Neʻepapa Ka Hana 2.0
Seventh-Grade Mathematics Resources
STEMD² Book Series

TEACHER'S GUIDE

LET'S TAKE CARE OF THE LOʻI

STEMD² Research & Development Group
University of Hawaiʻi at Manoa

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http://stemd2.com/

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Neʻepapa Ka Hana Seventh-Grade Mathematics Resources

Let's Take Care of the Loʻi

Teacher's Guide

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Contents

Introduction to *Let’s Take Care of the Loʻi*

Let’s Take Care of the Loʻi has been created by Neʻepapa Ka Hana (NKH) for 7th grade students of Hawaiʻi. The mathematical activities featured in *Let’s Take Care of the Loʻi* have been constructed to enrich students mathematical abilities through culturally responsive material and to increase interest and participation in the mathematical classroom.

Through the collaboration between the Neʻepapa Ka Hana (NKH) 2.0 and STEMD2 the mathematical curriculum of *Let’s Take Care of the Loʻi* has been made available for online classroom integration. The math activities are offered on a social platform which allows for online collaboration between students and teachers. The platform is free and accessible to users with internet access at www.community.stemd2.com

Neʻepapa Ka Hana (NKH) develop programs and materials that are culturally responsive to Hawaiʻi’s unique diversity – using research-based practices to support ongoing STEM education efforts across the state. *Let’s Take Care of the Loʻi* is the 7th addition to NKH’s middle-school book series.

The *Let’s Take Care of the Loʻi* book is composed by mathematical learning activities that serve as a supplementary mathematics curriculum to enhance inclusive instruction based on problem-based learning strategies and connectivism principles. The math activities incorporate real-world challenges that reflect Hawaiʻi’s unique culture, society, and geography. The goal of these activities is for both kumu and haumāna to collaborate while thinking critically and creatively – thereby, deepening students’ understanding, application, and appreciation for mathematical thinking in the context of Hawaiian and island culture.

Let’s Take Care of the Loʻi, highlights the Common Core State Standards through the theme of food, farming, and fishing in Hawaiʻi. The curriculum focuses on supporting food systems in Hawaiʻi and providing a background of the food that sustained the Hawaiian population through mathematical problems.

Lesson Planning Structure

Aloha kākou, e komo mai, and welcome to our Neʻepapa Ka Hana (NKH) guide for kumu! In this first chapter, we want to introduce to you the Lesson Planning Structure for developing, and reflecting upon your lessons. The planning suggestions presented provide guidelines for developing a range of meaningful lessons and memorable activities that truly engage your haumāna.

Formative Steps in the NKH Activity Set

Activities within each unit can be used separately and in various order. However, the cumulative activity should come after the different components of a module has been covered. To maximize the benefits of the activities, we suggest the following.

1. Allow the students to attempt the activity individually.
2. After reviewing students' initial solutions, formulate questions to challenge the students to explain their thought process and improve their responses.
3. Next, arrange students to work in small groups to synthesize their understandings of the activity. Four students per group is recommended, as students could also work in pairs within the group.
4. In the same small groups, students need to explain to each other how they come to the initial response and comment on initial responses by comparing them with their own work.
5. The group continues working together to finalize a solution for the given activity set to present to the class.
6. In a whole-class discussion–preferably moderated by themselves–students compare and evaluate the strategies they have seen and used.
7. In the end, you need to summarize the students' discussions and explain one or two possible solutions.
8. Before moving to the next lesson, ask students to individually reflect for 10 minutes on their work and on what they have learned. You may ask your students to write what they learn in a few sentences.

Along with the book, we also offer online activities available on our community platform at https://community.stemd2.com. We encourage teachers to implement the community platform to provide students an online collaboration forum where they can work with other students on the math activities.

To facilitate the group and class discussion, you may need mini whiteboards with markers and erasers to quickly and visibly check individual understanding. This instructional strategy also enhances attention and participation. Some activities need calculators and graph paper. Using a projector and screen to share students' sample responses are highly recommended as well. A few activities in *Let's Take Care of the Loʻi* require materials such as a six-sided die, a coin, and a pair of slippers (flip-flops).

Lesson Structure

Give each student a copy of the appropriate **NKH Activity** or access to the activities on the NKH community platform.

Examples of instructional prompts for individual students who are attempting any given activity include the following:

- Read the questions and try to answer them as carefully as you can.
- Show all your work, so that I can understand your reasoning.
- In addition to trying to solve the problem, I want you to check if you can present your work in a clear and organized fashion.

Students should work individually and without your assistance. Note that you may have to rearrange your students seating arrangements.

Assessing Students' Responses and Giving Feedback

After collecting the students' attempts at a NKH Activity, please take the time to create a few notes about what these samples of students' work reveal about their current levels of understanding and their unique approaches to problem-solving.

Scoring is not recommended during this phase.

It is also important to note that as a kumu, your feedback should summarize students' difficulties as a series of questions either by:

- Writing one or two questions on each students' work;
- Giving each student a printed version of you list of questions and highlight the questions that are more relevant to each individual student; or
- Selecting a few questions that will be of help to the majority of students and sharing them collectively with the whole class (either projected or written on the board) when returning students' initial attempts at the beginning of the NKH lesson.

When providing feedback to your haumāna, please refer to your own professional judgment and the respective needs of your unique instructional setting. That being said, certain common issues do arise across different classrooms and we recommend the following instructional prompts:

Common Issues	**Feedback Examples**
Student has difficulty getting started	• What do you know? • What do you need to find out?
Student omits some given information when solving the problem	Write the given information in your own words.
Student overlooks or misinterprets some constraints	• Can you organize... in a systematic way? • What would make sense to try? Why? • How can you organize your work?
Student makes incorrect assumptions	Will it always be the way you described?
Work is poorly presented	• Could someone unfamiliar with the task easily understand your work? • Have you explained how you arrived at your answer?

Common Issues	Feedback Examples
Student provides little or no justification	• How did you get your answer? • How could you convince me that...?
Completes the task early	• What would happen if...? • Double check your work • Can you spot any mistakes?

When you are delivering the full NKH Activity Set as a lesson, please make sure that you have allotted approximately 50 minutes for proper lesson delivery and activity execution.

That being said, reviewing a students’ first attempt at a NKH Activity should take approximately 5-10 minutes. This review is done individually and generally provided to the entire class, as a collective whole, by either projecting on a screen or writing on the board.

Collaborative Small-Group Work

Once divided into groups, students should take 10-15 minutes to share and reflect upon their individual attempts at the prior, independent NKH Activity.

During this time, you may provide a few additional guiding prompts for your student groups:

- You each have your own individual solution to the task. Now, I want you to share your work with your partner(s). Take turns to explain how you did the task and how you think it could be improved.
- If explanations are unclear, ask questions until everyone in the group understands the individual solutions.

This leads to the next 15-20 minutes where students work together towards a common solution. If you are using the NKH community platform, your joint solution can be posted onto the Forum. Of course, the use of your own professional judgment and any other format achieving this goal will suffice.

During this section, you should take note of the different approaches between groups, the change of direction, dialogue between groups, etc. This effort will help you guide the class discussion wrap-up.

You will support and foster problem-solving skills by asking questions that help your haumāna clarify their thinking, while encouraging students to develop self-regulation as well as error detection skills.

Sharing, discussing, analyzing different approaches (10-20 minutes)

In this section, a whole-class discussion may follow the previous section. Voluntary or randomly select groups to share their strategies that were developed towards a joint solution. It may be important to ask how the students’ group solution different from their individual solutions. If your students do not explicitly state their conclusions, you might ask how they checked their work. A conversation could be initiated via the online Forum as well.

Wrap-up (5-10 minutes)

As we wrap-up the final sections, a class discussion might conclude the NKH Activity Set by comparing the advantages and disadvantages of the approaches in the activity. Such discussion may center around shared difficulties or possible shortcuts that students could have developed either together or independently. It is important to recognize students’ feelings and attitudes both during and after these activities.

Please note that the timing for these sections and activities range from 40-70 minutes but may vary from classroom to classroom depending on the nature of your needs within your particular instructional setting.

Additional Notes

The given lesson duration are only approximate. Please feel free to spend more or less time on these activities if it suits your classroom better. Lastly the icon indicates where students can use the online learning platform.

Please send us any comments, issues, technical or otherwise, you might have with the content, the format, or the approach.

Common Core State Standards

Common Core State Standard	*Let’s Take Care of the Lo‘i* Unit
Ratios & Proportional Relationships	
7.RP.1 Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. For example, If a person walks 1/2 mile in each 1/4 hour, compute the unit rate as the complex fraction (1/2)/(1/4) miles per hour, equivalently 2 miles per hour.	2
7.RP.2 Recognize and represent proportional relationships between quantities.	2
7.RP.2a Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.	2
7.RP.2b Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.	2
7.RP.2c Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as t = pn.	5
7.RP.2d Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, r) where r is the unit rate.	2
7.RP.3 Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.	2
The Number System	
7.NS.1 Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram.	1
7.NS.1a Describe situations in which opposite quantities combine to make 0. For example, a hydrogen atom has 0 charge because its two constituents are oppositely charged.	1

Continued on next page

Common Core State Standard	***Let's Take Care of the Lo'i* Unit**
7.NS.1b Understand p + q as the number located a distance |q| from p, in the positive or negative direction depending on whether q is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational numbers by describing real-world contexts.	1
7.NS.1c Understand subtraction of rational numbers as adding the additive inverse, p – q = p + (–q). Show that the distance between two rational numbers on the number line is the absolute value of their difference, and apply this principle in real-world contexts.	1
7.NS.1d Apply properties of operations as strategies to add and subtract rational numbers.	1
7.NS.2 Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.	1
7.NS.2a Understand that multiplication is extended from fractions to rational numbers by requiring that operations continue to satisfy the properties of operations, particularly the distributive property, leading to products such as (–1)(–1) = 1 and the rules for multiplying signed numbers. Interpret products of rational numbers by describing real-world contexts.	1
7.NS.2b Understand that integers can be divided, provided that the divisor is not zero, and every quotient of integers (with non-zero divisor) is a rational number. If p and q are integers, then –(p/q) = (–p)/q = p/(–q). Interpret quotients of rational numbers by describing real-world contexts.	1
7.NS.2c Apply properties of operations as strategies to multiply and divide rational numbers.	1
7.NS.2d Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats	1
7.NS.3 Solve real-world and mathematical problems involving the four operations with rational numbers. (Computations with rational numbers extend the rules for manipulating fractions to complex fractions.)	1
Expressions & Equations	
7.EE.1 Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.	3
7.EE.2 Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. For example, a + 0.05a = 1.05a means that "increase by 5%" is the same as "multiply by 1.05."	2

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Common Core State Standard	*Let’s Take Care of the Lo‘i* Unit
7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations as strategies to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. For example: If a woman making $25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or $2.50, for a new salary of $27.50. If you want to place a towel bar 9 3/4 inches long in the center of a door that is 27 1/2 inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.	1, 2
7.EE.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.	3
7.EE.4a Solve word problems leading to equations of the form px + q = r and p(x + q) = r, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?	3
7.EE.4b Solve word problems leading to inequalities of the form px + q > r or px + q < r, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. For example: As a salesperson, you are paid $50 per week plus $3 per sale. This week you want your pay to be at least $100. Write an inequality for the number of sales you need to make, and describe the solutions.	3
Geometry	
7.G.1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.	4
7.G.2 Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.	4
7.G.3 Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.	4
7.G.4 Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.	4

Continued on next page

Common Core State Standard	***Let's Take Care of the Lo'i* Unit**
7.G.5 Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.	4
7.G.6 Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.	4
Statistics and Probability	
7.SP.1 Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.	5
7.SP.2 Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.	5
7.SP.3 Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability. For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the soccer team, about twice the variability (mean absolute deviation) on either team; on a dot plot, the separation between the two distributions of heights is noticeable.	5
7.SP.4 Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations. For example, decide whether the words in a chapter of a seventh-grade science book are generally longer than the words in a chapter of a fourth-grade science book.	5
7.SP.5 Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.	6
7.SP.6 Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability. For example, when rolling a number cube 600 times, predict that a 3 or 6 would be rolled roughly 200 times, but probably not exactly 200 times.	6

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Common Core State Standard	***Let’s Take Care of the Lo‘i*** **Unit**
7.SP.7 Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy.	6
7.SP.7a Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events. For example, if a student is selected at random from a class, find the probability that Jane will be selected and the probability that a girl will be selected.	6
7.SP.7b Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process. For example, find the approximate probability that a spinning penny will land heads up or that a tossed paper cup will land open-end down. Do the outcomes for the spinning penny appear to be equally likely based on the observed frequencies?	6
7.SP.8 Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.	6
7.SP.8a Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.	6
7.SP.8b Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language (e.g., “rolling double sixes”), identify the outcomes in the sample space which compose the event.	6
7.SP.8c Design and use a simulation to generate frequencies for compound events. For example, use random digits as a simulation tool to approximate the answer to the question: If 40% of donors have type A blood, what is the probability that it will take at least 4 donors to find one with type A blood?	6

Unit 1: The Number System

In this unit, we'll learn how to use positive and negative integers, fractions, and decimals to solve problems through exploration of traditional Hawaiian foods and the range of elevation on the Big Island. There are four activities in this unit. *Module 1* involves the use of adding and subtracting integers to help climb a cliff to pick limu. *Module 2* explores temperature changes with different altitudes by multiplying and dividing integers. *Module 3* supports the harvesting of kalo with the help of rational numbers. The final activity is cumulative and incorporates concepts from each of the previous activities in this unit.

Common Core State Standards

Common Core State Standard	Module 1	Module 2	Module 3	Unit 1
7.NS.1 Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram.	X		X	X
7.NS.1a Describe situations in which opposite quantities combine to make 0. For example, a hydrogen atom has 0 charge because its two constituents are oppositely charged.	X		X	X
7.NS.1b Understand p + q as the number located a distance |q| from p, in the positive or negative direction depending on whether q is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational numbers by describing real-world contexts.	X		X	X
7.NS.1c Understand subtraction of rational numbers as adding the additive inverse, p – q = p + (–q). Show that the distance between two rational numbers on the number line is the absolute value of their difference, and apply this principle in real-world contexts.	X		X	X
7.NS.1d Apply properties of operations as strategies to add and subtract rational numbers.	X		X	X
7.NS.2 Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.		X	X	X
7.NS.2a Understand that multiplication is extended from fractions to rational numbers by requiring that operations continue to satisfy the properties of operations, particularly the distributive property, leading to products such as (–1)(–1) = 1 and the rules for multiplying signed numbers. Interpret products of rational numbers by describing real-world contexts.		X	X	X
7.NS.2b Understand that integers can be divided, provided that the divisor is not zero, and every quotient of integers (with non-zero divisor) is a rational number. If p and q are integers, then –(p/q) = (–p)/q = p/(–q). Interpret quotients of rational numbers by describing real-world contexts.		X	X	X
7.NS.2c Apply properties of operations as strategies to multiply and divide rational numbers.		X	X	X
7.NS.3 Solve real-world and mathematical problems involving the four operations with rational numbers. (Computations with rational numbers extend the rules for manipulating fractions to complex fractions.)	X	X	X	X

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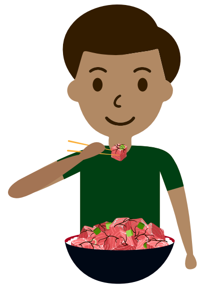
Common Core State Standard	Module 1	Module 2	Module 3	Unit 1
7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations as strategies to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. For example: If a woman making $25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or $2.50, for a new salary of $27.50. If you want to place a towel bar 9 3/4 inches long in the center of a door that is 27 1/2 inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.	X	X	X	X

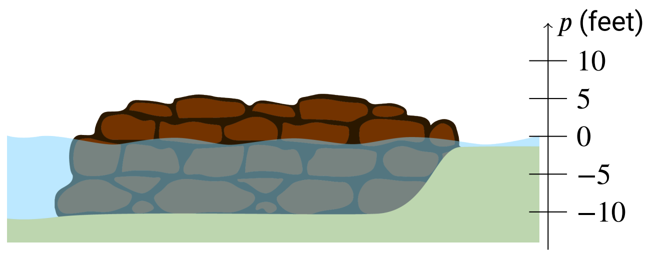
Module 1: Adding and Subtracting Integers *Activity*

Limu (seaweed) is a very important part of Hawaiian life. It is often used for food, decoration, and important ceremonies. Kohu, ʻeleʻele, and līpoa are some of the most delicious types of limu to eat. Limu huluhuluwaena was Queen Liliʻoukalani favorite limu. She loved it so much that she had it brought in from Maui to plant in Oʻahu.



Poke bowls are more delicious with limu!

In this activity, we will carefully climb up and down a rock wall to collect some limu.



1. You are starting at a position of $p = 0$ feet. Below are some descriptions of where you should climb to find limu. Write your position, p, after each description. The first two are done for you.

   (a) Climb up 2 feet from where you started to get the first limu.
   $p = 0 + 2 = 2$

   (b) Now climb down 3 feet to get to the next piece of limu.
   $p = 2 - 3 = -1$

   (c) The next piece of limu can be found if you decrease your position by 6 feet. Where is it located?

   $p = -1 - 6 = -7$

   (d) Add 2 feet to your position to get the next limu. What is your position now?

   $p = -7 + 2 = -5$

   (e) You are too deep in the water to get the next limu so let's go to a position that is "less deep" by subtracting -3 feet. What is your new position?

   $p = -5 - (-3) = -5 + 3 = -2$

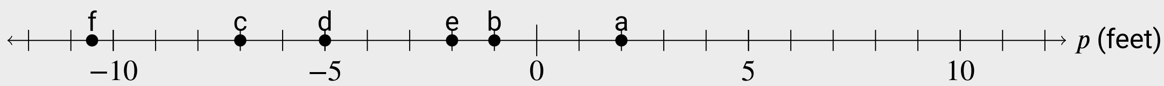
   (f) The final limu requires you to go deeper. So let's go "more deep" by adding -8.5 feet to get to the last limu. What is your final position?

