

FIFTH GRADE GARDEN BASED CURRICULUM

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UNIT 1: Precipitation and Water Conservation

Note: This unit will be most effective after students have a decent understanding of decimals and have had practice multiplying with decimals.

Unit Summary:

In this unit, 5th grade students will learn the importance of water, identify ways to conserve it, and calculate the amount of water contained in cisterns at our school.

Lesson Summaries:

Lesson 1~ Historical Yearly Precipitation

Teacher introduces unit of study to students. Students will study data about historical rainfall totals in Tucson. Students will create line graphs depicting rainfall totals for Tucson in 30-year blocks of time. Students will describe trends they see in the graphs and make predictions for rainfall totals for upcoming years.

Lesson 2~ How Can We Conserve Water

Students will create graphic organizers that show where water is used at their home, how water is conserved, and how water is wasted. Students will also select one or two areas at school where water is used, how it is conserved, and how it is wasted. Students will commit to one specific water conservation effort at home. During writing class, students will compose an essay on the topic: "What are some ways your family can conserve water at home?"

Lesson 3~ Measuring Circles

Teacher tells class that the next few lessons will focus on and prepare them to think about the rainwater cisterns we have at Manzo, specifically how to measure the volume of water in each. To prepare students to find the volume of water in our cisterns, students will first estimate the area of a variety of circles. They will record the circumference, radius, and area of their circles. They will make line graphs to look for the multiplicative relationship between diameter and circumference.

Lesson 4~ Measuring Cylinders

Students will now use the formula to find the area of the circles they estimated the area of in the last lesson. Students will compare their estimates to their more precise measurements using the formula.

Lesson 4~ Measuring Cylinders (Part 2)

Students will calculate the volume of their cistern.

Lesson 5~ How Much Water is in the Cistern?

Students will calculate volume for fractional capacities of their cistern and label these fractional volumes on their cistern.

Lesson 6~ Why Do We Store Rainwater?

Students will plot the results of each cistern's volume at Manzo on a graph. Students will calculate the total storage capacity we have for rainwater. Students will create posters that describe why we have cisterns, how they benefit our school, and that detail some of the facts and measurements they have learned about them

Precipitation and Water Conservation

Lesson 1~ Historical Yearly Precipitation in Tucson

Teacher:

Grade Level: 5

Date:

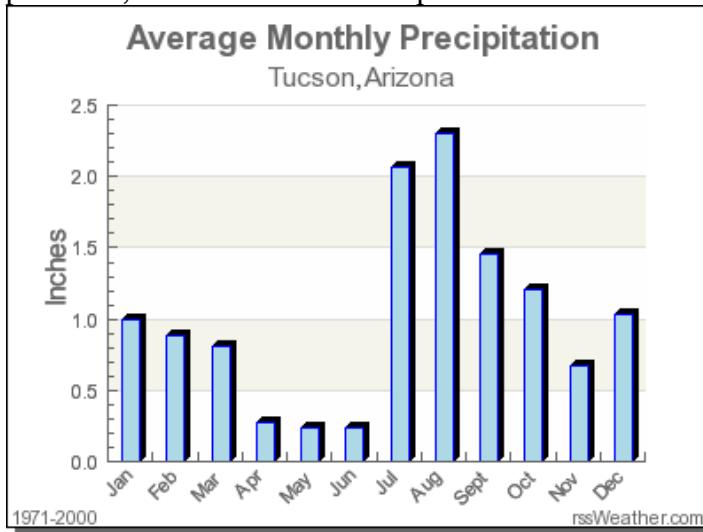
Author: Wes Oswald

Common Core Standard:	<p>5. NBT.3 Read, write, and compare decimals to thousandths.</p> <p>5. G.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.</p>
Ecology Objective:	Students will graph historical yearly precipitation for Tucson and note trends.
Enduring Understandings and Essential Questions	<p>Climate: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate.</p> <ul style="list-style-type: none">•How does regional climate affect the way we live? <p>Interconnectedness (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system.</p> <ul style="list-style-type: none">•How does our region's climate affect our culture?
Content Objective: <i>Math Reading Writing Other:</i>	<ul style="list-style-type: none">•Students will plot historical yearly rainfall data as a line graph on a coordinate grid.•Students will read, write, and compare decimals to the hundredths place value.
Language Objective:	

Vocabulary	Materials			
Axes, coordinate system, origin, ordered pairs, coordinates, x-axis, y-axis, precipitation	<ul style="list-style-type: none">•Graph paper•Historical yearly precipitation totals for Tucson (see accompanying documents)			
Seasonality: This lesson/unit would work during any season, as it is not reliant on any natural phenomenon.				
Monsoon July-Sept.	Autumn Oct.-Nov.	Winter Dec- Feb.	Spring Mar.-Apr.	Dry Summer May-June
Guiding Questions: Which year had the most/least precipitation? How much more/less precipitation fell in _____ year compared to _____ year? What trend does your graph show?				

Anticipatory Set:

Study the graph below, and then answer the questions.



- What is this graph about?
- During which month(s) do we get about 2 inches of rain?
- During which month(S) do we get about 1.25 inches of rain?
- During which months does the least rain fall? About how much rain falls during each of these months?

Activity/Investigation:

- After discussing Anticipatory Set responses...Tell students that in Tucson, we have two rainy seasons—the winter rainy season and the monsoon season. Ask students to identify the months during which each of these seasons fall (*Generally*, winter rains are from December through March and Monsoon is July and August—there is of course, variation from year to year).
- Distribute copies of historic “Yearly Rainfall for Tucson”. Encourage students to spend a few minutes just studying it and looking for anything interesting they notice. Then ask students to share their discoveries. If needed, give a mini lesson on place value to the hundredths. After you have given a few examples from the data, have class chorally read off selected monthly/yearly rainfall totals reading the decimals as fractions. Give the class three different years to find the yearly precipitation totals for and to work with a partner to order them from least to greatest. Select a yearly precipitation total and demonstrate to students how to write it in expanded form.
- Tell students that today they will use the data in front of them to create multiple line graphs showing yearly precipitation totals for Tucson from 1895 year to 2012. Each group will get a predetermined segment of time (25 years?), the class will decide on standard increments to use on each graph, and then connect the graphs to create one long line graph representing yearly rainfall in Tucson for over 100 years.
- Make sure students can (as accurately as possible) represent decimals on the graph. Tell students to use benchmark fractions/decimals as guides ($\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, 1) to help them

estimate where a point should go for each year. Encourage the students to start with easy decimals first. Remind students that their graph needs an appropriate title and labels. Guide the class in a discussion that will allow them to reach consensus on what increments to count by and use on the y axis for rainfall (should each line represent one inch, two inches, or half an inch?) and what kind of spacing to use on the x axis between years (should each line be a year, or should we skip every other line). **This is important so that the graphs can be lined up and read as one large graph.** Once students have completed graphing (and with your approval) they should use a ruler to connect the points from year to year.

5. On the board, write the following questions for students to respond to underneath their graph or in their journals:
 - a. Which year had the greatest precipitation? Write this in both expanded form and word form.
 - b. Which year had the least precipitation? Write this in both expanded form and word form.
 - c. Identify 2 years that had extremely similar amounts of precipitation. Exactly what was the difference in precipitation between those two years? (Show your work!)
 - d. Do you see any patterns or trends in total yearly rainfall in the last 10 years? Why does this matter?
 - e. What seems like a *typical* amount of rain in a year? How can you tell?
 - f. Describe anything else interesting you notice about what your graph shows or any questions you have or things you are wondering about.

6. Once enough time has been allotted for graphing and writing tell students to do the following:

- a. Place a small dot near one of the questions you're not sure if you answered correctly.
- b. Stand up and share your graph and your responses with another student at a different table.
Make sure that partnerships first discuss their questions that have dots next to them.
- c. Then partnerships can take turns sharing their graphs and responses with each other.

7. Have students return to their own seats. Then review answers to questions a-f, making sure to give students opportunity to discuss their findings for question f.

Closure:

Pose the following questions to the class:

- What's the most interesting thing you learned about precipitation in Tucson?
- How does the graph help you to understand the data better?

Hand out scraps of paper to students. Each paper should be randomly pre-color coded in four or five colors of your choice. Students will write their responses on their paper. After a few minutes, have students stand up, find a classmate with a paper of a matching color to share their writing with. Then select a few students to share their ideas. Collect all student responses.

Teacher Reflection:

Precipitation and Water Conservation

Lesson 2~ How Can We Conserve Water?

Teacher:

Grade Level: 5

Date:

Author: Wes Oswald

Common Core Standard:	<p>5.W.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information.</p> <p>5.NBT.3 Read, write, and compare decimals to thousandths.</p> <p>5.SL.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade five topics and texts, building on others' ideas and expressing their own</p>
Ecology Objective:	Students will think of ways their families can conserve water at home.
Enduring Understandings and Essential Questions	<p>Climate: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate.</p> <ul style="list-style-type: none">•How does regional climate affect the way we live?•How can we modify our culture to be more harmonious with our climate? <p>Interconnectedness (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system.</p> <ul style="list-style-type: none">•How does our region's climate affect our culture?
Content Objective: <i>Math</i> Reading Writing Other:	<ul style="list-style-type: none">•Students will complete a graphic organizer to plan an essay.•Students will communicate clearly with one another to share ideas.
Language Objective:	

Vocabulary	Materials			
conservation	<ul style="list-style-type: none">•Graphic organizer (see accompanying documents)			
Seasonality: This lesson/unit would work during any season as it is not reliant on any natural phenomenon.				
Monsoon July-Sept.	Autumn Oct.-Nov.	Winter Dec- Feb.	Spring Mar.-Apr.	Dry Summer May-June
Guiding Questions: How can you conserve water in the _____ room?				

Anticipatory Set:

Study the table below. Then answer the questions.

U.S. City	Average Annual Precipitation
Dallas, TX	34.73
Jacksonville, FL	52.34
Las Vegas, NV	4.49
New Orleans, LA	64.16
Phoenix, AZ	8.3
Philadelphia, PA	42.05
New York, NY	49.69
San Francisco, CA	20.1
Tucson, AZ	12.17
Tulsa, OK	42.4

- a. What kind of information does this table display?
- b. Which city receives the most rainfall? The least?
- c. Which city gets less than half the rain we do?
- d. Which city has more precipitation—Philadelphia or Tulsa? How much more?

