Grade Level/Course: Kindergarten - 2nd Grade
Lesson/Unit Plan Name: Teaching Mathematics Through Problem Solving
Rationale/Lesson Abstract: Students will use problem solving activities to learn new mathematical concepts instead of the traditional route of applying concepts to problem solve after those concepts have been learned.
Timeframe: This approach is designed to be implemented throughout all math content as you teach new concepts.
Common Core Standards Addressed in Examples: **K.OA.5** Fluently add and subtract within 5 **1.OA.6** Add and subtract within 20, demonstrating fluency for addition and subtraction within 10. **2.OA.2** Fluently add and subtract within 20 using mental strategies. By end of Grade 2, know from memory all sums of two one-digit numbers. **K.MD.2** Directly compare two objects with a measurable attribute in common, to see which object has "more of"/ "less of" the attribute and describe the difference. **1.MD.2** Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. **2.MD.2** Measure the length of an object twice, using length units of different lengths for the two measurements; describe how the two measurements relate to the size of the unit chosen. **MP.1** Make sense of problems and persevere in solving them **MP.4** Model with mathematics

Teacher Background:

Materials/Resources:

Teaching Student Centered Mathematics: Developmentally Appropriate Instruction for Grades PreK -2 by John A Van de Walle. This book was used as a reference to gain ideas for implementing problem based learning throughout instruction.

Goals of Teaching Mathematics through Problem Solving:

1. Focuses students' attention on ideas and sense making.
2. Emphasizes mathematical processes and practices.
3. Develops students' confidence and identities.
4. Provides a context to help students build meaning for the concept.
5. Allows entry and exit points for a wide range of students.
6. Allows for extensions and elaborations.
7. Engages students so there are fewer discipline problems.
8. Provides formative assessment data.
9. Engages students…learning math can be fun!

Features of a Problem:

1. The problem should engage the students where they are in their current understanding.
2. The problem should have a well-designed context and get students excited about learning math.
3. The problem must require justifications and explanations for answers and method.
4. The problematic or engaging aspect of the problem must be a result of the mathematics that the students are **to learn**.
5. Problem can be conceptual or procedural in nature.

Problem Based Activities/Lessons:

Example 1 – Flipped Facts

Instead of looking at learning basic facts as memorizing addition/subtraction equations, have students work frequently on the problem-based activity of decomposing numbers in different ways to gain hands-on experience with basic facts.

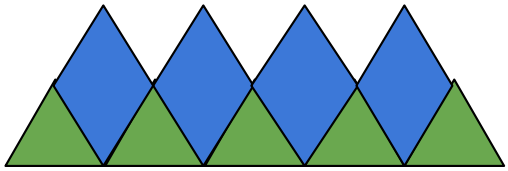
Suggested focus would be numbers 3-5 for Kindergarten, 5-10 for 1st Grade and 11-19 for 2nd grade (each part should have no more than 10 objects).

Materials/Resources

Work mats
Paper to record
Various manipulatives (such as):
- Pattern Blocks
- Unifix Cubes
- Bead Strands
- Tiles
- Toothpicks
- Bears
- Buttons
- Coins

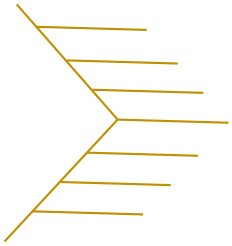
Students can work on a different "target" number each day/week decomposing using manipulatives. Students can choose the manipulative they would like to use to build facts or could rotate through stations with various manipulatives. They should use no more than two colors or two sizes of a manipulative so they can see the two "parts" of the number they are building. Also manipulatives should all be touching each other in some way. Students can build on a mat (felt or laminated) or build and record on a piece of paper more than one decomposition of the "target" number.

Example of student recording of "9" decomposed in more than one way with a related equation.



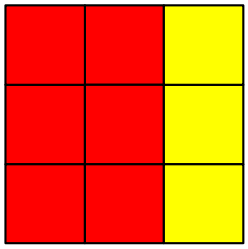
(pattern blocks)

4 + 5 = 9



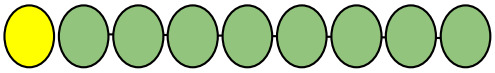
(toothpicks)

9 = 2 + 7



(tiles)

9 = 6 + 3



(beads)

9 - 1 = 8

Questions to ask:

"How many different ways can you decompose the target number?"
"How do you know when you have found all the different ways?"
"Can you record as an addition equation?"
"Can you record as a subtraction equation?"
"Can you record more than one equation?"
"Do you see any patterns in the decompositions?"