   $p = -2 + (-8.5) = -10.5$

2. Were there any positions that were opposite numbers? If so, what were these numbers?

Yes, the numbers from part a and e were opposite numbers, 2 and -2.

3. Plot and label the positions where you found the six pieces of limu. Label the limu **a-f** based on your answers above. The first two are done for you.



4. Use the number line to help you answer the following questions.

   (a) How many feet apart are the first limu and the last limu?

   The first and last limu are at $p = 2$ and $p = -10.5$ respectively.

   $|2 - (-10.5)| = 12.5$

   The first and last limu are 12.5 feet apart.

   (b) How many feet apart are the first limu, and the limu in part 1e?

   The limu in part 1e is at $p = -2$.

   $|2 - (-2)| = 4$

   The first limu and the limu in part 1e are 4 feet apart.

   (c) What if you wanted to return to where you started $p = 0$ after grabbing the last limu? What number do you need to add to get to $p = 0$?

   The last limu is at $p = -10.5$. To get to $p = 0$ we need to add 10.5.

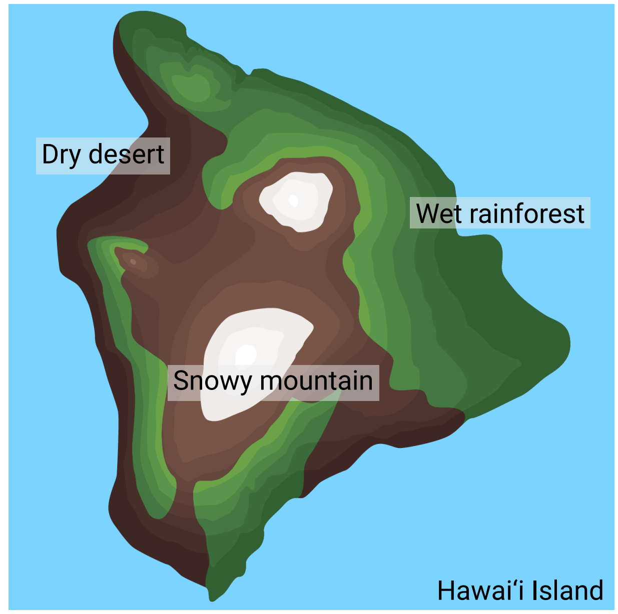
   (d) Maybe you could have saved time by starting at the bottom of the rock wall and collecting limu on the way up. Using the letters a-f, order the limu from lowest to highest.

   In order from the lowest to the highest altitudes, the limu are at: f, c, d, e, b, and a.

5. Share a time when you have eaten something that you found outside.

Module 2: Multiplying and Dividing Integers *Activity*

Hawai'i Island has 8 of the 13 possible climate zones. Ranging from tropical beaches to dry deserts to snow covered mountains, it is a truly beautiful and unique place. Mauna Kea is the tallest mountain in Hawai'i at $13,796$ feet (ft) above the sea level.



In an ahupua'a on Hawai'i, there is a temperature change of about -3°F for every $1,000$ ft increase in elevation.

1. If you went up 1 foot in elevation, what would be the temperature change? Make sure to include a negative sign if your answer is negative. Is your answer a rational number? How do you know?

-3°F $\div$ 1000 ft $= \frac{-3^\circ\text{F}}{1000\text{ ft}} = -0.003\frac{^\circ\text{F}}{\text{ft}}$

If we went up 1 foot, then the temperature would change by -0.003° F. This is a rational number because it can be written as a fraction of two integers -3 and 1000.

2. Imagine it is 84°F at $3,000$ ft above sea level. Fill in the chart to help you answer the following questions. You do NOT need to use your previous answer to fill out this table.

Temperature	Elevation
87°F	$2,000$ ft.
84°F	$3,000$ ft.
81°F	$4,000$ ft.
78°F	$5,000$ ft.
75°F	$6,000$ ft.
72°F	$7,000$ ft.
69°F	$8,000$ ft.

3. If you wanted to cool off, would you go up or down the mountain? Please explain your reasoning.

   Temperature decreases as elevation increases. So you should increase your elevation (go up) to experience a lower temperature.

4. What temperature would you expect at sea level?

   Sea level is at 0 feet. An easy way to find this temperature is to continue the pattern from the table.

Temperature	Elevation
$87°$F	$2,000$ ft.
$90°$F	$1,000$ ft.
$93°$F	0 ft.

   With this pattern, we can see that the temperature at sea level (0 feet) is $93°$F.

5. What temperature would you expect at the top of Mauna Kea? Round the elevation of Mauna Kea to the nearest thousand to estimate your answer. Explain the reasoning for your answer.

   It looks like the temperature changes by $-3°$F every $1,000$ feet, and the highest altitude that we have on our table is $8,000$ feet. Mauna Kea is almost $6,000$ feet taller, so we have to multiply our temperature change by 6.

   $6 \times (-3°\text{F}) = 6 \times (-1) \times (3°\text{F}) = (-1) \times 18°\text{F} = -18°\text{F}$

   We can see that Mauna Kea's temperature is $18°$ colder than the temperature at $8,000$ feet, which is $69°$F.

   $69°\text{F} - 18°\text{F} = 51°\text{F}$

   According to our calculations, the top of Mauna Kea is about $51°$F.

6. Mauna Kea actually starts on the sea floor, which means that most of the mountain is underwater. If it started at sea level, it would be over $33,000$ feet tall! That's taller than the tallest mountain in the world, Mount Everest! What temperature would you expect at $33,000$ feet?

   As we mentioned before, the temperature changes by $-3°$F every $1,000$ feet. $33,000$ feet is $33,000$ more than 0 feet, which we calculate to be at the temperature $93°$F from a previous problem. First, let's figure out how much the temperature changes over $33,000$ feet and then figure out the temperature that we get from changing the sea-level temperature by that much.

   $33 \times (-3°\text{F}) = -99°\text{F}$
   $93°\text{F} - 99°\text{F} = -6°\text{F}$

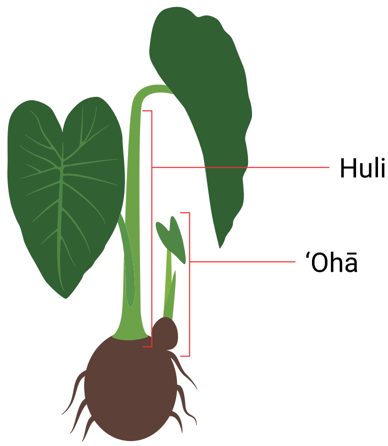
   It turns out that if the base of Mauna Kea is at sea level, then the top of Mauna Kea would be about $-6°$!

7. Kalo (taro) plants typically thrive in temperature between $78°$F and $95°$F. If you were to build a lo'i (taro garden), what elevation would you make it at? Please explain your reasoning.

   According to our data, at sea level, the temperature will be $93°$ F and at an altitude of $5,000$ feet, the temperature drops to $78°$ F. So, it would make sense to plant kalo between sea level and $5,000$ feet.

Module 3: Rational Numbers *Activity*

The kalo plant has been very important to the people in Hawai'i for a long time. Whether it is for a graduation party, a family dinner, or a religious offering, the kalo is still a staple for Hawaiians. So why don't more people plant it? Well, kalo is difficult to grow and reproduce after it is harvested. Most plants will give you hundreds or thousands of seeds that might grow into new plants, but not kalo. Instead, to regrow kalo, you must start with a healthy plant. Next, you'll cut off and replant a small part of it. Usually, you have to cut off the huli, or the top part of the kalo where the leaves begin. Sometimes, if you are lucky, you also get a ʻohā, which is a like a baby kalo that grows out of a bigger kalo. By planting a huli or a ʻohā and taking care of it for about a year, you might end up with a new kalo.



The parts of a kalo that can be replanted

Uncle Ikaika has a large farm, but he is only using 0.5 acres of it to grow kalo. His nephew has a graduation party next year, and he wants to grow more kalo for the party.

1. Uncle Ikaika needs to plant more kalo, so he uses all the huli that he has saved to grow $1/10$ acres of more kalo. How many acres of kalo does Uncle Ikaika have now?

$$\begin{aligned} 0.5 + \tfrac{1}{10} &= 0.5 + 0.1 \\ &= 0.6 \end{aligned}$$

Uncle Ikaika now has 0.6 acres of kalo.

2. Uncle Ikaika's neighbor has a much bigger farm, and he wanted to help by donating some of his ʻohā to Uncle Ikaika's. With these donations, Uncle Ikaika is able to grow 35% more kalo than he had in part 1! How many acres of kalo does Uncle Ikaika have now?

$$\begin{aligned} 35\% \times 0.6 &= 0.35 \times 0.6 \\ &= 0.21 \\ 0.21 + 0.6 &= 0.81 \end{aligned}$$

Uncle Ikaika now has 0.81 acres of kalo.

3. It's a good thing that he planted so much kalo! At the party, $8/9$ of the kalo was eaten. How many acres of kalo was eaten, and how many acres of kalo does Uncle Ikaika have left?

$$\begin{aligned} 0.81 \times \frac{8}{9} &= \frac{81}{100} \times \frac{8}{9} \\ &= \frac{9}{100} \times \frac{8}{1} \\ &= \frac{72}{100} \\ &= 0.72 \end{aligned}$$

0.72 acres of kalo was eaten.

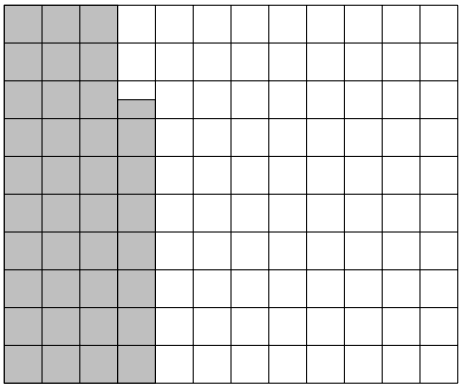
$$0.81 - 0.72 = 0.09$$

0.09 acres of kalo remains.

Unit 1: *Cumulative Activity*

We want to take care of a 120 thousand square feet loʻi in Kanēʻohe, a rainy part of Oʻahu. Unfortunately, two major floods have damaged the loʻi.

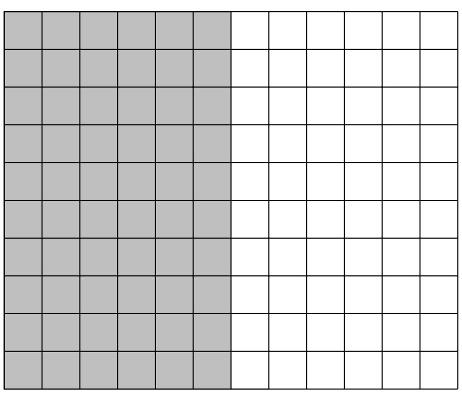
1. The first flood destroyed **$5/16$**th of the loʻi. Below is a grid of 120 squares representing 120 thousand square feet of the loʻi. Color/fill in the squares to represent how many thousand square feet of the loʻi was destroyed after the first flood.



$5/16$ of 120 is 37.5 so we need to color in 37 and a half squares.

$$\begin{aligned}\frac{5}{16}\times 120 &= \frac{5}{2}\times 15\\ &= \frac{75}{2}\\ &= 37\frac{1}{2}\end{aligned}$$

2. The second flood destroyed another **22.5 thousand square feet** of the loʻi. Below is a grid of 120 squares representing 120 thousand square feet of the loʻi. Color/fill in the squares to represent how many thousand square feet of loʻi was destroyed after both floods.



A total of 60 thousand square feet is now flooded.

$$37.5 + 22.5 = 60$$

3. What is the size of the loʻi after the two floods? Give your answer in thousands of square feet.

After two floods, 60 thousand square feet is lost. So, the original 120 thousand square feet is reduced to 60 thousand square feet.

4. You will need a lot of help to take care of the remaining parts of the loʻi. You decide to look for volunteers from your community and your uncle helps you figure out how many volunteers are needed. His tip is to use the **area of the loʻi** (in square feet), and **divide** it by the fraction **$25{,}000/30$**. Based on your answer in part 2 and your uncle's rule of thumb, how many volunteers do you need? Note that the area is in square feet, not thousands of square feet.

$$\begin{aligned} 60000 \div \frac{25000}{30} &= 60000 \times \frac{30}{25000} \\ &= 60 \times \frac{30}{25} \\ &= 60 \times \frac{6}{5} \\ &= 12 \times 6 \\ &= 72 \end{aligned}$$

According to your uncle's rule, we need 72 volunteers.

5. Your uncle's rule might be more complicated than it needs to be. Can you and your partner come up with four (4) other rules that mean the exact same thing?

There are many answers to this question.

$25{,}000/30$ can be reduced to the fraction $2{,}500/3$, so we can also **divide the area by the fraction $2{,}500/3$**. Dividing a fraction is equivalent to multiplying its reciprocal. We can also **multiply the area by the fraction $3/2{,}500$**. In decimal form, $3/2{,}500$ is 0.0012, so, we can **multiply the area by 0.0012**. We can even consider the denominator of the fraction as a division. This means that we can **multiply the area by 3 and then divide it by $2{,}500$**.

6. Come up with some ideas on how we might be able to protect a loʻi from severe rain. Share your ideas with a partner or in the online comment section.

Unit 2: Ratios and Proportional Relationships

In this unit, we'll learn how to recognize and describe proportional relationships and use ratios and rates to solve problems through farming lo‘i kalo and u‘ala (sweet potato). There are three activities in this unit. *Module 4* involves using ratios and proportionality to explore how farmers build Lo‘i. *Module 5* focuses on evaluating how a ‘uala grows through the seasons with the help of proportions and percents. The final activity is cumulative and incorporates concepts from each of the previous activities in this unit.

Common Core State Standards

Common Core State Standard	Module 4	Module 5	Unit 2
7.RP.1 Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. For example, If a person walks 1/2 mile in each 1/4 hour, compute the unit rate as the complex fraction (1/2)/(1/4) miles per hour, equivalently 2 miles per hour.	X		X
7.RP.2 Recognize and represent proportional relationships between quantities.	X		X
7.RP.2a Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.	X		X
7.RP.2b Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.	X		X
7.RP.2d Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, r) where r is the unit rate.	X		X
7.RP.3 Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.		X	X
7.EE.2 Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. For example, a + 0.05a = 1.05a means that "increase by 5%" is the same as "multiply by 1.05."		X	X
7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations as strategies to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. For example: If a woman making $25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or $2.50, for a new salary of $27.50. If you want to place a towel bar 9 3/4 inches long in the center of a door that is 27 1/2 inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.		X	X

Module 4: Ratios and Proportionality *Activity*

Turning undisturbed ground into a kalo loʻi takes a lot of work.

First, you have to pull all of the weeds out. Then, you need to stomp until the unwanted plants die, and the dirt turns into mud from the moisture in the ground. Then, you have to push the mud into mounds. If you do it correctly, the space around the mound will start to pick up water. Only then can you begin planting your kalo.

Building a kalo mound in a loʻi

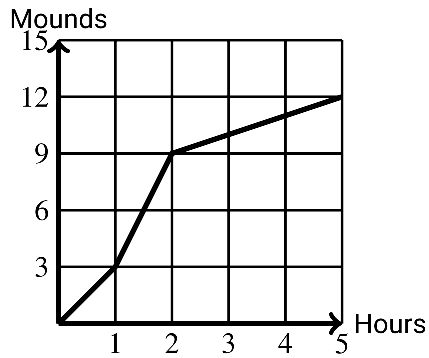
The amount of time it takes to build a loʻi often depends on how skilled the farmer is. However, it can also depend on the location of the loʻi. Let's take a look at a few farmers who are building a loʻi from scratch. We will pay attention to rate that they make a mound for the kalo.

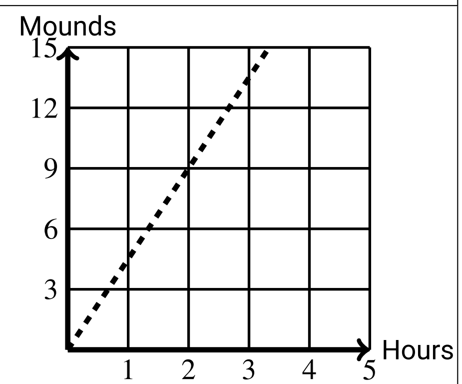
Farmer	**Kawika**
Location	Kapolei
Loʻi building	Kawika can build 10 mounds every 4 hours.

Farmer	**Kalani**
Location	Waiau
Loʻi building	After t hours, Kalani builds $3.5t$ mounds

<table>
<tr><td>Farmer</td><td>Kekoa</td></tr>
<tr><td>Location</td><td>Waimānalo</td></tr>
<tr><td>Loʻi building</td><td><table>
<tr><td>Hours</td><td>Mounds built</td></tr>
<tr><td>0</td><td>0</td></tr>
<tr><td>1</td><td>8</td></tr>
<tr><td>2</td><td>12</td></tr>
<tr><td>3</td><td>14</td></tr>
<tr><td>4</td><td>15</td></tr>
<tr><td>5</td><td>15.5</td></tr>
</table></td></tr>
</table>

<table>
<tr><td>Farmer</td><td>Mina</td></tr>
<tr><td>Location</td><td>Mililani</td></tr>
<tr><td>Loʻi building</td><td><table>
<tr><td>Hours</td><td>Mounds built</td></tr>
<tr><td>0</td><td>0</td></tr>
<tr><td>2</td><td>6</td></tr>
<tr><td>4</td><td>12</td></tr>
<tr><td>6</td><td>18</td></tr>
</table></td></tr>
</table>

<table>
<tr><td>Farmer</td><td>Kami</td></tr>
<tr><td>Location</td><td>Waiʻanae</td></tr>
<tr><td>Loʻi building</td><td>
</td></tr>
</table>

<table>
<tr><td>Farmer</td><td>Lani</td></tr>
<tr><td>Location</td><td>Kāneʻohe</td></tr>
<tr><td>Loʻi building</td><td>
</td></tr>
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1. Most of the farmers were planting at a constant rate. However, the information for **two** of these farmers did not show a *proportional relationship*. Which two farmers were **NOT** proportional? How can you tell? If you are not sure, work with a partner before moving on.

