The Puppy's Empire

I. UNIT OVERVIEW & PURPOSE:

The purpose of this unit is to use the adoption of a new dog of the teacher's choosing to connect geometry and algebra concepts to real world applications. These concepts include, but are not limited to, distance, equations of a circle, area of regular polygons, right triangle trigonometry, and evaluating functions.

II. UNIT AUTHOR:

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III. COURSE:

Mathematical Modeling: Capstone Course

IV. CONTENT STRAND:

Geometry/Algebra I/Algebra II

V. OBJECTIVES:

- The student, given the coordinates of the center of a circle and a point on the circle, will write the equation of the circle.
- The student will find area and perimeter of regular and irregular figures.
- The student will calculate distance given the formula.
- The student will evaluate functions.
- The student will find the equation of best fit for given data.
- The student will use a table of values to find the equation of best fit.
- The student will use right triangle trigonometry to calculate the measure of angles of elevation and depression.
- The student will use appropriate volume and surface formulas calculate the volume and surface areas.

VI. MATHEMATICS PERFORMANCE EXPECTATION(s):

MPE. 2: The student will collect and analyze data, determine the equation of the curve of best fit, make predictions, and solve real-world problems, using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.

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. 8: 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. 11 The student will use angles, arcs, chords, tangents, and secants to
a) investigate, verify, and apply properties of circles;
b) solve real-world problems involving properties of circles; and
c) find arc lengths and areas of sectors in circles.
MPE. 16: The student will investigate and analyze functions (linear, quadratic, exponential, and logarithmic families) algebraically and graphically.
MPE. 21: The student, given the coordinates of a circle and a point on the circle, will write the equation of a circle.
MPE. 22: The student will analyze graphical displays of univariate data, including dotplots, stemplots, and histograms, to identify and describe patterns and departures from patterns, using central tendency, spread, clusters, gaps, and outliers. Appropriate technology will be used to create graphical displays.

VII. **CONTENT:**
After adopting a new puppy, you have decided to install an invisible fence. What should the radius be for the fence? Where do the flags need to go? After the puppy has run around your yard for a few months, how much grass seed will you need to fix the patches? Using the dog's weight and height, can you predict how big the dog will be? If you are playing fetch with the dog from an above ground deck, what angle should you use? How far can you throw the toy so it remains in the "fenced area"? What size house should we build for our dog?

VIII. **REFERENCE/RESOURCE MATERIALS:**
- Classroom set of graphing calculators
- Graph paper
- Distance formula
- Area formulas
- Classroom set of laptops or iPads for internet access and Sketchpad or GeoGebra

IX. **PRIMARY ASSESSMENT STRATEGIES:**
- Written paragraph about discussion of the problem
- Calculate the distance from the center to the edge of the yard
- Write equations based on given information
- Evaluate functions
- Finding area
- Determining line of best fit
- Solving real world problems using right triangle trigonometry
- Solving volume and surface area problems

X. **EVALUATION CRITERIA:**
- A rubric will be used to include the main points of the discussion.
- Look for the use of the distance formula to calculate the fence position.
- Check equations for given information.
- Determine if functions are evaluated correctly
- Determine if area has been calculated correctly
- Check to see if the line of best fit has been calculated correctly

- Verify that right triangle trigonometry has been used correctly
- Verify that volume has been calculated correctly

XI. INSTRUCTIONAL TIME:

5 – 60 minute blocks

Lesson 1: The Puppy's Fence

Strand
Geometry

Mathematical Objective(s)
- The student will use the distance formula to determine the best position for a dog's invisible fence given the center of the circle.
- The student will write the equation of a circle given the center and after finding the radius.
- The student will calculate the area of the circle they found.

Mathematics Performance Expectation(s)

MPE. 21: The student, given the coordinates of a circle and a point on the circle, will write the equation of a circle.

Related SOL

SOL# G.12. (The student, given the coordinates of the center of a circle and a point on the circle, will write the equation of the circle.)

SOL# G.3 (The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation.)

NCTM Standards
- Analyze properties and determine attributes of two- and three-dimensional objects;

Materials/Resources
- Classroom set of graphing calculators
- Graph paper

Assumption of Prior Knowledge
- Students should have a mastery of the distance formula.
- Students should have a working knowledge of basic circle vocabulary – radius, center, etc.

Introduction: Setting Up the Mathematical Task

You have adopted a new puppy and decided to purchase an invisible electric fence. The fence will have a hub inside the home and you will need to set a radius so that dog can roam through a circular area of the front and back yard (remember your house falls in the middle of your lot) . We need to decide what to set the radius of the fence at to maximize our yard but not encroach on the neighbors. Assume that our lot is a square but the area enclosed by the fence will be circular.

- Individual work (10 minutes), small group discussion/work (30 minutes), whole class discussion (10 minutes)
- How many square feet are in an acre? If we are in the center of our lot, how far are we from the edge of the yard based on our square footage?
- Student will work in groups of 3-4 on this activity.
- Students should draw an overhead picture of the lot including the house.

Student Exploration:

- **Individual Work** – The individual student will determine what area of the yard will be enclosed by the invisible fence. The student must have a basic knowledge before entering small group work.
- **Small Group Work** - The students will construct the puppy play area using graph paper and pencils. They will need to choose the center of their circle to be the center of the puppy play area and the correct radius to determine the maximum amount of area they will be able to take advantage of for this use. The small groups of students will need to have discovered not only the correct center and radius of the circle but also the full equation of the circle used in constructing the puppy play area. $(x-h)^2 + (y-k)^2 = r^2$
- **Whole Class Sharing/Discussion** – The small groups will then come back together to discuss their equations and why they believe they will maximize the amount of yard the puppy will be able to play in.
  Student/Teacher Actions:
- **What should students be doing?** The students should be calculating the amount of area they have and how much room the puppy's play area can use without disrupting the neighbors as well as leaving room for the puppy to grow. We do not want the fence to reach the edge of the yard and encroach on the neighbors' property. They should be sketching the play area on graph paper and formulating an equation using their chosen radius and center.
- **What should teachers be doing to facilitate learning?** Teachers should be constantly monitoring the groups to ensure they are using the correct equation of circles, correct distance from the hub to the edge of the fence, and area formulas. They should also be

available for methodological questions but not hints on where to actually place the center or radius. If students are having trouble, they can use the textbook, internet, or classmates for help.

