Performance Based Learning and Assessment Task

Finding a location for your kitchen island

I. ASSESSSMENT TASK OVERVIEW & PURPOSE:
Students will be asked to find the perfect place for an island in their kitchen or to determine if their already existing island is in the best place. Students will need to take measurements of their kitchen and layout on graph paper. Students will need to mark the location of the work triangle on graph paper (including sink, refrigerator, and the stove) and then develop a method for finding the center of this triangle. Students will be asked to plot ordered pairs on a coordinate plane, to use the slope formula, find the equations of perpendicular lines, and to solve a system of equations to find a point of intersection.

II. UNIT AUTHOR:
Kelly Blackwell, Floyd County High School, Floyd County Public Schools

III. COURSE:
Algebra I

IV. CONTENT STRAND:
Algebra

V. OBJECTIVES:
Students will create a layout of the kitchen on graph paper. Students will locate the center of the kitchen work triangle using algebraic methods. Students will create a display board to present their work.

VI. REFERENCE/RESOURCE MATERIALS:
Students will use a high school Algebra and Geometry text book available to them in their classroom. Students will use graph paper, straight edge, calculators, computers, markers, and scissors.

VII. PRIMARY ASSESSMENT STRATEGIES:
Students will be assessed on how well they portray the work triangle on graph paper and on the display board. Students will also be assessed on how neat and well organized their display relays the situation. Students will also be assessed on the quality and accuracy of work shown to support their final answer. Students will be assessed on how adequately they explain how they found the center of the work triangle.

VIII. EVALUATION CRITERIA:
Self assessments and teacher assessments are attached at the end of this document, as well as a benchmark of what students are expected to produce.

IX. INSTRUCTIONAL TIME:
This activity should take two 90-minute class periods.

How will you find the center of the work triangle in your kitchen?

Strand
Algebra

Mathematical Objective(s)
The goal of this activity is for students to apply algebraic methods to find the center of a triangle. Students need to find the best location for the kitchen island using the kitchen floor plan created by their measurements taken of their own kitchen including the kitchen sink, refrigerator and stove. Students will need to graph three ordered pairs. Depending on the method applied, student will need to find the slope between each pair of points. Students could then consider the slopes of perpendicular lines. Students will need to find the midpoint between two points using the midpoint formula or just visually using a ruler and graph paper. Student will need to find the equations of two lines if given a point and the slope. Students will need to solve a system of equations to find the point of intersection also known as the center of the triangle. Students will need to make a presentation on a poster board to display their findings.

Related SOLs

Algebra A.1 (algebraic expressions)

Algebra A.4f (multi-step equations)

Algebra A.6 (graphing linear equations)

Geometry G.3 (distance, slope formulas and parallel versus perpendicular slopes)

NCTM Standards

- Apply and adapt a variety of appropriate strategies to solve problems.
- Communicate mathematical thinking coherently and clearly to peers, teachers, and others.
- Write equivalent forms of equations, inequalities, and systems of equations and solve them with fluency – mentally or with paper and pencil in simple cases and using technology in all cases.

Materials/Resources
Students will need a copy of the activity sheet that follows. Students will need a straight edge and a graphing calculator to complete the task. Students will need various presentation materials depending on how they choose to present their findings. Possibilities may include poster board, markers, scissors, computers, printers, and magazines.

Assumption of Prior Knowledge

- Students should know how to plot points on a coordinate plane. Students should understand how to use the slope formula and the relationship between perpendicular lines and their slopes.
- Students need to be able to apply the midpoint formula or use a ruler to find the midpoint.
- Students should know how to find the equations of lines given a point and the slope.
- Students need to know how to solve a system of equations. The system necessary for this task should have two variables and two equations. Students could solve by the elimination or substitution method.

Introduction: Setting Up the Mathematical Task

In this task, the students will investigate finding the center of a work triangle in a kitchen. The three most used items in a kitchen are the sink, the stove, and the refrigerator. I would like students to find the optimal location for the island so that it is centered between the most frequently used kitchen items. The students will use two 90 minute blocks to complete the task as well as prepare a display of what they discovered and the algebra they used to discover it. The students will be grouped using diversified ability groups. The activity sheet guides students through drawing the kitchen layout on graph paper and having them consider ways to find the location for the island. After the activity sheet is complete, students should make a display of the kitchen diagram on poster board with drawings or cuts outs from magazines or clipart printed out. Graph paper or grid lines should be part of the display.

