Performance Based Learning and Assessment Task

How do I Create a Scaled Model of a Full-Sized Basketball Court?

I. ASSESSSMENT TASK OVERVIEW & PURPOSE:

Students will apply their knowledge of distances, polygons, circles, and scale factors to accurately build a real life model of a basketball court.

II. UNIT AUTHOR:

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III. COURSE:

Geometry

IV. CONTENT STRAND:

Geometry G.3 ,Geometry G.11, Geometry G.14

V. OBJECTIVES:

Students will use their knowledge of measurement, ratios, circle constructions and properties of circles to:

- Measure a full-sized basketball court and record their measurements on a basketball court diagram.
- Create a scaled drawing of a model basketball court that is 48" long.
- Analyze and answer various questions concerning scale factor, properties of circles, slopes, midpoint, parallel and perpendicular lines, and symmetry.

VI. REFERENCE/RESOURCE MATERIALS:

Students will use a geometry textbook, tape measure, writing utensils, compass, straight edge measuring tools, calculators, loose leaf paper/printed computer paper, graph paper, scissors, tracing paper, large sheet paper, and the high school gymnasium.

VII. PRIMARY ASSESSMENT STRATEGIES:

Students will be assessed on how accurate their measurements of the real sized court are. They will be assessed on whether they show necessary work for the calculations, as well as the neatness of their math work, and their final basketball court model. They will be critiqued on how clear and accurately they answer questions, and how well they explain their reasoning in the "Geometrical Analysis" section.

VIII. EVALUATION CRITERIA:

Self-assessments/ teacher rubrics are used

IX. INSTRUCTIONAL TIME:

The measurements, conversions, and model drawing should take two 90-minute class periods. The completion of the "Geometrical Analysis" will take 1 additional class period.

How Do I Create a Scaled Model of a Full-Size Basketball Court?

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Mathematical Objective(s)
Students will be able to: 1)Measure and record distances, 2)Calculate measurements using a common ratio, 3)Convert distances between feet, inches, and 16^{ths} of an inch, 4)Understand basic properties of circles and semi- circles, involving radius, diameter, and the application of constructing circles with a compass, 5)Construct a neatly finished model accurately drawn to scale, 6)Analyze and communicate the relationship between ratios of distances and ratios of areas, 7)Apply knowledge of symmetry and reflections to the replication of half a basketball court to a full sized court

Materials/ Resources
Students will use: 1)geometry textbook, 2)tape measure, 3)writing utensils, 4)"Recording Measurements Chart for Full-Sized Court" and "Conversion Chart,", 5)calculator, 6)tracing paper, large sheet of paper, graphing paper, 7)scissors, 8)straight edge measuring tools

Assumption of Prior Knowledge

- Students should have a basic understanding of how to use a tape measure, compass, straight edge measuring tools, calculators, and scissors
- Students should have the basic concept of circles and the relationship between radius and diameter, as well as be able to calculate the area and circumference of a circle
- Students should be able to calculate a scale factor and apply it to respective measurements

Introduction: Setting Up the Mathematical Task

The teacher will ask the students if they have ever seen a smaller model of a larger real life structure. The teacher will allow students to think and then pick students to share their experiences with a scale factor model to the whole class. The teacher will then give an example of a model (such as VCU building a practice facility for their basketball program and that there will be a model to show the public what their facility will look like once it is completed).

The teacher will explain to the class that student groups will replicate a high school sized basketball court, by drawing a precise model on a large sheet of paper. The teacher will project an expectation of what the model might look like (without measurements written in).

Students will be placed into groups of 2 (one group of 3 if there is an odd number) by the teacher to ensure positive working environments. Each group will be given the needed materials in order to complete the project. In addition, each group will get a "Recorded Measurements Chart for Full-Sized Court," a second "Recorded Measuring Chart for Scaled Model" for the scaled down version, a "Conversion Chart," a "Self-Assessment," and a "Geometric Analysis" sheet to be completed.