Activity/Investigation:

1. After discussing Anticipatory Set responses...Tell students that today they will be using graphic organizers to organize their ideas about how their family can conserve water. They will use the ideas here to write a five paragraph persuasive essay during writing class on the topic, “What are ways my family can save water at home?” The intended audience for this essay will be to their parents/guardians. Distribute the graphic organizers and have students study it. Tell students that for each section, they are to write how water is used (ie: toilet, washing machine, orange tree, etc.), how it’s conserved (put a brick in your toilet tank, wash only full loads, direct water from gutters to orange tree basin, etc.), and how it’s wasted (the toilet runs, sometimes we don’t wash full loads of laundry in the washing machine, sometimes we forget to turn off the irrigation for the orange tree). Place the graphic organizer under the document camera and provide an example for students. Give students about 15 minutes to complete the graphic organizer themselves.
2. After students have completed the graphic organizer, have them get with a partner and share their ideas. Tell them that if their partner has an idea you like or didn’t think about, you can add it to your list too.
3. Have students share out innovative ideas they’ve added to their graphic organizer and compile information using your copy. Please share ideas you have as well if students didn’t think of them.

Closure:

Direct students to the bottom portion of their graphic organizer with the three questions:

- What's a way your family is good at conserving water?
- Describe the easiest way your family could conserve more water. Why would this be easy?
- Where at home would it be more challenging for your family to conserve water? Why would this be challenging?

Ask students to respond to these questions. After about five minutes, have students share responses with their table groups. Then ask the class for some of their responses.

Teacher Reflection:

Precipitation and Water Conservation

Lesson 3~ Measuring Circles

Teacher:

Grade Level: 5

Date:

Author: Wes Oswald

Common Core Standard:	5. OA.3 Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane.
Ecology Objective:	In preparation to calculate the volume of our cisterns, students will measure circles and determine their area.
Enduring Understandings and Essential Questions	Climate: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate. •How does regional climate affect the way we live? •How can we modify our culture to be more harmonious with our climate? Interconnectedness (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system. •How does our region's climate affect our culture?
Content Objective: <i>Math Reading Writing Other:</i>	•Students will measure circles to the nearest inch. •Students will estimate the area of circles. •Students will create a line graph showing the relationship between a circle's diameter and its circumference.
Language Objective:	

Vocabulary	Materials
Radius, diameter, circumference, area, volume, pi, multiplicative, formula, irrational number	•graph paper •string and rulers or •flexible measuring tape •class set of Measuring Circles Table (see accompanying documents). •class set of Circles Sheet (see accompanying documents) •Circle Sheet Teacher Edition (see accompanying documents)

Seasonality: This lesson/unit would work during any season, as it is not reliant on any natural phenomenon.

Monsoon
July-Sept.

Autumn
Oct.-Nov.

Winter
Dec- Feb.

Spring
Mar.-Apr.

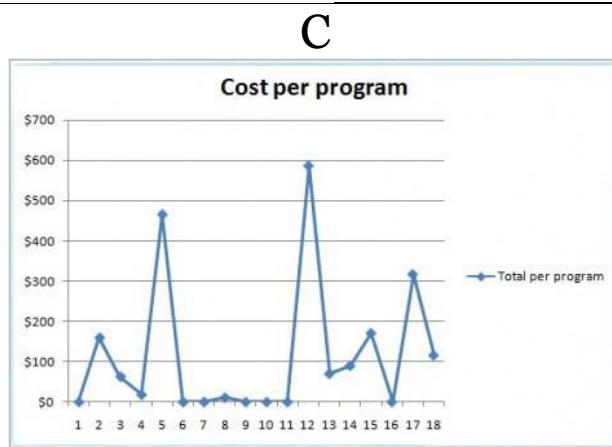
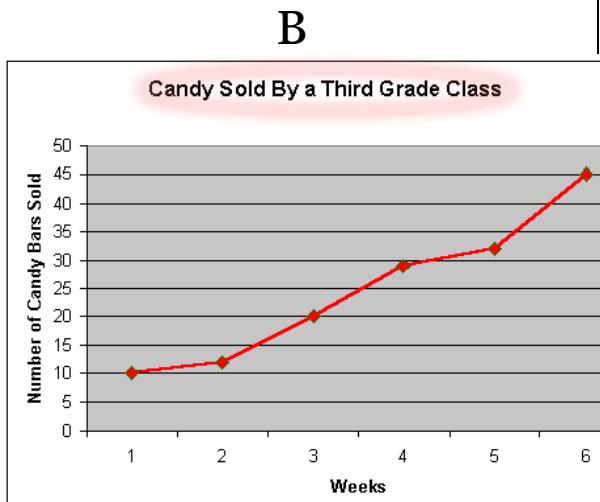
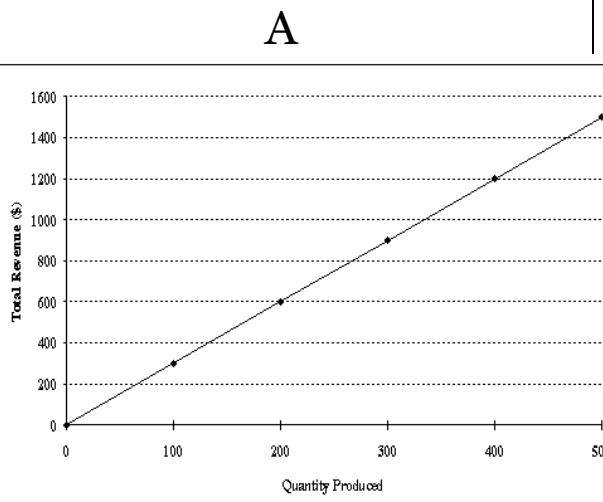
Dry Summer
May-June

Guiding Questions: What pattern/relationship do you see between the radius and diameter?

What pattern do you see between the diameter and the circumference?
Does your line graph show a constant pattern? How?

Anticipatory Set: (If this doesn't fit on the document camera completely, consider cutting out the graphs and placing them so they fit, or giving a copy of the graphs to each table group/student.)

Study the graphs below. Which shows a constant (unchanging) multiplicative relationship between the x and y coordinates? How can you tell?



Activity/Investigation:

1. After discussing Anticipatory Set responses...(Graph A shows a multiplicative pattern. You can tell because you can multiply the x coordinate by three each time to get the y coordinate. ie: $100 \times 3 = 300$, $200 \times 3 = 600$, etc. Another way you can tell is that the line in the graph is a completely straight line with no curves or angles.) Remind students that we are studying precipitation and the conservation of water. One way that we conserve water at Manzo is in our cisterns that collect rain that falls from the sky, onto the roof, into the gutter, and down into the cistern. That way we can store the water and use it during times of little or no precipitation. Tell students that next class period they will work to find the volume (how much water it holds) of each cistern. Before we learn about volume, however, we will need to learn about area.

2. Remind students that the area is how much flat space an object takes up. It is usually measured in square units. Tell students that volume measures the capacity of a 3-D figure. Ask the class what 3-D figure our cisterns are (cylinders). Ask the class what 2-d shape is most similar to a cylinder (circle). Tell students that a cylinder is basically many circles stacked on top of each other. Because cylinders are so closely related to circles, it's important to understand the parts of a circle and how to measure them before working with cylinders.

3. Draw a diagram of a circle on the board, which includes radius, diameter, and circumference. Have students take notes. Explain what each word means and how it is related to a circle. Remind students that to find the area of a shape you can either use a formula (such as length times height for a rectangle) or you can lay square units on top of/underneath a shape and count the square units. Tell students that today they will measure the parts of a circle and then estimate the square units a circle takes up for its area. Tell students that if they measure precisely and study the relationship between the diameter and circumference, they should find a multiplicative relationship that will be helpful (π). Later, students will get the formula to check the accuracy of their estimates.

4. Distribute printed circles (see accompanying document). Use a document camera to show students how they can use the flexible tape measure to find and record the radius, diameter, and circumference. Show how you can count squares to find an estimate of the area of the square (making sure to model how to reapportion incomplete squares inside). Have students measure and record with you. (Rather than cutting out the circles, it will be just as easy, and time-saving, to have students measure them already on the paper.) Ask students why this method is not completely accurate. (It is merely an estimate and it is impossible to count precisely the number of squares since many are broken up.)

5. Next demonstrate how to plot the diameter as the x coordinate and the circumference as the y coordinate, making sure to label and title your graph appropriately. Have students do this on their graphs as well. Tell students that they are to look for a multiplicative relationship between the diameter and circumference, as this ratio has a special name and symbol called π . Remind them that a line graph that has a multiplicative will produce a completely straight line.

6. Have students get to work on their measuring, recording, and graphing for about 25 minutes. Once students have mostly finished, draw their attention again so they can summarize their discoveries. Have students do intermittent closure and share with each other their line graphs and discuss possible relationships they are seeing between

diameter and circumference. (Students should discover that the circumference is approximately three times greater than the diameter.)

7. Select an accurately completed table and line graph. Show students how the line is completely (or almost!) straight. Ask students what multiplicative relationship they discovered between the diameter and the circumference and provide examples. Tell students that this relationship is called pi. Write some of pi on the board. Tell students that it is an irrational number because the digits never end in the decimal portion, but that for our purposes, we will consider pi to be 3.14. Tell students that there is a formula for calculating the area of a circle. It is $\pi \times \text{radius squared}$. Show an example of how to calculate the area using this formula for circle a. Alert students that pi is quite close to 3, and that knowing this will allow them to check the reasonableness of their calculations by estimating. Now have students calculate the actual area of circles b, c, d, and e on their tables using calculators (or manually if time allows).

8. If necessary review correct answers with class.

Closure:

Distribute small scrap paper to students. Ask them to use it to describe how a line graph can show a multiplicative relationship between x and y coordinates. Tell them to use words, pictures, and numbers to explain. After about five minutes, select a few key responses to share with the class.

Teacher Reflection:

Precipitation and Water Conservation

Lesson 4~ Measuring Cylinders

Teacher:
Author: Wes Oswald

Grade Level: 5

Date:

Common Core Standard:	<p>5.MD.3-5 3. Recognize volume as an attribute of solid figures and understand concepts of volume measurement.</p> <p>5.NBT.7. Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.</p> <p>5.OA.1 Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.</p>
Ecology Objective:	Calculate the amount of water our cisterns hold.
Enduring Understandings and Essential Questions	<p>Climate: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate.</p> <ul style="list-style-type: none">•How does regional climate affect the way we live?•How can we modify our culture to be more harmonious with our climate? <p>Interconnectedness (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system.</p> <ul style="list-style-type: none">•How does our region's climate affect our culture?
Content Objective: <i>Math Reading Writing</i> Other:	<ul style="list-style-type: none">•Students will use a formula to find the capacity of our cylindrical cisterns.•Students will model multiplication with decimals.•Students will use parentheses to separate factors in a multiplication problem.
Language Objective:	

Vocabulary	Materials
Radius, diameter, circumference, area, volume, pi, multiplicative, formula, irrational number, cylinder, exponent	<ul style="list-style-type: none">•flexible measuring tape•yard sticks (approximately 1 per student)•Cistern Measurement Data Table (see accompanying documents)•Cistern Volume (see accompanying documents)•Student Worksheet Volume Example (see accompanying documents)•Aquatainer (ask Wes for one in advance!)