Extensions:

Have one student build a fact with manipulatives and another student write an addition and/or subtraction equation to go along with it.

Have students play a matching game where they connect drawings of the manipulative fact to the corresponding equation that goes along with the drawing/recording.

Formative Assessment:

Observational data of student's manipulative work
Student samples of work if they record picture/equation
Can student easily create an equation to go along with their manipulative?
Can student write more than one equation for each creation?

Example 2 – Crooked Hiking Paths:

This activity is adapted from **Teaching Student Centered Mathematics** by John A. Van de Walle. The students will have 3 different hiking paths to consider. They are told that they are going on a hike and want to take the longest hike they can. Their job is to figure out which hiking path is the longest.

Kindergarten students begin to describe attributes of objects that can be measured with length.
In grade 1, one of the four focal areas is children measuring lengths indirectly and by iterating (or using groups of the same unit) with non-standard units
2nd grade students begin measuring with standard units and compare two objects they've measured to find the difference between them.

Materials:

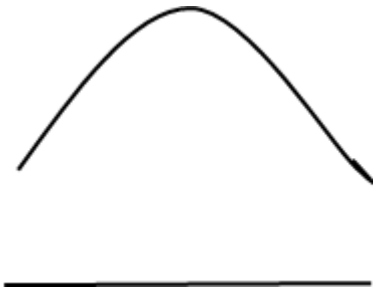
masking tape or chalk
Rope, string or yarn that is at least 10 feet long for each pair/group of students
8 ½ x 11 pieces of paper
Pipe cleaners
Crooked path recording sheet
Ruler, tape measure, or yard/meter stick

Set up the Stations:

1. Create hiking path A, B and C on the playground with masking tape or chalk. (use the BLM attached to the lesson to recreate the shape)
2. Make the 3 paths different lengths and record their length so you can recreate them at 8 different stations (if you want kids to work in groups of 3).
3. Prepare materials for each station that students could use to measure the paths: yarn, string or rope (cut into 10 feet sections for each station), 8 ½ x 11 paper, long pipe cleaners, etc.

Warmup:

Show the two lines below on the board:



T: "How can we tell which of these is longer?"
Have the students discuss in pairs and facilitate a class discussion. Students should share out their ideas. Some students may share that the curved path is longer. Ask how they would prove it.

Activity:
Out on the playground, gather around one station and ask:

T: "How will we figure out which hiking path to take if we want to take the longest path?"

Give each child a worksheet with smaller versions of the paths.
Break the students into groups of 3

Students should study the paths on the playground and make an estimate as to which one is longest. Discuss in small group. They can circle the path on their paper they think is the longest.

Have some students share out their reasoning.

Show them the materials for measuring and have them prove their estimate correct or incorrect.

Students should be able to choose their own measurement tool. Have the students write or draw which tool they chose on their worksheet.

Ask students to share with you why they chose the tool that they did to measure.

Monitor the activity of the students and take anecdotal notes about their choice in measurement tool and how they measure the path. Do not interfere with their work.

Students should complete the worksheet when done measuring.

Class Discussion:

"How many thought the zigzag path was longer in the beginning?"
"How many thought the curvy path was longer in the beginning?"
"How many of your estimates matched your results?"
"How many of you were surprised by the results?"
"How many of you chose the _____ to measure?" (insert different tools)

Have students share about their process in choosing the measurement tool and how they went about measuring the paths.

Extension:

2nd grade students could then use a tool to measure in standard units and find the difference between the two paths.

Leave this activity open-ended as well. Let the students decide which standard unit would be best to measure the paths and why. Also, which tool might be best to use? If they don't have a tape measure, how can they accurately measure the curvy path?

Students could measure the path with one unit and then use another unit. Afterward, the students could write/discuss why the paths are different measurements when different units are used.