Student Exploration

Student/Teacher Actions:

- Students should be in groups of different abilities, chosen by the teacher. Groups of three would probably work best. All students should complete the measurements of their kitchen for homework. The group can decide which layout they would like to pursue as the group project. Student groups should be following the activity sheet and completing the questions posed there.
- Teachers should be walking around observing groups and answering questions and providing guidance where necessary.
- Teachers should be encouraging students to work together and to check each other's work. These calculations are easily done incorrectly.
- Students may believe they can find the answer simply by visually estimating. Remind students that all work needs to mathematically based. Encourage them to check their answer by using the distance formula to check the distance between their center and the outlying points.
- Students may need to utilize a Geometry textbook or an online source regarding finding the center of a triangle. Here is a great website that I recommend. http://www.mathsisfun.com/geometry/triangle-centers.html Students don't need to understand the vocabulary to do the project but it could provide an enrichment opportunity.
- Students may arrive at the answer very quickly. If a group does this, encourage them to develop a solution for three general points (0,a), (b,0), and (c,d). The process is the same and students could apply it to any kitchen work triangle as long as two of the items were located along the same wall.
- Students could use Geogebra or Geometer's Sketchpad to solve the problem as well if time and resources allowed. Geogebra is a free software that can be found at http://www.geogebra.org/. Geometer's Sketchpad could be found at http://www.dynamicgeometry.com/ but is not free software.

Monitoring Student Responses

- Students will be discussing in their groups how to find the center of the triangle. Students may consider estimating the center by averaging the ordered pair values. Students may consider using a compass and constructing a circle that passes through all three ordered pairs, where the center of the circle would be the center of the triangle.
- Each student should be contributing ideas to the task and be an active participant in solving the problem and constructing the display board.
- If students have no ideas on how to find the center of the work triangle, encourage them to do some research online regarding the centers of triangles.
- Students should be recording each step on the original coordinate plane drawing to give them a visual idea of what they are doing and why the process gives the answer their looking for.
- If students are having trouble with a particular algebraic portion of the task, the teacher may need to show an example of that type of problem to the group in order to assist.
- If students are moving quickly through the task, the teacher could ask them to solve another problem like this, but with the stipulation that no two of the kitchen items are on the same wall.
- If students are moving quickly though the task, the teacher may ask students to generalize the problem to any three non-collinear points.
- If students are moving quickly through the task, the teacher may ask students to study the equation of circles and then find the equation of the circle that passes through all three points.

Assessment List and Benchmark

Students will be assessed on their correct completion of the activity sheet as well as their display board regarding their findings. The benchmark and answer key is below and each question has a detailed point value. The display board will use the rubric attached to determine the student's score for that portion of the task. Each task, activity sheet and display board, is worth 10 points. Teachers can decide how much weight they would like to place on the activity portion versus the presentation portion of the task.

Performance Assessment Task – Algebra Names: _____
"Find the location for your kitchen island" Date: _____ Block: _____

Find the optimal location for an island in your kitchen. If you already have a kitchen island, determine if its current location is the best possible place for it. The island needs to be in close proximity to all of the important points in your kitchen, namely the kitchen sink, stove, and refrigerator.

1. Measure out your kitchen at home. Make sure to detail the total dimensions of your kitchen as well as the location of your stove, refrigerator, and kitchen sink. Use graph paper to create a scaled drawing of your kitchen floor plan on the grid. (2pts)

2. Label each important point in the kitchen with an ordered pair. The important points to label in the kitchen are the sink, refrigerator and the stove. If these points are connected, a kitchen work triangle is formed. You're trying to find the best place to put the island to make it easily accessible from these points. Provide at least two ideas on what you think will be the best way to determine the location for your kitchen island. (3pts)

3. As these three locations, sink, refrigerator, and stove, create a triangle, there are mathematical methods that can be used to help us find the best location. Using your thoughts above and the fact we have a triangle, find the optimal location using graph paper. What is the formal name of this location? Show all your work using the graph paper. Make sure to provide a written explanation on how you found the location as well. (3.5 pts)

4. Check the distances between each important location in the kitchen and your island location choice. Provide these values on your choice board. (1.5 pts)

5. Create a display board with the given supplies. Your board must display the problem situation and you must show your work regarding how you solved the problem. The rubric detailing how your grade will be determined will be given out as well. Follow each piece of the rubric carefully. (10 pts)