Seasonality: This lesson/unit would work during any season, as it is not reliant on any natural phenomenon.

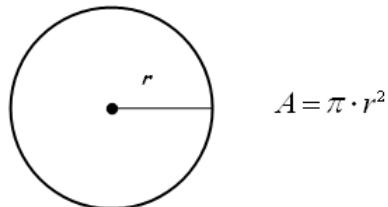
Monsoon July-Sept.	Autumn Oct.-Nov.	Winter Dec- Feb.	Spring Mar.-Apr.	Dry Summer May-June
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Guiding Questions: How does your measurement of the area compare to an estimate?

NOTE: *This lesson will likely take two class periods to measure, calculate, record data into tables, represent work clearly on posters, and compile class data. If a second class period is needed, another Anticipatory Set and Closing is included directly after this lesson.*

Anticipatory Set:

Remember the **formula** to find the **area** of a **circle** is



Remember we discovered that the **circumference** is always 3.14 times greater than the **diameter**.

Complete the chart below filling out the missing information. No measuring!

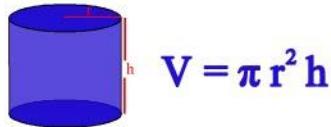
Radius	Diameter	Circumference	Area
	4 ft.		

Draw a diagram of your circle here:

Activity/Investigation:

1. After discussing Anticipatory Set responses and reviewing correct responses and strategies... Tell students that today they will measure cisterns around the school and use their measurements to find the volume of each.
2. Ask students how circles and cylinders are similar (both round, both have circumferences, diameters, radii, etc.). Ask students how they are different (circles are flat, cylinders have height). Tell students that because cylinders and circles are so similar, they will have similar formulas. Remind students that flat shapes have area but no volume and that 3D figures have volume. 3D figures have surface area, but that's a different story. Write the formula for the area of a circle on the board again. Ask students what's missing in this formula if we were to modify it to be used for a cylinder (height).

3. Write the formula for the volume of a cylinder:



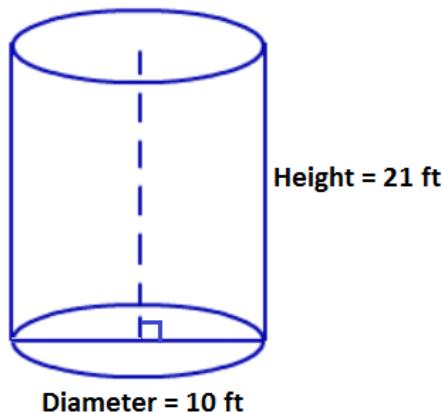
Ask students to compare and contrast this formula to the formula for the area of a circle (they are exactly the same except the cylinder has height multiplied to it).

4. Tell students that they will be working with a partner today to:

- Measure the diameter of a cistern. (Show how you can put yard sticks at opposite ends of a cistern, parallel to each other and measure the distance between the two yardsticks.)
- Check the accuracy of their diameter (it may be difficult to find the exact center of the cistern!) measurement by then measuring the circumference (it should be about 3 times bigger!).

-Return to the classroom to use the formula to find the volume of the cistern.
(Tell students that all measurements are to be made in feet, and each cistern has a diameter in whole feet without decimals or fractions.)

5. Before students go outside, model how to use the formula with this example:



Be sure to model how and why parentheses are used to represent multiplication. Also be explicit about what an exponent is and how to operate with one.

- a. Half of 10 is 5, thus diameter = 5
- b. $3.14 (5^2) (21)$
- c. $3.14 (25 \times 21)$
- d. $3.14 (525)$
- e. Model estimating strategies: 3.14 is about 3. 525 is about 500. So the product should be a little more than 1,500—maybe 1,600?
- f. $3.14 \times 525 = 1,648.5$

Show students the model “Student poster example” and tell them that this is a final product they will produce, most likely next class session. Since fifth grade students are expected to multiply whole digit numbers fluently, encourage them to use the algorithm to multiply the radius^2 and height. However, fifth grade students are expected to model

the multiplication of decimals to the hundredths. Thus, an array is a good model to use with students.

6. Show students a map of school that shows where each cistern is. (You may even want to use chalk to label the sidewalk near the cisterns with letters or numbers corresponding each cistern to prevent confusion). Tell each partnership which cistern they are assigned to. Be sure to assign more advanced students to the cisterns in front of the school since they are larger and will involve greater numbers. Show students the table they are to use to record their data. Give them the table or have them copy it into their journal. Tell students what signal (a whistle works well) you will use to call them to return to class in five or 10 minutes. Have each student bring a chair to use as a step-ladder if needed.

7. Students return to class. Collect flexible tape measures. Give students time to do calculations.

8. Once most students have calculated volume in square feet, ask students, “What unit did you use to determine the volume of your cistern?” (cubic feet). “Is this the best unit to measure the volume of water? What do we typically use to measure large volumes of water? (Gallons) So what we need to do is convert the cubic feet to gallons.” Show students an aquatainer (*Wes has one—ask him ahead of time and he'll loan it to you. It's not exactly one cubic foot, but it's super close!*). “How many gallons do you think this holds?” Take student guesses. Then empty out the aquatainer gallon by gallon (to then give to a plant later) and count the gallons. It should be about seven. Measure the aquatainer’s dimensions to note that it’s not a perfect cubic foot. Tell students that if it were, then it would hold 7.5 gallons of water. (To be precise, a cubic foot of water = 7.48 gallons. 7.5 would be easier to work with though. The number you use is up to you and dependent on the ability of your students.)

9. Direct students’ attention back to their volume table they have mostly completed. Point them to the column labeled “Actual Volume in Gallons.” Ask students how they would use this knowledge of 7.5 gallons of water are equivalent a cubic foot of water to determine how many gallons of water their cistern contains. (Multiply the volume in cubic feet by 7.5). *To keep things simple, you may want to have your students round their volume in cubic feet to the nearest whole number and then multiply by 7.5. Again, this depends on your students' fluency in multiplying with more complex decimals.*

******Completion of step 7 or 9 would be a good stopping point!* *****

10. Have students calculate the volume in gallons and add it to their data table and poster.

11. As students calculate the volume of their assigned cistern in gallons, have them record their answer in a pre-made/projected chart on the board. (See accompanying document.)

Closure:

Give each student a small piece of scratch paper. Tell them, “Summarize in approximately five steps how you calculate the volume of a cylindrical cistern.” Give students five minutes or so to complete this. Collect papers and read a few aloud to class.

Teacher Reflection:

Precipitation and Water Conservation

Lesson 4~ Measuring Cylinders

NOTE: This is a continuation of lesson Part 4: Measuring Cylinders. If your students need an extra class session to complete their work from Part 4, and they probably will, use this Anticipatory Set and Closure below as bookends for the continuation of this lesson. The lesson procedures are the same since they are a continuation of the same work.

Anticipatory Set:

Remember that 7.5 gallons and 1 cubic foot are equivalent. Use an array to calculate how many gallons of water would be in a cistern that holds 269 cubic feet of water:

Closure:

Pose the question, “What kind of person in what type of situation would find it helpful to know how to find the volume of a cistern?” (Someone preparing to install a cistern himself or herself and would want to size it correctly to the area of the building. Someone who needs a specific amount of water to irrigate a set number and type of crops, etc.)

Precipitation and Water Conservation

Lesson 5~ How Much Water is in the Cistern?

Teacher:

Grade Level: 5

Date:

Author: Wes Oswald

Common Core Standard:	5.NBT.7. Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.
Ecology Objective:	Students will calculate how much water is in each cistern at given fractional capacities.
Enduring Understandings and Essential Questions	Climate: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate. •How does regional climate affect the way we live? •How can we modify our culture to be more harmonious with our climate? Interconnectedness (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system. •How does our region's climate affect our culture?
Content Objective: <i>Math Reading Writing Other:</i>	Students will multiply whole numbers by decimals to calculate the fractional capacity of cisterns.
Language Objective:	

Vocabulary	Materials
Capacity, decimal	•Wide masking tape •permanent markers

Seasonality: This lesson/unit would work during any season, as it is not reliant on any natural phenomenon.

Monsoon July-Sept.	Autumn Oct.-Nov.	Winter Dec- Feb.	Spring Mar.-Apr.	Dry Summer May-June
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Guiding Questions: How can you tell where to put the $\frac{1}{2}$ mark masking tape on the cistern? How can you use the parts of the cistern you have already taped to determine where other fractional labels should go? Which strategy seems best to compute the number of gallons at _____ (fraction) full? Why?

Anticipatory Set:

I have a cistern at my house. When it is full it holds 750 gallons of water.

- a. How much would it hold when it is $\frac{1}{2}$ full?
- b. How much would it hold when it is $\frac{3}{4}$ full?
- c. How much would it hold when it is $\frac{2}{5}$ full?

Activity/Investigation:

1. In discussing and reviewing anticipatory set responses...Make sure to observe students' strategies for finding volume. $\frac{1}{2}$ full should be fairly easy, but pay attention to how students calculate the capacity at $\frac{3}{4}$ and $\frac{2}{5}$ full. For $\frac{3}{4}$, did students find $\frac{1}{4}$ and then multiply that by 3? Did they multiply 750 by .25? Did students use a number line to find the number that is halfway between 375 (half of 750) and 750? Noting student strategies will better allow you to scaffold instructions in this lesson. Spend time showing a variety of these strategies for calculating fractional capacities of the 750-gallon cistern.
2. Tell students that today they will be working with their same partner from the last couple lessons to calculate the volume in gallons for fractional capacities of the cistern they have been working with. Students will find the fractional capacity of their cistern at empty, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$, and full (or opt to use a different set of fractions, but these will be easiest to label on the cisterns later on). Tell students that although there are many strategies for doing this, today they will work primarily on using the strategy of turning the fraction into a decimal and multiplying. Model how you can multiply the total capacity of a cistern by decimals using an array or another strategy that employs understanding of place value.
3. Tell students that they will need to select at least three fractional capacities to use the strategy of converting the fraction to a decimal and multiplying. Select carefully, as certain fractional capacities will lend themselves much more smoothly to specific strategies. Once they have completed three this way, they may use any other strategies to calculate the remaining fractional capacities.
4. Either distribute the accompanying worksheet, or give students time to recreate the table in their notebooks. Point out the features of the table, emphasizing that there is a large portion dedicated for students to show their computation.
5. Tell students that once their work has been checked and verified, you will give them permanent markers and masking tape. On each piece of tape, they will write the seven fractional capacities they just worked with as well as empty and full. On the tape, students will also write the fractional equivalency in gallons. They will then adhere the tape pieces on their cistern at the corresponding fractional markings between 0 and 1.