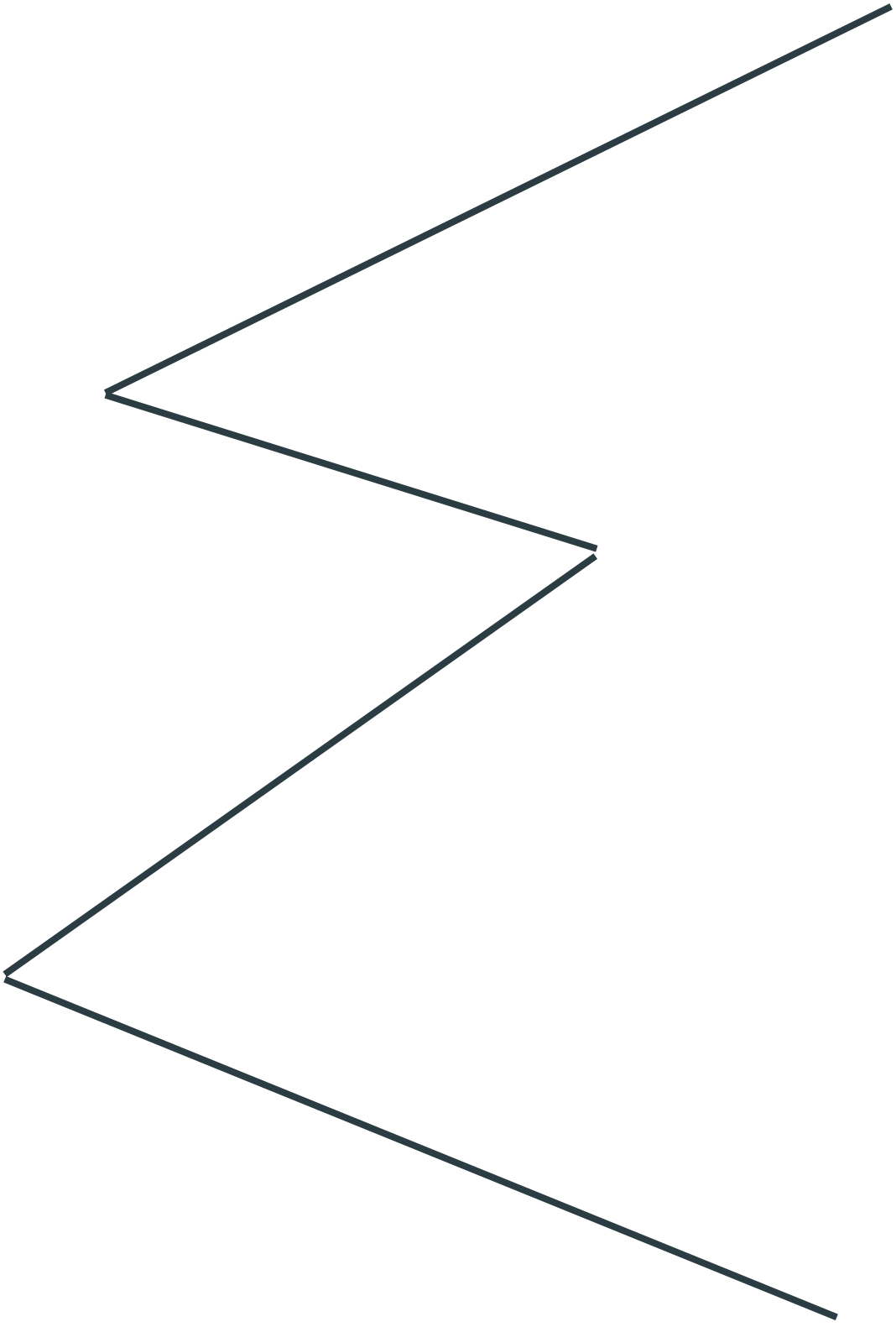
Assessment:
No formal assessment for this lesson

F**ormative Observational Data**
Keep observational notes about the following things:
How do students choose an appropriate tool to measure the paths?
Did the group measure with no gaps and overlaps between their units?
Did the group figure out which path is the longest?
Did they measure each path with the same units or different units?

