Subdivision Design and Quadrilaterals

I. **UNIT OVERVIEW & PURPOSE:**

In the unit Subdivision Design and Quadrilaterals, the students will use the quadrilaterals and their properties to design a subdivision. The students will subdivide a given plot of land into multiple lots to make a neighborhood. In the following lessons, they will create model house plans for their subdivision, design a playground area and equipment using quadrilaterals and 3-dimensional figures, and use local economics to decide prices for the lots as well as the houses. The final product will be a full plan for a subdivision ready for marketing with realtors to begin development. As part of this unit, students will do multiple levels of research to identify design ideas, safety codes, and local property values. Collaboration with local developers, architects and realtors will also be encouraged in this unit.

II. **UNIT AUTHOR:**

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III. **COURSE:**

Mathematical Modeling: Capstone Course

IV. **CONTENT STRAND:**

Geometry, Measurement, and Data Analysis and Probability

V. **OBJECTIVES:**

The students will use the properties of quadrilaterals to subdivide a plot and design a floor plan. The students will also use measurements and area properties to determine square footage and acreage. The students will use properties of circles to aid in the construction and measurements of the cul-de-sac sections of the subdivision.

VI. **MATHEMATICS PERFORMANCE EXPECTATION(s):**

MPE.4: The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

MPE.5: The student will solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.

MPE.6: The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.

MPE.7d: The student will use similar geometric objects in two- or three-dimensions to solve real-world problems about similar geometric objects.

MPE.8: The student will compare distributions of two or more univariate data sets, analyzing center and spread (within group and between group variations), clusters and gaps, shapes, outliers, or other unusual features.

MPE.11b: The student will use angles, arcs, chords, tangents, and secants to solve real-world problems involving properties of circles.

MPE.23: The student will analyze the normal distribution. Key concepts include
a)   characteristics of normally distributed data;
b)   percentiles;
c)   normalizing data, using z-scores; and
d)   area under the standard normal curve and probability
MPE.35: Construct and justify the constructions of congruent segments and angles, segment and angle bisectors, and parallel and perpendicular lines.

VII.   **CONTENT:**

In this society a large portion of the population will own a home and land plot at some time in their lives. For these people, being able to calculate and understand the land perimeters, area, square footage, and other mathematical aspects of their property will allow them to be informed in all manner of situations. When buying property, it is always important to know the meaning of the numbers and figures on property descriptions and architectural drawings. This unit will expose students to various aspects of buying a home. After this unit, they will be able to make more informed decisions when in such a situation. Some students may even take the information presented in this unit as inspiration to become an architect, developer, or real-estate agent.

REFERENCE/RESOURCE MATERIALS:

The students will use GeoGebra to review the properties of quadrilaterals. The students will use computer software to draw the subdivision layout and floor plans, such as GeoGebra or Microsoft Word. The students will also research websites on the internet for ideas on subdivisions, floor plans and property values.

VIII.   **PRIMARY ASSESSMENT STRATEGIES:**
- Classroom activities
- Journal entries
- Floor plan rubrics
- Final flyer presentation

IX.   **EVALUATION CRITERIA:**

The classroom activities will have worksheets to facilitate the research portions of the units. These will be graded for completeness and accuracy. The rubrics for the journal entries and floor plans will be attached to each relevant lesson. The final presentation of a flyer will be presented at the end of this project. A rubric is attached.

X.   **INSTRUCTIONAL TIME:**

9 90-minute blocks

Lesson 1 Have you seen any quadrilaterals lately?

Strand
Geometry and Measurement

Mathematical Objective(s)
Students will use Geogebra to construct quadrilaterals and calculate side lengths, angle measures, etc. This process should reinforce the properties of quadrilaterals. Students will organize this knowledge in a chart. Students should reinforce their existing knowledge of quadrilaterals and the properties that make each one distinctive. Students will also research on the web or at home to find examples of quadrilaterals in their environment, specifically used in construction. Students will use the properties of quadrilaterals to classify each group's findings.

Mathematics Performance Expectation(s)
MPE.4: The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

MPE.35: Construct and justify the constructions of congruent segments and angles, segment and angle bisectors, and parallel and perpendicular lines.

Related SOL

G.4 The student will construct and justify the constructions of a) a line segment congruent to a given line segment; b) the perpendicular bisector of a line segment; c) a perpendicular to a given line from a point not on the line; d) a perpendicular to a given line at a given point on the line;
e) the bisector of a given angle, f) an angle congruent to a given angle; and g) a line parallel to a given line through a point not on the given line.

G.9 The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.
The focus of this lesson is the properties of quadrilaterals.

NCTM Standards
- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems
- Use visualization, spatial reasoning, and geometric modeling to solve problems

Materials/Resources
- Computers with access to the internet and Geogebra.
- Digital cameras or cell phones with cameras (optional).
- Handout "Properties of Quadrilaterals" to be used with Geogebra.

Assumption of Prior Knowledge
- Students should have basic knowledge of the computer software program Geogebra.
- Students should understand basic geometry vocabulary like segments, angles, congruent, bisect, perpendicular, and supplementary.
- Students should have a basic understanding of quadrilaterals and their properties. This activity is designed to refresh students with the details of the properties.
- Students may struggle with constructing shapes in Geogebra and calculating length and angles. Students will need to understand that **order** of selection of the object matters in Geogebra.
- Students should start to notice more quadrilaterals in their everyday life. Specifically, we want students to start seeing quadrilaterals in their home environment and recognize how their specific properties play an important role in home construction.

Introduction: Setting Up the Mathematical Task
- In this lesson, the students will investigate the properties of the quadrilaterals such as parallelograms, rectangles, squares, rhombi, and isosceles trapezoids. The students will also begin to look at quadrilaterals used in home construction.
- This lesson should be completed during two 90-minute blocks.
- Show a YouTube video regarding using quadrilaterals in architecture. http://www.youtube.com/watch?v=_KIBMC8V52g
- Ask students: How many different examples of quadrilaterals did they see in the video? Which type of quadrilateral seemed to be the most prevalent? Why do you think that is the case?
- Students should explore the quadrilaterals with the Geogebra activity detailed in Student Exploration 1. This activity assumes that students remember basic content regarding quadrilaterals. For instance, rhombi have 4 equal sides, or squares have 4 right angles.
- Students will then find examples of the quadrilaterals used in building/home construction by using the internet or taking pictures at home. Students should compile these in a file and send them to the teacher. The pictures will be used to facilitate a whole class discussion regarding classifying quadrilaterals and which properties are useful. As an alternative, students could print out the pictures they find and create poster boards to display for the classroom.

Student Exploration 1:
Small Group Work – Students should be placed in groups of two.

Student/Teacher Actions:

- Each group of students should get a computer and open a blank Geogebra file. Students should follow directions on constructing each quadrilateral and answering prompts concerning each one using the handout named "Properties of Quadrilaterals".
- Teachers should be walking around the classroom offering assistance with Geogebra and also helping students make conclusions about the differences between each quadrilateral.

Monitoring Student Responses

- Students should be discussing the process of changing a parallelogram into a rectangle. Specifically, how can they change the ordered pairs to make the shape become a rectangle? What property is vital to becoming a rectangle? What properties are essential to change a rectangle to a square, etc? Students who are struggling could be assisted by the teacher or classmates by simply asking them to draw the desired shape on a piece of paper. Teachers may ask students: Why did they draw it that way? What specifically do they need to change about the current shape to make it become the desired different quadrilateral? Students who are a little more advanced could be asked to investigate the slope of the sides of the quadrilaterals. Have them figure out how to use Geogebra to calculate the slopes of the sides as well as the slopes of the diagonals. Have them write a summary of their findings.
- The last part of the activity has students finding real world examples of these quadrilaterals in building construction. Student will turn in a file of their results. The file should be a Word document with the pictures the students found. The teacher can compile these images and use them to facilitate a whole class discussion on classifying quadrilaterals using their properties.

Assessment

- Students will be assessed based on completion of the "Properties of Quadrilaterals" handout. The solution key is attached. There are multiple correct answers, but possible solutions are provided. Students will also be given a grade based on their participation in the internet/home search for examples of quadrilaterals in building construction. Also, students will be expected to contribute to the whole class discussion when classifying these examples.

Extensions and Connections (for all students)

- We will follow this lesson by using quadrilaterals in dividing up a large property into home lots. The students will be calculating square footage of some of those lots.
- Students will be using ordered pairs and graphing on a coordinate plane using Geogebra.
- This lesson is connected with architecture and drafting.

Strategies for Differentiation

- Students are using various learning strategies with this lesson including visual and kinesthetic. Students could also have another student read the instructions to them if there are reading disorders present in the group. If learning disabled students are present in the classroom, the teacher may consider including ordered pairs for each quadrilateral. Students would then just graph each one and fill in the chart and answer the questions. Students with high ability in geometry may be asked to investigate the slope of the sides of each quadrilateral as well as the diagonals. Have those students write a summary of what they discovered regarding each quadrilateral and also add the appropriate columns to their chart.

Properties of Quadrilaterals

Names: _____, _____

Please follow directions carefully.

1. Open a blank Geogebra file. Make sure the grid and axes are turned on.

2. Use the **Polygon Tool** to construct the quadrilateral with the following ordered pairs

A (2,2)   B (7,3) C (8, 5) D (3, 4).

3. Using the **Distance Tool**, measure the opposite sides of the quadrilateral. Record their lengths here.

AB = _____, CD = _____ and AD = _____, BC = _____

4. Using the **Angle Tool**, measure the opposite angles of the quadrilateral. Record their measures here. (Hint: You may need to check "object properties" of each angle by right clicking on the angle. The angle should be set to fall between 0 and 180).

<A = _____, <C = _____ and < B =_____, and <D = _____

5.   Based on the information you have gathered so far, can you determine if this quadrilateral is a parallelogram, rectangle, square, rhombus or trapezoid? Can you eliminate any of these based on the information you have?

6.   We are going to construct the diagonals of the quadrilateral. Using the **Segment Between Two Points Tool**, select the points on opposite ends of the quadrilateral to construct the diagonal. Repeat for the other diagonal. Using the **Intersect Two Objects Tool**, mark the point where the two diagonal intersect. Label this point M.