Closure:

Pose the question: Which strategy made the most sense to find the capacity of $\frac{1}{2}$ of your cistern? Why?

Pose the question: Which fractional capacity was the most difficult to compute using the strategy of multiplying by a decimal? Why? (Probably $\frac{3}{8}$ or $\frac{5}{8}$ since it has digits that go up to the thousandths, and thus requires a longer calculation.)

Give students time to think, discuss, and then share as a whole class. Emphasize again that it's a good idea to consider the types of numbers one has before selecting a strategy since certain strategies work much more easily with specific types of numbers.

Teacher Reflection:

Precipitation and Water Conservation

Lesson 6~ Why Do We Store Rainwater?

Teacher:

Grade Level: 5

Date:

Author: Wes Oswald

Common Core Standard:	<p>5. OA.1 Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.</p> <p>5. OA.2 Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them.</p> <p>W.5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.</p>
Ecology Objective:	Students will calculate the combined storage capacity of all cisterns at Manzo.
Enduring Understandings and Essential Questions	<p>Climate: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate.</p> <ul style="list-style-type: none">•How does regional climate affect the way we live?•How can we modify our culture to be more harmonious with our climate? <p>Interconnectedness (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system.</p> <ul style="list-style-type: none">•How does our region's climate affect our culture?
Content Objective: <i>Math Reading Writing</i> Other:	<ul style="list-style-type: none">•Students will write and solve an expression involving parentheses.•Students will write signage text that explains why it is important for our school to have cisterns and what they are used for.
Language Objective:	

Vocabulary	Materials
Capacity, decimal	<ul style="list-style-type: none">•Completed charts from lesson 4 (the charts that summarize the capacity of each cistern at Manzo)•String or baling wire•Cardboard or card stock to mount signage on•Masking tape or duct tape

Seasonality: This lesson/unit would work during any season, as it is not reliant on any natural phenomenon.

<i>Monsoon</i> July-Sept.	<i>Autumn</i> Oct.-Nov.	<i>Winter</i> Dec- Feb.	<i>Spring</i> Mar.-Apr.	<i>Dry Summer</i> May-June
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Guiding Questions: Can you give examples of why it is important that we store rainwater at Manzo?			
•What's the most concise way you can write your expression?			

Anticipatory Set:

A community garden has a variety of cisterns with capacities shown below:

Number of Cisterns	Capacity of Each in Gallons
3	1,125
1	682
2	489.5

Write a CONCISE expression that could be used to calculate the total number of gallons that the community garden can store. Then solve your expression.

Activity/Investigation:

1. In discussing and reviewing anticipatory set responses...make sure that students arrive at something like this as an expression:

$$3(1,125) + 682 + 2(489.5)$$

Make sure to remind students how parentheses are used for multiplication and that multiplication makes the expression more concise and the answer quicker to calculate. Tell students that today they will do two separate things to culminate this unit on precipitation and water conservation. First, they will write and solve an expression (like we just did in the Anticipatory Set) to find the total storage capacity of ALL Manzo's cisterns. Secondly, they will write text for signage that will be placed on their cistern of study. Their sign will explain why the cisterns at our school are important and what they are used for.

2. Repost the table the class made from lesson four, which has the storage capacity of each cistern at school. Tell students that they will work with their same partner to first write an expression to calculate the total storage capacity at school. Once their expression has been approved, they will work together to solve the expression. (Alternately, you may wish to write the expression as a whole class and then assign individual multiplication parts of the expression to different groups to solve. Then compile the parts from the groups and have the class find the sums of these products to find the total. With so many cisterns at school, this would be the faster way to find the storage capacity and would allow the lesson to focus more on the writing portion.) Add a new line to the class' cistern capacity chart with the total number of gallons that can be stored.

3. Tell students that they will collaborate with their partner to write the text for a sign that will be posted at the cistern they studied. The topic of their sign is, "Why is it

important that we have cisterns at Manzo and what are they used for?" Encourage students to think about what they learned in the first few lessons of this unit, and to go back to their notes to refresh their memories of these lessons on precipitation and ways to conserve water. Additionally, encourage students to make connections about how the water we store is related to the other ecology systems at our school. Also encourage students to think of and write about new proposed uses of the water we store at our school. There should also be a portion of the sign, which provides facts about the measurements of their cisterns as well as its capacity.

4. Give students about five or ten minutes to brainstorm ideas for this topic with their partner. Consider doing intermittent closure in which students share with members of other work groups their ideas before proceeding. Next, students will start writing. Remind students that they will need to introduce their topic, develop it with facts and details, use linking phrases and words, use specific vocabulary, and provide a closing to their writing. They will also need to break up their text into paragraphs as they see fit. You may wish to show students some of the various signage at our school (at the biome, in the tortoise habitat, in the pollinator garden, etc.) for examples of what outdoor signage can look like.

**(You may wish to turn this into a larger activity for writing class or extend the time for this lesson so that students can go through the writing process of editing and revising their work before publishing their signs around school.
Additionally, you may wish to let students include more than just text on their signs. Drawings or photos would benefit the design of their sign if time allows.)**

5. Once all signs are complete, have students mount their signs on cardboard, card stock, wood panels, or something else rigid that would help posters stand up to the elements outdoors. Students should then mount or hang their signs. They could be taped to the cisterns and then reinforced by tying the top and bottom corners around the tanks with baling wire or string. Signs could also be hung with baling wire from breezeway eaves nearest to the cisterns. Additionally, signs could be attached to a T-shaped or 7-shaped stake placed in the ground near the cisterns. (This will show the relevancy of our cisterns and provide a text-rich environment for our students!)

Closure:

Give students about ten minutes outside to read the various posters that have been placed at each cistern. As they read the signs, have them write down the following:

- Were you surprised at the capacity of any of the cisterns? Why
- Note an interesting fact or idea a writer presented.
- What's the most important thing you have learned through this unit?

Once students have had time to read at least a few posters, have them return to class and share their written reflections.

Teacher Reflection:

UNIT 2: Saguaro Germination

Unit Summary:

This is a five (or six or seven)-lesson unit in which students will read about the life cycle of the saguaro. They will then execute an investigation after posing a scientific question about saguaro seed germination rates and writing procedures/methods for their experiment. Once experiments have been completed, each group of students will compile data and compare. Students will create a line graph of their results. Lastly, students will share science posters that summarize their discoveries and results.

Lesson Summaries:

Lesson 1~ Life Cycle of the Saguaro

Teacher introduces unit of study to students. In this first lesson, students will use multiple sources to research the life cycle of the saguaro in order to give them the background knowledge to ask an interesting scientific question and a hypothesis they can justify. Students will also use texts to answer specific questions.

Lesson 2~ Designing and Setting Up a Germination Experiment

Students will write their question, hypothesis and work together with their group to collaboratively write the same procedures for their investigation. Once procedures have been approved, students will begin staging their investigation using saguaro seeds. (*Actually setting up their experiment may require an entire other class period depending on students' ability to effectively and efficiently design and write out their experiments.*)

Lesson 3~ Comparing Germination Rates

Class will compile germination rates. Students will compare germination rates of their control group to their experimental group by representing each germination rate using grid paper and number lines. They will write equivalencies of their germination rates. They will use symbols to show greater than, less than, or equal, and also compare germination rates to benchmark decimals such as 0.25, 0.5, 0.75, and 1.

Lesson 4~ Creating Line Graphs Using Ordered Pairs to Show Germination Rates

After four weeks of recording data of germination rates once per week, students will graph their data on a double line graph using ordered pairs.

Lesson 5~ How Much Water is in the Cistern?

Students will compile all their findings onto a poster, which will include their question, hypothesis, procedures, data tables, graphs, and conclusions. (*This may require an extra class period.*)

Saguaro Germination

Lesson 1~ Life Cycle of the Saguaro

Teacher:
Author: Wes Oswald

Grade Level: 5

Date:

Common Core Standard:	<p>ELA 5.W.7: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.</p> <p>ELA 5.RI.7: Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5.RI.7)</p>
Ecology Objective:	Students will describe the life cycle of a saguaro and why it is considered both an indicator species and a keystone species of the Sonoran Desert
Enduring Understandings and Essential Questions	<p>Interconnectedness (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system.</p> <ul style="list-style-type: none">•How is the saguaro interconnected with the plants, animals, and environment of the Sonoran Desert?
Content Objective: <i>Math Reading Writing Other:</i>	<ul style="list-style-type: none">•Students will conduct research about the life cycle of a saguaro cactus by reading multiple sources.•Students will quickly and efficiently answer questions about the life cycle of a saguaro cactus through their research.
Language Objective:	

Vocabulary	Materials
Germination, seed, seedling, life cycle, pollinate/pollination, crested, nurse plant, precipitation, archaeological, Indicator species, keystone species	<ul style="list-style-type: none">•NPS pamphlets (<i>How to Grow a Saguaro Cactus</i> and <i>the saguaro cactus</i>) and additional books/reading material about the saguaro's life cycle•Saguaro seeds•Life Cycle of the Saguaro worksheet (see accompanying documents)

Seasonality: From my understanding saguaro seeds have a much higher rate of germination when it is humid and warm outside, which is why it is important to do this toward the very beginning of the school year. However, using the greenhouse at another time of year may effectively replicate monsoonal conditions.

<i>Monsoon</i> July-Sept.	<i>Autumn</i> Oct.-Nov.	<i>Winter</i> Dec- Feb.	<i>Spring</i> Mar.-Apr.	<i>Dry Summer</i> May-June
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Guiding Questions: How can you use text features to help you efficiently answer your questions? How does _____ question relate to the saguaro's life cycle?

Anticipatory Set:

Describe all you know about how a saguaro lives, grows, and dies.

Activity/Investigation:

1. Teacher shows class the saguaro seeds and tells them that students will be researching the life cycle of the saguaro cactus today so they can acquire the background information to write a scientific question about germination of the saguaro cactus and then write a hypothesis. Teacher shows students their research material and places students into small table groups. Teacher explains that good readers can use text features to help them find answers to questions. Teacher asks, "What are some text features that can help a reader navigate through a text efficiently?" Teacher shows students questions that are to be answered and asks students to write two of their own questions about the life cycle of a saguaro. Tell students their main focus is to efficiently look for answers in the text, not necessarily to read the whole thing. Students then work in their groups or individually to answer their questions. If students finish early, encourage them to read parts of the text that were skimmed over.

2. About midway through the research session, take a break for intermittent closure to pose the question, "What's the most interesting thing you've learned about the saguaro's life cycle so far?"

3. Teacher asks students to share the results of their research and the answers to some of their questions. Teacher will then show a short slide show (see accompanying file) and/or video about the saguaro and its role as both **keystone species** (a species that plays an especially important role through its multiple connections to other members of its environment by providing food, shelter, etc.) and **indicator species** (a species whose presence, absence, or relative well-being in a given environment is indicative of the health of its ecosystem as a whole) of the Sonoran Desert.