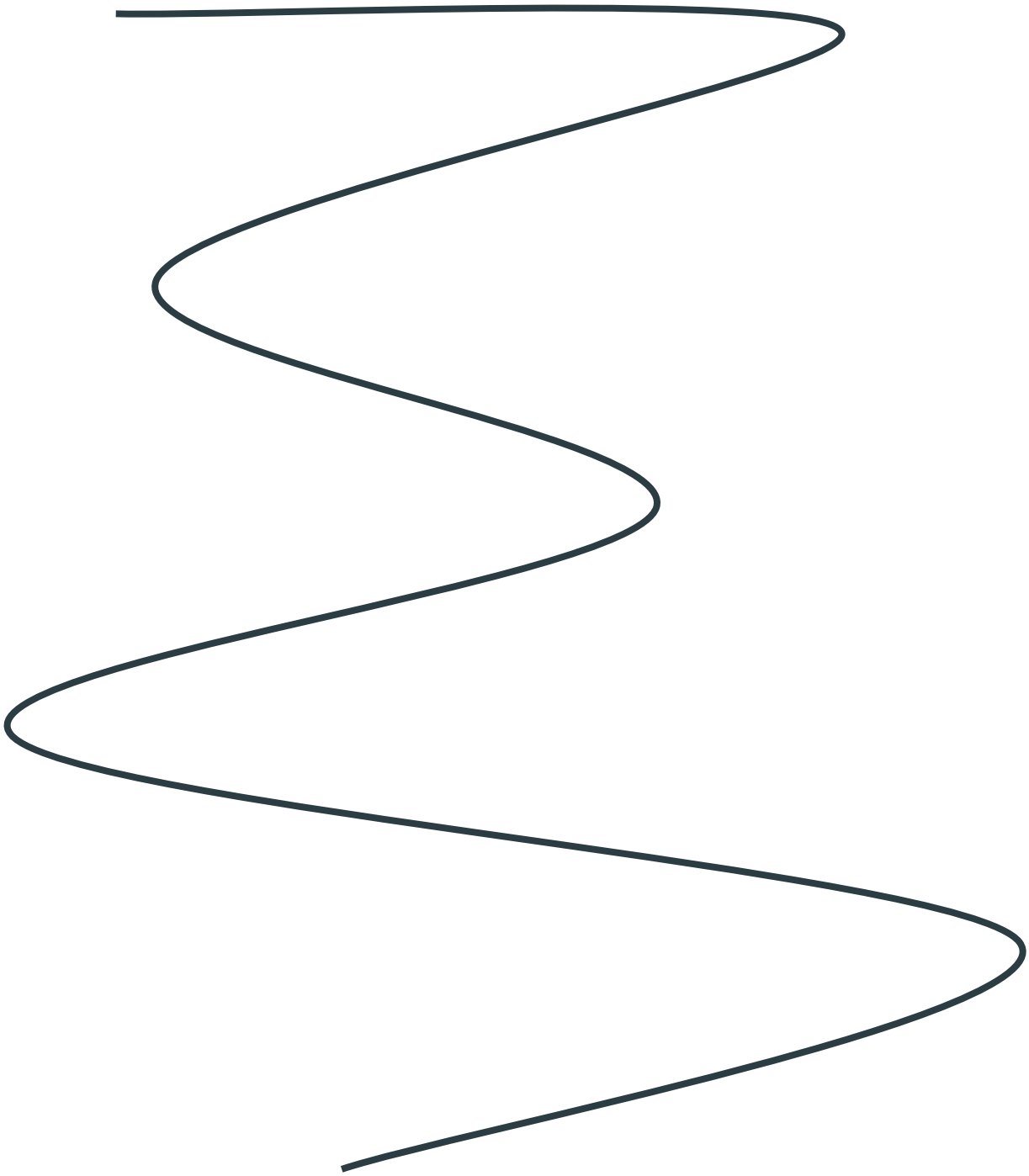
2nd grade Extension Formative Observational data questions to consider.

Did the group choose an appropriate tool and standard unit to measure the paths?
Did the group correctly measure the paths to find out which one was longer and shorter?
Did the group accurately find the difference between the two paths?