7. Using the **Distance Tool**, measure the length of each diagonal and record below. Also measure the length of each piece of the diagonal and record below.

AC = _____   BD = _____

AM = _____, CM = _____, BM = _____, DM = _____

8.   Using the **Angle Tool**, measure the angles constructed by drawing the diagonals. Record their measures here.

<AMB = _____, <BMC = _____, <CMD = _____, <DMA = _____

9. Based on the information you have gathered, you should be able to determine which quadrilateral you have constructed. Please fill in the following statements as a synopsis of the properties you have discovered about parallelograms. Put a check mark if the property is true or an X if the property is false.

	Opposite sides are congruent.	Opposite angles are congruent.	Consecutive angles are supplementary.	Diagonals are perpendicular.	Diagonals are congruent.	Diagonals bisect each other.
Parallelograms						
Rectangles						
Squares						
Rhombus	✓	✓	✓	✓	✗	✓
Isosceles Trapezoids						

10. Move the points B, C, and D to create a Rectangle. Record the ordered pairs you are using here.
A (_____, _____) B (_____, _____) C (_____, _____) D (_____, _____)

11. Using the figure you constructed and the measurements you found fill in the table above for rectangles.

12. Write a summary of the similarities between the parallelogram and the rectangle.

13. Move the points of the quadrilateral to create a Square. Record the ordered pairs you are using here.   A (_____, _____) B (_____, _____) C (_____, _____) D (_____, _____)

14. Fill in the table above by referring to the Geogebra construction of the square.

15. Write a short explanation of the differences between a rectangle and a square. Use all the properties as a guide.

16. Move the ordered pairs to construct a rhombus but the interior angles shouldn't be 90 degrees. Hint: All sides must be equal. Record the ordered pairs you are using here.

A (_____, _____) B (_____, _____) C (_____, _____) D (_____, _____)

17. Verify all the properties of a rhombus listed in the table above by looking at your construction.

18. Move the ordered pairs to construct an isosceles trapezoid. Remember: Isosceles means two non-parallel sides of the trapezoid must be equal. Record the ordered pairs you are using here.
A (_____, _____) B (_____, _____) C (_____, _____) D (_____, _____)

19. Fill in the table above regarding the properties of isosceles trapezoids.

20. What property(s) make the isosceles trapezoid different from all the other quadrilaterals we have looked at today?

Part II: Use the internet or your camera/phone camera to find pictures of quadrilaterals being used in home construction. Compile these pictures in a file using Word. Try to find an example of each type of quadrilateral that we have looked at in this lesson. When completed, send the file to your teacher's email address.

Properties of Quadrilaterals

Name: _____Key_____, _____

Please follow directions carefully.

1. Open a blank Geogebra file. Make sure the grid and axes are turned on.

2. Use the **Polygon Tool** to construct the quadrilateral with the following ordered pairs

A (2,2) B (7,3) C (8, 5) D (3, 4).

3. Using the **Distance Tool**, measure the opposite sides of the quadrilateral. Record their lengths here.

AB = _5.1__, CD = __5.1__ and AD = _2.24_, BC = __2.24__

4. Using the **Angle Tool,** measure the opposite angles of the quadrilateral. Record their measures here. (Hint: You may need to check "object properties" of each angle by right clicking on the angle. The angle should be set to fall between 0 and 180).

<A = _52.13°__, <C = _52.13°__ and < B =_127.87°__, and <D = __127.87°__

5. Based on the information you have gathered so far, can you conclude if this quadrilateral is a parallelogram, rectangle, square, rhombus or trapezoid? Can you eliminate any of these based on the information you have?

Opposite sides are congruent and opposite angles are congruent. The shape must be a parallelogram, but not a trapezoid, rectangle, rhombus, or square. All four sides are not congruent so this eliminates the square and rhombus. The angles are NOT ninety degree angles, so the shape is not a rectangle. Since both pairs of opposite sides are congruent, the shape cannot be a trapezoid. Students do not have to have all of the reasoning yet to make this conclusion.

6. We are going to construct the diagonals of the quadrilateral. Using the **Segment Between Two Points Tool**, select the points on opposite ends of the quadrilateral to construct the diagonals. Repeat for the other diagonal. Using the **Intersect Two Objects Tool**, mark the point where the two diagonals intersect. Label this point M.

7. Using the **Distance Tool**, measure the length of each diagonal and record below. Also measure the length of each piece of the diagonal and record below.

AC = _6.71_____ BD = __4.12_____

AM = 3.35___, CM = _3.35__, BM = _2.06__, DM = _2.06__

8. Using the **Angle Tool**, measure the angles constructed by drawing the diagonals. Record their measures here.

<AMB = _139.4°___, <BMC = __40.6°___, <CMD = _139.4°__, <DMA = __40.6°_____

9. Based on the information you have gathered, you should be able to determine which quadrilateral you have constructed. Please fill in the following statements as a synopsis of the properties you have discovered about parallelograms. Put a check mark if the property is true or an X if the property is false.

	Opposite sides are congruent.	Opposite angles are congruent.	Consecutive angles are supplementary.	Diagonals are perpendicular.	Diagonals are congruent.	Diagonals bisect each other.
Parallelograms	✓	✓	✓	✗	✗	✓
Rectangles	✓	✓	✓	✗	✓	✓
Squares	✓	✓	✓	✓	✓	✓
Rhombus	✓	✓	✓	✓	✗	✓
Isosceles Trapezoids	✗	✗	not base angles ✓	✗	✓	✗

10. Move the points B, C, and D to create a Rectangle. Record the ordered pairs you are using here.
A (_2_, _2_) B (_8_, __2_) C (_8_, _6_) D (_2_, _6_) other answers possible

11. Using the figure you constructed and the measurements you found fill in the table above for rectangles.

12. Write a summary of the similarities between the parallelogram and the rectangle.
The opposite sides of each shape are congruent. Opposite angles of each shape are congruent to each other. The consecutive angles of each shape add up to 180 degrees. The diagonals of each shape are not perpendicular. The diagonals of each shape bisect each other.

13. Move the points of the quadrilateral to create a Square. Record the ordered pairs you are using here. A (_2_, __2_) B (_8_, _2_) C (_8_, _8_) D (_2_, _8_) other answers possible

14. Fill in the table above using the Geogebra construction of the square.

15. Write a short explanation of the differences between a rectangle and a square. Use all the properties as a guide.
The four sides of a square must be the same length, but in a rectangle they do not have to be equal. The diagonals of a rectangle do not have to be perpendicular, but in a square they do.

16. Move the ordered pairs to construct a rhombus but the interior angles shouldn't be 90 degrees. Hint: All sides must be equal. Record the ordered pairs you are using here.
A (_3_, _3_) B (_7_, _2_) C (_6_, _6_) D (_2_, _7_) other answers possible

17. Verify all the properties for a rhombus listed in the table above by looking at your construction.

18. Move the ordered pairs to construct an isosceles trapezoid. Remember: Isosceles means two sides of the trapezoid must be equal. Record the ordered pairs you are using here.
A (_3___, __3__) B (_9___, __3___) C (__7__, __6__) D (_5___, __6__) other answers possible

19. Fill in the table above regarding the properties of isosceles trapezoids.

20. What property(s) make the isosceles trapezoid different from all the other quadrilaterals we have looked at today?

The isosceles trapezoid is different because it doesn't have two sets of parallel lines like all the other quadrilaterals. It has only one set of opposite sides congruent. The opposite angles are not congruent either. The diagonals of the isosceles trapezoid do not bisect each other as they do in all the other quadrilaterals.

Part II: Use the internet or your camera/phone camera to find pictures of quadrilaterals being used in building construction, specifically homes. Compile these pictures in a file using Word. Try to find an example of each type of quadrilateral that we have looked at in this lesson. When completed, send the file to your teacher's email address.

Lesson 2 Subdivision Layout

Strand

Geometry & Measurement

Mathematical Objective(s)

Students will be able to find the area of the basic planar shapes, using the correct units. Students will be able to convert between square footage and acreage. Students will be able to find the square footage of an irregular shape by using combinations of the basic planar shapes. Students will use these skills to divide up a larger shape into smaller regions and calculate the area of each smaller region using restrictions given.

Mathematics Performance Expectation(s)

MPE.4 The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

MPE.5 The student will solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.

Related SOL

8.11 The student will solve practical area and perimeter problems involving composite plane figures.

G.8 The student will solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.

G.9 The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

Quadrilaterals and their properties are the focus of this lesson and are also addressed in Lesson One.

NCTM Standards
- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.
- Use visualization, spatial reasoning, and geometric modeling to solve problems.
- Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Apply appropriate techniques, tools, and formulas to determine measurements.

Materials/Resources
- Graphing calculators
- Microsoft word
- Laptop computers with access to the internet
- Document projection device
- Handout A (Warm ups)
- Handout B (Sample lots)
- Handout C (Total property)

Assumption of Prior Knowledge
- Students should recall how to find the area of planar figures. Students should know how to convert from one unit to another if given the factor of conversion. Students should understand the properties of quadrilaterals. Students should be able to use the Pythagorean Theorem to find the value of a missing side in a right triangle. Students should know how to measure distances using a ruler to the nearest sixteenth of an inch.
- Students should be very comfortable with quadrilaterals and should be operating on an Analysis level on Van Hiele scale.
- Students may consider dividing the property into irregular shapes. Of course, this will make calculating the acreage of each lot more of a challenge. Students may also consider curved lots. Teachers should explain that only straight line divisions should be used, with the exception of the cul de sac area. Those pieces of property will have perimeters with arcs of a circle.
- Students may find the irregular property lot on handout B to be difficult. Students must use special right triangles and the area of a sector of a circle to calculate the square footage of the lot. Students may also find the final task of subdividing the property a challenging problem because it is open ended. There are many ways to achieve the goal. At first, teachers may consider pointing students to smaller areas of the subdivision so the task doesn't seem overwhelming. Teachers can also allow some class time to do some research online of possible subdivision layouts. The research should give students more confidence in completing the task.

- Students should have already mastered the properties of quadrilaterals, which were addressed in Lesson One. The properties of the quadrilaterals will help students decide how to divide up each section of the property efficiently.
- Designing a subdivision uses engineering, architecture, and building construction ideas.