Video idea: <http://channel.nationalgeographic.com/wild/the-wild-west/videos/secret-life-of-a-cactus/>

4. Teacher then explains that next class session, students will use their knowledge gained today to write a scientific question they'd like to investigate about saguaro seed germination.

Closure Questions:

You learned a lot about the life cycle of a saguaro today.

- a. What's the most surprising thing you learned today?
- b. What is a new question you have about the life cycle of a saguaro?
- c. What are some important text features you identified that allowed you to efficiently answer your questions?

Teacher Reflection:

Saguaro Germination

Lesson 2~ Designing and Setting up a Germination Experiment

Teacher:

Grade Level: 5

Date:

Author: Wes Oswald

Common Core Standard:	ELA AZ 5.W.4: Produce clear and coherent functional writing (e.g., formal letters, recipes, experiments, notes/messages, labels, timelines, graphs/tables, procedures, invitations, envelopes) in which the development and organization are appropriate to task and purpose.
Ecology Objective:	Students will use the scientific method to design an experiment about saguaro germination using a control and a variable.
Enduring Understandings and Essential Questions	Interconnectedness (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system. •How is the saguaro interconnected with the plants, animals, and environment of the Sonoran Desert? Climate: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate. •How does the climate of the Sonoran Desert affect saguaro seed germination?
Content Objective: <i>Math Reading Writing Other:</i>	•Students will conduct research about the life cycle of a saguaro cactus by reading multiple sources. •Students will quickly and efficiently answer questions about the life cycle of a saguaro cactus through their research.
Language Objective:	

Vocabulary	Materials
Controlled variable, independent variable, dependent variable, question, hypotheses, procedure, germination, seed, life cycle, nurse plant, precipitation, indicator species, keystone species	•cactus soil •pots or trays •plastic wrap

Seasonality From my understanding, saguaro seeds have a much higher rate of germination when it is humid and warm outside, which is why it is important to do this toward the very beginning of the school year. However, using the greenhouse at another time of year may effectively replicate monsoonal conditions.

<i>Monsoon</i> July-Sept.	<i>Autumn</i> Oct.-Nov.	<i>Winter</i> Dec- Feb.	<i>Spring</i> Mar.-Apr.	<i>Dry Summer</i> May-June
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Guiding Questions: What part of your experiment is the independent variable? What parts of your experiment will you make sure to control so that it is fair?

How could you vary the _____ in your experiment?

Anticipatory Set:

During our last class we read that the best way to germinate saguaro seeds is to:

Plant them 1/8 inch deep in cactus soil in a pot with drainage holes, then place the pot in a warm sunny area and water every 10 days.

Since you know a bit about how saguaros grow, describe ONE of those steps you could change to try to help improve germination. (For example, instead of planting them 1/8 inch deep, I will place them right on top of the soil.)

Activity/Investigation:

1. Teacher tells students that they will be taking the first steps today to start their saguaro germination experiment. Their challenge is to attempt to get better germination rates by changing ONE variable listed in the NPS pamphlet. Show students the materials they have to use including pots/trays, plastic wrap, cactus soil, etc. Tell students that with their group, they will plant two trays of saguaros—one exactly as NPS describes, and one where just one variable is changed (for example, the depth of planting, the amount of water or sun, presence or absence of drainage holes, type of soil, temperature, etc.) Each group will use exactly 50 saguaro seeds for each of their two trays. Their job today is to work with their group to agree on a question they can ask regarding their variable, write a hypothesis, and write their procedures. Once they have finished these tasks, they may begin their experiment.

2. Before allowing students to begin make sure they understand the following key words:

Variable: The part of an experiment that can change, such as amount of light, temperature, humidity, time changes, or plant growth		
Controlled Variable/Control: The parts of your experiment that do not change because you control them	Independent Variable: The one part of your experiment that you change or manipulate	Dependent Variable: The response or change that is measured because of your independent variable
<i>For example, let's say you want to design an experiment to test whether the depth of the seed will improve germination. The control would be that you make sure that both sets of seeds receive the same amounts of water, light, temperature, etc.) The independent variable would be the new depth at which you plant seeds that vary from 1/8 inch. The dependent variable would be the response you measure, in this case the rate of germination. Did it change compared to your control group?</i>		

3. All groups must also create 2 data tables (one for their control group and one for their experimental group) in their journals in which they will record the number of seeds germinated (and still living) along with the week. They should record this data 4 times—once exactly one week after sowing seeds, and three more times each week thereafter. Their data tables should look something like this:

Control Group	
Week Number	Number of seeds germinated and still living
Week 1	
Week 2	
Week 3	
Week 4	

Experimental Group	
Week Number	Number of seeds germinated and still living
Week 1	
Week 2	
Week 3	
Week 4	

4. Table groups begin collaboration on writing their question, hypotheses, and procedures. Groups should reach consensus to have the exact same question and procedures since they will be doing the same experiment together. Their hypothesis of course, may differ from one another. Check each part before students continue to the next part.

Closure Questions:

A member of each group will share their question with the whole class. Next, students will do a gallery walk of sorts. Each student should have their question, hypothesis, and procedures set at their tables. Students will spend a couple minutes at each table reading and evaluating their classmates' work thus far. Upon completion, teacher asks students to nominate a set of procedures that they think are best and tell why.

Teacher Reflection:

Saguaro Germination

Lesson 3~ Comparing Germination Rates

Teacher:
Author: Wes Oswald

Grade Level: 5

Date:

Common Core Standard:	<p>5.NBT.3 Read, write, and compare decimals to thousandths.</p> <p>a. Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., $347.392 = 3 \times 100 + 4 \times 10 + 7 \times 1 + 3 \times (1/10) + 9 \times (1/100) + 2 \times (1/1000)$.</p> <p>b. Compare two decimals to thousandths based on meanings of the digits in each place, using $>$, $=$, and $<$ symbols to record the results of comparisons.</p>
Ecology Objective:	Students will observe the effects of their independent variables (simulated change of climate or natural growing conditions) on saguaro germination.
Enduring Understandings and Essential Questions	<p>Interconnectedness (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system.</p> <ul style="list-style-type: none"> •How did the saguaro seedlings show interconnectedness with the simulated/actual plants, animals, and environment of the Sonoran Desert? <p>Climate: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate.</p> <ul style="list-style-type: none"> •How did your simulation of a change to the Sonoran Desert's climate affect saguaro seed germination?
Content Objective: <i>Math Reading Writing Other:</i>	<ul style="list-style-type: none"> •Students will represent and compare the germination rates of their control and experimental groups. •Students will list from least to greatest the success rates of each groups' experimental group.
Language Objective:	

Vocabulary	Materials
Controlled variable, independent variable, dependent variable, germination, tenths, hundredths, thousandths, fraction, numerator, denominator, greater than, less than, equal	<ul style="list-style-type: none"> •experiment seed trays •hundredths grids, thousandths grids •Saguaro Germination Data Tables (see accompanying documents)

Seasonality From my understanding saguaro seeds have a much higher rate of germination when it is humid and warm outside, which is why it is important to do this toward the very beginning of the school year. However, using the greenhouse at another time of year may effectively replicate monsoonal conditions.

Monsoon	Autumn	Winter	Spring	Dry Summer
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July-Sept.	Oct.-Nov.	Dec- Feb.	Mar.-Apr.	May-June
Guiding Questions: How do you say [name of decimal]? Which representation more clearly allows you to compare decimals? Where are the hundredths in your representation? Where are the tenths in your representation?				

Class will compile germination rates. Students will choose another group's germination rates to compare to their own by representing each germination rate using grid paper and number lines. They will write equivalencies for their own rates as well as that of their chosen group's germination rates. They will use symbols to show greater than, less, than or equal, and also compare germination rates to benchmark decimals such as 0.25, 0.5, 0.75, and 1.

Note: Do this lesson only once four weeks of data collection have been completed!

Anticipatory Set:

Draw a number line that contains the landmark numbers of:

0, 0.25, 0.5, 0.75, 1

Next, use your landmark numbers as guides to place the following numbers:

.31, .60, .06

Lastly, describe which landmark number each of the three numbers above is closest to and how you can tell.

Activity/Investigation:

1. After reviewing accurate responses from the Anticipatory Set... Tell students that today they will use their data tables in their journals to record their germination rates for both their control group and their experimental group. Distribute "Saguaro Germination Data Tables" worksheet or give students the opportunity to recreate (this is my preference as it forces students to find how the data table is organized and gives them time to understand the table) their own given the provided data table as a model.

2. Give students a lesson on decimals and finding equivalent fractions so they can accurately complete their Saguaro Seed Germination Data Table.
 - a. Review with students how to write a fractional part using a numerator and denominator as related to the fractional part of seeds germinated in each tray of their experiment.
 - b. Show students how you can change a fraction with a denominator of 50 (the number of seeds in each of their trays) into a fraction with a denominator of 100. Model this using hundredth charts.
 - c. Use a place value chart to show students where tenths and hundredths fall. Relate tenths to the value of a dime and hundredths to the value of a penny.
 - d. Review with students that a percent is based on a fractional part with a denominator of 100.

3. Once most students have completed their data tables, redirect their attention to the board so you can show students how you want them to represent their decimals on hundredth charts and number lines so they can compare the rates of their control group to that of their experimental group. Students will use the worksheet “Saguaro Germination Data Tables” to complete.

4. Have a chart on the board like this:

Group Name:	Experimental Group Germination Rate after 4 Weeks:	Rank:

As students complete their work, invite them to come to the board to record their groups' germination rates on the table. Then as a class, work together to rank (or rewrite in order) them in order from least to greatest.

5. Each group should select another group's experimental group's germination rates to compare their own to on the back of their “Saguaro Germination Data Tables” worksheet. Have available hundredths grids available for students to shade in and attach to their worksheets as models for germination rates.

Closure Questions:

What's the most important thing to remember when comparing decimals that have digits in the hundredths?