- **Possible questions** – Possible problems the students may face are those dealing with comparing the area of the yard to the amount of space the puppy play area can use without becoming a hindrance to the neighbors. Once the students choose the correct area and radius, they should be able to discover the correct equation quickly.
- **Technology Integration or Cooperative/Collaborative Learning Possibilities** – Students will be able to create the circle from their original sketches on Sketchpad or using GeoGebra software. They will need to draw the square lot and demonstrate the fence as a circle inside the lot.

Monitoring Student Responses

- o Students will communicate with their peers in a group discussion why they chose the center and radius they did.
- o Students will continue to use trial and error if their play area does not fit in the given allotment of land.
- o Teacher and/or students will record those chosen centers and radii that work and also those that will not work and why.
- o Teacher will also extend extra instruction to those struggling and will also re-shuffle the groups so that different ideas can be spread by different students into different groups.
- Summary
  - o Students will write a small paragraph, along with their play area drawing as an illustration, to summarize finding the correct equation of a circle for the puppy's play area.
  - o Students will turn in group work drawing and individual paragraphs to document their work.

Assessment

- **Exit Pass will be called "Peaks and Pits." This will be handed to the student as a chart template on paper. The student will list what the "peaks" (their favorite part or easiest part) of the lesson were and what the "pits" of the lesson were. This is not only what they didn't like but also what they did not understand.**

  Some ideas to think about when completing this chart:

- o   What did you like most about this lesson?
- o   What did you like least?
- o   What did you learn?
- o   What questions do you still have about the material covered in the lesson?

Exit Passes will be evaluated to see what each student learned and if they still have any questions about the material covered that day. If the students still have questions about the material covered, they will be addressed at the beginning of class the next day.

- Homework will be graded as a homework grade. It will determine how the students comprehended the information learned in class.

Extensions and Connections (for all students)
- Lesson extensions/follow-up
- Connections to content in other subject areas. Examples of these would be included in the "Peaks and Pits" portion of each lesson. Students will have to write complete sentences and organize ideas for this activity, therefore, it could be considered as grammatical work in English.

Strategies for Differentiation
- The exit pass is developed so that students are able to express themselves by word or by picture. They can list or draw a picture of their peaks or pits of the lesson. Another way the lesson is differentiated is the first part of the homework problems. This is a matching exercise. The students will just have to identify the formulas and know their "owner" rather than writing them out by memory. This is just a way the lesson is differentiated for different types of learners and different learning strategies.

Exit Pass – Homework 1

PEAKS	**PITS**

Homework – Lesson 1   **Part 1**

Match the correct formula to its owner:

1. Midpoint

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

2. Distance

$$\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$$

Homework – Lesson 1   **Part 2**

1. Find the distance between P(-7, 12) and Q(6, 5). Give an exact answer and an approximate answer to the nearest hundredth.

2. Find the coordinates of the midpoint of the line segment whose endpoints are P(-3, 10) and Q(6, -12).

Homework - Lesson 1   **Part 3**

1. center (0, 0); radius = 4

2.   center (2, 3); radius = 4

3. center (-1, -5); radius = 6

4.   center (8, -3); radius = 5

5. center (-9, 2); radius = 3

Answers for Homework – Lesson 1

Part 1

1. Midpoint

2. Distance

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$$

Part 2

1. 14.76
2. (1.5, -1)

Part 3

1. $(x-0)^2 + (y-0)^2 = 16$

2. $(x-0)^2 + (y-0)^2 = 16$

3. $(x+1)^2 + (y+5)^2 = 36$

4. $(x-8)^2 + (y+3) = 25$

5. $(x+9) + (y-2)^2 = 9$

Name _____

Date _____

Score out of 20 _____

Lesson 1: The Puppy's Fence

You have just gotten a new _____ (breed of dog). Throughout this unit, you will be solving problems involving your new puppy. The teacher will decide what type of dog you are to use, the lot size and the dimensions of the home. Use the same dog breed and lot size throughout the unit.

Below is an example of the overhead view of the yard that you will attempt to enclose by the electric fence.
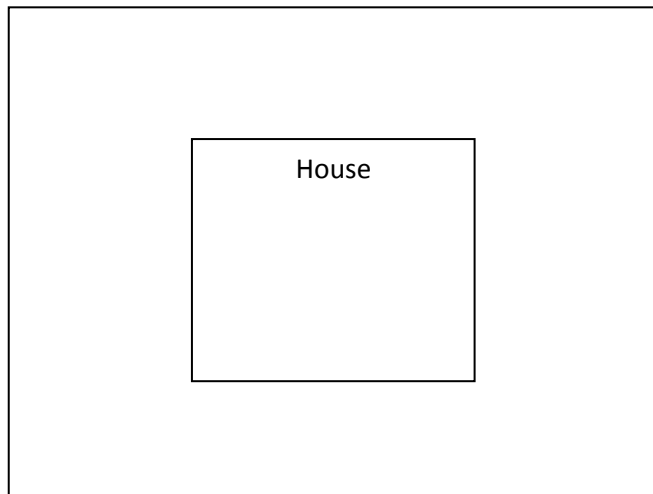
The hub of the electric fence needs to go in the center of your house. The center will serve as the origin. Based on the lot size your teacher has given you; calculate the equation of the circle using the center and radius found.