   Proportional relationships first need to start at the origin. At 0 hours, there needs to be 0 mounds made. All of these farmers satisfy this criteria. Secondly, a proportional relationship needs to have constant rate of change. **Kawika** clearly makes mounds at a constant rate. Expressions that show a constant rate of change look like $mt+b$, where m and b are constant or zero. Thus, **Kalani** shows a constant rate of change. Graphs of constant rates of change look like straight lines. **Lani** makes mounds at a constant rate, but **Kami** does not. When we have tables, we need to check each row to make sure that the rates of change stay constant. **Mina** makes mounds at a constant rate. **Kekoa** does not. We can see that in the first hour, Kekoa made 8 mounds, but in the second hour, he made 4 mounds.

   The two farmers that did not show a proportional relationship are **Kami and Kekoa**.

2. For the other four farmers, what is the unit rate of mounds made per hour? It is okay to answer as a decimal or a simplified fraction.

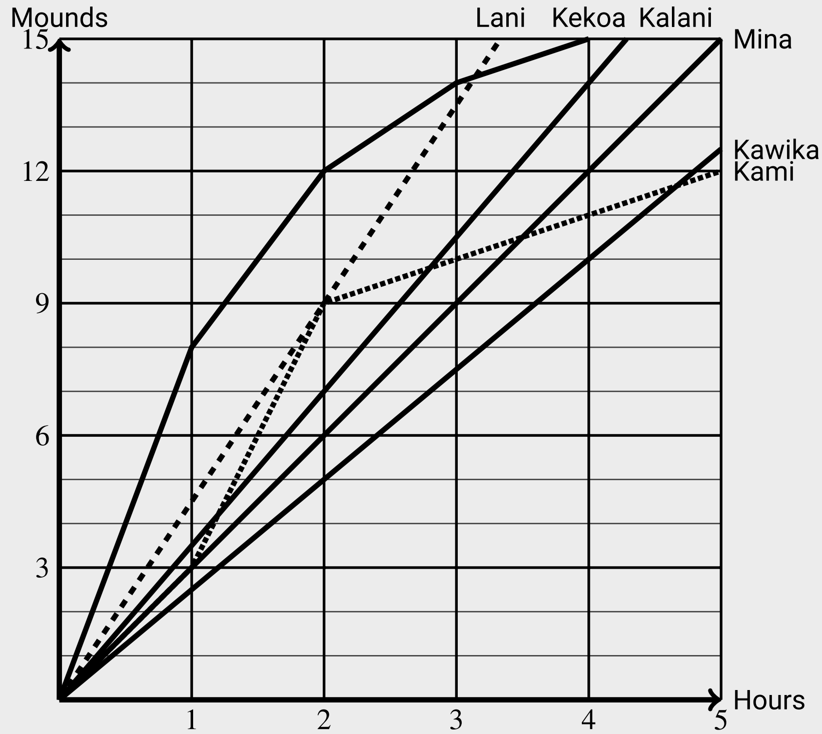
   Kawika makes 10 mounds every 4 hours which reduces to $\frac{5}{2}$ mounds per hour or 2.5 mounds per hour.

   Kalani makes 3.5 mounds per hour.

   Mina makes 6 mounds every 2 hours which reduces to 3 mounds per hour.

   Lani makes 9 mounds every 2 hours which, as a fraction is $\frac{9}{2}$ mounds per hour or 4.5 mounds per hour.

3. Graph and label the data for all six farmers. Two of them have already been done for you. Make sure to draw lines, especially when you are given data from a table. Make sure that your lines do not stop before reaching the edges of the graph.



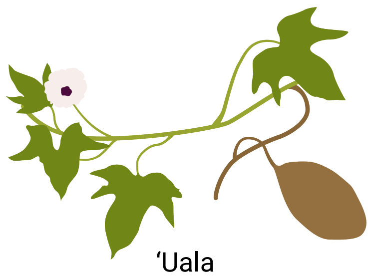
4. Rank the farmers from highest to lowest number of mounds made after 5 hours.

To answer this we need to look at the vertical line on the graph at 5 hours and consider where the farmers are on this line from lowest to highest. We can see the lowest number of mounds come from Kami, then Kawika, and then Mina. Kalani, Kekoa, and Lani do not touch this vertical line so we need to think a little more. Since Kalani and Lani have proportional relationships and will make straight lines, we know that Kalani will make less mounds than Lani after 5 hours. Kekoa's number of mounds happens to be in the given table at 15.5 mounds, which is just a little bit more than Mina. So from lowest to highest number of mounds after five hours, we have **Kami, Kawika, Mina Kekoa, Kalani, and Lani**.

5. Why do you think some environments are harder to build a loʻi on than others? Share and discuss your thoughts with your partner or in the online comment section.

Module 5: Proportions and Percent *Activity*

The ‘uala or sweet potato is a very important vegetable in Hawai‘i. It grows quickly and easily with many uses such as food, medicine, and decoration.



‘Uala

Suppose that you had grown a big batch of ‘uala in your garden that is about 125 square feet in area.

1. This winter, your ‘uala batch is thriving, and its area has grown 20% bigger. How big is your ‘uala batch at the end of winter?

$$\begin{aligned} 125 + 20\% \times 125 &= 1 \times 125 + 0.2 \times 125 \\ &= (1 + 0.2) \times 125 \\ &= 1.2 \times 125 \\ &= 150 \end{aligned}$$

Your ‘uala batch grew to 150 square feet.

2. The following summer was unusually hot, and 20% of the ‘uala died. You told your neighbor that you now have 120 square feet of ‘uala, but he did not believe you. He said “if your 125 square feet batch of ‘uala got bigger by 20% then, smaller by 20%, you should be back to 125 square feet.” Can you explain why you are right and your neighbor is wrong? Be sure to calculate how much ‘uala you have now, and show your work.

Your neighbor is wrong because 20% of the origin 125 is different from 20% of the 150 at the end of winter.

$$\begin{aligned} 150 - 20\% \times 150 &= 1 \times 150 - 0.2 \times 150 \\ &= (1 - 0.2) \times 150 \\ &= 0.8 \times 150 \\ &= 120 \end{aligned}$$

In some villages on Hawaiʻi Island, the ʻuala is considered to be very beautiful. Traditionally, the villagers would gather their best ʻuala and decorate the side of the road when a neighboring chief came to visit. Before the chief arrived, the villagers would put the ʻuala on the right side of the road. Then, they would move it to the other side of the road so the ʻuala would still be on the right side when the chief left.

3. A chief is visiting your village. You decide to give 21 square feet of your best ʻuala that survived the summer to decorate his arrival. What percent of your 120 square feet ʻuala did you give away?

   $21 \div 120 = 0.175 = 17.5\%$

   17.5% of your ʻuala was given to this occasion.

4. Of all the plants that you eat, which one do you think is the prettiest and why? Please share with your partner or in the online comment section.

Unit 2: *Cumulative Activity*

In one year, a typical 12 feet by 12 feet loʻi patch can produce 50 kalo.

1. Assuming that this rate is proportional, write the rate of kalo to square feet as a *simplified* fraction.

$$12 \text{ feet} \times 12 \text{ feet} = 144 \text{ square feet}$$
$$\frac{50 \text{ kalo}}{144 \text{ square feet}} = \frac{25 \text{ kalo}}{72 \text{ square feet}}$$

2. Find the total area of 5 loʻi patches. Remember each loʻi patch is 12 by 12 feet.

$$5 \text{ loʻi patches} \times \frac{144 \text{ square feet}}{\text{loʻi patch}} = 720 \text{ square feet}$$

3. How many kalo can be produced by 5 loʻi patches?

$$5 \text{ loʻi patches} \times \frac{50 \text{ kalo}}{\text{loʻi patch}} = 250 \text{ kalo}$$

4. How many kalo can a 12 by 18 feet patch produce in one (1) year?

$$12 \text{ feet} \times 18 \text{ feet} = 216 \text{ square feet}$$
$$\begin{aligned} 216 \text{ square feet} \times \frac{25 \text{ kalo}}{72 \text{ square feet}} &= 3 \text{ square feet} \times \frac{25 \text{ kalo}}{1 \text{ square foot}} \\ &= 75 \text{ kalo} \end{aligned}$$

5. A farmer named Kaliko has a loʻi patch that is 16 feet wide by 18 feet long. How many kalo can he typically produce in one (1) year?

$$16 \text{ feet} \times 18 \text{ feet} = 288 \text{ square feet}$$
$$\begin{aligned} 288 \text{ square feet} \times \frac{25 \text{ kalo}}{72 \text{ square feet}} &= 4 \text{ square feet} \times \frac{25 \text{ kalo}}{1 \text{ square foot}} \\ &= 100 \text{ kalo} \end{aligned}$$

6. Kaliko wants to break apart and rebuild his loʻi patch from part 5. He wants to produce 25% more kalo. What is the area of new loʻi that he needs?

$$125\% \times 288 = 1.25 \times 288 = 360$$

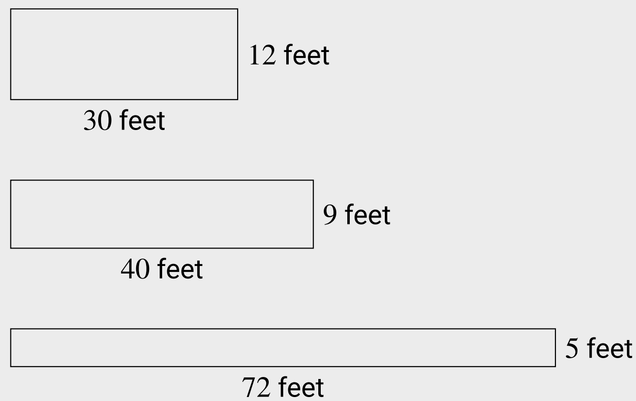
The new loʻi has an area of 360 square feet.

7. Work with a partner and draw at least three possible lo‘i that have the area needed in part 6. Be sure to label the lengths of each side.

If we were to have sides with whole number lengths, then we have 12 possibilities.

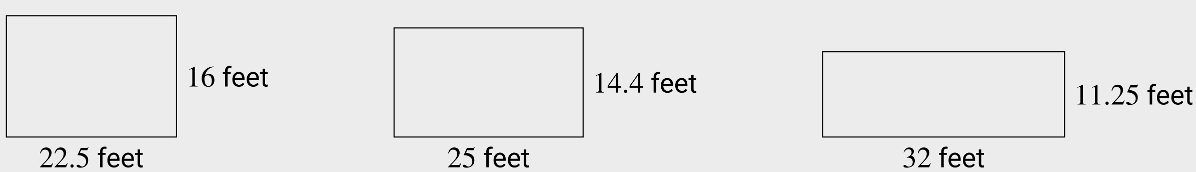
Width (feet)	Length (feet)
1	360
2	180
3	120
4	90
5	72
6	60
8	45
9	40
10	36
12	30
15	24
18	20

Examples:



It must be noted that we did not ask for whole number lengths. So, we can choose any positive number, x as the length of one side and $360/x$ as the length of the other side.

Examples:



8. Most of us have no idea how the food we eat made it to our tables. Describe a fruit or vegetable that you enjoy eating or have eaten recently. Now, imagine and share a story of how this plant might have gotten to your dinner table. Talk about where you think it was planted, who planted it, how it got to you, etc. Share with your partner or in the online comment section.

Unit 3: Expressions, Equations, and Inequalities

In this unit, we'll learn how to write and use algebraic equations and inequalities to solve problems through volunteering at the loʻi, planting sugar cane, and removing invasive fish species. There are four activities in this unit. *Module 6* involves evaluating loʻi volunteers' work hours through expressions and equations. *Module 7* focuses on using inequalities for planning a kō plantation. There are two cumulative activities in this unit. Each of the cumulative activities incorporate concepts from each of the previous activities in this unit.

Common Core State Standards

Common Core State Standard	Module 6	Module 7	Unit 3
7.EE.1 Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.	X		X
7.EE.2 Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. For example, a + 0.05a = 1.05a means that "increase by 5%" is the same as "multiply by 1.05."			X
7.EE.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.	X	X	X
7.EE.4a Solve word problems leading to equations of the form px + q = r and p(x + q) = r, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?	X	X	X
7.EE.4b Solve word problems leading to inequalities of the form px + q > r or px + q < r, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. For example: As a salesperson, you are paid $50 per week plus $3 per sale. This week you want your pay to be at least $100. Write an inequality for the number of sales you need to make, and describe the solutions.		X	X

Module 6: Expressions and Equations *Activity*

A high school on O‘ahu requires their seniors to volunteer in the Hawaiian community. Four senior high school friends decide to volunteer at a lo‘i in Kāne‘ohe (O‘ahu).

Hiapo is the leader of the volunteer group. First, she works 6 hours in the lo‘i. She really likes it, and she decides to work 4 hours each day after that. **Kalua** always works half as many hours as Hiapo and **Kekolu** works a third as many hours as Hiapo. **Maka** works 9 hours on his first day, but he didn't like it as much. So, he decided to work just 2 hours every 3 days after that. This is equivalent to working $2/3$ of an hour per day.

1. Complete the following table summarizing the four volunteers.

Volunteer	Starting hours	Hours per day	Total hours volunteered t days after the starting day
Hiapo	6	4	$6+4t$
Kalua	3	2	$3+2t$
Kekolu	2	$\frac{4}{3}$	$2+\frac{4}{3}t$
Maka	9	$\frac{2}{3}$	$9+\frac{2}{3}t$

2. The school is asking this group to volunteer for a total of 100 hours together.

(a) Find an algebraic expression showing the total number of hours worked by this group t days after the starting day.

To find this expression, we need to add up all four of the expressions that we found earlier and simplify it by combining like terms.

$$\begin{aligned}(6+4t)+(3+2t)+\left(2+\tfrac{4}{3}t\right)+\left(9+\tfrac{2}{3}t\right) &= 6+4t+3+2t+2+\tfrac{4}{3}t+9+\tfrac{2}{3}t\\ &= (6+3+2+9)+\left(4t+2t+\tfrac{4}{3}t+\tfrac{2}{3}t\right)\\ &= 20+8t\end{aligned}$$

(b) Use your expression from part 2a to find how many days it takes for this group to reach a total of 100 volunteer hours.

We need to set our expression from part 2a to 100 and solve for t, which turns out to be 10 days.

$$\begin{array}{rcl} 20+8t & = & 100\\ -20 & & -20\\ 8t & = & 80\\ \div 8 & & \div 8\\ t & = & 10\end{array}$$

3. To prevent students from slacking, the school also requires that each student volunteer for at least 20 hours. Using the answer for t that you found in 2b, check if all four students were able to complete over 20 hours each. Show your work below.

For each of the four expressions, we'll let $t = 10$.

Hiapo

$$\begin{aligned} 6 + 4t &= 6 + 4(10) \\ &= 6 + 40 \\ &= 46 \end{aligned}$$

Kalua

$$\begin{aligned} 3 + 2t &= 3 + 2(10) \\ &= 3 + 20 \\ &= 23 \end{aligned}$$

Kekolu

$$\begin{aligned} 2 + \tfrac{4}{3}t &= 2 + \tfrac{4}{3}(10) \\ &= 2 + \tfrac{40}{3} \\ &= 2 + 13\tfrac{1}{3} \\ &= 15\tfrac{1}{3} \end{aligned}$$

Maka

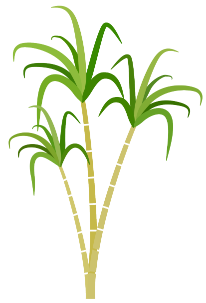
$$\begin{aligned} 9 + \tfrac{2}{3}t &= 9 + \tfrac{2}{3}(10) \\ &= 9 + \tfrac{20}{3} \\ &= 9 + 6\tfrac{2}{3} \\ &= 15\tfrac{2}{3} \end{aligned}$$

Kekolu and Maka did not complete enough hours.

4. Do you do volunteer work or community service? If so, what is it and why do you do it? If you aren't already helping your community, what is a community project that you would be interested in and why? Share with a partner or in the online comment section.

Module 7: Inequalities *Activity*

Kō, or sugar cane, is a giant grass that made life in Ancient Hawaiʻi more enjoyable. It is still a delicious snack that is easy to find and bring on long journeys. The kō makes foods like haupia and kūlolo much sweeter, and it protects the loʻi by holding the soil together during heavy rain and strong winds.



Kō

A group of farmers are planning to plant kō around a loʻi, but first, they must pull out all the weeds in the area. Right now there are 5000 square feet of weeds that need to be replaced by kō. One team of farmers will pull out weeds and, the other team will prepare and plant the new kō.

1. The weed-removal team is able to remove 20 square feet of weeds every 3 hours. Write the expression for the **amount of weeds remaining** (in square feet) after pulling them for t hours. Remember that the farmers start with 5000 square feet of weeds.

   The loʻi starts with $5,000$ square feet of weeds, which changes by $\frac{-20}{3}$ every hour. So, the expression for the area of weeds after t hours would be $5000 - \frac{20}{3}t$.

2. The kō-planting team is able to plant 5.5 kō every hour. Write the expression for the **amount of kō planted** (in square feet) after planting for t hours. Remember that the farmers start with 0 square feet of kō.