Teacher Reflection:

Saguaro Germination

Lesson 4~ Creating Line Graphs Using Ordered Pairs to Show Germination Rates

Teacher:

Grade Level: 5

Date:

Author: Wes Oswald

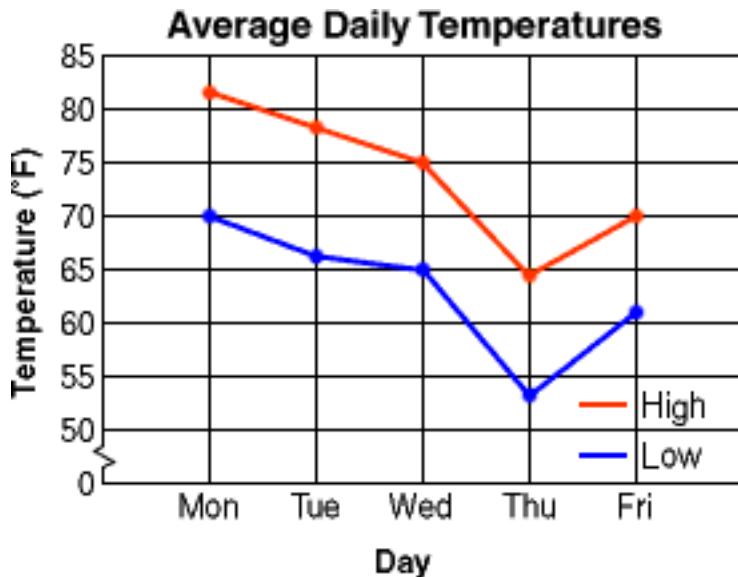
Common Core Standard:	<p>5.G.1. Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the o on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., x-axis and x-coordinate, y-axis and y-coordinate).</p>
Ecology Objective:	<ul style="list-style-type: none">Students will use a line graph to represent the effects of their independent variables (simulated change of climate or natural growing conditions) on saguaro germination.Students will interpret their line graph.
Enduring Understandings and Essential Questions	<p>Interconnectedness (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system.</p> <ul style="list-style-type: none">How did the saguaro seedlings show interconnectedness with the simulated/actual plants, animals, and environment of the Sonoran Desert?Climate: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate.How did your simulation of a change to the Sonoran Desert's climate affect saguaro seed germination?
Content Objective: <i>Math Reading Writing Other:</i>	<ul style="list-style-type: none">Students will use coordinate pairs to plot data on line graphs.
Language Objective:	

Vocabulary	Materials			
Axes, coordinate system, origin, ordered pairs, coordinates, x-axis, y-axis	<ul style="list-style-type: none">experiment seed traysCreating Line Graphs Using Ordered Pairs to Show Germination Rates (See accompanying documents)			
Seasonality (If more specificity is required, please note date/time range under season)				
Monsoon July-Sept.	Autumn Oct.-Nov.	Winter Dec- Feb.	Spring Mar.-Apr.	Dry Summer May-June

Guiding Questions: How does the graph help us interpret the results of your experiment?
 Why are labels important for a graph?
 What does this graph tell you about your results?

Anticipatory Set:

Study this double line graph:



- a. What is this graph about?
- b. Describe some things you notice about this graph.

Activity/Investigation:

1. After reviewing responses from the Anticipatory Set... Tell students that today they will represent the information in their data tables using a double line graph. Give students a lesson on line graphs, making sure touch on:

- a. What line graphs are used for (to represent change over time)
- b. The parts of a double line graph including title, labels, origin, key, x-axis, y-axis, and ordered pairs/coordinate pairs
- c. Using invented data, model how to create a double line graph and how to list the ordered pairs.

2. Distribute graph paper (or have students tape graph paper into their journal and have them write conclusions in journal below graph) to students so they can create a double line graph of their data. Students will graph each of their four coordinates of number of seeds germinated for each of the four weeks. This double line graph will show the change of germination over time for their control group and their experimental group. Make sure students color code each line and create a key. Below their double line graph students should write a paragraph in which they interpret their graph. Here are some sample sentence starters:

- I notice that....
- I predict that...
- If you look carefully at the graph, you will see that...

The saguaro in the _____ group had a higher rate of germination.
I think this group had a higher germination rate because...

Closure Questions:

Describe some organizational features of a line graph and some strategies someone could use to make a line graph easy to understand.

Teacher Reflection:

Saguaro Germination

Lesson 5~ Culminating Science Posters

Teacher:

Grade Level: 5

Date:

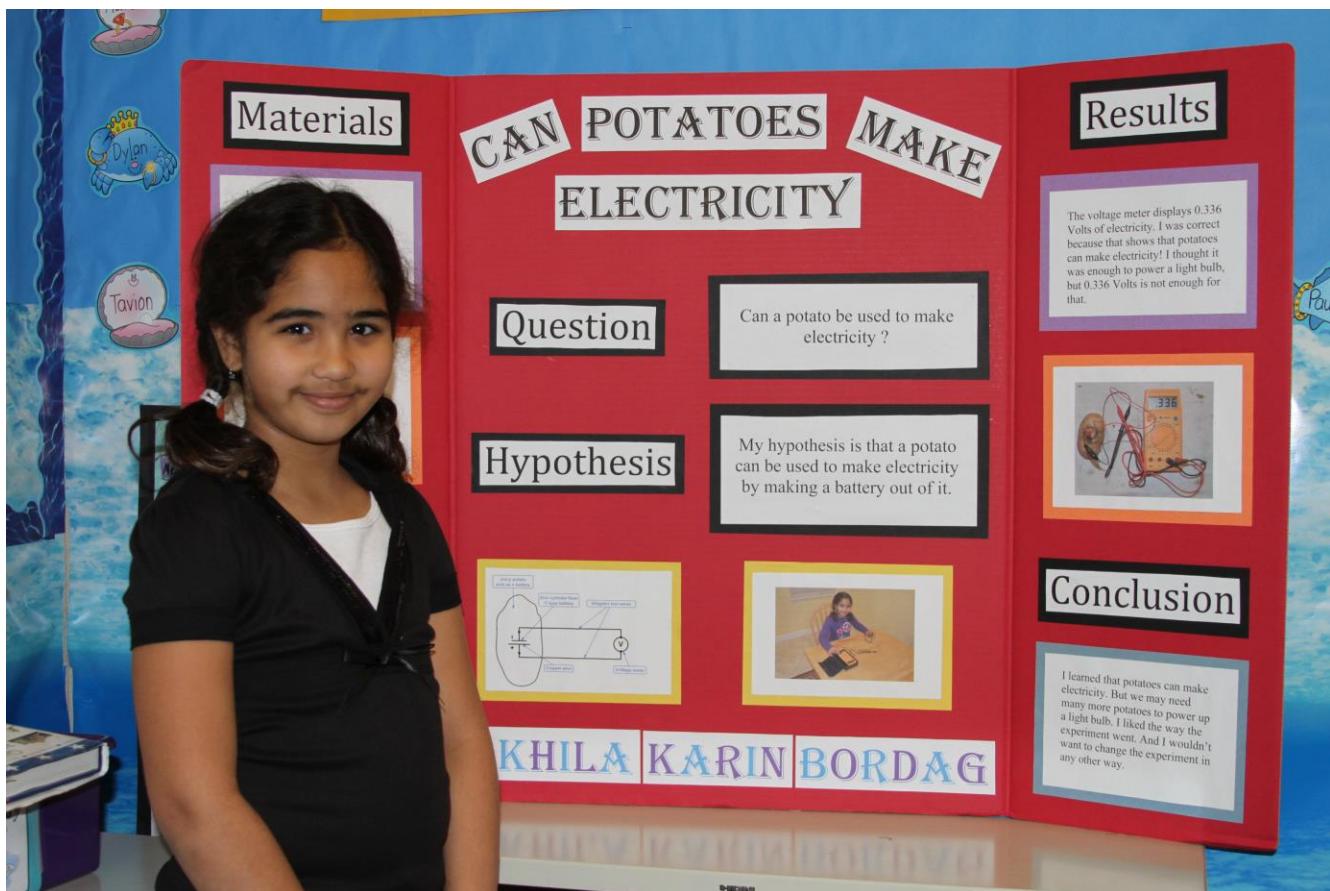
Author: Wes Oswald

Common Core Standard:	(Arizona does not use Next Generation Science Standards, so AZ State Standards are used here instead.) <i>Strand 1, Concept 4, PO 1. Communicate verbally or in writing the results of an inquiry.</i> <i>Strand 1, Concept 4, PO 3. Communicate with other groups or individuals to compare the results of a common investigation.</i>
Ecology Objective:	Students will communicate the importance of the Saguaro Cactus as a vital part of the Sonoran Desert through their conclusions and/or background research of their investigation.
Enduring Understandings and Essential Questions	Interconnectedness (being joined or related): Organisms and their environments are interconnected; changes in one part of the system will affect other parts of the system. •How did the saguaro seedlings show interconnectedness with the simulated/actual plants, animals, and environment of the Sonoran Desert? Climate: (long standing weather patterns): Life on Earth depends on, is shaped by, and causes changes in climate. •How did your simulation of a change to the Sonoran Desert's climate affect saguaro seed germination?
Content Objective: <i>Math Reading Writing Other:</i>	•Students will communicate the results of their scientific investigation on a poster through writing, graphs, and pictures.
Language Objective:	

Vocabulary	Materials			
Question, Background Research, Hypothesis, Methods, Data Table, Graph, Conclusions	•Poster boards or poster paper			
Seasonality				
Monsoon July-Sept.	Autumn Oct.-Nov.	Winter Dec- Feb.	Spring Mar.-Apr.	Dry Summer May-June
Guiding Questions: How can you improve upon your first draft? How can you best organize your poster?				

Anticipatory Set:

Study this Science Poster.



- Describe what makes this poster look visually appealing and organized.
- Describe improvements you would make to this poster.

Activity/Investigation:

- After reviewing responses from the Anticipatory Set... Tell students that today they will show the results of their investigation on a science poster. Show a few more examples from the internet or real life of student-created science posters. Discuss how each poster has a question, evidence of research, hypothesis, methods, data tables, graphs, conclusions and pictures, or some variation thereof. Write a list of all necessary parts on the board for students to reference. Additionally lead a discussion about what makes a poster look organized and visually appealing.
- Next, decide whether you would rather students work individually on their posters, with a partner or with their whole investigation group (each has its plusses and minuses!) Then tell students that they have most of this information already created. Their question, hypothesis, data tables, and graphs are already complete. They can use their worksheet from lesson one to summarize their background research to explain why saguaros are such an important part of the Sonoran Desert. They can use some of their graph interpretations from lesson four as a basis for their conclusions. Note that in addition to interpreting data and graphs, scientific conclusions typically tell why their

findings matter, what they learned from the experiment, what they would do differently if they were to redo their experiment, and whether or not their hypothesis was correct.

3. Students then create posters. This activity could lend itself to one more class period in which students spend half of the class period finishing their posters and the last half summarizing their findings to the whole class or to small groups.

Closure Questions:

What was the most interesting discovery you made during our Saguaro Germination unit?