Rubric for the Display Board

The display is neatly organized.	0 – No thought seems to have been given to the organization of the display board.	1- Some parts have been thought out, but some parts seem to have been rushed or misplaced.	2 – The display board has been well organized and easily read.
The display included the following elements: -problem statement -graph of the work triangle using grid lines -clearly marked the important pieces of the problem (as detailed on the activity sheet) -work shown to solve the problem -answer to problem statement	0 – one or none of the elements are present	1 – two or three elements are present	2 – all four of the required elements are present
The display board is visually pleasing by including the following: -board is neat using type for work or neat handwriting -color is incorporated into the board -board is easy to follow	0 – board is messy and little effort was given to enhance display	1 – board is somewhat disheveled and difficult to read.	2 – board is visually enhanced with color or clipart and is easy to read and understand.
The display board accurately displays work necessary to solve with the correct answer.	0 – the work is incomplete and/or the answer is incorrect	1 – the work is present but has errors and/or the answer is incorrect	2 – the work is correct and present as well as the answer
Group members were on task and each member contributed to the display board.	0 – group member(s) were repeatedly asked to stay on task	1 – group member(s) had to be redirected infrequently and/or project was not a product of all members	2 – all group members worked diligently without teacher direction

Portion of Rubric Being Assessed	Self – Assessment	Teacher Assessment
The display is neatly organized.		
The display included the following elements: -problem statement -graph of the work triangle using grid lines -clearly marked the important pieces of the problem (as detailed on the activity sheet) -work shown to solve the problem -answer to problem statement		
The display board is visually pleasing by including the following: -board is neat using type for work or neat handwriting -color is incorporated into the board -board is easy to follow		
The display board accurately displays work necessary to solve with the correct answer.		
Group members were on task and each member contributed to the display board.		
TOTALS		

Student Grade _____

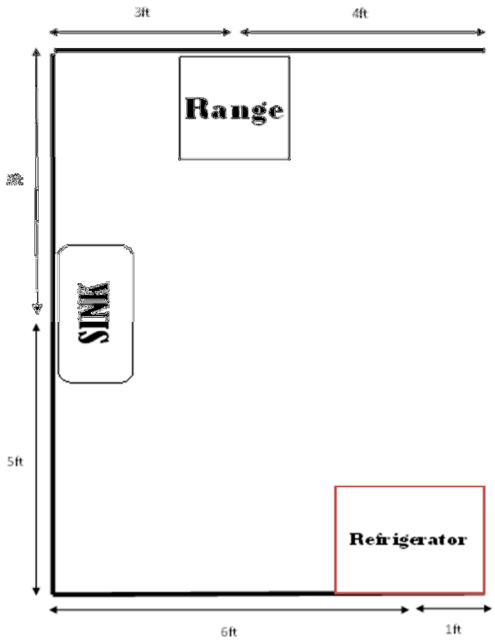
Performance Assessment Task – Algebra
"Find the location for your kitchen island"

Names: _____KEY_____
Date: _____ Block: _____

Find the optimal location for an island in your kitchen. If you already have a kitchen island, determine if its current location is the best possible place for it. The island needs to be in close proximity to all of the important points in your kitchen, namely the kitchen sink, stove, and refrigerator.

1. Measure out your kitchen at home. Make sure to detail the total dimensions of your kitchen as well as the location of your stove, refrigerator, and kitchen sink. Use graph paper to create a scaled drawing of your kitchen floor plan on the grid.

Graph paper is attached with possible sketches of the kitchen. (2pt)



2. Label each important point in the kitchen with an ordered pair. The important points to label in the kitchen are the sink, refrigerator and the stove. If these points are connected, a kitchen work triangle is formed. You're trying to find the best place to put the island to make it easily accessible from these points. Provide at least two ideas on what you think will be the best way to determine the location for your kitchen island.

Possible ordered pairs to be used…(3pt)
Refrigerator (6, 0)
Sink (0, 5)
Range (3, 10)

Option 1: Circumcenter
Students can find the circumcenter of the kitchen work triangle. This option will find the point that is equidistant from the given locations for the refrigerator, sink, and range. Students will need to construct perpendicular bisectors to each side of the triangle. The equations of the perpendicular bisectors will create a system of equations to be solved to find the circumcenter of the triangle.