Center: (0,0)

Radius: _____

Equation of the circle: _____

Summarize your findings:

Lesson 2: "Looks like we're gonna need some grass seed…"

Strand
Geometry

Mathematical Objective
- The student will use area formulas to calculate the amount of ground that will need to be recovered with grass seed.

Mathematics Performance Expectation
MPE. 6: Use formulas for surface area and volume of three-dimensional objects to solve real-world problems.

Related SOL

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

NCTM Standards
- Analyze properties and determine attributes of two- and three-dimensional objects.
- Draw geometric objects with specified properties, such as side lengths or angle measures.

Materials/Resources
- Classroom set of graphing calculators
- Graph paper
- Colored Pencils
- Sketchpad or GeoGebra
- Use of a classroom set of laptops or iPads for internet research

Assumption of Prior Knowledge
- Students should have a working knowledge of basic area formulas.

Introduction: Setting Up the Mathematical Task

Your new puppy has torn up all the grass in the back yard and you need to buy seed and hay (straw) to plant more. How much area needs to be covered and how much is it going to cost? Referring to what you did in lesson 1, calculate the area of the

yard that has been enclosed by the fence. Remember the house is in the middle of the yard.

- Individual work (10 minutes), small group discussion/work (30 minutes), whole class discussion (10 minutes)
- What is the shape of our area? How do we find the area of this figure?
- Student will work in groups of 3-4 on this activity.
- Students should draw a picture of the space being reseeded and use this picture to aid in finding the area.

Student Exploration:

- **Individual Work** - The individual student should determine the shape of the space in question and how to find the area of the figure.
- **Small Group Work –** from the previous lesson, the students should construct the backyard area that needs to be reseeded using graph paper and colored pencils. They should also research how expensive grass seed and hay are to know what their costs will be (www.lowes.com or www.southernstates.com are good places to look). They will need to take into consideration how much area each bag of seed will cover.
- **Whole Class Sharing/Discussion** – The small groups will then come back together to discuss their findings and what amount of grass seed they'll need to purchase and how much it will be.
  Student/Teacher Actions:
- **What should students be doing?** The students should calculate the amount of area they have and how much the seed will cost. They should sketch the play area on graph paper and formulate an area and a cost.
- **What should teachers be doing to facilitate learning?** Teachers should be constantly monitoring the groups to ensure they are using the correct area formulas and they are staying on task while researching prices. They should also be available for methodological questions such as how to account for the house in the middle of the yard and how to calculate the total cost.
- **Possible questions** – Possible problems the students may face are those dealing with the irregularity of the figure since the house is in the middle of the yard. Once the students calculate the area correctly, they should move quickly through the task.
- **Technology Integration or Cooperative/Collaborative Learning Possibilities** – Students will be able to create the area of the circle on Sketchpad or using GeoGebra software as well as the internet to research prices. They should use Sketchpad or GeoGebra to verify the area they found.

Monitoring Student Responses

- o Students will communicate with their peers why they chose the area formula.
- o Teacher and/or students will record those areas and potential seed prices.
- o Teacher will also extend extra instruction to those struggling and will also re-shuffle the groups so that different ideas can be spread by different students into different groups.

- Summary
  - o Students will write a small paragraph, along with using their play area drawing as an illustration, to summarize finding the correct area of the yard.
  - o Students will turn in group work drawing and individual paragraphs to document their work.

Assessment

- **Exit Pass will be called "Peaks and Pits." This will be handed to the student as a chart template on paper. The student will list what the "peaks" (their favorite part or easiest part) of the lesson were and what the "pits" of the lesson were. This is not only what they didn't like but also what they did not understand.**

  Some ideas to think about when completing this chart:

  - o What did you like most about this lesson?
  - o What did you like least?
  - o What did you learn?
  - o What questions do you still have about the material covered in the lesson?

  Homework Questions
  PART 1, 2, 3, & 4 – Will be included on a Student-Ready Worksheet at the end of the lesson.
  PART 4
  The students will be given their most difficult task for this lesson in Part 4. **The students will be given the dimensions of the complete yard and the dimensions of the play area (the only part the puppy can use), then the students will have to find both areas and subtract the area of the puppy play area to determine the amount of area the residents have to use for their yard.** For example: to plant grass, flowers, and/or expand for the puppy's growth. **The dimensions of the yard are 15 ft. by 12 ft. and the puppy's play area has a radius of 5 feet**

Exit Passes will be evaluated to see what each student learned and if they still have any questions about the material covered that day. If the students still have questions about the material covered, they will be addressed at the beginning of class the next day.

- Homework will be graded as a homework grade. It will determine how the students comprehended the information learned in class.

Extensions and Connections (for all students)

- Lesson extensions/follow-up
- Connections to content in other subject areas

Strategies for Differentiation

- This lesson has somewhat less differentiation based on its practice methods. However, allowing the students to work in groups to identify the important parts of the circle and identifying the correct formula to use would be suitable for some students. Then, based on their progress, encourage them to begin to perform the calculations.

Exit Pass – Homework 2

PEAKS	PITS

Name : _____ (Homework pt 1, 2,3)

Find the area of each.

1.   5 in
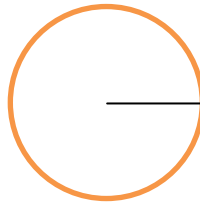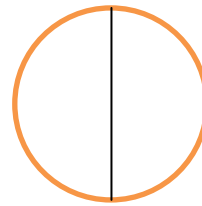
4 in

2.   6 m

3.

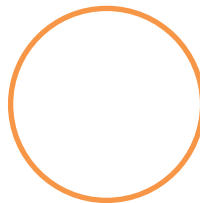Radius =

7 in.

4.

Diameter =

12 in.

5.

Area =

28.26 ft²

Find the radius.

6.

6 ft

Area = 120 ft²

Find the length.