   The loʻi starts with 0 square feet of kō and that changes by $+5.5$ every hour. The expression for the area of kō after t hours would be $5.5t$.

3. For each of the following statements, **write the equation or inequality** it describes, then **solve the equation or inequality**.

   (a) The area of **weeds remaining** after t hours of removal is 3000 square feet.

$$\begin{aligned} 5000-\tfrac{20}{3}t &= 3000 \\ -5000 \quad & \quad -5000 \\ -\tfrac{20}{3}t &= -2000 \\ \times 3 \quad & \quad \times 3 \\ -20t &= -6000 \\ \div(-20) \quad & \quad \div(-20) \\ t &= 300 \end{aligned}$$

   (b) The area of **weeds remaining** after t hours of removal is less than 1000 square feet.

$$\begin{aligned} 5000-\tfrac{20}{3}t &< 1000 \\ -5000 \quad & \quad -5000 \\ -\tfrac{20}{3}t &< -4000 \\ \times 3 \quad & \quad \times 3 \\ -20t &< -12000 \\ \div(-20) \quad & \quad \div(-20) \\ t &> 600 \end{aligned}$$

   (c) The amount of **kō planted** after t hours of planting is 1650 square feet.

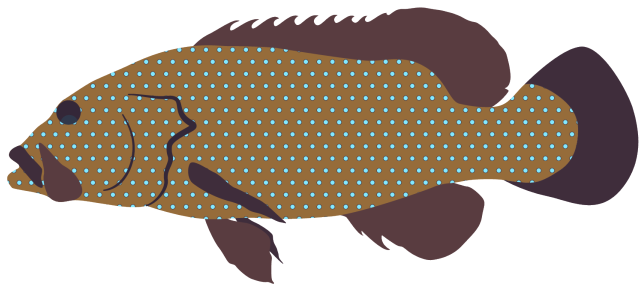
$$\begin{aligned} 5.5t &= 1650 \\ \div 5.5 \quad & \quad \div 5.5 \\ t &= 300 \end{aligned}$$

   (d) The amount of **kō planted** after t hours of planting is greater than or equal to 3300 square feet.

$$\begin{aligned} 5.5t &\geq 3300 \\ \div 5.5 \quad & \quad \div 5.5 \\ t &\geq 600 \end{aligned}$$

Unit 3: *Cumulative Activity 1*

The roi fish, also known as the peacock grouper, is a very invasive fish in Hawaiʻi. In fact, many scientists believe that it is now the top predator along Hawaiʻi's shorelines. It is estimated that in a three-square-mile area off the Kona Coast, the roi will eat about 8.2 million fish per year.



Roi fish

Many local fishermen despise the roi because they are a major threat to the local fish population. Fishermen are also afraid to eat roi because their meat has a reputation of making people sick. To diminish the population of the invasive roi, the State of Hawaiʻi has been arranging spearfishing events called the Roi Roundup.

Keoni and his dad Kawika joined this year's Roi Roundup. They arrive early to the event because they want to do their part in helping the native environment recover.

1. At $4{:}00$ AM, before the Roi Roundup started, Keoni catches 3 pounds of roi. Every hour after $4{:}00$ AM, Keoni catches $\frac{5}{3}$ pounds of roi. Write an expression for the amount of fish caught by Keoni t hours after $4{:}00$ AM.

   If t is the number of hours after $4{:}00$ AM, then Keoni catches $3 + \frac{5}{3}t$ pounds of fish.

2. At $4{:}00$ AM, Kawika catches 5 pounds of roi. Every hour after $4{:}00$ AM, Kawika catches $\frac{3}{2}$ pounds of roi. Write an expression for the amount of fish caught by Kawika t hours after $4{:}00$ AM.

   If t is the number of hours after $4{:}00$ AM, then Kawika catches $5 + \frac{3}{2}t$ pounds of fish.

3. After how many hours will Keoni and Kawika have the same amount of roi?

   When Keoni ($3 + \frac{5}{3}t$) and Kawika ($5 + \frac{3}{2}t$) has the same number of fish, we have that $3 + \frac{5}{3}t = 5 + \frac{3}{2}t$. This equation is true when $t = 12$ (12 hours after $4{:}00$ AM).

$$\begin{array}{rcl}
3 + \frac{5}{3}t & = & 5 + \frac{3}{2}t \\
-3 & & -3 \\
\frac{5}{3}t & = & 2 + \frac{3}{2}t \\
-\frac{3}{2}t & & -\frac{3}{2}t \\
\frac{5}{3}t - \frac{3}{2}t & = & 2 \\
\frac{10}{6}t - \frac{9}{6}t & = & 2 \\
\frac{1}{6}t & = & 2 \\
\times 6 & & \times 6 \\
t & = & 12
\end{array}$$

4. Write an expression for the total amount of roi caught by Keoni and Kawika t hours after 4:00 AM.

Keoni catches $3+\frac{5}{3}t$ fish and Kawika catches $5+\frac{3}{2}t$. Together they catch $8+\frac{19}{6}t$ pounds of fish.

$$\begin{aligned}\left(3+\tfrac{5}{3}t\right)+\left(5+\tfrac{3}{2}t\right) &= (3+5)+\left(\tfrac{5}{3}+\tfrac{3}{2}\right)t\\ &= 8+\left(\tfrac{10}{6}+\tfrac{9}{6}\right)t\\ &= 8+\tfrac{19}{6}t\end{aligned}$$

5. Last year, Keoni and Kawika spearfished until 4:00 PM ($t = 12$) and caught $33\frac{1}{3}$ pounds of fish. This year, they are catching even more. How many hours after 4:00 AM will Keoni and Kawika need to catch at least $33\frac{1}{3}$ pounds of roi?

It will take Keoni and Kawika at least 8 hours

$$\begin{array}{rcl} 8+\frac{19}{6}t & \geq & 33\frac{1}{3}\\ -8 & & -8\\ \frac{19}{6}t & \geq & 33\frac{1}{3}-8\\ \frac{19}{6}t & \geq & \frac{100}{3}-\frac{24}{3}\\ \frac{19}{6}t & \geq & \frac{76}{3}\\ \times 6 & & \times 6\\ 19t & \geq & 152\\ \div 19 & & \div 19\\ t & \geq 8 & \end{array}$$

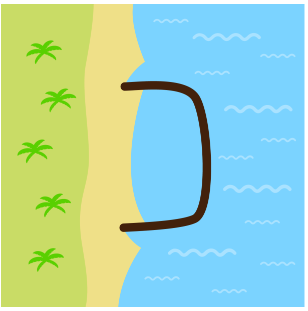
6. Work with a partner to discuss why people are only allowed to spearfish in this event. Why don't they allow other ways of catching fish like using a net or a fishing pole? What are the benefits of only using a spear?

7. With your partner or in the online comment section, share your favorite seafood. Please explain whether or not it is something that is found in the waters of Hawai'i. If it is found in Hawai'i, is it originally from here or was it brought here by people? Feel free to look online for research and pictures (with your teacher's permission).

Unit 3: *Cumulative Activity 2*

Many characters in traditional Hawaiian stories have super powers. For example, Kūʻulakai (also known as Kūʻula) was known to build large fishponds by himself and communicate with the fish in the sea. According to Hawaiian legend, he would often call fish in from the sea to help those in need of fish or call fish away from entire coastlines to punish evil doers.

Let's imagine that Kūʻula is planning to build a rectangular fishpond. One side of the fishpond will be part of the shoreline and the other three sides will be stone walls sticking out into the ocean. He could measure the three stone walls by swimming in the ocean.



Rectangular fishpond

1. Kūʻula measures the length of his first wall by swimming straight out into the ocean. He takes 8 strokes and then swims 3 more feet. If s is the length of his swim stroke (in feet), write the expression for length of the first wall.

   $8s + 3$

2. Next, Kūʻula makes a sharp 90° turn and swims along the shoreline. He takes 10 strokes to measure his second wall. If s is the length of his swim stroke (in feet), write the expression for length of the second wall.

   $10s$

3. Finally, he swims straight back to shore, traveling the same distance that he swam out in the beginning. So, the measurement of his last wall is the same as his first. Write the expression for the total length of all three stone walls.

$$\begin{aligned}(8s+3)+(10s)+(8s+3) &= 2(8s+3)+10s \\ &= 16s+6+10s \\ &= 26s+6\end{aligned}$$

4. The three stone walls will have a total length of 240 feet. How long is Kūʻula's swim stroke, s, in feet?

$$\begin{aligned}26s+6 &= 240 \\ -6 &\quad -6 \\ 26s &= 234 \\ \div 26 &\quad \div 26 \\ s &= 9\end{aligned}$$

   Each of Kūʻula's swim strokes are 9 feet long.

Imagine that a young girl saw the fishpond and wanted to catch a fish. She didn't know how to fish, but after many hours of trying, she finally caught a big one. She's hungry and tired so she carried her fish home. On her way home, she passed by an old man who said that he was really hungry. Without hesitation, the young girl gave away her big fish and went back to the pond, hoping to catch another one before it gets dark.

5. Kūʻula sees this and is impressed by the girl's kindness. He knows the girl is tired and it took a long time for her to catch the fish, so he calls out for the fish to come to his pond so that the girl could easily catch a new fish. The amount of fish in the pond increases by 140% as a result. If f was the amount of fish that were in the pond earlier, in pounds, write an expression for the amount of fish that are in the pond now.

$$\begin{aligned} 100\% f + 140\% f &= 1f + 1.4f \\ &= (1 + 1.4)f \\ &= 2.4f \end{aligned}$$

6. More than 240 pounds of fish are in this pond now and the young girl catches many fish with ease! Write this as an **inequality** with the expression from the part 5.

$2.4f > 240$

7. At least how many pounds of fish, f, used to be in the pond before Kūʻula called for more?

$$\begin{array}{rcl} 2.4f & > & 240 \\ \div 2.4 & & \div 2.4 \\ f & > & \frac{240}{2.4} \\ f & > & \frac{2400}{24} \\ f & > & 100 \end{array}$$

There used to be at least 100 pounds of fish in this pond.

8. If you could talk to an animal, what kind of animal would it be and why? Share with a partner or in the online comment section.

Unit 4: Geometry

In this unit, we'll learn about scale drawings, and two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, and right prisms through Hawaiian quilt making, constructing fish traps, and building an imu. There are four activities in this unit. *Module 8* involves modeling geometric figures by measuring and drawing a kalo quilt. *Module 9* has two activities that focus on circumference, area, and volume while exploring the size and structure of umu. The final activity is cumulative and incorporates concepts from each of the previous activities in this unit.

For some of the activities in this unit, students will need a ruler with centimeters.

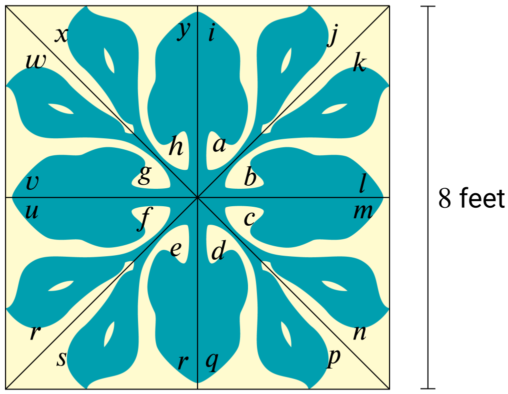
Common Core State Standards

Common Core State Standard	Module 8	Module 9	Unit 4
7.G.1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.	X		
7.G.2 Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.	X		
7.G.3 Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.		X	
7.G.4 Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.		X	X
7.G.5 Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.	X		
7.G.6 Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.		X	X

Module 8: Modeling Geometric Figures *Activity*

For this activity, you will need a ruler with centimeters.

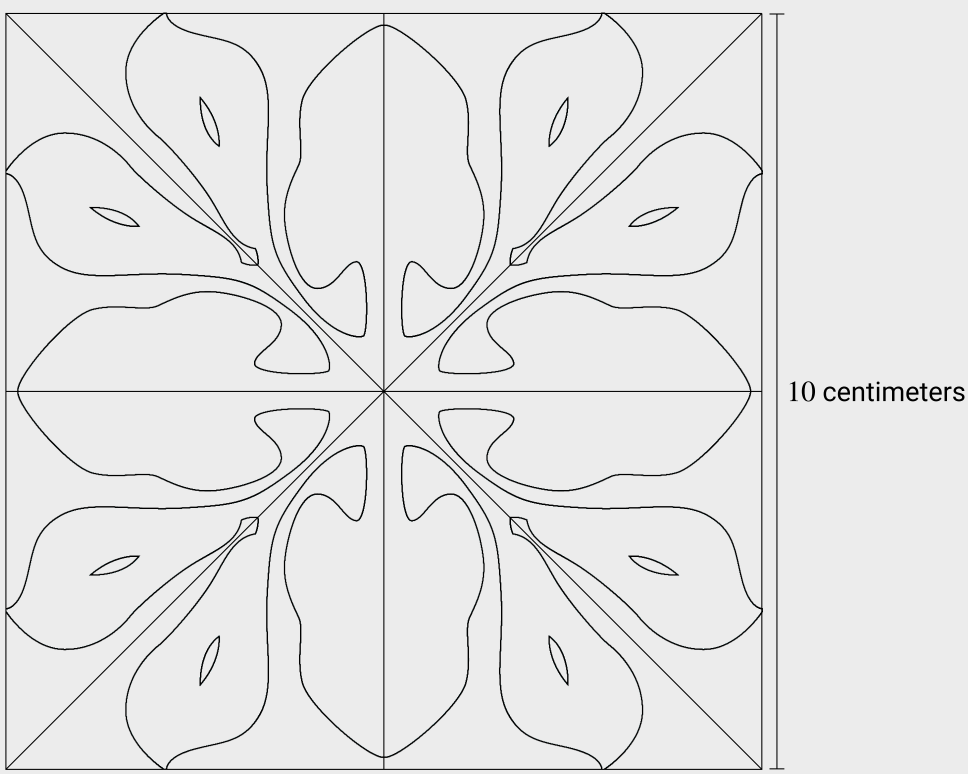
As you know, kalo was a very important plant to the Native Hawaiians. It even made its way into the patterns of Hawaiian quilts. Below is an image of a quilt with some lines showing the symmetry of the design. This particular **square** quilt measures 8 feet by 8 feet in real life.



Hawaiian quilt

1. Use a ruler to sketch a scale drawing of this quilt. For your scale, 2.5 centimeters in your drawing should be 2 feet in real life. (You don't have to draw the pattern perfectly, a rough sketch is fine.)

$$8 \text{ feet} \times \frac{2.5 \text{ centimeters}}{2 \text{ feet}} = 10 \text{ centimeters}$$



2. Find **2** angles that are adjacent to $\angle a$.

   (a) $\angle$ b

   (b) $\angle$ h

3. Find **3 pairs** of vertical angles on the quilt.

   (a) $\angle$ ____ and $\angle$ ____
   (b) $\angle$ ____ and $\angle$ ____
   (c) $\angle$ ____ and $\angle$ ____

   There are four pairs of vertical angles:
   $\angle a$ and $\angle e$, $\angle b$ and $\angle f$, $\angle c$ and $\angle g$, and $\angle d$ and $\angle h$.

4. Find **2 pairs** of complementary angles.

   (a) $\angle$ ____ and $\angle$ ____
   (b) $\angle$ ____ and $\angle$ ____

   There are 120 possible pairs of complementary angles. Any two from the following list will make a pair that works.
   $\angle a$, $\angle b$, $\angle c$, $\angle d$, $\angle e$, $\angle f$, $\angle g$, $\angle h$, $\angle j$, $\angle k$, $\angle n$, $\angle p$, $\angle s$, $\angle r$, $\angle w$, or $\angle x$

5. Find **2 pairs** of supplementary angles.

   (a) $\angle$ ____ and $\angle$ ____
   (b) $\angle$ ____ and $\angle$ ____

   There are 28 possible pairs of supplementary angles. Any two from the following list will make a pair that works.
   $\angle i$, $\angle l$, $\angle m$, $\angle q$, $\angle r$, $\angle u$, $\angle v$, or $\angle y$

6. Looking at the original image, it is divided into 8 isosceles triangles. Each triangle has two sides with the same length of 4 feet, and a third side. For any triangle where two sides have a length of 4 what is the shortest and longest possible length for the third side? Explain your reasoning and sketch a drawing to help with your explanation.

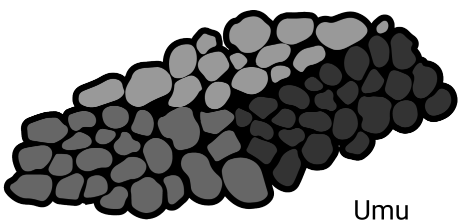
   We can connect the two known sides to make an angle. If we close up the angle until it is almost $0°$, then the third side would have a length of almost 0. If we open up the angle until it is almost $180°$, then the third side would have a length of almost 8. So the third side can have a length between 0 and 8.

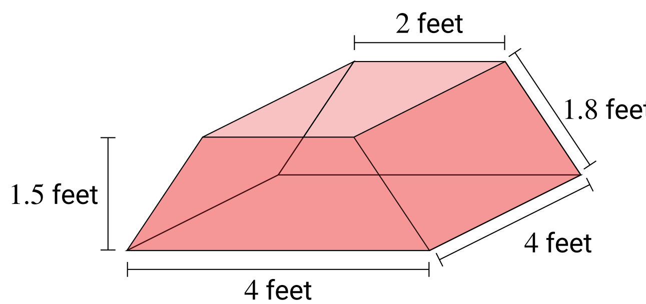
Module 9: Circumference, Area, and Volume *Activity 1*

The umu is a fish trap made out of rocks or coral that is, basically, a man-made home for fish. The umu is a place for fish to find food and protection. When a big enough fish begins to get comfortable in its man-made environment, fishermen can surround the umu with a net to catch the big buggah.