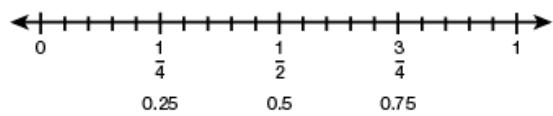
Teacher Reflection:

Appendix 1: Water Conservation Supplemental Materials

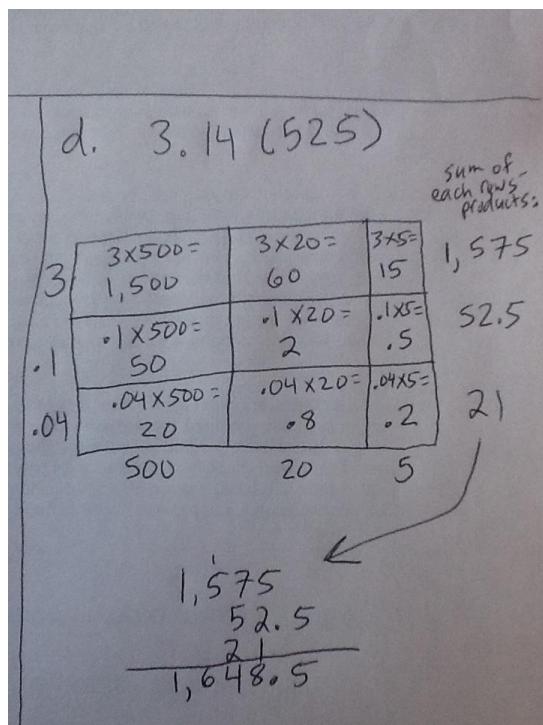
Aquatainer



Decimal Number Line



Array with Decimals



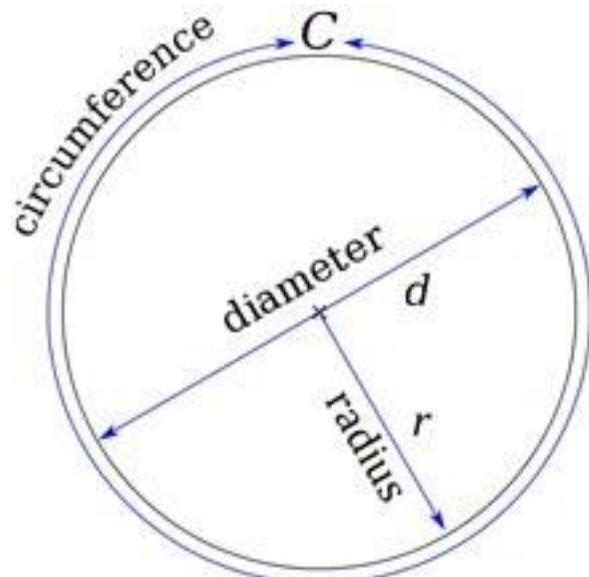
d. 3.14×525

$3 \times 500 = 1,500$	$3 \times 20 = 60$	$3 \times 5 = 15$
$.1 \times 500 = 50$	$.1 \times 20 = 2$	$.1 \times 5 = .5$
$.04 \times 500 = 20$	$.04 \times 20 = .8$	$.04 \times 5 = .2$

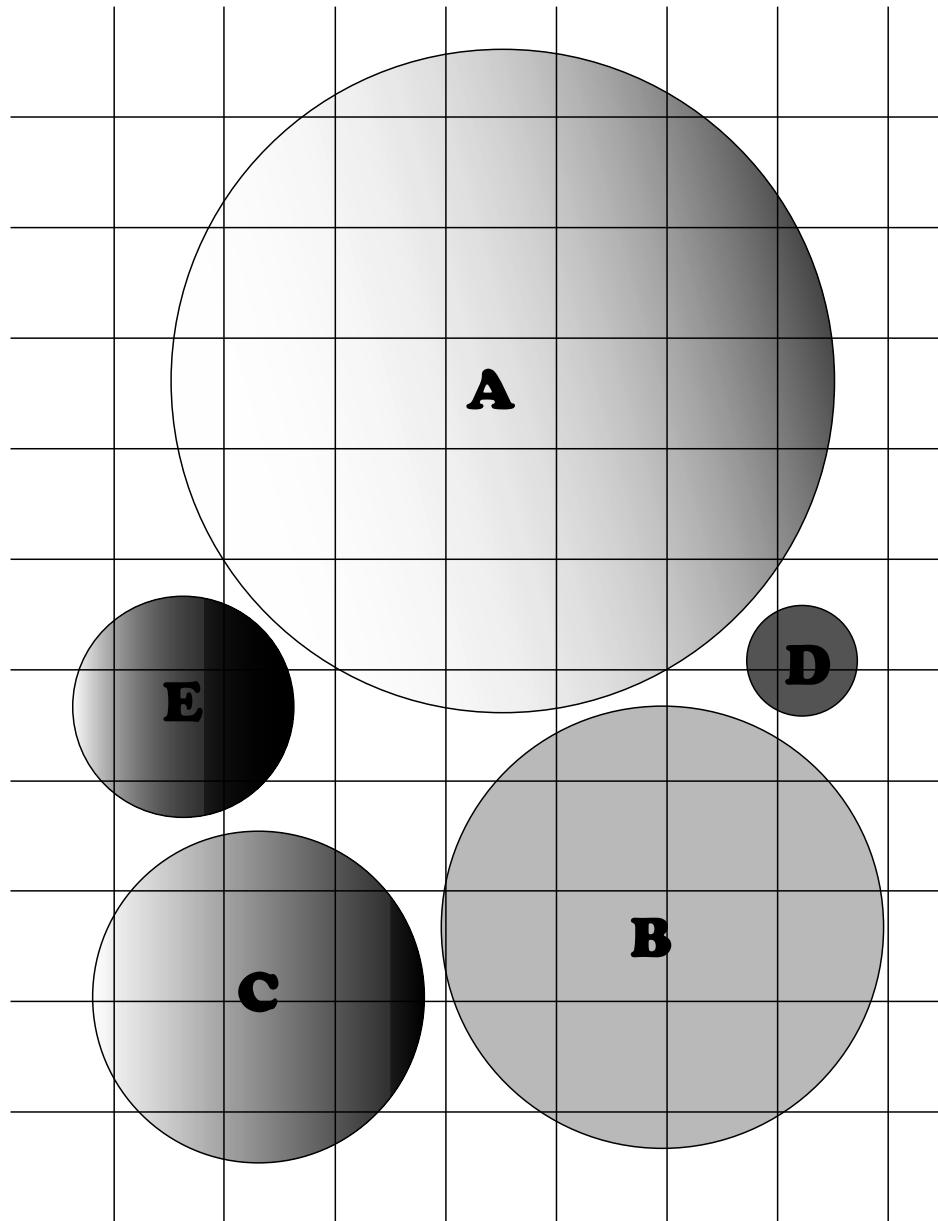
sum of each row's products: 1,575
52.5
21

$1,575$
 52.5
 $\underline{+ 21}$
 $1,648.5$

Circle Diagram



Calculating the Diameter, Radius, Circumference, and Area of a Circle



A: Diameter = 6, Radius = 3, Circumference = 18.84, Area = 28.26

B: Diameter = 4, Radius = 2, Circumference = 12.56, Area = 12.56

C: Diameter = 3, Radius = 1.5, Circumference = 9.42, Area = 7.07

D: Diameter = 1, Radius = 0.5, Circumference = 3.14, Area = 0.79

E: Diameter = 2, Radius = 1, Circumference = 6.28, Area = 3.14

Exercise: Measuring Circles

Name: _____

Directions: Copy this table in your journal or record the measurements of your circles right here.

Circle	Diameter	Radius	Circumference	Estimated Area	Actual Area
A					
B					
C					
D					
E					

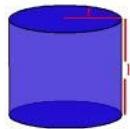
1. On the back of this sheet (or in your journal) plot the relationship between diameter and circumference. Plot the Diameter on the x axis and circumference on the y axis. Be sure to give your graph appropriate labels and a title.
2. What multiplicative relationship do you notice between the diameter and circumference? (You will likely need to estimate!)

3. If you know the diameter of a circle, how could you figure out the circumference without measuring?

4. If you know the circumference of a circle, how could you figure out the diameter without measuring?

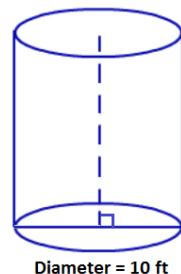
Exercise: Volume of a Cylindrical Cistern
Student Worksheet

Name: _____



$$V = \pi r^2 h$$

a. $V = 3.14 (5^2) (21)$



Height = 21 ft

Diameter = 10 ft

b. $V = 3.14 (25) (21)$

c. 25×21

$$\begin{array}{r} 25 \\ \times 21 \\ \hline 25 \\ 500 \\ \hline 525 \end{array}$$

d. $3.14 (525)$

d. $3.14 (525)$

3	$3 \times 500 = 1,500$	$3 \times 20 = 60$	$3 \times 5 = 15$
.1	$.1 \times 500 = 50$	$.1 \times 20 = 2$	$.1 \times 5 = .5$
.04	$.04 \times 500 = 20$	$.04 \times 20 = .8$	$.04 \times 5 = .2$
	500	20	5

sum of
each row's
products:

1,575
52.5

21

$$\begin{array}{r} 1,575 \\ 52.5 \\ \hline 1,648.5 \end{array}$$

1,648.5 = $3.14 (5^2) (21)$

The cylindrical cistern has a volume of 1,648.5 ft.³

**But, there
are 7.5
gallons in a
cubic foot of
water, so I'll
multiply by
7.5 to
calculate the
volume in
gallons...**

1,648 rounds to 1,649

$$1,649 \times 7.5$$

7	$7 \times 1,000 =$ 7,000	$7 \times 600 =$ 4,200	$7 \times 40 =$ 280	$7 \times 1 =$ 63	Sum of each four products: 11,543
.5	$.5 \times 1,000 =$ 500	$.5 \times 600 =$ 300	$.5 \times 40 =$ 20	$.5 \times 1 =$ 4.5	824.5
	1,000	600	40	9	

$$\begin{array}{r} 11543 \\ + 824.5 \\ \hline 12,367.5 \end{array}$$

The cylindrical cistern has a volume of 12,367.5 gallons!

Which cistern are you measuring? _____

Where is this cistern? _____

<i>-To be completed in the field-</i>			<i>-To be completed in class-</i>		
1.	3.	2.	4.	5.	6.
Radius	Diameter	Circumference <i>(Make this measurement second. Is it just over 3 times larger than the diameter?)</i>	Estimate d Volume (in cubic feet)	Actual Volume (in cubic feet)	Actual Volume (in gallons)

(If you have time and permission to do a second set of measurements and calculations...)

Which cistern are you measuring? _____

Where is this cistern? _____



Precipitation and Water Conservation Part 4: Measuring Cylinders

What is the Volume of Each of Manzo's Cylindrical Cisterns?