Key for Worksheet (HW 1,2,3)

1. 20 in²
2. 36 in²
3. 153.94 in²
4. 113.1 in²
5. R = 3
6. 20 ft.

Rubric for Part 4 of Homework

	Provides Clear Understanding	Needs Improvement	Fails to Understand
Identifying the appropriate dimensions			
Using the correct formula			
Finding the area residents can use			
Drawing of extra land and what it can be used for			

Name _____

Date _____

Score out of 20 _____

Lesson 2: Looks like we're gonna need some grass seed…

Using the dimensions from lesson 1 for the lot, you will find the area of the grass within the dog's fence.

Below is an example of the overhead view of the fenced area with the house.
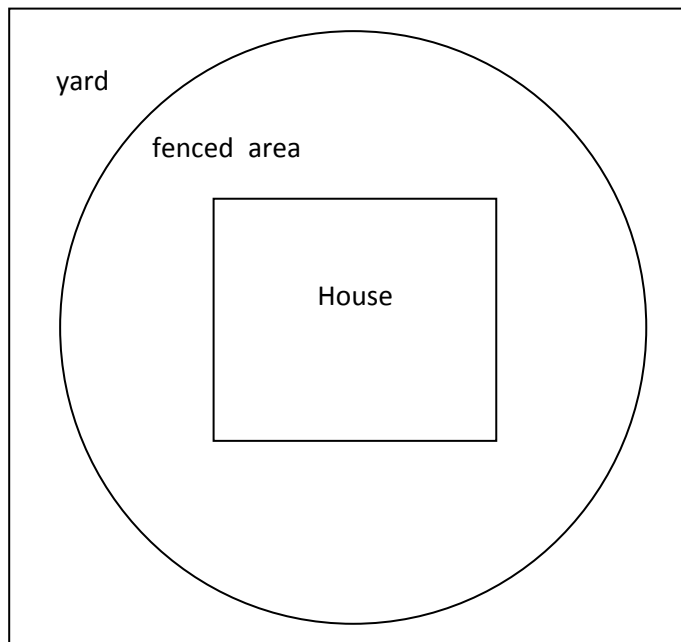
Using the radius from lesson 1, what is the area of the circle? The square? The grass?

Using your reputable online sources with your laptop or iPad, do some research and find out how much a bag of grass seed is? How many bags will you need? How expensive is hay? What amount will you need? What is your total cost?

Summarize your findings:

Lesson 3: Man, that dog is getting big!

Strand
Probability and Statistics

Mathematical Objective(s)
- The student will compare data by using various statistical displays.
- The student will make a scatter plot using data collected.

Mathematics Performance Expectation(s)

MPE. 22: The student will analyze graphical displays of univariate data, including dotplots, stemplots, and histograms, to identify and describe patterns and departures from patterns, using central tendency, spread, clusters, gaps, and outliers. Appropriate technology will be used to create graphical displays.

MPE. 8: 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.

Related SOL

SOL# PS.1 (The student will analyze graphical displays of univariate data, including dotplots, stemplots, and histograms, to identify and describe patterns and departures from patterns, using central tendency, spread, clusters, gaps, and outliers. Appropriate technology will be used to create graphical displays.)

SOL#PS.3   (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.)

SOL#PS.4 (The student will analyze scatterplots to identify and describe the relationship between two variables, using shape; strength of relationship; clusters; positive, negative, or no association; outliers; and influential points.)

NCTM Standards
- Understand histograms, parallel box plots, and scatterplots and use them to display data.
- Make conjectures about possible relationships between two characteristics of a sample on the basis of scatterplots of the data and approximate lines of fit.

Materials/Resources
- Classroom set of graphing calculators or Excel

- Classroom set of laptops or iPads for internet access

Assumption of Prior Knowledge
- Should have some knowledge of statistics such as measures of central tendency, finding the 5 number summary (Minimum, Q1, Median, Q3, Maximum), and how to construct a box and whisker plot.

Introduction: Setting Up the Mathematical Task

Your new dog is growing at an unbelievable rate and consuming tons of food. Can you write a prediction equation for the weight versus the food consumption? What kind of a model would it be? If you are not familiar with the amount of food a dog consumes, this website is a helpful tool. http://www.dogfoodadvisor.com/dog-feeding-tips/dog-food-calculator/ or http://www.beneful.com/Products/Dry-Dog-Food/Healthy-Growth/

- Individual work (10 minutes), Small group discussion about the weight of the dog and the amount of food they are consuming (30 minutes), whole class discussion (10 minutes)
- What are the dog's weight measurements and food consumption totals? Use the website from above for help.
- Student will work in groups of 3-4 of their own choosing on this activity.
- Students should draw a table to display the data.

Student Exploration 1:
- **Individual Work** – the individual student should organize the data provided by the teacher and draw a table that displays dog's weight versus the amount of food he consumes on a daily basis.
- **Small Group Work –** the students will use this data to make a scatter plot on the calculator as well as on paper and determine the line of best fit (or prediction equation). They will also research dog food prices to determine what the yearly expenditure will be for the food.
- **Whole Class Sharing/Discussion** – The small groups will then come back together to discuss their new equations and how much food they think the dog will be eating in the years to come as well as the cost. The class will discuss the form of the equation and whether or not this pattern will continue for the life of the dog.
  Student/Teacher Actions:

- **What should students be doing?** The students should be using the calculator to formulate the line of best fit from the table of values and then using the formula to make predictions about the future. They should be researching dog food prices so they can determine the yearly expenditure on dog food.
- **What should teachers be doing to facilitate learning?** Teachers should be constantly monitoring the groups to ensure they have found the correct equation. They should also be available for methodological questions such as how to get the prediction equation.
- **Possible questions** – Possible problems the students may face are those dealing with interpreting the slope correctly as well as setting up the formula correctly. The teacher should remind students what slope represents in terms of the problem (i.e. amount of food consumed verses weight)
- **Technology Integration or Cooperative/Collaborative Learning Possibilities** – Students will be using a graphing calculator or Excel to create a scatterplot and calculate the line of best fit as well as the internet to research dog food prices.