Fishing with an umu

We built an umu that is the shape of a trapezoidal prism.





1. Find the volume of this umu. Give your answer in cubic feet.

This umu is a trapezoidal prism. To find its volume we first need to find the area of its trapezoidal face in the front. This face has an area of 4.5 square feet. Then, we multiply that area by the distance between the front trapezoid and the one in the back, which is 4 feet. We have a final volume of 18 cubic feet.

Trapezoidal face:

$$\begin{aligned}\text{Area} &= \frac{1}{2}(\text{top} + \text{bottom}) \times \text{height} \\ &= \frac{1}{2}(2+4) \times 1.5 \\ &= 3 \times 1.5 \\ &= 4.5\end{aligned}$$

Trapezoidal prism:

$$\begin{aligned}\text{Volume} &= \text{front face} \times \text{distance between front and back} \\ &= 4.5 \times 4 \\ &= 18\end{aligned}$$

2. After a few weeks, plenty of fish had swam into the umu. We found that for every cubic foot of umu, there were 0.3 pounds of fish. Find the total weight of the fish in the umu.

$$(18 \text{ cubic feet of umu}) \times \frac{0.3 \text{ pounds of fish}}{1 \text{ cubic foot of umu}} = 5.4 \text{ pounds of fish}$$

There are a few ways to catch the fish in the umu. If you are working with several friends, you can hold a long net and create a fence around the whole umu. Then, someone can take apart the umu and guide the fish into the net. If you are working with one friend, you can make two openings in the umu. You can hold the net at one opening, while your friend scares the fish from the other opening.

3. You are trying to get the fish on your own, so you decide to cover the entire umu with a large net. Then, one by one, you remove the rocks from the umu until the fish have nowhere left to hide. Find the **total** surface area of the top and the four sides of the umu. (Do not include the bottom in your total.)

There are five sides on this trapezoidal prism. There are two trapezoids standing straight up on the front and the back. There are two rectangles on the sides, leaning into umu. Lastly, there is a rectangle laying flat on the top of the umu.

In part 1, we found that the two trapezoids each have an area of 4.5 square feet. Although the umu is 1.5 feet tall, the slanted edge of the rectangles are 1.8 feet long. So to find the area, we multiply the length of that edge by the perpendicular edge which is 4 feet long. This gives us an area of 7.2 square feet for each of the two sides. The top rectangle has perpendicular edges that are 2 feet by 4 feet long, so it has an area of 8 square feet.

$$\begin{aligned}\text{area of slanted rectangle} &= 1.8 \times 4 \\ &= 7.2\end{aligned} \qquad \begin{aligned}\text{area of top rectangle} &= 2 \times 4 \\ &= 8\end{aligned}$$

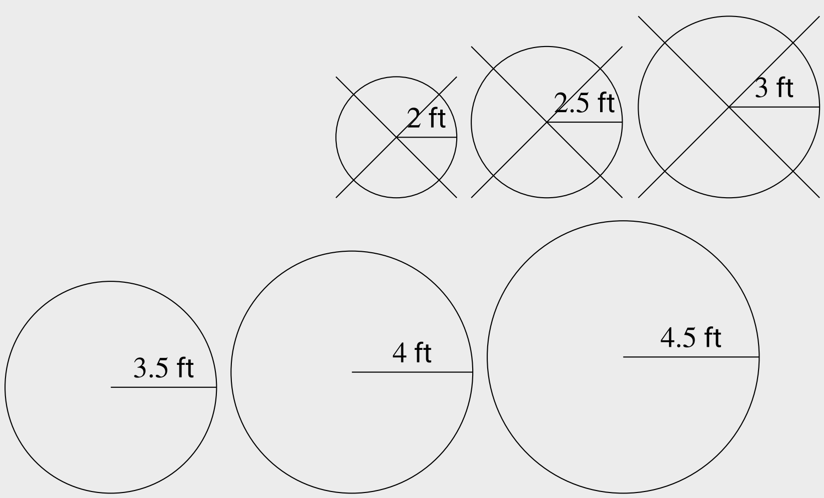
This gives us a total surface area of 31.4 square feet.

$$\begin{aligned}\text{total surface area} &= 2 \times \text{area of trapezoidal side} + 2 \times \text{area of slanted rectangle side} \\ &\quad + \text{area of rectangular top} \\ &= 2 \times 4.5 + 2 \times 7.2 + 8 \\ &= 9 + 14.4 + 8 \\ &= 31.4\end{aligned}$$

4. Below are the sizes of some of the circular nets. Cross out the nets that **do not have enough area** to cover the top and four sides of the umu.

By guessing and checking, we can find that a circle with radius 3 is too small, but a circle with radius 3.5 is big enough.

Area $= \pi r^2$
$\pi(3)^2 \approx 28.3 < 31.4$
$\pi(3.5)^2 \approx 38.5 \geq 31.4$

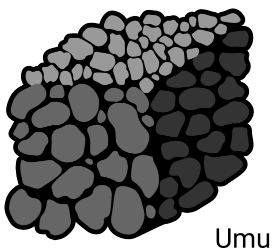


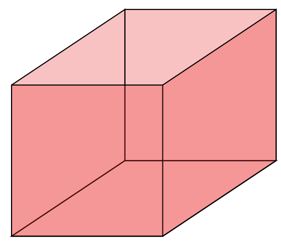
Module 9: Circumference, Area, and Volume *Activity 2*

The umu is a fish trap made out of rocks or coral that is basically, a man-made home for fish. The umu is a place for fish to find food and protection. When a big enough fish begins to get comfortable in its man-made environment, fisherman can surround the umu with a net to catch the big buggah.

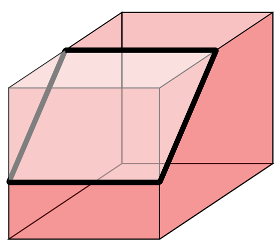
Fishing with an umu

We were able to make a cube-shaped umu before a part of it broke off in the waves.



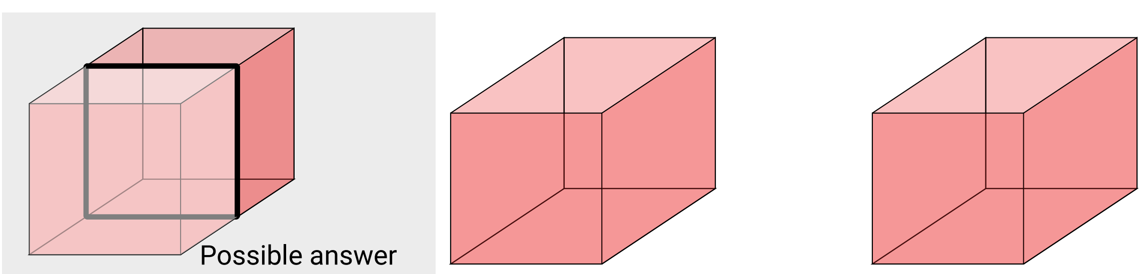


If the top front edge broke off, we would see a **rectangular cross section**.

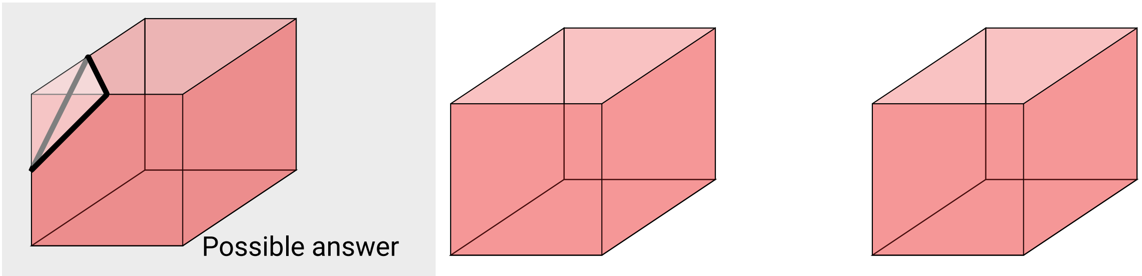


For each of the following questions, three cubes are given to you. **You only have to use one** and may use the other two for practice.

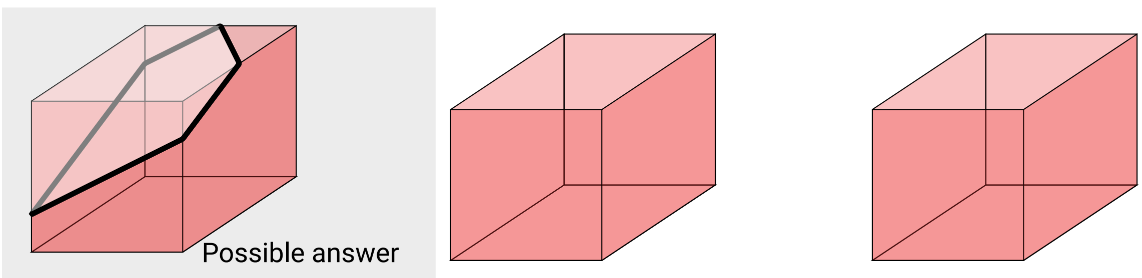
1. How can a piece be broken off and leave behind a **rectangular cross section** that is different from the one shown above? Use four lines to draw this rectangle.



2. How can a piece be broken off and leave behind a **triangular cross section**? Use three lines to draw this triangle.

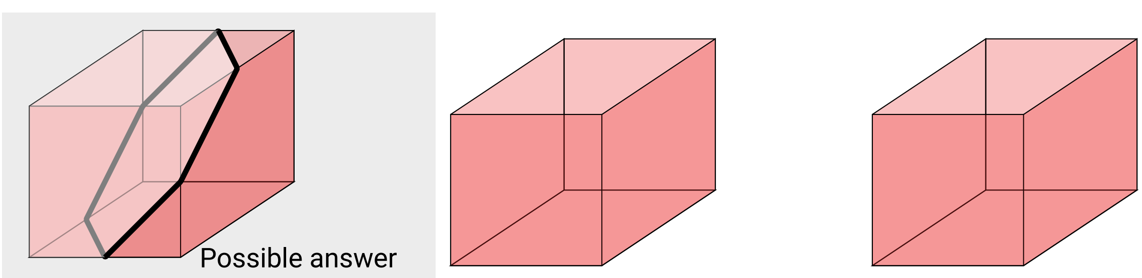


3. How can a piece be broken off and leave behind a **pentagonal cross section**? Use five lines to draw this pentagon.



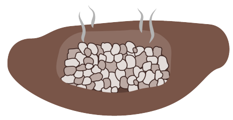
This pentagonal cross section and the hexagonal one in the next part might be difficult for some students to find. It may help to have to students work in groups or have manipulatives (especially a box that that they may draw on).

4. How can a piece be broken off and leave behind a **hexagonal cross section**? Use six lines to draw this hexagon.

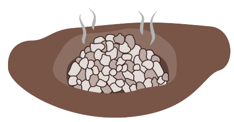


Unit 4: *Cumulative Activity*

In the Hawaiian culture, food was often cooked in underground ovens called imu. The building and use of an imu requires an enormous amount of preparation.

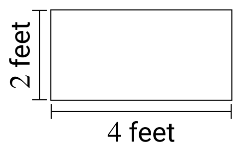


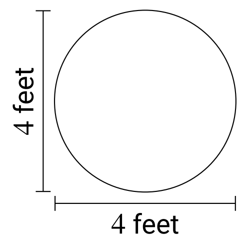
Rectangular imu

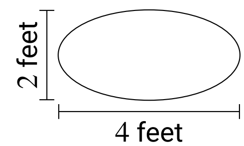


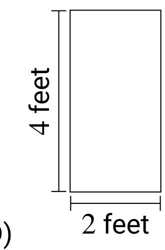
Round imu

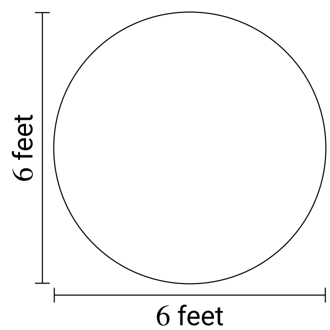
To build an imu, a pit must be dug into the ground. The pit can have a variety of shapes. Here are some drawings and measurements of common pits used for imu.

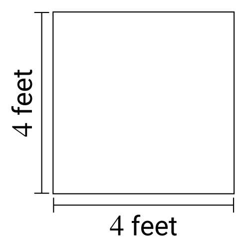
(A)


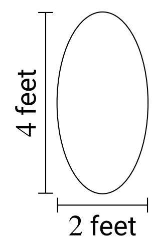
(B)


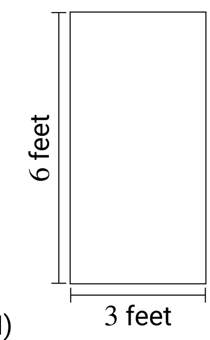
(C)


(D)


(E)


(F)


(G)


(H)


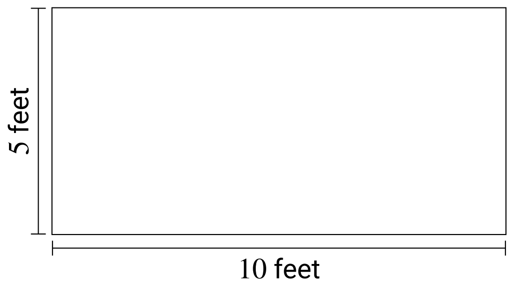
1. Find the perimeter/circumference and area of the two biggest imu in the drawings, (E) and (H). Round to 1 decimal point.

	Perimeter or circumference	Area
Imu (E)	18.9	28.3
Imu (H)	18	18

Imu (E)
Circumference $= 2\pi \times 3 \approx 18.9$
Area $= \pi \times (3)^2 \approx 28.3$

Imu (H)
Perimeter $= 3 + 3 + 6 + 6 = 18$
Area $= 3 \times 6 = 18$

2. Mathematically speaking, which of the previous imu drawings are **similar** to this one:

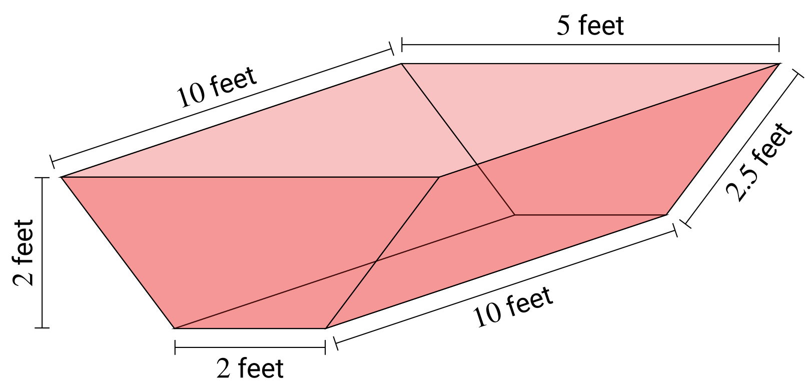


The other shapes that are mathematically similar are the rectangles with one side twice as long as the other. These are Imu (A), (D), and (H).

3. How do you know that the shapes that you chose were similar shapes?

Mathematically similar shapes have the congruent (same) angles and proportional lengths–in this case, one side is twice the length of the other.

After digging the pit, we build a fire to heat up some rocks. The red hot rocks are then arranged to make space available in the hole.



Let's look inside the imu. Our imu is 2 feet deep. The opening of the imu is 5 feet wide by 10 feet long, and the bottom of the imu is 2 feet wide and 10 feet long. The shape turns out to be a trapezoidal prism with the sides sloping in 2.5 feet from the top to the bottom.

4. What is the volume of our imu?

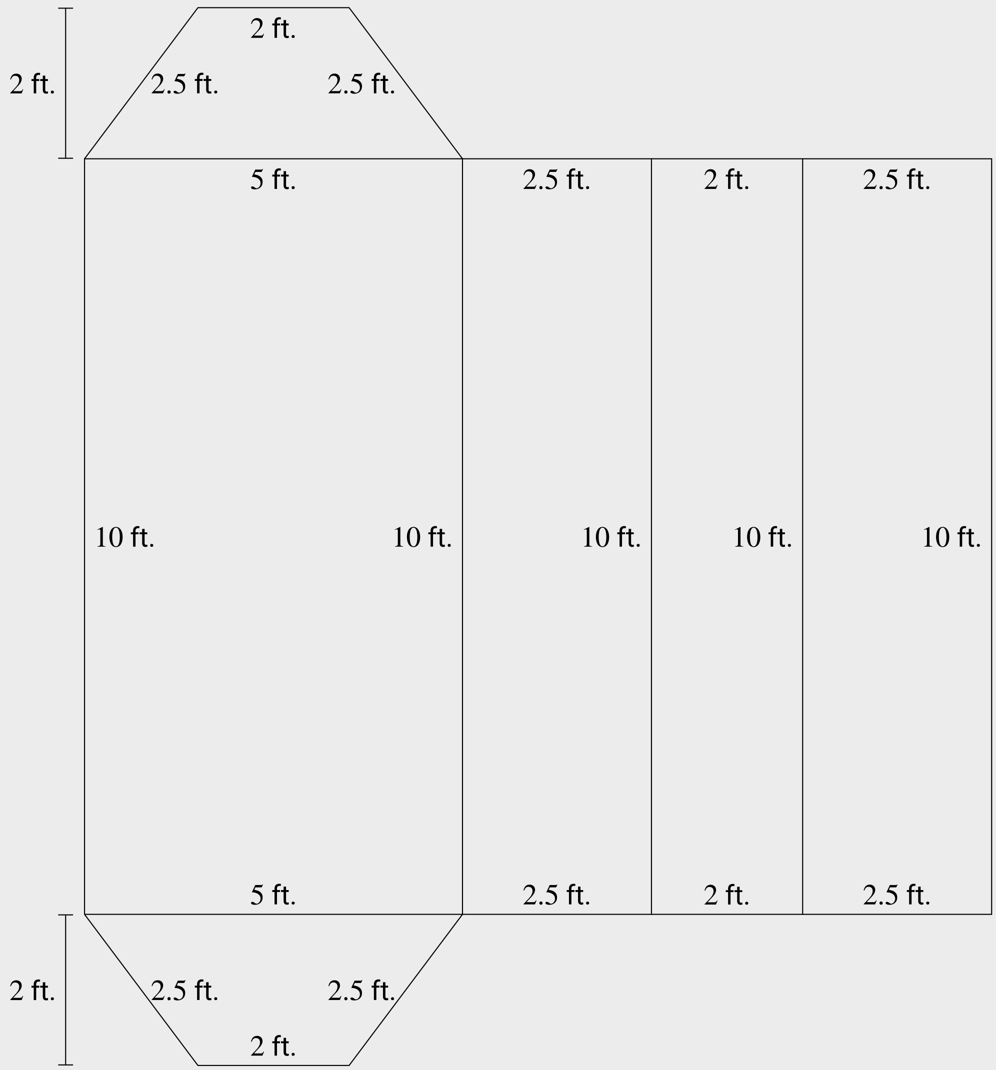
The imu is the shape of a trapezoidal prism. So its volume can be found by multiplying the front trapezoidal face ($\frac{1}{2} \times (5+2) \times 2$) by its distance to the back trapezoidal face (10).

$$\begin{aligned} \text{volume} &= \frac{1}{2} \times (5+2) \times 2 \times 10 \\ &= \frac{1}{2} \times 7 \times 2 \times 10 \\ &= 7 \times 10 \\ &= 70 \end{aligned}$$

The imu has a volume of 70 cubic feet.