Introduction: Setting Up the Mathematical Task

- In this lesson, students will use quadrilateral properties to divide up larger quadrilaterals and find their area.
- The lesson should take at least two 90 minute blocks, but could be more depending on the level of the students.
- Students should complete Handout A individually. Students should be placed in groups of varying abilities to complete Handout B and Handout C. Group size should be 2 to 3 students per group.
- Introduction to the Activity: Ask the students to raise their hand if they live in a subdivision. Of those students, ask a few of them: What shape is the property where your home sits? Is it rectangular? Is it trapezoidal? Is it triangular? Today, you will be given the opportunity to design your own subdivision. You can make the shape of your property lots whatever you decide, within reason. Plots of land are generally divided up using straight lines whenever possible. Can anyone explain why that is the case? Can you think of a property border that wouldn't have to be straight and you could still calculate the square footage?
- On Handout A: Students will calculate the area of planar shapes, when given the dimensions. Students should use appropriate units of measure. Students will also convert from square feet to acres and from acreage to square footage when given the conversion factor.
- On Handout B: Students will calculate the square footage of sample property lots with given dimensions. Students will also convert from square feet to acres for each sample. Students should then write a journal entry describing the process.
- On Handout C: Students will divide an existing property into lots using constraints and a scaled drawing of the subdivision. They should use a variety of area formulas, including area of rectangles, trapezoids, parallelograms, circles, and possibly triangles. Students will then write the acreage of each lot on the map and check to see that their summation of the individual lots totals to a corresponding value less than the total acreage of the subdivision.

Student Exploration 1:

Individual Work

- Students should complete Handout A individually. This could be used as a warm up activity for the day of the lesson or possibly the day before.

Whole Class Sharing/Discussion

- The teacher should introduce the activity using questions stated earlier. It may be beneficial to show students sample subdivision lots from searches on the internet, especially if subdivisions are not a common part of the students' lifestyle.

Small Group Work

- Students should complete Handout B and C in a small group.

Student/Teacher Actions:

- Individually, students will be finding the area of 2D shapes and converting square feet to acres and vice versa. In small groups, students will be finding area of sample lots and dividing property into lots with restrictions as outlined on the handout.
- During individual work, teachers may need to help students to find appropriate formulas. A formula sheet is provided in the lesson plan if the teacher wants to copy and distribute to students. During the group work on handout B, teachers may need to help students get started on discovering the dimensions of the unlabeled parts of the sample lots. Specifically, on the sample lot with the cul de sac, teachers may need to point out how to divide the bottom part into triangles and use special right triangles to determine missing dimensions. See the key for more specifics.
- Students could use the internet to research examples of subdivisions before proceeding with handout C if the task seems too challenging. As a follow up activity, students could use Microsoft Word to construct the subdivision. The teacher would provide an electronic copy of the layout of the whole property and students would use the Drawing toolbar to divide into individual lots.
- Students will be completing a journal entry after Handout B to explain the process of calculating the square footage of irregular shapes. The teacher should be walking around assisting groups who need help. If students are having problems, have them start in the lower, right hand portion of the property. The lots should be rectangular and easily calculated.   To extend the lesson for students who are ready, have students consider which lots would be the "prime" real estate in the subdivision. What makes them the prime location? Does the size of your lots affect their "prime" status?
- Each group can show their subdivision design by using a document camera. Have each group highlight a specific lot and how they calculated the acreage. Also have students discuss why each property lot is a certain shape. What about the quadrilateral made it a good fit for that spot?

Assessment

- Journal/writing prompts
    - Handout B: Describe how you calculated the square footage/acreage of each sample lot. Describe the steps in the order that you did them. List any formulas you used to find the answers. Include any strategies you might have used to find the dimensions that were not given explicitly.
    - Handout C: Pick one or two of the lots in your subdivision. Explain carefully how you calculated the acreage. Discuss why each property lot is a particular shape. What about the quadrilateral made it a good fit for that location in the subdivision?
- The Handouts A, B, and C have problems/questions on each. The appropriate answer keys are provided below.
- A rubric for the journal prompts in included below.
- A rubric for grading Handout C is included below.

Extensions and Connections (for all students)

- Students will design house plans for the subdivision or choose plans from internet research. Students will design a parks/recreational area with quadrilateral themed playground equipment. Students will look at the financial means necessary to plan and develop a subdivision as well as the marketing and economics end of the business. These ideas will be explored in Lessons 3 through 5.
- This lesson has connections with architectural drawing courses.

Strategies for Differentiation

- Students could create larger models of the subdivision using cardboard. The teacher could omit the cul de sac from the subdivision plan for an easier activity. The teacher could divide the subdivision up and have each group design a portion then put all the plans together for a completed project.
- For the high ability group of students, teachers could have them draw the subdivision plan on Microsoft Word and add the acreage to the electronic document. Have students research prime real estate lots and design their subdivision using those characteristics to maximize the amount of money made for each lot.
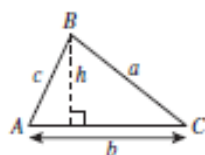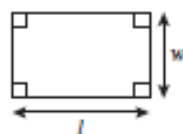
$$A = \frac{1}{2}bh$$
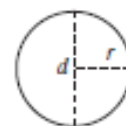
$$A = \frac{1}{2}ab \sin C$$
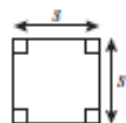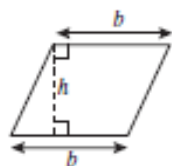
$$p = 4s$$
$$A = s^2$$

$$p = 2l + 2w$$
$$A = lw$$

$$C = 2\pi r$$
$$C = \pi d$$
$$A = \pi r^2$$

$$A = bh$$
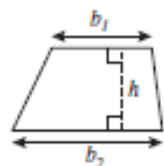
$$A = \frac{1}{2}h(b_1 + b_2)$$
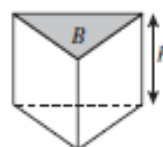
$$V = Bh$$
$$L.A. = hp$$
$$S.A. = hp + 2B$$
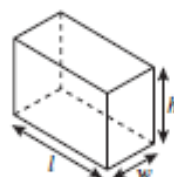
$$V = lwh$$
$$S.A. = 2lw + 2lh + 2wh$$
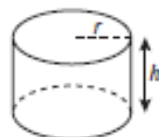
$$V = \pi r^2 h$$
$$L.A. = 2\pi rh$$
$$S.A. = 2\pi r^2 + 2\pi rh$$

$$V = \frac{4}{3}\pi r^3$$
$$S.A. = 4\pi r^2$$
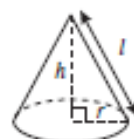
$$V = \frac{1}{3}\pi r^2 h$$
$$L.A. = \pi rl$$
$$S.A. = \pi r^2 + \pi rl$$
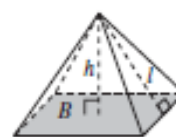
$$V = \frac{1}{3}Bh$$

$$L.A. = \frac{1}{2}lp$$

$$S.A. = \frac{1}{2}lp + B$$

Handout A: Warm-Up: Find the Area of each shape. Include the appropriate units.

24.75ft

9.4 ft

r=125 cm

8m

h=25 m

20.25 m

12 yd

45°

32.8 cm

10.4 in

10.4 in
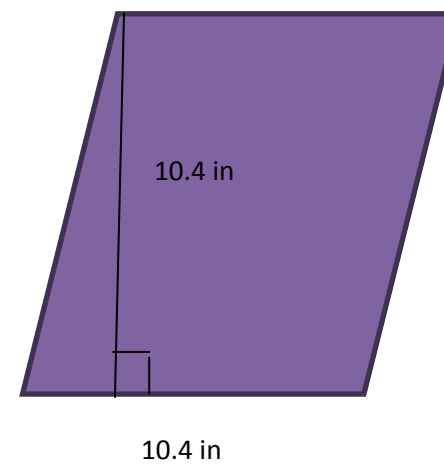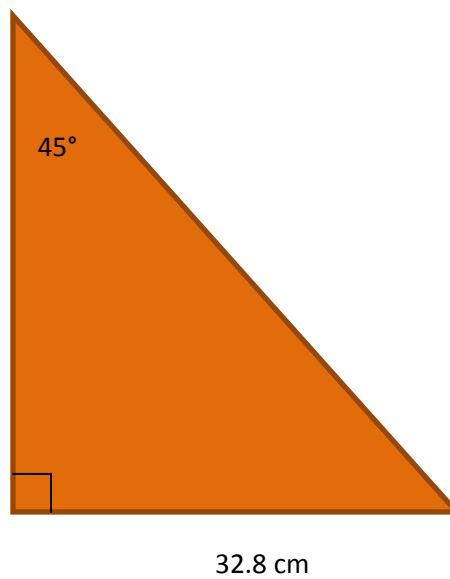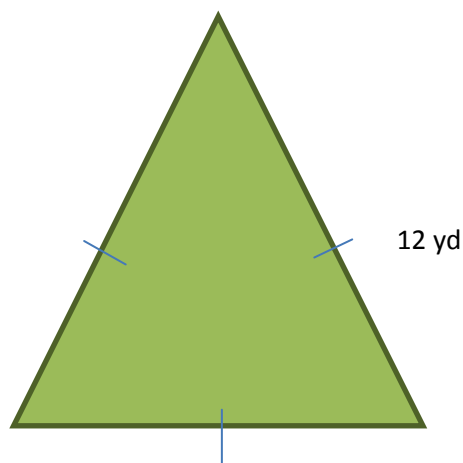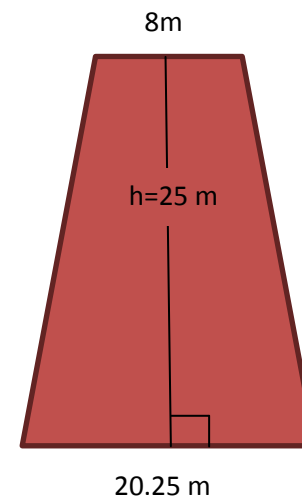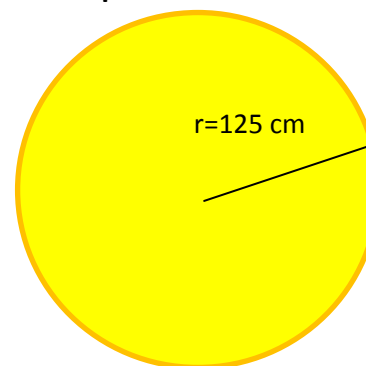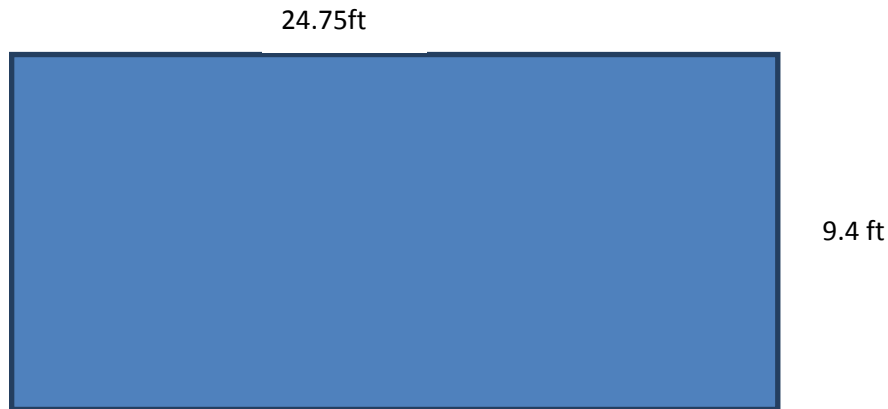
Convert the following to amounts of property using the equivalencies stated below:

1 acre = 43,560 square feet

1 square foot = 0.00002295684 acre

30 acres = _____square feet

217,800 square feet = _____acres

51 acres = _____square feet

136,848 square feet = _____ acres
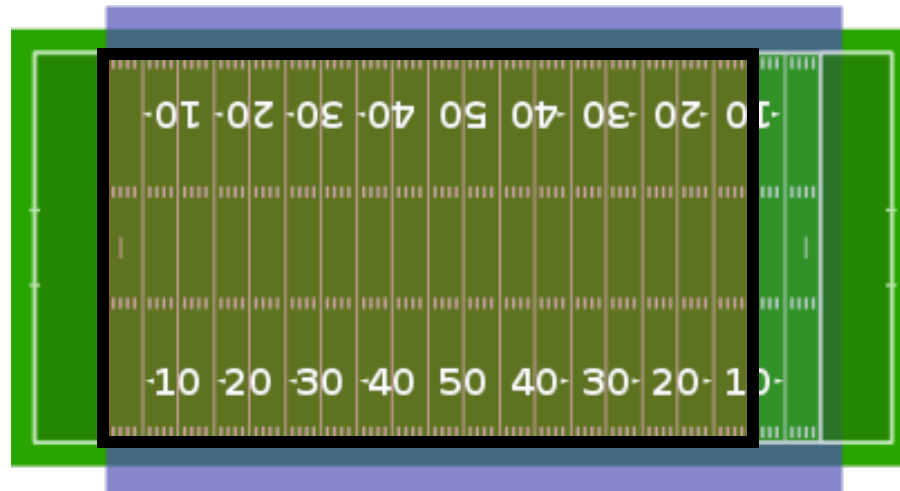
Did you know: One acre is 76% of a football field, which is the area outlined.

Handout B: Sample Property lots

Calculate the square footage of each sample lot. Show all your work. Your steps should be easy to follow. The lot is the shaded area.

Lot #1

300 ft

300 ft

$300+100\sqrt{3}$ ft

r=200ft
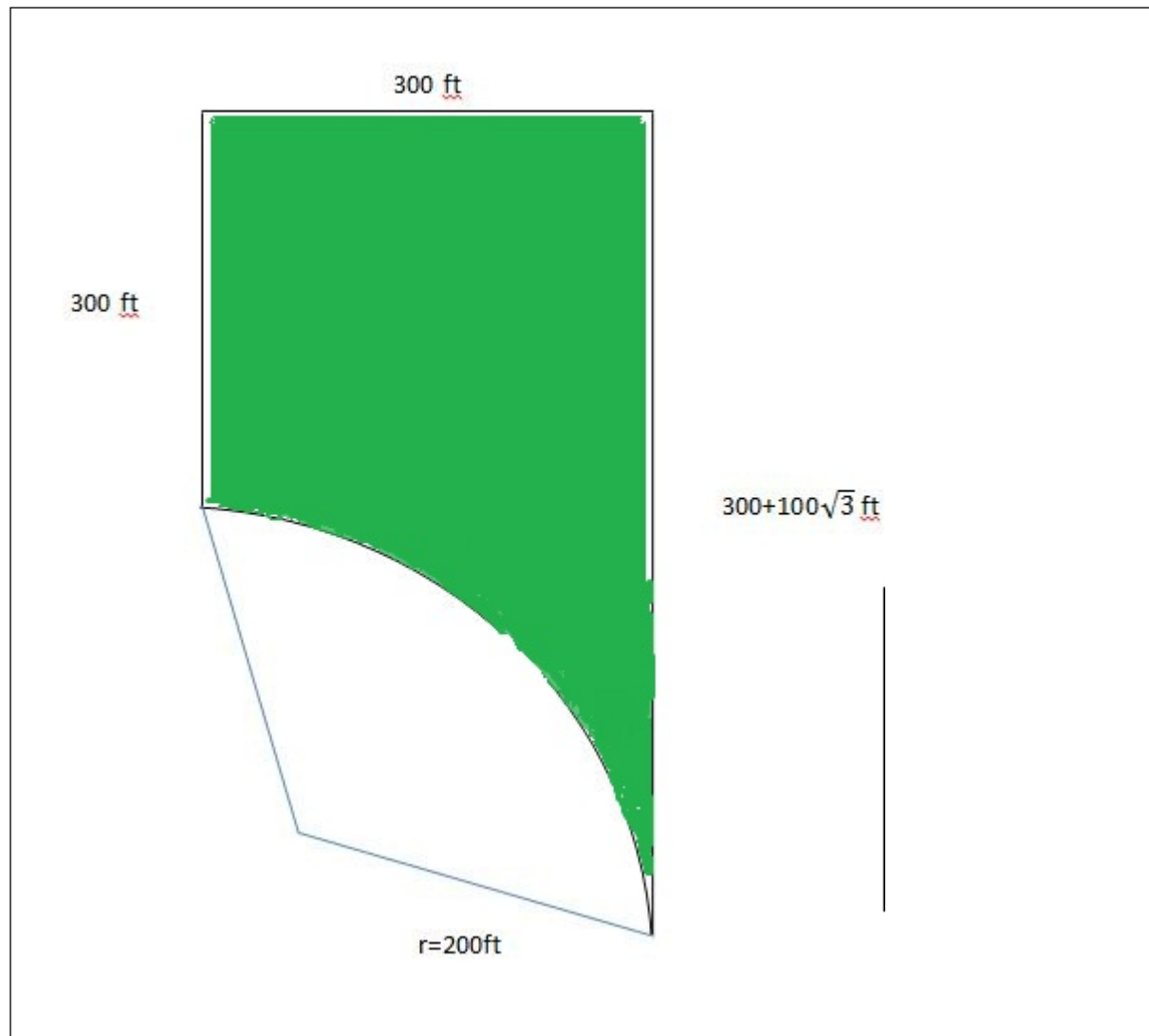
Square footage = _____

Acreage = _____

Lot #2

375 ft

200 ft

400 ft

175 ft
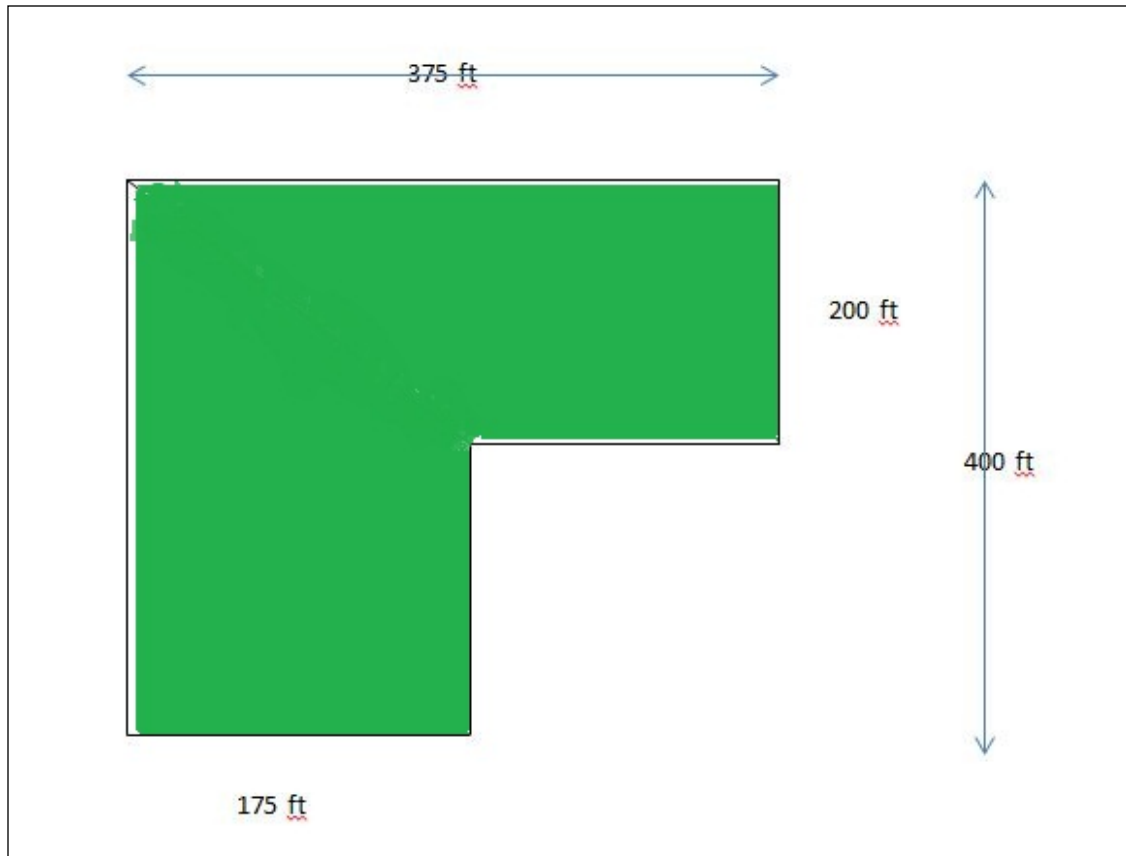
Square footage = _____

Acreage = _____

Write a **journal entry** describing how you calculated the square footage/acreage of each sample lot. Describe the steps in the order that you did them. List any formulas you used to find the answers. Include any strategies you might have used to find dimensions that were not given explicitly.

