent
sides, in contrast to a
square.
rectangle
A polygon
with exactly
four sides.
quadrilateral
parallelogram
a four-sided
plane rectilinear
figure with
opposite sides
parallel
rhombus
A quadrilateral
with four
congruent sides.
(Or, equilateral
quadrilateral)
Three sides with
each corner
exactly 60 degrees.
equilateral triangle
a triangle
with (at least)
two equal
sides.
isosceles triangle
is a triangle in
which one
angle is a right
angle.
right triangle
square
A quadrilateral
with congruent
sides and
angles.
Geogebra Portfolio:
Carl, Alex and Mac
Isocceles Trapezoid
A convex
quadrilateral
with a line of
symmetry
bisecting one
pair of
opposite
sides.

“Bullseye” Geogebra Probability Project- Ellie Carys Kayla

During this project, my group members and I found that by using probability we could figure out theoretical and experimental solutions.

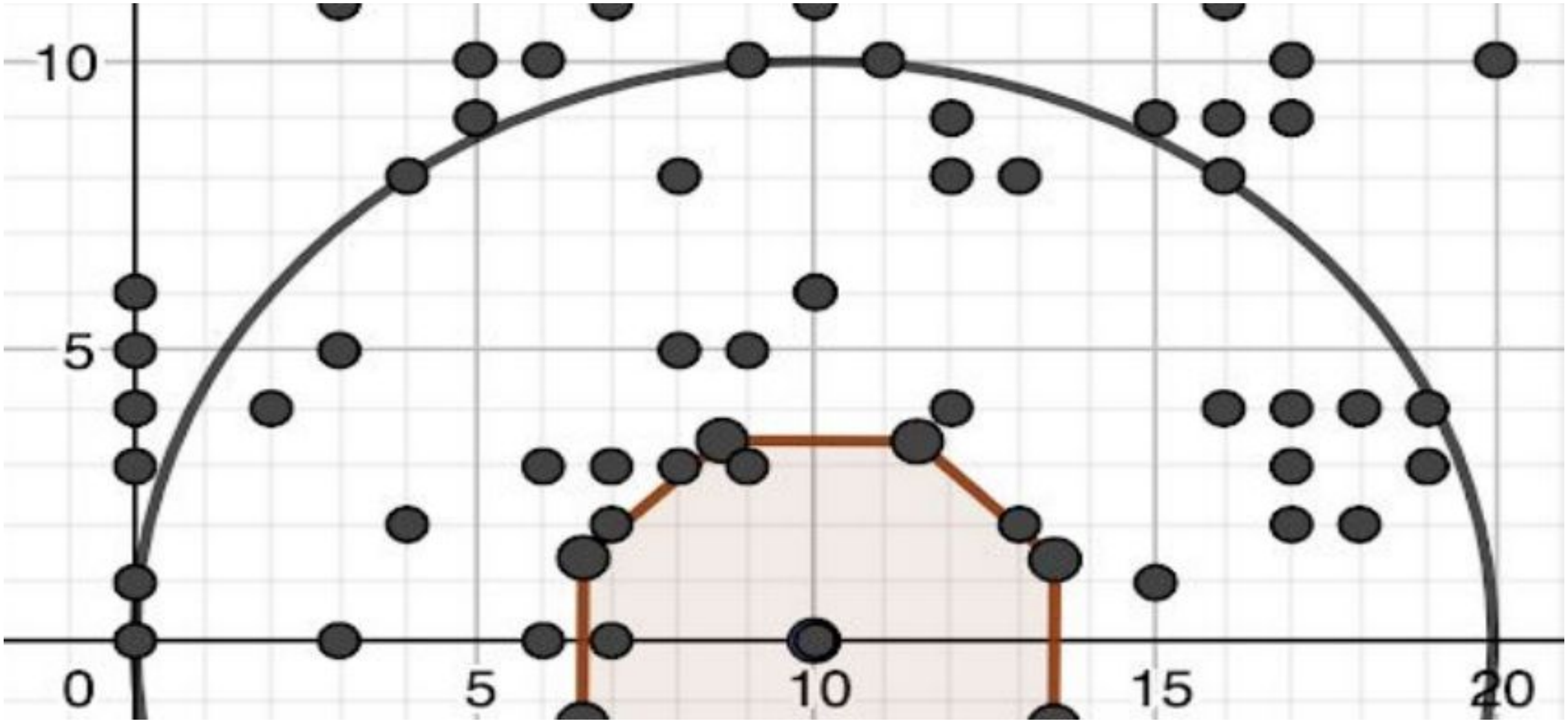
Question: What is the probability that a random shot taken will hit a circular target and hit a hexagon bullseye.

Background Info: The target and the bullseye were both made using GeoGebra, Ellie created the shapes and target on geogebra while Kayla created random numbers and bullets through Google Sheets. I, Carys am writing the analysis.

To figure out the ***theoretical geometrical probability*** we used the definition of probability that means “ the area of the bullseye divided by the total area of the target.”

$$\frac{\text{Area of a Bullseye}}{\text{Area of a Target}} = \frac{\text{Area of a Hexagon}}{\text{Area of a Circle}} = \frac{40}{314.16} = .254$$

To figure out the ***experimental geometrical probability*** we used the definition of probability that means “ the number of events that we are interested in, divided by the total number of events.”


10
5
0
5
10
15
20

On to the video tabs!