5. Do you think an adult pig would fit in this imu? Discuss with your partner and justify your reasoning. What did you decide and why?

6. Sketch this imu as a geometric **net** (include the rectangle at the opening on top), and label each side of the net. What is the surface area of our imu?

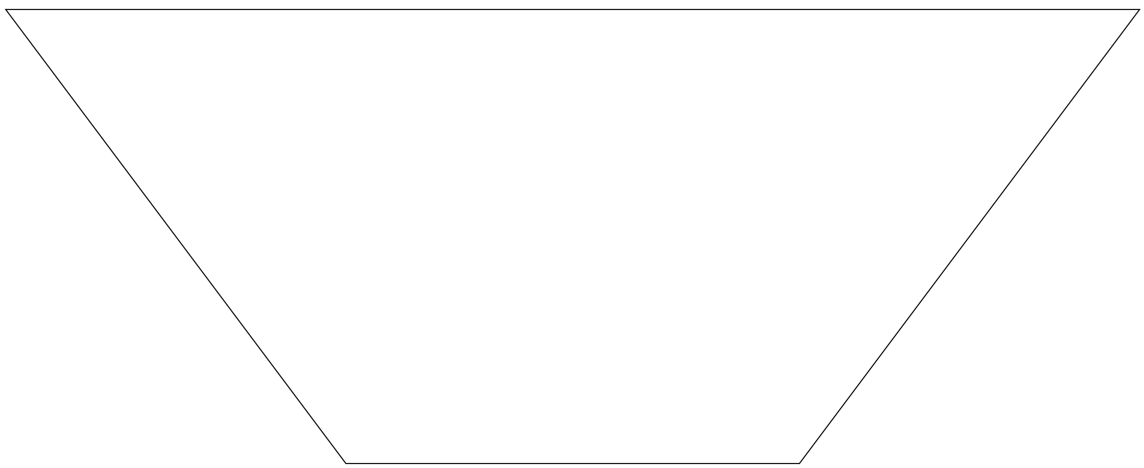


$$\begin{aligned}
\text{surface area} &= 2 \times \text{area of trapezoids} + 2 \times \text{area of sloped sides} \\
&\quad + \text{area of top opening} + \text{area of bottom} \\
&= 2 \times (7) + 2 \times (2.5 \times 10) + (5 \times 10) + (2 \times 10) \\
&= 14 + 50 + 50 + 20 \\
&= 134
\end{aligned}$$

The total surface area is 134 square feet.

Banana tree stumps, ti leaves, and other native plants are placed on the hot rocks first. This green leafy layer produces steam to cook the food, while protecting the food from the rocks. Meat and other foods are placed on top of the green leafy layer. If a large animal like a whole pig is to be cooked, hot rocks are also placed in their belly. Another layer of banana leaves, old lauhala mats, and tarps cover the food to protect it from dirt. A final layer of dirt will help to keep the heat in until all the food has completely cooked.

7. What would you put in this imu? Below is a cross section of the imu. Draw and label each layer with the items above and anything else you would like to put in there.



8. With your partner or in the online comment section, share some of the ideas you came up with in part 7.

Unit 5: Statistics

In this unit, we'll learn how to use statistics to describe data and make conclusions through fishing with the aunties, exploring traditional Hawaiian measures, and tagging fish. There are three activities in this unit. *Module 10* involves evaluating a fish population through the use of random samples and populations. Module 11 focuses on analyzing and comparing data to help farmers with their crops. The final activity is cumulative and incorporates concepts from each of the previous activities in this unit.

Some of the activities in this unit will require a coin and a six-sided die to complete.

Common Core State Standards

Common Core State Standard	Module 10	Module 11	Unit 5
7.RP.2c Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as t = pn.	X		X
7.SP.1 Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.	X		
7.SP.2 Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.	X		
7.SP.3 Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability. For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the soccer team, about twice the variability (mean absolute deviation) on either team; on a dot plot, the separation between the two distributions of heights is noticeable.		X	X
7.SP.4 Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations. For example, decide whether the words in a chapter of a seventh-grade science book are generally longer than the words in a chapter of a fourth-grade science book.		X	X

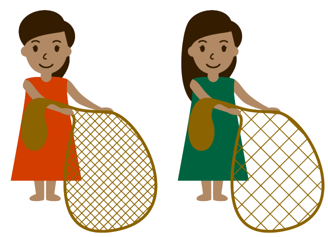
Module 10: Random Samples and Populations *Activity*

For this activity, you will need a coin and a six-sided die.

Aunty Momona and Aunty Manini are studying the fish population on the shores of Nānākuli Beach. They both decide to throw their nets into the water a few times to get a random sample of fish. A random sample will allow them to get a rough idea of the fish sizes in this area.

Halfway through the experiment, they realize something is wrong. Aunty Momona's **smallest fish** is much bigger than **almost all** of Aunty Manini's fish!

Aunty Manini suspects that Aunty Momona's sample is not random, but is a biased sample instead.



Aunty Manini Aunty Momona

1. What do you think is actually going on? (Hint: look at the picture of the two aunties fishing.)

   From the picture it looks like the holes in Aunty Momona's net are very large. So, the small fish are probably not getting caught at all. This would most likely lead to the biased sample.

The Aunts finally figured out what was disrupting the samples and decide to only use the data that Aunty Manini collected. Below is the data; it shows the length of every fish Aunty Manini caught (in inches).

columns (rows)

7	8	5	1	4	6
8	4	8	13	16	7
15	7	10	18	12	6
5	8	5	12	12	4
12	3	7	6	5	5
10	9	10	10	10	8

(heads)

columns (rows)

10	6	17	9	11	16
10	4	13	11	9	6
5	7	2	7	12	9
8	3	10	15	10	11
1	8	3	7	5	9
13	6	7	10	1	5

(tails)

2. Let's use the coin and die to help us choose some random numbers from the data.
   (a) First flip a coin. If it is "heads", use the table on the left. If it is "tails", use the table on the right.
   (b) Roll a die. This number will tell you which row (from the top) to look at.
   (c) Roll a die again. This number will tell you which column (from the left) to look at.
   (d) Write down your numbers. For example, if you got "tails, 3, 4" then you write down "7." This is because on the right (tails) table, 3rd row, 4th column, it shows that Aunty Manini caught a 7-inch fish.
   (e) Repeat these steps until you have collected 10 numbers. Record your data (numbers) on the tables on the following page.

Numbers that the students will obtain will likely be different, but here are the 10 numbers that we got.

Coin flip	First die	Second die	Number
Heads	6	1	10
Heads	4	1	5
Tails	4	6	11
Heads	1	6	6
Heads	3	5	12

Coin flip	First die	Second die	Number
Tails	3	6	9
Heads	6	4	10
Tails	6	6	5
Heads	5	5	5
Tails	4	2	3

3. Find the mean of the 10 numbers you collected in part 2.

With our example numbers, we calculated a sample mean of 7.6.

$$\frac{10+5+11+6+12+9+10+5+5+3}{10} = \frac{76}{10} = 7.6$$

4. The actual mean of all 72 numbers in the table is $8.222....$ How does the mean that you found compare to the actual mean? Is it greater than or less than the actual mean? Is it close to the real mean or way off? Why? How do you think you can get a closer answer? Feel free to discuss with a partner.

Our sample mean of 7.6 is quite close to the actual mean of $8.222....$ Our sample mean is lesser by just 0.6. With a quick inspection of the 72 numbers, there are no obvious outliers or unusual distributions. It might have been unlikely to get 10 unusual samples from this set of numbers. An easy way to get a sample mean that is closer to the actual mean is by taking more samples.

5. Let's go back to the full table of 72 numbers.

   (a) What fraction of the fish in Aunty Manini's random sample are greater than or equal to 15 inches?

   In the table only 6 of the 72 numbers are 15 or greater. This means that $1/12$th of the fish population is likely to be 15 inches or longer.

   $\frac{6}{72} = \frac{1}{12}$

   (b) If you swam by $2,400$ random fish at this beach. How many of them would you expect to be greater than or equal to 15 inches?

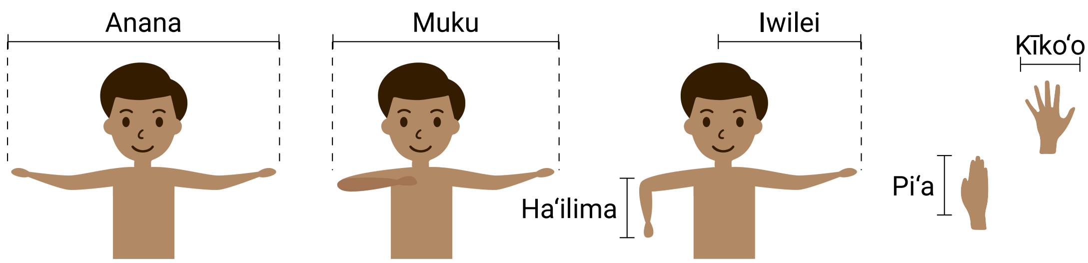
   $1/12$th of the fish population is likely to be 15 inches or longer. This amounts to 200 fish.

   $\frac{1}{12} \times 2400 = 200$

Module 11: Analyzing and Comparing Data *Activity*

In a loʻi, the spacing between the kalo is very important. There are many issues that can occur if they are grown too far apart or too close together. If the kalo are too far apart, you would be wasting land that could be used to grow more plants. If the kalo are grown too close together, it may be hard for the farmer to come into the loʻi and take care of the plants. It would also be easy for bugs and weeds to grow quickly, destroying the kalo.

Traditionally, Hawaiians used their body parts to measure things. In particular, the rows of a loʻi are often spaced one muku apart.



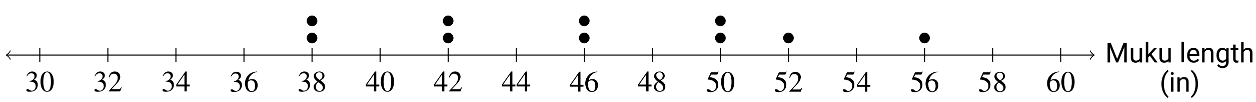
Nā Anakahi Hawaiʻi: The Hawaiian Units of Measurement

Measuring with our body parts is more convenient than carrying around a large ruler. However, it might cause problems if the farmers have very different body sizes.

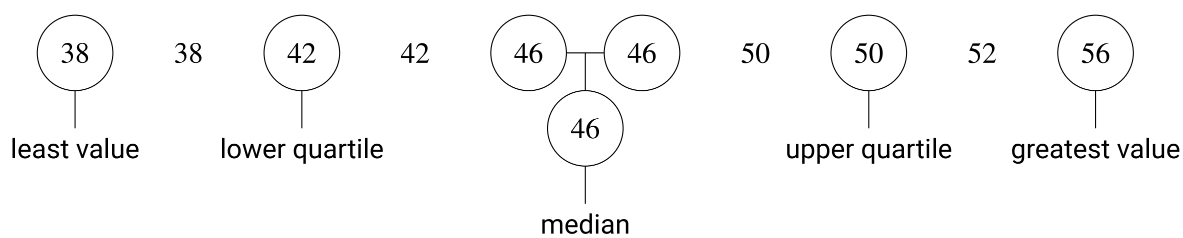
Let's take a look at a group of farmers from **Waiʻanae** and the lengths of their muku in inches (in).

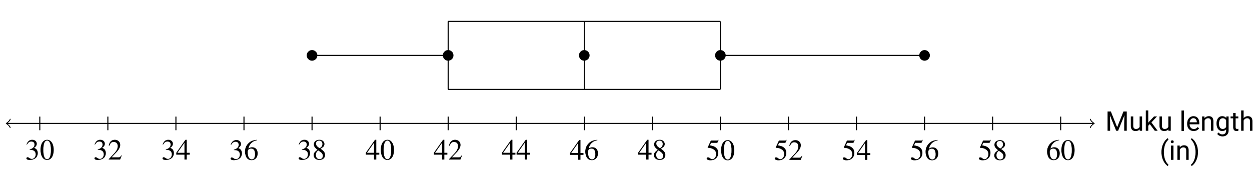
50 , 56, 46, 42, 52, 38, 38, 46, 42, 50

We will first put the numbers on the dot plot.



Next, we can find the least value, or minimum, and greatest value, or maximum. Then we find the median, and the lower and upper quartiles to make a box plot.





Finally, we can see that the mean is 46:

$50 + 56 + 46 + 42 + 52 + 38 + 38 + 46 + 42 + 50 = 460$

$460 \div 10 = 46$

and the mean absolute deviation (MAD) is 4.8.

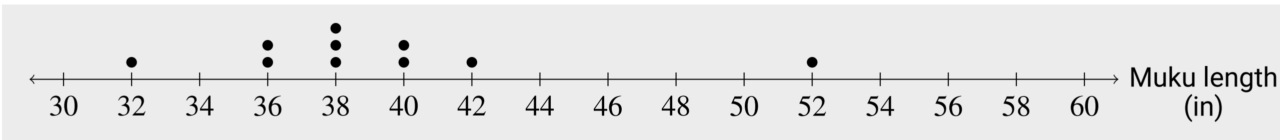
$|50-46|=4$ $|56-46|=10$ $|46-46|=0$ $|42-46|=4$ $|52-46|=6$
$|38-46|=8$ $|38-46|=8$ $|46-46|=0$ $|42-46|=4$ $|50-46|=4$
$4+10+0+4+6+8+8+0+4+4=48$
$48 \div 10 = 4.8$

A group of volunteers from **Kahuku** measured their muku as well, and below is their data.

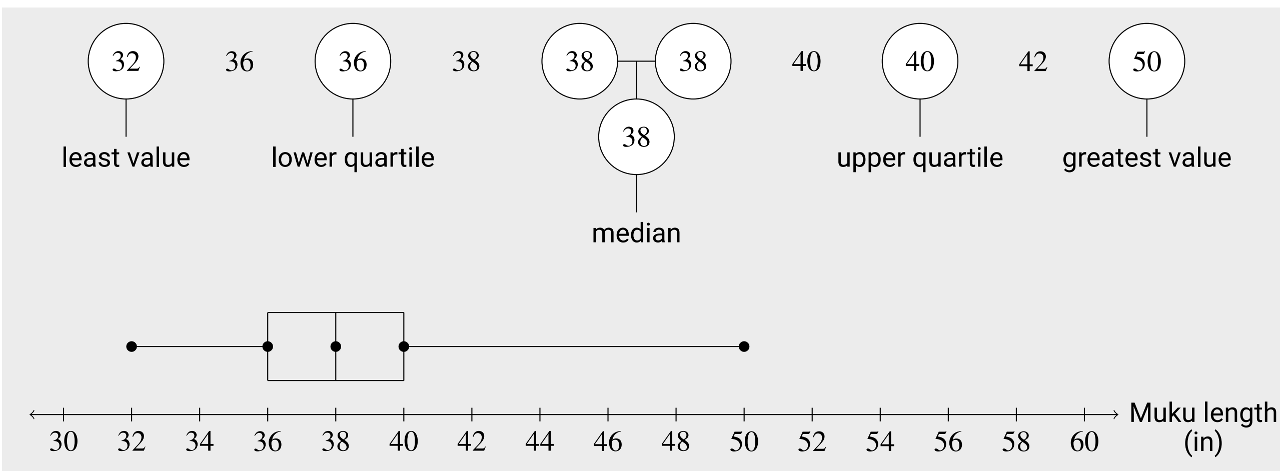
42 , 50, 38, 38, 40, 32, 36, 38, 36, 40

1. Create a dot plot and box plot of the Kahuku data.

 (a) Dot plot



 (b) Box plot



2. Use the plots to compare the Wai'anae farmers with the Kahuku volunteers.

 (a) Compare the shapes of the dot plots.

 The Wai'anae farmer plot has a uniform ("even") shape with little differences between the spacing between each of the quartiles. The Kahuku volunteer plot is less uniform, with a greater amount of lower numbers and one number that is much greater than the rest.

 (b) Compare the centers of the box plots.

 The center/median of the Wai'anae farmer plot is greater than the center/median of the Kahuku volunteer plot. (46 vs. 38).

 (c) Compare the spread, or variance, of the plots.