Students will be told by the teacher that their measurements must be precise and not approximated. They will be given one, 90 minute, class period to record their measurements on the "Recorded Measurements Chart for Full-Sized Court" and fill out the "Conversion Chart." The students will then use the next class period to complete the "Recording Measurements Chart for Scaled Model" with scaled down measurements on it, draw their model on a large sheet of paper, and tracing paper. Each group will complete a "Self-Assessment" based on their model. In addition, the students will then use their tracing paper with graph paper underneath it (graph paper will be used for a specific question in the analysis), along with both of the "Recording Measurements Charts, and "Conversions Chart" to thoroughly answer the questions on the "Geometric Analysis."

Student Exploration

Small Group Work:

Recording Measurements Chart for Full-Sized Court and Conversion Chart:

The teacher will take the class to the gymnasium. Each group will bring their "Recording Measurements Chart for Full-Sized Court," "their "Conversion Chart," a measuring tape, and writing utensil. The "Conversion Chart" will help show the students what measurements are necessary to find. Each group will measure. Groups will record their findings ONLY in column one (Full Size ft) of the "Conversion Chart" and also on their "Recording Measurements Chart for Full-Sized Court". Once groups are finished, the class will go back to the classroom and complete the other three columns of their "Conversion Chart

A whole class discussion should take place the last 5 minutes of class. Teacher should ask, "What was or were the most difficult part(s) of the day? What strategies worked well to be most efficient within your group?"

Recording Measurements Chart #2 and Model Drawing-

The teacher will provide each group a "Recording Measurements Chart for Scaled Model" to fill out with the scaled down model measurements listed. To clarify, the groups will be copying the measurements from the last column of their "Conversion Chart" onto the second "Recording Measurements Chart for Scaled Model" which is on an 8 ½ by 11 sheet of paper. This will help students more easily visualize what their model will look like.

Students will then take the large sheet of paper given to them and start creating their scaled down full court model from scratch. The large sheet of paper given will be larger than what is necessary to complete the model and may need to be cut later at the very end.

The groups will use their “Recording Measurements Chart for Scaled Model” to construct their model. Students will also use straight edge measuring tools, a compass for the circles and semi-circle. It is important to note that students should use pencil for their model drawing.

The teacher will instruct the students that they have the option of constructing only half the court (other than the center circle which can be drawn in entirety using a compass), and explain that they will use their tracing paper to copy and then replicate an exact image for the other half of the court. Once the model is completed, the students will neatly and clearly label every measurement category from the furthest left column of their “Conversion Chart” titled “Specific Measurement. The teacher will encourage students to use key terms such as, radius, parallel, perpendicular, semi- circle, reflection, and symmetry. If the model looks perfect, the group can start working on their “Self- Assessment.”Once all groups are done, the class can spend the last few minutes of class to compare the models amongst the different groups.