Scale: 1 inch = 200 feet

Handout C: Total Subdivision Property

Divide up the subdivision into individual property lots using the following guidelines. Follow directions on sheet attached:

- The lots should be less than 1 acre.
- Each lot must have at least 50 feet of road frontage.
- Designate an area for a park/recreational location. It should be ½ to 1 acre in size.

Road

Road

Road

Road

Road

Road
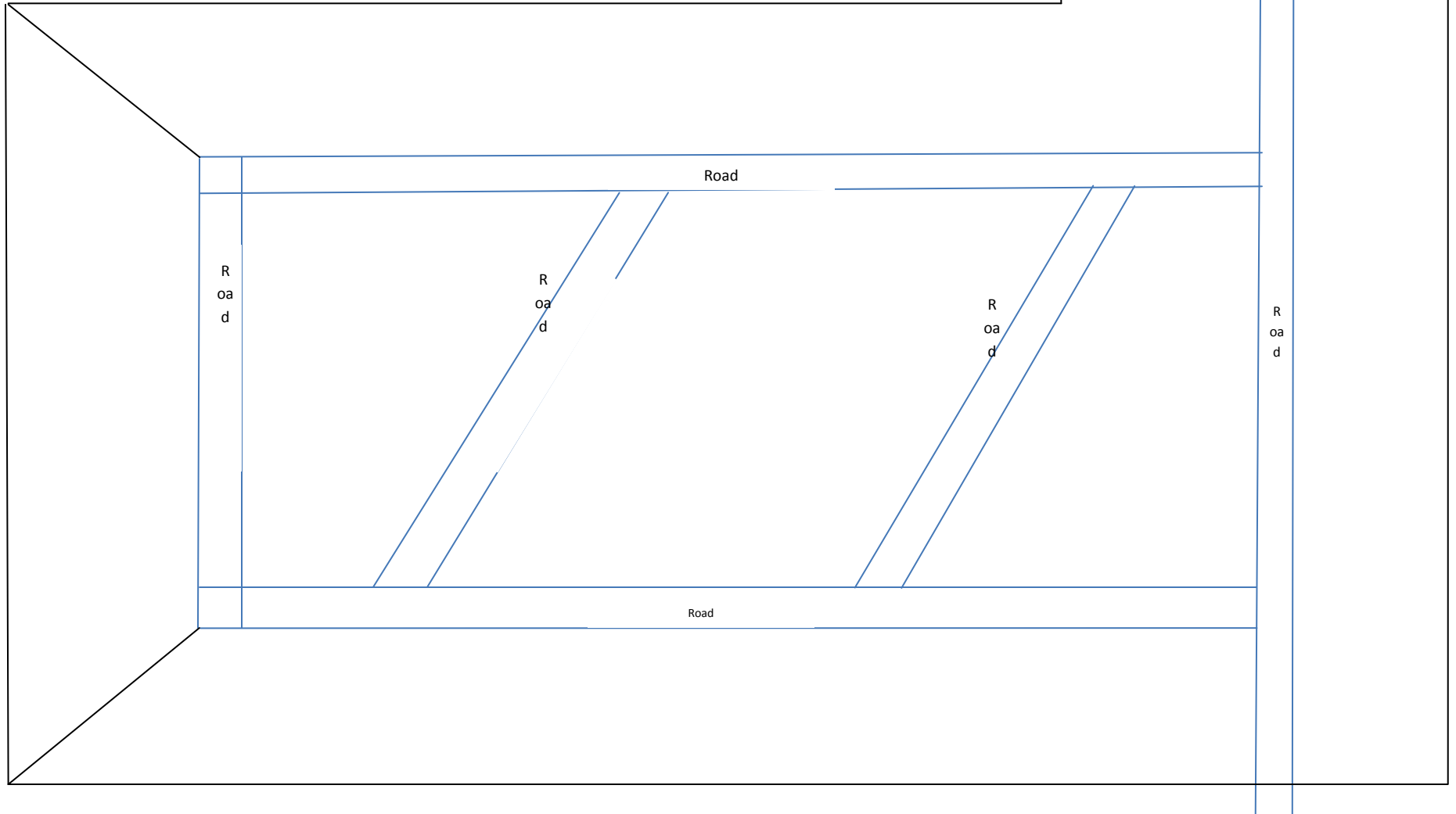
Handout C: Total Subdivision Property

You will be dividing up our subdivision into individual property lots. You are free to divide them up how you wish, with a few helping guidelines to keep in mind:

- The lots should be less than 1 acre.
- Each lot must have 50 feet of road frontage (This means each property must border a road for at least 50 feet)
- You must designate a portion of the property for a park/recreational area. This location must be ½ to 1 acre in size.
- Try to use many different examples of quadrilaterals as you divide up the property.
- Keep in mind that you must calculate the acreage of each lot you create and record on your map. The total acreage of the entire property is around 50 acres. The total you get should be less than 50 since the area for the road(s) would be deducted.
- Use a ruler to measure each lot. You should use the inches side of the ruler. Use the scale provided to figure out the square footage of each lot, then convert to acreage as you did on Handout A.
- After you finish your divisions, answer the questions below:

How many lots did you divide the subdivision into?_____

What was the size of your largest lot? _____acre

What was the size of your smallest lot? _____acre

What size did you make the park/recreational area? _____acre

Journal Prompt: Pick one or two of the lots in your subdivision. Explain carefully how you calculated the acreage. Discuss why the property lot is a particular shape. What about the quadrilateral made it a good fit for that location in the subdivision?

Answers to Handout A:

Area of Rectangle = 232.65 ft^2
Area of Circle = 49, 087.385 cm^2
Area of Trapezoid = 353.125 m^2
Area of Equilateral Triangle = 62.3538 yd^2
Area of Right Triangle = 537.92 cm^2
Area of Parallelogram = 108.16 in^2

30 acres = 1, 306, 800 square ft
217, 800 sq ft = 5 acres
51 acres = 2,221,560 sq ft
136,848 sq ft = 3.141598 acres

Answers to Handout B:

Lot #1
Square footage: 91, 413.368
Acreage: 2.09856
Lot #2
Square footage: 110,000
Acreage: 2.52525

Area of square = 90,000 ft^2

Area of Right triangle = 25, 980.76211 ft^2

Area of Isosceles triangle = 17, 320.50808 ft^2

Area of Sector = 13, 333.333π ft^2

The angles in the obtuse triangle are 30 - 30 - 120.

Area of lot = (A of Rt Tri + A of Isos Tri) − (A of Sector)
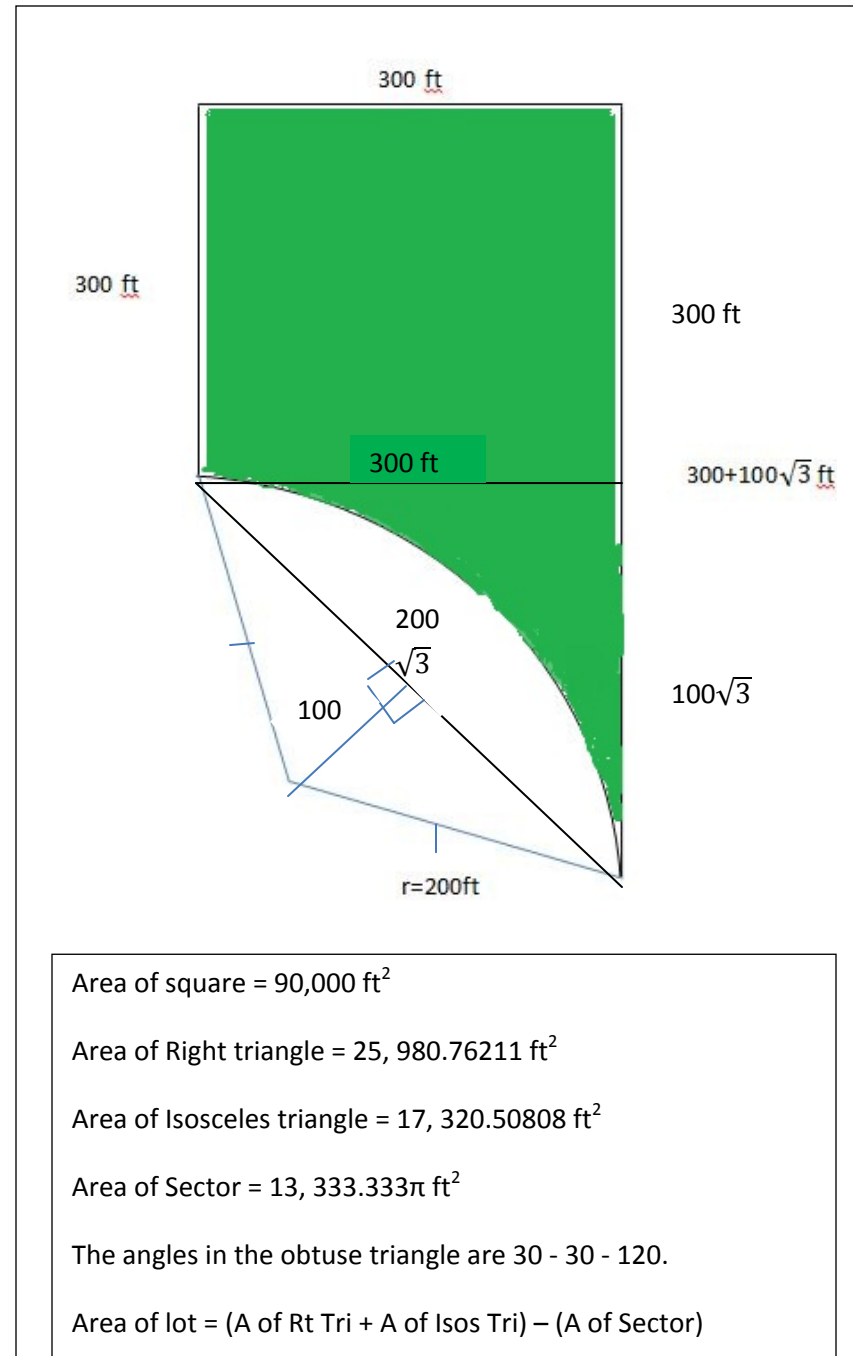
Rubric for Journal Entries on Handout B and Handout C

Score each student based on responses to the four criteria below. Add their points. Maximum score is 40 points.