 The Wai'anae farmer plot contains a greater amount of similar numbers (less spread), while the Kahuku volunteer plot has outliers and more spread.

3. Find the mean muku length of the Kahuku volunteers.

$$\frac{32+36+36+38+38+38+40+40+42+50}{10} = \frac{390}{10} = 39$$

The muku length of the Kahuku volunteers has a mean of 39 inches.

4. How many inches longer is the mean muku length of the Waiʻanae farmers compared to the mean muku length of the Kahuku volunteers.

$|46 - 39| = |7| = 7$

The mean muku length of the Waiʻanae farmers is 7 inches longer than the Kahuku volunteers.

5. Find out how many mean absolute deviations (MADs) Kahuku's mean is from Waiʻanae's mean based on Waiʻanae's MAD. To find this, divide your answer in part 4 by the MAD of the Waiʻanae farmers. Round to one decimal place.

$7 \div 4.8 \approx 1.5$

The mean of the Kahuku volunteers is different from the Waiʻanae mean by 1.5 times the MAD of the Waiʻanae farmers.

6. Find the MAD of the Kahuku volunteers.

$|32-39| = 7 \quad |36-39| = 3 \quad |36-39| = 3 \quad |38-39| = 1 \quad |38-39| = 1$
$|38-39| = 1 \quad |40-39| = 1 \quad |40-39| = 1 \quad |42-39| = 3 \quad |50-39| = 11$
$7+3+3+1+1+1+1+1+3+11 = 32$
$32 \div 10 = 3.2$

The MAD of the Kahuku volunteers is 3.2 inches.

7. Find out how many mean absolute deviations (MADs) Waiʻanae's mean is from Kahuku's mean based on Waiʻanae's MAD. To find this, divide your answer in part 4 by the MAD of the Kahuku volunteers in part 6. Round to one decimal place.

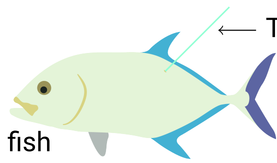
$7 \div 3.2 \approx 2.2$

The mean of the Waiʻanae farmers is different from the Kahuku mean by 2.2 times the MAD of the Kahuku volunteers.

Unit 5: *Cumulative Activity*

The ancient Hawaiians were experts in building highly advanced loko iʻa, or fish ponds, which made significant contributions to their sustainable way of life. The loko iʻa were designed to keep fish in, keep their predators out, and allow fresh water to flow through. Unfortunately, most of these fish ponds have disappeared with time, and fish populations are not as they used to be.

In the 2000's, the Hawaiʻi Department of Land and Natural Resources set out to monitor and learn more about the papio fish and the ʻulua (papio over 10 lbs). Fishermen were recruited to help the project by catching, tagging, and releasing these fish. The initial fish length, type, location, and date tagged was recorded by the fishermen and sent to the state. If a tagged fish was caught again, the new length, date, and location was recorded again and sent to the state. With all this data, the state was able to gather a tremendous amount of information about the ulua and papio, giving us an insight into the health of the fish population.



One method of surveying fish populations involves tagging a species of fish, releasing them, and fishing the same area again at a later date. Scientists can then use proportions to make estimates of fish populations based on how many of the caught fish were tagged.

1. Initially 500 papio were tagged in a fish pond. At a later date, fishermen caught and released 100 papio and only 10 of them had tags. Using this information, estimate how many total papio are in the pond. Please explain your reasoning, and show your work.

   Entire pond 500 tagged : x total Caught fish 10 tagged : 100 total

$$\begin{aligned} \frac{500}{x} &= \frac{10}{100} \\ \frac{500}{x} &= \frac{1}{10} \\ \times(10x) & \quad \times(10x) \\ \frac{5000x}{x} &= \frac{10x}{10} \\ 5000 &= x \end{aligned}$$

   One-tenth of the fish caught are tagged, so it is likely that one-tenth of the entire pond is tagged. There is 500 tagged fish and that is one-tenth of $5{,}000$. Note that for some students it is easier to set up the equation as $\frac{x}{500} = \frac{100}{10}$. This is a great time to talk about how they are mathematically the same or perhaps solve them in both ways.

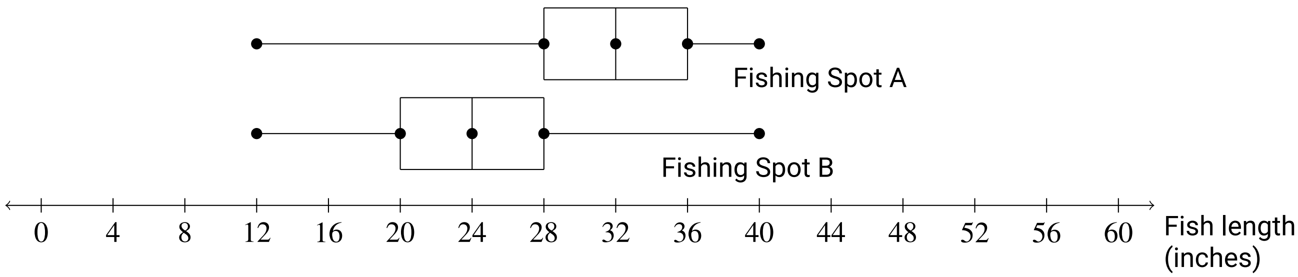
2. If you know that 25% of mullet's in the fish pond are tagged, and you catch 20 mullet's, how many of those 20 would you expect to have tags? Please explain your reasoning.

   $25\% \times 20 = 0.25 \times 20 = 5$

   25% of the fish are tagged so it is likely that 25% of the fish that you catch are tagged as well. 25% of 20 is 5 so we can expect that 5 of the caught mullet were tagged.

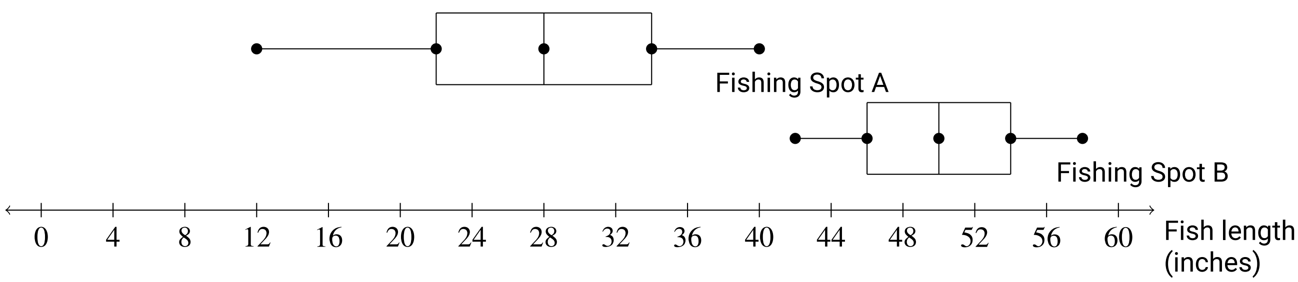
We mentioned that fishermen take measurements when they tag fish. Let's compare some 'ulua/papio data that were collected from different fishing spots around O'ahu.

3. Which of these two fishing spots have more large fish? Explain.



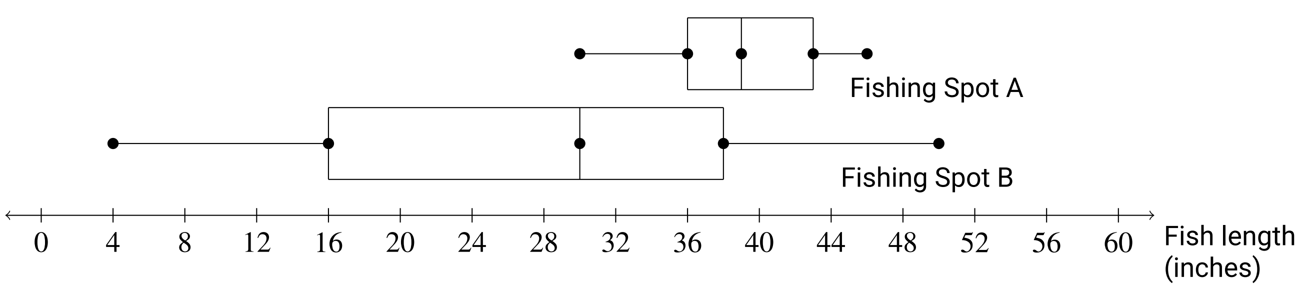
About 75% of the fish in Fishing Spot A are larger than about 75% of the fish in Fishing Spot B. So the answer is Fishing Spot A.

4. Based on the box plots below, which of the two fishing spots would you expect to have more variation in fish sizes? Explain.



The range of Fishing Spot A is about 28, while the range of Fishing Spot B is around 16. Even the interquartile range is larger in Fishing Spot A than B. So the fish in Fishing Spot A has a wider range of fish sizes.

5. Which of these two fishing spots would you rather fish in? Explain what the size of fish you expect to catch and why you chose that fishing spot.



Answers may vary. Some students may prefer Fishing Spot B because it has a larger maximum. So although you'd expect to catch a lot of small fish, you might be able to catch a really big one in Fishing Spot B.

Other students may prefer Fishing Spot A. It's distribution is small, and the overall lengths are quite high. So, you could expect to catch a lot of fish that are a pretty big size. In fact, most of the fish in Fishing Spot A are larger than about half the fish in Fishing Spot B.

6. With a partner or in the online comment section, explain why you think it is important to do experiments like these. What can we learn from them and how can it help make our world a better place?

Unit 6: Probability

In this unit, we'll learn how to use probability to make predictions and study random events through exploration of the traditional Hawaiian drink, ʻawa, cultivating kalo, and making a plate lunch. There are four activities in this unit. *Module 12* involves experimental probability by tossing a slipper. *Module 13* evaluates true kava from false kava with the use of theoretical probability and simulations. There are two cumulative activities in this unit. Each of the cumulative activities incorporate concepts from each of the previous activities in this unit.

For some of the activities in this unit, students will need a slipper or a flip-flop.

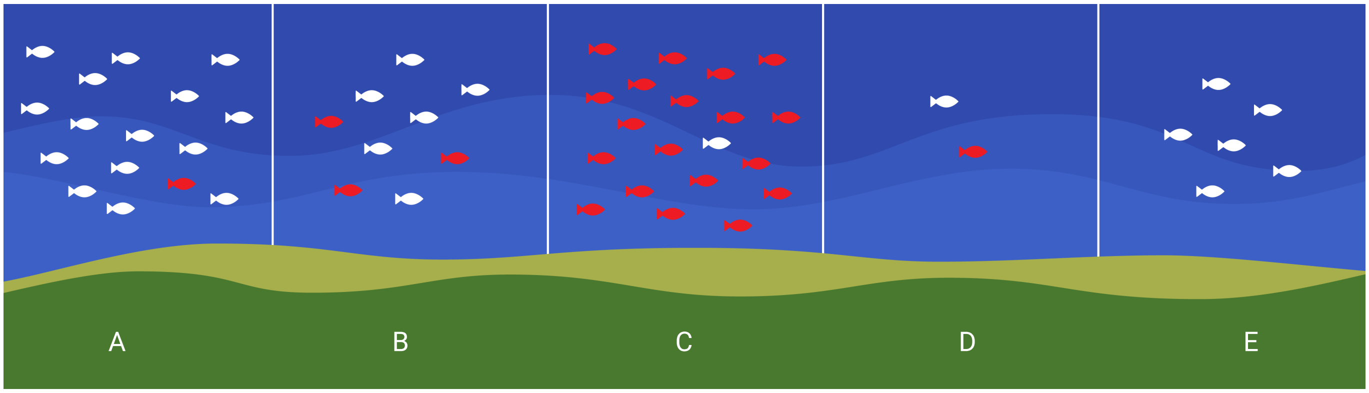
Common Core State Standards

Common Core State Standard	Module 12	Module 13	Unit 6
7.SP.5 Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.	X	X	X
7.SP.6 Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability. For example, when rolling a number cube 600 times, predict that a 3 or 6 would be rolled roughly 200 times, but probably not exactly 200 times.	X		
7.SP.7 Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy.		X	X
7.SP.7a Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events. For example, if a student is selected at random from a class, find the probability that Jane will be selected and the probability that a girl will be selected.	X	X	X
7.SP.7b Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process. For example, find the approximate probability that a spinning penny will land heads up or that a tossed paper cup will land open-end down. Do the outcomes for the spinning penny appear to be equally likely based on the observed frequencies?	X		X
7.SP.8 Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.	X		X
7.SP.8a Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.	X		X
7.SP.8b Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language (e.g., “rolling double sixes”), identify the outcomes in the sample space which compose the event.			X
7.SP.8c Design and use a simulation to generate frequencies for compound events. For example, use random digits as a simulation tool to approximate the answer to the question: If 40% of donors have type A blood, what is the probability that it will take at least 4 donors to find one with type A blood?	X		X

Module 12: Experimental Probability *Activity*

In this activity, you will need a slipper or a flip-flop.

Let's take a look at the fishing spots, A, B, C, D, and E. At these spots, there are white fish and there are red fish.

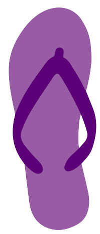


Fishing spots

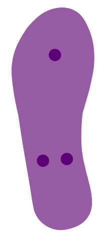
1. Look at the picture above and match each fishing spot with the probability of a red fish being caught. Use a line to connect each fishing spot with one item on the column to the right that best matches that fishing spot. There will be extra ones on the right that do not match with anything.

Fishing spot	Probability that a caught fish would be red
A	Less than 0
	Exactly 0
B	A little more than 0
	Between 0 and $1/2$
C	Close to or equal to $1/2$
	Between $1/2$ and 1
D	A little less than 1
	Exactly 1
E	More than 1

You want to catch red fish, so you go to the spot that gives you the best chance of catching red fish. However, another fisherman arrives at the same time. To be fair, you decide to flip a coin to see who will get to stay at the spot. But... neither one of you have any coins, so you decide to flip something else. What about a slipper?!



Top up



Bottom up

2. Let’s get a slipper and toss it gently in the air twice. Be sure to toss the same slipper two times and not a pair of slippers one time. Then, we will note whether it lands with its top up both times, top then bottom, bottom then top, or bottom up both times. Do this 24 times. Use the table below or one like it to create a frequency chart.

Here is the data that we came up with when we did this activity.

		First toss: Top up	First toss: Bottom up
Second toss	Top up	𝍸 |||	𝍸 |
	Bottom up	𝍸 ||||	|

3. Did each of the possible events occur the same number of times? Why or why not?

The probabilities of having at least one “top up” slipper are similar but not exactly equal. It seems like the slipper we used tends to land with “top up” a lot more often than “bottom up.” This is because the slipper has a very unusual shape. None of the probabilities in our experiment were exactly the same. This is common when we do random experiments.

4. Use your data to calculate the experimental probabilities of each of the four possible events. Write your results as a simplified fraction.

   (a) Top up both times $\frac{8}{24} = \frac{1}{3}$

   (b) Top up first then bottom up $\frac{9}{24} = \frac{3}{8}$

   (c) Bottom up first then top up $\frac{6}{24} = \frac{1}{4}$

   (d) Bottom up both times $\frac{1}{24}$

5. If you were to do this experiment a total of 1200 times, based on your results in part 4, about how many times do you expect "top up both times" as a result? Please show your work.

Our experimental probability tells us that we will have the event "top up both times" occur about $8/24$ or $1/3$ of the time.

$1200 \times \frac{1}{3} = 400$

This tells us that 400 of the 1200 events will result in "top up both times." Note that your numbers will likely be different.

There are several ways to use your slipper to decide who "wins" the fishing spot.

6. If you wanted to make this as **fair** as possible, which of these contests should you choose and why? How do the results of your experiment show that this choice is more fair? (Circle your choice then explain.)

   (a) **Both top up** versus **both bottom up**, otherwise, try again.

   (b) **Top up then bottom up** versus **bottom up then top up**, otherwise, try again.

Both top up versus both bottom up has a probability of $8/24$ versus $1/24$. Top up then bottom up vs bottom up vs top up has a probability of $9/24$ versus $6/24$. The first combination is much more unfair than the second combination. The probabilities of the first combination differ by $7/24$ compared to $3/24$ of the second combination.

So **top up then bottom up** versus **bottom up then top up** is more fair.

7. If you wanted to make this as **unfair** as possible, which of these contests should you choose and why? How do the results of your experiment show that this choice is less fair? (Circle your choice then explain.)

   (a) **Both top up** versus **both bottom up**, otherwise, try again.

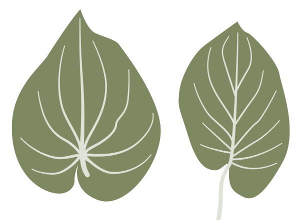
   (b) **Top up then bottom up** versus **bottom up then top up**, otherwise, try again.

Both top up versus **both bottom up** is more unfair.

8. Play the **unfair** game from part 7 with a partner. Did you end up having an advantage? Was it a small advantage or a large one?

Module 13: Theoretical Probability and Simulations *Activity*

Kava is an important plant in Polynesia. Originally from Marquesas Islands and Tonga, kava means "bitter" and is also known as ʻawa in Hawaiʻi and ʻava in Samoa. The root can be chewed or ground up and pounded into a saucy texture. After that, the root is mixed with cold water or other ingredients. Kava can be consumed as part of a meal, used as medicine, or as an important part of a ceremony.