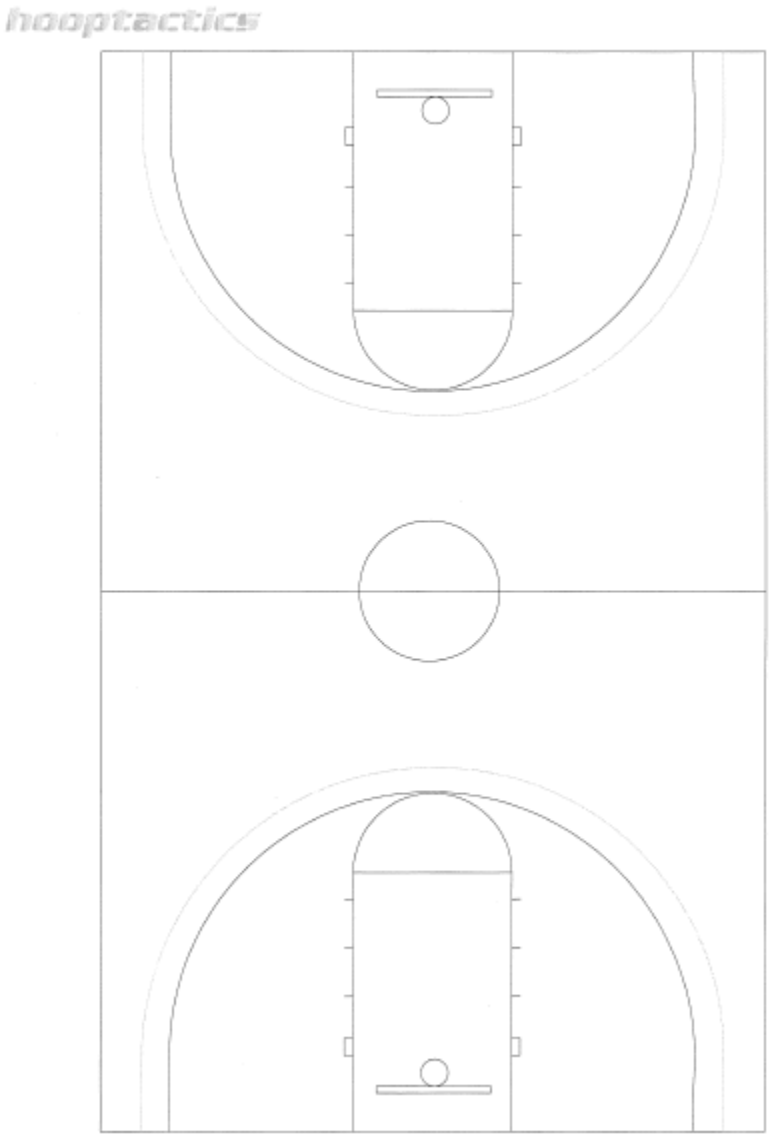
Geometric Analysis-
Groups will use all of the documents created up to this point in order to answer the questions on the “Geometric Analysis.” The teacher should encourage the students to use key geometric terms within their answers.

Assessment List and Benchmarks

Students will complete their “Recording Measurements Chart for Full-Sized Court,” “Conversion Chart,” “Recording Measurements Chart for Scaled Model,” “Model,” “Tracing Model,” “Self-Assessment,” and “Geometric Analysis.” The self- assessment will also act as the rubric for the teacher when assessing the students’ work.

Names:_____

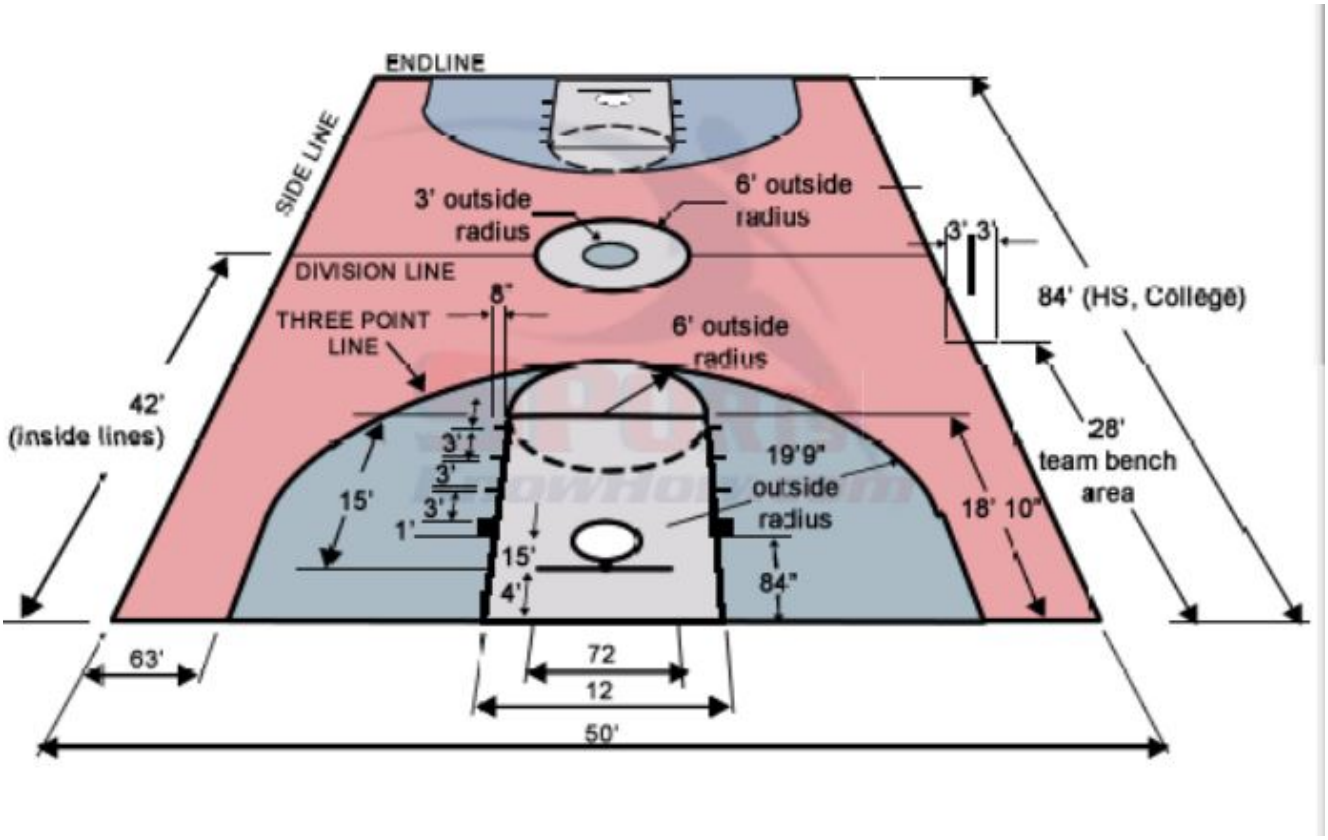
Recording Measurements Chart for Full-Sized Court