	0 points	5 points	7.5 points	9 points	10 points
Complete sentences/Grammar	No sentences	Less than 50% are complete sentences, and many grammatical mistakes	Most sentences are complete, but have a few grammatical errors	All sentences are complete and most grammar is correct	All sentences have good structure and grammar is perfect
Ideas	No ideas or original thought	It is difficult to determine what entry is about	Ideas are somewhat organized but not very clear	Ideas are expressed well, but organization could have been better	Ideas are organized and flow well
Mathematical Vocabulary	No math terms are used	A few math terms are used, maybe some are used incorrectly	Correct vocabulary is used, but not every opportunity to use terms is optimized	Most of the necessary vocabulary is used correctly	All of the necessary vocabulary is used appropriately
Answered questions in the prompt	No ideas are related to the prompt	Less than 50% of the questions from the prompt are addressed	Most of the prompt is addressed, but some responses are short	90% of the prompt is addressed well	All of the prompt is answered well

Rubric for Handout C

Use this rubric to grade each group's final project of dividing up the property into subdivision lots.

A. Students divided up the total property into lots that are less than 1 acre in size. Students identified the acreage of each lot on the scaled drawing. (10 points)

_____

B. Students calculated the area of each individual lot accurately. (10 points)

_____

C. Each lot has at least 50 feet of road frontage. (5 points)

_____

D. Students designated an area for a parks/recreational area that is ½ to 1 acre in size. (5 points)

_____

E. Students used a variety of quadrilaterals to divide up the property. Students should use at least three different quadrilaterals for full points. (10 points)

_____

F. Students answered questions on Handout C correctly. (10 points)

_____

Total points = _____ (out of 50 points)

Lesson 3 Floor Plans

Strand
Geometry and Measurement

Mathematical Objectives
Students will use an on-line floor plan software (http://www.homestyler.com/designer) to create a one-level floor plan for a house. Students will find the square footage of the house plan they have created, using their existing knowledge of finding the areas of various shapes, including quadrilaterals.
(Note – Geogebra may be used in place of on-line floor plan software, but Geogebra is not specifically made for the purpose of making floor plans – it does not have all the tools available on a specialized software.)

Mathematics Performance Expectations
MPE.4: The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

MPE.7d: The student will use similar geometric objects in two- or three-dimensions to solve real-world problems about similar geometric objects.

Related SOL

8.11 The student will solve practical area and perimeter problems involving composite plane figures.

G.9 The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.
G.14.d Solve real-world problems about similar geometric objects.

NCTM Standards
- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems.
- Use visualization, spatial reasoning and geometric modeling to solve problems.

Additional Objectives for Student Learning (include if relevant; may not be math-related): None.

Materials/ Resources
- Computers with access to the internet.
- http://www.homestyler.com/designer
- (If the option for Geogebra is used, computers must have Geogebra loaded.)
- Graphing Calculators
- Document Camera (or similar device)
- Handout "Getting Started with Floor Plans."
- Handout "Floor Plan Summary".

Assumption of Prior Knowledge
- Students should have a basic understanding of quadrilaterals and their properties.
- Students should know or have access to formulas for the areas of basic geometric shapes.
- Students should be operating on Analysis level on Van Hiele scale with respect similar figures and scale drawing.
- Students should have been tasked with measuring their own bedroom in their home as well as at least one other room, to get an idea of actual room sizes. Students should make a rough drawing of their room and measurements.

Introduction: Setting Up the Mathematical Task
- In this lesson, students will create a one-story floor plan of a house and find the square footage of the house.
- This lesson should be completed in two 90-minute blocks.
- Students may never have seen a floor plan before, so in the "Getting Started with Floor Plans" Handout, there are two examples of single-story floor plans that the students and teacher can look over together, and the students can use these examples to learn how to read a floor plan.
- Have the students start thinking about their own homes (whatever kind it is) and then go beyond that to imagine what they would like to change, or add, to the current design. This will get the students thinking, as well as getting them to draw upon their prior knowledge (where they live).

- You may decide to have the students work in pairs or individually, but consider having them answer the following questions in a Think/Pair/Share activity.   1) What is your home like now? 2) What would you change about your home?

Student Exploration 1:

Individual Work Answer the questions 1) what is your home like now, and 2) what would you change about your home. The student should write their answers down, then Think/Pair/Share with a person near them.

Small Group Work The whole project can be done individually or in pairs, by the teacher's discretion.

Whole Class Work The students and teachers should go over the "Getting Started with Floor Plans" Handout together. The teacher should use a document camera, overhead or a computer and projector to show the floor plan examples and explain to the class how to read the floor plans.

Student/Teacher Actions:
- The teacher may decide to model how to start a floor plan with their students, depending on the level of computer ability their students possess.
- The teacher should remind the students that they measured their own bedroom as well as another room in their home, and to keep realistic measurements in mind for their floor plans.
- Each student (or pair) should get a computer and log onto the internet.
- Teacher should be walking around the room, monitoring the students' progress, offering assistance in using the software.
- Teacher should be able to answer questions the students have about their floor plan designs, and can help students by asking questions like, "Do you have a door?" "Is the door in a good location?" "What rooms do you have to go through to get to another room?" "Are there steps into the house?" "Is that a realistic size for that room?"
- Each group can show their floor plans to the class by using a document camera. Each group can highlight specific features of their floor plans.

Student Exploration 2:

Individual Work The whole project can be done individually or in pairs, by the teacher's discretion.

Small Group Work The whole project can be done individually or in pairs, by the teacher's discretion.

Whole Class Work The students and teachers should go over where to find formulas for the areas of the geometric shapes that were created in their floor plans.

Student/Teacher Actions:
- The teacher may decide to model how to find the square footage of a floor plan with their students.
- Each student (or pair) begins calculating the square footage of each room and recording the square footage on the "Getting Started with Floor Plans" Handout.
- Teacher should be walking around the room, monitoring the students' progress, offering assistance when needed.
- Students have practiced finding the areas of geometric shapes in Lesson 2 of this Unit and should be comfortable with the formulas.

Assessment
- Students will be assessed based on their completion of the "Getting Started with Floor Plans" Handout.
- Students will also be assessed on their answers to the "Floor Plan Summary" Handout. This includes writing about the assignment.
- There is no key due to the nature of the assignment and questions.

Extensions and Connections (for all students)
- This lesson follows a lesson on property acreage and will be followed by a lesson on creating a playground.
- This lesson is connected to architecture and technical drawing, and/or AutoCAD.
- This lesson is connected to building construction.

Strategies for Differentiation

- Students will be using visual and kinesthetic strategies in this lesson.
- Students could have another student read the directions to them if there were reading disorders present in the group.
- Students with a very high ability might enjoy trying a two-story floor plan, as it is more complex and requires more thought as to room/door/stair placement.

DINING
11'-5" x 16'
Vaulted Ceiling

**COVERED DECK/
SCREENED PORCH**
31'-8" x 10'-8"
Vaulted Ceiling

HEARTH ROOM
15' x 15'-11"
Vaulted Ceiling

Storage

SITTING
11'-4" x 9'-2"
Vaulted Ceiling

**MASTER
SUITE**
16' x 15'
Raised Tray Ceiling

FAMILY
16' x 19'
Raised Ceiling

KITCHEN
15' x 17'
Vaulted Ceiling

NOOK
9'-11" x 9'-4"

Shoes   Shoes

Dn

Linen

Lin

Desk

Pantry

DW

Up   Dn

Coats

74'-8"

BEDROOM 2
11'-0" x 16'-4"

BEDROOM 3
11' x 14'
Vaulted Ceiling

**COVERED
PORCH**
11' x 5'

BONUS ROOM
16'-5" x 31'-4"
Vaulted Ceiling
Bonus Sq Ft = 518

**3-CAR
GARAGE**
21' x 33'

71'-4"

Patio
20'-6" x 8'-10"

9' Clg. Ht.

Mstr. Clos.

Master Bedroom
14'-8" x 15'-0"
10' Clg. Ht.

Trayed Clg.

L

Shwr

9' Clg. Ht.

Covered Porch
18'-6" x 7'-8"

Breakfast
14'-0" x 13'-10"
9' Clg. Ht.

Optional Built-ins

Bedroom 3
12'-0" x 10'-6"
9' Clg. Ht.

Mstr. Bath
8'-10" x 16'-0"

Jet Tub

Gas Logs

10' Clg. Ht.

To Bonus
Up

9' Clg. Ht.

V

L

Great Room
18'-6" x 16'-0"
11' Clg. Ht.

Trayed Clg.

Bar

Half Bath

Hall 2

Hall 1

Bath 2
8'-0" x 7'-7"

Mstr. Clos.
8'-10" x 6'-0"

L

Kitchen
14'-0" 15'-6"

Ref.

Obl. Oven

Utility
6'-6" x 7'-2"

W

Sto. Under Stairs

Tub/Shwr

L

Island

D

10' Clg. Ht.

Storage
9'-2" x 4'-4"

WH

WH

Bedroom 2
12'-0" x 10'-6"
9' Clg. Ht.

Foyer
6'-2" x 10'-10"
10' Clg. Ht.

Flex Space
12'-0" x 10'-6"
10' Clg. Ht.
(Clear)

Pan.