Option 2: Centroid
Students can find the centroid of the kitchen work triangle. This option will place the island closest to the sink and furthest away from the refrigerator. Students will need to find the midpoint of each side of the work

triangle then find the equations of the medians. The centroid is obvious if the ordered pairs used are the values above. A system of equations is not necessary in this option.

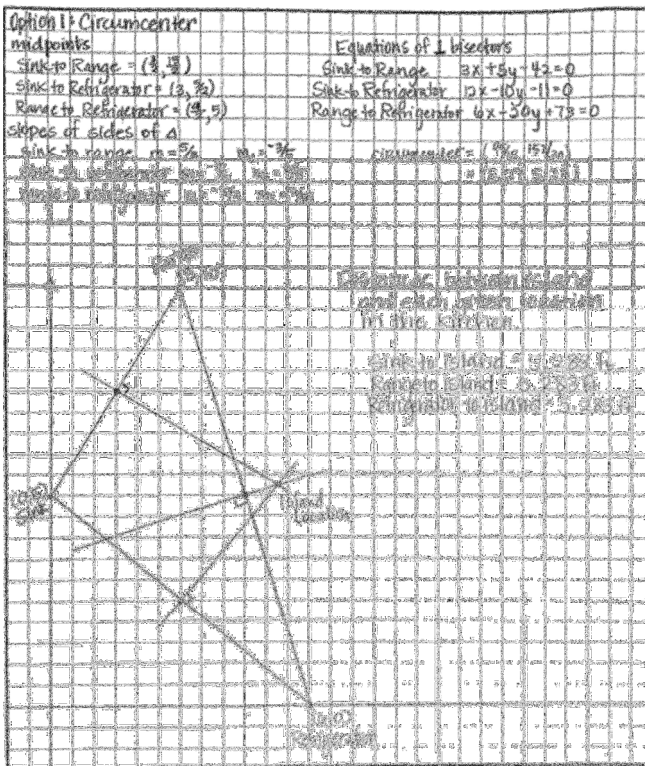
Other options are possible to find a center of the work triangle. Students will need to support their work with mathematical ideas. The orthocenter does not work in the context of this problem. The point would be outside the dimensions of the kitchen.

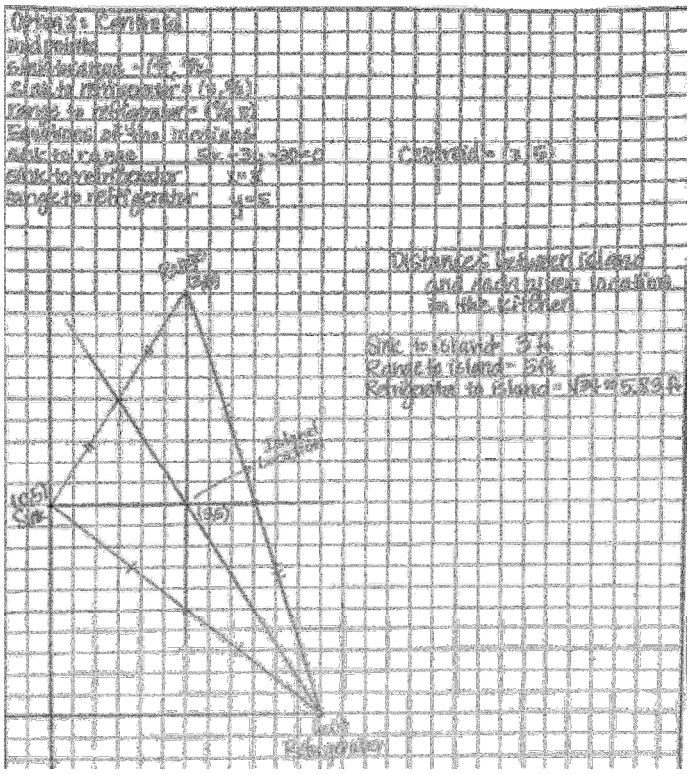
3. As these three locations, sink, refrigerator, and stove, create a triangle, there are mathematical methods that can be used to help us find the best location. Using your thoughts above and the fact we have a triangle, find the optimal location using graph paper. What is the formal name of this location? Show all your work using the graph paper. Make sure to provide a written explanation on how you found the location as well.

Possible work for the two options detailed above is included below. (3.5pt)

4. Check the distances between each important location in the kitchen and your island location choice. Provide these values on your choice board.