Reference:

http://www.hooptactics.net/freesite/coachstrategies/gamepreparation/pdffiles/diagrams1fullcourtsusa.pdf

Recording Measurements Chart for Full-Sized Court: Benchmark



Reference:

http://www.sportsknowhow.com/basketball/dimensions/high-school-basketball-court-dimensions.html

Conversion Chart ** (round numbers to 4 decimal places when necessary)**

* MUST SHOW WORK on separate sheet and attach it* 1 pt for each box (41 pts)

Scale Factor = _____

Specific Measurement	Full Size (ft)	Full Size (in)	Model Size (in)	Model Size (16^{th} of an inch) round to nearest 16^{th} of an inch **Multiply column 3 by 16
Length of court				
Length of half-court				
Width of court				
From sideline to 3pt line (in corner)				
From baseline to where 3pt line starts to curve				
Diameter of center-court circle/radius				
Diameter of free throw line circle/radius				
Width of "the lane"				
Width of backboard parallel to baseline	6 ft			
Diameter of the rim/radius	1.5 ft/0.75 ft			
From baseline the back of the backboard	4 ft			
From front of the backboard to the edge of the outer rim (closest to the free throw line)	2 ft			
The piece of metal between the backboard and the back of the rim	0.5 ft			
From the front of the backboard to the free throw line	15 ft			
From baseline to free throw line				
Distance from center of the rim to the 3pt line	19.75 ft			