D/W

Two-Car Garage
23'-10" x 22'-10"

Covered Porch
31'-6" x 8'-0"

It's Hip to Be Square

Most house plans are shaped with rectangles or squares, which makes calculating the square footage easy, whether you're measuring outside or inside the home. But what if you need to measure inside a house that has an odd number of walls and corners that aren't 90 degrees? That doesn't have to be difficult either. Just break it down into smaller rectangles, squares and triangles. Then determine the square footage of each individual section and add them together.

Square footage is a measurement of area, and area is the measurement of any two-dimensional space contained within a set of lines. Think of it in the sense of a dance floor. Take a moment to imagine a dance floor that is 20 feet by 20 feet (6.09 meters by 6.09 meters). How do we express the area that it takes up? This one is easy, because the dance floor is a square. We simply multiply the width of the floor by the length of the floor, 20 feet times 20 feet equals 400 square feet. Therefore, the total area of the dance floor is 400 square feet (37.2 square meters). The equation is the same for a rectangle.

Areas to Include When Calculating Square Footage

So you might think that you can just add all your measurements up, complete the calculations and be done, right? Not so fast -- that's how square footage can be confusing in the first place. It turns out there are several areas that shouldn't be included in your calculations.

First off, there's the matter of ceiling height. While you're not measuring the three-dimensional area of a room (length x width x height) to get your overall square footage, in order for a room to be included in the total square footage of a house, the ceiling must be a certain height -- so that crawl space doesn't count. To count in the square footage equation, a ceiling must be 7 feet (2.13 m) tall, or 6 feet 4 inches (1.9 m) with beams or any thing else that might hang down. If the ceiling is angled, it must be 7 feet or higher for at least half of the room's floor area. If it is, then any part of the room with a ceiling of 5 feet (1.52 m) or higher should be included [source: Boddy]. If not, you shouldn't include any of that space.

Outside, garages are not included, period. If the garage is attached to the house, the shared wall will serve as the outside wall of the house when determining square footage. The same goes for guesthouses, pool houses or any rooms that require you to leave the finished area of the main house to gain access. Whether they are finished or not, they cannot be included in the square footage of the main residence [source: Boddy]. They should be reported as "bonus rooms." However, if you have a finished area above an attached garage and you can get to it without leaving the house, go ahead and count it.

[Source: http://tlc.howstuffworks.com/home/measure-square-footage3.htm]

Making Your Floor Plan

Minimum Requirements:

What to do:

- 3 bedrooms
- 2 bathrooms
- Garage
- Kitchen
- Family room
- Dining room

1. Create your floor plan, using http://www.homestyler.com/designer or (Geogebra)
2. After reading the previous page about what to include in home square footage, begin calculating the square footage in the house you have laid out in the floor plan.
3. Fill in the chart below.

Room	Shape of Room	Square Footage	Room	Shape of room	Square Footage
Bedroom1			Family Room		
Bedroom 2			Dining Room		
Bedroom 3			Garage		
Kitchen			Optional		
Bathroom 1			Optional		
Bathroom 2			Optional		

Floor Plan Summary   Name_____

1. What special rooms (or special features in a room) did you include?

2. Why did you include these things?

3. After drawing your own floor plan, what would you advise someone else to AVOID when they draw their floor plan? WHY???

4. After drawing your own floor plan, what would you advise someone else to INCLUDE when they draw their floor plan? WHY???

5. What was the best or worst part of this assignment?

Rubric for the Floor Plan Lesson   Name_____

Category	3	2	1
Making Your Floor Plan Handout	Fully completed, has minimum room requirements	Mostly completed, and the think/pair/share activity was done correctly. Websites found are relevant	Partially completed, and the think/pair/share activity was done but not correctly. Websites found are somewhat relevant
Floor Plan Summary	Fully completed with thoughtful answers.	Fully completed, but with insufficient answers.	Partially completed.
Floor Plan Drawing	Drawing is done correctly, has the minimum number of rooms, square footage is correct.	Drawing is done correctly, has the minimum number of rooms, square forage is NOT correct.	Drawing is done correctly, has LESS than the minimum number of rooms, square forage is NOT correct
(Bonus Points) Artistic/Effort	Plan includes three extra rooms and/or a significant amount of "extras" in the floor plan.	Plan includes two extra rooms and/or a good amount of "extras" in the floor plan.	Plan includes one extra room and/or some "extras" in the floor plan.

Lesson 4 Playground

Strand
Geometry and Measurement

Mathematical Objectives
Students will design a playground to be used by the children who live in the subdivision they created in Lesson 2. Geogebra or Microsoft Word may be used for creating the playground layout, or any comparative software used for drawing.

Mathematics Performance Expectations
MPE.4: The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

MPE.7d: The student will use similar geometric objects in two- or three-dimensions to solve real-world problems about similar geometric objects.

G.14.d Solve real-world problems about similar geometric objects.

Related SOL

8.11 The student will solve practical area and perimeter problems involving composite plane figures.

G.9 The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

G.14.d Solve real-world problems about similar geometric objects.

NCTM Standards
- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems.
- Use visualization, spatial reasoning and geometric modeling to solve problems.

Additional Objectives for Student Learning (include if relevant; may not be math-related):
None.

Materials/ Resources
- Computers with access to the internet.
- (If the option for Geogebra is used, computers must have Geogebra loaded.)
- Calculators
- Document Camera (or similar devise)
- Handout "Playground Basics."
- Handout "Ready, Set, Play!"
- Teacher or students should get online and find a few playground manufacturers and request a catalog. This will make it much easier for the students to plan their layout. (It is hard to find prices online, so a catalog in hand might help speed the process.)

Assumption of Prior Knowledge

- Students should have a basic understanding of quadrilaterals and their properties.
- Students should know or have access to formulas for the areas of basic geometric shapes.
- Students should be operating on Analysis level on Van Hiele scale with respect similar figures and scale drawing.
- Students should be familiar with playgrounds and their set up and equipment.

Introduction: Setting Up the Mathematical Task

- In this lesson, students will create a layout for a community playground.
- This lesson should be completed in one 90-minute block – some of the background material should be done as homework the night before this class, using the "Playground Basics" Handout.
- The "Playground Basics" Handout will help students understand what safety features need to be considered in laying out a play area, as well as give them the opportunity to get ideas for the equipment they may want to include in their plan.
- You may decide to have the students work in pairs or individually, but having them talk about the answers to the "Playground Basics" Handout would work well in a Think/Pair/Share activity.
- If the students don't bring up safety zones around equipment (like swings) and the base (like rubber mulch) the playground is built on, the teacher should bring it into the wrap up of the Think/Pair/Share activity.

Student Exploration 1:

Individual Work: Complete Handout "Playground Basics". The student should then Think/Pair/Share with a person near them.

Small Group Work: The whole project can be done individually or in pairs, by the teacher's discretion.

Whole Class Work: The students and teachers should go over the "Playground Basics" Handout together. The teacher could choose to look at pictures or plans of playgrounds together with the class before beginning.

Student/Teacher Actions:

- The teacher should walk around the room, clarifying questions on the "Playground Basics" Handout.
- The teacher should facilitate the Think/Pair/Share activity done with the answers to the "Playground Basics" Handout.
- Each student (or pair) should get a computer and log onto the internet.
- Teacher should be walking around the room, monitoring the students' progress, offering assistance for the searches the students are doing for the end of the "Playground Basics" Handout.

- Once the "Playground Basics" Handout has been completed and shared, the students should begin building their playground. Geogebra (or a similar drawing software) should be used in conjunction with the Handout "Ready, Set, Play!" Handout.
- This is where the students would be able to use the catalogs that had been acquired previously. The students will use the catalogs to look for equipment they would like to include in their playground, and also to find out required areas, safety zones , age recommendations and prices.

Assessment

- Students will be assessed based on their completion of the "Playground Basics" Handout and the "Ready, Set, Play" Handout.
- There is a rubric attached to the "Ready, Set, Play" Handout.

Extensions and Connections (for all students)

- This lesson follows a lesson on floor plans and scale drawings.
- This lesson is connected to architecture and technical drawing, and/or AutoCAD.
- This lesson is connected to building construction.

Strategies for Differentiation

- Students will be using visual and kinesthetic strategies in this lesson.
- Students could have another student read the directions to them if there were reading disorders present in the group.
- Students with a very high ability might enjoy trying to get the most equipment SAFELY on the area they set aside for the playground, or getting the most for the least money.

Name_____ Date_____

PLAYGROUND BASICS

BEFORE you look anything up, answer the following questions

What pieces of equipment do you feel are important on a great playground?

_____ _____

_____ _____

BESIDES equipment, what else is necessary to create a great playground?

_____ _____ _____

_____ _____ _____

What are some safety concerns to think about?

_____ _____ _____

_____ _____ _____

Now that you have thought about this a little, get on the internet and do some research!

Some things to search for would be equipment, safety, age appropriateness, space required and costs.

List at least three websites that you visit during your research.

1._____

2._____

3._____

What did you search for and couldn't find?
_____

Ask someone else in the class if they were able to find anything you could not.

Someone else found
_____

Lesson 4   Name_____ Date_____

Ready, Set, Play!

In the subdivision you have created, you were to set aside an area for a playground. Now you are going to create it!

Things to keep in mind –
- Acreage for the whole playground – make sure it fits into the space you allocated in Lesson 2.
- Types of equipment.
- Age appropriateness – is the playground split up into age-areas.
- "Base" of playground – what material is the playground built on.
- "Safety" areas or space around the individual equipment.
- MINIMUM 10 pieces of equipment. (note – three swings on one pole set will count as one piece of equipment.
- Cost – you will have a budget of $25,000 (this will NOT include labor)

For this assignment you will turn in an itemized list, with prices, for the equipment. With each piece of equipment you must give the age- recommendations. On page 2 is an equipment/price list. List all the equipment you plan to use here, as well as the age-recommendations, cost and area (with safety zones taken into account) it takes up.

You will also need to make a scale drawing of the actual playground layout in Geogebra (or an equivalent drawing program). In the scale drawing, you should include the scale, any key you might develop for equipment, etc. Make sure your equipment has the appropriate safety zone around it to avoid injuries.

Include any benches, landscaping, etc, on the drawing and in the equipment list /price list.