Cistern	Volume (in gal.)
A	
B	
C	
D	
E	
F	
G	
H	
I	
J	
K	
L	
M	
N	
O	
P	

Fractional Capacity	Equivalent Decimal	Computation	Capacity in Gallons
1/8			
1/4 (2/8)			

Fractional Capacity	Equivalent Decimal	Computation	Capacity in Gallons
$3/8$			
$1/2$ $(2/4 \text{ or } 4/8)$			

Fractional Capacity	Equivalent Decimal	Computation	Capacity in Gallons
5/8			
3/4 (6/8)			

Fractional Capacity	Equivalent Decimal	Computation	Capacity in Gallons
7/8			

Yearly Precipitation Totals for Tucson, AZ

(Courtesy of National Weather Service, Tucson, AZ)

Year	Precip.	Year	Precip.	Year	Precip.	Year	Precip.
(in.)		(in.)		(in.)		(in.)	
1895	11.07	1925	9.8	1955	15.9	1985	12.88
1896	11.39	1926	12.15	1956	7.04	1986	11.8
1897	10.77	1927	9.74	1957	13.56	1987	12.5
1898	12.72	1928	6.5	1958	12.6	1988	11.63
1899	8.38	1929	9.33	1959	9.99	1989	6.48
1900	7.79	1930	11.27	1960	8.74	1990	14.95
1901	9.72	1931	16.26	1961	10.89	1991	10.78
1902	8.6	1932	10.94	1962	8.58	1992	16.42
1903	8.8	1933	9.6	1963	9.97	1993	14.99
1904	7.85	1934	8.59	1964	17.99	1994	11.63
1905	24.17	1935	15.77	1965	11.53	1995	11.18
1906	11.75	1936	12.24	1966	14.41	1996	10.5
1907	14.09	1937	8.43	1967	12.93	1997	10.56
1908	14.04	1938	8.89	1968	8.94	1998	13.62
1909	10.21	1939	7.05	1969	9.94	1999	9.68
1910	9.8	1940	14.75	1970	11.98	2000	12.44
1911	11.25	1941	15.85	1971	12.17	2001	7.81
1912	9.84	1942	7.87	1972	14.86	2002	7.84
1913	9.32	1943	11.91	1973	7.22	2003	10.05
1914	19.9	1944	13.53	1974	11.92	2004	7.62
1915	12.62	1945	10.58	1975	6.64	2005	9.57
1916	13.15	1946	13.81	1976	6.28	2006	11.81
1917	10.7	1947	5.53	1977	10.17	2007	9.78
1918	9.12	1948	9.11	1978	15.73	2008	8.67
1919	18.01	1949	7.66	1979	10.39	2009	5.67
1920	10.72	1950	9.29	1980	12.23	2010	11.13
1921	13.78	1951	11.7	1981	13.7	2011	12.23
1922	9.39	1952	12.65	1982	13.79	2012	7.91
1923	15.22	1953	5.34	1983	21.86	2013	8.53
1924	5.07	1954	11.63	1984	15.53		

From 1894 to early 1930 the official recording spot was at the U of A. From early 1930 to late 1948, the site was at the old Tucson airport, which is now DM. When the new airport was built, at current site, the official site was moved there, in Oct 1948.

Exercise: Water Use at Home and School

Name: _____

HOME

Kitchen		
What uses water?	How is water wasted?	How is water conserved?
Living Room		
What uses water?	How is water wasted?	How is water conserved?
Bathroom		
What uses water?	How is water wasted?	How is water conserved?
Laundry		
What uses water?	How is water wasted?	How is water conserved?
Front Yard and/or Side Yard		

What uses water?	How is water wasted?	How is water conserved?
Back Yard		
What uses water?	How is water wasted?	How is water conserved?

SCHOOL

Name a location: _____	What uses water?	How is water wasted?	How is water conserved?

•What's a way your family is good at conserving water?

•Describe the easiest way your family could conserve more water. Why?

•Where would be more difficult for your family to conserve water. Why?

Appendix 2: Saguaro Germination Supplemental Materials

National Park Service Brochure: *How to Grow a Saguaro and Life Cycle of the Saguaro Cactus*

<http://www.nps.gov/sagu/planyourvisit/upload/How%20to%20Grow%20a%20Saguaro.pdf>

National Park Service Brochure: *The Saguaro Cactus*

<http://www.nps.gov/sagu/planyourvisit/upload/the%20saguaro%20cactus.pdf>

Saguaro Life Cycle Questions

1. What natural event helps **germinate** saguaro seeds? How?

2. Many saguaro **seedlings** die. Some don't. Where will the successful saguaro **seedlings** most likely be found? Why?

3. Describe one **connection** between the saguaro and an animal.

4. Describe two things that help the saguaro **reproduce** (make new saguaros).

5. _____?

6. _____?

Creating Line Graphs Using Ordered Pairs to Show Germination Rates

The x-axis shows

The y-axis shows

List of ordered pairs:

Describe where the origin of a line graph is:

Interpretations of my graph:

Saguaro Germination Data Tables

Control Group (the group that was planted in exactly the same way as recommended)

Date:	Number of seeds germinated:	Fractional part of seeds germinated:	Fractional part of seeds germinated using 100 as denominator:	Decimal of seeds germinated:	Percent of seeds germinated:

Experimental Group (the group that was exposed to your independent variable)

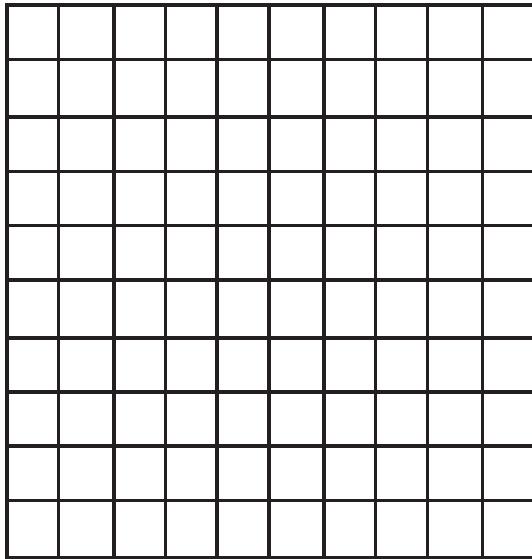
Date:	Number of seeds germinated:	Fractional part of seeds germinated:	Fractional part of seeds germinated using 100 as denominator:	Decimal of seeds germinated:	Percent of seeds germinated:

1. In the end did the experimental group or the control group have a higher rate of germination? Use the space below to demonstrate how you can tell which group of seeds was more successful. Use words, pictures, and numbers to explain.

2. Select another group to compare your experimental germination rates to.

I will compare my experimental group's germination rate to _____'s group.

My group's germination rate:

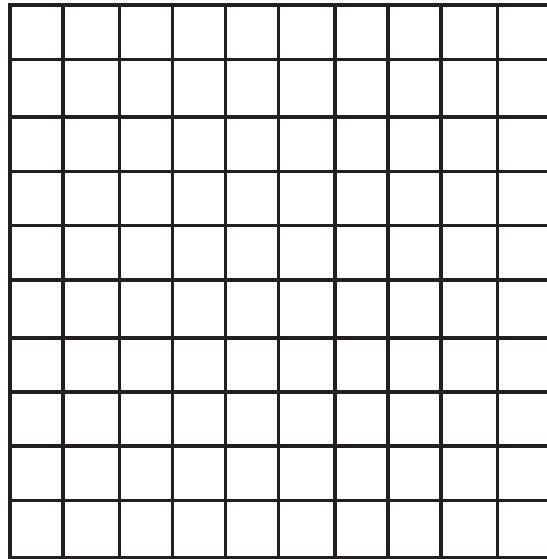


Fraction: _____

Decimal: _____

Percent: _____

_____ 's group's germination rate:



Fraction: _____

Decimal: _____

Percent: _____

Compare the two germination rates: _____ 

Explain which group's experiment had a higher germination rate:

Saguaro Cactus: A Keystone Species



This palo verde acts as a nurse plant to the young saguaros. How many saguaros is it protecting?



Not only is it Arizona's state flower, but the white flower provides nectar to bats which help pollinate the saguaro causing it to produce fruit and seeds.



Allan Morgan

Sweet Saguaro fruits don't last very long with these doves around!



Historically, the saguaro fruit is a special food to Tohono O'odham people. Today, many people enjoy the tasty fruits. The tool they are using is made of a saguaro rib!



This Gila Woodpecker pecked this home in the saguaro. This bird is feeding a grub to its chicks inside.



Once the nest has been made and abandoned by a woodpecker, other birds like this ferruginous owl or maybe a pygmy owl will move in.

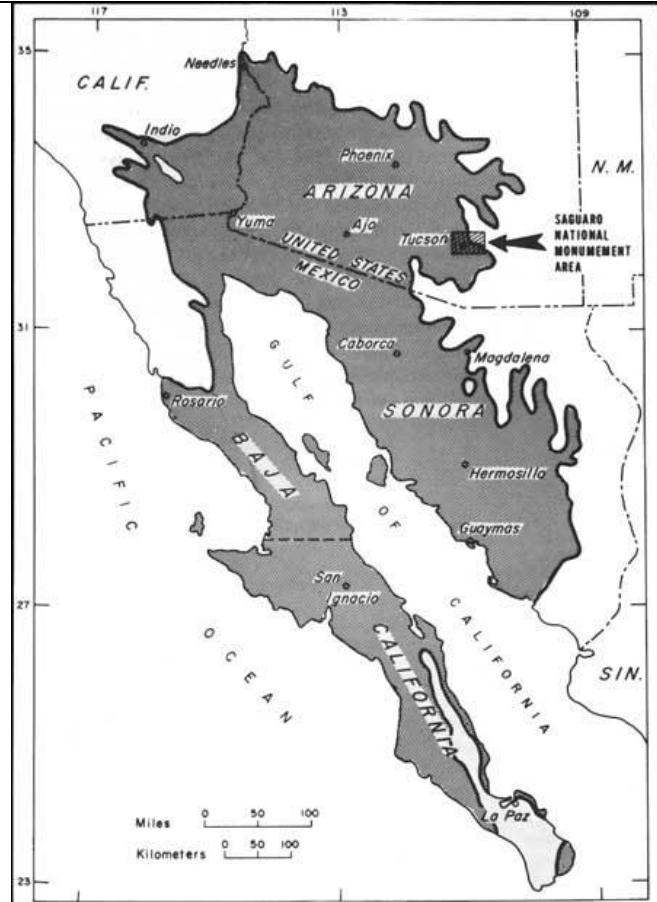


Harris hawks will construct huge nests among the arms of a saguaro to raise and protect its young.



Even in death, the saguaro contributes to its environment. Insects will feast on rotting flesh or it will amend the soil. Its ribs are used by people as a tool or building material.

Saguaro Cactus: An Indicator Species



Map of the Sonoran Desert



Map of wild saguaro habitat

What do you notice about these two maps?

Which looks like a healthier environment?



or...





©2010 Aaron Flesch

Buffel grass creates an environment where fire becomes a possibility.