Monitoring Student Responses
  - Students will communicate with their peers how they determined the prediction equation in small group discussion.
  - Teacher and/or students will record the equations.
  - Teacher will extend extra instruction to those struggling and will also re-shuffle the groups so that different ideas can be spread by different students into different groups. Re-shuffling will be done to the teacher's discretion based on how the students seem to grasp these concepts.
- Summary
  - Students will write a small paragraph, along with using their table and the equation found. They will report their expected yearly dog food expenditure.
  - Students will turn in group work equation and individual paragraphs to document their work.
  - All work will be collected and checked for completion.

Assessment for Lesson

- **Exit Pass will be called "Peaks and Pits." This will be handed to the student as a chart template on paper. The student will list what the "peaks" (their favorite part or easiest part) of the lesson were and what the "pits" of the lesson were. This is not only what they didn't like but also what they did not understand.**

Some ideas to think about when completing this chart:

- o What did you like most about this lesson?
- o What did you like least?
- o What did you learn?
- o What questions do you still have about the material covered in the lesson?

Homework Questions are available in Student-Ready format at the end of this lesson.

- Exit Passes will be evaluated to see what each student learned and if they still have any questions about the material covered that day. If the students still have questions about the material covered, they will be addressed at the beginning of class the next day.
- Homework will be graded as a homework grade. It will determine how the students comprehended the information learned in class.

Extensions and Connections (for all students)

- Lesson extensions/follow-up
- Connections to content in other subject areas

Strategies for Differentiation

- This lesson has great potential for differentiation because of the graphing and charting that takes place in the homework section. Again, the students will be allowed to work in groups so they can capitalize on their strengths so they may contribute to the success of the group. The exit pass also allows for their strengths and weaknesses to be addressed by drawings and/or listing in word form.

Exit Pass – Homework 3

PEAKS	PITS

Name: _____

1. Students will graph the following on an X and Y axis:

x	1	1.5	2	3	3.5	4.5	5	6	8	8
y	5	6	7	5	6	5.5	5	2.5	3	4

2. Students will graph the following in a scatter plot:

Year	Population (thousands)
1970	1509
1980	2141
1985	2529
1987	2813
1988	2768
1989	2962
1990	3005
1991	3057
1992	3114
1993	3215
1994	3266

3. Students will draw a scatter plot of the data and construct a line of best fit.

x	−3	−2	−1	0	0.5	1	2	2.5	3.5	4
y	6	5	4	3	3.5	3	1	−2	−4	−3.5

4. Students will determine the line of best fit for the scatter plots below.
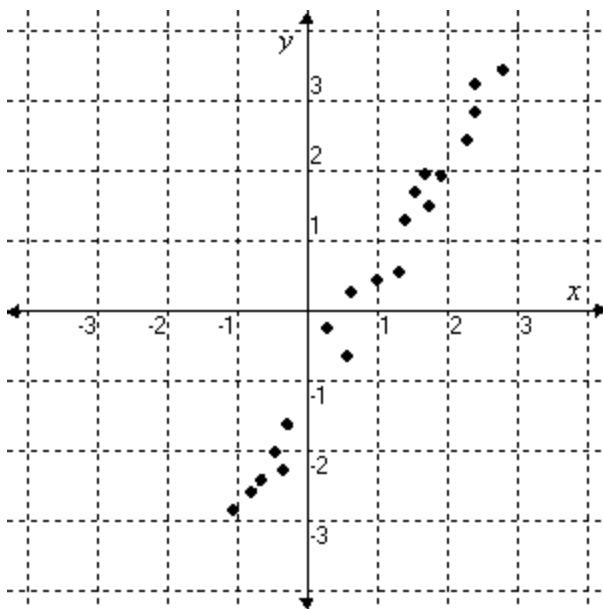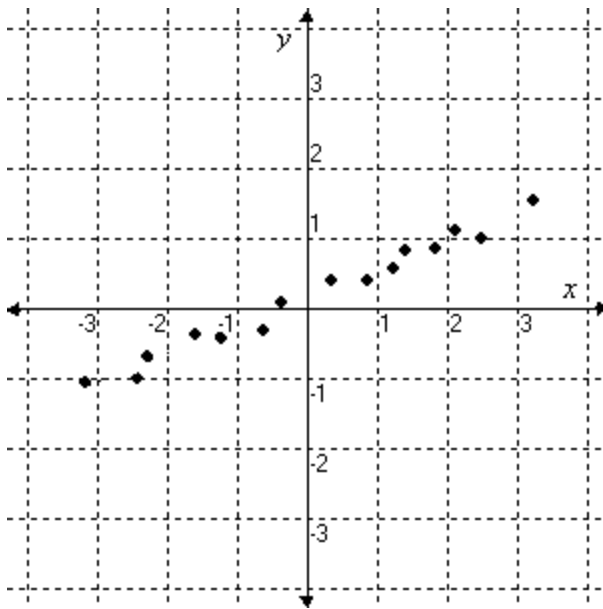
Name _____ Date _____

Quiz: Scatter Plots and Line of Best Fit

1. Variable p is the number of employees trained on new software, and variable q is the number of calls to the computer helpline. You suspect that more training reduces the number of calls. Does this follow positive correlation or negative correlation?

2. The table lists the number of population of a city from the year 1960 to 1995.

Population (by year)	1960	1964	1971	1982	1985	1993	1995
People (in thousands)	15	19.5	21	24	27	33	37.5

   a. Sketch a scatter plot of the data.

   b. Draw the line of best fit.

   c. What type of correlation does this graph show?

   d. Calculate the slope of the line through points (24, 1970) and (33, 1993).

   e. Write the equation of the line.