Rubric for the assignment

Category	3	2	1
Playground Basics Handout	Fully completed, and the think/pair/share activity was done correctly. Websites found are relevant	Mostly completed, and the think/pair/share activity was done correctly. Websites found are relevant	Partially completed, and the think/pair/share activity was done but not correctly. Websites found are somewhat relevant
Equipment/Price List	Fully completed, correctly completed and within budget	Fully completed, but with errors, within budget.	Partially completed, with errors, over budget.
Scale Drawing	Drawing is done correctly, has minimum pieces of equipment, includes base of playground.	Drawing is done correctly, has LESS than the minimum pieces of equipment, includes base.	Drawing is mostly correct, has less than the minimum pieces of equipment, does not include base.
Artistic/Effort	Plan includes three or more extra things like benches, landscaping, picnic area, etc.	Plan includes two extra things like benches, landscaping, picnic area, etc.	Plan includes one extra thing like benches, landscaping, picnic area, etc.

Equipment/ etc.	Ages	Price	Area equipment takes up, including safety zones.
SAMPLE Summit Wall Climber	SAMPLE 4 - 8	SAMPLE $585.00	

Total your equipment		Total your area	
Budget	$25,000	Area Set Aside	
Under or over by		Under or over by	

Lesson 5 Pricing and Marketing the Subdivision

Strand
Measurement and Data Analysis and Probability

Mathematical Objective(s)
The students will calculate the acreage of the subdivision lots and the square footage of the floor plans. The student will collect data on current market values for similar lots and use the median to set a price for the subdivision lots. The students will collect data on current prices for building homes similar to the floor plans drawn in a previous lesson. The students will calculate the median price per square foot of home to use in determining price of the homes for the subdivision.

Mathematics Performance Expectation(s)
MPE.4: The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

MPE.8: The student will compare distributions of two or more univariate data sets, analyzing center and spread (within group and between group variations), clusters and gaps, shapes, outliers, or other unusual features.

MPE.23: The student will analyze the normal distribution. Key concepts include
   e) characteristics of normally distributed data;
   f) percentiles;
   g) normalizing data, using z-scores; and
   h) area under the standard normal curve and probability

Related SOL

8.11: Area of Plane figures

A. 9: Analyzing normal distribution and z-score

A.10: Comparing multiple univariate data sets

NCTM Standards List all applicable NCTM standards related to each lesson. Example:
* Apply and adapt a variety of appropriate strategies to solve problems
* Communicate mathematical thinking coherently and clearly to peers, teachers, and others
* <u>Formulate questions</u> that can be addressed with data and collect, organize, and display relevant data to answer them
* <u>Select and use</u> appropriate statistical methods to analyze data
* <u>Develop and evaluate</u> inferences and predictions that are based on data
* <u>Apply appropriate techniques</u>, tools, and formulas to determine measurements.

Materials/Resources
* Computers with access to the internet.
* Graphing Calculators
* Microsoft word
* www.architecture.about.com
* www.realtor.com (or some other local realtor's website)

Assumption of Prior Knowledge

- Students should have a basic understanding of quadrilaterals and their properties.
- Students should be operating on an analysis level on the Van Hiele scale.
- Students should research the property values to determine the price for their floor plans and acreage. They should use the research to determine the floor plans that are not cost effective and should begin thinking in terms of profit and economy.
- The subdivision plots and floor plans were created in prior lessons, so this lesson is focused on pricing them within current market values.
- Students should have good understanding of the subdivision plots and floor plans that were previously created, as well as the dimensions.
- Students will need to analyze current market values to determine an appropriate price for the lots and the homes that go on them.

Introduction: Setting Up the Mathematical Task

- In this lesson, the students will do research and work with statistics to set a price for the lots in the subdivision and the floor plans offered.
- This lesson should take about two 90 minute blocks for the best results of the work.
- Students should complete Handout A on their own to gather data. The other activities should be completed in pairs or groups of three for a final presentation.
- Introduction to the activity: You may want to introduce this part of the unit by having a building contractor or realtor speak on market pricing and values. If this is not possible or feasible, begin the discussion by commenting on the housing market. Ask if any of the students' parents have recently bought or sold a house or if any of them know a realtor. Get them talking about what makes house prices change and what makes a desirable neighborhood. These are all ideas that will need to be considered when completing this assignment.
- On Handout A: The students will research using www.architecture.about.com, www.realtor.com, or some other local realtor or builder's site. They will gather data on housing prices, lot prices and special features. The information gathered will be placed in the chart on Handout A to help the students keep the information organized and to be sure they are looking at the right pieces of information. Students need to look up at least 10 properties.
- Handout B: Students will gather the data from all of the group members and begin to calculate the statistics for the data.
- The final portion of this lesson is for the students to create a flyer advertising the subdivision and a selected floor plan for the group. Handout C will give the students the basic requirements for the flyer.

Student Exploration 1:

Individual Work

- Students should complete Handout A individually. This is the gathering of the data used in future portions of the lesson. They will need access to a computer with the internet.

Small Group Work

- The students should be put into small groups of two or three to compile the data using Handout B. They should then design the flyer for their group using the guidelines on Handout C.

Whole Class Sharing/Discussion

- Each group should present their flyers at the end of the lesson. The class as a whole should choose a few flyers to be part of the final subdivision.

Student/Teacher Actions:

- The students should compile the data on their own.
- Once placed in groups, the students should compile the data from each group member. Each group should choose one floor plan to price. Looking at the data, the group should choose 5-10 data samples that resemble their floor plan and calculate the median price per square foot. They should do the same thing for the lots to calculate the median price per acre on a lot.
- Once they have calculated the unit prices for the floor plan and lots, they need to calculate a total price for their floor plan and lot. The total square footage and acreage was calculated in Lessons 2 and 3.
- After calculating the total prices, the students should choose a name for the subdivision and design a flyer advertising the subdivision featuring the group's floor plan and the subdivision plot map. They can design the flyer by hand or using computer software.
- The students will complete a journal entry after Handout B to discuss the process of selecting data that is relevant to their floor plans. The teacher should walk around to aide in discussion and to prompt higher levels of thinking.

Assessment

- Journal Entry
    - Describe your thought processes in selecting the relevant data used to calculate price per square foot and acre.
    - What did you learn about price in relation to the size and features of a house?
- Rubrics for Handouts A and B are included below.
- A rubric for the journal entry is included below.
- A rubric for the flyer is included below.

Extensions and Connections (for all students)

- The students will research current local property values to determine an appropriate price range for the subdivision and floor plans designed in previous lessons.
- This lesson connects with ideas of economics, architecture and surveying.

Strategies for Differentiation

- ✓ Students that are at a lower level and are struggling with the research may need a little more specific direction from the teacher. If the teacher wishes, it is possible to provide data of property values and eliminate the research portion of the lesson.
- ✓ More advanced students can be asked to come up with a catchy slogan or marketing scheme for the subdivision as if they were going to be listing it with a realtor.

HANDOUT A: FILL OUT THE CHART USING LOTS AND HOMES FOR SALE ON A LOCAL REALTOR SITE.

*Be sure to note any special features on the floor plan that might affect the price.

for example: A swimming pool would raise the price.

Property Description	Square Footage	Price	Special Features

Property Description	Acreage	Price	Special Features

HANDOUT B: Choose 5-10 data samples that match your floor plan and lot and follow the calculations to determine median value.

Square Footage	Price		Price/Sq Ft

Find the median of the Price/Sq Ft Column:

$_____

Total cost of your chosen floor plan:

$ _____

(hint: Median $ * Total Sq.ft)

Acreage	Price		Price/Acre

Find the median of the Price/Acre Column:

$_____

Total cost of your chosen lot:

$ _____

(hint: Median $ * Total Acre)

HANDOUT C: Model for the advertisement flyer.

The following items must be included:
- Subdivision Name
- Chosen Floor Plan
- Subdivision Layout
- Total price for Floor Plan
- Total price for Lot

Subdivision Name

Floor Plan

$Price of house
$Price of Lot __

Subdivision Layout

Rubric for Journal Entries on Handout B

Score each student based on responses to the four criteria below. Add their points.
Maximum score is 40 points.

	0 points	5 points	7.5 points	9 points	10 points
Complete sentences/ Grammar	No sentences	Less than 50% are complete sentences, and many grammatical mistakes	Most sentences are complete, but have a few grammatical errors	All sentences are complete and most grammar is correct	All sentences have good structure and grammar is perfect
Ideas	No ideas or original thought	It is difficult to determine what entry is about	Ideas are somewhat organized but not very clear	Ideas are expressed well, but organization could have been better	Ideas are organized and flow well
Mathematical Vocabulary	No math terms are used	A few math terms are used, maybe some are used incorrectly	Correct vocabulary is used, but not every opportunity to use terms is optimized	Most of the necessary vocabulary is used correctly	All of the necessary vocabulary is used appropriately
Answered questions in the prompt	No ideas are related to the prompt	Less than 50% of the questions from the prompt are addressed	Most of the prompt is addressed, but some responses are short	90% of the prompt is addressed well	All of the prompt is answered well

Rubric for Handout A and B Combined

Use this rubric to grade each group's worksheet on calculating the unit price and total price for the square footage and acreage.

A. Students found property prices for at least 10 lots and 10 new homes (10 points)

_____

B. Students listed at least one special feature. (5 points)

_____

C. Students as a group chose at least 5 properties for data comparison. (5 points)

_____

D. Students calculated the unit price for each property correctly. (10 points)

_____

E. Students correctly calculated the median unit price for square footage and acreage. (10 points)

_____

F. Students calculated total price correctly. (10 points)

_____

Total points = _____ (out of 50 points)

Rubric for Handout C

Use this rubric to grade each group's final flyer advertising the subdivision.

A. Students came up with a creative name for the subdivision. (5 points)

_____

B. Students included all of the required information. (8 points each**)**

- Subdivision Name   _____

- Chosen Floor Plan   _____

- Subdivision Layout   _____

- Total price for Floor Plan   _____

- Total price for Lot   _____

C. The calculations are correct. (5 points)

_____

D. Students added creative design elements to make an attractive flyer. (10 points)

_____

Total points = _____ (out of 55 points)