Patterning Math Lab 5

Sign-in & Sign-up

- If you haven't already, log your arrival by signing in on the Week 5 Math Lab 5 Sign-in sheet, located in CAL East.
- If you have are prepared for a Quiz 3 Revision Discussion, sign up for a slot using the Quiz 3 Revision Discussion Sign-up sheet, also located in CAL East.
  - There are 5 time windows: 9:30 – 10:00, 10:00 – 10:30, 10:30 – 11:00, 12:00 – 12:30, and 12:30 – 1:00.
  - Sign up during one time window; you will have the opportunity for your short Quiz Revision Discussion during your time window.
  - Only sign up for a Quiz Revision Discussion if you are fully prepared:
    - You have completed a Quiz 3 Revision using the Revision Version of the quiz.
    - You have brought your original Quiz 3.

Today, you have the opportunity to return to several questions that have been introduced over the past several weeks, as well as to work on some new questions. These questions give you practice with problem-solving and modeling, with emphasis on the math and physics topics we have covered.

You should work at your own computer and keep your own notes, but are welcome to consult with your classmates.

You may work on any of the questions below, in any order you choose.

As you work through these questions, pay attention to:

- the patterns that you see (both math and physics patterns and patterns in your process),
- the concepts, skills, tools, and resources (cite your sources as needed) that you use, and
- the connections between math and physics.

All videos and pictures are available in the program share, under Handouts: Week 5 Lab.

When Will They Pass?

You have worked with battery powered tumble buggies. The video When Will They Pass shows two buggies moving towards each other: one moving to the right and one moving to the left. When and where will the buggies pass each other?

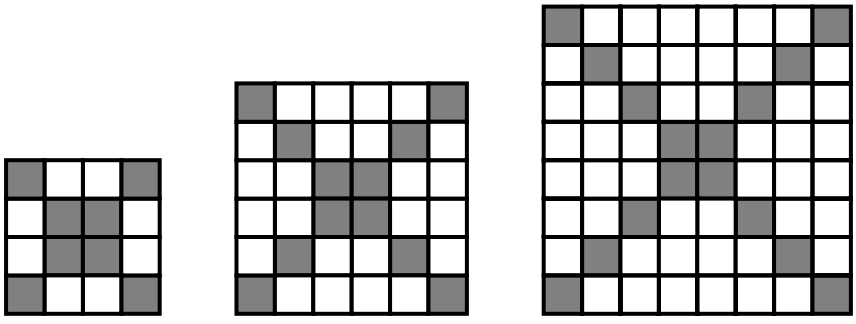
Will They Collide?

The video Will They Collide shows a red tumble buggy moving to the right and a blue tumble buggy moving down. Will They Collide?

Building Boxes

Consider the following series of patterns of white and grey boxes. Assume the series of patterns continues.

a) How many total boxes would be in the 9^{th} pattern in the series?
b) How many grey boxes would be in the 12^{th} pattern in the series?
c) What number pattern in the series has 100 grey boxes?
d) How many white boxes would be in the 15^{th} pattern in the series?
e) What number pattern in the series has 1680 white boxes?



1 **2** **3**

Speeding Story

In each scenario below, determine when and where the police car catches up to the motorcycle, and how fast the police car is going at that time.

A motorcycle moving at constant speed 30 m/s on a straight road passes a stationary police car.

a) At the instant the motorcycle passes the police car, the police car begins to move with constant acceleration 3 m/s^2 in the same direction as the motorcycle.
b) A more accurate scenario would require some time before the police car starts to chase after the motorcycle. Say the police car starts to move with constant acceleration 3 m/s^2 in the same direction as the motorcycle 5 seconds after the motorcycle passes the police car.
c) A different scenario has the police car already moving when the motorcycle passes by. Say the police car is moving at 15 m/s and at the instant the motorcycle passes by starts to move with constant acceleration 3 m/s^2 in the same direction.