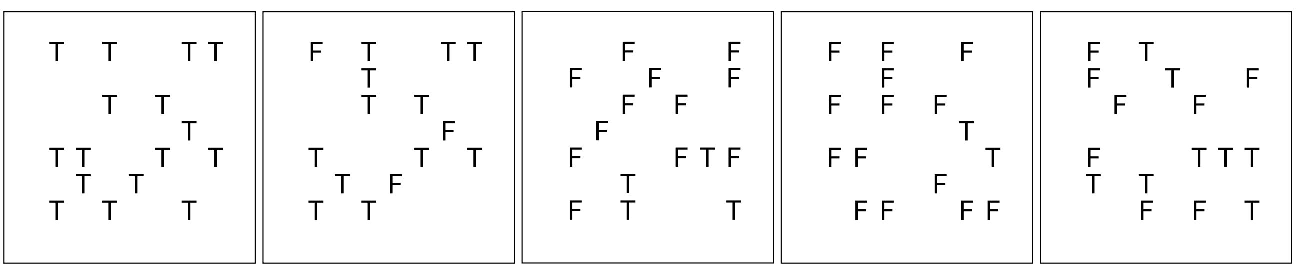


Kava False kava

Unfortunately, there is another plant that looks like kava but that doesn't act like it. This impostor, called the false kava, does not have any of the medical properties of real kava, and it grows much more aggressively. The false kava will spread twice as fast as real kava, covering other plants and taking over entire areas.

Two (2) nature experts and ten (10) student volunteers decide to hike through Nāhiku on Maui to pull out the false kava. However, there are some true kava, and although the experts can easily tell them apart, the volunteers can't.

The experts have found five (5) areas where kava is growing. Here is a rough map of where the true kava (labeled "T") and the false kava (labeled "F") are in each area. Each area had 16 total plants.



Area A Area B Area C Area D Area E

1. For each area, if you were to pull a plant by random, what is the probably that it would be a false kava? Give your answer as a number between 0 and 1. It is okay to give your answer as a simplified fraction.

To answer this, we count the number of false kava and divide it by the total number of plants, 16.

(a) Area A $\frac{0}{16} = 0$

(b) Area B $\frac{3}{16}$

(c) Area C $\frac{12}{16} = \frac{3}{4}$

(d) Area D $\frac{14}{16} = \frac{7}{8}$

(e) Area E $\frac{8}{16} = \frac{1}{2}$

2. Suppose a volunteer randomly picks a plant area to pull plants.

   (a) What is the probability of choosing an area (A, B, C, D, or E) that has false kava?

   Four of the five areas have false kava so the probability of choosing those is $\frac{4}{5} = 0.8$.

   (b) What is the probability of choosing an area (A, B, C, D, or E) that does not have any false kava?

   Only Area A does not have false kava. So the probability of choosing that area is $\frac{1}{5} = 0.2$.

   (c) What is the probability of choosing Area C and pulling a false kava?

   The probability of choosing Area C is $1/5$ and the $3/4$ of the plants in that area are false kava. We can get the probability of choosing Area C and pulling a false kava by multiplying the two probabilities.
   $\frac{1}{5} \times \frac{3}{4} = \frac{3}{20} = 0.15$

The twelve people will split up and work in different areas at the same time. They want to pull out the false kava while leaving as much of the true kava as possible.

- As we mentioned before, there were two experts who can tell the plants apart and ten volunteers who cannot.
- If an area has at least one expert, they will guide everyone who is with them. All of the false kava will be correctly pulled out, leaving the true kava to thrive.
- If an area only has student volunteers, they will randomly pull out plants since they can't tell the difference between the true and the false kava.

3. How would you distribute the experts and volunteers to each area? Explain your reasoning. The experts and volunteers do not have to be distributed evenly among the areas.

   The reasoning behind how the experts and volunteers are distributed is more important than the actual distribution. There are many different ways to do this, and one example is shown below.

   (a) Area A — Area A has no false kava. We do not need to send anyone to work in this area.

   (b) Area B — Area B has a few false kava and a lot of true kava. So in order to remove the correct kava, we need to have one expert in this area. We also send $1/4$ of the remaining volunteers here to help, which is three volunteers.

   (c) Area C — Area C has a lot of false kava. It would be good to have an expert here but we need our last expert for a different area. We can send three volunteers here and have them remove plants randomly. They are more likely to remove the correct ones here by chance.

   (d) Area D — Area D has the most false kava. We use the same plan here as with Area C, and for the same reason.

   (e) Area E — Area E has the same amount of true kava as false kava. So, this area would benefit from having an expert and the remaining three volunteers.

Unit 6: *Cumulative Activity 1*

Kalo is one of the most important crops the Native Hawaiian people cultivated. In modern times, we make kalo into bread, chips, and even mochi. Traditionally, kalo is pounded into poi, but not all kalo varieties can be used in this process. Only wetland kalo and a few varieties of upland kalo can be made into poi. The difference between wetland and upland kalo is that wetland kalo is grown underwater in a loʻi and upland kalo isn't. There have been over 300 different kalo named in Hawaiʻi; about half of which is believed to be the same species, just with a different name.

Two important upland kalo are the piko ulaula and the iliuaua. The piko ulaula is great for making poi, and the leaves of the iliuaua are great for laulau.

Piko ulaula Iliuaua

You have to gather a lot of kalo for an upcoming party, so you ask your neighbors for donations. Your neighbors grow a mix of piko ulaula and iliuaua, which they randomly choose to give you.

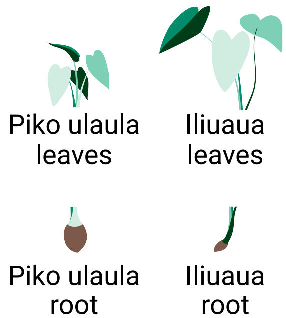
Neighbor A: 30% of the kalo in this loʻi are piko ulaula.
Neighbor B: 60% of the kalo in this loʻi are iliuaua.
Neighbor C: $1/3$ of the kalo in this loʻi are piko ulaula.
Neighbor D: There are 3 iliuaua for every 1 piko ulaula in this loʻi.

1. Order your neighbors from least likely to most likely to give you a piko ulaula. Show your work and explain.

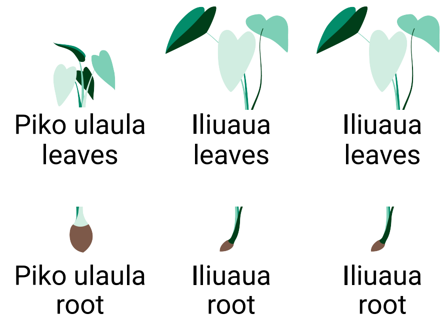
> Neighbor A has 30% piko ulaula, which represents a probability of 0.3.
> Neighbor B has 60% iliuaua, so 40% of his kalo is piko ulaula. This represents a probability of 0.4.
> Neighbor C has $1/3$ piko ulaula, which represents a probability of $0.\overline{3}$.
> Neighbor D has 3 iliuaua for every 1 piko ulaula. So, out of 4 kalo, 1 would be piko ulaula. $1/4$ represents a probability of 0.25.
>
> From least to greatest probability, we have Neighbors D, A, C, and B.

2. Your neighbors are not giving you the whole kalo plant because they need parts of it to grow more kalo. After randomly choosing a kalo (piko ulaula or iliuaua), they will cut it and randomly give you either the leaves or the main root. This means that you will either get piko ulaula leaves, piko ulaula roots, iliuaua leaves, or iliuaua roots.

   Explain why the model on the right is a more useful model than the one on the left for representing the kalo that make up **Neighbor C**’s loʻi.



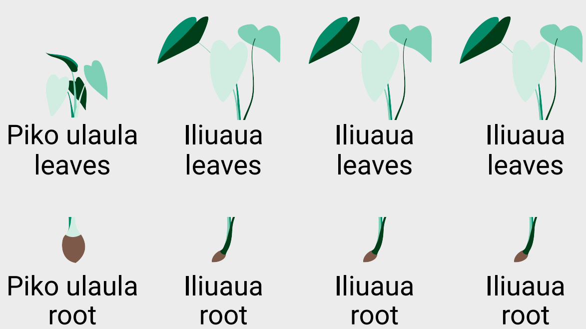
Model



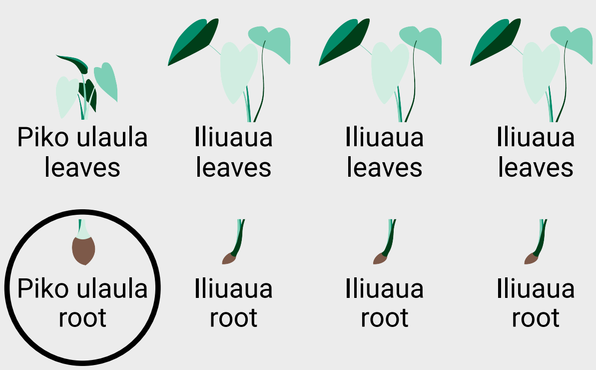
Better model

   The model on the left does not show a higher frequency of iliuaua. The model on the right does show that $1/3$ of the kalo are piko ulaula and $2/3$ of the kalo are iliuaua.

3. Make a similar model to represent the kalo in **Neighbor D**’s loʻi.

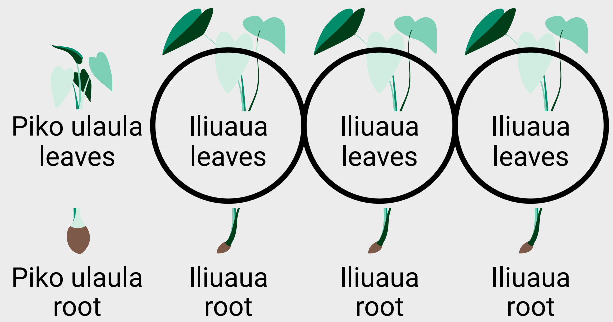


4. The roots of piko ulaula are great for making poi. What is the probability that **Neighbor D** will give you the root of a piko ulaula?



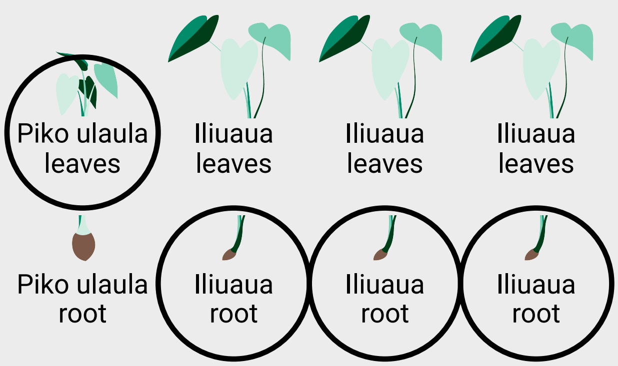
   $1/8$ or 0.125 is the probability of Neighbor D giving you the root of a piko ulaula.

5. The leaves of iliuaua are great for laulau. What is the probability that **Neighbor D** will give you the leaves of a iliuaua?



$3/8$ or 0.375 is the probability of Neighbor D giving you the leaves of iliuaua.

6. If you receive 64 kalo parts from **Neighbor D**, how many of them do you expect to be the leaves of piko ulaula or the roots of iliuaua? Show your work.



$4/8$ or 0.5 is the probability of Neighbor D giving you the leaves of piko ulaula or the roots of iliuaua. Since you received 64 kalo parts, you would expect 32 of them to be the leaves of piko ulaula or the roots of iliuaua.
$0.5 \times 64 = 32$

7. With a partner or in the online comment section, make a hypothesis about why one type of kalo is better for poi and the other type is better for laulau.

Unit 6: *Cumulative Activity 2*

In this activity, you will need a six-sided die and a coin.

We are at a lūʻau and making ourselves a plate lunch. Let's grab a protein, a plant starch, and a drink.

Proteins	Starches	Drinks
Iʻa (fish)	Poi (taro)	Coconut water
Moa (chicken)	ʻUala (sweet potato)	Māmaki tea
Puaʻa (pork)	ʻUlu (breadfruit)	

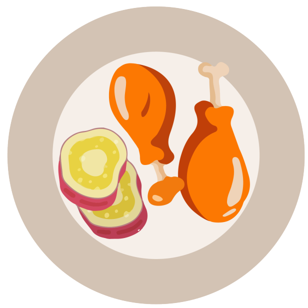


Plate lunch

Let's look at the different kinds of plate lunches that can be made with this menu.

1. Part 1: On the next page, complete the first part of the table by writing all of the possible menu combinations that are missing.
2. Part 2: Let's do an experiment to see what happens when we have to choose our menu randomly.
   (a) Roll a die two times and flip a coin to see which menu combination you would get.

First roll	Protein
1 or 2	Iʻa
3 or 4	Moa
5 or 6	Puaʻa

Second roll	Starch
1 or 2	Poi
3 or 4	ʻUala
5 or 6	ʻUlu

Coin flip	Drink
Heads	Coconut water
Tails	Māmaki tea

   For example, if you roll and flipped a 3, 6, and tails, then you get a moa-ʻulu-māmaki tea combination.

   (b) On the next page, complete the second part of the table by adding a tally for each meal combination that you got in your experiment.

   (c) Repeat until you've gotten 36 meals.

Answers will vary for Part 2.

<table>
<tr><td colspan="3">Part 1: Menu combinations</td><td>Part 2: Random choices</td></tr>
<tr><td>Proteins</td><td>Starches</td><td>Drinks</td><td>Frequency</td></tr>
<tr><td>Iʻa</td><td>Poi</td><td>Coconut water</td><td>||</td></tr>
<tr><td>Iʻa</td><td>Poi</td><td>Māmaki tea</td><td>|</td></tr>
<tr><td>Iʻa</td><td>ʻUala</td><td>Coconut water</td><td>|</td></tr>
<tr><td>Iʻa</td><td>ʻUala</td><td>Māmaki tea</td><td>|||</td></tr>
<tr><td>Iʻa</td><td>ʻUlu</td><td>Coconut water</td><td>||||</td></tr>
<tr><td>Iʻa</td><td>ʻUlu</td><td>Māmaki tea</td><td>||</td></tr>
<tr><td>Moa</td><td>Poi</td><td>Coconut water</td><td>||</td></tr>
<tr><td>Moa</td><td>Poi</td><td>Māmaki tea</td><td>|||</td></tr>
<tr><td>Moa</td><td>ʻUala</td><td>Coconut water</td><td>|</td></tr>
<tr><td>Moa</td><td>ʻUala</td><td>Māmaki tea</td><td>||||</td></tr>
<tr><td>Moa</td><td>ʻUlu</td><td>Coconut water</td><td>||</td></tr>
<tr><td>Moa</td><td>ʻUlu</td><td>Māmaki tea</td><td>|</td></tr>
<tr><td>Puaʻa</td><td>Poi</td><td>Coconut water</td><td>|</td></tr>
<tr><td>Puaʻa</td><td>Poi</td><td>Māmaki tea</td><td>|||</td></tr>
<tr><td>Puaʻa</td><td>ʻUala</td><td>Coconut water</td><td>||</td></tr>
<tr><td>Puaʻa</td><td>ʻUala</td><td>Māmaki tea</td><td>|</td></tr>
<tr><td>Puaʻa</td><td>ʻUlu</td><td>Coconut water</td><td>|</td></tr>
<tr><td>Puaʻa</td><td>ʻUlu</td><td>Māmaki tea</td><td>||</td></tr>
</table>

Key for Part 2:

First roll	Protein
1 or 2	Iʻa
3 or 4	Moa
5 or 6	Puaʻa

Second roll	Starch
1 or 2	Poi
3 or 4	ʻUala
5 or 6	ʻUlu

Coin flip	Drink
Heads	Coconut water
Tails	Māmaki tea

Use the table to answer the questions on the following page.

3. How many menu combinations are possible? There are 18 possible combinations.

4. Let's look at the puaʻa-ʻuala-coconut water combination.

   (a) Out of 36 tries, what is the **theoretical** probability that someone would get this menu combination?

   This is one (1) out of the 18 possible combinations, so we expect that two (2) out of the 36 tries would give this combination.

$$\begin{aligned} \frac{1}{18} &= \frac{x}{36} \\ \times 36 & \quad\ \times 36 \\ 2 &= x \end{aligned}$$

   (b) Based on your results, what is the **experimental** probability that someone would get this menu combination?

   In our experiment, the puaʻa-ʻuala-coconut water combination appeared 2 times.

5. Let's look at the menu combinations that have puaʻa as the protein.

   (a) Out of 36 tries, what is the **theoretical** probability that someone would get this menu combination?

   Puaʻa is in six (6) out of the 18 possible combinations, so we expect that twelve (12) out of the 36 tries would give this combination.

$$\begin{aligned} \frac{6}{18} &= \frac{x}{36} \\ \frac{1}{3} &= \frac{x}{36} \\ \times 36 & \quad\ \times 36 \\ 12 &= x \end{aligned}$$

   (b) Based on your results, what is the **experimental** probability that someone would get this menu combination?

   In our experiment, the combinations with puaʻa appeared 10 times.

6. Let's look at the menu combinations that have māmaki tea as the drink.

   (a) Out of 36 tries, what is the **theoretical** probability that someone would get māmaki tea as their drink?

   Māmaki tea is in nine (9) out of the 18 possible combinations, so we expect that eighteen (18) out of the 36 tries would give this combination.

$$\begin{aligned} \frac{9}{18} &= \frac{x}{36} \\ \frac{1}{2} &= \frac{x}{36} \\ \times 36 & \quad\ \times 36 \\ 18 &= x \end{aligned}$$

   (b) How many times did these combinations actually appear in your experiment?

   In our experiment, the combinations with māmaki tea appeared 20 times.

7. How well does the results from your experiment match with the **theoretical** probabilities? Explain why your results did or did not match.

   Answers will vary. The number of samples is small compared to the size of the sample space, so it is not likely that the experimental and the theoretical probabilities would match exactly. We would expect that out of 36 tries, each event would happen 2 times. Just one more or one less would mean that we an event occurred 50% more or 50% less than what we expected. If we were to repeat the experiment many more times, then the variations between events would likely start to disappear and we would see a nearly uniform distribution.

8. Which of the menu combinations would you prefer? Share with a partner or in the online comment section.