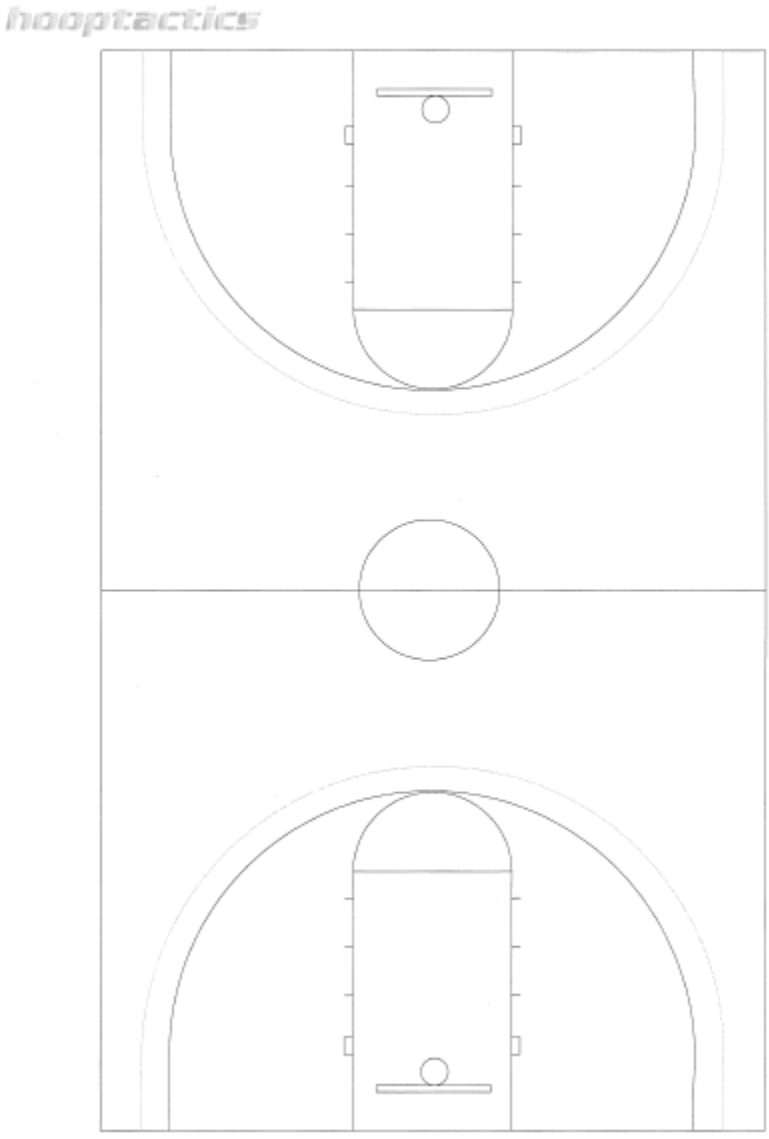
Conversion Chart ** (round numbers to 4 decimal places when necessary)**

* MUST SHOW WORK* on separate sheet and attach it* **Scale Factor =** 21: 1 (1008/48) = 21

Specific Measurement	Full Size (ft)	Full Size (in)	Model Size (in)	Model Size (16^{th} of an inch) round to nearest 16^{th} of an inch Multiply column 3 by 16
Length of court	84 ft	1008 in	48 in	48 0/16 in
Length of half-court	42 ft	504	24 in	24 0/16 in
Width of court	50 ft	600 in	28.57142857 in	0.57142857 * 16 = 9.14 28 9/16 in
From sideline to 3pt line (in corner)	5.25 ft	63 in	3 in	3 0/16 in
From baseline to where 3pt line starts to curve	5.25 ft	63in	3 in	3 0/16 in
Diameter of center-court circle/radius	12 ft/6 ft	144 in/ 72 in	6.857142857 in 3.428571429 in	0.857142857 * 16 = 13.71 d = 6 7/8 in r = 3 7/16 in 6/2= 3 (7/8)/2 = 7/16
Diameter of free throw line circle/radius	12 ft/ 6 ft	144 in/ 72 in	6.857142857 in 3.428571429 in	0.857142857 * 16 = 13.71 d = 6 7/8 in r = 3 7/16 in 6/2= 3 (7/8)/2 = 7/16
Width of "the lane"	12 ft	144 in	6.857142857 in	0.857142857 * 16 = 13.71 6 7/8 in
Width of backboard parallel to baseline	6 ft	72 in	3.428571429 in	0.428571429 * 16 = 6.857 3 7/16 in
Diameter of the rim/radius	1.5 ft/0.75 ft	18 in/ 9 in	0.8571428571 in 0.4285714286 in	0.8571428571 * 16 = 13.72 d = 7/8 in r = 7/16 in
From baseline to the back of the backboard	4 ft	48 in	2.285714286 in	0.285714286* 16 = 4.57 2 5/16 in
From front of the backboard to the edge of the outer rim (closest to the free throw line)	2 ft	24 in	1.142857143 in	0.142857143 = 2.29 1 1/8 in
The piece of metal between the backboard and the back of the rim	0.5 ft	6 in	0.2857142857 in	0.2857142857* 16 = 4.58 5/16 in
From the front of the backboard to the free throw line	15 ft	180 in	8.571428571 in	0.571428571 * 16 = 9.14 8 9/16 in
From baseline to free throw line	18.8333	226 in	10.76190476 in	0.76190476 * 16 = 12.19 10 ¾ in
Distance from center of the rim to the 3pt line	19.75 ft	237 in	11.28571429 in	0.28571429 * 16 = 4.57 11 5/16 in