3. Create your own scatter plot based on the information below. Decide if it is a positive or negative correlation.

# of Correct Answers	1	2	3	4	5	6	7	8	9
Score (in %)	10%	20%	30%	40%	50%	60%	70%	80%	90%

Name _____

Date _____

Score out of 20 _____

Lesson 3: Man that dog is getting big!

Complete the table based on the breed of dog you chose in lesson 1. Go to www.beneful.com or http://www.aspca.org/pet-care/dog-care/feeding-your-puppy.aspx to find recommendations for feeding your puppy.

Age of dog (weeks)	Weight of dog (pounds)	Amount of food recommended daily (cups)
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		

What is the equation for the line of best fit? _____

Based on the equation, how much food can you expect your dog to consume daily during its 25th week of life? _____

Would this function be linear? Will the dog continue to eat more and more as he ages?

How much does a bag of dog food cost (make sure you record the size of the bag)? How long will it last based on the amount your dog consumes?

What are your findings?

Lesson 4: Fetch!

Strand
Geometry

Mathematical Objective(s)
- The student will apply the correct area formula for the shape.
- The student will use angles of elevation and depression to calculate the angle and/or distance an object will be thrown.

Mathematics Performance Expectation(s)
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

SOL# 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.)

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

NCTM Standards
- Analyze properties and determine attributes of two- and three-dimensional objects
- Draw geometric objects with specified properties, such as side lengths or angle measures

Materials/Resources
- Classroom set of graphing calculators

Assumption of Prior Knowledge
- Student should have knowledge of basic 2 dimensional area formulas such as rectangle, triangle, and circle.
- Student should have knowledge of right triangles including Pythagorean Theorem and right triangle trigonometry.

Introduction: Setting Up the Mathematical Task

Your dog really loves to play! Your task is to find the angle of elevation and depression that you can throw toys from the elevated deck that is attached to the

house. Also, you need to determine what area the dog can cover if he is contained by the invisible fence.

- Individual work (10 minutes), small group discussion/work (30 minutes), whole class discussion (10 minutes)
- What is the height of the deck? (this is determined by the teacher)
- Student will work in groups of 3-4 of their choosing on this activity.
- Students should draw a diagram of the yard including a right triangle from the dog to the deck.

Student Exploration:

- **Individual Work** – the individual student should organize the information obtained from the previous lessons and draw a diagram of the yard including the deck with a right triangle clearly displayed.
- **Small Group Work –** the students will use this data to calculate the angle of elevation and depression the toys should be thrown at so they will fall within the fenced area.
- **Whole Class Sharing/Discussion** – The small groups will then come back together to discuss their angles and area findings.
  Student/Teacher Actions:
- **What should students be doing?** The students should be using the calculator to find the correct angle measure (in degrees) and the correct area the toys can be thrown into so their dog can access them while confined by the fence.
- **What should teachers be doing to facilitate learning?** Teachers should be constantly monitoring the groups to ensure they are using the correct formulas. They should also be available for methodological questions.
- **Possible questions** – Possible problems the students may face are those dealing with interpreting the angle correctly as well as computing the area correctly.
- **Technology Integration or Cooperative/Collaborative Learning Possibilities** – Students will be using a graphing calculator to compute the sine, cosine, and tangent of the angles as well as the arcsine, arccosine, and arctangent.

Monitoring Student Responses
  o Students will communicate with their peers in small group discussion how they determined the angle measure and area.
  o Teacher and/or students will record the equations.

- Teacher will also extend extra instruction to those struggling and will also re-shuffle the groups so that different ideas can be spread by different students into different groups.
- Summary
  - Students will write a small paragraph about their findings using the angle measures they have found as well as the area they computed.
  - Students will turn in group work angle measure and area as well as individual paragraphs to document their work.

Assessment for Lesson

- **Exit Pass will be called "Peaks and Pits." This will be handed to the student as a chart template on paper. The student will list what the "peaks" (their favorite part or easiest part) of the lesson were and what the "pits" of the lesson were. This is not only what they didn't like but also what they did not understand.**

  Some ideas to think about when completing this chart:

  - What did you like most about this lesson?
  - What did you like least?
  - What did you learn?
  - What questions do you still have about the material covered in the lesson?

    Homework Problems will be available at the end of the lesson on Student-Ready worksheets.

- Exit Passes will be evaluated to see what each student learned and if they still have any questions about the material covered that day. If the students still have questions about the material covered, they will be addressed at the beginning of class the next day.
- Homework will be graded as a homework grade. It will determine how the students comprehended the information learned in class.

Extensions and Connections (for all students)
- Lesson extensions/follow-up
- Connections to content in other subject areas

Strategies for Differentiation

- To differentiate instruction for this lesson, the teacher may need to aid the students with drawing their right triangle and allowing them to verbally express what sides are given a specific measurement and which need to be solved. As always, the students will also be able to express their strengths and weaknesses in the "exit pass" portion of the lesson.

Exit Pass – Homework 4

PEAKS	**PITS**

1. A rectangular plasma TV screen has a width of 40 inches and a diagonal of 52 inches. Find the height of the TV screen. Round your answer to the nearest tenth of an inch.
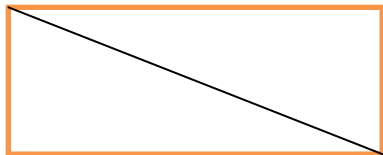
2. To get from point A to point B you must avoid walking through a pond. To avoid the pond, you must walk 34 meters south and 41 meters east. To the *nearest meter*, how many meters would be saved if it were possible to walk through the pond?