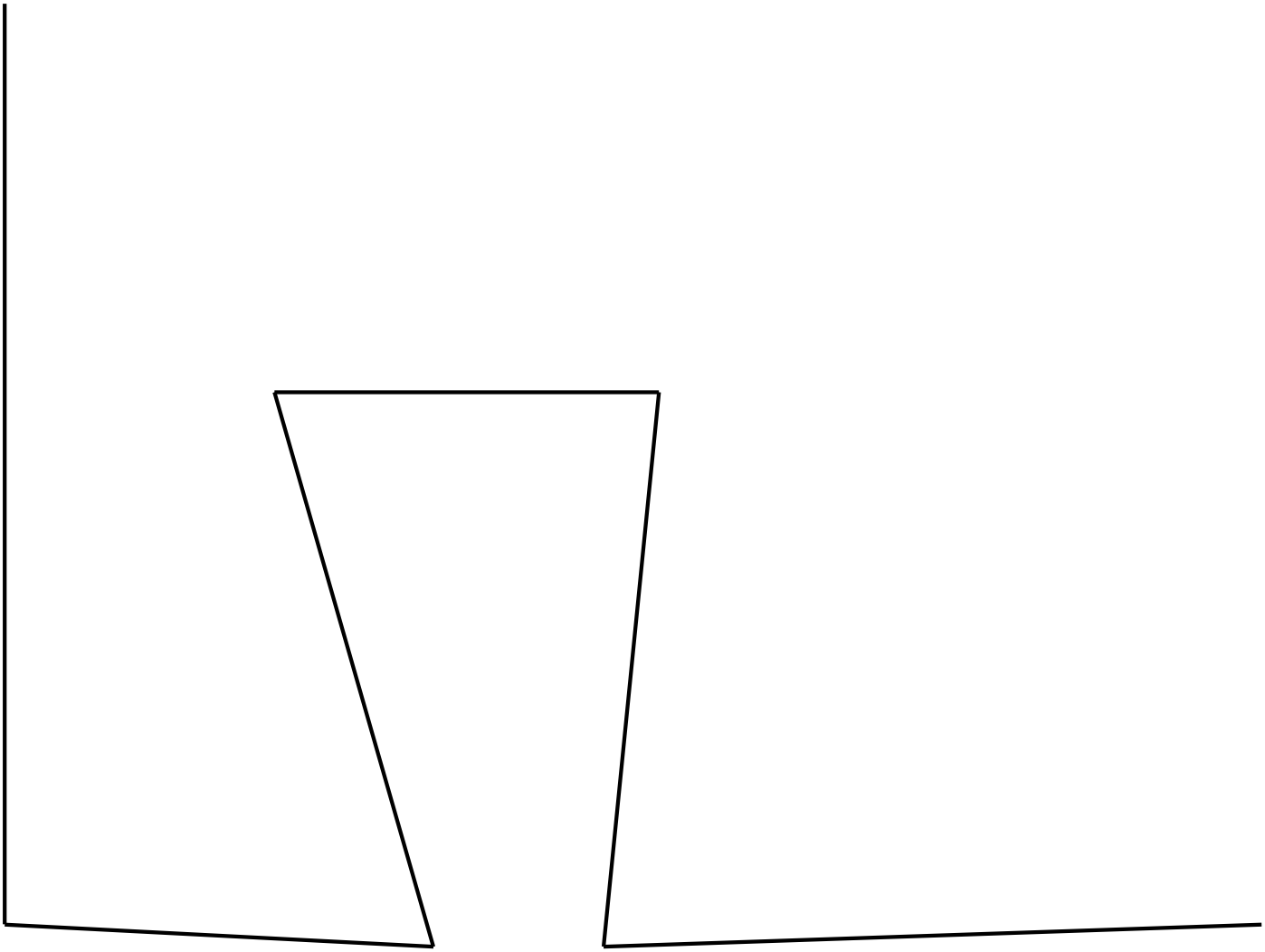
Hiking Trail A



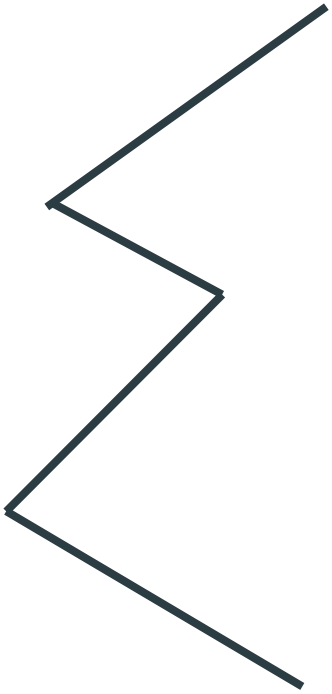
Hiking Trail B



Hiking Trail C

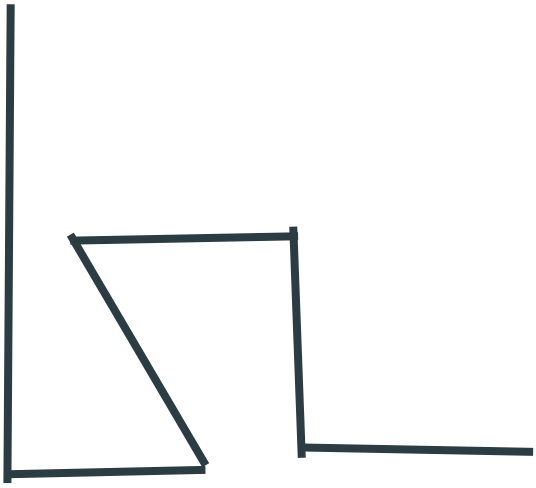


Hiking Trail A



Hiking Trail B

Hiking Trail C



Hiking Trail _____ is the longest.

We used _____ to measure the trails.