Names:_____

Recording Measurements Chart for Scaled Model

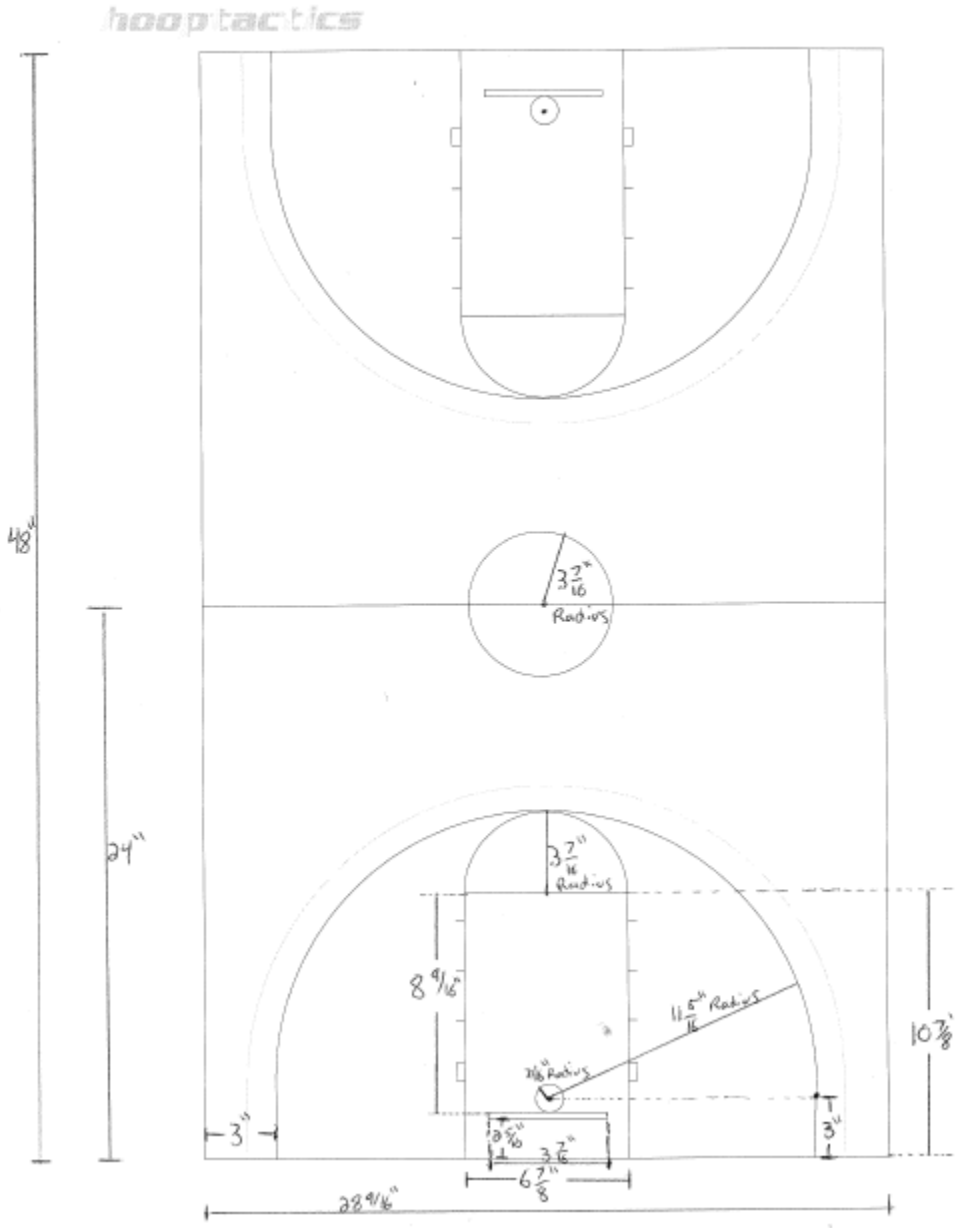


Reference:

http://www.hooptactics.net/freesite/coachstrategies/gamepreparation/pdffiles/diagrams1fullcourtsusa.pdf