A

pond

B
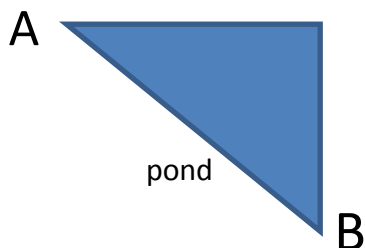
3. Chris went to Cape Canaveral to watch the space shuttle take off. The solid rocket boosters are ejected after the shuttle passes through the threshold of space. This is scheduled to occur when the shuttle reaches a height of 354,200 feet. If Chris is 10 miles from the launch pad, at what angle will he have to look up to see the boosters ejected?

354,200 ft

← Angle of Perspective

10 feet away
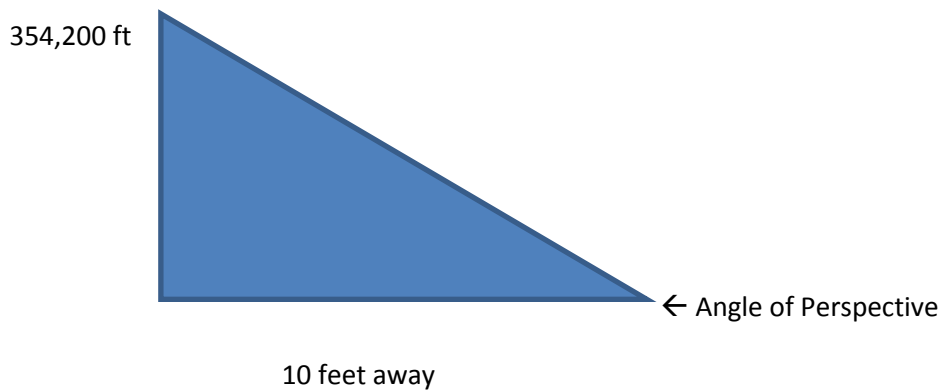
Key for Worksheet

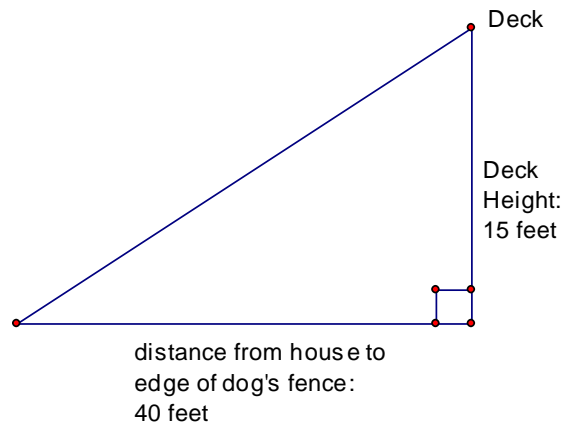1. 33. 23 inches
2. 53.26 meters
3. 89.9° almost 90° angle of elevation

Name _____

Date _____

Score out of 20 _____

Lesson 4: Fetch!

Below is a right triangle representing the deck's elevation above ground.

Deck

Deck
Height:
15 feet

distance from house to
edge of dog's fence:
40 feet

What is the angle of elevation?

If you are on the deck, how far will you throw the toy so that it reaches the edge of the dog's space?

Suppose the dog is standing 25 feet from the base of the house. What is the angle of depression to the dog?

Summarize your findings:

Lesson 5: The Puppy's New Palace

Strand

Geometry

Mathematical Objective(s)

- The student will use surface area formulas to compute surface area of a dog house so they can determine how much material they will need for construction.
- The student will find the volume of the dog house to ensure that it is large enough for the needs of their dog.

Mathematics Performance Expectation(s)

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

Related SOL

SOL# G.13 (The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.)

NCTM Standards

- Analyze properties and determine attributes of two- and three-dimensional objects;
- Draw geometric objects with specified properties, such as side lengths or angle measures.
- Understand, select, and use units of appropriate size and type to measure angles, perimeter, area, surface area, and volume.

Materials/Resources

- Classroom set of graphing calculators
- Classroom set of laptops or iPads for internet access

Assumption of Prior Knowledge

- Student should have knowledge of surface area formulas.
- Student should have knowledge of volume formulas.

Introduction: Setting Up the Mathematical Task

Once it gets colder, your dog needs somewhere warm to sleep. In this task, you will be finding a design or designing a dog house as well as figuring out how much

material you will need and determining the expected expenditure on the materials. Here is a useful site to find plans for the dog house: http://www.doghouseplans.com/

- Individual work (10 minutes), small group discussion/work (30 minutes), whole class discussion (10 minutes)
- What are the dimensions of the house? What is the volume and surface area of the dog house?
- What materials do you need? How much can you expect to spend on materials? www.lowes.com is a good place to start
- Student will work in groups of 3-4 of their own choosing on this activity.
- Students should draw a 3D and a net diagram by hand or using Sketchpad or GeoGebra of the house from their internet research.

Student Exploration:

- **Individual Work** – the individual student should research dog house designs and bring ideas to their group.
- **Small Group Work –** the students will decide on a design and find the volume and surface area so they know how much material they will need to purchase. They need to research building materials so they know the expected expenditure on the project.
- **Whole Class Sharing/Discussion** – The small groups will then come back together to discuss their volume and surface area findings as well as how much money they expect to spend on materials.
  Student/Teacher Actions:
- **What should students be doing?** The students should be using the internet to find dog house plans, or may design their own, and finding building material prices. They should be using the graphing calculator to calculate the volume and surface area of the house.
- **What should teachers be doing to facilitate learning?** Teachers should be constantly monitoring the groups to ensure they are using the correct formulas. They should also be available for methodological questions.
- **Possible questions** – Students may face problems dealing with using the formulas correctly as well as computing the costs correctly. They may also have trouble determining what materials they will need.
- **Technology Integration or Cooperative/Collaborative Learning Possibilities** – Students will be using a graphing calculator as well as the internet to research dog house plans and building material costs.