Possible work for the two options detailed above is included below. (1.5pt)



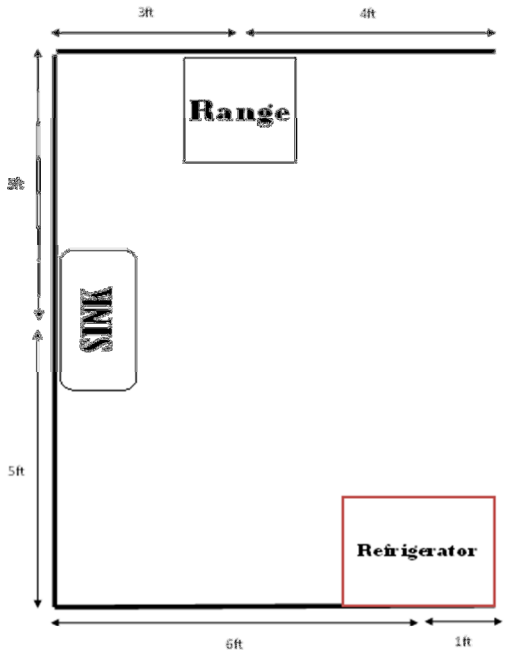


5. Create a display board with the given supplies. Your board must display the problem situation and you must show your work regarding how you solved the problem. The rubric detailing how your grade will be determined will be given out as well. Follow each piece of the rubric carefully.
Sample display board follows. (10pt)

Sample Display Board

Mrs. Blackwell's Kitchen Island Location

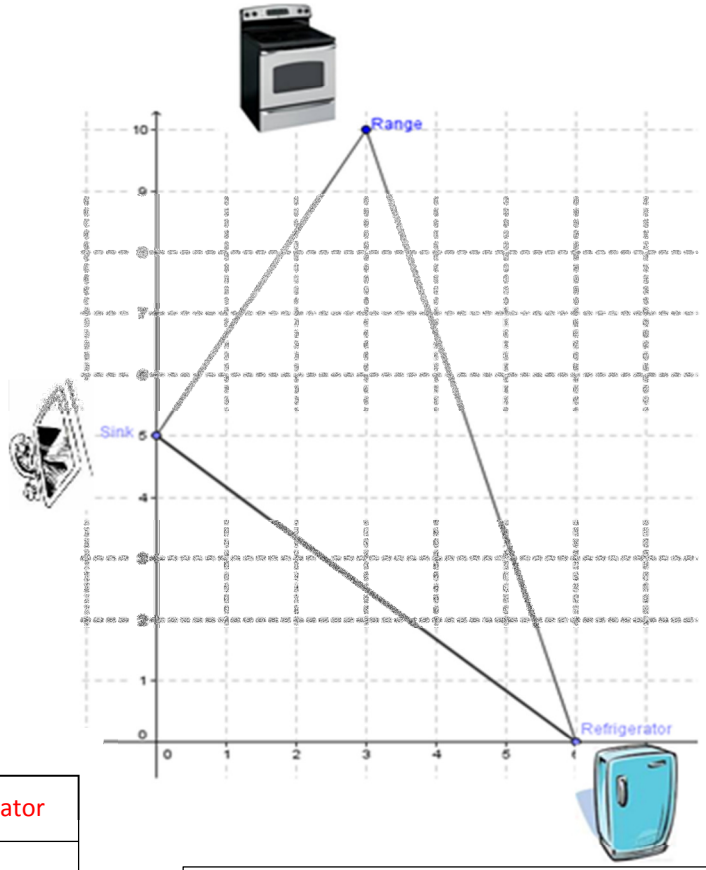
The island needs to be in the optimal location in relation to the kitchen sink, range, and refrigerator.



Possible Location for the Island

$\left(\frac{95}{18}, \frac{157}{30}\right)$

$(5.2\overline{7}, 5.2\overline{3})$



Sample Work

	Sink to Range	Sink to refrigerator	Range to refrigerator
Midpoints of each side of triangle	$\left(\frac{3}{2}, \frac{15}{2}\right)$	$\left(3, \frac{5}{2}\right)$	$\left(\frac{9}{2}, 5\right)$
Slopes of the sides of the triangle	5/3	-5/6	-10/3
Perpendicular Slopes	-3/5	6/5	3/10
Equations of Perpendicular Bisectors	3x+5y-42=0	12x-10y-11=0	6x-20y+73=0

Distance between the island and each important point in kitchen…

Sink – 5.283 ft

Range – 5.283 ft

Refrigerator – 5.283 ft