Names:____BENCHMARK

Recording Measurements Chart for Scaled Model



Reference:

http://www.hooptactics.net/freesite/coachstrategies/gamepreparation/pdffiles/diagrams1fullcourtsusa.pdf

Performance Assessment Task – Geometry Names_____

"*How Do I Create a Scaled Model of a Full-Sized Basketball Court?"*

Self-Assessment- Final Model **21 Possible Points**

	3 points	2 points	1 point
Model neatness	Model is crisp and neat, no non- numeric errors	Most lines are straight and angles appear to be correct	More than a few lines are not crisp, and court isn't an exact rectangle
Perimeter measurements	The perimeter has the correct measurement, and lines are straight	The perimeter is within 1/8 of an inch of being correct, lines straight	The perimeter has more than 1/8 inch of error, lines aren't straight
Circle radii	Radii are exact, with fluent circle, and make with a compass	Radii are within 1/8 of an inch of being correct and mostly fluent circle, attempted with compass	Radii have more than 1/8 inch of error, with choppy circle, poor attempt with compass or lack there of
3 point line	Perfectly measured radius and fluent semi circle drawn using a compass	Within 1/8 of an inch of being correct, mostly fluent semi circle, attempted use of compass	More than 1/8 of an inch of error, choppy semi circle, poor use of compass or lack there of
All other measurements	All are measured precicsel	Less than two errors of 1/8 inch	More than 1 error of 1/8 of an inch
Labels	Measurements are labeled correctly and are clear	No more than 1 measurement is labeled poorly	2 or more measurements are labeled poorly
Symmetry	When folded at the half court line, the model lays perfectly on top of one another	When folded at half court, there is no more than 1/8 inch of error	When folded at half court, there is more than 1/8 inch of error
Total:			

Performance Assessment Task – Geometry Names_____

"*How Do I Create a Scaled Model of a Full-Sized Basketball Court?"*

Teacher Assessment- Final Model **21 Possible Points**

	3 points	2 points	1 point
Model neatness	Model is crisp and neat, no non- numeric errors	Most lines are straight and angles appear to be correct	More than a few lines are not crisp, and court isn't an exact rectangle
Perimeter measurements	The perimeter has the correct measurement, and lines are straight	The perimeter is within 1/8 of an inch of being correct, lines straight	The perimeter has more than 1/8 inch of error, lines aren't straight
Circle radii	Radii are exact, with fluent circle, and make with a compass	Radii are within 1/8 of an inch of being correct and mostly fluent circle, attempted with compass	Radii have more than 1/8 inch of error, with choppy circle, poor attempt with compass or lack there of
3 point line	Perfectly measured radius and fluent semi circle drawn using a compass	Within 1/8 of an inch of being correct, mostly fluent semi circle, attempted use of compass	More than 1/8 of an inch of error, choppy semi circle, poor use of compass or lack there of
All other measurements	All are measured precicsel	Less than two errors of 1/8 inch	More than 1 error of 1/8 of an inch
Labels	Measurements are labeled correctly and are clear	No more than 1 measurement is labeled poorly	2 or more measurements are labeled poorly
Symmetry	When folded at the half court line, the model lays perfectly on top of one another	When folded at half court, there is no more than 1/8 inch of error	When folded at half court, there is more than 1/8 inch of error
Total:			

Names:_____

Geometric Analysis (Each question is worth 4 points)

1. Explain how you calculated the scale factor for this project. (Use numbers and words)

2. What type of symmetry does your model have? (point, line, both, or neither) Explain your answer.

3. What is the ratio of the radii of the center court circle from the full sized court, to the model court? Prove your answer with numbers.

4. What is the ratio of the areas of the center court circles in the full sized court compared with the model court? Prove your answer with numbers.

5. What is the ratio of the areas of "the key" EXCLUDING the semi-circle between the free throw line and the 3 point line when comparing the full sized court to the model court? Prove your answer with numbers

6. What is the pattern for #3, #4, and #5? How else could you have found this number without dividing?

7. What has a bigger area, “the key” (including the semi-circle connecting to the 3 point line, or the other total space within the 3 point line not in “the key?” Show your work to prove your answer.