Monitoring Student Responses
- o Students will communicate with their peers how they determined the volume and surface area as well as their costs.
- o Teacher and/or students will record the findings.
- o Teacher will also extend extra instruction to those struggling and will also re-shuffle the groups so that different ideas can be spread by different students into different groups.

- Summary
  - o Students will write a small paragraph, along with their dog house plans and volume and surface area calculations.
  - o Students will turn in group work findings and individual paragraphs to document their work.

- **Exit Pass will be called "Peaks and Pits." This will be handed to the student as a chart template on paper. The student will list what the "peaks" (their favorite part or easiest part) of the lesson were and what the "pits" of the lesson were. This is not only what they didn't like but also what they did not understand.**

  Some ideas to think about when completing this chart:

  - o What did you like most about this lesson?
  - o What did you like least?
  - o What did you learn?
  - o What questions do you still have about the material covered in the lesson?

- Exit Passes will be evaluated to see what each student learned and if they still have any questions about the material covered that day. If the students still have questions about the material covered, they will be addressed at the beginning of class the next day.
- Homework will be graded as a homework grade. It will determine how the students comprehended the information learned in class.

Extensions and Connections (for all students)
- Lesson extensions/follow-up
- Connections to content in other subject areas

Strategies for Differentiation
One key strategy for differentiation in this lesson is to stress to the students that they can separate the composite figures to find the individual areas or volumes and them put

them back together so that they do not feel as overwhelmed with determining which of the formulas to use. Another strategy to help the students would be to start with a categorizing prisms, pyramids, and cylinders so they will be able to identify them on the formula sheet
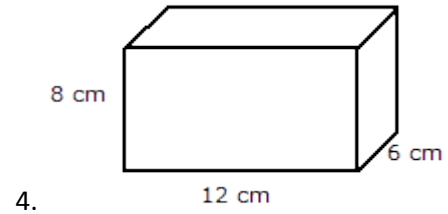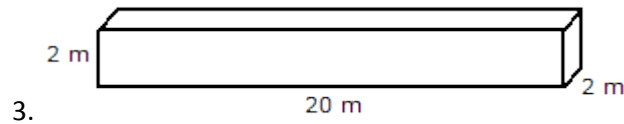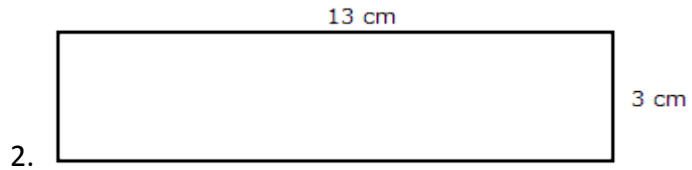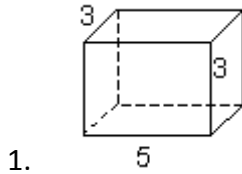
Exit Pass – Homework 5

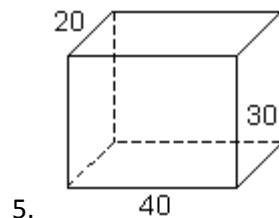|	
PEAKS	PITS

Worksheet for Homework 5

Name: _____ Date: _____

Students will be reviewing simple area and volume problems.
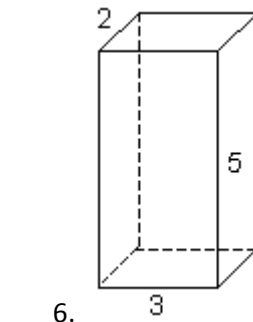Find the volume of #1 and area of #2
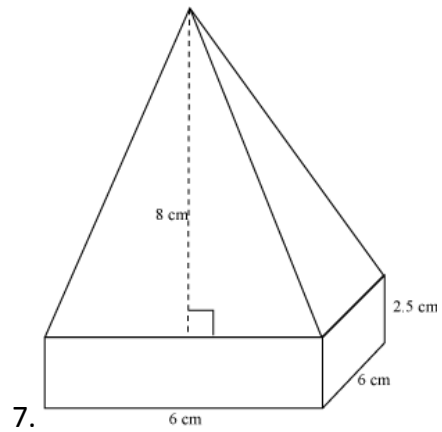
1.

2.

3.

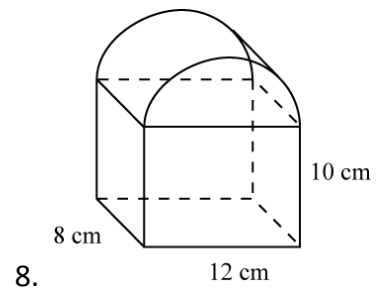surface area = _____

4.

surface area = _____

5.
Volume = _____

6.
Volume = _____

8 cm

2.5 cm

6 cm

6 cm

7.

Surface area = _____

10 cm

8 cm

12 cm

8.

Volume = _____

Key for Homework Worksheet (pt. 1, 2, 3, and 4)

1. 45 units^2
2. 65 cm^2
3. 80 m^2
4. 432 cm^2
5. 24,000
6. 30
7. 141
8. 1864.8

.

Name _____

Date _____

Score out of 20 _____

Lesson 5: The puppy's new palace

Today you will be designing or finding a design for a dog house. Go to http://www.doghouseplans.com/ for choose one that you like or create your own. Sketch the outline of the house below or use Sketchpad or GeoGebra and print it out.

Design:

What type and how much material will you need? (Don't forget the roof!)

_____

What is the total square footage of your dog house? _____

How much do you expect to spend on materials? Go to www.lowes.com to find prices. _____

What would be the volume of your house? _____

Summarize your findings:

Name _____

Teacher Grading Rubric:

Each lesson is worth 20 points totaling 100 points.

For each lesson:

5 points for labeling their drawing or completing the table correctly.

5 points for answering the questions associated with the drawing or table correctly.

5 points for doing their summary.

5 points for the individual assessment (homework).