Will He Hit the Hoop?

View the movies associated with the images below (the movie has the same name as the corresponding image). Movies by Dan Meyer from blog.mrmeyer.com

Basketball Shot I

Basketball Shot II

a) In each case, determine whether he will hit the hoop. (note: you can Insert: Picture into LoggerPro just like you Insert:Movie). Can you also determine if he will make the shot?
b) In each case, determine the velocity (components and magnitude) when the ball leaves Dan's hand.

Rectriangle

Open the following Desmos file **https://www.desmos.com/calculator/ovsmagtuxw**

If not already playing, press the play button for the a slider and watch what happens (you can also slide the slider manually). What's the area of the rectangle when a = 0? What's the area of the rectangle when a = 8? Somewhere in between, the area of the rectangle must have a maximum value – why?

a) Determine the dimensions of the rectangle with maximum area, as well as that maximum area.
b) You solved the specific case with the line y = 4 – ½ x. Generalize your results for any line y = b – m x (where b and m are positive numbers).

How Helpful

a) Person A can do a job in 1 day. Person B can do the job in 2 days. How long does it take if they work together on the job?
b) Person C can do the job in 4 days. How long if A, B, and C work together?
c) Person D can do the job in 8 days. How long if A, B, C, and D work together?
d) It takes each new person twice the time to do the job as the previous person. If you can have as many people as you'd like, what is the minimum amount of time for the job?

Current Events

A motorboat travels 12 miles down the river with the current. When the motorboat returns, it is moving against the current, so it travels 2 miles per hour slower and the trip takes 3 hours longer. Determine the speed of the current.

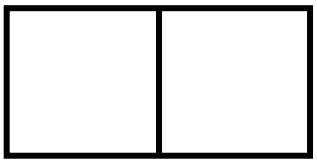
Rocket Roll

A toy rocket goes straight up and down, and is in the air for 4 seconds (time between launch and land). Neglect air resistance.

a) What is the maximum height above its launch point? What is the launch speed?
b) Determine how long it takes to reach half of its maximum height. Try all of the following methods:
c) Graphical
d) Solving a quadratic equation using the quadratic equation formula
e) Solving a quadratic equation by ransforming to vertex form and doing the algebra
f) Only using the 3 constant acceleration kinematics equations and not solving a quadratic equation at all.

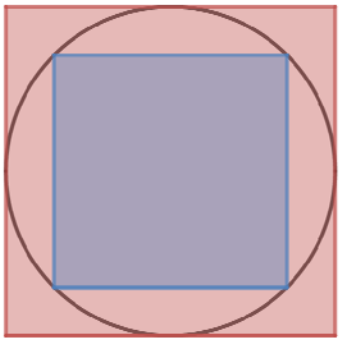
Good Fences

a) A farmer plans to enclose two pens with fencing, as shown. She has 600 feet of fencing available. Determine the dimensions of the pen which maximize the enclosed area.
b) A rancher wants to fence in an area of 1500000 square feet in a rectangular field and then divide it in half with a fence down the middle parallel to one side. What is the shortest length of fence that the rancher can use?
c) Ask Krishna for a fun extension of these problems.

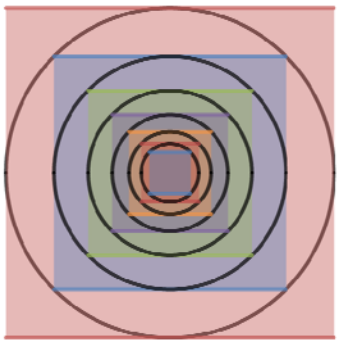


Circles and Squares

The picture below shows a circle inscribed in a square (side length 1), with a square inscribed in the circle. Determine the ratio of the area of the inner square to the ratio of the outer square.



The picture below continues the pattern in the previous picture, with circles in squares in circles. Imagine this goes on forever. What is the sum of the area of all the squares?



Aurum Proportions

See the board for this question.