8. If a standard basketball hoop as a height of 10 feet, what would the height have been if we included it in our model? (Give your answer in inches rounded to the nearest 16^{th} of an inch)

9. If you put graph paper under your tracing paper and make the very center of the center court circle your origin, how can you prove that the sidelines are parallel to each other? Also, how can you prove that the baseline is perpendicular to the sideline? (No need for numbers here, but rather describe in detail how you would prove these two relationships)

Names:_____BENCHMARK___

Geometric Analysis

1. Explain how you calculated the scale factor for this project. (Use numbers and words)

I knew that the full length of the full sized court was 1,008 inches and the model length needed to be 48 inches so I divided 1,008/48 = 21 so the scale factor for the full sized court to the model court is 21:1

2. What type of symmetry does your model have? (point, line, both, or neither) Explain your answer.

The court has both point and line symmetry. The half court line provides line symmetry, as does if we drew a line cutting through from basket to basket running perpendicular to the baselines. The court has point symmetry about the center court.

3. What is the ratio of the radii from the full sized court, to the model court? Prove your answer with numbers.

The radii in the full sized court were both 72 inches. The radii in the model were 3.428571429.

72/3.428571429 = 21 so the ratio is still 21:1 this is because radii are lengths so the ratio will be the same

4. What is the ratio of the areas of the center court circles in the full sized court compared with the model court? Prove your answer with numbers.

Full Sized court center circle area = pi*r^2 = 3.14 *72^2 = 16,277.76 in^2

Model sized court center circle area = 3.14 * 3.428571429^2 = 36.91 in^2

16,277.76/36.91 = 441 so the areas have a ratio of 441:1

5. What is the ratio of the areas of "the key" EXCLUDING the semi-circle between the free throw line and the 3 point line when comparing the full sized court to the model court? Prove your answer with numbers

Full sized court key area = bh = 144" * 226 = 32,544

Model sized court key area = 6.857142857 * 10.76190476 = 73.80

32,544 / 73.80 = 441 so the areas have a ratio of 441:1

6. What is the pattern for #3, #4, and #5? How else could you have found this number without dividing?

If distances/lengths have a ratio of 21:1 then areas will have a ratio of 21^2 : 1^2 = 441:1

7. What has a bigger area, "the key" (including the semi circle connecting to the 3 point line, or the other total space within the 3 point line not in "the key?" Show your work to prove your answer.

Using the measurements from the full sized court, the area of the key = bh + ½ pi *r^2

= 144" * 226 + ½ * 3.14 *72^2 = 40,682.88 in ^2

Total area within the 3 pt line = bh below the center of the rim + ½ pi* r^2 of semi circle above center of rim within the 3 pt line = (600 – 63*2)(63) = 29,862 + ½ *3.14 * 237^2 = 88,185.33

29,862 + 88,185.33 = 118,047.33 118,047.33 – 40,682.88 = 77,364.45 > 40,682.88

So the area within the 3 pt arc outside of the key has a bigger area.

8. If a standard basketball hoop as a height of 10 feet, what would the height have been if we included it in our model? (Give your answer in inches rounded to the nearest 16^{th} of an inch)

10 ft * 12 = 120 inches for the full sized court height. 120/21 = 5.714285714

0.714285714 * 16 = 11.43 so the model sized hoop would have a height of 5 11/16 inches

9. If you put graph paper under your tracing paper and make the very center of the center court circle your origin, how can you prove that the sidelines are parallel to each other? Also, how can you prove that the baseline is perpendicular to the sideline? (No need for numbers here, but rather describe in detail how you would prove these two relationships)

You would find the slope of both sidelines by finding two ordered pairs on each sideline and then using the slope formula. If the slopes are the same then that proves that they are parallel.
Do the same thing for the 2^{nd} part. If you find two ordered pairs on the baseline and then find the slope using the slope formula, the slope of the sideline should be the negative reciprocal of the slope of the baseline. This would prove they are perpendicular.